Interim Report on the Jordan River Levee Excavation

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1 Introduction

1.1 Preamble

The Department of Infrastructure, Energy and Resources (DIER) is proposing to construct the Brighton Bypass to take road traffic on the Midland Highway around the townships of Brighton and Pontville in southern Tasmania. The Brighton Bypass Project extends north from the Derwent River to Pontville, mostly alongside the valley of the Jordan River. The project has a 'Northern Section' and a 'Southern Section' to be built concurrently with the proposed Brighton Transport Hub.

In order to investigate the potential impact on Aboriginal heritage values resulting from the proposed development, Tim Stone and Aaron Everett were engaged by GHD Pty. Ltd. to conduct an Aboriginal site survey of the Northern Section. A result of this investigation was the identification of the Jordan River Levee site.

The Jordan River Levee site is situated on the west bank of the Jordan River, near Brighton. The Levee deposit is approximately 1metre deep 500 metres long and 60 metres wide. It is situated on an alluvial floodplain which is ~1000 metres long and ~300 metres wide. The alluvial flood plain contains a surface stone artefact scatter, identified as TASI 10757 (Figure 1.1). The levee deposit associated with TAS 10757 was identified by Stone and Everett (2009), and assessed as having potential to contain a deeply stratified cultural sequence. As a result of this assessment it was recommended that a controlled excavation of a targeted sample of the levee deposit, the JRL site, be undertaken in order to test the character of the site. This testing program was to be undertaken in collaboration with the Tasmanian Aboriginal community via an Aboriginal Heritage Officer (AHO), Aboriginal Heritage Tasmania (AHT) and the Department of Infrastructure, Energy and Resources (DIER).

1.2 Project History

Initial excavation of the JRL site was carried out under the directorship of Rob Paton and Tim Stone, and the supervision of Cornelia de Rochefort, over a period of three weeks from the 3rd August to 24th August 2009. The proposed scope of work and methodology for the archaeological excavation was previously set out by Rob Paton and Tim Stone to Aboriginal Heritage Tasmania (AHT) and Aaron Everett (Aboriginal Heritage Officer). The overall aim of the excavation was to test the potential of the site and recover evidence of changes in site use and lithic technology over time.

However, due to issues relating to appropriate collaboration with the Tasmanian Aboriginal community, the Tasmanian Aboriginal Centre (TAC) requested that works be postponed until the matter could be resolved. As a result, excavation at the site ceased on 24th August 2009. After considerable discussion between various parties a new methodology was submitted by Rob Paton with reference to Stone and Everett (2009), and works resumed at the site, with the endorsement of the TAC, the TALSC, and AHT. The second stage of excavation was undertaken under the directorship of Rob Paton and Cornelia de Rochefort from the 8th to 26th February 2010. Specialist geomorphological services were provided by Dr Tim Stone and Dr Matthew Cupper, while Dr Sophie Collins provided on site supervision and management of artefactual material.

1.3 Limitations

Several limitations and constraints may be identified for this study. First and foremost is the fact that this report is an interim report and by definition will lack key components; the completion of which is necessary to make an informed assessment of the archaeological significance of the levee site. These key components comprise a detailed analysis of the artefact material retrieved from all the trenches, the completion of detailed geomorphological studies and further radiometric dating of the deposits, and the analysis and collation of all data collected during the excavation process.

To date a degree of this analysis has been completed and the archaeological significance of the site may be indicated. Analysis of artefactual material for Trench 2 is presented in this report, while the analysis of the seven remaining trenches is still pending. Furthermore, an assessment of the presence of possible intact living floors may only be completed with artefact conjoin analysis. The current timeframe has not allowed for this degree of analysis and is an important aspect of the JRL site, owing to the great antiquity of the deposits and the potential to retrieve information about Pleistocene human life. Allowing the time to complete a detail statistical analysis of the artefactual material is important and necessary.

Three Optically Stimulated Luminescence (OSL) samples have been taken from Trench 2, and two other samples from from a nearby quarry. The results of this analysis are presented in this report however, further radiometric studies are recommended, specifically the dating of Trench 1 and further samples to be collected from Trench 2. This is necessary in order to refine the temporal framework established for the site and to establish the integrity of the deposits. Given that the age and integrity of the archaeological deposits reported on are fundamental to the significance of the site, the importance of further radiometric studies should be understood.

This discussion is in no way final or comprehensive and may be subject to extensive alteration following detailed analysis and interpretation of the artefact assemblages and further radiometric results. Likewise, a final assessment of the archaeological, or scientific, significance of the site will only be possible once the above results and analysis are known. The assessment of significance presented in this report is an indication, albeit a good one, of significance only.

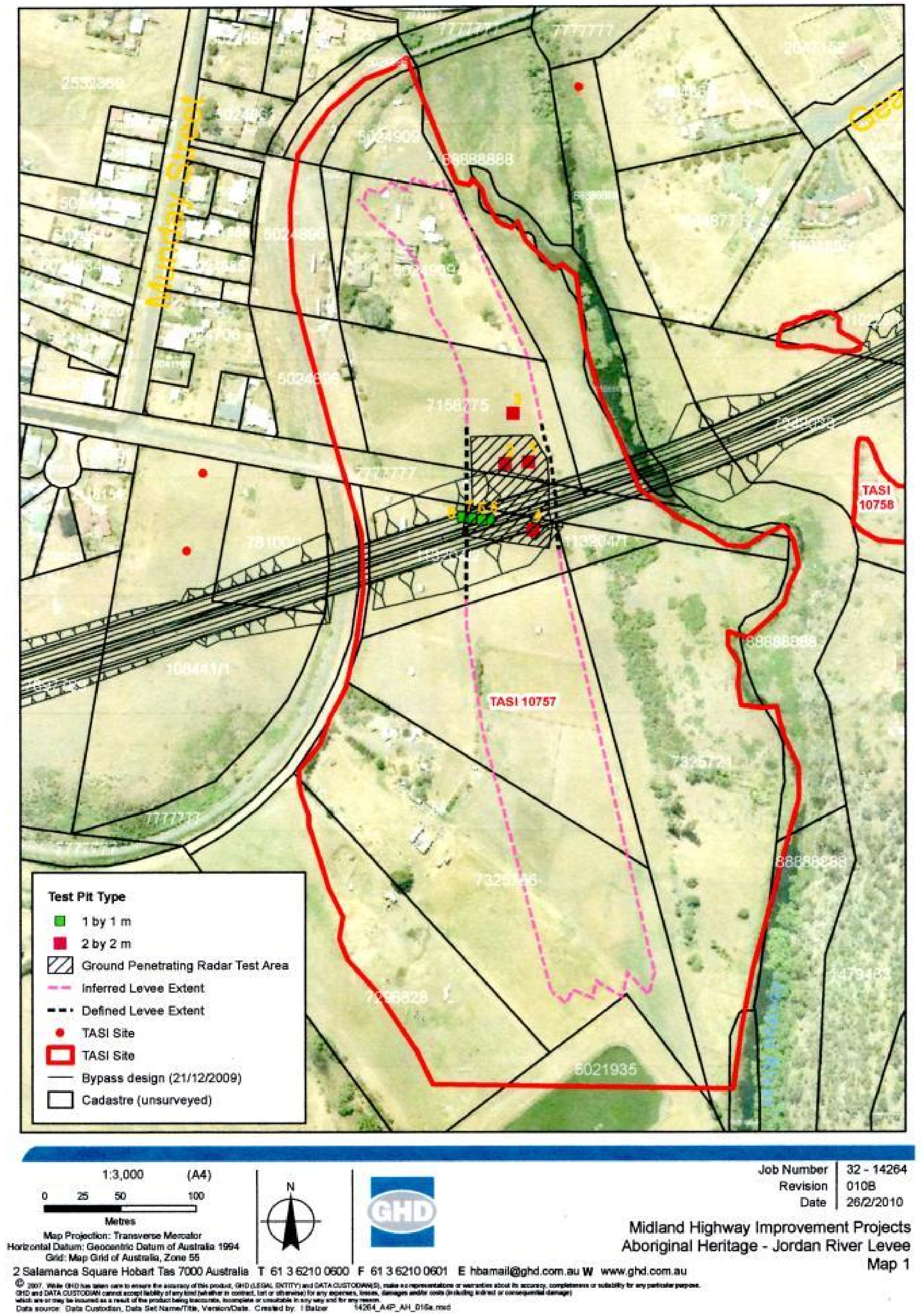

Figure 1.1:Map of the study area detailing TASI 10757 and the known and predicted extent of the Levee site.

1.4 Development Proposal

The development proposal has been described previously in the initial archaeological assessment by Stone and Everett (2009); details of which are reproduced below.

The Brighton Bypass Project is a key component in the Southern Tasmania National Transport Network Investment Program 2007-2015. The proposed Brighton Bypass will become part of the Midland Highway (and Auslink network), connecting the city of Hobart with population centres in the north of the State. Under the project, the towns of Brighton and Pontville will be bypassed, forming a new highway offering a higher level of service. The Northern Section study corridor stretches from the southern outskirts of Brighton to the Midland Highway ~1.1 km north of Pontville. This proposed route will take highway traffic up to 2 km east of the Brighton township across three major roads (Briggs Road, Tea Tree Road, Rifle Range Road), and the South Line Railway. The width of the corridor varies over the ~6 km long route depending on the type of infrastructure required. The widest section is at the northern end to accommodate future ancillary infrastructure. Here it is up to 800 m across. However, most of the corridor is only ~100 m wide.

The concept design provides for a 110 km/h design speed dual carriageway along the majority of the bypass route, incorporating a 4 m wide central median strip, with a central Wire Rope Safety Fence. Initially the development footprint in the vicinity of the levee site was to consist of a carriageway supported by fill over a distance of ~110 m as it approached the proposed Jordan River Bridge. However, subsequent to the archaeological excavation and the preliminary radiometric findings the development proposal was revised and it is now proposed that a bridge which spans the entire levee deposit be built, in order to minimise construction impact to the Aboriginal site.

1.5 Aboriginal Collaboration

Throughout the course of archaeological investigations along the northern section of the proposed bypass route, there has been considerable discussion around the issue of appropriate collaboration with the Tasmanian Aboriginal community. Detail of this consultation process and resolution thereof has been reported on by Paton (2010) in the revised excavation methodology and is attached as an appendix to this report.

Aboriginal consultation was undertaken according to best practice principles in the absence of detailed Aboriginal heritage consultation protocols in Tasmania. Prior to excavation works recommencing on the levee site it was made clear that all archaeological work was to be undertaken with the participation and approval of the Tasmanian Aboriginal Centre and TALSC (refer to Appendix 1: Revised Methodology). Further to this, the entire archaeological and consultation process carried out on site has been recorded on film and will be available on DVD at the time of production of the final report.

Aboriginal heritage officers Aaron Everett and Robert Hughes were present on site during the first stage of excavations from the 3rd to 24th August 2009 and during the second stage of excavations from 8th to 26th February 2010. Leigh Maynard was present for the second stage of excavations. Further to this, Aaron Everett facilitated a community meeting on site, whereby various members of the Aboriginal community toured the site and were given the opportunity to contribute to the consultation process.

It should be stressed that this particular project has been one of the first large scale investigations using new protocols in Tasmania. As such it has attracted more than its fair share of public and media attention. Under such critical scrutiny there is a tendency to only see the things that are wanting in the process and ignore all of the hard work and dedication of many people who have strived to see the heritage studies completed to the highest standard. To go some way to rectifying this matter, the Principal Archaeologist Rob Paton had the following letter printed in the Hobart *Mercury*:

> Dear Editor,
>
> As Principal Archaeologist on this project I have read with interest the articles, letters and comments on the Brighton Bypass archaeology and impasse. Until we archaeologists are able to fully investigate the sites along the Jordan River with Aboriginal consent and participation enough has probably been said about the character and importance of the archaeology. Without the benefit of more information, it is not possible for anyone to make any clear statements about the scientific importance of these sites, other than to say they have "considerable potential" to tell us some things about the deep history of Tasmania.
>
> What has not been mentioned throughout the reporting of this impasse is the considerable personal and professional effort that has been put into this project by Aborigines and Public

Servants. This has impressed me. While I acknowledge disputes remain between these parties, all sides have worked in good faith with the archaeologists for the best outcome. Knowing the pressure of these large development projects, particularly where there is constant media, I have been encouraged by the high moral and professional standards displayed by all. Tremendous efforts have been made without individual acknowledgement by people in the TAC, the Tasmanian Aboriginal Land Sea Council, Aboriginal Heritage Tasmania and DIER to resolve problems where common ground has been often hard to find. I have been deeply moved by the sacrifices people have been willing to make to accommodate disparate views. It gives me confidence that a resolution is close at hand.

Rob Paton
Archaeologist

2 Environmental Background

The purpose of this section is to provide a geomorphological context within which to interpret the results presented in section 5. The geomorphological context comprises a description of how levee bank deposits are formed and also deals with post depositional processes, such as soil formation, which will have influenced the integrity of the cultural deposits.

2.1 Levee Bank Formation and Soil Genesis

Levees are formed from numerous flood deposits that create sinuous ridges of sediments along river banks, and will form on any type of river floodplain that regularly floods. Levees are formed through the process of overbank flood sedimentation. During this process the velocity and depth of water flowing outside of the river channel declines with distance away from the channel, which acts to hydraulically segregate and deposit material that was suspended in the flood waters. The coarsest sediment (usually fine sand and silt) undergoes rapid deposition immediately adjacent to the channel, while the finest sediment (clay) is deposited away from the channel out on the floodplain. Multiple flooding constructs a levee adjacent to the active river channel (Mount 1995; Hudson n.d.). This process is outlined in Figure 2.1.

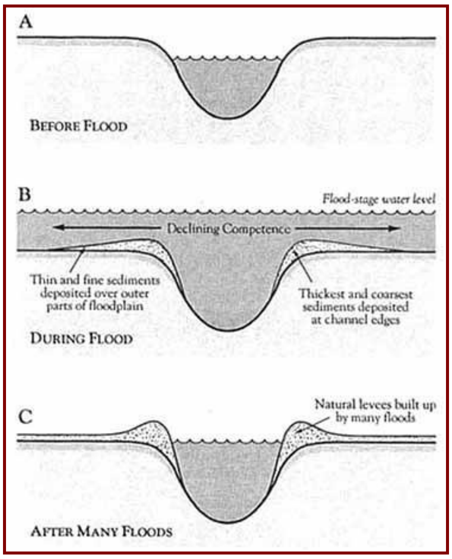

Figure 2.1:Formation of a levee bank deposit (from Mount 1995)

As natural levees are formed through large flooding events, individual strata-sets[1] may be anywhere from centimetres to decimetres thick. These strata-sets decrease in thickness away from the river channel, owing to the rapid lateral loss in stream power and attendant loss in sedimentation rates as one moves away from the river channel. As a result of this, the strata-sets appear wedge shaped in profile. The length of time for the sedimentary structure (strata-sets) to be preserved is dependent on inherited primary factors such as primary material (the material the flood event deposited (sand, silt, clay), sediment particle size (the size of the sand, silt and clay particles), the bedding structures formed (the stratum/ sediment layers), and the pedogenic regime (Hudson n.d.).Generally speaking, the coarser sediment structures are more resilient than the finer clay lamination structures over time.

The pedogenic regime, involves the process of soil formation, whereby a variety of factors interact to alter the original composition and structure of a primary material. In this instance the primary material is the alluvium (sands, silts and clays) deposited as a result of levee formation. Soil forming factors include the combined processes of climatic and biological activity, as modified by topography, acting on parent material over time. Soil formation, or pedogenesis has been termed a poly-genetic process (Johnson 1985), whereby multiple processes act to produce any particular soil type. It should be evident that once soil formation commences it serves to obliterate alluvial structures (strata-sets) formed as a result of levee bank formation.

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[1] Stratum: a single bed of sedimentary material, generally consisting of one kind of matter representing continuous deposition. In this instance a stratum may be the deposition of a fine sand layer as a result of a flood event. Strata- sets may comprise one of a number of parallel layers one upon another, i.e. fine sand layers overlain by clay layers. These layers generally appear as laminations in section (layers upon layers of deposition)

Soils are generally described according to the distinct horizons they may contain. A soil generally comprises an A_1 horizon over a B_2 horizon, over a C horizon. The A_1 horizon is a surface mineral horizon, with a relatively dark colour, an accumulation of organic matter and maximum biological activity. An A horizon may be further annotated with the sub script $A_{2,}$ which is indicative of an A_1 horizon which has been leached of its mineral components and is distinguished by a paler colour. The B_2 horizon is often referred to as the master horizon. It will generally display the strongest structure[2] and the brightest colour and/or contain an alluvial, residual or other concentration of silicate clay, iron, aluminium, humus or carbonate, alone or in combination. The C horizon represents the parent or primary material (the material from which the soil has formed) which may be unweathered sediment or bed rock (Isbell 1996; McDonald et al 1990).

Simply put, a soil may form on unweathered sediment or weathering bed rock products. Initially the sediment will be transformed in to an A horizon overlying the C horizon. Over time the B_2 horizon will start to form as mineral products and clays are leached down through the soil and redeposited at depth. In this way a B_2 horizon will form underneath the A_1 horizon. Over long periods of time, the constant removal of mineral and clay products from the A_1 horizon and their redeposition in the B_2 horizon gives rise to an A_2 horizon. In this instance the A_2 forms at the interface between the A_1 and $B_{2.}$

Soils that develop on levees will display soil catenas, which means, that they will display predictable changes in soil type from channel bank along the levee to floodplain bottoms. Soil maturity, as marked by the degree of pedological development will increase with distance from the channel, owing to a decrease in sedimentation rates, which are higher closer to the river channel. Soils formed close to the river channel will typically only have A horizons over C horizons (primary material). This is because the constant addition of primary material will hinder structural development. Soils closer to the river channel will be coarser grained, sandier and as a consequence well drained. As a by product of their drainage, these soils will show higher rates of oxidization compared to soils developing at the distal end of the levee in back swamp deposits. Oxidization is typically identified as a brighter red or orange colour to the soil. Soils will also be affected by bioturbation, which is the mixing of soil particles from root activity and soil fauna. As such, alluvial bedding planes will no longer be extant (Hudson n.d).

Soils that have developed at locations further away from the river are typically more structurally developed owing to lower sedimentation rates. These soils may display horizonation with well developed A and B horizons and evidence of elluviation and illuviation (removal of clay from upper layers and deposition of clay in lower layers). These soils will display a higher degree of bioturbation and higher frequencies of mineral nodule formations, such as carbonates. All levee bank soil profiles have the potential to contain palaeosols, which are buried soil surfaces. These may represent A horizons which formed in between flooding events during levee formation or may represent a soil surface which formed on the older floodplain deposits before being covered up by the levee bank deposits (Hudson n.d).

2.2 Site Formation: Pedogenesis and Artefact Movement

The majority of material which has been previously excavated throughout Tasmania has been retrieved from surface soil contexts. Surface soils will generally not contain stratified artefacts, as when an artefact is left on the soil surface it is slowly mixed into the soil profile through the process of bioturbation. The result is the mixing together of numerous artefacts which are unrelated and as such, valuable temporal information is lost. Artefact displacement as a result of pedogenic processes has been the topic of several research papers in the last 20 years (see for example Johnson *et al* 1987; Johnson 1989, 1990, 1992; Vermeersch and Babel 1997; Peacock and Fante 2002).

Understanding the affect that pedogenesis has on the displacement of artefacts is of prime importance as it determines the conversion of a living floor to an archaeological horizon. Artefact positioning within soil horizons may be the result of stratigraphic burial and then movement through bio- turbation, or the vertical scatter may be the result of bio-turbation alone. Most Aboriginal sites in Australia are of the latter type. When attempting to reconstruct the behaviour of Aboriginal hunter gatherer societies, the question that should be asked of the artefact assemblage is to what extent has the original position of the artefacts changed, and is their position a representation of an occupation period. The affects of differing bio-turbation events and agents can be modelled and the results of field studies can be compared to these models in order to construct site formation histories. Inferences of past human behaviour based on artefact positioning can then be made within a geomorphological and pedological framework (Peacock and Fante 2002:91-92).

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[2] Soil structure refers to the shape and development of the peds formed within the soil. A ped is the natural aggregation of soil particles (sand, silt and clay) and may be described according to a variety of forms, i.e. crumb, blocky, polygonal. A soil with well developed structure is a soil with strong pedological development, as over time the primary sediments will naturally form into soil aggregates (peds) and the longer the period of time the more pedological or structural development.

Generally speaking soil genesis proceeds along two pathways, specifically progressive and regressive pathways. Progressive pathways work to promote horizonation and/or chemical stability, while regressive pathways work to provide homogenisation and/ or chemical instability (Johnson and Watson Stegner, 1987). Both pathways are in operation to some degree at the same time. The result of these opposing processes, constitute the overall soil developmental pathway (Johnson and Watson Stegner 1987; Peacock and Fante 2002). For any given soil profile the determination of which process has been the dominant pathway may be determined from the structural characteristics of the soil. Johnson et al (1987) point out that bio- turbation can contribute to either progressive or regressive soil development.

Peacock and Fante (2002:98-100), following Johnson *et al* (1987), present specific criteria which can be used to model soil development in silty- sandy soils and the affect progressive and regressive pathways have on artefact positioning within the soil. Progressive dominant soils will have well developed horizons and particle size will follow a predictable sequence. This sequence will generally comprise a silty or loamy A horizon with translocation of clay further down the profile Artefacts present within the sequence will typically form a stone line at the extent of bio- turbation within the soil. This is typically at the interface of the A horizon (zone of maximum biological activity) and the B horizon (zone of clay and mineral deposition). Archaeological models of progressive soil pathways and the affect of bio-turbation indicate that artefacts will still retain a fair semblance of their original, generally horizontal placement on the surface. Regressive dominant soils will be homogenous and display simple soil profiles with a distinct lack of horizonation. Tree upheaval and modern ploughing and agricultural activities are the most dominant regressive agents that will serve to homogenise the soil through the repeated mixing of the soil. Artefacts may form a stone enriched surface layer from the repeated upheaval of the soil, while artefacts within the soil profile will be oriented at random angles rather than lying in a generally horizontal plane. To surmise, progressive soil pathways differentiate a soil profile while regressive pathways homogenise a soil.

3 Archaeological Background

The archaeological background for the JRL site has been reported on by Stone and Everett (2009) an excerpt of which is presented below.

Archaeological excavation of limestone cave deposits in the Maxwell Valley of southwest Tasmania has demonstrated Aboriginal occupation dating back 35,000 years (Cosgrove, 1995). This period of occupation includes the Last Glacial Maximum or "Ice Age" of 20,000 years ago. It was during this period that cooler temperatures reduced the forest cover of the region (Kiernan et al, 1983). Late Pleistocene cave sites are also known in the valley of the Weld River, the Cracroft Valley and the Ida River karst (Jones et al., 1988; Cosgrove, 1989; McGowan, 1990). Some of these caves have paintings preserved on the cave walls. Aboriginal people also occupied the Tasmanian Highlands during the Last Glacial Maximum (LGM) when ice sheets covered most of the Central Plateau. This is demonstrated by the site of ORS 7 in the upper valley of the Shannon River, which drains the plateau (Cosgrove, 1995a).

Beginners Luck Cave in the Florentine River Valley is another significant Ice Age site. It has stone artefacts and the remains of butchered animals dating back 20,000 years (Murray et al., 1980). The LGM lowered sea levels by 150 m causing a land bridge to form between Tasmania and the Australian mainland. In northern Tasmania, Aboriginal people occupied rockshelters on Hunter Island and King Island when the islands were joined to the mainland (Bowdler, 1977; Sim, 1994). The Parmerprar Meethenar rockshelter in the Forth Valley was also occupied at this time (Cosgrove, 1992). Another early Aboriginal site in northern Tasmania is the Warragarra rockshelter in the Upper Mersey Valley below the Great Western Tiers (Lourandos, 1983). This shelter contains evidence of Aboriginal hunting from before 9,000 years ago. Most coastal sites in Tasmania (and the Australian mainland) date from 6-7,000 years ago when global sea levels stabilized following the melting of the glaciers and ice-caps. Shell middens in the Furneaux Group of islands are the oldest dating to 9,000 years ago (Sim, 1994). The Carlton Bluff midden in the Derwent region began forming 8,000 years ago (Brown, 1986; 1991). One of the longest, continuous cultural sequences in Tasmania has been excavated at Rocky Cape, some 20 km east of Smithton (Jones, 1971). Rockshelters containing stratified midden material show Aboriginal occupation dating back 8,000 years. About 3,500 years ago, fish remains ceased to be deposited in the excavated sequence. Stone tool technology also changed during this period of occupation. Bone points and undifferentiated quartzite flakes characterize the early assemblages but around 5,500 years ago bone points disappear from the tool kit to be replaced by stone artefacts made from a wider range of raw materials.

3.1 Derwent Estuary region

Aboriginal occupation of the Derwent Estuary may predate its formation by rising sea levels 10,000 years ago. An aeolian sand sheet that mantles a hilltop at Old Beach contains stone artefacts at its base older than surface occupation (hearths and shell middens) dated to ~5,500 years ago (Sigleo and Colhoun, 1975). It is possible that the stone artefacts were buried when the dune sand was blown from the bed of the Derwent River at the height of the LGM. However, pedogenic processes are known to move objects down soil profiles and they may be younger. Most Aboriginal sites around the Derwent Estuary have been located along the shoreline. These date from ~6,000 years ago when rising seas stabilized near their present level.

The sites are mostly shell middens dominated by *Mytilus planulatus* and *Ostrea angasi*. Stone artefact assemblages are often associated (Searle, 1992). Basal radiocarbon dates from six middens show that they began forming between 5,800 and 5,200 years ago (Brown, 1986). Stone artefacts excavated at Risdon Brook are associated with charcoal dated to 4,900 years ago (McGowan, 1985). Officer (1980) located most of the known shell middens around the Derwent Estuary demonstrating the largest concentration at the mouth of the Jordan River. One of these sites, JRM 1 now registered as TASI 1355, was excavated (Gaffney, 1978; Gaffney and Stockton, 1980). Seven stone artefacts were recovered from the 35 cm deep midden deposit but no fish or animal bones. Interestingly, *Mytilus planulatus* was replaced by another mussel, *Xenostrobus securis* in the excavated sequence. *X. securis* has a wide salinity tolerance and probably indicates decreasing salinity in the Jordan River. Charcoal samples were taken to date the sequence and issued lab numbers (SUA 1112 and 1113) but the results are unknown. Du Cros (1994) concluded that the hinterland of the Derwent Estuary would have a low density of isolated artefacts with most stone artefact sites and shell middens concentrated on river banks. She did not consider the geology suitable for rockshelters or stone quarries (cf. Sutherland, 1972). Du Cros also made an attempt to re-locate the site of an 1804 massacre of Aboriginal people at Risdon Brook. Du Cros believed that the site was most likely on the south or east side of the creek. McGowan (1985) refers to a human skull found between the creek and Grasstree Hill Road in 1918. It is possible that this was one of the Aboriginal people killed in the massacre.

3.2 Jordan River valley

The Jordan River valley upstream of the proposed Brighton Bypass (and tidal influences) is rich in Aboriginal stone artefact assemblages (Stone and Stanton, 2006). Ethnohistorical records suggest that the river formed a tribal boundary between the Big River Tribe, numbering 3-400 people, and the Oyster Bay Tribe, numbering 6-800 people (Brown, 1986). Stone and Stanton (2006) proposed that the Jordan River valley was probably intensively occupied by Aboriginal people, particularly as it is a natural conduit between the Central Plateau and the Derwent Estuary. Accordingly, a high density of Aboriginal sites can be expected in the river valley. Brown (1986) included the Jordan River valley in his regional overview of the archaeology of South East Tasmania. His findings were partly based on the unpublished survey results of Cosgrove who sampled some of the archaeological record of the Jordan valley. Brown (1986) concluded that most Aboriginal sites in the mountainous hinterland of SE Tasmania are located on the floors of major river and creek valleys. The footslopes adjoining these areas and sandstone shelters were also preferred campsites. Kee (1990) drew similar conclusions from her study of the Midlands, identifying alluvial terraces, old floodplain surfaces and gentle slopes adjacent to rivers and creeks as likely Aboriginal site locations. Stone and Stanton's (2006) Aboriginal site survey of the proposed Waddamana-Risdon Vale 220 kV transmission line route confirmed the predicted high density of sites in the Jordan valley. They located a total of 16 Aboriginal sites in the middle reaches of the Jordan and 19 potential Aboriginal site locations. Most of the confirmed sites are stone artefact scatters (n = 14) and the remainder isolated artefacts (n = 2). In addition, a large number of rockshelters were noted in the sandstone escarpments that form the valley sides. Some of these rockshelters may have been occupied but those investigated did not contain any surface archaeological traces. Stone and Stanton (2006) identified two "narrows" in the Jordan Valley, where Aboriginal cultural material is concentrated. One is the Elderslie Sandstone Formation reach of the Jordan River (between the Sand Hills and Heathy Hills) and the other the Broadmarsh reach (between Gards Hill and Terrys Hill). Some of the sites along these reaches of the Jordan are so large that they cover entire landforms. The distribution of stone artefact sites in the Jordan valley shows a preference for sandy landforms as campsites. These landforms include sandy bedrock spurs, alluvial terraces and dunes. Typically, the stone assemblages comprise flakes of chert, quartzite, silcrete and chalcedony, with minor elements of mudstone and petrified wood.

3.3 Lower Jordan

Planning studies undertaken previously for the proposed Brighton Bypass account for most of the known Aboriginal sites along the lower reaches of the Jordan River valley. Of relevance are those by Stokes and Summers (1993), Parham (1993), Searle (1996), Richardson (1996), Scotney (1996), Maynard (2002), Stanton (2008, 2008a, 2008b, 2008c, 2008d) and Everett (2008). These field studies have resulted in the TASI registration of 19 Aboriginal sites, comprising stone artefact scatters, stone quarries and isolated artefacts. Cosgrove's 1984 survey also located two large scatters (TASI 1433 and 1434) in a sand sheet ~2 km west of Pontville (see Brown, 1986). Initially, the Department of Transport engaged Stokes and Summers (1993) to survey the Tea Tree Road corridor between Brighton and Colebrook. One stone artefact scatter and six isolated artefacts were located, with three of the isolated artefacts (TASI 6835, 6836 and 6837) located in the Jordan valley between Brighton and Tea Tree. Siltstone was the most frequently recorded raw material followed by cherty hornfels, mudstone and silcrete, typical of Jordan River assemblages.

Parham's (1993) survey for the proposed Brighton Bypass route between the Boral Quarry and Brighton Lodge (either side of Crooked Billet Creek) did not locate any Aboriginal sites because of poor ground surface visibility. Searle (1996) extended this survey the full length of the proposed bypass route but could only locate two Aboriginal sites. One is a small cluster of chert artefacts on the east bank of the Jordan River near Geard Place (TASI 7463). The second is a small quartzite quarry (with introduced chert and possibly glass artefacts) located beside the rail line some 2 km east of Brighton (TASI 7464). Searle notes that the stone was worked from a distinct sandstone/quartzite outcrop but is of relatively poor quality for artefact manufacture. Richardson (1996) located another artefact (a silcrete scraper) during a survey for the proposed Midland Highway/Brighton Lodge Interchange. This find was made on the southern outskirts of Brighton some 400 m west of the Jordan River, outside the Northern Section. However, the site was never registered on the TASI and retains in the literature its field designation of BLA-001. Closer to Pontville, Scotney (1996) located a very large stone artefact scatter (TASI 8676) centred on a sandy ridge between the Jordan River and Bagdad Rivulet. The ridge runs parallel with the disused Douglas Aspley rail formation. A total of 91 artefacts were recorded over a distance of ~1 km. Of these, 39 % were formal tools such as scrapers. Scotney (1996) located six more artefacts on a tributary of the Bagdad Rivulet ~600 m to the east of TASI 8676 (outside the Northern Section) and an isolated artefact on the south side of Rifle Range Road (inside the Northern Section). Neither site was registered (see also Scotney, 1997, 1997a). Maynard (2002) surveyed a small portion of the Pontville Small Arms Range Complex (PSARC) close to the Bagdad Rivulet. The isolated artefact located by Scotney (1996) was found to be part of a scatter of stone artefacts that Maynard registered as TASI 9158. The site overlooking the rivulet contains several waste flakes but no tools (in contrast to TASI 8676), which suggested a reduction site where tools were made and taken away for use. The remainder of the PSARC, extending beyond Shene Hill, is unsurveyed. However, local knowledge reported to Maynard suggests that there are rockshelters at the extreme northeastern end of the PSARC. Recent surveys by Stanton (2008, 2008a, 2008b, 2008c, 2008d and 2008e) for the proposed Brighton Transport Hub and southern section of the proposed Brighton Bypass have located a total of seven Aboriginal sites. Perhaps the most significant of these is TASI 10601 located on the Parkholm property not far from Boral's Bridgewater quarry (Stanton, 2008). The site is a large stone artefact scatter that follows the contours of two low ridges for a distance of 650 m. Surface artefact density was estimated at 1/5- 400 m2 over an area of ~120,000 m2. Among the artefacts are steep-edge and round edge scrapers, retouched flakes and large flakes. Chert, silcrete, quartzite and mudstone are the dominant raw materials, with porcellanite (white chert) also recorded. Many of the artefacts retain 10-30 % cortex suggesting a local source. Stanton (2008) also located two artefacts (TASI 10602) close to the Parkholm residence.

Subsequent investigations of an alternative transport hub site by Stanton (2008a, 2008b) located three Aboriginal sites associated with Crooked Billet Creek (TASI 10648) and Ashburton Creek (TASI 10649 and 10650), west of the Midland Highway. All are relatively small scatters (five artefacts or less) located alongside these creeks. TASI 10648 is currently the subject of an archaeological excavation. Stanton (2008c) returned to the original transport hub site to survey the proposed Boral East site east of Parkholm. An isolated round-edge siltstone scraper was recorded on a ridgeslope (TASI 10651). Further artefact finds (TASI 10667 and 10713) were made by Stanton north of Crooked Billet Creek. Only three artefacts were recorded at these two sites (Stanton, 2008d). The Northern Section of the proposed Brighton Bypass was initially surveyed for Aboriginal sites by Everett (2008) who located six new exposures of stone artefacts in the study area. Four of these exposures were located alongside Briggs Road east of Brighton and two near Pontville. Everett's finds were re-identified and registered on the TASI as part of this investigation (see Section 8). Huys (2008) recently surveyed the Southern Section of the proposed Brighton Bypass locating six Aboriginal sites (five stone artefact scatters and an isolated artefact) along the proposed road alignment. Each site comprised between one and six sparsely distributed artefacts. Two of the sites (STR4 and STR5) were claimed to have Aboriginal glass artefacts (five in total) struck from green bottle glass. Given that only twenty artefacts were recorded in total across the six sites, the ratio of stone to glass artefacts is 4:1, which is interesting and unusual.

4 Methodology

This chapter outlines the methodological approach and technical design of the excavation process and data management. It defines the excavation strategy and the methods of information retrieval and management employed. Moreover, this chapter defines the research questions which will be applied to the data retrieved.

4.1 Research Questions

The overall aim of the excavation was to test the potential of the JRL site and recover evidence of changes in site use and lithic technology over time. Therefore, several research questions have been devised as a part of this methodology in order to better identify and define these types of cultural and technological changes through time.

1. Was the site occupied throughout the period of levee construction or occupied only after the levee was constructed?

This question invites comparison between surface and subsurface cultural layers. The hypothesis that the levee deposit contains a stratified cultural sequence will be tested by controlled archaeological excavation and radiometric dating of the sediments. This will establish a chronology of occupation for the site and show changes in site use and lithic technology over time, including periods when particular raw materials were preferred (exploited) over others. The limiting factor on the depth of excavation will be the age and origin of the basal sediments and whether or not these sediments have the potential to yield cultural material.

2. How intact or disturbed is the site?

- This is very important since the integrity of all other results depends on it. Field observations indicate the
- following post-depositional processes:
- Disturbance by tree and grass roots, tree upheaval.
- Mixing by natural pedogenic processes.
- Repeated ploughing.
- Soil erosion, particularly by wind and water.
- Trampling by stock and farm vehicles.
- Potential vertical and horizontal displacement of artefacts in the soil by the above processes.

3. Questions to ask of the lithic assemblages

The purpose of stone artefact analysis is to provide a detailed understanding of the prehistoric technology of the site and its relationship to the hunter-gatherer populations responsible for its manufacture and use.

The principal aims and methods of the stone artefact analysis were as follows;

- Examine variability across the site and over time by exploring different proportions of raw material use and techniques of artefact manufacture. Attribute analysis of artefacts will allow a determination of whether different raw materials were used differently across the site.
- Investigate the relative availability of raw materials through examination of conservations strategies such as platform preparation, core reduction and rejuvenation activities.
- Explore the extent to which the site was used for the manufacture of stone tools or for maintenance and use at the site. Core frequencies, artefact size and the presence of modified and unmodified flakes on site were compared to assess the frequency of artefact manufacture on site.

A detailed technological analysis was undertaken by Sophie Collins on the stone material from Trench 2. The overall aim of this analysis was to determine if a new cultural sequence can be made for Southern Tasmania. The analysis for the remaining 7 trenches is still pending.

4. Wider questions to be considered

- How does TASI 10757 compare with other known sites in the region?
- Can TASI 10757 be linked with the recent ethnohistoric past and documented tribal groups in the region?

4.2 Excavation Strategy

As stated above, the excavation of the JRL site had two key objectives. The first was to determine if the site contains a stratified cultural sequence. The second was to demonstrate the degree of site intactness. Only then, can a complete assessment of the scientific significance of the site be made. The strategy involved the controlled excavation of four 2m x 2m excavation trenches and four 1 x 1m trenches. Trenches 1 and 2 were aligned perpendicular to the strike of the levee ridge, and Trenches 3 and 4 were aligned parallel to the strike of the levee ridge. Trenches 5-8 were placed perpendicular to the strike of the levee towards the distal end of the levee in order to identify the edge of the levee landform. By aligning the excavation trenches across the levee ridge in this way, two cross sections of the landform will be exposed; one will encapsulate the soil stratigraphy from river front to distal end of the levee and the other will define the lateral spread of the artefacts both within and outside of the potential impact zone (refer Figure 4.1).

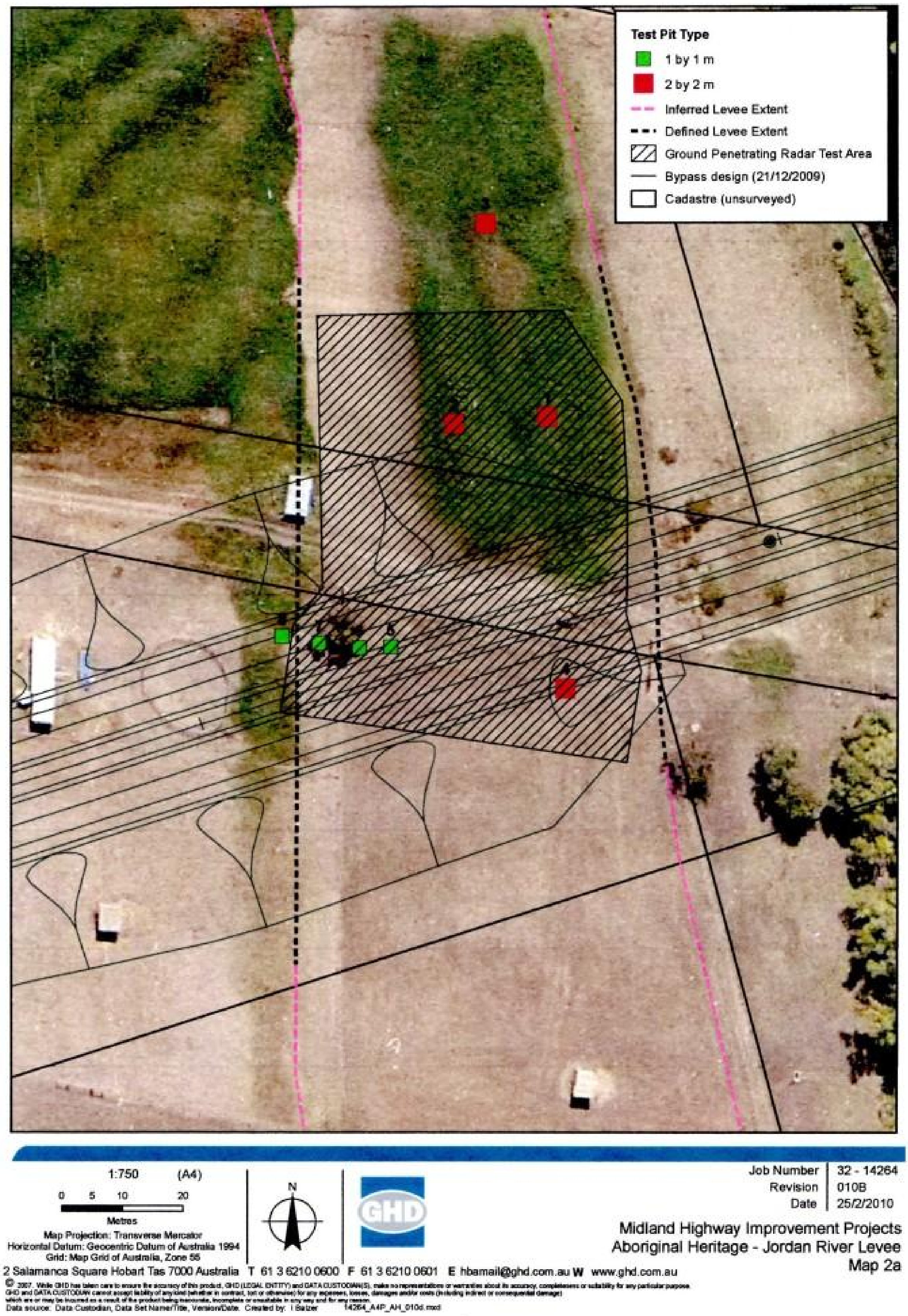


Figure 4.1: Map detailing the location of the excavation trenches in relation to the Levee site.

4.3 Excavation Methodology

Two different methodologies were applied to the test trenches at the JRL site. This is due to the fact that the methodology was revised in February as a result of the issues raised during the consultation process. The initial methodology has largely been conformed to and is summarised below. This methodology applies to Trenches 1 and 2.

1. All 8 trench sites were surveyed with the use of differential GPS. The pits were aligned to the north and placed perpendicular and parallel to the strike of the levee (i.e. along an east west and south north axis).

2. The deposits were excavated in 5cm spits or layers, with exception to instances where a clear change in the soil/sediment unit became evident. In these instances spits were generally variable in depth depending on the nature of the contact between the two units.

3. Excavation of the 5 cm spits was conducted by hand with trowel and brush in order to record and photograph artefacts in situ, and make detailed observations of the soil profile.

4. Each 2 x 2m test trench was divided in to four squares (labelled 1-4), with each square further divided in to four quadrants (labelled A-D). This enabled a degree of spatial control for the artefacts that were retrieved from the sieves. This division and sub-division is shown in Figure 4.2. Each 1 x 1m test trench was also divided according to four quadrants (A-D), the sub-division of which is shown in Figure 4.3.

5. Where artefacts were encountered through hand excavation, their location in the test trench was measured according to the x, y and z axis’ of the trench. All x and y measurements were taken from the eastern and northern walls of each square, respectively. Z measurements were taken from a datum which was set up, using differential GPS, along the western wall of the trench. Depth was measured from this point using a string line and line level.

6. The inclination of the long axis and dip of individual artefacts was recorded on the hand excavated artefacts. A hand held compass was used to measure the inclination, while a clinometer was used to measure the dip. These measurements were taken in order to test for post-depositional disturbances.

7. All excavated sediment was placed in labelled buckets according to the square and quadrant from which the sediment came. Each bucket was recorded in a sieve log before being wet sieved by hand, through a 3mm sieve plate. A copy of the sieve log recording form is located in Appendix B.

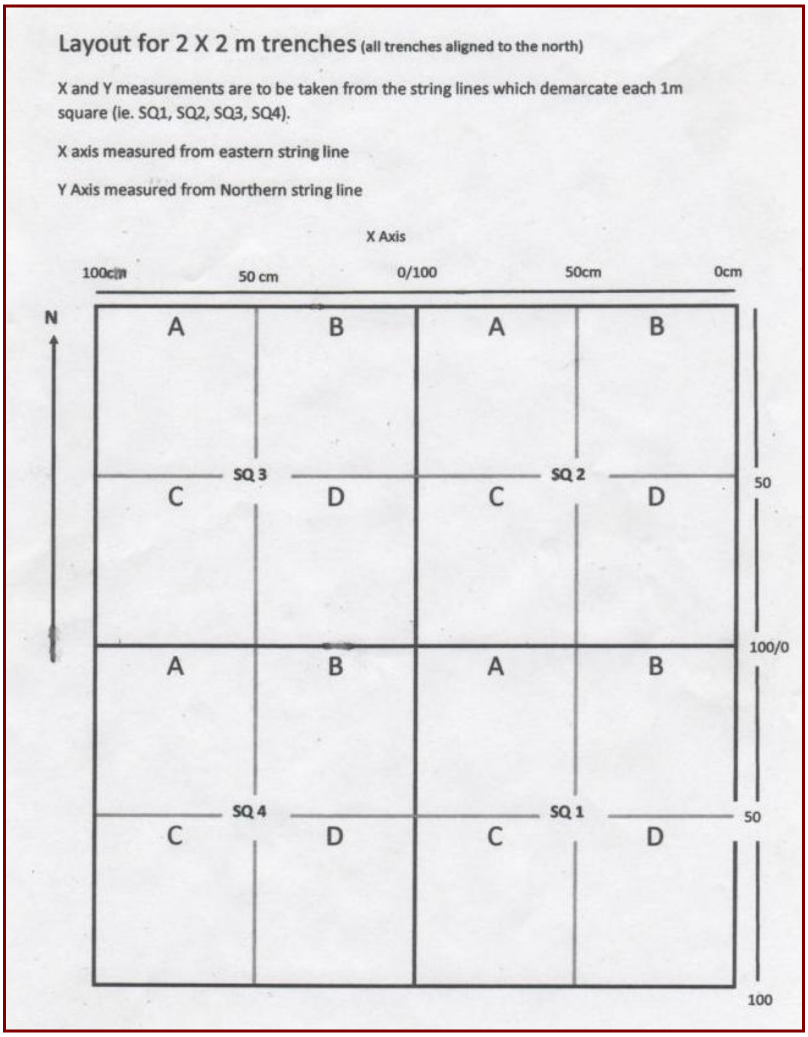
8. All artefactual material was bagged and labelled according to provenance and retained for further analysis.

9. Stratigraphic sections were recorded and three dating samples were taken from trench 2. It is the intention that further OSL samples be taken from trench 1at a time yet to be determined.

10. A standard site recording form was used for each excavated spit. Details included site name, trench, square and quadrant number, the documentation of bioturbation markers, soil colour and texture, frequency and size of both organic and inorganic inclusions, and a sketch plan for the documentation of the artefacts which were hand excavated. An example of a site recording form is located in Appendix B.

11. Soil colour was measured with a Munsell Soil Colour Chart, and soil texture was identified using a soil texture field sheet. Soil texture is a measure of the behaviour of a handful of soil when moistened and kneaded into a bolus and then pressed out between thumb and forefinger. Nineteen grades of texture, such as sandy loam, clay loam and silt loam, are commonly recognised (See table in Appendix C).

The remainder of the test trenches 3-8 were also excavated and managed in accordance to the guidelines outlined above, with the exception that no *in situ* artefact recording was undertaken. Specifically, point 5 in the list above was not applied to trenches 3-8. However, spatial provenance was controlled with the grid system applied to each trench, while vertical control was maintained with the use of 5cm spits as outlined in points 2 and 4.



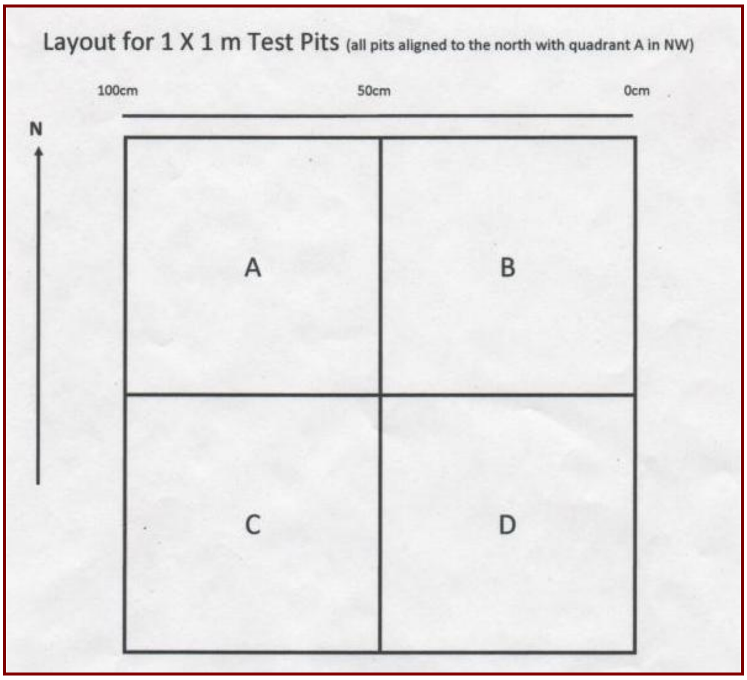
Layout for 2 X 2 m trenches (all trenches aligned to the north)

X and Y measurements are to be taken from the string lines which demarcate each 1m square (ie. SQ1, SQ2, SQ3, SQ4).

X axis measured from eastern string line

Y Axis measured from Northern string line

Figure 4.2: Subdivision of 2x2m test pits, showing squares (1-4) and quadrants (A-D)



Layout for 1 X 1 m Test Pits (all pits aligned to the north with quadrant A in NW)

Figure 4.3:Subdivision of 1x1m test trenches, showing quadrants (A-D)

4.4 Artefact Analysis

A detailed technological analysis was undertaken by Sophie Collins on the stone material from Trench 2. Results from the remaining 7 trenches are still pending. The overall aim of this analysis was to determine if a new cultural sequence can be made for Southern Tasmania, for the time frame of levee accumulation. This will test the overall aim of the research project component of this investigation.

4.4.1 Attribute Analysis

The range of attributes recorded on the stone artefacts from the site reflect the various areas of inquiry explored in the analysis. In addition to simple size characteristics (such as length, width, thickness, weight, elongation), were taken measurements relating to platform size, external platform angle and platform preparation. These attributes allow analyses to be performed relating to artefact manufacture and reduction techniques and to raw material conservation.

The following attributes were recorded for each artefact:

Providence the trench, square and quadrant from which each artefact came was recorded in detail. Where possible, X,Y and Z co-ordinates were also taken.

Spit Number each 5cm spit was numbered sequentially.

Raw Material a large range of raw materials were identified at the site.

Basalt

Brecciated Chert

Ceramic

Chert

Cortex

Fine Grained Siliceous

Fine Grained Volcanic

Glass

Hornfels

Petrified Wood

Quartz

Quartzite

Sandstone

Silcrete

Silicified Mudstone

Artefact Type A range of different artefact types were identified during analysis. These are defined below:

Flake A flake is a piece of stone struck from a core and exhibiting a range of diagnostic features that indicate that the removal of the flake was deliberate and of human origin. Flakes are most commonly removed through percussion which involves using a hard hammer to direct the force of the blow onto the surface of the core. Percussive flakes commonly bear the following diagnostic characteristics: a ring crack (visible as a semi-circular protuberance on the ventral surface of the flake and located exactly where the blow was struck), a positive bulb of percussion on the ventral surface of the flake and possible eraillure scar (a small flake detached beneath the impact point caused by the force with which the main flake was removed).

Flakes may also be produced by pressure and produce different characteristics than those detailed above for hard hammer percussion. Pressure flakes are known as ‘bending’ initiated flakes and occur when the pressure that causes the flake to separate from the core is applied further away from where the fracture initiates – usually at a point of weakness or where flaws already exist in the stone. Bending flakes do not have a ring crack or bulb of percussion and instead can be identified from a small lip protuberance extending the platform from the ventral surface.

All complete flakes will have a proximal, medial and distal component, a dorsal and a ventral surface, a point of initiation, two lateral margins and point where the fracture terminates.

Core Cores represent the nucleus piece of stone from which flakes have been removed. Cores will always retain negative flake surfaces showing negative bulbs, ring cracks and so on. Each negative flake scar shows the location of a flake previously removed.

Retouched Flake Retouched flakes are flakes that have been modified following manufacture. That is to say that subsequent flakes have been removed from any of the flakes margins or in any way impact upon the ventral surface.

Flaked Piece This category includes those pieces that are clearly man made but which for various reasons cannot be clearly assigned as flake, retouched flake or core. Diagnostic features are often removed or compromised by processes of heat affect/weathering causing items to be classed as flaked pieces.

Heat Shatter These are pieces of flakeable stone that have been fractured through non-human agency such as extreme heat (through fire) or the natural processes of heating and cooling with the weather. Heat shatter is identifiable by the irregularity of the shattered surfaces, colour changes to the materials, crazing of the surface or the presence of potlid fractures.

Weight weight was measured using an electronic balance to the nearest 0.01g.

Length In this study length was measured in accordance with percussion length – that is, the length along the direction of the blow stretching from the point of initiation at the ring crack to the distal end. Length was recorded to the nearest 0.01mm using digital callipers.

Width Width was measured perpendicular to the line of percussion and was taken at the midpoint of the flake to the nearest 0.01mm using digital callipers.

Thickness Thickness was measured at the point where the length and width measurements met – the midpoint of the flake in line with the percussion line. It was measured to the nearest 0.01mm using digital callipers.

% Cortex Cortex forms as an outer layer or skin on the surface of raw materials due to weathering. In most cases the fracturing properties of cortex differ greatly from those of the raw material itself. As such, decortication or the removal of the cortical layer is usually undertaken as a preliminary step in the manufacture of stone artefacts. The presence/absence of cortex and the amount remaining is therefore an indicator of the raw materials stage of reduction. Percent cortex was a visual estimate in this study based on the proportion of the item considered to still retain cortex.

Platform Width The platform width measures the distance between the two lateral margins of the flake at the platform where the fracture was initiated. Platform width and thickness are used together to give an idea of platform area, which in turn informs about the amount of force required to initially cause the flake to come away from the core.

Platform Thickness Platform thickness refers to the distance between the dorsal and ventral surfaces across the striking platform. Platform width and thickness were measured to the nearest 0.01mm using digital callipers.

Overhang Removal The presence or absence of overhang removal was recorded for all flakes. Overhang removal is a form of platform preparation which comprises removing excess stone from the platform of a core prior to removing the flake. The process reduces the total area of the platform allowing a large flake to be manufactured without requiring too great an increase in the force of the blow. Platform preparation is visible in the form of a series of small flake scars on the dorsal surface of the platform.

External Platform Angle The external platform angle refers to the angle between the platform and the dorsal surface, and it records the shape of the core immediately before the manufacture of the flake. This angle affects the amount of force required to detach a flake from a core; the higher the angle, the greater the force required and the larger the flake produced, the lower the external platform angle the smaller the force

	required and the smaller the flake produced. Platform angles were measured to the nearest degree using a goniometer.
Retouch	The existence and type of retouch was recorded for each artefact and was examined using a 10x hand lens. Retouch is identified as a series of deliberately removed small flakes from along the edge of an artefact. The location of retouch and its orientation was recorded in all cases. In the absence of access to high magnification microscopes no suggestion of artefact function has been made.
Retouch Length	The area of the flake affected by retouch was recorded to the nearest 0.01mm using digital callipers.
Retouch Angle	The angle of the edge produced by retouch was recorded to the nearest degree using a goniometer.

4.5 Radiometric Dating

The fine sand that forms the levee deposit is ideal material for optically stimulated luminescence (OSL) dating methods. Five samples were collected in total with three samples collected from Trench 2 and two samples collected from a quarry cutting located in close proximity to the JRL site. The quarry cutting provided the opportunity to date the basal sands of the floodplain deposit on which the levee was constructed, allowing for a complete geomorphological reconstruction of site formation history at the JRL site. Owing to the preliminary nature of this report the analytical methods, and sample collection procedures employed will be presented in the final excavation report.

4.6 Ground Penetrating Radar

A geophysical investigation using Ground Penetrating Radar (GPR) was conducted from the 15th to the 19th February 2010 at the JRL site by GBG Australia. GPR was employed at the site owing to the fact that the loose sandy deposits which comprise the JRL site have the potential to contain Aboriginal burials.

It is not necessary to reiterate the methods and detailed findings of the GPR survey in the body of this report as this information is presented in Appendix D as a separate report.

5 Results: Soil Stratigraphy and Post-depositional disturbance

The results presented in this section deal with the soil stratigraphy, the ground penetrating radar analysis and the post-depositional disturbance to the excavated deposits. The radiometric and site formation results are presented in section 6, while the artefact analysis is presented in section 7. Section 8 provides a discussion of the results presented in sections 5, 6 and 7.

5.1 Soil Stratigraphy

Stratigraphy at the JRL site is comprised of two soil stratigraphic units. The upper unit is comprised of the levee deposit and the lower unit is comprised of the buried floodplain soil upon which the Levee is situated. The levee deposit is comprised of three soil stratigraphic units, namely the plough layer, a zone of oxidisation and unweathered alluvial sand deposits. The floodplain soil is comprised of a truncated A2 horizon and underlying Iron B horizon and B2k horizon and a basal Ck horizon. Each of these units are described below.

The soil stratigraphy is the same for all 8 trenches. The levee deposit is from 67 to 80 cm deep with the underlying floodplain soil over 1m deep. Owing to the homogeneity of soil stratigraphy across the site it is sufficient to present schematic sectional data from a selection of excavation trenches only. In order to provide a cross section of the soil/sediment deposits from the river channel to the distal end of the levee, 2 cross sections are outlined in Figures 5.1 and 5.2, comprising trenches 4-8 and 1, 2 and 8 respectively.

The top soil unit across the JRL site has been identified as an A_p horizon. This is simply a top soil mineral horizon which has been transformed through ploughing. In Trenches 1 and 2, the contact between the A_p horizon and underlying sub-soil was carefully excavated (**Plates 5.1** and **5.2**) in order to differentiate artefacts associated with the plough layer and the underlying soil. A similar method of separation of the two soil units was also applied in Trenches 3-8, however, no plough marks were evident. Across the site the plough layer ranged from 20 to 30cm in depth, was Dark Brown (7.5YR 3/2) to Brown (10YR4/3) in colour, and varied from a Fine Sandy Clay Loam to a Sandy Clay Loam soil field texture (refer to Appendix C for field texture classes).

Plate 5.1: View facing west of plough furrows in trench 2; depth 25-30cm.

Plate 5.2: View facing north of plough furrows in trench 1;depth 25cm.

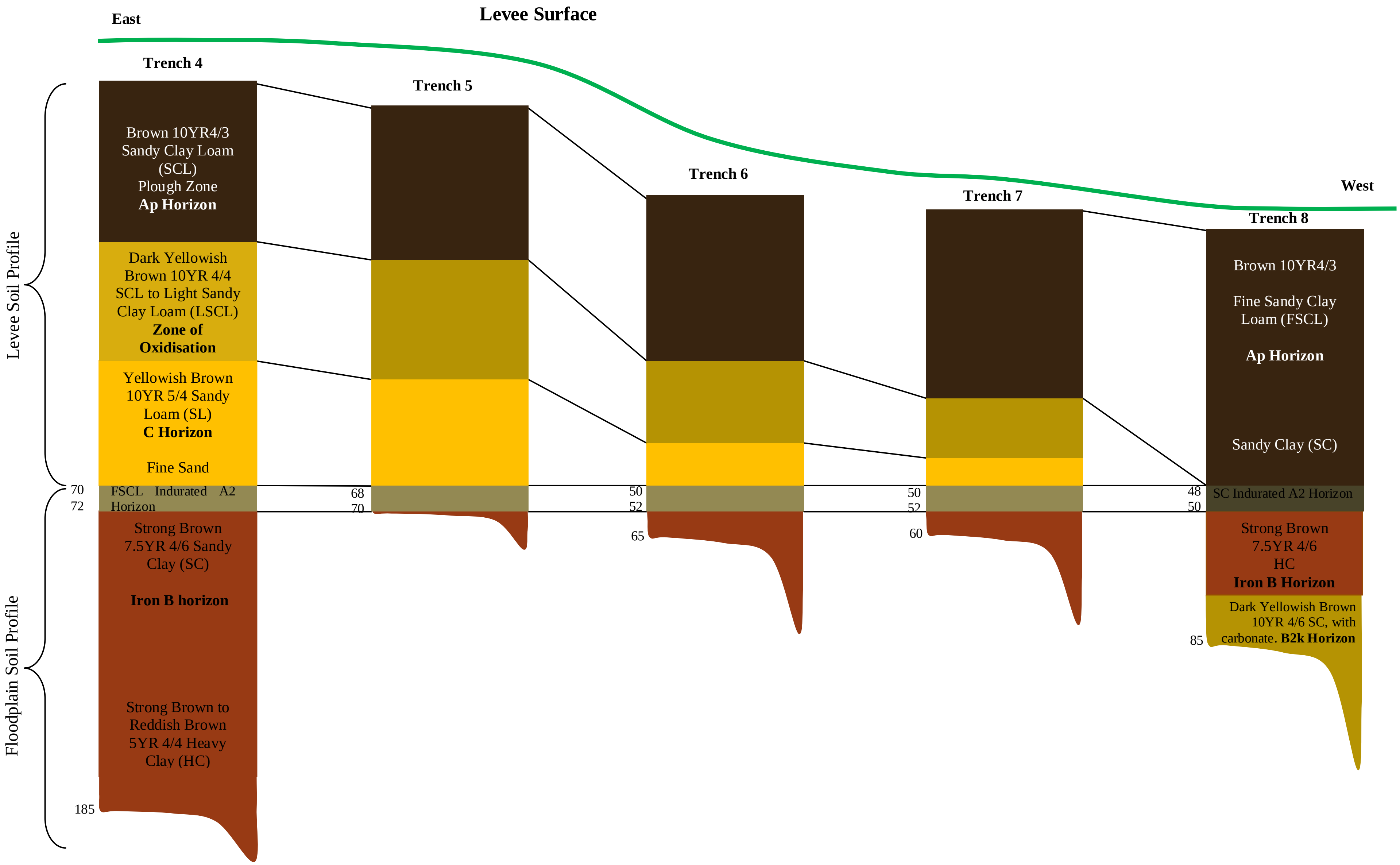


Figure 5.1: Schematic representation of soil stratigraphic units, trenches 4-8.

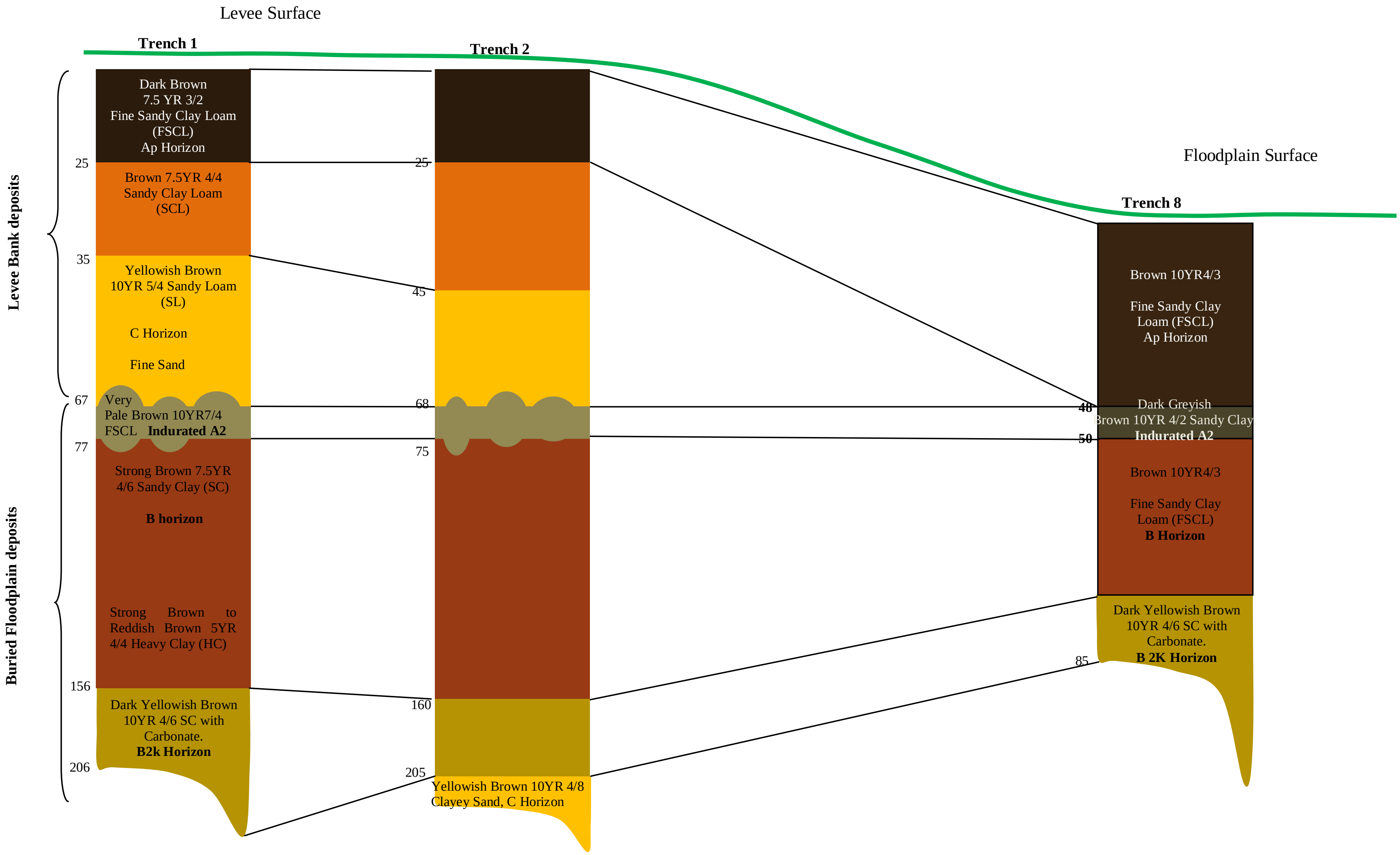


Figure 5.2: Schematic representation of soil stratigraphy, trenches 1,2 and 8

Beneath the A_p horizon the sub soil unit comprised an oxidised horizon, which displayed a high level of biological activity as evidenced by numerous root and soil fauna casts (**Plate 5.3**). Soil mixing within this unit is particularly strong in Trench 2 with the presence of a rabbit burrow from 40cm to 60cm in depth along the northern wall of the trench (**Plate** 5.**4**). This unit was the most variable across the site generally constituting a Brown (7.5YR4/4) colour in Trenches 1,2 and 3 (**Plate 5.5**), and a Dark Yellowish Brown (10YR4/4) in Trenches 4 to 7 (**Plate 5.6**). The oxidised layer is absent in Trench 8 (**Plate 5.7**), owing to its landscape position at the distal end of the levee and proximity to a small rivulet. This means that the soil will have been frequently water logged; an environment which is not conducive to oxidization. Soil field texture varied little within the oxidized soil horizon across the site, ranging from a Sandy Clay Loam to a Light Sandy Clay Loam.

Plate 5.3: Detail of soil fauna and root casts in the oxidised zone of the levee soil in trench 1, eastern section.

Plate 5.4: Detail of rabbit burrow disturbance present in trench 2, at 40cm depth.

Plate 5.5: View of northern section of trench 2 showing contrast between upper A_p horizon and underlying oxidized soil horizon.

Plate 5.6: View facing north of trench 5, showing colour of oxidised soil at 50cm depth.

Plate 5.7; View facing west of trench 8. Note the absence of an oxidised layer.

The oxidized soil horizon generally extended in depth from beneath the A_p horizon to a maximum depth of 35 to 50cm in Trenches 1-5 and steadily decreased in thickness across Trenches 6 and 7, until it became non extant in Trench 8. This pattern is understandable in light of the fact that soil depth will be greater closer to the river channel, where maximum sediment deposition took place, and will become increasingly shallower as one moves towards the distal end of the levee. Similarly, the decrease in thickness of the oxidised layer is also understood in terms previously explained, whereby the distal landscape position of the levee will have undergone frequent periods of water logging preventing a high degree of oxidisation.

Beneath the oxidized zone the sediment becomes increasingly lighter and grades from a Light Sandy Clay Loam through to a Sandy Loam and fine to medium unweathered sand at the base of the levee (**Plate 5.8**). This unit extends in thickness from approximately 35 -75cm in Trenches 1-5, and from 35-55cm in Trenches 6 and 7. This unit is absent in Trench 8. Trench 8 soil stratigraphy comprises a relatively deep A_p horizon overlying the buried floodplain soil (**Plate 5.7**).

Of stratigraphic interest here is the occurrence of a potentially buried fossil cast, either associated with the base of the levee or with the floodplain surface. This fossil cast was only encountered in Trench 2 at the interface between the basal levee sands and the surface of the buried A_2 horizon (**Plate 5.9**).

Plate 5.8: View facing south of trench 4. Note the three distinctive soil units.

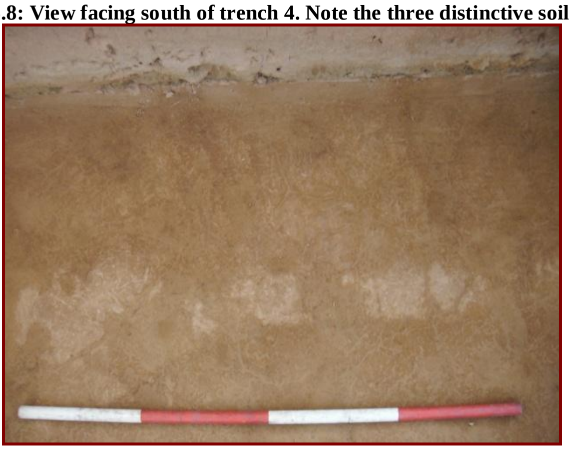


Plate 5.9: Detail of fossil trace in trench 2, at 67.5- 70.5cm

Beneath the unweathered levee bank sands a buried A_2 horizon was encountered at depths ranging from 60 to 75cm across the site. This soil horizon is the remnant top soil associated with the buried floodplain (**Plates 5.10** and 5.**11**). Texture and colour were uniform across the site, ranging from a Fine Sandy Clay Loam to a Sandy Clay Loam of Very Pale Brown colour (10YR7/4). This buried soil is truncated in various places across the site and ranges in thickness from 1-5cm. The buried soil horizon was easily recognisable as over time it has become indurated (hardened).

A total of 4 sondage test pits measuring 1 x 1m where excavated from this surface in Trenches 1-4 (**Plate 5.12**). The purpose of the sondage test pits were to test for cultural material in the buried flood plain soil. If artefactual material was encountered, it was the intention to excavate the entire 2 x 2m test trench. In the instances of Trenches 5-8 only one to two 5cm spits were excavated in to the buried A_2 horizon in order to establish that this unit was culturally sterile. In all instances the floodplain soil was found to be culturally sterile, however the subsequent artefact analysis identified several examples of possible flaked material. Confirmation of this result will be presented in the final excavation report.

The flood plain soil was excavated to a depth of approximately 1-1.1m (**Plate 5.10**), encompassing 4 to 5 spits of 10cm in depth. From this point, soil auger tests were undertaken in Trenches 1, 2, 3, 4 and 8 in order to define a complete soil profile for the buried floodplain surface. Soil auger tests were undertaken in Trench 8 in order to determine that the Heavy Clay encountered beneath the A_p was in fact the buried floodplain surface. From below the A_2 horizon at 75-80cm depth a B_2 horizon extends to 1.6-1.7m depth. It is comprised of a Strong Brown (7.5YR4/6) Sandy Clay to Heavy Clay with a strongly developed polygonal ped structure. Beneath the B_2 horizon a B_{2k}[3] horizon was encountered, which extended in depth from approximately 1.7-2m in depth. It comprised of a Dark Yellowish Brown (10YR4/6) Sandy Clay with many weak and fine carbonate segregations. From below 2.05m, sediments comprised a Yellowish Brown (10YR5/8) Clayey Sand with very few weak to medium carbonate fragments. Owing to the length of the soil auger we were unable to retrieve sediment samples from below 2.10m in depth. Generally speaking the site displays a high degree of homogeneity, in that soil units are equally represented across the site at comparable depths.

Soil stratigraphic data according to spit and depth for each individual trench is presented in tables 5.1-5.8 below.

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[3] A B_{2k} horizon is simply a second component of the B horizon which contains carbonate. Similarly the denotation Ck Horizon also indicates a C horizon with carbonate.

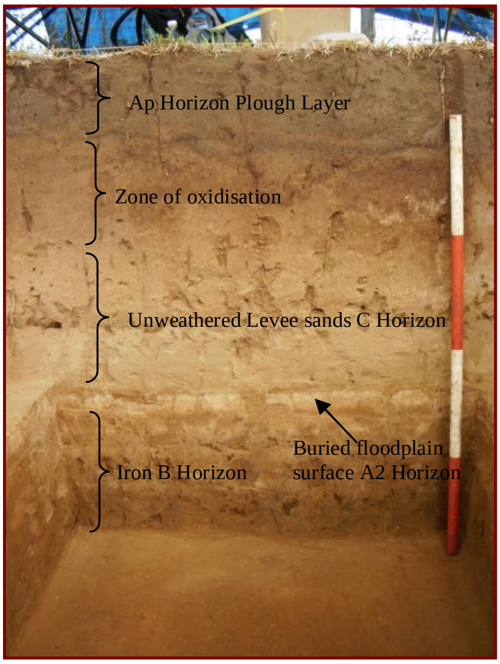


Plate 5.10: Southern section of trench 2, showing the levee deposit overlying the buried floodplain surface

Plate 5.11: Detail of floodplain surface in trench 1. Note the polygonal structure evident in the floodplain surface.

Plate 5.12: View facing north of sondage test pit in trench 4.

Trench 1

Spit	Depth	Soil/sediment texture	Soil Colour	Stratigraphic Interpretation
1-4	0 to18-25cm	Fine Sandy Clay Loam	Dark Brown 7.5 YR 3/2	Ap Horizon Plough Layer
5-7	18-25 to 35cm	Sandy Clay Loam	Brown 7.5YR 4/4	Zone of Oxidization- bio-sphere
8-15	35 to 67-75cm	Sandy Loam to Fine Sand	Yellowish Brown 10YR 5/4	Unweathered levee sand deposit- C horizon
Sondage 16	67-75 to 70-77	Fine Sandy Clay Loam	Very Pale Brown 10YR 7/4	Indurated A2 horizon- buried floodplain top-soil
	70-77 to 77	Sandy Clay	Strong Brown 7.5YR 4/6	Indurated B horizon. Buried flood plain sub-soil.
17-19	77 to 103	Sandy Clay	Strong Brown 7.5YR 4/6	Indurated B horizon. Buried flood plain sub-soil.
Auger	103-156cm	Heavy Clay	Strong Brown7.5 YR 4/6 to Reddish Brown 5YR 4/4	B horizon. Buried flood plain sub- soil.
Auger	156-206cm	SC, with many coarse weak carbonate concretions	Dark Yellowish Brown 10YR4/6	B2k horizon. Buried floodplain sub-soil

Table 5.1: Trench 1 soil stratigraphy

Trench 2

Spit	Depth	Soil/sediment texture	Soil Colour	Stratigraphic Interpretation
1-4	0 to 16-28cm	Fine Sandy Clay Loam	Dark Brown 7.5 YR 3/2	Ap Horizon Plough Layer
5-8	16 to 28-45cm	Sandy Clay Loam	Brown 7.5YR 4/4	Zone of Oxidization- bio-sphere
9-13	45 to 68.5-71.5	Sandy Loam to Fine Sand	Yellowish Brown 10YR 5/4	Unweathered levee sand deposit- C horizon
14	68.5-71.5 to 72	Sandy Loam to Fine Sand	Yellowish Brown 10YR 5/4	Unweathered levee sand deposit- C horizon
	72 to75cm	Fine Sandy Clay Loam	Very Pale Brown 10YR 7/4	Indurated A2 horizon- buried floodplain top- soil
Sondage 15-17	75 to 90cm	Sandy Clay	Strong Brown 7.5YR 4/6	Indurated B horizon. Buried flood plain sub-soil.
18-20	90 to 120cm	Heavy Clay	Strong Brown7.5 YR 4/6 to Reddish Brown 5YR 4/4	B horizon. Buried flood plain sub- soil.
Auger	120-160	Heavy Clay	Strong Brown7.5 YR 4/6 to Reddish Brown 5YR 4/4	B horizon. Buried flood plain sub- soil.
Auger	160-205cm	Sandy Clay, with many coarse weak carbonate concretions	Dark Yellowish Brown 10YR4/6	B2k horizon. Buried floodplain sub-soil
Auger	>205cm	Clayey sand with very few weak to medium carbonate fragments	Yellowish Brown 10 YR 5/8	Interface of B2k horizon and C horizon (floodplain sediment)

Table 5.2: Trench 2 soil stratigraphy

Trench 3

Spit	Depth	Soil/sediment texture	Soil Colour	Stratigraphic Interpretation
1-3	0 to 15cm	Fine Sandy Clay Loam	Dark Brown 7.5 YR 3/2	Ap Horizon Plough Layer
4-7	15 to 35cm	Sandy Clay Loam	Brown 7.5YR 4/4	Zone of Oxidization- bio-sphere
8-14	45 to 65-67	Sandy Loam to Fine Sand	Yellowish Brown 10YR 5/4	Unweathered levee sand deposit- C horizon
Sondage 15	65-67 to 67	Fine Sandy Clay Loam	Very Pale Brown 10YR 7/4	Indurated A2 horizon- buried floodplain top- soil
16-21	67 to 102cm	Sandy Clay	Strong Brown 7.5YR 4/6	Indurated B horizon. Buried flood plain sub-soil.
Auger	102 to 110cm	Heavy Clay	Strong Brown7.5 YR 4/6 to Reddish Brown 5YR 4/4	B horizon. Buried flood plain sub- soil.
Auger	110-170	Sandy Clay, with many coarse weak carbonate concretions	Dark Yellowish Brown 10YR4/6	B2k horizon. Buried floodplain sub-soil

Table 5.3: Trench 3 soil stratigraphy

Trench 4

Spit	Depth	Soil/sediment texture	Soil Colour	Stratigraphic Interpretation
1-6	0 to 30cm	Sandy Clay Loam	Brown 10 YR 4/3	Ap Horizon Plough Layer
7-10	30 to 50cm	Sandy Clay Loam to Light Sandy Clay Loam	Dark Yellowish Brown 10YR 4/4	Zone of Oxidization- bio-sphere
11-14	50 to 70	Sandy Loam to Fine Sand	Yellowish Brown 10YR 5/4	Unweathered levee sand deposit- C horizon
15	70 to 72	Fine Sandy Clay Loam	Very Pale Brown 10YR 7/4	Indurated A2 horizon- buried floodplain top- soil
	72 to 75cm	Sandy Clay	Strong Brown 7.5YR 4/6	Indurated B horizon. Buried flood plain sub-soil.
Sondage 16-19	75 to 115cm	Sandy Clay to Heavy Clay	Strong Brown7.5 YR 4/6 to Reddish Brown 5YR 4/4	B horizon. Buried flood plain sub- soil.
Auger	115-185	Heavy Clay	Strong Brown7.5 YR 4/6 to Reddish Brown 5YR 4/4	B horizon. Buried flood plain sub- soil.

Table 5.4: Trench 4 soil stratigraphy

Trench 5

Spit	Depth	Soil/sediment texture	Soil Colour	Stratigraphic Interpretation
1-6	0 to 30cm	Sandy Clay Loam	Brown 10 YR 4/3	Ap Horizon Plough Layer
7-10	30 to 50cm	Sandy Clay Loam to Light Sandy Clay Loam	Dark Yellowish Brown 10YR 4/4	Zone of Oxidization- bio-sphere
11-14	50 to 66-68cm	Sandy Loam to Fine Sand	Yellowish Brown 10YR 5/4	Unweathered levee sand deposit- C horizon
15	66-68 to 70cm	Fine Sandy Clay Loam	Very Pale Brown 10YR 7/4	Indurated A2 horizon- buried floodplain top- soil

Table 5.5: Trench 5 soil stratigraphy

Trench 6

Spit	Depth	Soil/sediment texture	Soil Colour	Stratigraphic Interpretation
1-4	0 to 25cm	Sandy Clay Loam	Brown 10 YR 4/3	Ap Horizon Plough Layer
5-7	25 to 35cm	Sandy Clay Loam to Light Sandy Clay Loam	Dark Yellowish Brown 10YR 4/4	Zone of Oxidization- bio-sphere
8-10	35 to 50cm	Sandy Loam to Fine Sand	Yellowish Brown 10YR 5/4	Unweathered levee sand deposit- C horizon
11	50-52	Fine Sandy Clay Loam	Very Pale Brown 10YR 7/4	Indurated A2 horizon- buried floodplain top- soil
	52-55	Sandy Clay	Strong Brown 7.5YR 4/6	Indurated B horizon. Buried flood plain sub-soil.
12-13	55-65	Sandy Clay	Strong Brown 7.5YR 4/6	Indurated B horizon. Buried flood plain sub-soil.

Table 5.6:Trench 6 soil stratigraphy

Trench 7

Spit	Depth	Soil/sediment texture	Soil Colour	Stratigraphic Interpretation
1-7	0 to 35cm	Sandy Clay Loam	Brown 10 YR 4/3	Ap Horizon Plough Layer
8-9	35 to 45cm	Sandy Clay Loam to Light Sandy Clay Loam	Dark Yellowish Brown 10YR 4/4	Zone of Oxidization- bio-sphere
10-11	45 to 55cm	Sandy Loam to Fine Sand	Yellowish Brown 10YR 5/4	Unweathered levee sand deposit- C horizon
12	55-57	Fine Sandy Clay Loam	Very Pale Brown 10YR 7/4	Indurated A2 horizon- buried floodplain top- soil
	57-60	Sandy Clay	Strong Brown 7.5YR 4/6	Indurated B horizon. Buried flood plain sub-soil.

Table 5.7: Trench 7 soil stratigraphy

Trench 8

Spit	Depth	Soil/sediment texture	Soil Colour	Stratigraphic Interpretation
1-9	0 to 45cm	Fine Sandy Clay Loam to Sandy Clay	Brown 10 YR 4/3	Ap Horizon Plough Layer
10	45 to 48cm	Sandy Clay	Brown 10 YR 4/3	Ap Horizon Plough Layer
	48-50	Sandy Clay	Dark Greyish Brown 10YR 4/2	Indurated A2 horizon- buried floodplain top- soil
Auger	50 to 80cm	Sandy Clay to Heavy Clay	Strong Brown 7.5YR 4/6	Indurated B horizon. Buried flood plain sub-soil.
Auger	80-85	Sandy Clay, with many coarse weak carbonate concretions	Dark Yellowish Brown 10YR4/6	B2k horizon. Buried floodplain sub-soil

Table 5.8: Trench 8 soil stratigraphy

5.2 Post depositional disturbance

For the purposes of this report, post depositional disturbance may be classed in to three possible categories;

- Pedogenesis: the natural alteration of the primary sedimentary particles through soil formation;
- Disturbance through bio-turbation, tree throw/ root activity and burrowing animals; and,
- Historic disturbance to the soil/ sediment stratigraphic units.

5.2.1 Disturbance through Pedogenesis and Bio-turbation

Soil formation and historic agricultural practices often result in the vertical and horizontal displacement of artefactual material (see Section 2.2). Soil formation and historic farming activities has affected the top 50cm of the JRL site and as such any interpretation as to whether the artefacts are in a primary depositional context needs to be assessed in light of pedological and historic processes and their affect on the original positioning of the artefacts.

In section 2.2 progressive and regressive soil forming pathways were discussed. In the case of the JRL site the levee soil displays both regressive and progressive vectors. Soil formation in the top 25cm of the levee soil is dominated by regressive soil forming factors. The deposit has been disturbed through ploughing activity and has resulted in a high degree of soil mixing creating a homogenous horizon. Artefacts located with this zone were generally oriented at random angles and the histogram in Figure 5.3 displays a generally homogenous distribution of artefacts within spits 1-4, which is indicative of soil mixing.

The lower levee soil deposit (spits 5-15) displays evidence of progressive soil formation with the presence of a distinct oxidised horizon (spits 5-8) and soil fauna activity (see **Plate 5.3**). Evidence of progressive soil formation is however only weak and confined to the oxidised horizon. It is also argued that pedogenic activity within the oxidised horizon has had a potentially marginal affect on the original positioning of the artefacts. This interpretation is supported with the absence of a distinct stone line, whereby the artefacts show two peak frequencies in spits 5 and 7 and are in general evenly represented in surrounding spits. A stone line will typically produce a battle ship type curve in relation to artefact frequency by depth, with the highest frequencies occurring from between 30 to 40cm depth and lower frequencies in the overlying and underlying layers. Furthermore, the majority of artefacts excavated *in situ* were predominantly horizontal in orientation, suggesting that soil mixing has been minimal and that artefact movement, if any, will have been in the vertical plane (see Section 2.2). The question of the degree of artefact movement can be definitively resolved with radiometric dating of this soil unit. The advantage of OSL dating lies not only in its ability to date a deposit but to also identify the presence and degree of pedogenic activity. Thus far only the basal sands of the levee have been dated. A complete dating sequence is necessary.

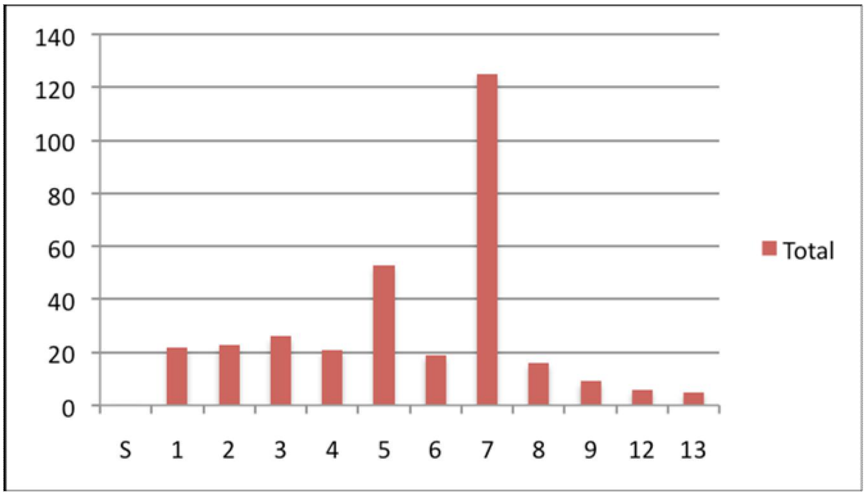


Figure 5.3: Artefact frequency by spit depth.

The basal sands of the levee deposit (spits 9-15) display no evidence of progressive or regressive soil formation. The unit displays a distinct lack of bio- turbation with no evidence of soil formation. This unit has undergone localised disturbances through root activity. However the radiometric results (see section 6) show that this disturbance is minor and has not affected the integrity of the deposit. Disturbance to this unit through animal burrowing activity is limited and only present along the northern wall of trench 2. The sediment contained within spits 9 to 15 is stratified.

The underlying floodplain soil in all instances represents a highly developed soil profile. Soil formation within the buried floodplain unit has followed a progressive pathway. The soil displays distinct horizonation, structural development and a predictable particle size sequence. The sediments within these units have been mixed and differentiated to the extent that they no longer represent their primary depositional context. Trench 2 represents the only case where primary alluvial material was encountered, specifically the Ck horizon from below 2.05m in depth. Whilst artefacts were not encountered in the floodplain soil, if present elsewhere, it is expected that they will occur as a stone line at the interface of the A and B horizon (see Section 2.2)

5.2.2 Historic Disturbance

Historic disturbances to the JRL site are evident across all excavated trenches. The top 20 to 25cm of deposit represents a plough zone, and is the most disturbed unit across the site. Furthermore, several post holes have been identified in Trenches 3 and 5. Trench 3 contains a total of 9 post hole cuts, while 2 identical cuts were identified in Trench 5 (**Plates 5.13** and **5.14**).These post holes have been cut in to the unweathered basal sediments of the levee deposit and in some instances have been cut in to the buried flood plain surface. Soil mixing in Trench 3 is considered to be high.

Historic artefacts have been found in all 8 trenches. Table 5.1 outlines the historic finds according to trench and spit depth. The majority of these finds are confined to the top 30cm of deposit comprising the plough zone. The presence of historic material in this soil unit requires no further discussion owing to the fact that the entire top soil deposit has been interpreted as anthropogenic in origin. Four of the historic finds do however require further discussion owing to their location in what have been interpreted as potentially undisturbed deposits.

A small piece of European green bottle glass was recovered from Trench 3 at 65-67cm depth. This unit comprises the unweathered levee basal sands. Its presence is irrelevant as it comes from soil collected when the trench walls were scraped back during cleaning for photographs. It is obvious that this piece of glass could have come from any depth in the trench and has to be disregarded. Furthermore, Trench 3 has undergone the highest degree of historic disturbance down to depths which penetrate the buried floodplain soil.

The historic material found in Trench 4 comprises a single piece of colourless glass, 1cm in size. It was found in spit 11 from between 50 and 55cm in depth. In the case of Trench 4 this spit lies immediately underneath the oxidised layer which has already been interpreted as potentially disturbed, with evidence of maximum soil mixing. It is situated at the upper most extent of the unweathered basal sands and its presence does not cast doubt on the integrity of the underlying stratified deposit. It simply denotes that this layer is likely to have undergone a degree of disturbance and any artefacts associated with this layer should be interpreted with this finding in mind.

The historic material found in Trench 2 at 90-100 cm comprises a ceramic fragment <3 mm in size. This piece is probably the result of contamination during the excavation process. Alternatively, being so small, it may have been carried down from the upper layers through soil fauna and root activity. Its presence should not cast doubt on the integrity of the deposit. Trench 2 has been subject to radiometric analysis, which has established the integrity of the deposit (see Section 6). In this light, the ceramic fragment indicates either contamination or minor disturbance of the sediments.

Disturbance to Trench 1 is not as easily explained as the find comprises an earthenware fragment >2cm in size. Trench 1 has not been the subject of a detailed radiometric analysis and until this analysis is completed interpretations as to the integrity of the deposit in Trench 1 will be speculative at best. It is worth noting that in light of the radiometric results from trench 2, it is probable that disturbance through soil movement will be highly localised and will therefore not cast doubt on the integrity of the entire deposit.

Overall, post- depositional disturbance across the levee site is not significant. However artefactual material will need to be interpreted in light of the soil forming factors and historic disturbances highlighted above.

Trench Id.	Historic Finds / depth cm	Soil Stratigraphic Unit
Trench 1	Spits 1-4 (0-25cm)	Plough Zone- Ap Horizon
	Spit 16 (67-77cm)	Indurated A2 horizon- buried floodplain soil
Trench 2	Spits 1-4 (0-25cm)	Plough Zone- Ap Horizon
	Spit 18 (90-100cm)	Iron B Horizon- buried floodplain soil
Trench 3	Spits 1-3 (0-15cm)	Plough zone- Ap horizon
	Spits 4-7 (15-35cm)	Bio-sphere, zone of oxidisation and soil fauna activity
	Spit 9 (40-45cm)	C horizon- unweathered levee sand deposit
	Spit 14 (65-67cm)	C Horizon- unweathered levee sand deposit
Trench 4	Spits1-5 (0-25cm)	Plough Zone- Ap Horizon
	Spit 11 (50-55cm)	Interface of bio-sphere and C Horizon
Trench 5	Spits 1-4 (0-25cm)	Plough Zone- Ap Horizon
	Post hole	Historic Feature
Trench 6	Spits 1-2 (0-10cm)	Plough Zone Ap Horizon
Trench 7	Spits 1-6 (0-30cm)	Plough Zone Ap Horizon
	Spits 2-5 (5-25cm)	Plough Zone Ap Horizon

Table 5.9: Historic finds according to depth and soil stratigraphic unit.

Plate 5.13; Detail of post hole in trench 5, view facing west.

Plate 5.14; Detail of three post holes evident along the northern wall of trench 3.

5.3 Ground Penetrating Radar

A geophysical investigation using Ground Penetrating Radar (GPR) was conducted from the 15th to the 19th February 2010 at the JRL site by GBG Australia. The results of this report are presented in Appendix D

GPR was employed at the site owing to the fact that the loose sandy deposits which comprise the JRL site have the potential to contain Aboriginal burials. Aboriginal burials are commonly found in loose sandy deposits such as alluvial or aeolian landforms, as sand deposits are easily excavated for the internment of the dead. Non-invasive methods such as GPR can provide subsurface information enabling the detection of potential burials.

It is not necessary to reiterate the methods and detailed findings of the GPR survey in the body of this report as this information is presented in Appendix D. Rather, what follows is a brief summary of the findings of the analysis and how the results fit in to the wider archaeological picture identified at the levee.

No conclusive evidence of Aboriginal burials within the levee deposit is apparent in the GPR data. The collected GPR profiles show that the soil stratigraphic units excavated in trenches 1-8 are uniform across the entire levee deposit and the majority of the features identified in the data appear to be contained to the plough zone or near the interface between the plough zone and fine sand layer. Deeper subsurface features within the fine sand layer were less common, with few targets of potential interest identified below a depth of approximately 70cm.

Numerous small hyperbolic reflections were visible in the GPR profiles, observed at shallow depths within the plough zone. The majority of these findings have been interpreted as small isolated features such as rock floaters or small objects often metal fragments from recent human occupation, whilst others may represent larger objects. Some of the features identified within the plough zone were identified over multiple adjacent profiles and have been interpreted as lateral roots, either from trees outside the survey area or remnants of previously removed trees. A feature identified on numerous profiles has been identified as the buried optic fibre cable running through the site (refer Appendix D).

Throughout the investigation area a number of anomalies were identified at a depth near to the interface between the plough zone and lower fine sand layer. The majority of these are observable on single or two GPR profiles which suggest that they are of limited size. Anomalies within this class have been interpreted as objects which were deposited within the plough zone but have been pushed into the lower fine sand layer. A number of interpreted fence post holes which have penetrated into the fine sand layer were exposed during the archaeological excavation in Trench 3 and 5, and may be of this type.

The majority of the collected GPR profiles show a distinctive high amplitude reflective layer at an approximate depth of between 20 and 50cm. This layer has been attributed to the interface between the plough zone and the fine alluvial sand layer, the high amplitude suggesting that there is a marked difference in the composition of the two layers. This finding supports the soil stratigraphic information retrieved from the archaeological excavation. This difference is primarily related to the fact that the lower sandy deposit comprises an unweathered alluvial deposit distinctly different from the overlying soil profile.

The interpretation of the GPR data at the Jordan River Levee site has identified only a few features within the fine alluvial sand layer. Being the layer most probably containing potential Aboriginal burials, detailed analysis of all identified anomalies within this layer was performed. As with anomalies identified at shallower depths, these all appear to be present on either single or at most 2 GPR profiles and therefore are of limited extent. Together with their limited extent, the GPR signal characteristics of the anomalies within this layer indicate that they are unlikely to be Aboriginal burials.

The interface marked by the indurated A2 horizon, between the levee deposit sequence and lower buried soil is not clearly defined as an increased amplitude layer in the GPR data. Rather the interface is marked by drop in the data quality at a depth of over 1 m resulting from the high rate of radar wave absorption from clay dominant composition of the buried soil.

A number of features of potential interest have been identified in the GPR data within grids B, C, H, J and K and have been labelled on diagrams (refer to Appendix D). These probably do not represent Aboriginal burials as they are limited in extent however they do warrant a mention as the signal characteristics of these anomalies are different to others identified in the investigation area. The exact nature of these features is unknown however destructive examination of these features would be straightforward if deemed necessary.

The findings of the GPR survey indicate that the soil stratigraphic units are homogenous across the site, in that each unit is continuous and equally represented. The soil stratigraphic findings and post- depositional disturbances identified throughout the archaeological investigations may therefore be extrapolated across the entire levee deposit. While disturbance to the soil deposits is present across the JRL site it is important to note that these disturbances appear to be limited in extent.

6 Radiometric Analysis and Site Formation

6.1 Background

The Jordan River floodplain deposits are ideal for Optically Stimulated Luminescence (OSL) dating. These deposits contain quartz grains that have been subject to ionizing radiation (U, Th, Rb & K) following transport and burial. Electron traps in the crystal lattice of the quartz accumulate this energy over time. The stored radiation dose can be evicted by stimulation with white light and is released as photons or ‘luminescence’. OSL dating is based on measuring the radiation dose received by the sediment sample since it was last exposed to sunlight and the dose rate that produced it. Put simply, the age is the palaeodose (or equivalent dose, ED) divided by the dose rate.

The soil stratigraphy at the JRL site is composed of two distinct soil stratigraphic units (see Section 5). The upper unit is the levee deposit while the lower unit is the older floodplain that the levee has been built on. The basal sediments of the levee and older floodplain have been dated using OSL. Figure 6.1 and Table 6.1 show the results.

6.2 OSL Results

			Radionuclide concentrations[b]									
Sample name	Depth (m)	Water[a] (%)	K (%)	Th (ppm)	U (ppm)	α radiation[c] (Gy ka^{-1})	β radiation[d] (Gy ka^{-1})	γ radiation[e] (Gy ka^{-1})	Cosmic-ray radiation[f] (Gy ka^{-1})	Total dose rate (Gy ka^{-1})	Equivalent dose[g] (Gy)	Optical age (ka)
JR01	0.98	10 ± 2	1.18 ± 0.04	8.99 ± 0.28	1.78 ± 0.06	0.03 ± 0.01	1.11 ± 0.05	0.75 ± 0.06	0.18 ± 0.02	2.08 ± 0.08	113 ± 7	54.4 ± 3.9
JR02	1.90	10 ± 2	0.95 ± 0.03	6.09 ± 0.19	1.13 ± 0.04	0.03 ± 0.01	0.84 ± 0.04	0.66 ± 0.05	0.15 ± 0.02	1.68 ± 0.07	100 ± 5	59.4 ± 3.6
JR03	0.45	5 ± 2	1.11 ± 0.04	14.14 ± 0.43	2.38 ± 0.08	0.03 ± 0.01	1.33 ± 0.06	1.03 ± 0.08	0.19 ± 0.02	2.57 ± 0.10	68 ± 6	26.6 ± 2.6
JR04	0.55	5 ± 2	1.15 ± 0.04	14.29 ± 0.44	2.35 ± 0.08	0.03 ± 0.01	1.35 ± 0.06	1.04 ± 0.08	0.19 ± 0.02	2.61 ± 0.10	89 ± 6	34.0 ± 2.8
JR05	0.65	5 ± 2	1.11 ± 0.04	12.51 ± 0.38	2.15 ± 0.07	0.03 ± 0.01	1.26 ± 0.06	1.04 ± 0.08	0.19 ± 0.02	2.52 ± 0.10	95 ± 9	37.5 ± 3.8

[a] estimated time-averaged moisture contents, based on measured field water values (% dry weight)

[b] obtained by INAA (Becquerel Laboratories, Mississauga, ON, Canada)

[c] assumed internal alpha dose rate

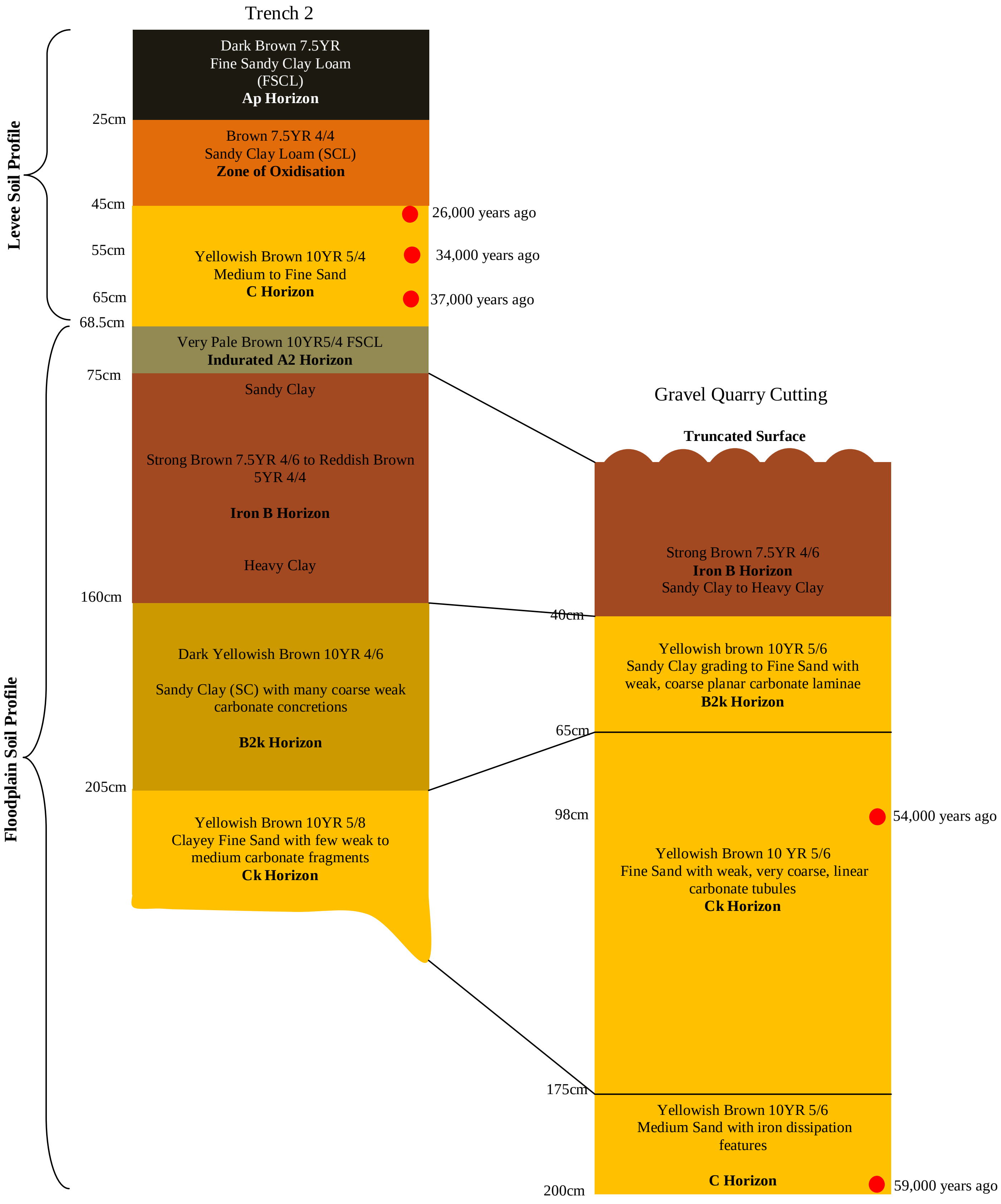
[d] derived from INAA radionuclide concentration measurements using the conversion factors of Adameic and Aitken (1998), corrected for attenuation by water and beta attenuation

[e] derived from field gamma spectrometry measurements using the conversion factors of Adameic and Aitken (1998), corrected for attenuation by water

[f] calculated using the equation of Prescott and Hutton (1994), based on sediment density, depth and site latitude and altitude

[g] central age model (Galbraith *et al*. 1999), including a ± 2 % systematic uncertainty associated with calibration of the laboratory beta-source.

Table 6.1: Radiometric results.


Trench 2
Levee Soil Profile
Floodplain Soil Profile
Dark Brown 7.5YR
Fine Sandy Clay Loam
(FSCL)
Ap Horizon
25cm
Brown 7.5YR 4/4
Sandy Clay Loam (SCL)
Zone of Oxidisation
45cm
26,000 years ago
55cm
Yellowish Brown 10YR 5/4
Medium to Fine Sand
C Horizon
34,000 years ago
65cm
37,000 years ago
68.5cm
Very Pale Brown 10YR5/4 FSCL
Indurated A2 Horizon
75cm
Sandy Clay
Strong Brown 7.5YR 4/6 to Reddish Brown 5YR 4/4
Iron B Horizon
Heavy Clay
160cm
Dark Yellowish Brown 10YR 4/6
Sandy Clay (SC) with many coarse weak carbonate concretions
B2k Horizon
205cm
Yellowish Brown 10YR 5/8
Clayey Fine Sand with few weak to medium carbonate fragments
Ck Horizon
Gravel Quarry Cutting
Truncated Surface
Strong Brown 7.5YR 4/6
Iron B Horizon
Sandy Clay to Heavy Clay
40cm
Yellowish brown 10YR 5/6
Sandy Clay grading to Fine Sand with weak, coarse planar carbonate laminae
B2k Horizon
65cm
98cm
54,000 years ago
Yellowish Brown 10 YR 5/6
Fine Sand with weak, very coarse, linear carbonate tubules
Ck Horizon
175cm
Yellowish Brown 10YR 5/6
Medium Sand with iron dissipation features
C Horizon
200cm
59,000 years ago

6.3 Discussion

The most striking feature of the OSL dating results is that the ages are much older than expected and in perfect stratigraphic order. The two ages from the older floodplain unit show a major episode of fluvial aggradations' in the Jordan River valley around 60,000 years ago. This episode had ceased by around 50,000 years ago, with no deposition until the onset of levee formation around 40,000 years ago. During this hiatus of at least 10,000 years, a weakly calcareous red brown alluvial soil formed on the older floodplain unit. This stable land surface would have been an ideal campsite for early Aboriginal occupation and significant evidence of this is likely to be present in the study area.

Levee building commenced around 40,000 years ago but it is unclear when deposition ceased because the uppermost 45 cm of the 70 cm thick sequence is yet to be dated. Nonetheless, the three OSL ages obtained so far show a gradual build up of sediment over a period of around 12,000 years. This is a rate of deposition of ~1 cm/600 years. If this rate was constant over the period that the levee was building, deposition would be continual to the present day.

The OSL dating results are remarkable for not only being in perfect stratigraphic order but also for demonstrating the integrity of the Aboriginal site. Most open sites in Australia are not well-preserved or stratified because of disturbance factors ranging from natural pedogenic processes to European impacts such as the introduction of rabbits. These processes have the effect of mixing artefacts and sediments so that they are no longer in their original position. When OSL dating is applied, the distribution of palaeodoses will be skewed by younger grains as a consequence of this mixing.

The OSL data for the JRL site show no evidence of mixing. This was to be expected of the older floodplain samples, which were taken at significant depths below the surface. The younger levee deposit, in contrast, was vulnerable to post-depositional mixing but returned unusually peaked palaeodose distributions similar to the older sediments. This is significant because it shows that the lowermost levee sediments are undisturbed and the cultural layers *in situ*.

A complete radiometric analysis will be included in the final excavation report.

7 Artefact Analysis

A total of 8 trenches were excavated along the Jordan River Levee; only one of which has been analysed in any detail. The following discussion of the stone artefact assemblage recovered from Trench 2 therefore represents only one eighth of the available information for the site and must not be considered a conclusive or exhaustive interpretation of prehistoric behaviour at the JRL site

The excavation of the site by the removal of spits in strict 5cm layers allowed tight temporal control over the site. Spatial control was also assured through the removal of the deposit in 50 x 50cm squares and with the exact locations of in situ artefacts plotted in three dimensions. The unique level of spatial and temporal control exerted over this site will allow for the identification of isolated knapping events and snapshots of human behaviour in time that are all but impossible in 99% of archaeological sites. Unfortunately, this level of analysis has not been possible at this time due to the urgent need to provide feedback on the site. Future investigations will need to be conducted that involve conjoin analyses of related artefacts and that explore relationships between artefacts with similar spatial and temporal relationships. These studies will not only improve our understanding of the technology of the site but also our understanding of the sites integrity.

It must, therefore, be understood that the following summary and interpretation is not complete and that further information will be provided in the final report.

7.1 Assemblage Composition

An assemblage of 466 lithic items was obtained from the deposit in Trench 2. The vast majority of the assemblage comprised unretouched flakes (N=317), with shatter and non-diagnostic flaked pieces comprising another 25% (N=121). Cores and retouched flakes together make up less than 3% of the assemblage (N=15) and non-artefactual manuports complete the total (N=13, 2.79%). These figures are summarised in Table 7.1.

Artefact Class	Total	%
Core	6	1.29%
Flake	317	68.03%
Flaked Piece	55	11.80%
Non-artefactual	5	1.07%
Retouched Flake	9	1.93%
Shatter	66	14.16%
Unworked Manuport	8	1.72%
Total	466	100%

Table 7.1: Assemblage Composition at Trench 2, JRL.

From the eighteen spits excavated from the site, only thirteen layers were found to be artefact bearing. Spits 5 and 7 show the highest artefact levels, with over 50% of the assemblages occurring in these two layers. Artefact classes are relatively evenly spread between these layers with flakes representing 60-70% in most layers with a reasonable sample size (see Table 7.2).

Spit	Core	Flake	Flaked Piece	Non-artefactual	Retouched Flake	Shatter	Unworked Manuport	Total
Surface					1			1
1	2	20	5			3		30
2		22	8		2	1		33
3		27	6			2		35
4	1	21	2			12		36
5		51	4		2	9	6	72
6		18	3		1	1		23
7	2	124	22	2	1	30	2	183
8		14	1		2	3		20
9	1	8	4	3		4		20
12		6						6
13		5						5
17		1						1
18						1		1
Total	6	317	55	5	9	66	8	466

Table 7.2: Artefacts by Spit

A wide range of raw materials are present at the site, with quartzite (27.9%), silcrete (21.89%), chert (14.38%), a fine grained siliceous material (12.88%) and hornfels (11.16%) most common. The distributions of raw materials by artefact class are detailed in Table 7.3. The dominance of shatter in the same raw materials as most of the flaked artefact categories lends strong support to much of this material being non-diagnostic by-products of manufacture.

Raw Material	Core	Flake	Flaked Piece	Non-artefact	Retouched Flake	Shatter	Unworked Manuport	Total
Basalt		3					1	4
Brecciated Chert					1		1	2
Ceramic		1				2		3
Chert		54	9			4		67
Cortex		2						2
Fine Grained Siliceous	1	47	6	1	1	4		60
Fine Grained Volcanic		5						5
Glass		2				1		3
Hornfels		45	4		2		1	52
Petrified Wood		1						1
Quartz		3						3
Quartzite	1	69	16	1	1	40	2	130
Sandstone		7		2		1	1	11
Silcrete	3	64	19		4	10	2	102
Silicified Mudstone	1	11	1	1				14
Unknown		3				4		7
Total	6	317	55	5	9	66	8	466

Table 7.3: Artefact Class by Raw Material.

The artefacts recovered from trench 2 of JRL are generally very small in size, with more than 80% of the assemblage measuring less than 20mm, and over half measuring between 5-15mm (N= 289) in length. Only 8 artefacts measure more than 50mm in length and all were recovered from spits 8, 9 and 12. Table 7.4 below shows that a wide range of sizes occurred at all depths of excavation. The absence of size sorting in layers throughout the site indicates that the deposit has retained good stratigraphic integrity.

7.2 Technological Analysis

The technological analysis below provides detailed information relating to the manufacture of stone artefacts, mobility strategies and provisioning systems. Due to the fact that a single flake may break into several pieces and thus be counted several times, the majority of these measurements have been made on complete artefacts only. This is to ensure that artefact numbers are not artificially inflated (such as counting the same flake twice) or distorted by the inclusion of potentially non-artefactual material (such as shatter). As such, the following technological analysis has been conducted only on those items considered to be unequivocally artefactual and complete. Broken flakes and useable portions of broken flakes are discussed separately in a subsequent section.

7.2.1 Raw Material Usage

A total of 185 flakes, 5 cores and 8 retouched flakes were recovered complete from the Trench 2 deposit. These artefacts were made from the same range of raw materials detailed above with chert, quartzite, fine grained siliceous (FGS) and hornfels dominating the assemblage. Importantly, the cores found were manufactured only from FGS, quartzite, silcrete and silicified mudstone, whilst the unretouched and retouched flakes recovered have been made from a far wider range of materials. For example, 37 chert flakes exist for which no core has been found on site (see Table 4). The presence of flakes without cores indicates that prehistoric visitors to the site were transporting materials to the site and performing low level maintenance activities before continuing to transport that material elsewhere. Failure to discard a core onsite indicates that it continued to be useful and was retained for use elsewhere.

Having said as much, it is important to remember that the excavated portion of the site is less than 1% of the total size of the levee and that the analysed portion of the material is approximately one eighth of the excavated material. It must therefore, be remembered that the interpretation of this single trench will be subject to change should analysis of the additional trenches identify larger frequencies of cores or different technologies. The ability for interpretations to change with increased information must be remembered throughout the discussion below.

Raw Material	Core	Flake	Retouched Flake	Grand Total
Basalt		3		3
Brecciated Chert			1	1
Ceramic		1		1
Chert		37		37
Cortex		2		2
FGS	1	34	1	36
FGV		3		3
Glass		2		2
Hornfels		17	1	18
Petrified Wood		1		1
Quartz		3		3
Quartzite	1	36	1	38
Sandstone		5		5
Silcrete	2	32	4	38
Silicified Mudstone	1	7		8
Unknown		2		2
Grand Total	5	185	8	198

Table 7.4: Artefact Class by Raw Material – Complete Artefacts Only

The sizes of the individual artefacts recovered from trench 2 are, in general, very small, ranging in size from less than 3mm to 95mm but with more than 81% of the assemblage measures less than 20mm in length with more than 60% measuring between 5 and 15mm.

Artefact weights further demonstrate the micro size of the assemblage, with more than 71% of the site weighing less than 1g (see Table 7.5). These figures show a site that is dominated by small, light micro-flakes with minimal evidence of on-site manufacture (as indicated by the small numbers of cores present on site). Similarly, the presence of large numbers of flakes from a wide range of raw materials indicates the on-site maintenance of existing tools/materials that have been subsequently transported for further use elsewhere and not discarded at this site.

Comparisons of artefact sizes relative to raw materials show very little differences, with the range of artefact sizes directly related to the number of artefacts manufactured from that material. The larger the assemblage size, the greater the range in artefact sizes represented. Overall, there does not appear to have been any preferential treatment of raw materials across the site.

Weight (g)	Total	Total
less than 0.09g	63	31.98%
0.1-0.19g	30	15.23%
0.2-0.29g	14	7.11%
0.3-0.39g	10	5.08%
0.4-0.49g	5	2.54%
0.5-0.99g	21	10.66%
1.0-1.99g	12	6.09%
2.0-2.99g	9	4.57%
3.0-3.99	5	2.54%
4.0-4.99g	1	0.51%
5.0-9.99g	6	3.05%
10.0-14.99g	3	1.52%
15.0-19.00g	1	0.51%
20.0-24.99g	3	1.52%
25-29.99g	2	1.02%
30-39.99g	3	1.52%
40-49,99g	5	2.54%
57.28g	1	0.51%
60.59g	1	0.51%
130.8g	1	0.51%
203.9g	1	0.51%
Total	198	100.00%

Table 7.5: Artefact Weights in Trench 2 (complete artefacts only).

7.2.2 Artefact Reduction

A number of measurements of artefact reduction were taken for this assemblage, flake elongation, decortication, presence/absence of overhang removal, dorsal scar numbers on flakes and evidence of rotations of the core prior to each flake's manufacture. These are discussed in order below.

Flake elongation measures the extent to which knappers are regularly producing flakes of a particular shape, by providing a length to width ratio for the flake. It provides some measure of whether a particular technology is being consistently utilised. Elongation measures for trench 2 range between 0.3 and 3.5 with 74% of the assemblage falling between the ranges of 0.6 and 1.5. The majority of the flakes at this site therefore tend to be rounded in shape with length being shorter than width in most cases. The second most common group of ratios shows length becoming up to 50% longer than width but does not suggest a strong intention to produce consistent blade like performs. A total of 15 flakes (8%) have lengths that are more than double their width and are able to characterised as 'blade-like' in form. However, these flakes have been manufactured from 6 different raw materials and cover 7 different size categories indicating that there was no consistent blade size production or material used. Elongation measures therefore indicate that specialised blade making or regular blank technologies were not utilised at this site.

Decortication levels are extremely high at this site, with more than 75% of the assemblage (N=139) no longer retaining any cortex and a further 22% (N=41) of artefacts retaining secondary cortex. Only 5 of the artefacts recovered were primary cortex flakes, with no more than two found in any single layer of the site. These measures lend support to the argument that on site manufacture was minimal at trench 2. Raw materials were arriving on site having already been decorticated elsewhere and were then carried on for future use.

Overhang removal is a technique used by knappers to alter the shape and size of the platform and therefore adjust the amount of force required to create a flake as well as the size of the resultant flake. Its presence at a site gives some indication of the need to preserve raw materials, be reducing platform size and therefore reducing the amount of material used in each flake's production. The small size and weight of the flakes recovered from this site already lend support to the idea of raw material provisioning, however rates of overhang removal provide greater confirmation with over 50% of flakes (N=100) showing evidence of platform preparation. Comparisons between frequencies of overhang removal and raw material (see Table 7.6) show that platform preparation was less necessary on materials such as silcrete, quartzite and chert. This suggests that the need to conserve these particular raw materials was not as great at this site and may have been locally available.

Raw Material	Absent	Present	Total
Basalt	1	2	3
Brecciated Chert	1		1
Ceramic	1		1
Chert	17	20	37
Cortex	2		2
FGS	16	19	35
FGV		3	3
Glass		2	2
Hornfels	6	12	18
Petrified Wood	1		1
Quartz	2	1	3
Quartzite	26	12	38
Sandstone	1	4	5
Silcrete	21	17	38
Silicified Mudstone	2	6	8
Unknown		2	2
Total	92	100	192

Table 7.6: Frequency of platform preparation with raw material.

The number of dorsal scars and dorsal rotations on a flake records the number of flakes removed from that portion of the core prior to the manufacture of the flake and the number of times the core was rotated to create a fresh platform. As such, they provide a measure of how much reduction the core had experienced. Dorsal scar counts at trench two number between 0 and 8, from anywhere between 0 and 3 platforms. Highest frequencies of both dorsal scars and rotations occurred on chert, FGS, silcrete and hornfels. The ability to reduce these materials further than others may be due to a number of reasons. The first is that the materials themselves may outcrop in larger nodules than other materials making it physically possible to reduce them further than alternative materials. The second is that the other materials being brought into the site had been decorticated but not heavily reduced, to the extent that they were transported away retaining much of their future reductive potential. The third is that these materials were more highly prised and were reduced further for conservation purposes. The first two of these options seem most likely at this site, given that the larger size categories are filled by these raw materials and that exhausted cores from the remaining materials have not been discarded at the site.

Across the site, the generally low levels of reduction indicated by both dorsal scar numbers/rotations and the presence or absence of overhang removal may be explained in large part by the small sizes of the artefacts present. If these flakes are being removed from a small portion of an already reduced flake/core that is no longer present at the site, then the need for overhang removal is much lower and the number of dorsal scars/rotations that will be represented on the flakes themselves will be much lower than is likely to be present on the artefact from which it was removed.

7.2.3 Retouched Flakes and Cores

A total of 8 retouched flakes were recovered from 5 spits (spits 2, 5, 6, 7 and 8) within trench 2. The raw materials used were FGS, hornfels, quartzite, silcrete and brecciated chert. In general, the retouch on each flake is quite minimal, not extending past one or two edges and generally relatively shallow. The details of the retouched flakes have summarised in table 7.7 below.

Spit	Raw Material	Length	Weight	Dorsal Scars	Dorsal Rotations	Ret Length	Ret Orient	Ret Depth	Ret Angle
2	Hornfels	41.14	29.7	6	1	48.2	V-D	9.13	69,85
2	Hornfels	54.24	21.24			31.66	Both	7.24	78
5	FGS	49.62	25.28	4	1	107.63	V-D	18.96	67,53, 80
5	Silcrete	49.76	40.62	5	2	40.57	V-D	3.86	67
6	Brecciated Chert	35.58	8.56	4	1	30.76	Both	8.26	129
7	Silcrete	39.75	22.46	4	1	11.75	V-D	11	57
8	Quartzite	26.03	5.13	3	0	14.55	V-D	6.32	68
8	Silcrete	79.91	130.8	9	1	23.94	V-D	4.17	63

Table 7.7: Metrics for Retouched Flakes from Trench 2.

One exception is the fine grained siliceous retouched flake recovered from spit 5 which has three retouched edges, with the retouch varying from quite steep along the distal end to lighter scarring that appears to be use-wear. This artefact will be subject to high-magnification analysis as soon as it can be removed to the mainland. These retouched artefacts are likely to have been rejuvenated before discard on site.

A total of 5 cores were recovered from 3 spits in Trench 2 (Table 7.8). This assemblage size is too small to produce any level of complicated analyses and only general observations may be made. All five cores are made from locally available raw materials and retain up to 80% cortex. Only 1 core shows signs of extensive working with more than 28 scars emanating from 6 rotations. The remaining cores show minimal scarring, with only 2 considered to be exhausted at discard. The presence of these cores does show that artefact manufacture did occur at the site, but only in extremely low levels.

Spit	Raw Material	Length (mm)	Weight (g)	% cortex	Number of Scars	Number of Rotations	Termination of last scar	Exhausted
1	Silcrete	36.17	46.32	0	28	6	Step	
1	Silicified Mudstone	21.65	14.16	40	1	0	Step	Yes
7	Fine Grained Siliceous	89.37	39.36	80	1	0	Feather	
7	Quartzite	17.12	2.88	0	2	1	Feather	Yes
9	Silcrete	77.25	57.28	10	6	2	Feather	

Table 7.8: Metrics for Cores from Trench 2.

These retouched artefacts are likely to have been rejuvenated before discard on site. The low levels of artefact manufacture evidenced by the assemblage as a whole and the lack of cores within layers containing retouched artefacts indicates that retooling did not occur at the site. However, the contents of the remaining 7 trenches may identify retooling areas and other activity loci.

7.2.4 Changes Over Time

The tight chronological control that this site provides makes it possible to explore changes in assemblages over time. Figures 7.1- 7.6 summarise the mean/mode calculations for a range of technological including length, elongation, weight, dorsal scar and rotation frequencies and cortex for each spit. While it must be remembered that in some cases the mean has been determined on only a handful of cases and in others 70 or 80 artefacts, it is still clear that some changes have occurred over time at the site. Statistical analyses are required before any weight can be given to many of these observed trends and will be carried out and reported on in the final report. In the meantime, a number of observations can be made.

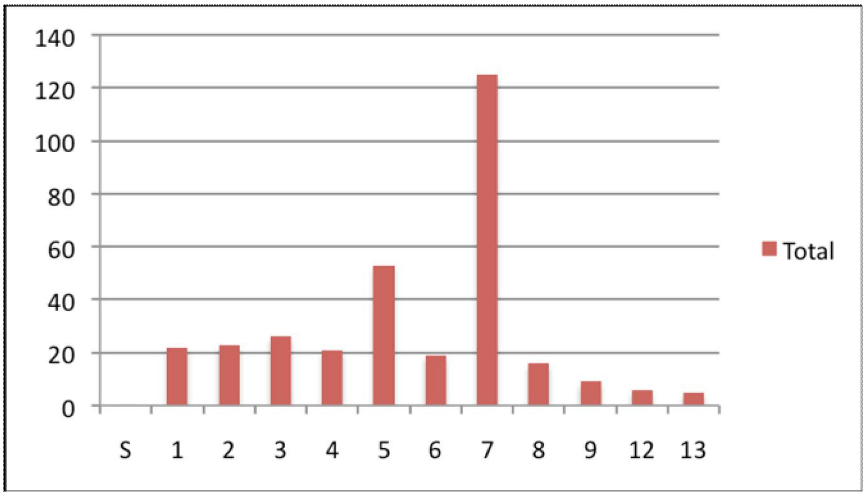


Figure 7.1:Total number of artefacts per spit at Trench 2.

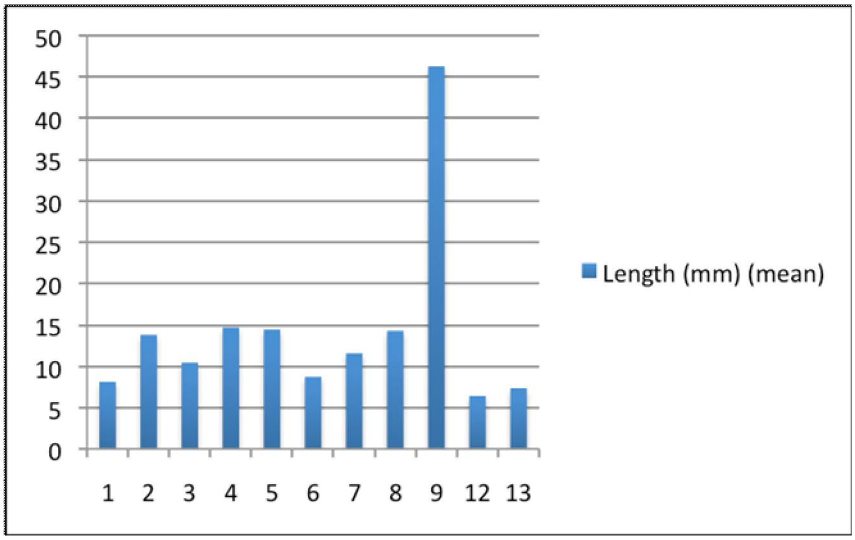


Figure 7.2: Mean artefact length by spit at Trench 2.

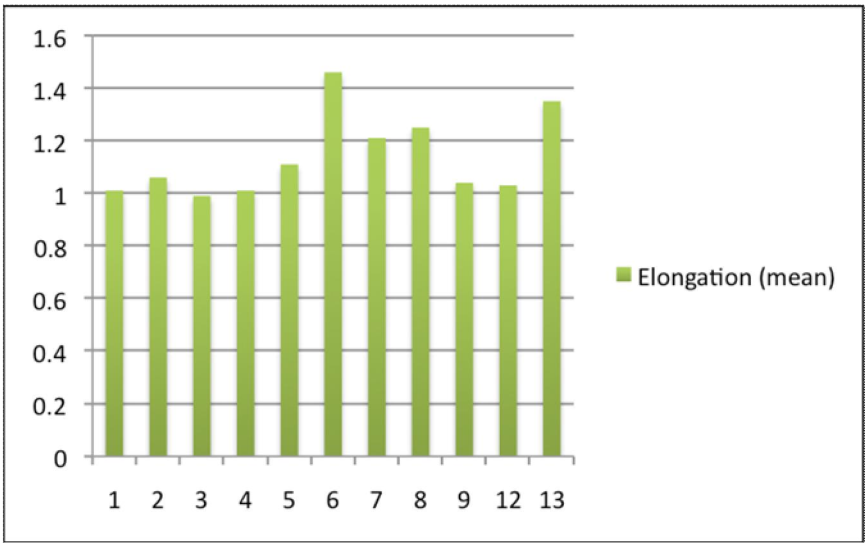


Figure 7.3: Mean elongation ratios by spit at Trench 2.

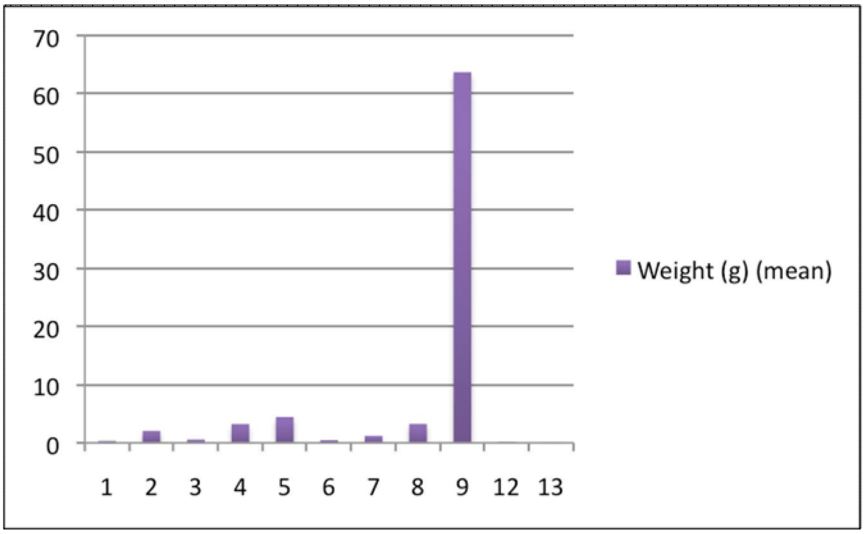


Figure 7.4: Mean weight by spit at Trench 2.

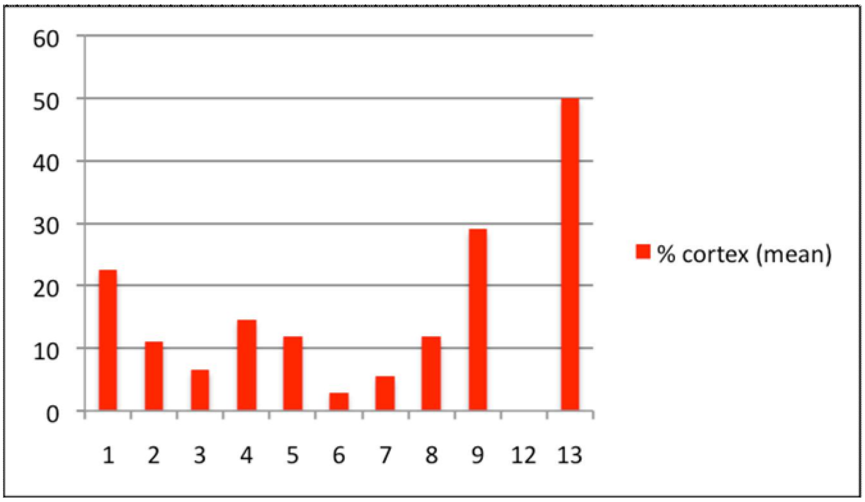


Figure 7.5: Mean cortex by spit at Trench 2.

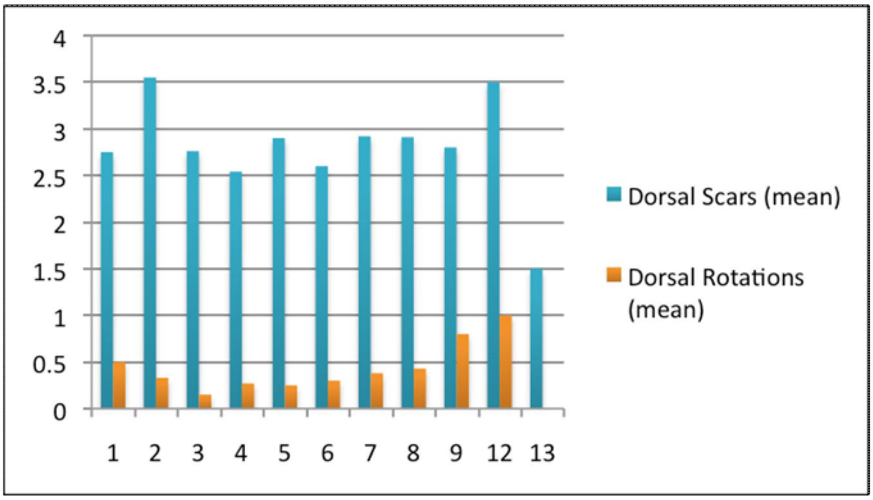


Figure 7.6: Mean dorsal scar and rotation numbers by spit at Trench 2.

At a general level flake lengths and shape remain fairly similar over time at trench 2. Subtle shifts can be seen in mean artefact length in the upper 8 spits and spits 6, 8 and 13 show slight increases in flake elongation. Dramatic differences occur in the mean length and weight of artefacts recovered from spit 9. While only 8 complete flakes were excavated from this spit, 4 of these were large and heavy and show a marked difference from the much tinier flakes recovered throughout the deposit. Three out of four of these larger flakes were made from silcrete which appears to be locally available, with the fourth flake made from hornfels, another local material.

The higher rates of mean cortex remaining on artefacts from spit 9 also support this interpretation with the curated behaviour of maintenance evidenced by low levels of cortex, such as in spits 5, 6 and 7 and more expedient tool use represented by higher levels of cortex (e.g. spits 9 and 13). Nevertheless, it is important to note that overall rates of cortex are extremely low across the entire site and changes in % cortex are more subtle than they appear.

Dorsal scar frequencies and rotations are fairly similar across the site with 1 or fewer scars differentiating the highest from the lowest means in most cases. Spit 13 is the exception to this rule, with the 2 flakes found to have 100% cortex in a spit of only 6 flakes affecting the mean in this case.

These studies suggest that while differences clearly exist in occupation intensity over time, with peak periods of occupation at spits 5 and 7, there are very few obvious changes in technology over time. Flake size, weight and decortication measures do show a change in site use between spits 8 and 9. Spits 1-8 indicate use of the site as a place for tool maintenance and rejuvenation with raw materials being decorticated elsewhere, minimally worked on site and then transported for further use elsewhere. By comparison, the number, size and weight of the flakes in spits 9 and 13 show low-level site use, with expedient use of locally available materials, which have been discarded on site.

Three OSL dates were taken from the basal sand deposits of the levee soil. These dates encapsulate a depth range from the base of spit 8, dating to 26,000 years, the base of spit 10, dating to 34,000 years, and the base of spit 12, dating to 37,000 years ago. The artefacts from spit 13 and 12 are around 37,000 years old, while the artefacts within spit 9 date from between 34,000 to 26,000 years ago. Artefacts from spit 8 are from 26,000 years old (see section 6). No radiometric data has been retrieved for spits 5-7, and it is not possible to date spits 1-4. Radiometric data should be retrieved for spits 5-7 as it may be possible to obtain a reliable OSL reading within these spits (see Section 5.2.1). This is of particular importance owing to the fact that the majority of the assemblage is located within these spits.

In the absence of radiometric data from the full soil sequence of the levee deposit it is difficult to interpret the assemblage entirely. However, it is likely that the artefacts within spits 9 to 13 represent brief use of the site for the expedient use of raw materials from between 37,000 to 26,000 years ago, and that later use of the site from 26,000 years ago, shifted to longer term, more frequent occupation, during which maintenance/rejuvenation activities were undertaken.

Further to this and of great importance at the JRL site is the presence of two pieces of flaked European glass. This suggests that the JRL site was occupied from the Pleistocene era through to the present historic era, a finding which represents continuity of Aboriginal presence at the site over a vast period of time.

It is important to reiterate that statistical analyses of the artefact assemblage are required before any weight can be given to many of these observed trends and will be carried out and reported on in the final report. Furthermore, the unique level of spatial and temporal control exerted over this site will allow for the identification of isolated knapping events and snapshots of human behaviour in time that are all but impossible in 99% of archaeological sites. Unfortunately, this level of analysis has not been possible at this time due to the urgent need to provide feedback on the site. Future investigations will need to be conducted that involve conjoin analyses of related artefacts and that explore relationships between artefacts with similar spatial and temporal relationships. These studies will not only improve our understanding of the technology of the site but also our understanding of the sites integrity.

7.2.5 Post-Depositional Damage and Minimum Number Estimates

Post depositional damage has affected a large proportion of the trench 2 assemblage, with 38.5% (N=129) of the assemblage showing some sign of damage (Table 9). Spits 1-4 show signs of post-depositional damage on approximately 50% of the assemblage. This damage accords with what we know of the history of the site with the top 4 spits having been subject to ploughing and mixing through mechanical damage and bioturbation. These rates of damage decrease with soil depth down to 30% or less in the lower levels.

The broken flakes detailed in Table7.9 include the 5 longitudinally conal split (LCS) flakes recovered from spits 1, 2, 3 and 4. LCS flakes are created through excessive force when the flake itself is manufactured and are therefore signs of on-site manufacture. All 5 LCS flakes are made from quartzite, silcrete or chert and provide some evidence of on-site manufacture in the upper layers of the site.

State	**S**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**12**	**13**	**17**	**Total**
Complete	1	11	11	13	11	32	11	83	13	6	2	4		198
Broken		11	12	13	10	21	8	42	3	3	4	1	1	129
Total	1	22	23	26	21	53	19	125	16	9	6	5	1	327

Table 7.9: Artefact State by Spit at Trench 2.

Broken artefacts are not included in the above discussions of artefact frequencies and densities so as not to inflate artefact numbers, they contribute to an understanding of a site by allowing estimates of minimum artefact numbers by counting remaining components. Table 7.10 details frequencies of broken artefacts by raw materials and remaining flake portions. By counting components of flakes for which there can only be one on each flake it is possible to make an estimate of the minimum number of flakes represented by the broken pieces found at the site (i.e. each flake has only one proximal and one distal, or a left lateral or right lateral). Table 7.10 shows 51 distal portions, 17 left laterals and 1 flake missing right lateral, indicating that a minimum of 69 flakes is represented. Minimum numbers of artefacts for the site can therefore be stated to be 267 artefacts.

Remaining portion	Total
Distal	51
Left Lateral	17
Left Proximal	1
Medial	20
No left distal	1
No left lateral	3
No right distal	3
No right lateral	1
Proximal	23
Right Lateral	6
Right Proximal	2
Grand Total	129

Table 7.10: Broken Flakes – Remaining flake portions.

8 Discussion

The nature of this discussion is severely hindered by the fact that the study is incomplete. There still remains a great deal of geomorphological and archaeological material to be analysed as part of the post excavation process. As such, this discussion is in no way final or comprehensive and may be subject to alteration following detailed analysis and interpretation of the entire artefact assemblage and further radiometric results.

The upper soil units of the levee deposit comprise a bio-sphere. While differences in soil colour and texture are evident, these do not constitute discrete stratigraphic alluvial layers, but are the result of both anthropogenic and soil forming factors. The deposits comprised Sandy Clay Loams which showed a strong degree of oxidization and bio-turbation. As outlined in Section 2, these characteristics are indicative of soils found on levee deposits.

Artefactual material which was retrieved from the top 30cm of deposit is not regarded as *in situ* owing to the high degree of soil mixing from agricultural activities and evidence of historic disturbances with the presence of European artefacts both modern and historic. The entire top unit is interpreted as an A_p horizon, or a plough layer. The natural soil surface has been obliterated and any artefactual material will have been mixed through the soil as a result of ploughing. The artefacts in this instance simply document a presence or absence of material.

Beneath the plough zone sediments gradually become sandier and lighter in colour. The deposit immediately below the plough zone (from 30-50cm) is pedogenic with no traces of alluvial stratification. The extent of post depositional disturbance cannot be determined until further geomorphological and radiometric analyses are conducted. This is particularly important as during excavation two potential knapping floors were encountered in spits 7 and 8 in both Trenches 1(**Plates 15** and **16**) and 2 (**Plates 17** and **18**). In the instance of Trench 2 spits 7 and 8 are both situated within the oxidised zone and therefore may have been affected by pedogenesis. While pedogenesis is argued to be relatively weak owing to the frequency distribution of the artefacts by depth and the fact that the majority of finds in these layers were generally oriented in the horizontal plane (see Section 5.2), this interpretation would need validation with further radiometric analyses. In general the OSL signal from such soil horizons returns a result indicative of pedogenesis and sediment mixing. This type of result would mean that the artefacts contained therein would have been subjected to a degree of post depositional movement and may not represent an intact living floor. However Stone’s (2006) study of the dune systems within the Murray River Basin suggest that in some instances the zone of oxidisation was relatively weakly developed and OSL dates returned from these soil horizons indicated relatively little disturbance to the sediments. The sand immediately below the zone of oxidisation has been dated to 28,000 years, which means that further radiometric ages taken from higher up in the soil profile are necessary, particularly in light of the fact that the majority of the finds in Trench 2 come from the zone of oxidisation.

Of great significance to this site is the identification of unweathered fine sand deposits at the base of the levee. These deposits have not been affected by soil formation and according to the site formation and radiometric results represent stratified deposits. The artefacts contained within these units are highly significant as they can be contextualised within a temporal framework. The unweathered levee deposits (specifically spits 9-15) and associated artefacts have provided important chronological information which is generally lacking in the archaeological record. This material is approximately 37,000 to 26,000 years old.

The results of the analysis of the artefacts recovered from trench 2 indicate that changes in technology and site usage occurred over time. The oldest layers of the site (spits 9 and 13) show low level site use, expediently utilising locally available raw materials and low levels of artefact reduction from between 37,000 to 26,000 years ago. From 26,000 years ago and continuing to more recent layers site use became more intensified, peaking at spits 5 and 7 and maintaining consistent numbers until the uppermost layer.

With more intensified use of the site from 26,000 years ago came a shift in raw material usage with non-local raw materials being utilised and conserved. The majority of raw materials had already been reduced before being transported to the site, but not sufficiently reduced to require discard. Very low levels of artefact manufacture accompanied tool maintenance and rejuvenation activities, before the still minimally reduced raw materials were transported for further use elsewhere.

Clarification of these interpretations will need to be made in the final report following further statistical investigation, conjoin analyses and use-wear analyses. Determining the validity of these interpretations will be contingent upon analysis of the remaining 7 trenches. At present, only one eighth of the available information from the site has been assessed and the remaining 7 trenches have the potential to completely alter these interpretations. Analysis and interpretation of the rest of the site is essential to the accurate interpretation of the prehistory of the JRL site as a whole.

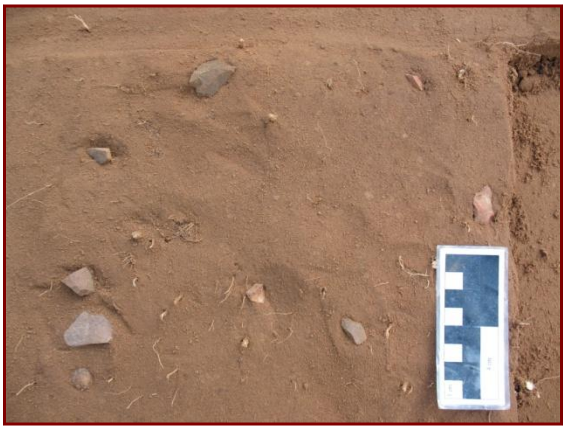


Plate 8.1: detail of potential knapping floor in trench 2, spit 7.

Plate 8.2: Detail of potential *in situ* artefacts, trench 2, spit 8.

Plate 8.3: Detail of potential knapping floor, trench 1, spit7.

Plate 8.4: Detail of potential knapping floor, trench 1, spit 8.

9 Research Questions

The overall aim of the excavation was to test the potential of the site and recover evidence of changes in site use and lithic technology over time. In Section 3 several research questions were posed. At this point in time it is not possible to answer all of them however several questions relating to site integrity, post depositional disturbance and site formation may be answered. Lithic technology has been reported on and indicative temporal and technological patterns are addressed

1. *Was the site occupied throughout the period of levee construction or occupied only after the levee was constructed?*

The preliminary analysis presented in this report indicates that the JRL site was occupied throughout the period of levee construction. Radiometric analysis indicates that the levee soil deposit is stratified from 45 to70cm depth and has undergone limited disturbance through mixing of the sediment. This conclusion is supported by both pedological and geomorphological assessment of the deposit and the positioning of the artefacts themselves. Furthermore, these latter assessments also indicate that the overlying deposits situated within the oxidised zone have a high potential to also be relatively intact. This means that the majority of artefactual material contained within the levee soil was deposited during levee construction.

To date there is no indication that the underlying floodplain deposit was occupied by Aboriginal people. However, owing to the fact that the JRL site contains artefacts in layers immediately above the buried soil surface (dating to 37,000 years old), it is highly likely that the floodplain soil may contain artefacts. The potential to encounter artefacts is however low, as floodplain environments generally only comprise artefacts which are reflective of short term use comprising one off foraging events. If artefacts are present they will be present as a pedogenic stone line. The origin of this stone line will have arisen through one of two processes. Either the artefacts were once stratified with their placement now altered through pedogenesis or occupation of the site occurred after floodplain construction with the artefacts having moved down through the soil profile. The later interpretation is far more likely as the floodplain construction took place 60,000 year ago. Nevertheless, should artefacts be present they would date to the same time period of the base of the levee (40,000 years) or older.

2. *How intact or disturbed is the site?*

Soil formation and historic agricultural practices often result in the vertical and horizontal displacement of artefactual material. Soil formation and historic farming activities have affected the JRL site. Disturbance to Trench 3 is considered to be high, with numerous historic disturbances resulting in the mixing of the soil. The remainder of the JRL site has undergone low to moderate post depositional disturbance. The majority of this disturbance is confined to the top 25 to 30cm of deposit constituting the plough zone. Artefacts within these layers have undergone the most post depositional damage.

There is disturbance to the oxidised unit within the levee relating to soil fauna activity, however artefact frequency by depth does not indicate the presence of a pedogenic stone line. Furthermore the majority of artefacts situated within these layers were oriented horizontal to the surface and have undergone less post depositional damage then artefacts confined to the plough zone. There is also a distinct absence of size sorting via root activity amongst the artefacts. The oxidised unit (spits 5-8) is thought to have retained a moderate to high degree of stratigraphic integrity.

Disturbance to the unweathered basal sands of the levee is very low, excepting the case of Trench 3. Despite prevalent root activity there is no evidence of size sorting amongst the artefact assemblage and the radiometric results indicate no evidence of pedogenesis.

Soil erosion at the JRL site is limited to the surface of the floodplain soil unit as evidenced by a truncated A2 horizon. Artefactual material may be associated with this soil layer, however, it is likely that any material will have been removed through flooding events. No artefactual material has been identified in this soil unit.

3. *Questions to ask of the lithic assemblages: The overall aim of the artefact analysis was to determine if a new cultural sequence can be made for Southern Tasmania, for the time frame of levee accumulation*

A total of 8 trenches were excavated at the JRL site; only one of which has been analysed in any detail. The data from Trench 2 therefore represents only one eighth of the available information for the site and must not be considered a conclusive or exhaustive interpretation of prehistoric behaviour at the JRL site. As such this question cannot be answered at this stage. Only tentative interpretations of past Aboriginal behaviour at the JRL site can be indicated.

Analysis of the artefacts recovered from Trench 2 indicates that changes in technology and site usage occurred over time. The oldest layers of the site show low level site use, expediently utilising locally available raw materials and low levels of artefact reduction from between 37,000 to 26,000 years ago. From 26,000 years ago and continuing to more recent layers site use became more intensified, peaking at spits 5 and 7 and maintaining consistent numbers until the uppermost layer. With more intensified use of the site from 26,000 years ago came a shift in raw material usage with non-local raw materials being utilised and conserved. The majority of raw materials had already been reduced before being transported to the site, but not sufficiently reduced to require discard. Very low levels of artefact manufacture accompanied tool maintenance and rejuvenation activities, before the still minimally reduced raw materials were transported for further use elsewhere.

4. *How does TASI 10757 compare with other known sites in the region?*

A comparison of the JRL site with other sites in the region will be presented in the final excavation report as the analysis of the artefact assemblage is still incomplete

5. *Can TASI 10757 be linked with the recent ethnohistoric past and documented tribal groups in the region?*

Given the great antiquity of the JRL site this seems unlikely, however some examples of historic use of the site are evidenced through the presence of flaked glass material, suggesting continuity of site occupation over a vast period of time. Further research and the analysis of artefactual material and a complete suite of OSL dates for the entire soil sequence will be necessary in order to answer this question.

10 Site Significance Assessments

The following provides an outline of the processes used to assess the significance of any cultural heritage sites that were identified during the course of the assessment.

10.1 Assessment Guidelines

There are several different ways of defining types of significance, and many practitioners have developed their own system of significance assessment. However, as Sullivan and Pearson (1995) point out, there seems to be a general advantage in using a set of criteria which is already widely accepted. In Australia cultural significance is usually assessed against the Burra Charter guidelines and the Australian Heritage Commission guidelines (ICOMOS 1988, 1999, Lennon and Mathews 1996).

10.2 The Burra Charter

Under the guidelines of the Burra Charter 'cultural significance' refers to the 'aesthetic, historic, scientific, social or spiritual value for past, present or future generations' of a 'place' (ICOMOS 1999:2). The guidelines to the Burra Charter comment :

> *"Although there are a variety of adjectives used in definitions of cultural significance in Australia, the adjectives 'aesthetic', 'historic', 'scientific' and social' ... can encompass all other values".*

The following provides the descriptions given for each of these terms.

Aesthetic Value

Aesthetic value includes aspects of sensory perception for which criteria can and should be stated. Such criteria may include consideration of the form, scale, colour, texture and materials of the fabric; the smells and sounds associated with the place and its use (Marquis-Kyle & Walker 1992).

Historic Value

A place may have historic value because it has influenced, or has been influenced by, an historic figure, event, phase or activity. It may also have historic value as the site of an important event. For any given place the significance will be greater where evidence of the association or event survives in situ, or where the settings are substantially intact, than where it has been changed or evidence does not survive. However, some events or associations may be so important that the place retains significance regardless of subsequent treatment (Marquis-Kyle & Walker 1992).

Scientific Value

The scientific or research value of a place will depend upon the importance of the data involved or its rarity, quality or representativeness and on the degree to which the place may contribute further substantial information.

A site or a resource is said to be scientifically significant when its further study may be expected to help current research questions. That is, scientific significance is defined as research potential (Marquis-Kyle & Walker 1992).

Social Value

The social value of a place is perhaps the most difficult value for heritage professionals to substantiate (Johnston 1994). However, social value is broadly defined as 'the qualities for which a place has become a focus of spiritual, political, natural or other cultural sentimental to a majority or minority group' (ICOMOS 1988:30). In What is Social Value, Johnston (1994) has provided a clear definition of social value:

> *"Social value is about collective attachment to places that embody meaning important to a community, these places are usually community owned or publicly accessible or in some other way 'appropriated' into people's daily lives. Such meanings are in addition to other values, such as the evidence of valued aspects of history or beauty, and these meanings may not be apparent in the fabric of the place, and may not be apparent to the disinterested observer". (Johnston 1994:10)*

Although encompassed within the criterion of social value, the spiritual value of a place is a new addition to the Burra Charter (ICOMOS 1999:1). Spiritual value is predominantly used to assess places of cultural significance to Indigenous Australians.

The degree to which a place is significant can vary. As Johnston (1994:3) has stated when trying to understand significance a 'variety of concepts [are] used from a geographical comparison ('national', 'state', 'local') to terms such as 'early', 'rare', or 'seminal''. Indeed the Burra Charter clearly states that when assessing historic significance, one should note that for any given place the significance will be greater where evidence of the association or event survives *in situ*, or where the setting are substantially intact, than where it has been changed or evidence does not survive. (ICOMOS 1988:29)

10.3 Significance Criteria Relevant to Indigenous Sites

Indigenous heritage sites and places may have educational, tourism and other values to groups in society. However, their two principal values are likely to be in terms of their cultural / social significance to Aboriginal people and their scientific / archaeological significance. These are the two criteria that are commonly used in establishing the significance of Aboriginal sites. The following provides an explanation of these criteria.

1) Aboriginal Cultural / Social Significance

This relates to the value placed upon a site or suite of sites by the local or regional Aboriginal community. The identification and assessment of those sites that are significant to Aboriginal people is a matter for Aboriginal people. This assessment can only be made by the appropriate Aboriginal representatives of the relevant communities.

2) Scientific (Archaeological) Significance

Archaeological significance values (or scientific values) generally are assessed on the potential of a site or place to generate knowledge through archaeological research or knowledge. Bowdler (1984) states that the scientific significance should be assessed according to timely and specific research questions (research potential) and site representativeness.

Research potential entails the potential of a site or suite of sites for scientific research and excavation. This is measured in terms of a site's ability to provide information on aspects of Aboriginal culture. In this respect, the contents of a site and their state of preservation are important considerations.

Representativeness takes account of how common a site type is (Bowdler 1984). That is, it allows sites to be evaluated with reference to the known archaeological record within the given region. The primary goal of cultural resource management is to afford the greatest protection to a representative sample of sites throughout a region. The corollary of a representative site is the notion of a rare or unique site. These sites may help to understand the patterning of more common sites in the surrounding area, and are therefore often considered of archaeological significance. The concept of a rarity cannot be easily separated from that of representativeness. If a site is determined to be rare, then it will by definition be included as part of the representative sample of that site type.

The concepts of both research potential and representativeness are ever changing variables. As research interests shift and archaeological methods and techniques change, then the criteria for assessing site significance are also re-evaluated. As a consequence, the sample of site types which are used to assess site significance must be large enough to account for the change in these variables.

10.4 Scientific (Archaeological) Significance for Aboriginal Sites Identified During the Present Investigations

The Jordan River Levee site represents an intact stratified cultural deposit of great archaeological and cultural value. The top 25 to 30cm of the archaeological deposit does not retain any useful stratigraphic information, however this does not negate from the importance of these finds. While their temporal association with the stratified archaeological material situated below cannot be ascertained they are associated with a site of great antiquity and should not be dismissed as irrelevant. In fact these deposits contain some evidence of Aboriginal use of the site during the historic era, linking Aboriginal use of place in recent times to a site of great antiquity. This continuity of presence will need to be confirmed, however the potential to have Aboriginal occupation of a site from the Pleistocene era through to the present day, is exceptionally rare and of very high cultural and scientific significance.

It is imperative that further analysis be undertaken, in particular the completion of the radiometric studies, which includes revisiting the site to collect further sediment samples from Trench 1 and 2. It is imperative that a full dating sequence is acquired in order to contextualise the artefact assemblage retrieved from the JRL site. This is particularly important in light of the findings in Trench 2, whereby the majority of the assemblage is confined to the upper layers and represents a possible shift in site use.

Furthermore the importance of allowing the time to conduct the artefact analysis should not be underestimated. Stone artefacts are our primary source of information on the past behaviours of Aboriginal people. Detailed analysis of stone tools can inform on all aspects of prehistoric Aboriginal behaviour, including strategies of subsistence, mobility, trade-routes, tool manufacture and maintenance and population size. Variations in assemblage composition and diversity over time and space reflect shifts in human behaviour in response to their environment. Variations in the nature and types of stone tools recovered from a site both through time and across space allow us to monitor changes in Aboriginal behaviour and subsistence overtime and to reconstruct past life ways in ways that cannot be provided by any other medium.

Sedimentological and chronological sequences at a site are therefore only able to tell part of a story. The humanization of any site is dependent upon the analysis and interpretation of the tools that enabled prehistoric hunter-gatherers to subsist and exploit their environment. In the absence of this analysis, it is difficult, at this stage, to draw many specific conclusions regarding Aboriginal behaviour at the JRL site.

It is however clear that the JRL site can provide detailed and intact information regarding prehistoric Aboriginal behaviour The nature of the levee formation coupled with the clear separation of layers of activity observed during excavation indicates that the site is intact and stratified. Sites such as these are exceptionally rare in Australia, with most open sites subject to continual erosion over time and the subsequent merging of occupation layers with one another. In most cases, an open site is expected to represent a minimum of 1000 years of occupation in a single layer. Subtle differences in behaviour over time are simply not possible to discern with tools from hundreds of years of occupation blended into one. By comparison, preliminary observations and mapping of the depths of artefacts recovered from the site suggests that single knapping events may have been captured, with a single and isolated event such as the reduction of a core/manufacture of a tool preserved. Confirmation of these levels of resolution at the JRL site will be able to be clarified during artefact analysis by conjoin analysis. If artefacts recovered from a single stratigraphic layer can be refitted together (like a 3 dimensional puzzle) then a single knapping event will have been preserved. Knapping floors such as this are extremely rare. The JRL site is the oldest and best stratified open site in Tasmania and one of the oldest sites in Australia. The JRL site can provide invaluable information regarding details of Aboriginal subsistence. At present, models of past behaviours and subsistence have needed to be generalized and broad in nature due to the compression of layers of occupation in 99% of archaeological sites. A finer resolution simply has not been possible. The ability for the JRL site to flesh out these models, fine tune them and enhance our understanding of both Tasmanian Aboriginal communities and hunter-gatherer groups in general is exceptional.

The great antiquity of the JRL site means that not only is the site of great cultural value to Aboriginal people but it is also important to the human population as a whole. The JRL site was occupied at a time of global expansion of *Homo sapiens* across the planet. The site therefore plays an important role in the history of the spread of human beings across the world; from out of Africa to the southernmost extent of the planet.

In short, the archaeological and cultural heritage significance of this site is of extremely high cultural and scientific significance. However until further post excavation work is undertaken it is not possible to make a final assessment of significance.

10.5 Aboriginal Cultural/Social Significance

Statements of Aboriginal cultural and social significance will be provided by the Aboriginal community.

11 Future Work at the JRL site

Several key issues have resulted from the preliminary analysis presented in this report.

- The JRL site represents a site of high cultural and archaeological significance on both a national and international scale. As such it is imperative that the site be conserved.
- The JRL site is situated on a floodplain deposit that was previously thought to be of low sensitivity as it was expected to be much older than the results of the radiometric analysis have indicated. The OSL results confirm that the floodplain surface would have been available for Aboriginal occupation. The likelihood of encountering evidence of occupation is however low, although any potential development impacts will require mitigation planning in consultation with the Aboriginal community.
- It is imperative that time be given to analyse the remainder of the artefact assemblage and that a full suite of radiometric analyses be undertaken in order to provide a complete history of the site.
- A clear position from the Aboriginal community and the cultural values of the site needs to be obtained. Any cultural heritage management options need to discussed and developed in consultation with Aboriginal community.

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12 Appendix A- Revised Methodology

BRIGHTON TRANSPORT ROUTE (NORTHERN SECTION)
ARCHAEOLOGICAL SCOPE OF WORKS
JORDAN RIVER LEVEE (TASI 10757)
REVISED METHODOLOGY
FEBRUARY 5TH 2010

By

Robert Paton with reference to Stone and Everett (2008)

PREFACE

A number of issues have arisen as archaeological investigations have progressed along the Northern Section of the Brighton Bypass. Two of these issues in particular warrant a review of the original method statement for TASI 10757 attached to Permit 9/11. The first of these issues relates to Aboriginal community concerns. and is essentially a matter for the Aborigines themselves to address, primarily via their own social, cultural and heritage report. The second concerns the archaeological test pitting strategy. This strategy is detailed in this method statement. In the first instance the strategy is designed to uncover preliminary data via small (2m x 2m and 1 x 1m) test pits. Further works may arise from this initial work and the proponent needs remain aware of this. For the Aboriginal community this further work, at least within the impact zone, should entail large scale ploughing of any areas of the levee that will suffer impact. Such areas should be ploughed, water sprayed on the disturbed sediments, and then a detailed surface survey undertaken with AHO's and archaeologists. Records should be made of any uncovered artefacts as part of the ploughing programme including Differential Global Positioning of any finds. Some additional detailed studies may also be undertaken outside the impact zone at a later date.

All data produced from any of these works, including mapping, reports, artefact analysis by Sophie Collins, will be supplied to the Aboriginal community representatives.

1. Aboriginal Community Concerns

Firstly, there has been considerable discussion around the issue of appropriate collaboration with the Tasmanian Aboriginal community. It has been pointed out that much of the consultation to date has been seen as more of an afterthought rather than a precondition to works. There has been a clear message from the Aboriginal community that this is an unsatisfactory situation.

One result of this message is that the Aboriginal community has resolved to produce its own historical, social and cultural reports. These reports will be produced by the Aboriginal community, and are a matter for that community to define the scope of and to produce.

Another important outcome of these discussions is that the archaeologist acknowledges that this method statement is governed by ethical protocols relating to Aboriginal control of their heritage. While it is important not to oversimplify this complex issue[4], there is a simple protocol that we will abide by when investigating any Aboriginal sites. This involves the concept of "asking first" to gain approval from the Aboriginal community for an investigation. This has to be more than just informing people of intentions to do something, regardless of what they might say. It is after all Aboriginal heritage we are dealing with and people need to have the chance to articulate their viewpoints.

My understanding is that the current Heritage Legislation does not provide for such a collaborative approach, and the Permits simply allow interference with particular sites for purposes detailed in attached methodologies. However, the methodology attached to a Permit (this document) can lend itself to giving wider scope for seeking Aboriginal approval. This is particularly the case if the archaeologist and developer working on the project commits to certain undertakings with the Aboriginal community as part of the methodology. in this regard, I have made it clear as the Project Archaeologist, that I do not work without Aboriginal approval and involvement (as a condition not an afterthought - see Appendix 1). Again I

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[4] For an in depth discussion see for example I. McBryde (1985) *Who Owns the Past*

understand that nobody will ever gain total consensus with any community. There are, however, peak bodies in Tasmania (the TAC and the TALSC) who either deal with heritage issues or who have significant community support and are widely acknowledged as being able to "speak for country". These organisations, in my opinion, need to have a pivotal role in developing and guiding any archaeological investigation.

To make matters as clear as possible, I have attached a letter (which is essentially a statement of ethical standards) that governs the remainder of this method statement (Appendix 1). Whether this satisfies the Aboriginal communities concerns about viable involvement and control of the process is a matter for them to discuss and decide upon.

2. Archaeological Issues
Secondly, the questions regarding the significance and size of site TASI 10757 have crystallised as a result of numerous discussions between the parties. This has an immediate bearing on the configuration of test pits and the questions we are able to answer as archaeologists.

TASI 10757 is a large stone artefact scatter on the west bank of the Jordan River near Brighton. The scatter occupies a levee deposit ~2 m thick, which has the potential to contain a deeply stratified cultural sequence. Stone and Everett (2008) recommended a controlled archaeological excavation of a targeted sample of the levee deposit, under permit. The purpose will be to test this potential and recover evidence of changes in site use and lithic technology over time.

To this point we have begun excavating one pit measuring 2m x 2m (pit 48 on the attached plan). We have excavated pit 48 to approximately 60cm. The deposit appears to continue to an unknown depth beyond this point. Two other pits (pits 47 and 49 - also measuring 2m x 2m) have been marked out as per the original method statement. These three pits were originally placed to test the east-west extent and depth of the levee deposit.

Since this time, questions have been asked by both the Aboriginal community and DIER about the age, and north south extent of the levee. In particular people want to know something of the deposit with the impact zone and whether this is replicated outside of this zone. There have also been concerns expressed about the potential for human burials within the deposit which would not be detected by our limited excavations.

To resolve the above issues with a minimum amount of disturbance to the site, I have proposed the following (see Figure 1):

- test pit 48 should be completed to the standard outlined in the original method statement.
- test pit 49 (2m x 2m) at the front (the eastern side of the levee should be completed as per the original method statement.
- test pit 47 at the western edge of the levee should be abandoned and instead four 1m x 1m test pits should be dug in its place. These new pits should be spread in an east-west line to define the edge of the cultural material to the west (approximately as shown on Figure 1). It should be possible to dig these smaller pits in this area as the levee should be very shallow here (approximately 20-40cm thick). Provenance of material in these pits should be in 50cm x 50cm squares within the pits. This should be sufficient given that the plough zone extends down to at least 30cm. The pits should be dug in 5cm spits and sieved through a 3mm mesh.
- two additional 2m x 2m pits should be dug (one to the north and one to the south of pit 48). These pits will answer the question about the lateral spread of artefacts both within and outside of the potential impact zone. Both of these pits should be dug in 5cm spits and all material wet sieved through 3mm mesh. Given that the pits are specifically placed to answer questions relating to lateral distribution, provenance of artefacts could be in 50cm x 50cm blocks within each spit. Pits 48 and 49 are designed (as described below) to assess the disturbed nature of any cultural material via detailed recording of provenance.
- ground penetrating radar should be used in an attempt to locate any features such as burials within the sandy sediments, particularly within the potential impact zone.

As per the original method statement, the overall research questions are detailed below:

Research Questions

1. Was the site occupied throughout the period of levee construction or occupied only AFTER the levee was constructed?

This question invites comparison between surface and subsurface cultural layers. The hypothesis that the levee deposit contains a stratified cultural sequence will be tested by controlled archaeological excavation and radiometric dating of the sediments. This will establish a chronology of occupation for the site and show changes in site use and lithic technology over time, including periods when particular raw materials were preferred (exploited) over others. The limiting factor on the depth of excavation will be the age and origin of the basal sediments and whether or not these sediments have the potential to yield cultural material.

2. How intact or disturbed is the site?

This is very important since the integrity of all other results depends on it. Field observations indicate the following post-depositional processes:

- Disturbance by tree and grass roots, tree upheaval.
- Mixing by natural pedogenic processes.
- Repeated ploughing.
- Soil erosion, particularly by wind and water.
- Trampling by stock and farm vehicles.
- Potential vertical and horizontal displacement of artefacts in the soil by the above processes.

Assessing the degree of site intactness requires artefact distributional studies and finer examination of the soil and depositional matrix. i.e. the identification and measurement of voids and other disturbances to test this matter further.

In all likelihood, the uppermost ~40 cm will have been disturbed primarily by pedogenesis and ploughing but below this zone there is possibly a metre or more of deposit that is unlikely to be significantly disturbed.

3. Questions to ask of the lithic assemblages

A detailed technological analysis will be undertaken by Sophie Collins on the stone material in conjunction with Rob Paton. The overall aim of this analysis will be to determine if a new cultural sequence can be made for Southern Tasmania. The same attributes (or at least comparable ones) will also be made on all surface sites and at the quarries. This will test the overall aim of the research project component of this investigation.

4. Wider questions to be considered

- How does TASI 10757 compare with other known sites in the region?
- Can TASI 10757 be linked with the recent ethnohistoric past and documented tribal groups in the region?

Excavation Methodology (pits 48 and 49).

- High resolution excavation techniques i.e. 2 m x 2 m squares at each of the three locations selected.
- Excavation in 5 cm spits by hand with trowel and brush to record and photograph artefacts *in situ*, with detailed observations of soil profile. No mechanical digging.
- Artefacts recorded *in situ* using total station or similar.
- Orientation of the long axis of individual artefacts and groups of artefacts to be recorded to test for post-depositional disturbances.
- Inclination of individual artefacts and groups of artefacts to be recorded by clinometer where not approximately horizontal, again to test for post-depositional disturbances.

- Wet sieving by hand (or mechanical sieving, if available) of all excavated sediment to recover all artefacts that escape *in situ* detection.
- Use of possibly two nested sieves with mesh no greater than 3 mm at bottom.
- Retention of all excavated artefacts for analysis and cataloguing.
- Stratigraphic sections recorded and samples taken for immediate dating.
- Documentation of all bioturbation markers i.e. insect and animal burrows, tree roots, sediment mixing etc.
- Backfilling of the test pits.
- Geomorphological analysis of the sediments.
- Spatial analysis of the data using a GIS platform.

Artefact Analysis

Artefact analysis will be undertaken by Sophie Collins, who is in the process of developing a stone artefact database for the Brighton Transport Hub. She will also be analyzing artefacts for the Brighton Bypass Southern Section. To maintain consistency, she will also be engaged for the Brighton Bypass Northern Section. Her duties will include (but not be restricted to):

- Standard descriptive and metrical analyses
- Conjoining if permitted
- Vertical size class distribution
- Vertical raw material distribution
- Technological change in flake production (i.e. platform characteristics, reduction strategies)
- Relationship between flakes less than 1 cm and larger flakes for each raw material type (i.e. inferential evidence of *in situ* artefact production)

Artefacts will be bagged/boxed and labeled to museum standard. The Aboriginal community can decide what will eventually be done with any material.

Radiometric Dating

The silt that forms the levee deposit is ideal material for optically stimulated luminescence (OSL) dating methods. Charcoal features may also be uncovered that can be dated using ^{14}C methods. For a deposit up to ~2 m thick and laterally dispersed, approximately ten radiometric ages would be required, based on the number and depths of the proposed excavation trenches. Once the samples are taken, it would be 6-10 weeks before any results are known. This is extremely rapid turnover and is possible only because Tim Stone has a PhD in OSL dating and ready access to the University of Melbourne OSL dating facilities.

Second Stage Excavation Strategies

It is not possible to outline further strategies for excavation and analysis until the site contents are known. However, the excavation process can be modified at short notice in response to the information that emerges, with additional or extended trenches.

FURTHER RECOMMENDATIONS AND CONDITIONS

- The findings of the salvage and sub-surface investigations specified above for the various sites should be compiled into a report.

- Further changes to the permit should be considered on the recommendation of the archaeologist, approved by the Aboriginal representative on site, to AHT where the opinion of the archaeologist is that issues not anticipated under the current permit have arisen.

- An Unanticipated Discovery Plan should be developed for the whole of the Northern Bypass development zone.

- Once the fieldwork outlined in this Permit Application is complete a Draft Cultural Heritage Management Plan (CHMP) should be developed detailing any further works. The CHMP will detail the dates for submission of the final report.

References

Stone, T. and Everett, A. 2009. *Proposed Brighton Bypass Northern Section Aboriginal site survey*. A report to GHD Pty. Ltd.

Macfalane, I and R. Paton 2005 *Many Exchanges.* Australian National University Press.

Paton, R. 1995 *Uses of Aboriginal Silcrete and Quartzite Quarries, Central NT, Australia.* A paper to the World Archaeological Congress, India.

Paton, R. 1996 Speaking Through Stones. *World Archaeology*.

APPENDIX A

LETTER TO THE TAC OUTLINING ETHICAL STANCE FOR CONDUCTING ARCHAEOLOGICAL WORKS LONG THE NORTHERN BYPASS UNDER PERMIT 9/11

Michael Mansell
Tasmanian Aboriginal Centre
Launceston

Dear Michael,

Since our discussions at the TAC last week, I've had follow-up talks with Aaron, Steve Gall from Aboriginal Heritage Tasmania and DIER about the Brighton Bypass archaeology. I believe you have also met with Steve Gall.

Some of the discussions have been about my involvement in the archaeological works at the Jordan River levee site, and the potential for research works to resume there in the near future, subject to certain conditions. It's probably important at this point that I make a couple of matters clear to all parties regarding where I stand in terms of this work (hence why I've circulated this letter). In a sense, this is a statement outlining the ethical conditions that I hold to on pretty much any job I do involving Aboriginal archaeology. Of course, some of the stuff below relates specifically to the Northern section of the Bypass and in particular the Jordan River.

Firstly, I do not work on archaeological projects in Australia without meaningful Aboriginal community involvement. Nor, in all fairness to everybody on this project, has anyone ever suggested that I should. In fact, if the works continue I would like to increase my involvement in community consultation with an Aboriginal Heritage Officer via some larger on-site meetings and more day to day interaction with the TALSC and the TAC.

I respect the fact that I am allowed to work on Aboriginal sites, and I see my research as being undertaken in collaboration with the Aboriginal community. If in the end the Aboriginal community doesn't want me as the archaeologist on this project just say so, and I'll leave.

Secondly, let me be absolutely clear that any works I undertake under the Permit 9/11 are *investigative research* to provide information about sites to interested parties with the intention of informing debate.

Thirdly, any archaeological works I undertake would be done sensitively and with due care for the sites. If I believed the work I was doing was unnecessarily destructive or it was causing undue Aboriginal community concern I would call a halt, as I have done previously.

Finally, I think there is some wonderful archaeology along the Jordan River and it will add significantly to our understanding of Tasmania's past and present. I've done archaeology my whole life because I believe it's vital to know where we come from to understand our cultures and identities. So, naturally, I'd love to get back out there and resume excavating. Professionally, I think I can do as good a job as anyone, and hopefully do justice to the sites. I will also do my best to do the work with a degree of sensitivity commensurate with the wishes of the Aboriginal community. I recognise and acknowledge that first and foremost these are Aboriginal sites, not a playground for archaeological researchers, and the work has to be of some substantial benefit to the Aboriginal community.

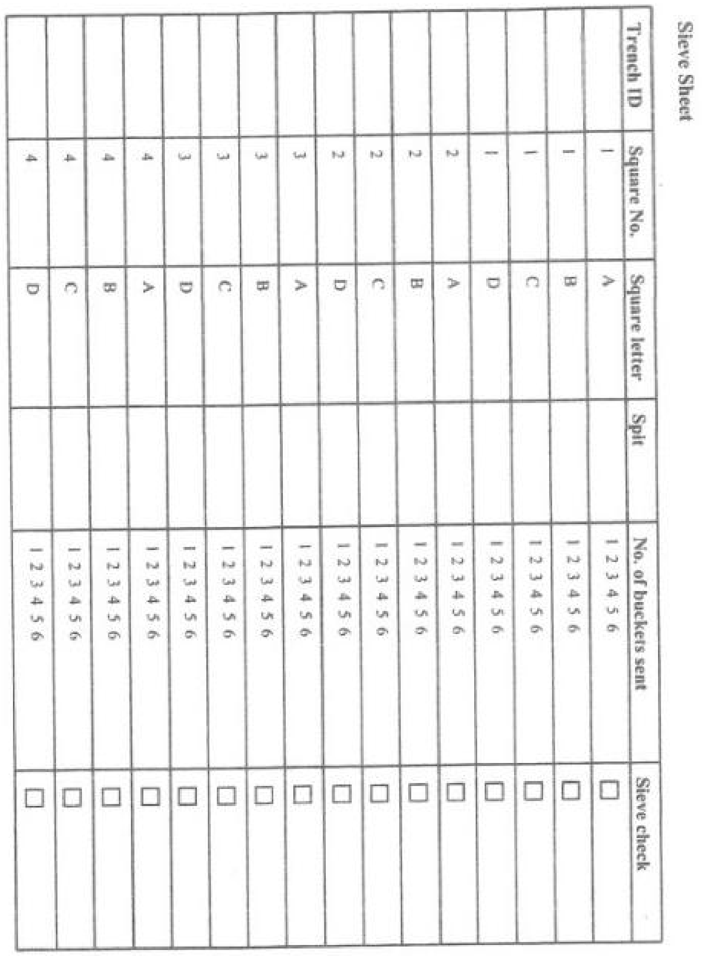
Thanks for your time the other day. I've circulated this letter to AHT and DIER so everyone is aware of my professional and personal stand on this matter.

All the best

Rob Paton

13 Appendix B: Site Recording Forms

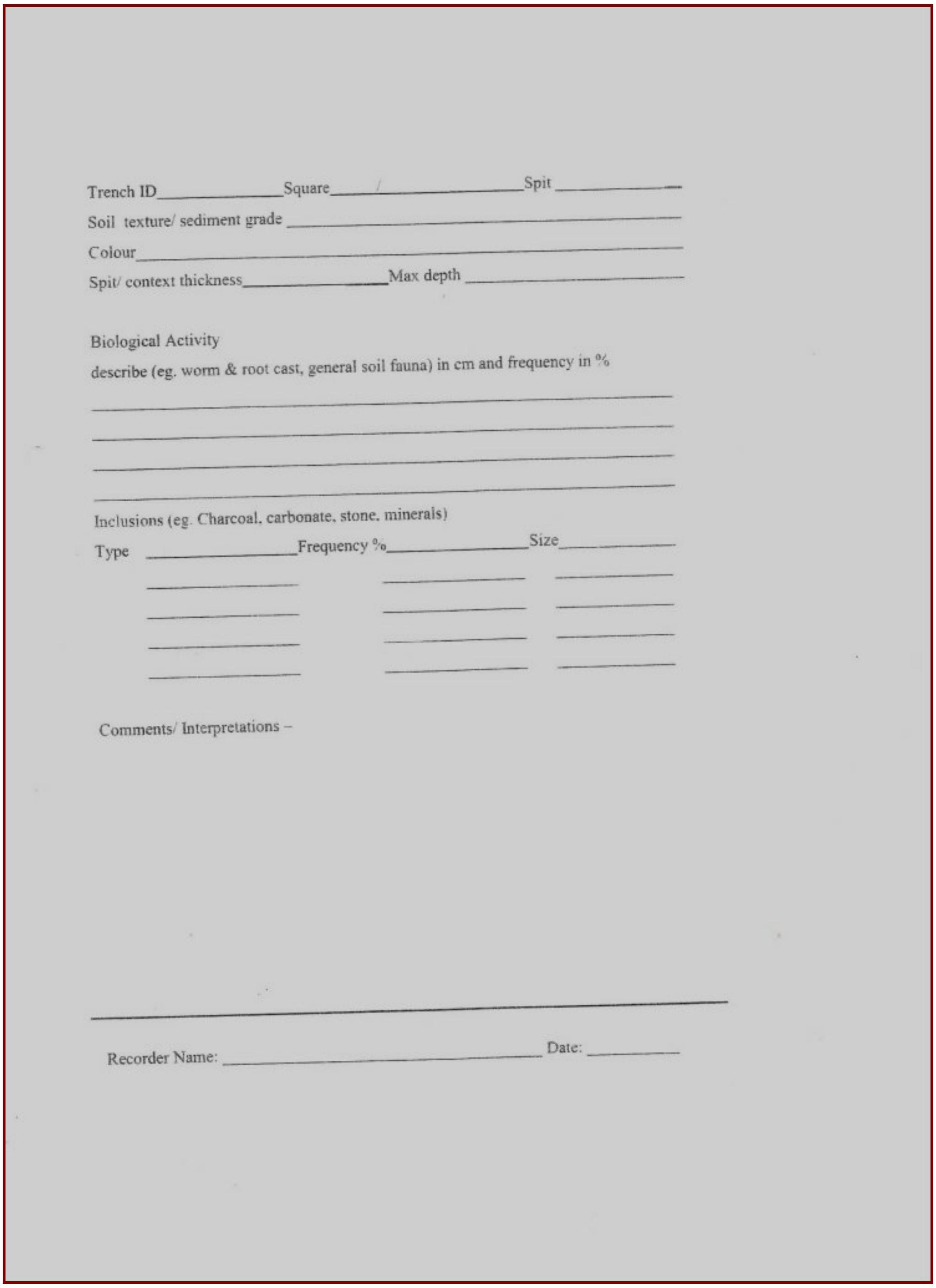
Sieve Log Recording Form



Sieve Sheet

Trench ID	Square No.	Square letter	Spit	No. of buckets sent	Sieve check
	1	A		1 2 3 4 5 6	☐
	1	B		1 2 3 4 5 6	☐
	1	C		1 2 3 4 5 6	☐
	1	D		1 2 3 4 5 6	☐
	2	A		1 2 3 4 5 6	☐
	2	B		1 2 3 4 5 6	☐
	2	C		1 2 3 4 5 6	☐
	2	D		1 2 3 4 5 6	☐
	3	A		1 2 3 4 5 6	☐
	3	B		1 2 3 4 5 6	☐
	3	C		1 2 3 4 5 6	☐
	3	D		1 2 3 4 5 6	☐
	4	A		1 2 3 4 5 6	☐
	4	B		1 2 3 4 5 6	☐
	4	C		1 2 3 4 5 6	☐
	4	D		1 2 3 4 5 6	☐

Excavation/Context Sheet



Trench ID Square / Spit

Soil texture/ sediment grade

Colour

Spit/ context thickness Max depth

Biological Activity

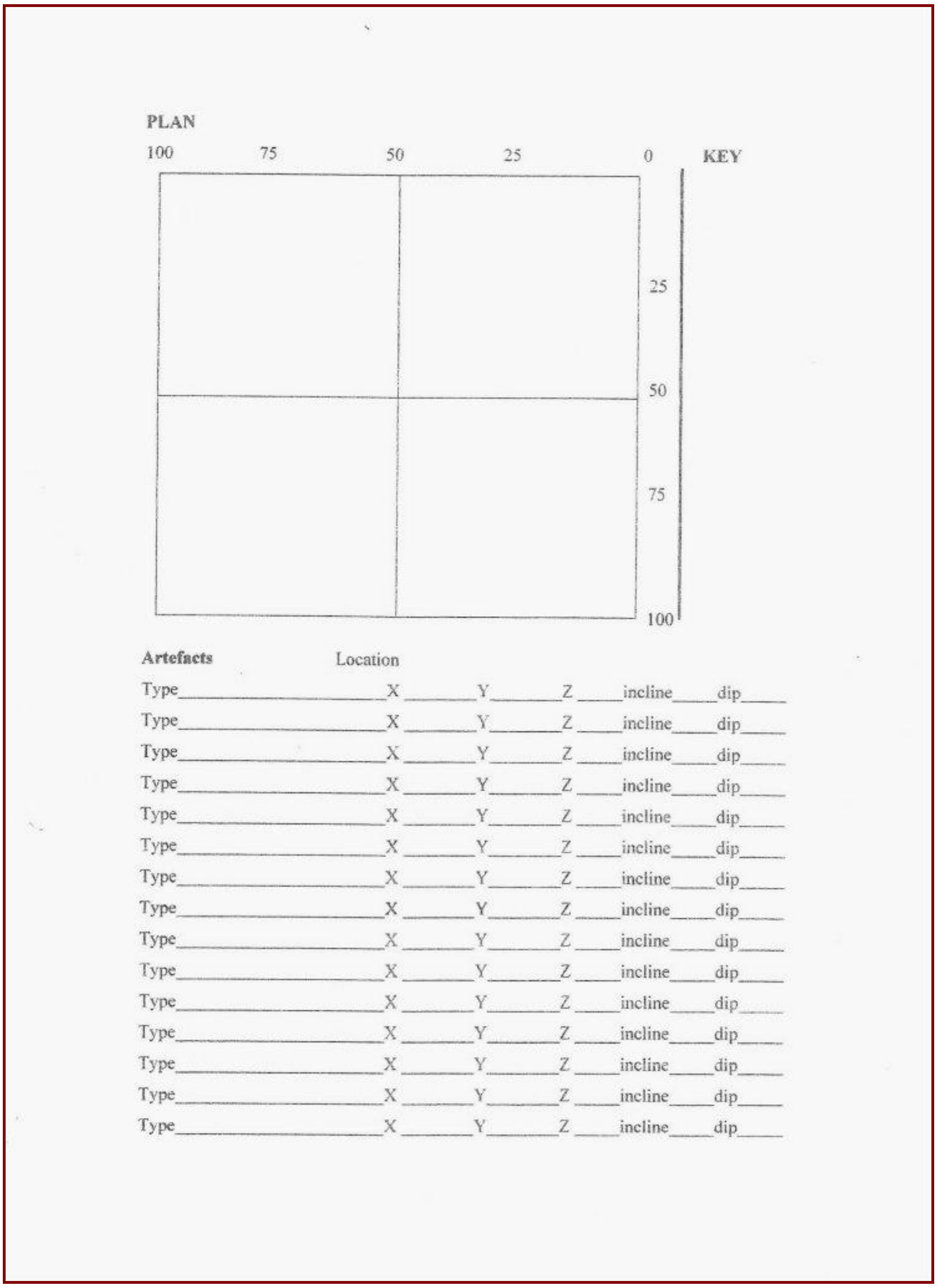
describe (eg. worm & root cast, general soil fauna) in cm and frequency in %

Inclusions (eg. Charcoal, carbonate, stone, minerals)

Type Frequency % Size

Comments/ Interpretations –

Recorder Name: Date:



PLAN

100 75 50 25 0 **KEY**

25

50

75

100

Artefacts Location

Type____________________X _______Y_______Z ____incline____dip____

Type____________________X _______Y_______Z ____incline____dip____

Type____________________X _______Y_______Z ____incline____dip____

Type____________________X _______Y_______Z ____incline____dip____

Type____________________X _______Y_______Z ____incline____dip____

Type____________________X _______Y_______Z ____incline____dip____

Type____________________X _______Y_______Z ____incline____dip____

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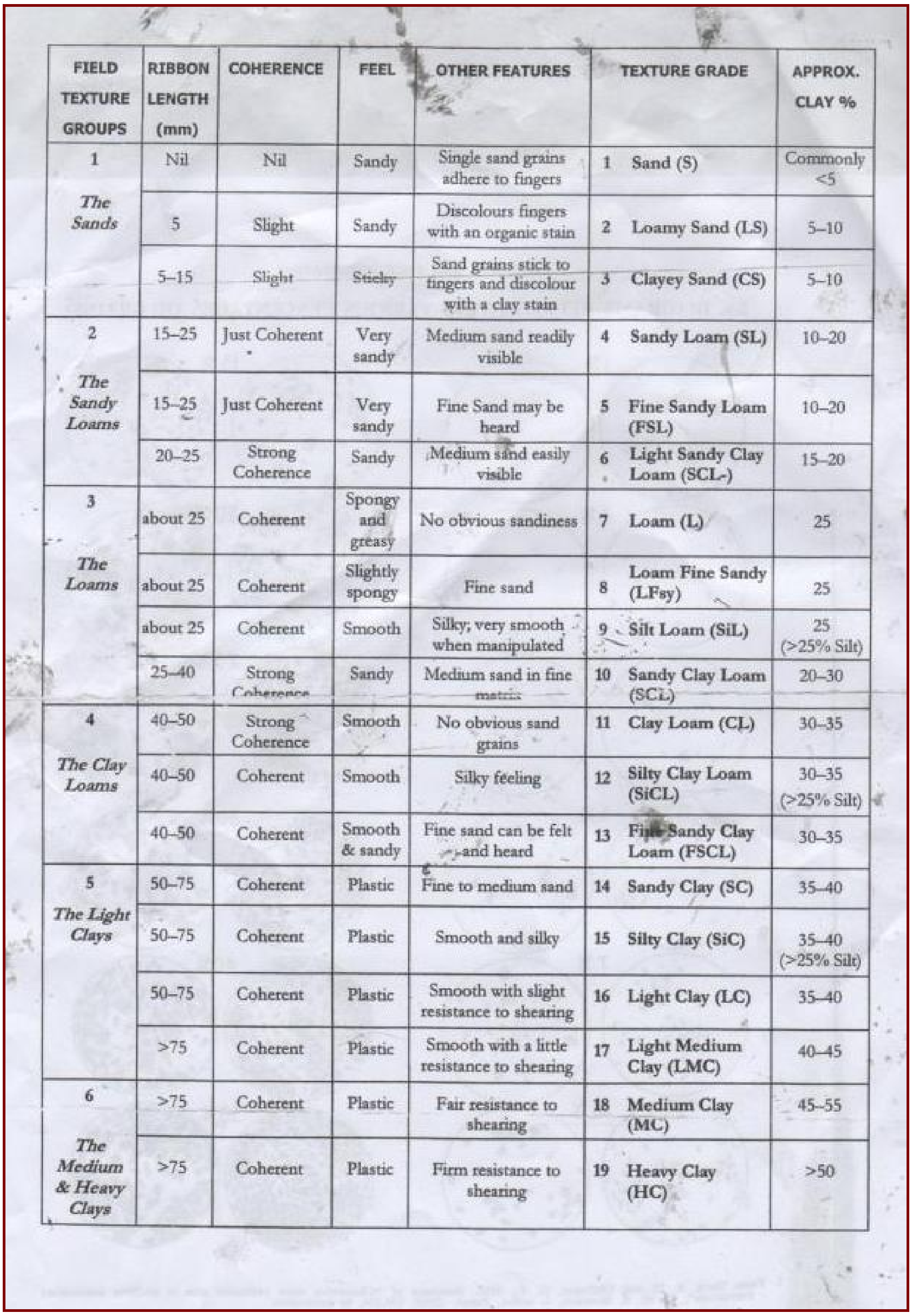
Type____________________X _______Y_______Z ____incline____dip____

Type____________________X _______Y_______Z ____incline____dip____

Type____________________X _______Y_______Z ____incline____dip____

14 Appendix C- Soil Field Texture Sheet



FIELD TEXTURE GROUPS	RIBBON LENGTH (mm)	COHERENCE	FEEL	OTHER FEATURES	TEXTURE GRADE	APPROX. CLAY %
1 *The Sands*	Nil	Nil	Sandy	Single sand grains adhere to fingers	1 **Sand (S)**	Commonly <5
	5	Slight	Sandy	Discolours fingers with an organic stain	2 **Loamy Sand (LS)**	5–10
	5–15	Slight	Sticky	Sand grains stick to fingers and discolour with a clay stain	3 **Clayey Sand (CS)**	5–10
2 *The Sandy Loams*	15–25	Just Coherent	Very sandy	Medium sand readily visible	4 **Sandy Loam (SL)**	10–20
	15–25	Just Coherent	Very sandy	Fine Sand may be heard	5 **Fine Sandy Loam (FSL)**	10–20
	20–25	Strong Coherence	Sandy	Medium sand easily visible	6 **Light Sandy Clay Loam (SCL-)**	15–20
3 *The Loams*	about 25	Coherent	Spongy and greasy	No obvious sandiness	7 **Loam (L)**	25
	about 25	Coherent	Slightly spongy	Fine sand	8 **Loam Fine Sandy (LFsy)**	25
	about 25	Coherent	Smooth	Silky; very smooth when manipulated	9 **Silt Loam (SiL)**	25 (>25% Silt)
	25–40	Strong Coherence	Sandy	Medium sand in fine matrix	10 **Sandy Clay Loam (SCL)**	20–30
4 *The Clay Loams*	40–50	Strong Coherence	Smooth	No obvious sand grains	11 **Clay Loam (CL)**	30–35
	40–50	Coherent	Smooth	Silky feeling	12 **Silty Clay Loam (SiCL)**	30–35 (>25% Silt)
	40–50	Coherent	Smooth & sandy	Fine sand can be felt and heard	13 **Fine Sandy Clay Loam (FSCL)**	30–35
5 *The Light Clays*	50–75	Coherent	Plastic	Fine to medium sand	14 **Sandy Clay (SC)**	35–40
	50–75	Coherent	Plastic	Smooth and silky	15 **Silty Clay (SiC)**	35–40 (>25% Silt)
	50–75	Coherent	Plastic	Smooth with slight resistance to shearing	16 **Light Clay (LC)**	35–40
	>75	Coherent	Plastic	Smooth with a little resistance to shearing	17 **Light Medium Clay (LMC)**	40–45
6 *The Medium & Heavy Clays*	>75	Coherent	Plastic	Fair resistance to shearing	18 **Medium Clay (MC)**	45–55
	>75	Coherent	Plastic	Firm resistance to shearing	19 **Heavy Clay (HC)**	>50

15 Appendix D: Geophysical Assessment Report