C.2 Test excavation data

C.2.1 Archaeological Research Design

Hunter Transmission Project

Archaeological Research Design

Prepared for The Energy Corporation of NSW

September 2024

Hunter Transmission Project

Archaeological Research Design

The Energy Corporation of NSW

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1 Introduction

1.1 Project background and purpose of this document

The Energy Corporation of NSW (EnergyCo), the NSW Government statutory authority responsible for delivering the project is proposing to build a new 500 kilovolt (kV) double circuit transmission line between Bayswater and Eraring. This will unlock electricity supply from the Central-West Orana and New England Renewable Energy Zones (REZs), allowing it to be imported to the electricity grid via Bayswater, to consumers in the Hunter, Sydney and Illawarra (where 80% of electricity is consumed).

The project has been declared Critical State Significant Infrastructure under the *NSW Environmental Planning & Assessment Act 1979* (EP&A Act). EMM Consulting Pty Limited (EMM), on behalf of EnergyCo, is preparing the Environmental Impact Statement (EIS) for the project. The requirements for Aboriginal heritage are outlined in the Secretary's Environmental Assessment Requirements (SEARs) received for the project:

- an assessment of the impact to Aboriginal heritage (cultural and archaeological), including test excavations, in accordance with the Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH, 2011) and the Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW (DECCW, 2010)
- evidence of consultation with Aboriginal parties in determining and assessing impacts, having regard to the Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010)
- if the test excavations do not conform with the Code of Practice, then the excavations may only be carried out with the written endorsement of Heritage NSW following consultation with the Registered Aboriginal Parties.

As such, EMM is undertaking an Aboriginal Cultural Heritage Assessment (ACHA) in accordance with Heritage NSW guidelines and developing suitable Aboriginal cultural heritage management strategies for the project. As part of the ACHA, archaeological test excavations are proposed to investigate and further characterise a range of site types encountered within the Project area during field survey. These include rockshelters, artefact scatters, and areas of potential archaeological deposit (PAD). Several of these sites cannot be investigated under the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW* (Code of Practice) guidelines, which specifically require further approvals for excavations of rockshelters and post-Contact sites. The latter has not been specifically found within the project, but one of the Aboriginal parties has suggested that many of these stone artefact sites and deposits encountered may come from this period.

Therefore, this document is to outline a proposed archaeological research design (ARD) to undertake archaeological excavations for the project, and seek approval from Heritage NSW under the SEARs above. To avoid project complexity and confusion, the ARD includes *all* proposed test excavations for the project, even where they may align and be permissible under established Heritage NSW guidelines.[1]

1.2 The Project

1.2.1 Key Project elements

The Hunter Transmission Project (HTP) includes:

[1] Due to the project's program, some selected test pits that do conform with the Code of Practise may be implemented prior to the endorsement and implementation of this document. These are likely to be those in the vicinity of Wollombi Road, Loder Creek and/or Monkey Place Creek. Where undertaken, requirements and process in accordance with the Code of Practise would be adopted.

- a new overhead 500 kV double circuit transmission line of around 100 kilometres (km) connecting the existing 500 kV transmission line at Bayswater to the existing 500 kV transmission line in the Olney State Forest near Eraring
- two new substations (Bayswater and Olney)
- associated works including upgrades to the existing Bayswater and Eraring substations, adjustments to existing transmission lines, road upgrades, access tracks, temporary construction facilities such as laydown areas, stringing sites, construction support sites and workers accommodation.

The key elements are summarised in Table 1.1. Test excavations focus on specific sites and/or deposits that are within these proposed elements and may be adversely affected if the Project proceeds. Further details of these activities are presented in Section 3.

Table 1.1 Project overview

Summary	• The HTP involves building a new overhead 500 kV double circuit transmission line of around 100 km and ancillary infrastructure • The existing 500 kV transmission line at Bayswater will connect to the existing 500 kV transmission line in the Olney State Forest near Eraring • The project will protect energy security in NSW by closing the northern gap in the 500 kV Ring and strengthening the core electricity grid in NSW for generations to come • The HTP will unlock electricity supply from the Central-West Orana and New England REZs. This will enable a clean and reliable electricity supply for consumers particularly in the Hunter, Sydney and Illawarra where 80% of the State's electricity is used
Project area	• The critical State significant infrastructure application for the HTP covers five local government areas • Most development will be concentrated in and around the HTP corridor. Some ancillary development such as construction support sites, road upgrades and laydown areas will be outside the corridor • Current HTP project area around 10,713 hectares (ha) • Indicative construction footprint around 1,785 ha • Indicative operational footprint around 810 ha
New transmission line	• Overhead 500 kV double circuit transmission line of around 100 km • Steel lattice towers up to 75 metres (m) high that are typically spaced about 300 m to 600 m apart – but could extend to over 1 km in some cases • 500 kV transmission lines with a minimum ground clearance of 13.5 m • Ancillary infrastructure such as earth wire and communications systems • Construction easement up to 140 m wide • Operational easement around 70 m wide
Adjustments and crossings -existing transmission lines	• Line 5A3: Bayswater – Mt Piper 500 kV • Line 5A4: Bayswater – Wollar 500 kV • Line 31: Bayswater – Regentville 330 kV • Line 32: Bayswater – Sydney West 330 kV • Line 81: 330 kV: Newcastle – Liddell 330 kV • Line 82: 330 kV: Tomago – Liddell 300 kV • Line 5A1 and 5A2: Eraring – Kemps Creek 500 kV • Other lower voltage lines • Upgrades to existing earth wire and communications systems
Substation works	• New Bayswater 500 kV substation • Upgrades at the existing Bayswater substation • New Olney 500 kV substation • Upgrades at the Eraring substation, including installation of two new 1500 MVA transformers
Road works	• Modifications to the existing public road network • New and upgraded access tracks for construction and operation
Ancillary works	• construction support facilities, including workers accommodation • Laydown areas • Stringing sites • Third party utility and property adjustments
Timing	• Construction to start in 2026 • Operation by the end of 2028

1.2.2 The Project area

The project corridor is under continuous refinement during the development of the Reference Design to avoid and minimise environmental and heritage impacts. Figure 1.1 presents the project corridor, with further details of the proposed test excavation locations provided in Section 3 and Appendix B.

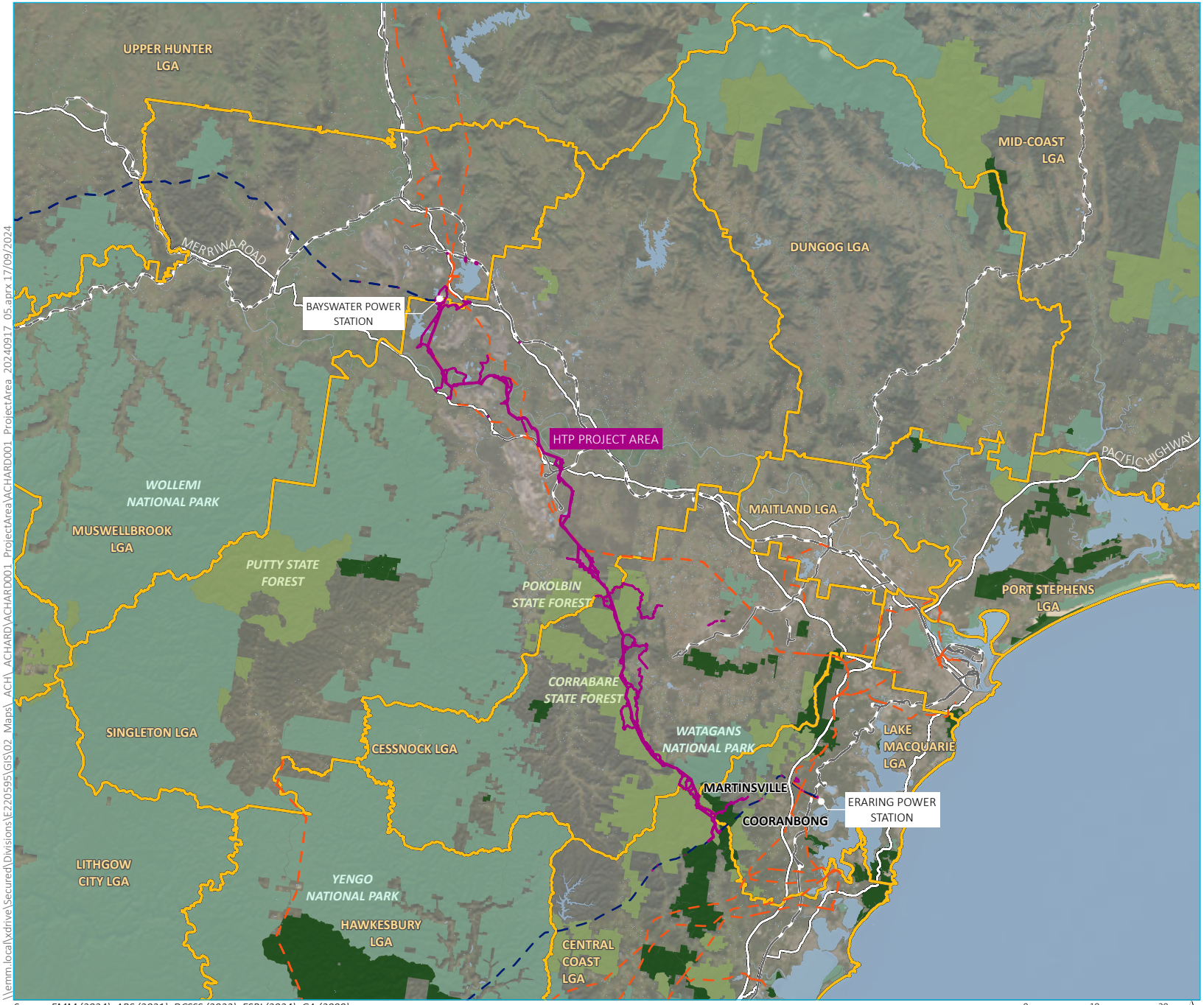
1.3 Aboriginal consultation

Aboriginal consultation has included both a project specific engagement strategy with known key and locally-based traditional owners, and the application of the broader Heritage NSW consultation requirements. Aboriginal consultation was initiated in September 2023, with co-designed workshops through late 2023 and early 2024, and the formal notification and information stages undertaken in December 2023.

Through these processes, some 48 Aboriginal individuals and/or organisations are registered to be consulted upon the Project (Appendix A.1). Of these, 28 are more extensively engaged in meetings, cultural values mapping, and on-Country activities aligning with the connections to Wonnarua, Awabakal and/or Darkinjung traditional boundaries.

To date some 750 interactions have been undertaken with the Aboriginal parties, including ten meetings and over 18 weeks of field survey. In relation to the proposed test excavations, the following activities have been undertaken:

- 5 February 2024 – distribution of project information and proposed assessment methodology for a period of 28 days. The methodology including the proposed excavation methods should any sites requiring such investigation be found. However, it only included general spatial information for any test excavations, since specific targets or deposits had yet to be located.
- 9 July 2024 – undertook an Aboriginal Focus Group (AFG) meeting with HTP North Aboriginal traditional owners to discuss the field survey and key findings and begin to discuss the expected test excavation program.
- 10 August 2024- undertook an AFG meeting with HTP Central Aboriginal traditional owners to discuss the field survey and key findings and begin to discuss the expected test excavation program.
- 10 August 2024- undertook an AFG meeting with HTP South Aboriginal traditional owners to discuss the field survey and key findings and begin to discuss the expected test excavation program.
- 17 August 2024 - distributed this document to all registered Aboriginal parties (RAPs) and sought comment for a period of 28 days.
- Mid-October 2024 – undertook an AFG meeting to discuss the test excavations outlined in this document with HTP North, HTP Central and HTP South traditional owners.





KEY

- HTP project area

Existing transmission line

- 500 kV transmission line
- 330 kV transmission line

Existing environment

- Rail line
- Major road
- Waterbody
- NPWS reserve
- State conservation area
- State forest
- Local government area

INSET KEY

- NPWS reserve
- State forest

Project area

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Source: EMM (2024); ABS (2021); DCSSS (2023); ESRI (2024); GA (2009)

0 10 20 km

GDA2020 MGA Zone 56

N

Hunter Transmission Project
Aboriginal Cultural Heritage Assessment
Archaeological Research Design
Figure 1.1

EMM
creating opportunities

2 Aboriginal sites and deposits within the Project area

The following section outlines desktop information and a summary of field activities that have identified Aboriginal sites and/or potential archaeological deposits (PADs) where test excavation is desirable to further identify their significance.

2.1 Desktop information

In the north of the project area, there have been numerous Aboriginal heritage investigations associated with the mining activities (e.g. AMBS, 2002; Brayshaw, 1981, 1990; Brayshaw and Haglund, 1981, 1983; CQCHM, 2014, 2016; EMM, 2022; ERM, 1995, 1997, 1998, 1999a, 1999b; Haglund, 1982, 1993; Hiscock et al. 2000; Hughes, 1999, 2000a, 2000b, 2003; Hughes and Hiscock, 2000; Jacobs, 2019, 2021; OzArk Environment and Heritage, 2013, 2016; Rich, 1990, 1993; Scarp Archaeology, 2009). In summary, these studies all develop a similar model of past occupation and use. Specifically, past studies and previously documented sites indicate that cultural materials within the regional context are generally dominated by stone artefact sites, most frequently isolated stone artefacts or low density (<20) artefact scatters. Relatively few sites feature subsurface deposits, and this reflects the nature of shallow duplex soils throughout the Hunter Valley as well as high susceptibility to erosional impacts due to natural and historical disturbances. Archaeological material is scattered almost continuously across the Hunter Region in all contexts, disturbed and undisturbed, across all landforms. These sites have generally been attributed low scientific significance.

Distribution of higher density artefact sites shows a strong correlation with elevated landforms such as ridgelines, spurs or terraces in proximity to water with archaeological evidence in the Hunter Valley primarily contained within a corridor approximately 100 m wide on either side of a watercourse. While these types of sites can demonstrate higher densities of artefacts they still usually reflect disturbed contexts or lack discernible stratification and, therefore, are usually assigned moderate scientific significance.

Stone artefact scatters demonstrating higher densities, stratification and potential to be of greater age (i.e. Pleistocene) are more likely to be identified within aeolian or colluvial sand dune/sheets contexts as they are characterised by deeper deposits with better preservation contexts. These landforms are source bordering dunes which are associated with the Warkworth sand system and are generally found within proximity to the Hunter River, Wollombi Brook and their immediate tributaries (usually within 5 to 10 km of their intersection). These site types have generally been assessed as having high scientific significance as they are limited in number, represent stratified deposits (which is rare across the region), and can be of Pleistocene age.

The focus of the proposed test excavation program (Section 3) is undisturbed locations where these Warkworth sand system deposits are predicted to be present within the project area (Figure B.1). Spatially, these deposits are focussed in the vicinity of the confluence of the Wollombi Brook and Hunter River, as well as discrete pockets extending northwards into Hunter Valley Operations (HVO). While the sand sheet has been found to extend up to 4 m in depth, typically cultural materials are found in the upper 1 m of the deposit. Previous excavations of the deposit within HVO (EMM, 2022) and along Sandy Hollow Creek (Scarp Archaeology 2009) have demonstrated cultural materials to depths of ~80 cm and up to 1.25 m below surface, respectively. The latter was aligned with dates of >45 ka, and while they were considered to have been deposited more recently and pedoturbated through the soil profile to these depths, it does indicate that parts of the sand unit deeper than this are likely to pre-date the initial peopling of Australia (i.e. will be culturally sterile). In addition to the Warkworth sand system, historically the banks of Loder Creek have also demonstrated extensive cultural materials. Of note were previous investigations by Margrit Koettig of Loder Creek and Moorland Creek in the late 1990s, during which some 13,000 artefacts were documented. More recently, OzArk Environment and Heritage (2016) undertook an investigation of the Bulga coal mine, which was proposing to expand eastwards from its established operation into areas around Broke Road and the Golden Highway. The report, which included field survey and test excavations,

ultimately identified 14 previously unidentified site 'complexes' encompassing ~200 ha, and some 45 other previously documented sites including grinding grooves and culturally modified trees. In most cases, these sites were found either on the surface or in shallowly buried duplex soils.

While the cultural deposits in the vicinity of Loder Creek are typically shallow, the potential density of stone artefacts is regionally high; and has the potential to be extremely significant in informing past use and activity. As such, this area also forms a focus of test excavations for the project (Figure B.2; Table B.1).

Within HTP Central and HTP South, there has been limited investigations to date. Previously documented sites within the State Forests appear to be a mixture of amateur bushwalkers and/or hobby groups, and by NSW State Forests personnel when encountered. We are aware of a recent formal assessment of Corrabare North Flora Reserve by Heritage Now Pty Limited, although the report is still under development. Discussions with Heritage Now indicate that all identified Aboriginal objects and sites are documented on the Heritage NSW AHIMS database. These sites are almost exclusively characterised as rockshelters with various amounts of art and/or deposit.

2.1.1 Geotechnical investigations

Geotechnical investigations have been undertaken by WSP for some components of the project. To date these have been of limited use in the areas proposed for archaeological excavations above, being focused on specific tower locations that are generally outside of these sensitive environments.

In the case of the Hunter River/Wollombi Brook confluence, only three bore-holes are currently available immediately south near Gouldsville (BHA19-BB, BHA19.1-BB, BHA20-BB). These reveal a shallow 20-centimetre (cm) topsoil over-lying clay subsoil, and no indication of the Warkworth sand system in this locale. Although further south within Gouldsville, a single bore-hole (BHA 20.1-BB) indicates a thin band of sand at 60 to 130 cm below surface, under modern overburden, with in an area not mapped as part of the sand system.

In the vicinity of Loder Creek, several bore-holes all indicate shallow duplex soils. Although, it must be highlighted that many of these are adjacent an artificial dam east of Broke Road, and the distribution of this soil profile must be considered with caution. Only BHA24-BB is found north of Loder Creek on one of its tributaries some distance from the main channel appears in a natural context; and here to only shallow duplex soil profiles were encountered.

Further south, only one borehole can inform the banks of Monkey Place Creek. BHA32.1-BB undertaken near Cessnock Road suggests a sand unit between 50 to 120 cm below surface underneath modern overburden.

Given the sparse distribution of this data, the geotechnical investigations cannot inform specific locales that should be targeted for test excavation. However, they provide a general indication that two main soil profiles have been encountered, either a shallow duplex soil where cultural materials will probably be constrained to the top 30 cm; or a deeper sandy profile that is frequently buried by modern overburden, and which may extend to depths of 120 to 130 cm below the surface. These differing soil profiles have been used to inform and develop archaeological excavation methods based on the conditions encountered during the works.

2.2 Field investigations

Overall, some 18 weeks of field survey by archaeologists and Aboriginal traditional owners of the project area has been undertaken. While these works remain ongoing, they conservatively have investigated some 2,276 ha of the project area to date, and identified 352 Aboriginal sites and/or places (with a further 205 previously recorded AHIMS sites reinvestigated). Further information of the investigations and findings will form part of the ACHA for the project.

The field investigations to date have systematically surveyed the proposed alignment, access tracks and any ancillary works. While the majority of the survey work has been undertaken the surveys are ongoing and are

aiming to reach 100% coverage prior to undertaking test excavations. To date the surveys have confirmed that areas of higher sub surface archaeological potential in the north of the study area are located close to watercourses, in particular Loder Creek, the Hunter River, Wollombi Brook and Monkey Place Creek. The areas in which areas of potential archaeological deposit have been identified are in locations that have had little to no disturbance and where no archaeological investigations have been undertaken to date. These areas of potential are mostly located on elevated landforms with the potential to contain sand deposits. A range of site types have been recorded including culturally modified trees, grinding grooves, artefact scatters of varying densities, isolated finds, stone arrangements and rockshelters. Stone arrangements and rockshelter sites have been found in the steep, densely vegetated southern portion of the project area, in the state forests.

Many of the sites and places have clear cultural characteristics and their spatial extent and significance can be discerned. However, a number of sites were tentatively identified in the field with a need to undertake further investigation – typically test excavation – to identify cultural characteristics (if present) and any other relevant information. For this project, there are two main sites types that require such consideration: rockshelters and areas of PAD.

In the case of rockshelters, a large number of those within or near the project area have been previously identified, and include art motifs and/or stone artefactual material. Such sites can clearly be identified as an Aboriginal site and managed accordingly. However, there are numerous sites where such cultural materials are absent, and further investigations generally of floor deposits are needed to identify whether they have been used in the past. Further investigations for tentative rockshelters would only be considered if project related impacts were unavoidable, and a mechanism to ensure this is robustly considered is presented in Section 3.4.1. Table B.1 in Appendix B presents a summary of these sites within the project area.

Similarly, a number of areas of PADs have been identified where buried cultural material may be expected based on regional archaeological models (Section 2.1). In most instances for this project, these areas are constrained to the proximity of major water courses that are already being proposed for further investigation. Appendix B presents a summary of any discrete areas of PAD identified within the project area, and which require further investigation.

2.3 Synthesis

Based on the information above, there are several areas where test excavation is considered necessary to further understand the composition and/or significance of an Aboriginal site or potential archaeological deposit. These include (Figure B.2 in Appendix B):

- undisturbed areas where the project may result in impacts within 500 m of Wollombi Brook and Hunter River where the Warkworth sand system is known to be regionally present
- areas where the project may result in impacts within 200 m of Loder Creek and tributaries where dense cultural materials may be expected based on previous investigations
- areas where the project may result impacts within 200 m of Monkey Place Creek where identified cultural materials, such as grinding grooves and/or where deep sand units may be present
- sites that have a tentative classification due to a lack of observable cultural materials (see Table B.1, Appendix B).

3 Research design

3.1 Rationale, objectives and aims

As outlined in Section 2, the proposed activity has the potential to intersect tentatively classified sites and/or areas where buried cultural material may be present. This section outlines a proposed test excavation of these sites and places to further understand their cultural origins and significance to inform the project. The rationale for the development of this document is twofold:

- To obtain permission from Heritage NSW under the project SEARs (Section 1.1) to undertake an archaeological test excavation that does not align with the Code of Practice guidelines. The test excavations are developed to closely align with the established guidelines, but they deviate in a number of specific scenarios that require permission:
    - the archaeological test excavation program does not implement a systematic grid across the project area, which represents a linear corridor of over 100 km; rather, it proposes both smaller grids within the project area focussing on major infrastructure components, and prioritises a quantum of excavation in square metres rather than a specific number of test pits
    - while Contact sites and/or deposits have not been encountered, they have been raised as a concern by one of the registered Aboriginal parties. Such sites are excluded from excavations under the Code of Practice guidelines, without further permission or approval
    - several potential rockshelters are proposed for further investigation, since they lack clear signs of being habited in the past. All sites are within the project footprint and may be adversely affected. Such sites are excluded from excavations under the Code of Practice guidelines, without further permission or approval.
- To outline all test excavations proposed for the ACHA in a single place to avoid confusion and promote transparency in a project where large numbers of Aboriginal traditional owners involved.

Overall, the aims of the ARD are to:

1. answer and/or resolve the research questions outlined Section 3.2 in relation to the cultural formation of sites and deposits identified by the desktop information and field survey, and what they can tell us about Aboriginal populations in the past
2. determine the spatial extent and depths of any cultural deposits to inform the project and allow consideration of robust avoidance opportunities to be explored. Where they cannot be avoided, such information can be used to develop suitable cultural offsets and/or mitigation strategies
3. allow greater cultural association between the sites and deposits and Aboriginal traditional owners through on-Country activities, often in areas where access has been restricted in the modern era
4. integrate any findings into the ACHA to provide a holistic and comprehensive understanding of the archaeological landscape and cultural materials within it
5. inform future interpretation proposed for the project.

3.2 Research questions

The research questions for the ARD include:

1. Are Warkworth Pleistocene sand system deposits present within the project area and if so, is the evidence of past occupation within them? What proximity are these deposits to the Hunter River, and Wollombi Brook and their immediate tributaries (usually within 5 to 10 km of their intersection) and how can this inform on the potential and period of occupation of past human activities for the region?

2. A number of specific landform features and/or places are identified based on detailed review of previous assessments presented in Section 2.1, and which highlighted creeks such as Hunter River, Loder Creek and Wollombi Brook as documented to contain significant cultural assemblages. The results of the survey have found that Monkey Place Creek also contains high potential for cultural material. What is the nature of cultural materials within the proposed alignment in close proximity to these watercourses? What is the evidence and nature of past human activity in other identified areas?

3. What is the spatial and stratigraphic patterns of cultural materials within rockshelters in Pokolbin, Corrabare, Olney and Watagan State Forests, and Jilliby State Conservation Area? Can these sites be robustly identified as cultural or non-cultural through targeted excavation and can this add to the current evidence of past activity for rockshelters sites for the region?

4. What are the environmental characteristics associated with the distribution of Aboriginal cultural heritage within the project area? Can the formative processes of the stratigraphic profile provide information on the nature and/or survivability of the archaeological resources? Are there other key factors in the distribution and extent of the material culture within the project area?

5. How do the differing methodologies proposed in relation to sieve sizes and wet/dry sieving influence the results of the archaeological excavations? Which approach recovers greater amounts of cultural materials, and does this provide further information to answer other research questions?

6. What are the cultural, social and public values associated with the cultural materials in the project area?

7. How should the cultural materials be conserved and managed in future?

3.3 Archaeological test excavation overview

The archaeological test excavation program ultimately incorporates three slightly different approaches depending on the deposits encountered during the works, with all of them adopting the Code of Practice guidelines as a foundation (Section 3.4). Specifically:

- where rockshelters require further investigation, test excavations would consist of a very small number of test pits excavated at a high resolution to account for the significant and finite deposits typically found in such sites

- where the Warkworth sand system is encountered, a focus would be on ensuring the full depth of the soil profile is encountered and undertaking a lesser number of large, deeper test pits, rather than a broader grid of smaller test pits

- where duplex soils are encountered, test excavations would typically align with Code of Practice approaches.[2]

All test excavations are indicative and would be further refined as on ground conditions become apparent during the program. Further, they have the potential to be reduced when Project refinement is available that outlines areas of potential deep ground disturbance (e.g. transmission tower foundations) compared with lesser impacts (e.g. temporary hard stands, storage areas, etc). A focus on the program would be on the areas proposed for greater impact where such information is available. Excavation would focus on tower footprints and their construction compounds, which are both the most well-defined components of the project, and where the greatest impacts from the project are expected to occur. In the case of tentative rockshelters, those proposed for excavation are considered at high risk of direct, or more commonly indirect impacts from vibration and/or increased access during and following the construction. A single validated rockshelter, #45-3-0263 is also included at the request of the Darkinjung traditional owners. Where other areas become apparent during the project, their inclusion would adopt the approach and methods outlined here, and a short update document outlining their inclusion provided to Heritage NSW and the RAPs.

All excavations are proposed to be undertaken manually with a team of archaeologists and Aboriginal traditional owners. The team would include an archaeologist with historical heritage experience to provide input into any Contact cultural materials if encountered. All sediment recovered would be subject to sieving for cultural materials. In the case of rockshelters, sieve mesh would be 3 millimetres (mm), while all other excavations would adopt a 5 mm size. A range of environmental, soil and chronological samples would be collected at each site where significant cultural materials is encountered. These would be processed in accordance with Section 3.6.

All reporting of the excavations would be integrated into the ACHA and/or other project relevant documents. However, we would also provide brief summaries of the excavations and their findings to Heritage NSW and the RAPs as the works progress. These would include the general areas that have been completed, whether cultural materials have been encountered, any deviations from the proposed approach, and future proposed activities.

3.4 Excavation methods

3.4.1 Rockshelters

Prior to the excavation of any rockshelter, the location of the site will be reviewed based on the latest project information. Only sites that are within a projected disturbance area would be subject to archaeological test excavations.

The following methods would be adopted for the excavation of rockshelters listed in Appendix B:

- all test pits would be established using a hand-held Leica RTK CS10/GS08 survey grade Differential GPS device (or equivalent)
- establishment of a single 0.25 m^2 test pit within the deepest portion of any observable soil profile within the rockshelter; or within the talus slope where the site has no internal deposit. Expansion of test pit to 1 m^2 where >5 artefacts are initially recovered. Consideration of additional discrete 0.25 m^2 test pits elsewhere within the site if required. Where proposed, any excavations would not total more than 10% of the cultural deposit evident within the site

[2] Due to the project's timeframes, some of these locations may be implemented under the Code of Practise and prior to the endorsement of this document by Heritage NSW.

- excavations will be manually dug in 5 cm spits to culturally sterile deposits, expected to <1 m. Where depths exceed 1m, any test pit would be expanded (if not already) to 1 m^2 to allow safe access to these depths

- all sediment recovered will be dry sieved through a 3 mm mesh for cultural materials. Wet sieving is the preference for excavation where access is achievable for water supply (e.g. water truck), however, this is not expected to be the case for these sites that are in remote elevated locations in any instances. All cultural materials (including any European debris) would be collected for subsequent analysis

- all completed test pits will have a layer of geofabric material established and then manually backfilled shortly following completion

- field documentation:

    - all test pits would be documented using photographic records, written descriptions and scaled drawings

    - soil profiles would be recorded in accordance with the Code of Practice guidelines, including scaled drawings, photographs, and written descriptions

    - soil samples may be collected for description, sedimentological and chronological analysis where such analysis is considered likely to contribute significant information. Optically Stimulated Luminescence (OSL) samples would be taken in areas where Aboriginal objects are found, and generally try to bracket the deposit (to provide a maximum and minimum age). Material for radiocarbon analysis may also be undertaken opportunistically if archaeological features containing charcoal or other dateable material are evident

    - reduced levels of the top and bottom of each test pit and at every fourth spit (20 cm) would be documented using a dumpy level against a known elevation. Other levels may be taken as required

- excavation procedures and protocols may be modified at the discretion of the Excavation Director, in consultation with the Aboriginal traditional owners as the conditions in the field and nature of the excavations develop. This includes the movement/discontinuance of test pits to avoid existing obstacles, buried services and disturbances.

3.4.2 Where the Warkworth sand system is encountered

The following methods would be adopted for the excavation of PADs and areas where the Warkworth sand system is predicted and/or encountered (Appendix B):

- all test pits would be established using a hand-held Leica RTK CS10/GS08 survey grade Differential GPS device (or equivalent)

- establishment of a grid of 0.25 m^2 test pits at 40 m spacing (Phase 1), with option to infill this initial grid to 20 m spacing where artefacts exceed >5/m^2 in adjacent test pits (Phase 2 where needed).[3] Additional expansion of test pits may be undertaken to further resolve any uncertainties about the cultural deposits (see below). Excavation would:

[3] Please note that the maps presented in Appendix B show a grid of 20 m with the initial 40 m grid represented by "Test pits (Phase 1)", and any infilling to a 20 m grid that is required is represented by "Test pits (Phase 2)".

- initially focus on a single test pit in the centre of the proposed impact to determine the presence and depth of the sand sheet, and the depth of any cultural materials within it if present
- where the cultural deposits are found to be <50 cm, the proposed grid would be undertaken
- where the deposits are found to be >50 cm, the grid would be reduced and re-focussed on undertaking a lesser number of 1 m^2 test pits to ensure suitable characterisation of the cultural deposits. The exact reduction would be determined in the field in discussion with the participating Aboriginal traditional owners and prioritising resolution of the ARD's aims and research questions
- expansion of test pits to 1 m^2 will occur where >5 artefacts are initially recovered in the 0.25m^2 test pit

- the first excavation unit will be excavated and documented in 5cm spits at each area. Based on the findings of the first excavation unit, 10 cm spits or sediment/stratigraphic excavation may then be implemented
- excavations will be manually dug in 10 cm spits to culturally sterile deposits, geological substrate or 1.5 m below current surface. It is not expected that cultural materials would be encountered below this depth given previous investigations of the Warkworth sand system. However, should cultural materials be encountered near the base of these test pits, discussions with Heritage NSW and the Aboriginal participants would be undertaken to explore additional actions and/or methods to enable excavation to greater depths (e.g. expansion of the test pit to enable shoring systems to be used to gain greater depths, etc).
- all sediment recovered will be sieved through a 5 mm mesh for cultural materials. Where expansion of test pits as a result of artefact thresholds are implemented, sieving would be modified of a 3 mm mesh. All sieving would prioritise wet sieving methods wherever feasible, although this will be dependent on accessibility of water supply, landowner permissions and/or other environmental factors. Where this cannot be achieved dry sieving would be adopted. All cultural materials (including any European debris) would be collected for subsequent analysis
- all completed test pits will be backfilled shortly following completion
- field documentation:
  - all test pits would be documented using photographic records, written descriptions and scaled drawings
  - soil profiles would be recorded in accordance with the Code of Practice guidelines, including scaled drawings, photographs, and written descriptions
  - soil samples may be collected for description, sedimentological and chronological analysis where such analysis is considered likely to contribute significant information. OSL samples would be taken in areas where Aboriginal objects are found, and generally try to bracket the deposit (to provide a maximum and minimum age). Material for radiocarbon analysis may also be undertaken opportunistically if archaeological features containing charcoal or other dateable material are evident
  - reduced levels of the top and bottom of each test pit would be documented using a dumpy level against a known elevation. Other levels may be taken as required

- excavation procedures and protocols may be modified at the discretion of the Excavation Director, in consultation with the Aboriginal traditional owners as the conditions in the field and nature of the excavations develop. This includes the movement/discontinuance of test pits to avoid existing obstacles, buried services and disturbances.

3.4.3 All other sites and deposits

The following methods would be adopted for the excavation of areas that do not align with conditions in Section 3.4.1 or 3.4.2 (Appendix B):

- all test pits would be established using a hand-held Leica RTK CS10/GS08 survey grade Differential GPS device (or equivalent)
- establishment of a grid of 0.25 m^2 test pits at 40 m spacing (Phase 1), with option to infill this initial grid to 20 m spacing where artefacts exceed >5/m^2 in adjacent test pits (Phase 2 where needed).[4] Additional expansion of test pits will be undertaken to 1 m^2 where >5 artefacts are recovered in the initial 0.25 m^2 test pit, to help further resolve any uncertainties about the cultural deposits
- the first excavation unit will be excavated and documented in 5cm spits at each area. Based on the findings of the first excavation unit, 10 cm spits or sediment/stratigraphic excavation may then be implemented
- excavations will be manually dug in 10 cm spits to culturally sterile deposits, geological substrate or 1.5 m below current surface
- all sediment recovered will be sieved through a 5 mm mesh for cultural materials. Where expansion of test pits as a result of artefact thresholds are implemented, sieving would be modified of a 3 mm mesh. All sieving would prioritise wet sieving methods wherever feasible, although this will be dependent on accessibility of water supply, landowner permissions and/or other environmental factors. Where this cannot be achieved dry sieving would be adopted. All cultural materials (including any European debris) would be collected for subsequent analysis
- all completed test pits will be backfilled shortly following completion
- field documentation:
    - all test pits would be documented using photographic records, written descriptions and scaled drawings
    - soil profiles would be recorded in accordance with the Code of Practice guidelines, including scaled drawings, photographs, and written descriptions
    - soil samples may be collected for description, sedimentological and chronological analysis where such analysis is considered likely to contribute significant information. OSL samples would be taken in areas where Aboriginal objects are found, and generally try to bracket the deposit (to provide a maximum and minimum age). Material for radiocarbon analysis may also be undertaken opportunistically if archaeological features containing charcoal or other dateable material are evident

[4] Please note that the maps presented in Appendix B show a grid of 20 m with the initial 40 m grid represented by “Test pits (Phase 1)”, and any infilling to a 20 m grid that is required is represented by “Test pits (Phase 2)”.

- reduced levels of the top and bottom of each test pit would be documented using a dumpy level against a known elevation. Other levels may be taken as required.

- excavation procedures and protocols may be modified at the discretion of the Excavation Director, in consultation with the Aboriginal traditional owners as the conditions in the field and nature of the excavations develop. This includes the movement/discontinuance of test pits to avoid existing obstacles, buried services and disturbances.

3.5 Ancestral remains

No activities proposed in this document authorise the excavation or interactions with ancestral (human) remains if encountered.

If ancestral remains are found, the following steps would be implemented:

- archaeological activities would immediately cease
- NSW Police (131 444) would be notified
- EnergyCo, Heritage NSW and the Aboriginal parties would be also be advised of the find, although no actions would be sought until direction from the NSW Police has been provided
- follow any subsequent directions and requirements of the NSW Police
- should the human remains be released by the NSW Police as being archaeological, Heritage NSW via the Environment Line (131 555) would be contacted. EMM would provide details of the remains and their location, and seek advice on next steps to resolve the situation.

3.6 Post excavation analysis and reporting

The post-excavation analysis (incorporating data from the excavations) would be designed to address the research objectives and aims, along with other relevant questions that may arise based on the results of the excavation. These would include, but not be necessarily limited to:

- Stone artefact analysis, including descriptive and functional recording of the assemblage, as well as interpretation of past activities, post-depositional change and comparison with other nearby data. Conjoining may also be attempted where sufficient cultural materials have been recovered. Geochemical analysis of stone artefacts for provenance and other material source research questions using X-Ray Fluorescence, Inductively Coupled Plasma Mass Spectrometry and/or Thermal Ionisaton Mass Spectrometry may also be undertaken. These samples would be processed either at Australia's Nuclear Science and Technology Organisation (ANTSO), University of Wollongong and/or University of New South Wales.
- Other human indicators, including the consideration of sediment DNA and/or faecal biomarkers. While of limited commercially available, Consiglio Nazionale delle Ricerche (National Research Council of Italy) Institute of Polar Sciences (CNR-ISP), Venice, Italy and the Australian Centre for Ancient DNA, University of Adelaide would be contacted to explore the interest and feasibility to undertake these types of analyses. These are both cutting edge techniques that can further inform the presence of past human activity, but their application in cultural heritage management has not been explored to date in Australia.
- Geochronology, including the processing and analysis of samples to inform the absolute age of the soil profile and/or cultural assemblage recovered. This would include OSL ages, as well as radiocarbon samples were recovered. While large number of these samples are likely to be collected, given the prohibitive cost

of processing, it is probable that a small number of ages would be obtained in a small number of master-sequences to inform the broader archaeological program. The samples would be processed by either University of Gloucestershire and/or University of Wollongong.

- Geochemistry and soil analysis that would be used to further inform and interpret the formation history of the soil profile from which cultural materials are recovered. This would include the use of Itrax X-ray Fluorescence (XRF) core scanning methods at ANTSO, as well as particle size analysis to explore changes in the alluvial and colluvial history of the river corridor.

- Palaeo-environmental analysis, including palynology, phytolith analysis and/or charcoal analysis to explore the past vegetation and fire regimes that may have influenced and/or modified by past human activity. These would utilise the same samples collected for geochemistry and/or sampling and sent to a range of university specialists in these fields to process and interpret the results.

- Reporting that would provide information on the field investigations, compilation and synthesis of the post-excavation analyses, and interpretation of the results to inform the past activity and use of the region. This would be integrated into the ACHA and/or other relevant documents for the project.

- As per requirement 16a(13) of the Code of Practice, all AHIMS site cards or Aboriginal site impact recording forms (ASIRFs) will be updated and/or submitted for all identified Aboriginal sites subject to test excavations. These would be submitted during the finalisation of the ACHA.

3.7 Storage of Aboriginal objects

All Aboriginal objects recovered will be securely stored at EMM's Sydney office for analysis.

The final location of the Aboriginal objects will depend on the amount of material found, their significance, and the general agreement of the Aboriginal traditional owners. The final location will be determined at the completion of the excavation program when the nature of the cultural assemblage is known.

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Appendix A
Aboriginal consultation

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A.1 Registered Aboriginal parties

- Tocomwall/Yarrwalk
- Awabakal LALC
- Biraban LALC
- Darkinjung LALC
- Kevin Duncan
- Mindaribba LALC
- Robert Syron
- Wanaruah LALC
- Awabakal and Guringai Pty
- Awabakal Traditional Owners Aboriginal Corporation
- Steve Talbott
- Lower Hunter Aboriginal Incorporated
- Marrung-Ta Aboriginal Corporation/Culturally Aware
- DFTV Enterprises
- Didge Ngunawal Clan
- Gomery Cultural Consultants
- Kawul Pty Ltd trading as Wonn1 Sites
- Miromaa Aboriginal Language and Technology Centre
- Nunawanna Aboriginal Corporation
- Thomas Dahlstrom
- Trudy Smith
- Ungooroo Aboriginal Corporation
- Wonnarua Nation Aboriginal Corporation
- Girragirra Murun Aboriginal Corporation
- Wingarra Wilay Aboriginal Corporation
- Gunjeewong Cultural Heritage Aboriginal Corporation

- Long Gully Cultrual Services
- Widescope Indigenous Group
- A1 Indigenous Services
- Hunters & Collectors
- Jarban & Mugrebea
- Wallagan Cultural Services
- Yurwang Gundana Consultancy Cultural Heritage Services.
- Renee Sales
- Murra Bidgee Mullangari Aboriginal Corporation
- Wonnarua Elders Council/Upper Hunter Wonnarua Council Incorporated
- AGA Services
- Bawurra
- Cacatua Culture Consultants
- Warren Taggart
- Kiray Putjung Aboriginal Corporation
- Awabakal Descendants Traditional Owners
- Amanda Hickey Cultural Services
- AT Gomeroi
- Bara Barang Corporation Pty Ltd*
- Lower Hunter Wonnarua Cultural Services
- Wattaka Wonnarua Cultural Consultants
- Aliera French Trading

A.2 Distribution of assessment methodology and any responses

A.3 Meeting minutes

A.4 Any comments received following distribution of this document

Appendix B
Proposed test excavations

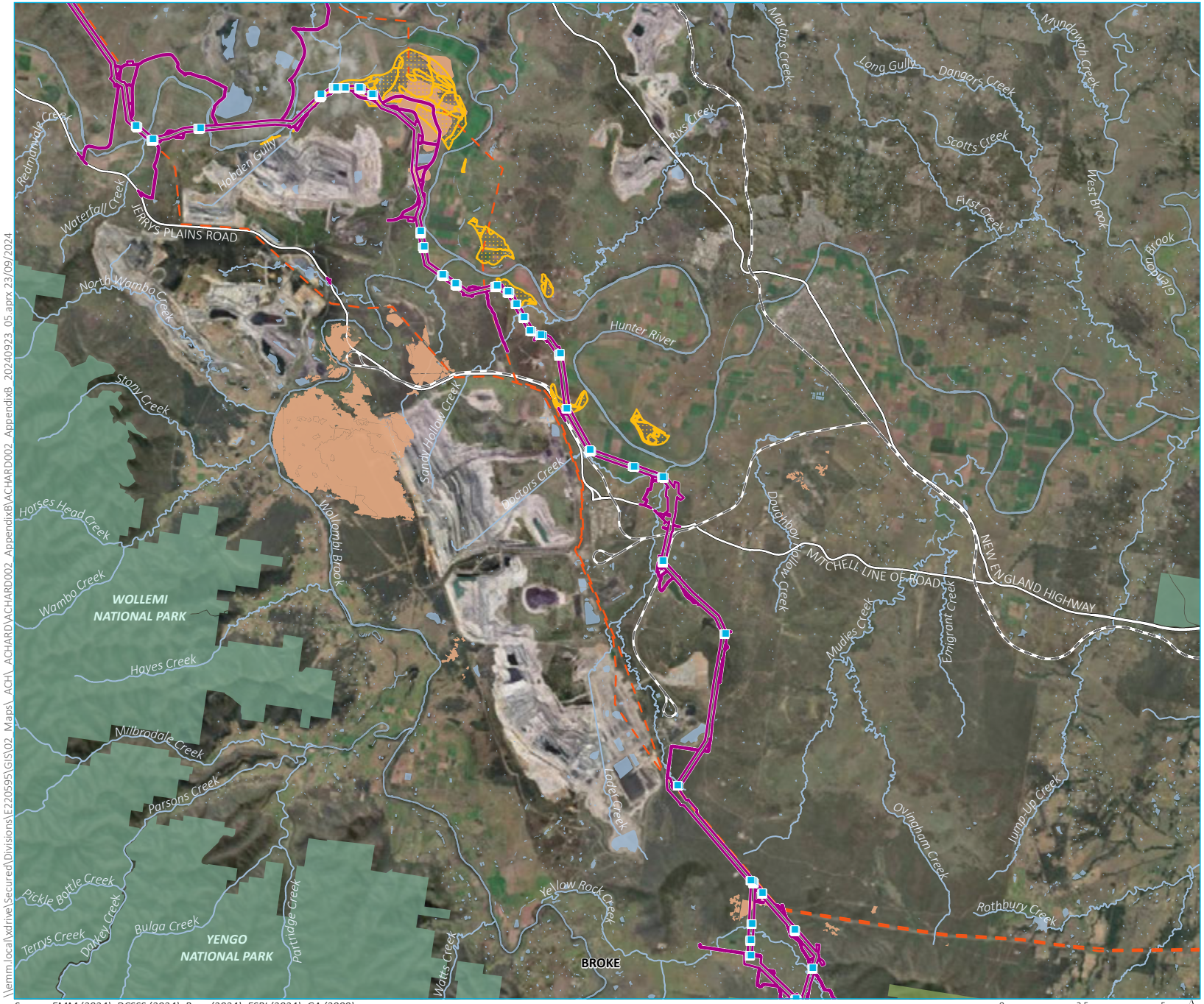
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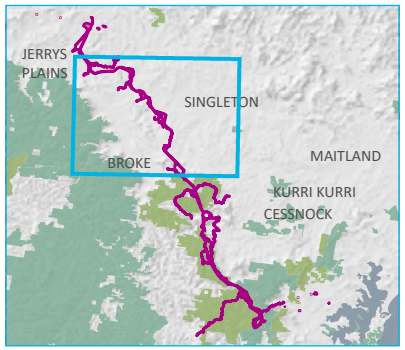
B.1 Aboriginal site or potential archaeological deposit identified within the project area for further investigation

Table B.1 Sites or potential sites for further investigation

Site ID	Site type	Description	Location
HTP-N-AS39, HTP-N-AS40, HTP-N-GG01	Low density artefact scatters, grinding grooves	Area of PAD within proximity to an artefact scatter.	Inside proposed alignment – Tower 85
AHIMS #37-6-2842	Low density artefact scatter	Area of PAD within proximity to an artefact scatter.	Inside proposed alignment – Tower 94
HTP-N-AS38	Low density artefact scatter	Area of PAD within proximity to an artefact scatter	Inside proposed alignment – Tower 99
Site complex – HTP-N-IF27, HTP-N-IF51, HTP-N-IF48, previously recorded sites – AHIMS #37-6-3156, #37-6-3156, #37-6-2064	Isolated finds, Low density artefact scatters	Area of PAD within a site complex. In proximity to the Hunter River, in an area mapped as having potential for a Pleistocene deposit.	Inside proposed alignment – Tower 125
AHIMS #37-6-4049	Low density artefact scatter	Area of PAD within proximity to an artefact scatter and in proximity to the Hunter River.	Inside proposed alignment – Tower 132
Site complex – HTP-N-IF22, HTP-N-IF23, HTP-N-IF53, HTP-N-IF52, HTP-N-IF20, previously recorded sites AHIMS #37-6-3507, #37-6-3505, #37-6-3516, #37-6-3499, #37-6-3514, #37-6-4068	Isolated finds, Low density artefact scatters	Area of PAD within a site complex. On an elevated landform in close proximity to Wollombi Brook. In an area mapped as having potential for a Pleistocene deposit.	Inside proposed alignment – Tower 135
Site complex – HTP-N-AS26, HTP-N-IF2, previously recorded sites – AHIMS #37-6-3484, #37-6-3488	Isolated finds, Low density artefact scatters	Area of PAD within a site complex. On an elevated landform in close proximity to Wollombi Brook. In an area mapped as having potential for a Pleistocene deposit.	Inside proposed alignment – Tower 136
Site complex – previously recorded sites – AHIMS #37-6-3384, #37-6-3379, #37-6-3348, #37-6-3350	Isolated finds, Low to moderate density artefact scatters	Area of PAD within a site complex. On an elevated landform in close proximity to Wollombi Brook.	Inside proposed alignment – Tower 140
HTP-C-RS03	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Inside proposed alignment – Tower 48
HTP-C-RS14	Rockshelter	Rockshelter with art. There is PAD within the rockshelter and/or immediately outside.	Outside proposed alignment – within 50 m of proposed access track (Langans Road)
HTP-C-RS15	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Outside proposed alignment – within 50 m of proposed access track (Cabans Road)

Site ID	Site type	Description	Location
HTP-C-RS16	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Outside proposed alignment – within 50 m of proposed access track (Cabans Road)
HTP-C-RS17	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Inside proposed alignment – Tower 29
HTP-C-RS18	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Inside proposed alignment – Tower 50
HTP-C-RS24	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Inside proposed alignment – Tower 39
HTP-C-RS44	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Outside proposed alignment – within 50 m of proposed alignment – Tower 28
HTP-C-RS45	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Inside proposed alignment – Tower 70
HTP-C-RS61	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Outside proposed alignment – within 50 m of proposed access track (Langans Road)
HTP-S-RS13	Rockshelter	Potential rockshelter with no cultural markers. However, there is PAD within the rockshelter and/or immediately outside.	Inside proposed alignment – Tower 16
AHIMS #45-3-0236	Rockshelter with art	Rockshelter with art, artefacts and potential archaeological deposit.	Outside proposed alignment – within 200 m of proposed access track





KEY

- HTP project area
- Test pit
- Warkworth sands
- Potential pleistocence desposit

Existing transmission line

- 330 kV transmission line

Existing environment

- Rail line
- Major road
- Named watercourse
- Waterbody
- NPWS reserve
- State forest

Mapped sand systems

Hunter Transmission Project
Aboriginal Cultural Heritage Assessment
Archaeological Research Design
Figure B.1

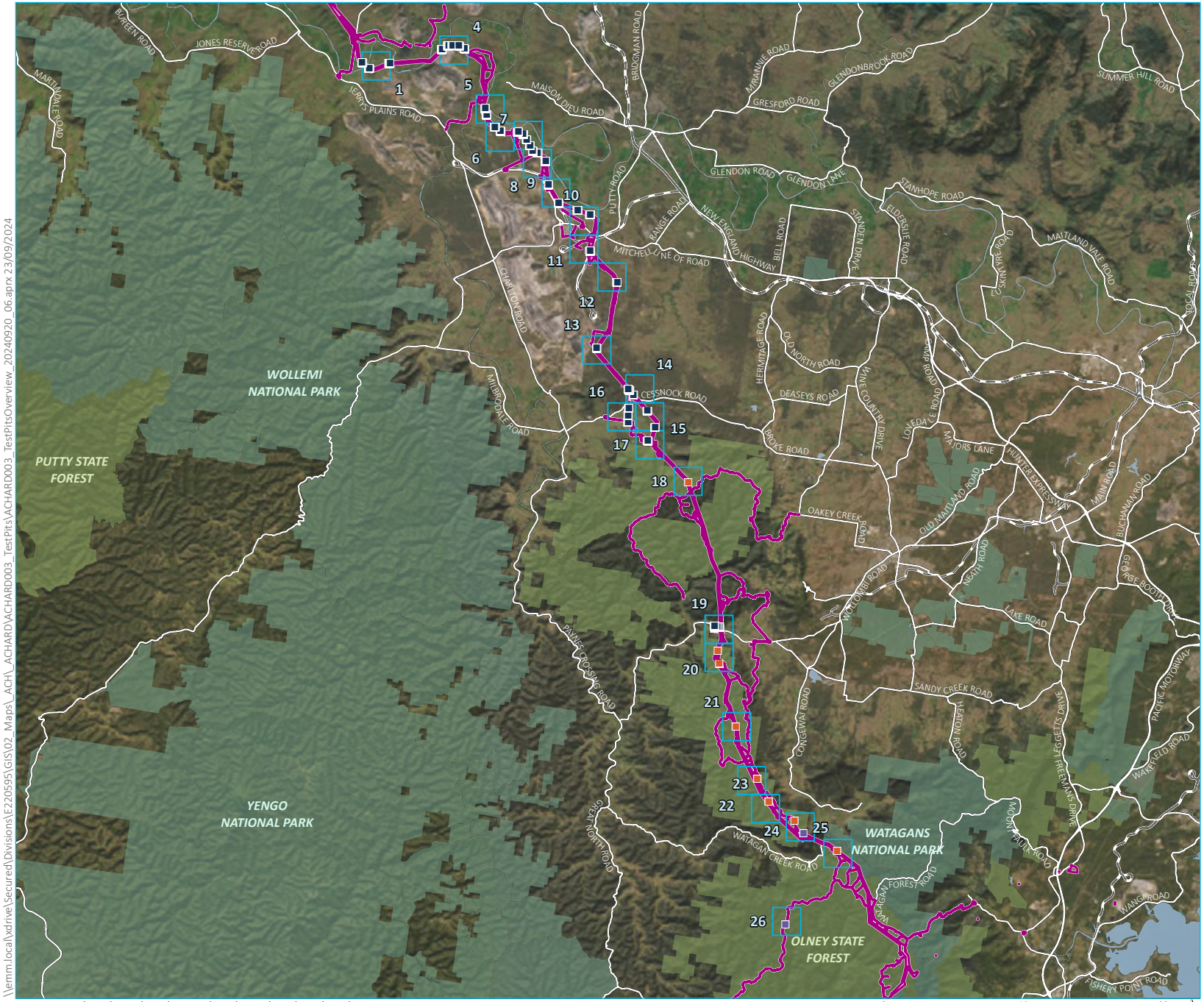
Source: EMM (2024); DCSSS (2024); Beca (2024); ESRI (2024); GA (2009)

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creating opportunities



KEY

- Project area
- Test pit
- Rockshelter proposed for investigation
- Potential rockshelter proposed for investigation

Existing environment

- Rail line
- Named waterbody
- NPWS reserve
- State forest

INSET KEY

- Major road
- NPWS reserve
- State forest

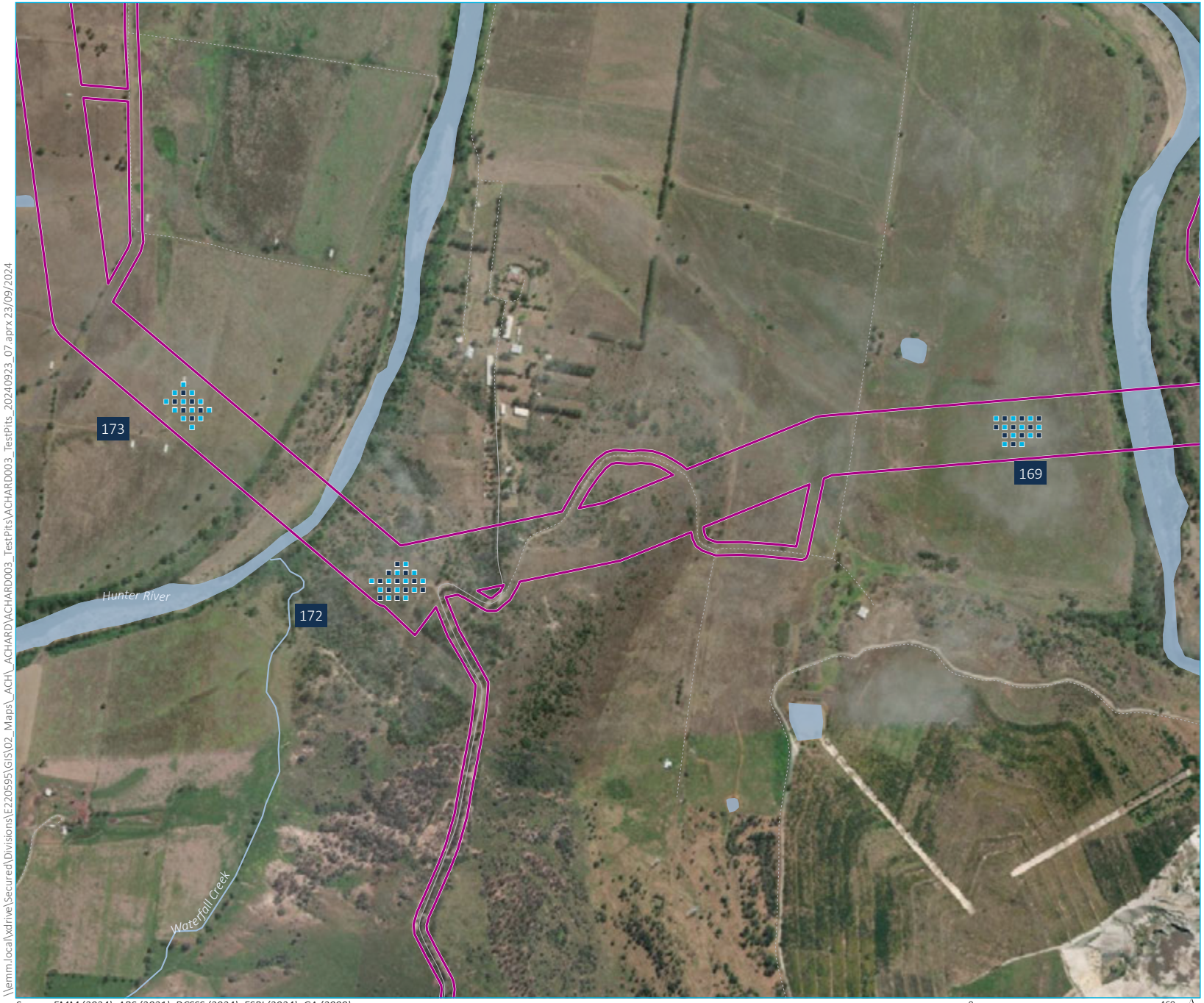
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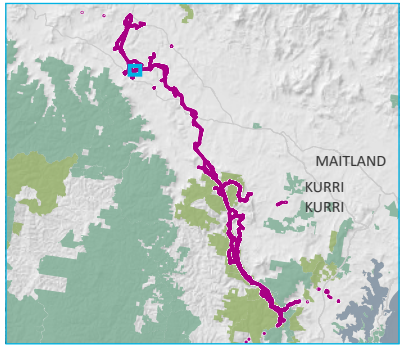
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Proposed test excavation locations Overview

Hunter Transmission Project
Archaeological research design
Appendix B.2

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KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- NPWS reserve
- State forest

Proposed test excavation locations
Towers 169-173
Page 1 of 23

Hunter Transmission Project
Archaeological research design
Appendix B.2

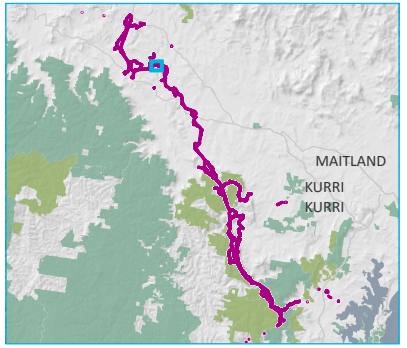
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Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

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KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- NPWS reserve
- State forest

Proposed test excavation locations
Towers 155-159
Page 2 of 23

Hunter Transmission Project
Archaeological research design
Appendix B.2

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

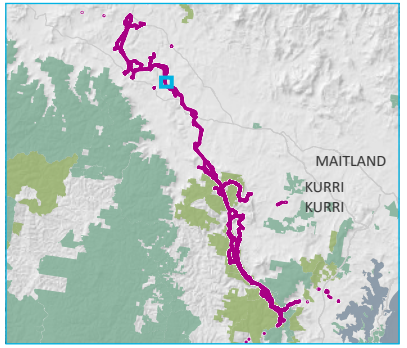
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creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Minor road
- Vehicular track
- Named waterbody

INSET KEY

- NPWS reserve
- State forest

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

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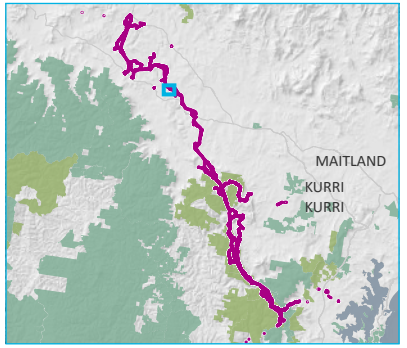
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Proposed test excavation locations
Towers 143-144

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM
creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- NPWS reserve
- State forest

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Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

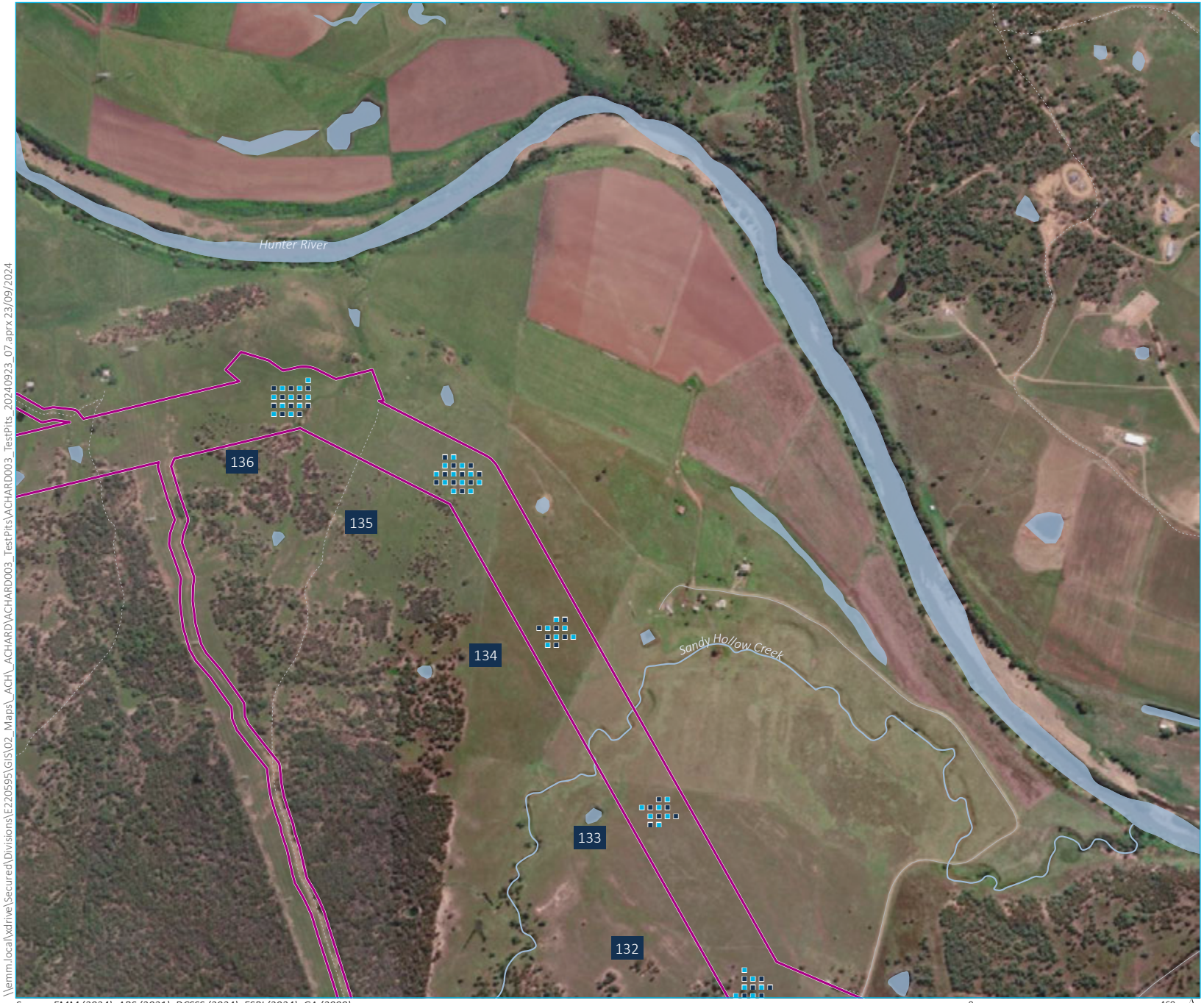
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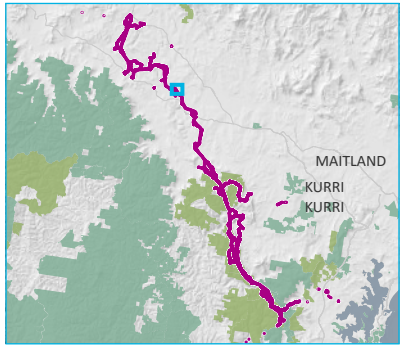
GDA2020 MGA Zone 56

N

Proposed test excavation locations
Towers 140-141

EMM
creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- NPWS reserve
- State forest

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

0 460 m

GDA2020 MGA Zone 56

N

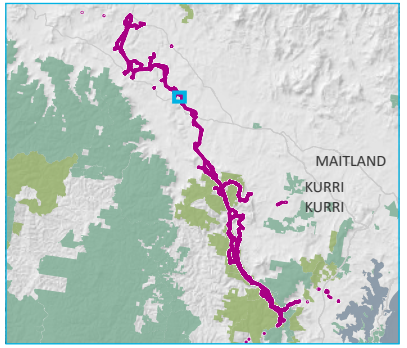
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Proposed test excavation locations
Towers 133-136

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM
creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- Major road
- NPWS reserve
- State forest

Proposed test excavation locations
Towers 129-130
Page 6 of 23

Hunter Transmission Project
Archaeological research design
Appendix B.2

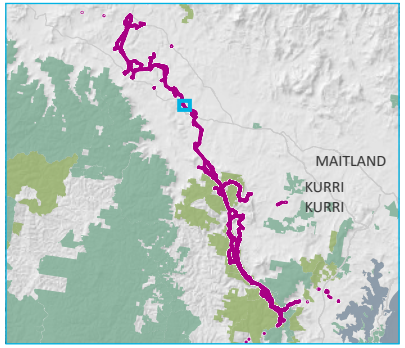
creating opportunities

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

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GDA2020 MGA Zone 56
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KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- Major road
- NPWS reserve
- State forest

Proposed test excavation locations
Towers 122-125
Page 7 of 23

Hunter Transmission Project
Archaeological research design
Appendix B.2

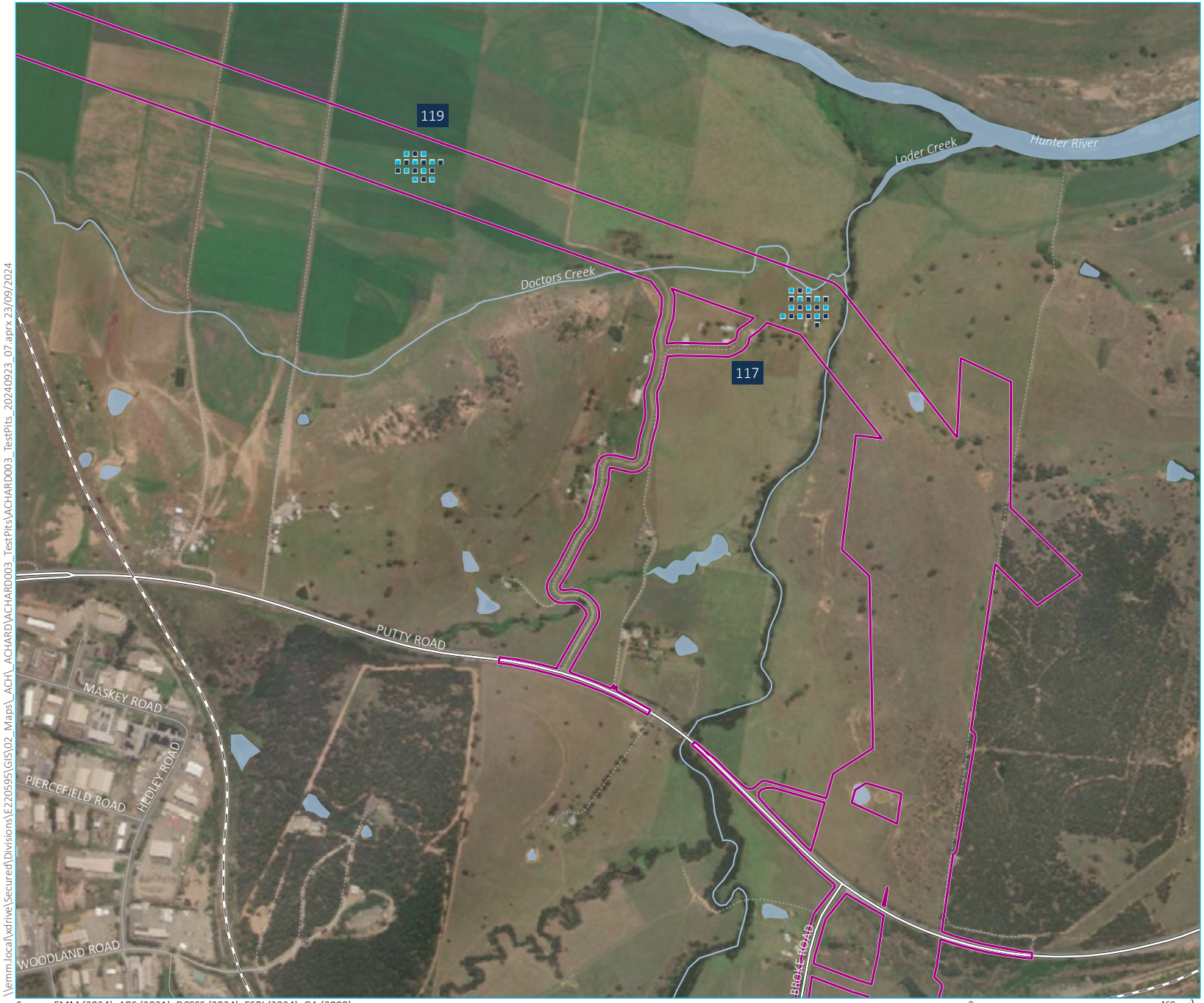
EMM
creating opportunities

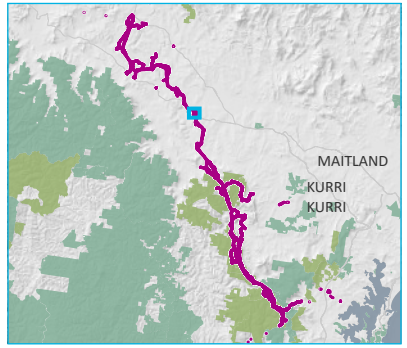
Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

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GDA2020 MGA Zone 56

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KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- Major road
- NPWS reserve
- State forest

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GDA2020 MGA Zone 56

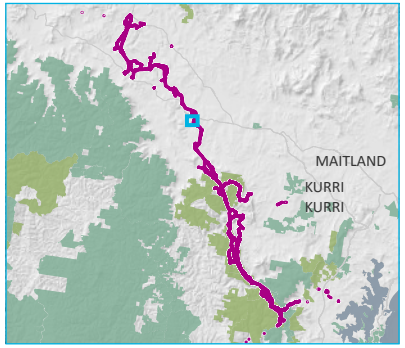
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Proposed test excavation locations
Towers 117-119

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM
creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Named watercourse

INSET KEY

- Major road
- NPWS reserve
- State forest

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

0 460 m

GDA2020 MGA Zone 56

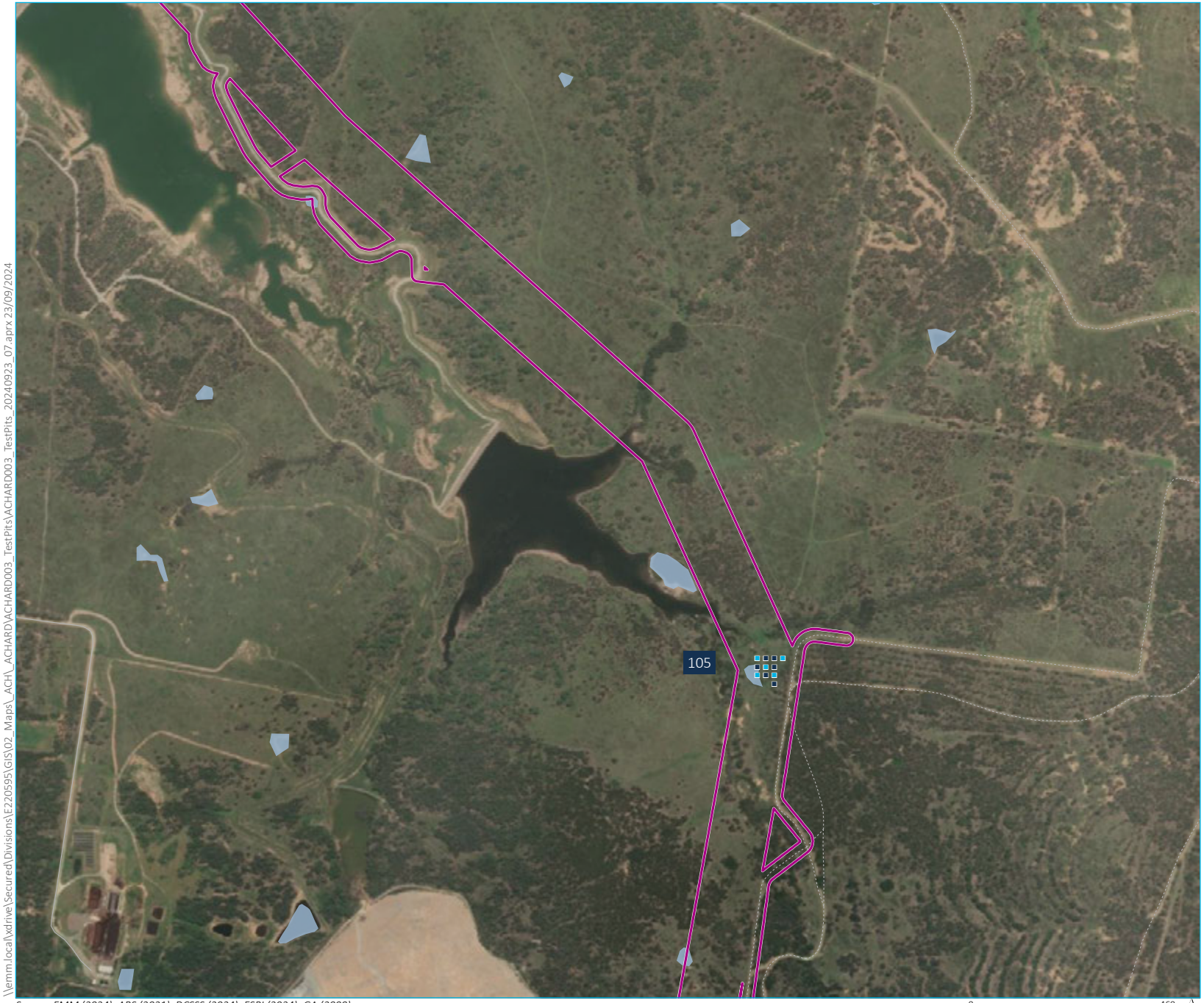
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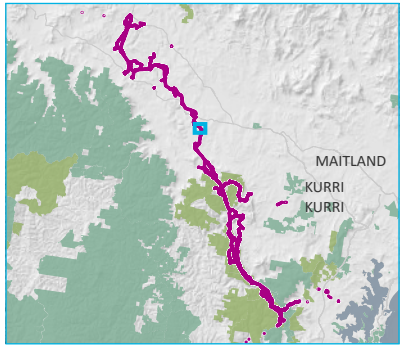
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Proposed test excavation locations
Tower 111

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM
creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Minor road
- Vehicular track

INSET KEY

- NPWS reserve
- State forest

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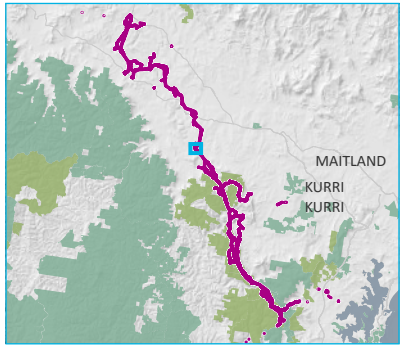
GDA2020 MGA Zone 56

N

Proposed test excavation locations
Towers 105

EMM
creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Minor road
- Vehicular track
- Named watercourse

INSET KEY

- NPWS reserve
- State forest

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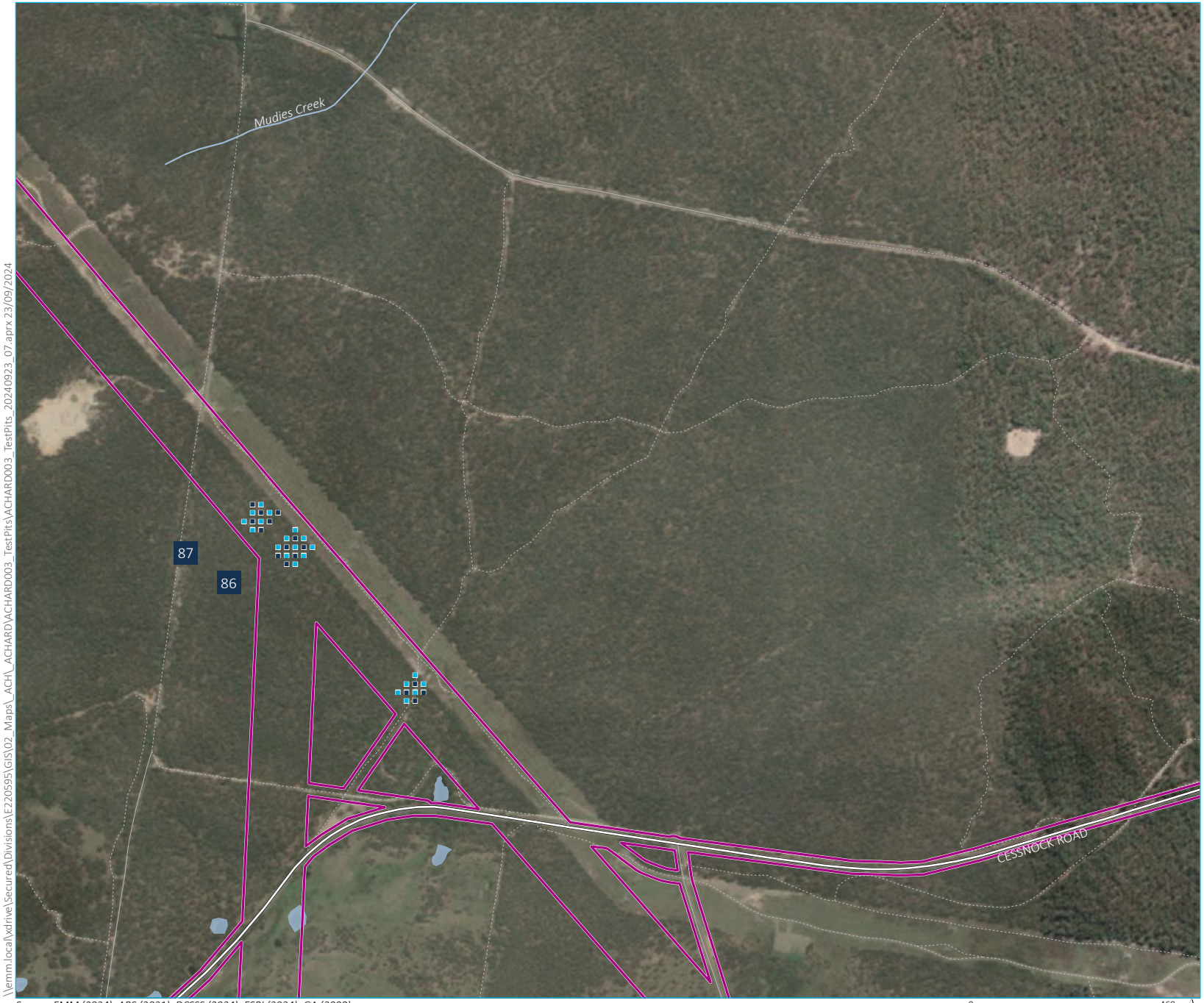
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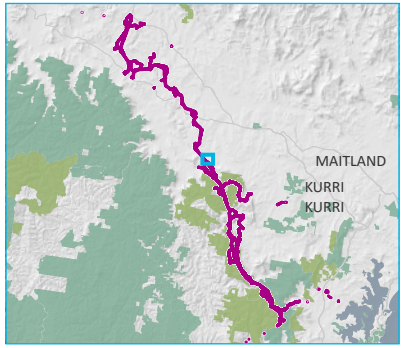
GDA2020 MGA Zone 56

N

Proposed test excavation locations
Towers 94

EMM
creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Major road
- Minor road
- Vehicular track
- Named watercourse

INSET KEY

- NPWS reserve
- State forest

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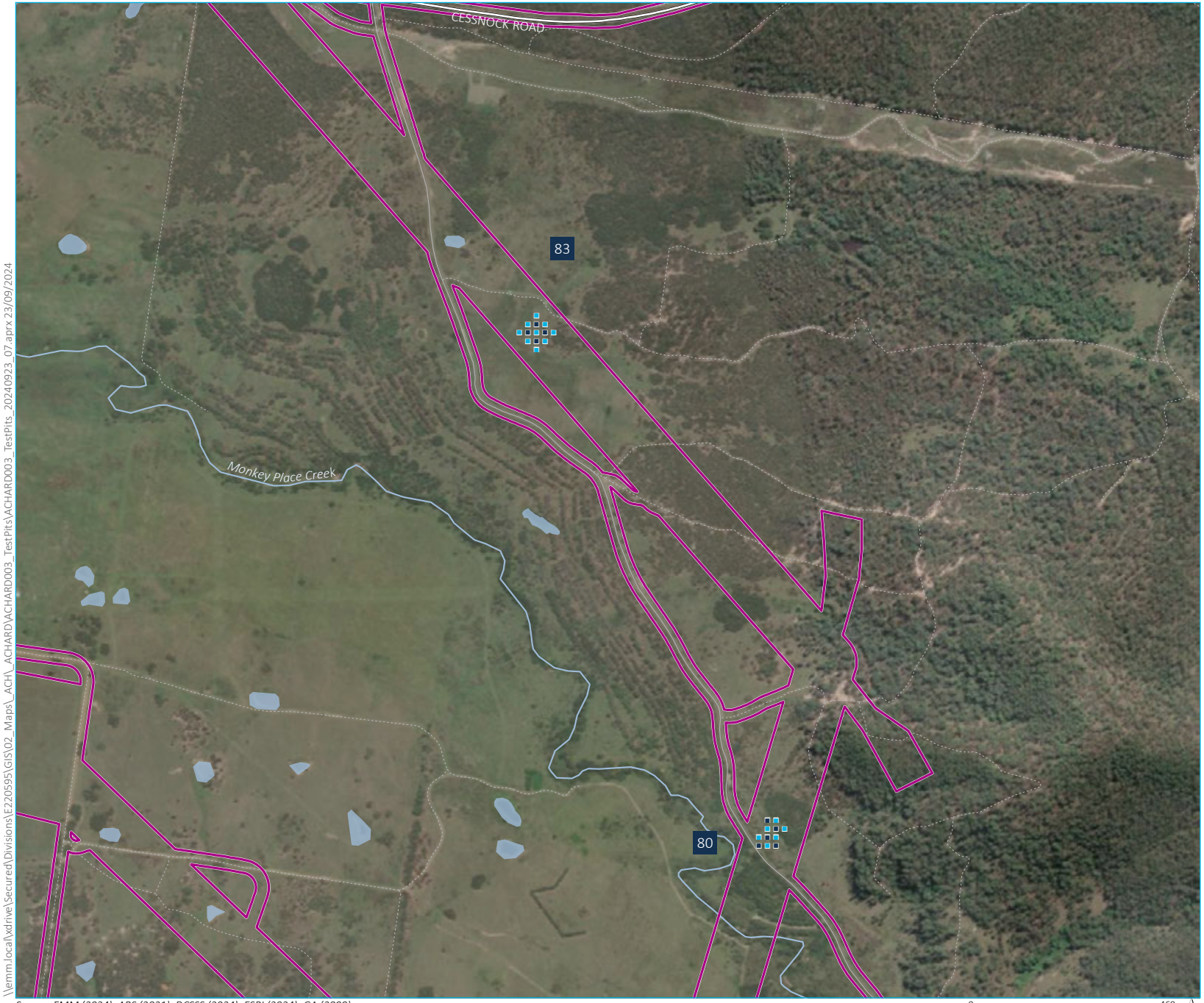
GDA2020 MGA Zone 56

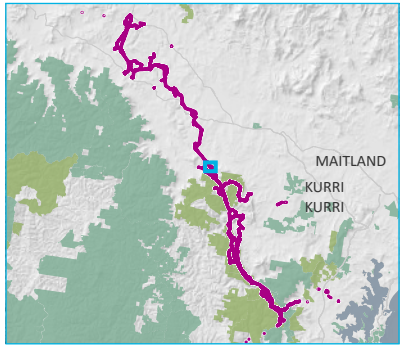
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Proposed test excavation locations Towers 85-87

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Major road
- Minor road
- Vehicular track
- Named watercourse

INSET KEY

- NPWS reserve
- State forest

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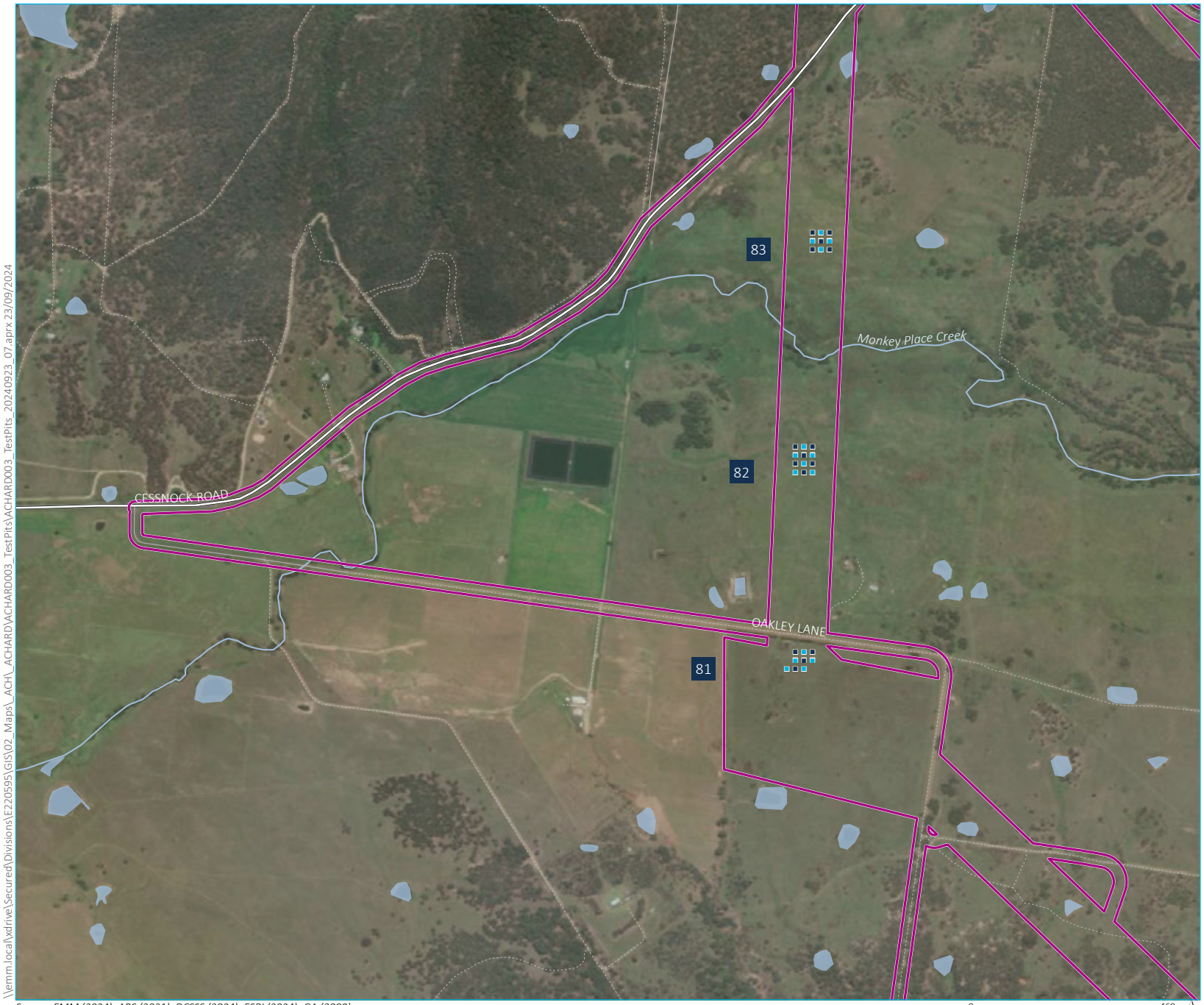
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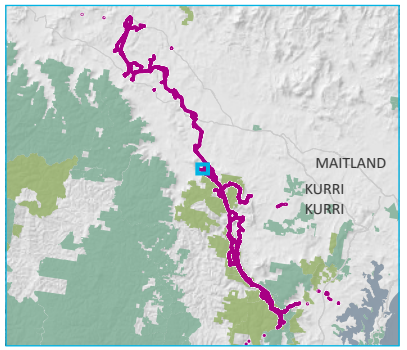
GDA2020 MGA Zone 56

N

Proposed test excavation locations
SMA Central Option- Towers 80-83

EMM
creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Major road
- Minor road
- Vehicular track
- Named watercourse

INSET KEY

- NPWS reserve
- State forest

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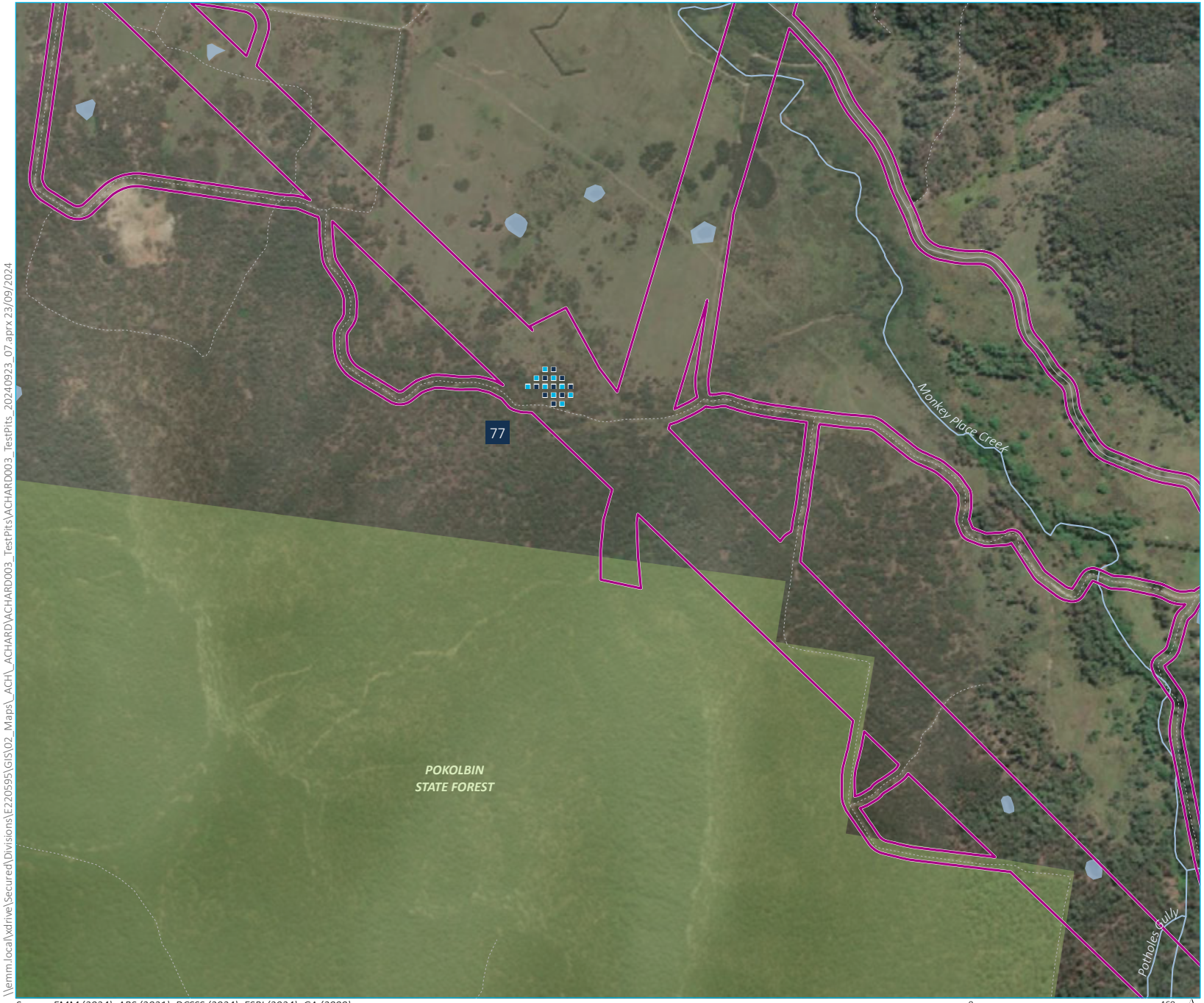
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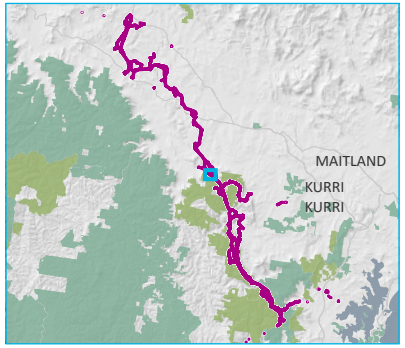
GDA2020 MGA Zone 56

N

Proposed test excavation locations
SMA Western Option- Towers 80-83

EMM
creating opportunities





KEY

- Test pit (Phase 1)
- Test pit (Phase 2)
- Project area

Existing environment

- Minor road
- Vehicular track
- Named watercourse
- State forest

INSET KEY

- NPWS reserve
- State forest

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

0 460 m

GDA2020 MGA Zone 56

N

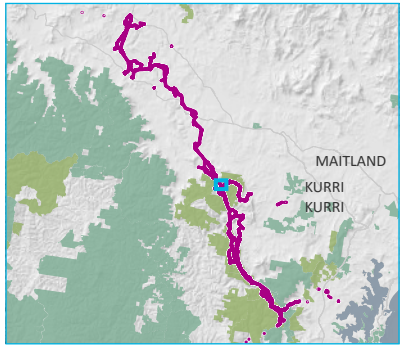
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Proposed test excavation locations
SMA Central Option- Tower 77
Page 15 of 23

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM
creating opportunities





KEY

- Potential rockshelter proposed for investigation
- Project area

Existing environment

- Vehicular track
- Named watercourse
- State forest

INSET KEY

- NPWS reserve
- State forest

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

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GDA2020 MGA Zone 56

N

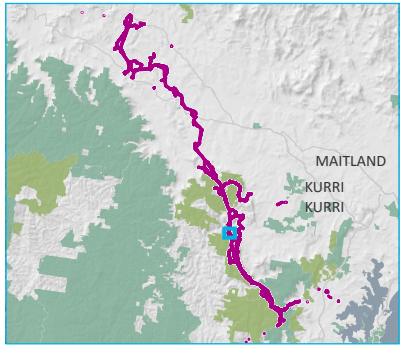
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Proposed test excavation locations
Potential rockshelter
Page 16 of 23

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM
creating opportunities





KEY

- Potential rockshelter proposed for investigation
- Project area

Existing environment

- Vehicular track
- Named watercourse
- State forest

INSET KEY

- NPWS reserve
- State forest

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

0 460 m

GDA2020 MGA Zone 56

N

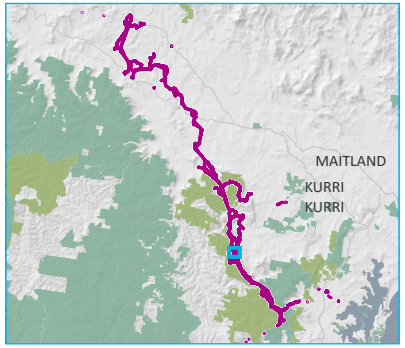
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Proposed test excavation locations
Potential rockshelter

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM
creating opportunities





KEY

- Potential rockshelter proposed for investigation
- Project area

Existing environment

- Vehicular track
- Named watercourse
- State forest

INSET KEY

- NPWS reserve
- State forest

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

0 460 m

GDA2020 MGA Zone 56

N

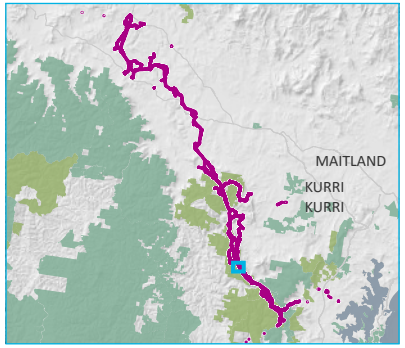
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Proposed test excavation locations
Potential rockshelter

Hunter Transmission Project
Archaeological research design
Appendix B.2

creating opportunities





KEY

- Potential rockshelter proposed for investigation
- Project area

Existing environment

- Vehicular track
- State forest

INSET KEY

- NPWS reserve
- State forest

Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

0 460 m

GDA2020 MGA Zone 56

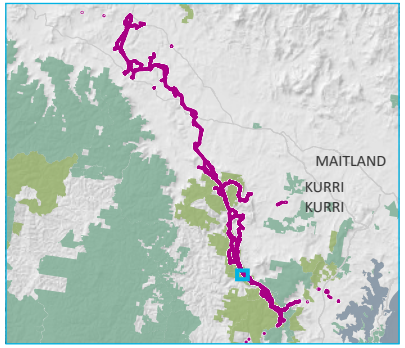
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Proposed test excavation locations
Potential rockshelter

EMM
creating opportunities





KEY

- Potential rockshelter proposed for investigation
- Project area

Existing environment

- Vehicular track
- State forest

INSET KEY

- NPWS reserve
- State forest

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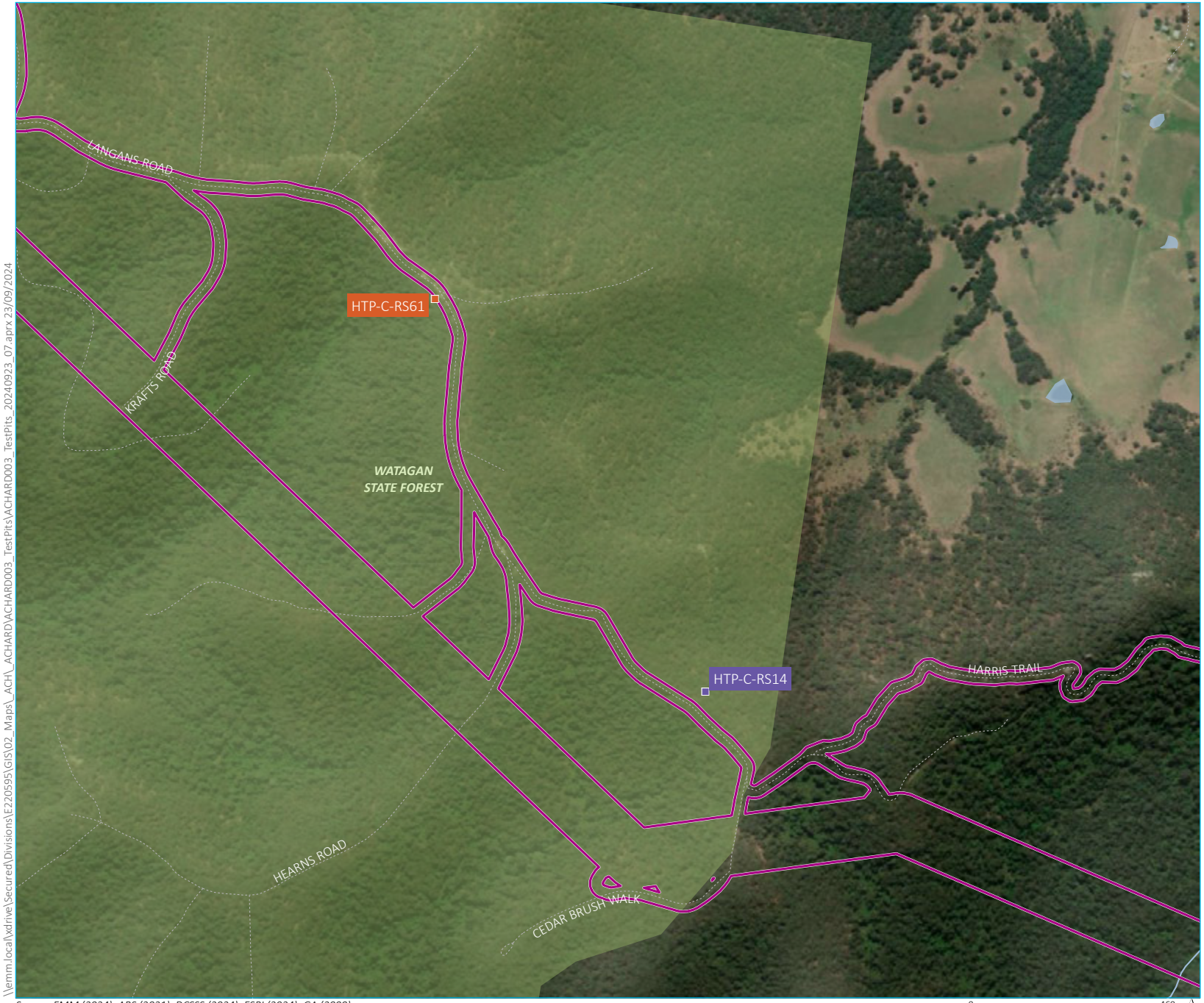
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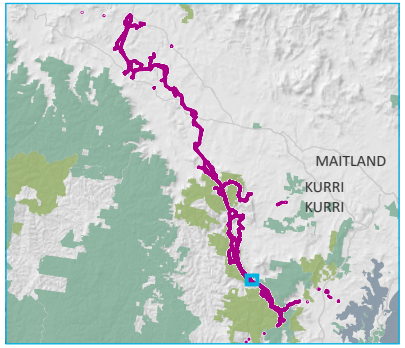
GDA2020 MGA Zone 56

N

Proposed test excavation locations
Potential rockshelter

EMM
creating opportunities





KEY

- Rockshelter proposed for investigation
- Potential rockshelter proposed for investigation
- Project area

Existing environment

- Vehicular track
- Named watercourse
- State forest

INSET KEY

- NPWS reserve
- State forest

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0 460 m

GDA2020 MGA Zone 56

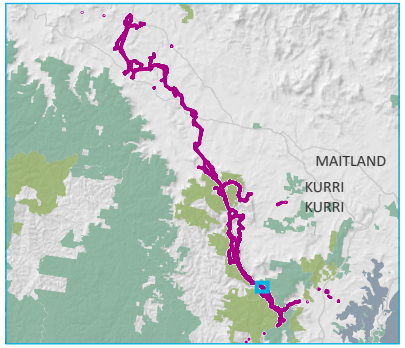
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Proposed test excavation locations Rockshelter and potential rockshelter

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM
creating opportunities





KEY

- Potential rockshelter proposed for investigation
- Project area

Existing environment

- Major road
- Vehicular track
- Named watercourse
- NPWS reserve
- State forest

INSET KEY

- NPWS reserve
- State forest

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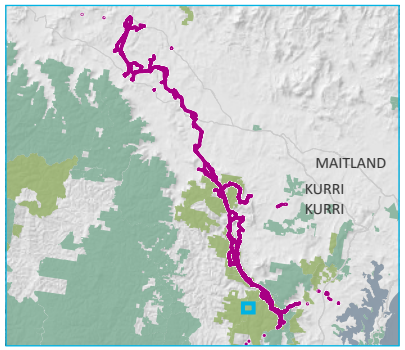
GDA2020 MGA Zone 56

N

Proposed test excavation locations
Potential rockshelter

EMM
creating opportunities





KEY

- Rockshelter proposed for investigation
- Project area

Existing environment

- Minor road
- Vehicular track
- Named watercourse
- State forest

INSET KEY

- NPWS reserve
- State forest

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Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009)

0 460 m

GDA2020 MGA Zone 56

N

Proposed test excavation locations
Rockshelter

Hunter Transmission Project
Archaeological research design
Appendix B.2

EMM
creating opportunities

C.2.2 Test pit data

Table C.2 Summary of test pits excavated for this ACHA addendum

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
Phase 1 Pits							
131-1	320256	6394571	0.25	15	No	0	0
131-3	320293	6394558	0.25	25	No	0	0
131-6	320244	6394597	0.25	15	No	0	0
131-8	320281	6394583	0.25	15	No	0	0
131-10	320319	6394570	0.25	20	No	0	0
131-12	320269	6394609	0.25	20	No	4	16
131-14	320307	6394595	0.25	20	No	0	0
131-16	320331	6394607	0.25	25	No	1	4
131-17	320257	6394635	0.25	20	No	1	4
131-19	320295	6394621	0.25	15	No	0	0
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phase 1 Pits							
132-1	319956	6394747	0.25	15	No	1	4
132-3	319942	6394710	0.25	15	No	0	0
132-5	319979	6394696	0.25	20	No	0	0
132-7	319968	6394721	0.25	20	No	0	0
132-9	319993	6394733	0.25	15	No	1	4

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phase 1 Pits							
133-1	319722	6395105	0.25	20	No	0	0
133-4	319742	6395125	0.25	20	No	0	0
133-6	319782	6395125	0.25	20	No	0	0
133-8	319722	6395145	0.25	40	No	1	4
133-10	319762	6395145	0.25	25	No	1	4
133-11	319742	6395165	0.25	20	No	1	4
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phase 1 Pits							
134-2	319506	6395525	0.25	30	No	1	4
134-3	319486	6395545	0.25	20	No	1	4
134-5	319526	6395545	0.25	40	No	1	4
134-7	319466	6395565	0.25	20	No	0	0
134-9 (EXP)	319506	6395565	1	40	No	22	22
134-12	319526	6395585	0.25	20	No	0	0
Phase 2 Pits							
134-4	319506	6395545	0.25	30	No	0	0

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
134-8	319486	6395565	0.25	20	No	0	0
134-10	319526	6395565	0.25	30	No	1	4
134-11	319506	6395585	0.25	20	No	1	4
Phase 1 Pits							
135-2	319288	6395886	0.25	20	No	0	0
135-4	319229	6395910	0.25	20	No	0	0
135-6	319269	6395907	0.25	20	No	0	0
135-8	319309	6395904	0.25	20	No	0	0
135-11	319250	6395928	0.25	20	No	4	16
135-13	319290	6395926	0.25	30	No	1	4
135-15	319330	6395923	0.25	20	No	2	8
135-17	319272	6395947	0.25	20	No	0	0
135-19	319312	6395944	0.25	20	No	2	8
135-20	319253	6395968	0.25	20	No	0	0
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phase 1 Pits							
136-2	318874	6396063	0.25	30	No	2	8
136-4	318913	6396072	0.25	20	No	0	0
136-5	318850	6396077	0.25	35	No	4	16

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
136-7	318889	6396087	0.25	30	No	3	12
136-9	318928	6396097	0.25	20	No	1	4
136-11	318865	6396102	0.25	40	No	0	0
136-13	318903	6396111	0.25	20	No	1	4
136-15	318840	6396116	0.25	60	No	2	8
136-17	318879	6396126	0.25	30	No	1	4
136-19	318918	6396136	0.25	20	No	1	4
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phase 1 Pits							
140-2	317686	6396102	0.25	40	No	0	0
140-3	317626	6396122	0.25	40	No	0	0
140-5	317666	6396122	0.25	30	No	1	4
140-7	317606	6396142	0.25	30	No	0	0
140-9	317646	6396142	0.25	30	No	0	0
140-11 (EXP)	317686	6396142	1	30	No	7	7
140-13	317626	6396162	0.25	40	No	0	0
140-15	317666	6396162	0.25	40	No	0	0
140-18 (EXP)	317646	6396182	1	40	No	8	8

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
Phase 2 Pits							
140-6	317686	6396122	0.25	30	No	0	0
140-10	317666	6396142	0.25	20	No	0	0
140-12	317706	6396142	0.25	20	No	0	0
140-14	317646	6396162	0.25	40	No	0	0
140-16 (EXP)	317686	6396162	1	30	No	25	25
140-17	317626	6396182	0.25	30	No	4	16
140-19	317666	6396182	0.25	40	No	1	4
140-20	317646	6396202	0.25	30	No	0	0
Phase 1 Pits							
141-2 (EXP)	317266	6396402	1	30	No	16	16
141-4	317206	6396422	0.25	30	No	0	0
141-6	317246	6396422	0.25	25	No	0	0
141-8 (EXP)	317286	6396422	1	35	No	32	32
141-9	317186	6396442	0.25	20	No	1	4
141-11	317226	6396442	0.25	30	No	0	0
141-13	317266	6396442	0.25	20	No	1	4
141-15 (EXP)	317306	6396442	1	60	No	84	84
141-16 (EXP)	317206	6396462	1	20	No	12	12
141-18	317246	6396462	0.25	30	No	0	0

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
141-20 (EXP)	317226	6396482	1	50	Yes	0	0
Phase 2 Pits							
141-1	317246	6396402	0.25	30	No	0	0
141-3 (EXP)	317286	6396402	1	40	No	37	37
141-7	317266	6396422	0.25	30	No	3	12
141-10 (EXP)	317206	6396442	1	30	No	28	28
141-14 (EXP)	317286	6396442	0.25	25	No	10	10
141-17	317226	6396462	0.25	20	No	0	0
141-21	317246	6396482	0.25	40	No	2	8
Phase 1 Pits							
143-2	316646	6397262	0.25	50	No	0	0
143-3	316626	6397282	0.25	50	No	0	0
143-5	316666	6397282	0.25	50	No	0	0
143-7	316646	6397302	0.25	50	No	0	0
143-12	316666	6397322	0.25	50	No	0	0
143-13	316606	6397342	0.25	50	No	0	0
143-15	316646	6397342	0.25	50	No	0	0
143-18	316666	6397362	0.25	30	No	0	0
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
Phase 1 Pits							
144-2(EXP)	316546	6397722	1	100	No	0	0
144-4	316526	6397742	0.25	50	No	0	0
144-6	316566	6397742	0.25	50	No	0	0
144-9	316546	6397762	0.25	50	No	0	0
144-11	316586	6397762	0.25	50	No	0	0
144-12	316526	6397782	0.25	60	No	0	0
144-14	316566	6397782	0.25	50	No	0	0
144-17	316546	6397802	0.25	50	No	0	0
144-19	316566	6397822	0.25	50	No	0	0
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phase 1 Pits							
155-1	315086	6402002	0.25	120	Yes	1	4
155-4 (EXP)	315066	6402022	1	120	Yes	8	8
155-6	315106	6402022	0.25	120	Yes	2	8
155-8	315046	6402042	0.25	100	Yes	0	0
155-10	315086	6402042	0.25	120	Yes	3	12
155-12	315026	6402062	0.25	90	Yes	1	4
155-14	315066	6402062	0.25	90	Yes	2	8

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
155-16	315106	6402062	0.25	70	Yes	2	8
155-17	315046	6402082	0.25	70	Yes	0	0
Phase 2 Pits							
155-3	315046	6402022	0.25	90	Yes	0	0
155-5	315086	6402022	0.25	100	Yes	0	0
155-9	315066	6402042	0.25	100	Yes	1	4
Phase 1 Pits							
156-2	314666	6402202	0.25	100	Yes	0	0
156-4	314706	6402202	0.25	90	Yes	0	0
156-5	314646	6402222	0.25	80	Yes	2	8
156-7	314686	6402222	0.25	90	Yes	2	8
156-9	314726	6402222	0.25	90	Yes	0	0
156-10	314626	6402242	0.25	60	Yes	0	0
156-12 (EXP)	314666	6402242	1	150	Yes	12	12
156-14	314706	6402242	0.25	110	Yes	2	8
156-16	314646	6402262	0.25	90	Yes	0	0
156-18	314686	6402262	0.25	120	Yes	0	0
156-21	314666	6402282	0.25	120	Yes	0	0
Phase 2 Pits							
156-6 (EXP)	314666	6402222	1	90	Yes	22	22

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
156-11	314646	6402242	0.25	90	Yes	2	8
156-13	314686	6402242	0.25	100	Yes	3	12
156-17	314666	6402262	0.25	100	Yes	4	16
Phase 1 Pits							
157-2	314166	6402242	0.25	65	Yes	0	0
157-4	314206	6402242	0.25	60	Yes	1	4
157-6	314146	6402262	0.25	80	Yes	0	0
157-8	314186	6402262	0.25	60	Yes	0	0
157-10	314226	6402262	0.25	25	Yes	1	4
157-12	314166	6402282	0.25	60	Yes	1	4
157-14	314206	6402282	0.25	35	Yes	1	4
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phase 1 Pits							
158-2	313886	6402222	0.25	50	Yes	0	0
158-4	313926	6402222	0.25	55	Yes	0	0
158-6	313966	6402222	Not excavated	Not excavated	Disturbed	Not excavated	Not excavated
158-8	313866	6402242	0.25	70	Yes	3	12
158-10 (EXP)	313906	6402242	1	150	Yes	28	28
158-12	313946	6402242	0.25	60	Yes	0	0

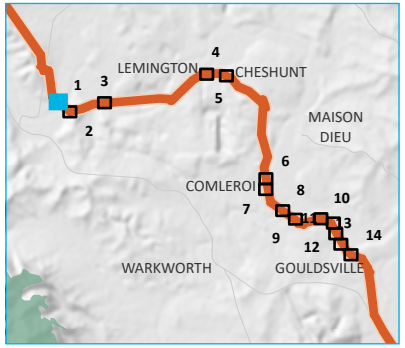
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158-13	313846	6402262	0.25	40	Yes	2	8
158-15 (EXP)	313886	6402262	1	100	Yes	18	18
158-17	313926	6402262	0.25	90	Yes	4	16
158-20	313866	6402282	0.25	70	Yes	3	12
158-22	313906	6402282	0.25	90	Yes	2	8
158-24	313946	6402282	0.25	40	Yes	3	12
Phase 2 Pits							
158-3	313906	6402222	0.25	50	Yes	2	8
158-9 (EXP)	313886	6402242	1	110	Yes	50	50
158-11	313926	6402242	0.25	30	Yes	1	4
158-16 (EXP)	313426	6402022	1	100	Yes	33	33
Phase 1 Pits							
169-2	309686	6400962	0.25	40	No	0	0
169-4	309666	6400982	0.25	50	No	1	4
169-6	309706	6400982	0.25	50	No	0	0
169-8	309746	6400982	0.25	70	No	0	0
169-9	309646	6401002	0.25	40	No	0	0
169-11	309686	6401002	0.25	80	No	1	4
169-13	309726	6401002	0.25	40	No	0	0
169-16	309666	6401022	0.25	3	No	0	0

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
169-18	309706	6401022	0.25	40	No	0	0
169-20	309746	6401022	0.25	55	No	0	0
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phase 1 Pits							
172-1	308206	6400602	0.25	5	No	0	0
172-3	308246	6400602	0.25	20	No	0	0
172-6	308226	6400622	0.25	5	No	0	0
172-8	308266	6400622	0.25	10	No	0	0
172-10	308306	6400622	0.25	20	No	3	12
172-12	308206	6400642	0.25	10	No	0	0
172-14	308246	6400642	0.25	10	No	0	0
172-16	308286	6400642	0.25	5	No	0	0
172-18	308226	6400662	0.25	25	No	0	0
172-20	308266	6400662	0.25	20	No	1	4
172-22	308246	6400682	0.25	25	No	0	0
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phase 1 Pits							
173-3	307768	6401028	0.25	80	No	0	0

TP ID	Easting	Northing	Size (m²)	Depth of excavation (cm)	Potential Warkworth Sands system identified? (Y/N)	Artefact count	Extrapolated artefact count (/m²)
173-6	307747	6401046	0.25	80	No	0	0
173-8	307787	6401049	0.25	30	No	0	0
173-11	307726	6401065	0.25	70	No	0	0
173-13	307765	6401068	0.25	70	No	0	0
173-16	307744	6401086	0.25	70	No	0	0
Phase 2 Pits							
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

C.2.3 Test excavation photographic log





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Named waterbody

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

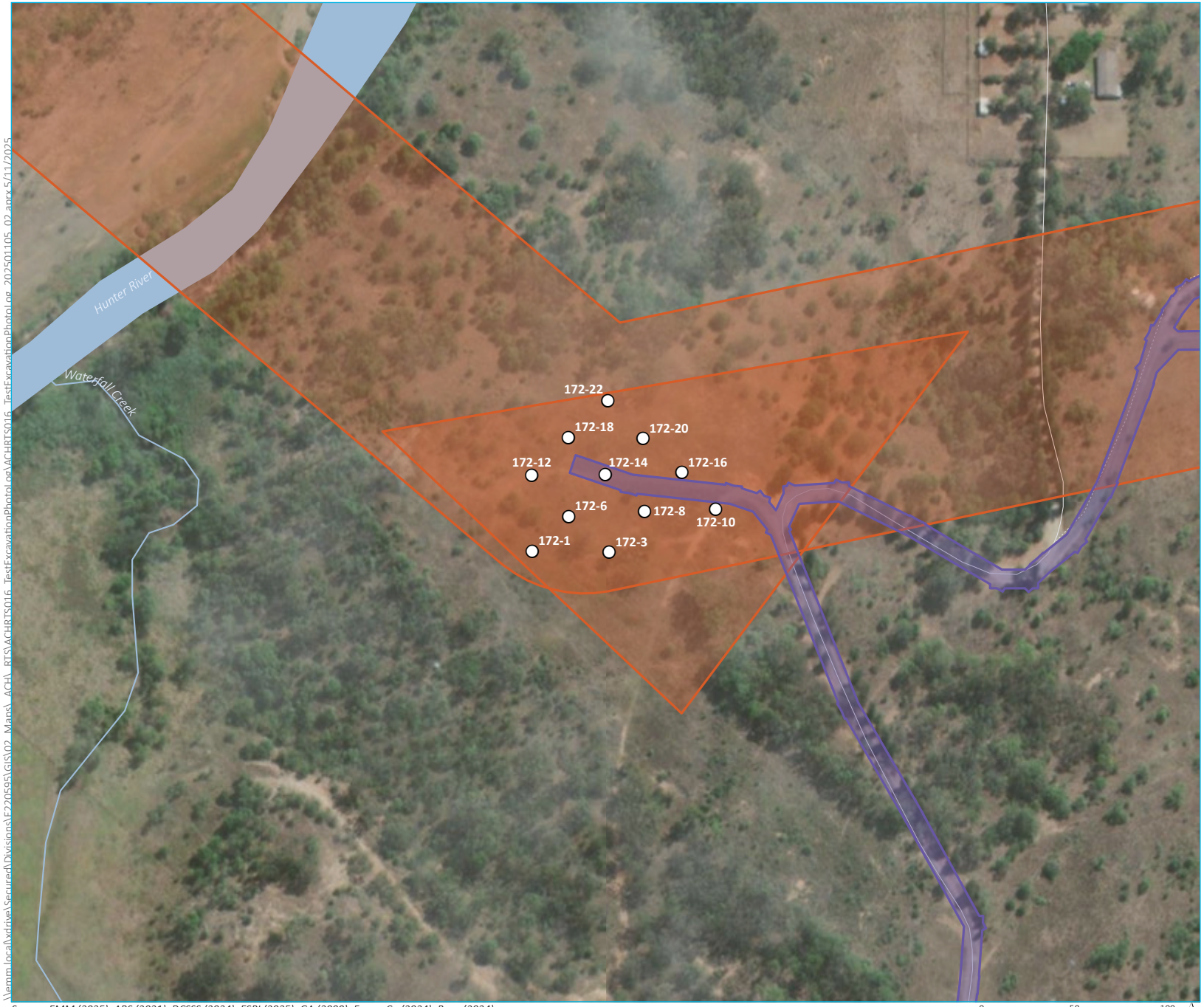
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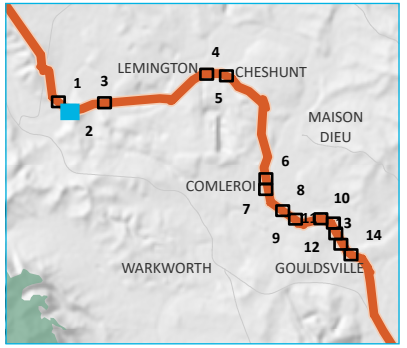
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Text excavation photo log
Map 1 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Minor road
- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

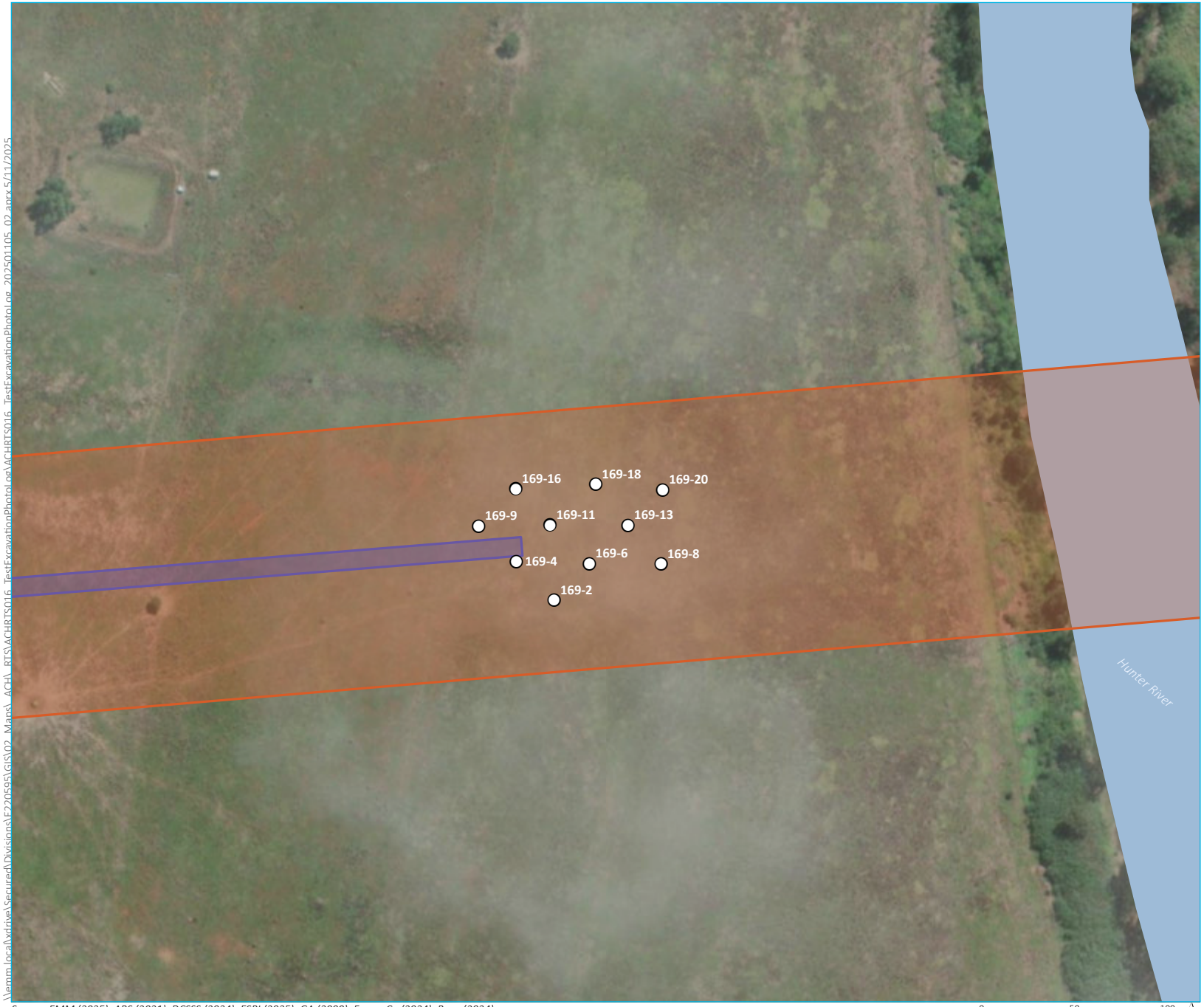
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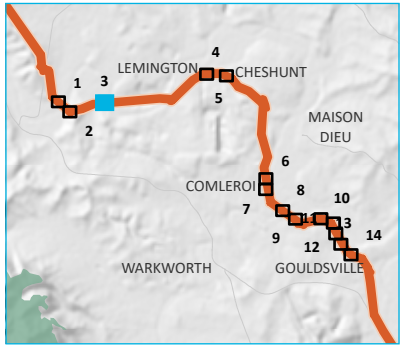
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Text excavation photo log
Map 2 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Named waterbody

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

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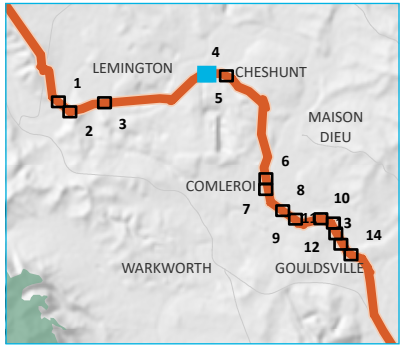
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Text excavation photo log
Map 3 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Vehicular track
- Named watercourse

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

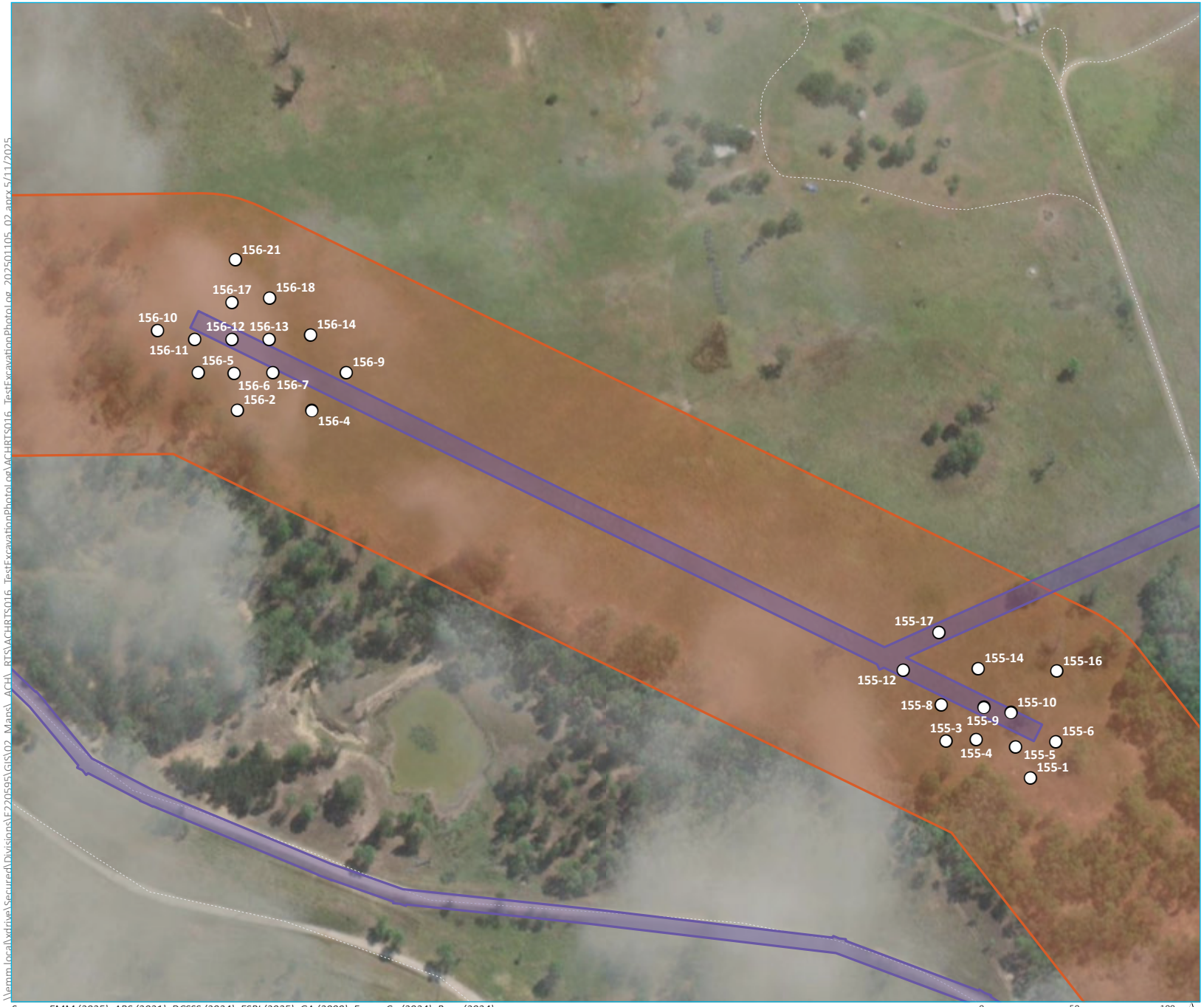
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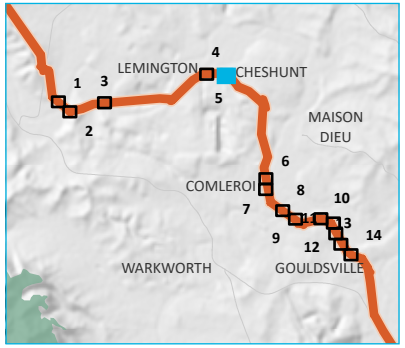
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Text excavation photo log
Map 4 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Vehicular track

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

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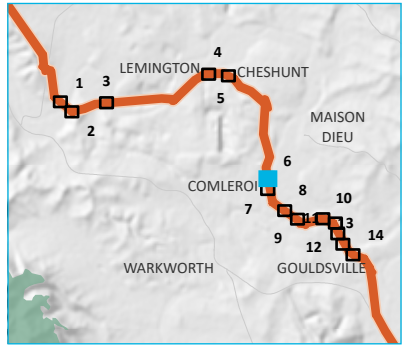
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Text excavation photo log
Map 5 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Vehicular track
- Named waterbody

INSET KEY

- HTP corridor
- NPWS reserve

\\emm.local\wdrive\Secured\Divisions\EF220595\GIS\02_Maps_ACH_RTS\ACHRTS016_TestExcavationPhotoLog\ACHRTS016_TestExcavationPhotoLog_20250111105_02.aprx 5/11/2025

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

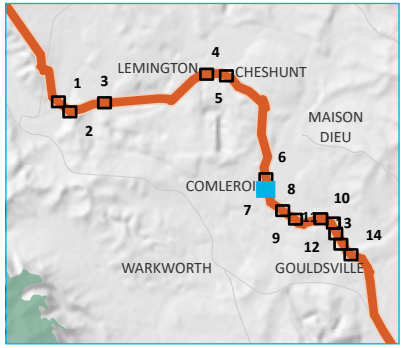
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Text excavation photo log
Map 6 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

Photographic record

Project impact area

HTP corridor

Access track

INSET KEY

HTP corridor

NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

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GDA2020 MGA Zone 56

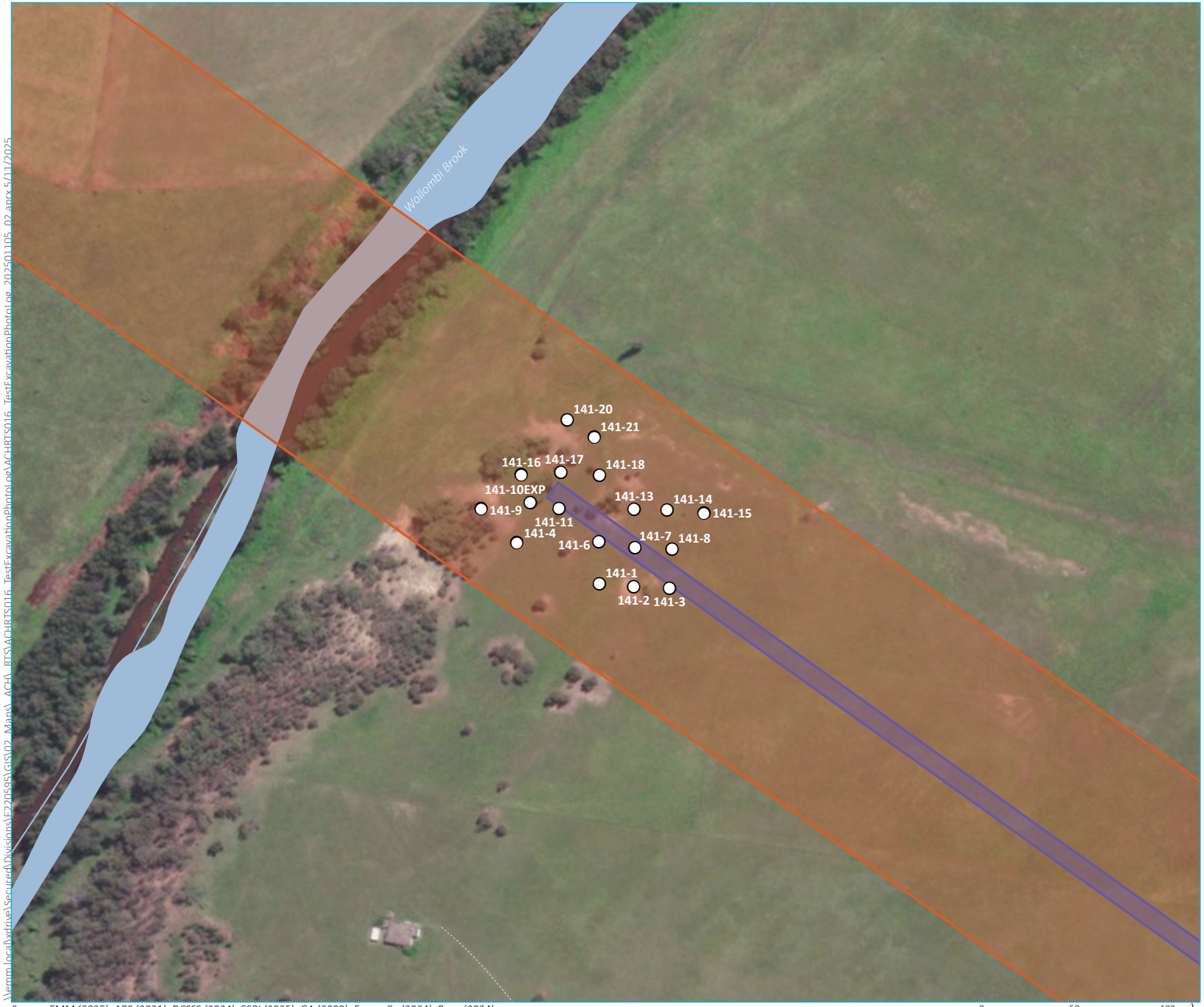
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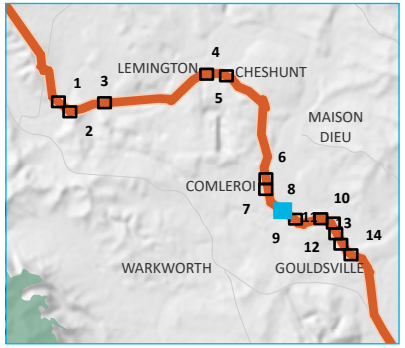
Text excavation photo log
Map 7 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities

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KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Vehicular track
- Named watercourse
- Named waterbody

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

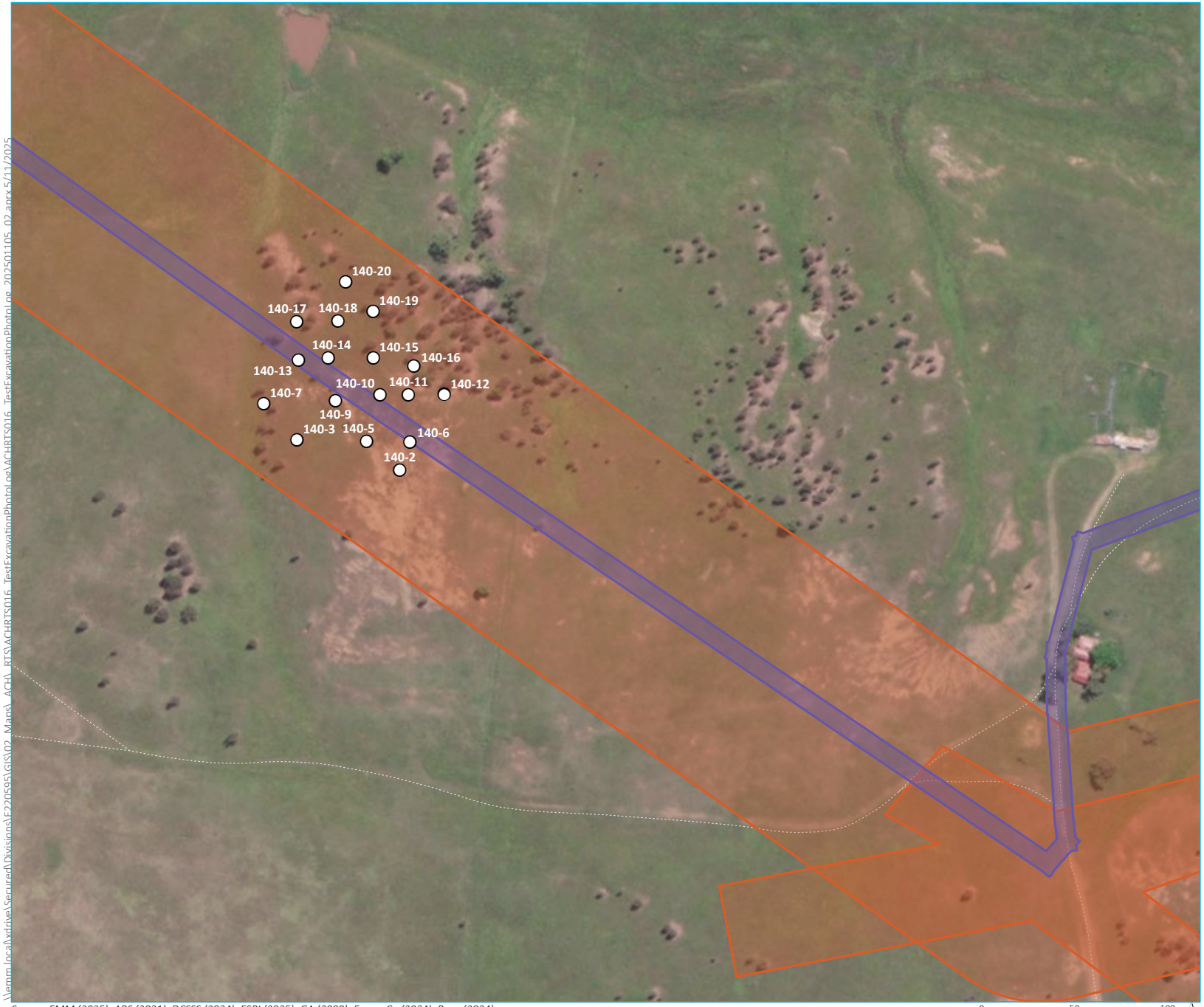
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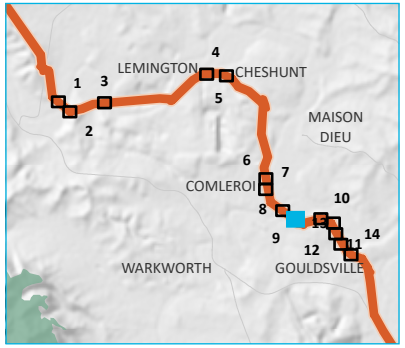
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Text excavation photo log
Map 8 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Vehicular track

INSET KEY

- HTP corridor
- NPWS reserve

Text excavation photo log
Map 9 of 14

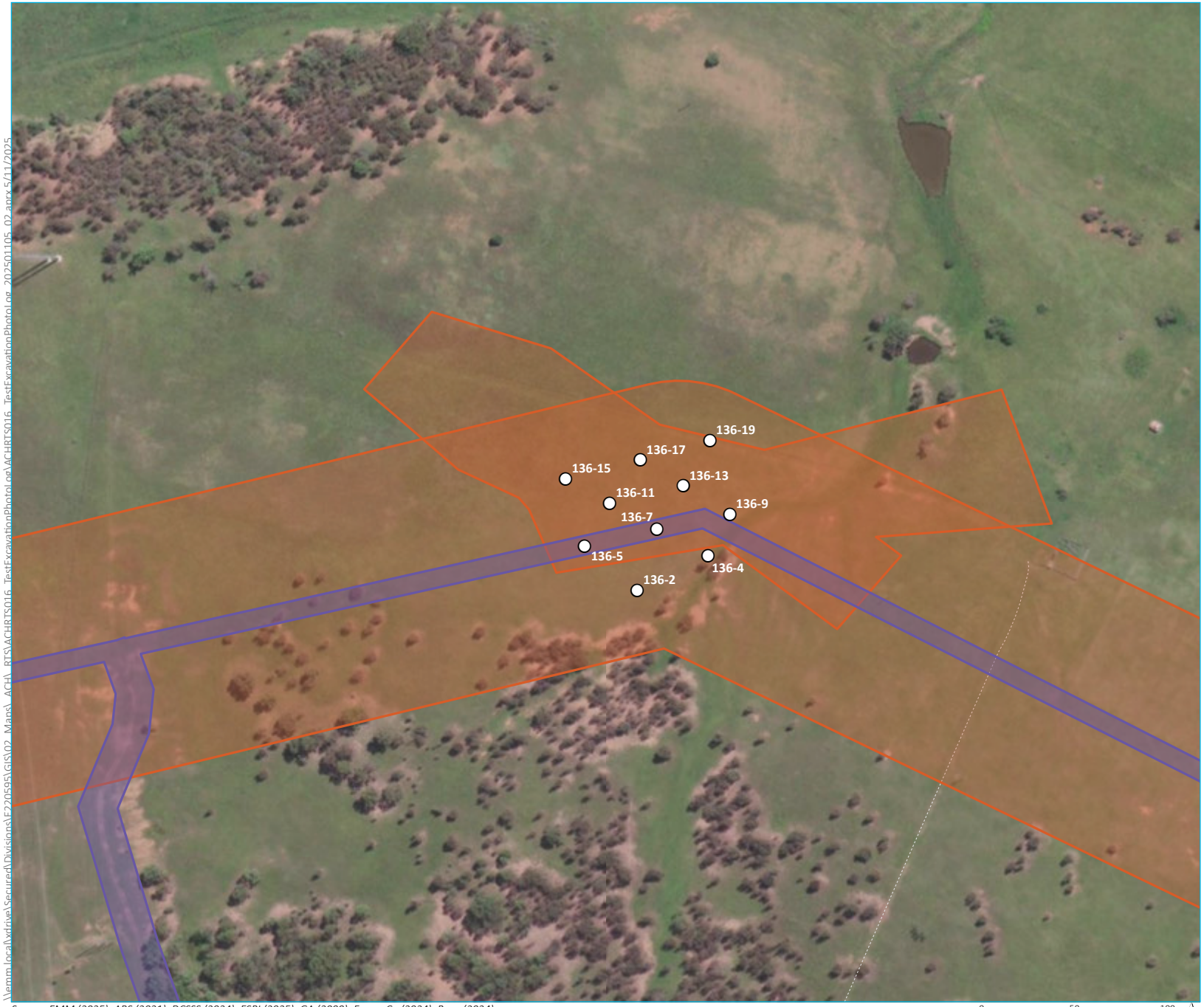
Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

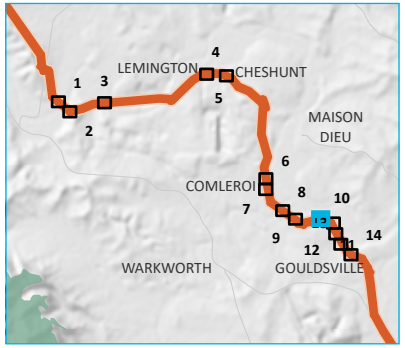
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0 50 100 m
GDA2020 MGA Zone 56

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KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Vehicular track

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

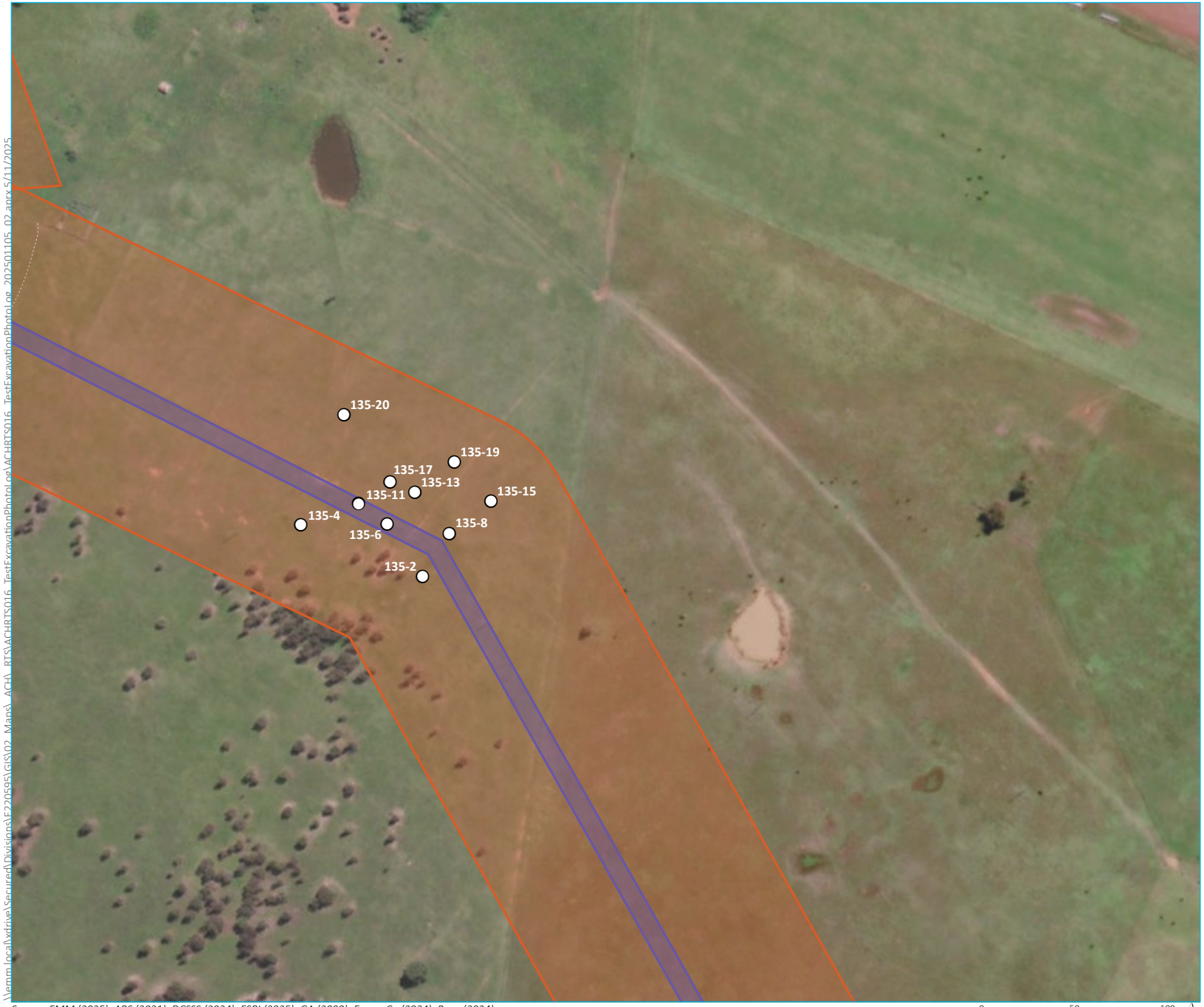
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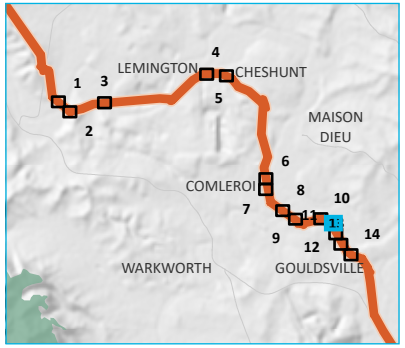
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Text excavation photo log
Map 10 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Vehicular track

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

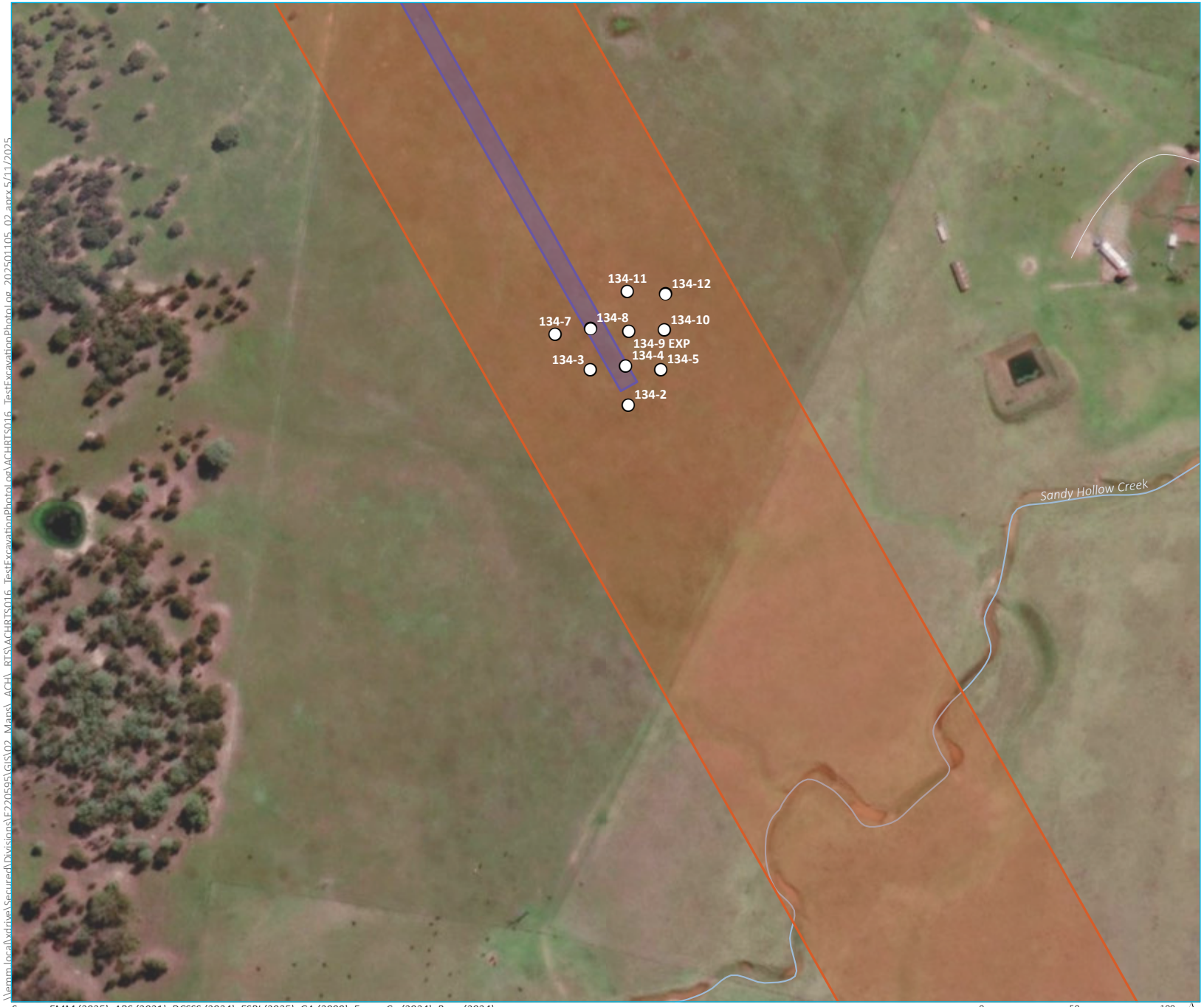
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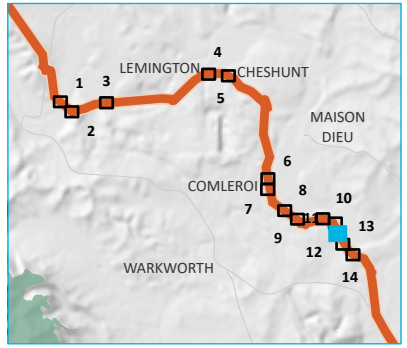
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Text excavation photo log
Map 11 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Minor road
- Named watercourse

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

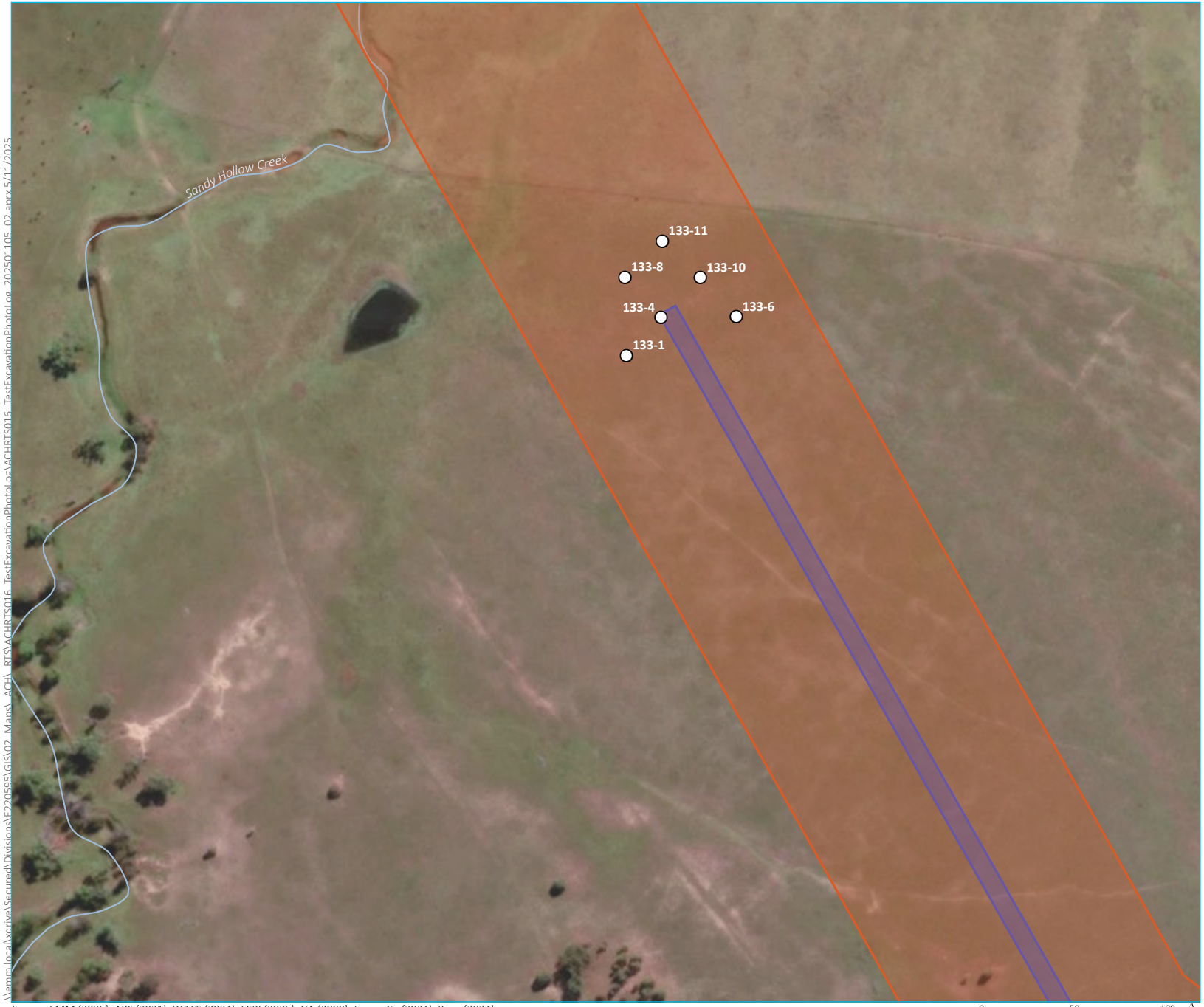
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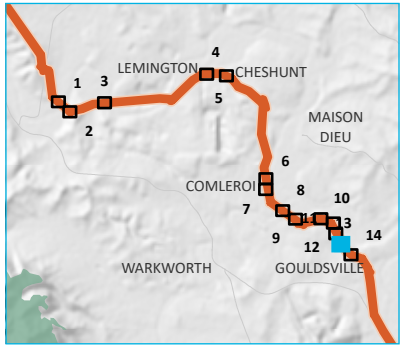
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Text excavation photo log
Map 12 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Named watercourse

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

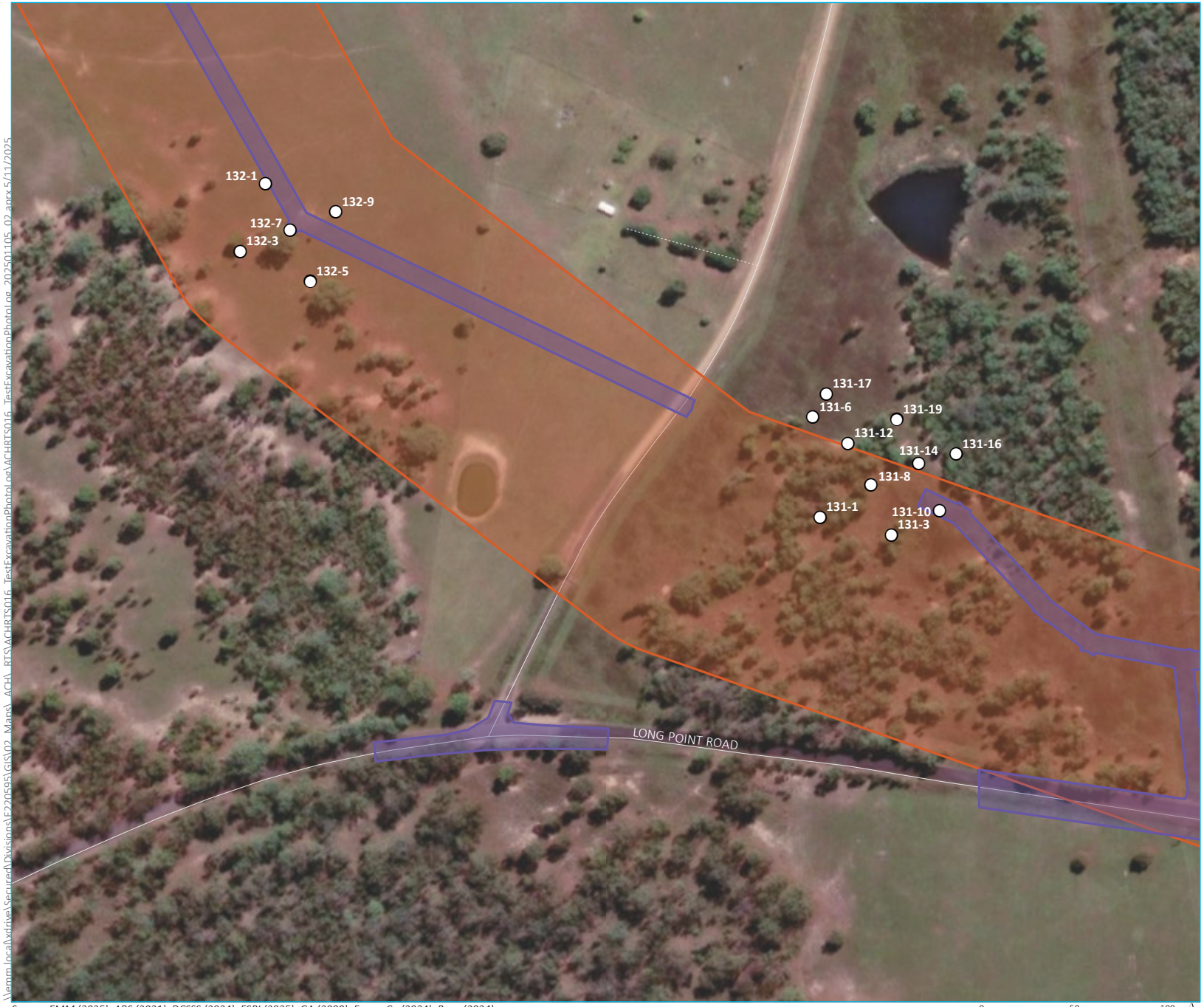
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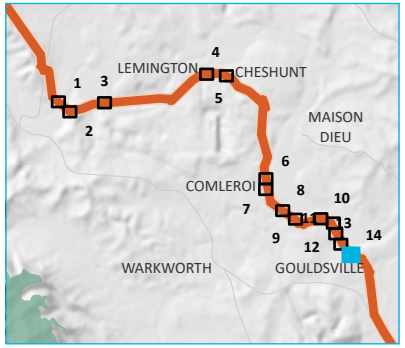
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Text excavation photo log
Map 13 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities





KEY

- Photographic record

Project impact area

- HTP corridor
- Access track

Existing environment

- Minor road
- Vehicular track

INSET KEY

- HTP corridor
- NPWS reserve

Source: EMM (2025); ABS (2021); DCSSS (2024); ESRI (2025); GA (2009); EnergyCo (2024); Beca (2024)

0 50 100 m

GDA2020 MGA Zone 56

N

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Text excavation photo log
Map 14 of 14

Hunter Transmission Project
Aboriginal Cultural Heritage
Assessment Addendum
Figure C.2.3

EMM
creating opportunities

Test pit ID: 131-1

Context North	Base of pit - north	North section
		

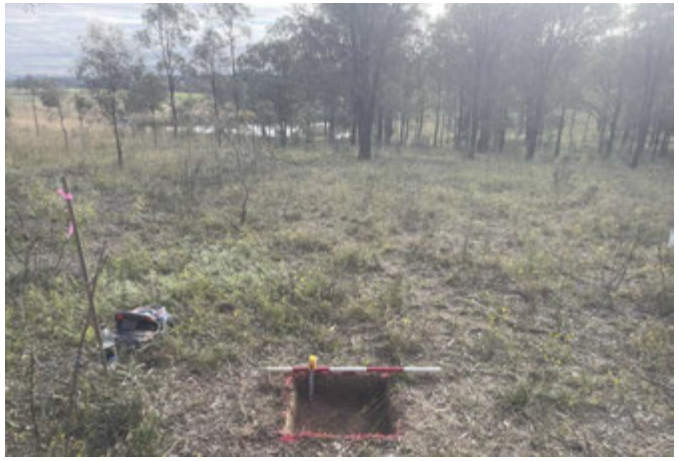
Test pit ID: 131-12

Context North	Base of pit - north	North section
		

Test pit ID: 131-16

Context North	Base of pit - north	North section
		

Test pit ID: 131-19

Context North	Base of pit - north	North section
		

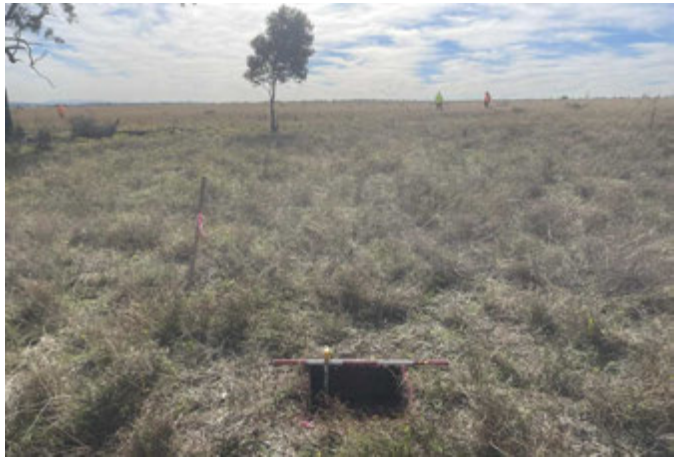
Test pit ID: 131-6

Context North	Base of pit - north	North section
		

Test pit ID: 132-1

Context North	Base of pit - north	North section
		

Test pit ID: 132-5

Context North	Base of pit - north	North section
		

Test pit ID: 132-9

Context North	Base of pit - north	North section
		

Test pit ID: 133-10

Context North	Base of pit - north	North section
		

Test pit ID: 133-4

Context North	Base of pit - north	North section
		

Test pit ID: 133-8

Context North	Base of pit - north	North section
		

Test pit ID: 134-11

Context North	Base of pit - north	North section
		

Test pit ID: 134-2

Context North	Base of pit - north	North section
		

Test pit ID: 134-4

Context North	Base of pit - north	North section
		

Test pit ID: 134-7

Context North	Base of pit - north	North section
		

Test pit ID: 135-13

Context North	Base of pit - north	North section
		

Test pit ID: 135-17

Context North	Base of pit - north	North section
		

Test pit ID: 135-2

Context North	Base of pit - north	North section
		

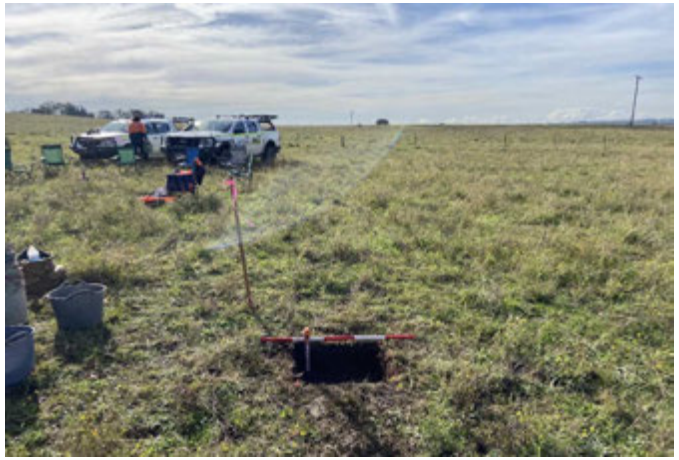
Test pit ID: 135-4

Context North	Base of pit - north	North section
		

Test pit ID: 135-8

Context North	Base of pit - north	North section
		

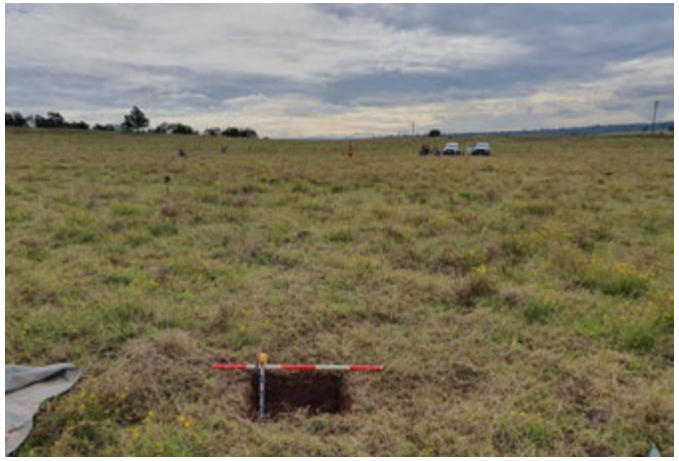
Test pit ID: 136-13

Context North	Base of pit - north	North section
		

Test pit ID: 136-17

Context North	Base of pit - north	North section
		

Test pit ID: 136-2

Context North	Base of pit - north	North section
		

Test pit ID: 136-5

Context North	Base of pit - north	North section
		

Test pit ID: 136-9

Context North	Base of pit - north	North section
		

Test pit ID: 140-12

Context North	Base of pit - north	North section
		

Test pit ID: 140-14

Context North	Base of pit - north	North section
		

Test pit ID: 140-17

Context North	Base of pit - north	North section
		

Test pit ID: 140-20

Context North	Base of pit - north	North section
		

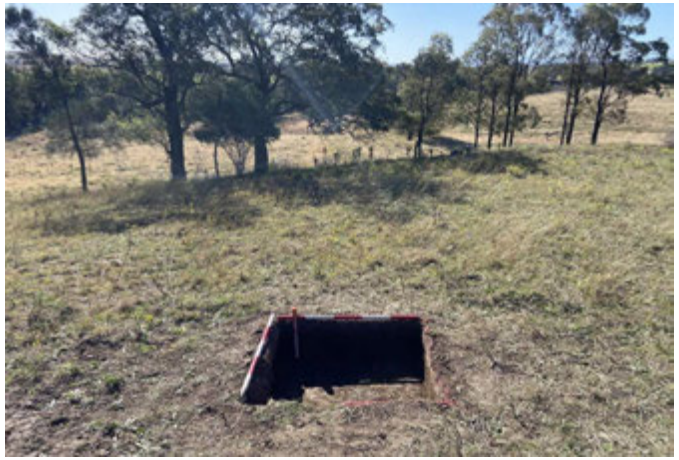
Test pit ID: 140-5

Context North	Base of pit - north	North section
		

Test pit ID: 140-9

Context North	Base of pit - north	North section
		

Test pit ID: 141-10EXP

Context North	Base of pit - north	North section
		

Test pit ID: 141-13

Context North	Base of pit - north	North section
		

Test pit ID: 141-17

Context North	Base of pit - north	North section
		

Test pit ID: 141-2

Context North	Base of pit - north	North section
		

Test pit ID: 141-21

Context North	Base of pit - north	North section
		

Test pit ID: 141-4

Context North	Base of pit - north	North section
		

Test pit ID: 141-7

Context North	Base of pit - north	North section
		

Test pit ID: 141-9

Context North	Base of pit - north	North section
		

Test pit ID: 143-12

Context North	Base of pit - north	North section
		

Test pit ID: 143-15

Context North	Base of pit - north	North section

Test pit ID: 143-2

Context North	Base of pit - north	North section
		

Test pit ID: 143-5

Context North	Base of pit - north	North section

Test pit ID: 144-11

Context North	Base of pit - north	North section
		

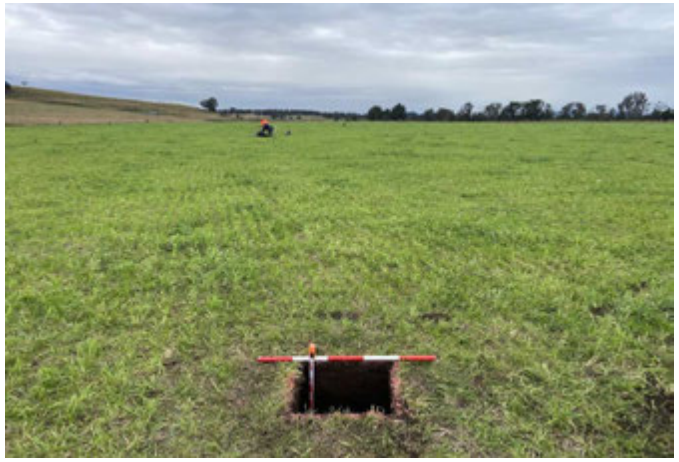
Test pit ID: 144-14

Context North	Base of pit - north	North section





Test pit ID: 144-4

Context North	Base of pit - north	North section
		

Test pit ID: 144-9

Context North	Base of pit - north	North section





Test pit ID: 155-10

Context North	Base of pit - north	North section
		

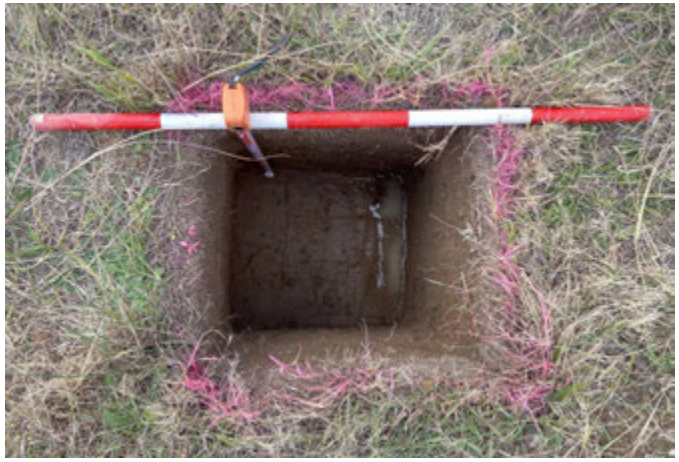
Test pit ID: 155-14

Context North	Base of pit - north	North section





Test pit ID: 155-17

Context North	Base of pit - north	North section
		

Test pit ID: 155-4

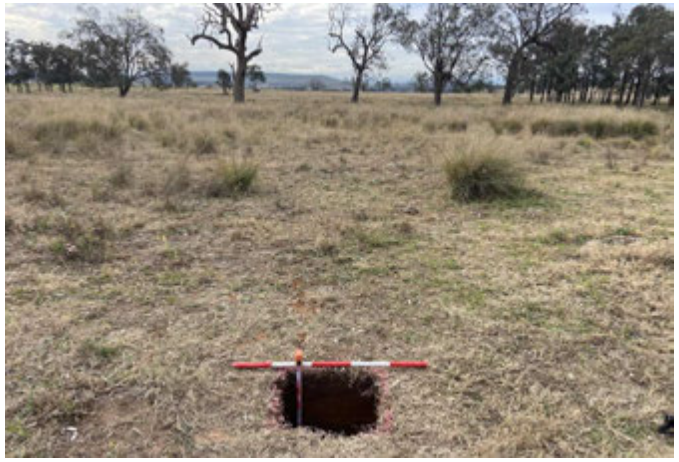
Context North	Base of pit - north	North section







Test pit ID: 155-6

Context North	Base of pit - north	North section
		

Test pit ID: 155-9

Context North	Base of pit - north	North section





Test pit ID: 156-11

Context North	Base of pit - north	North section
		

Test pit ID: 156-14

Context North	Base of pit - north	North section





Test pit ID: 156-18

Context North	Base of pit - north	North section
		

Test pit ID: 156-21

Context North	Base of pit - north	North section







Test pit ID: 156-5

Context North	Base of pit - north	North section
		

Test pit ID: 156-9

Context North	Base of pit - north	North section





Test pit ID: 157-12

Context North	Base of pit - north	North section
		

Test pit ID: 157-4

Context North	Base of pit - north	North section





Test pit ID: 157-8

Context North	Base of pit - north	North section
		

Test pit ID: 158-12

Context North	Base of pit - north	North section





Test pit ID: 158-14

Context North	Base of pit - north	North section
		

Test pit ID: 158-17

Context North	Base of pit - north	North section







Test pit ID: 158-20

Context North	Base of pit - north	North section
		

Test pit ID: 158-24

Context North	Base of pit - north	North section







Test pit ID: 158-4

Context North	Base of pit - north	North section
		

Test pit ID: 158-9

Context North	Base of pit - north	North section

Test pit ID: 169-13

Context North	Base of pit - north	North section
		

Test pit ID: 169-18

Context North	Base of pit - north	North section
		

Test pit ID: 169-20

Context North	Base of pit - north	North section
		

Test pit ID: 169-6

Context North	Base of pit - north	North section
		

Test pit ID: 169-9

Context North	Base of pit - north	North section
		

Test pit ID: 172-10

Context North	Base of pit - north	North section
		

Test pit ID: 172-14

Context North	Base of pit - north	North section
		

Test pit ID: 172-18

Context North	Base of pit - north	North section
		

Test pit ID: 172-22

Context North	Base of pit - north	North section
		

Test pit ID: 172-6

Context North	Base of pit - north	North section
		

Test pit ID: 173-11

Context North	Base of pit - north	North section
		

Test pit ID: 173-16

Context North	Base of pit - north	North section
		

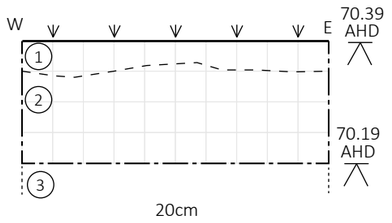
Test pit ID: 173-3

Context North	Base of pit - north	North section
		

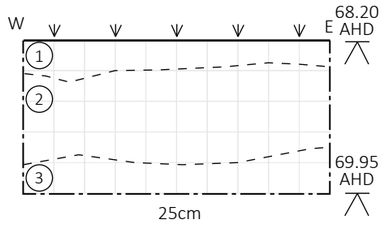
C.2.4 Stratigraphic drawings of artefact bearing test pits

TPs 131-12 to 131-17 - Elevated terraces and associated slopes

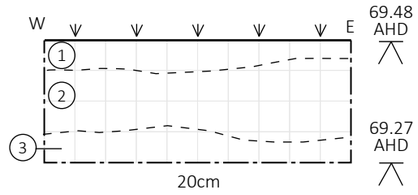
TP 131-12
NORTH SECTION



TP 131-16
NORTH SECTION



TP 131-17
NORTH SECTION



1 DARK BROWN DISTURBED SILTY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON)

3 ORANGE/BROWN HEAVY CLAY (B2 HORIZON)

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E info@emmconsulting.com.au
www.emmconsulting.com.au

VERSION	DESCRIPTION	DATE
0.1	DRAFT	18/07/2025

LEGEND

- PIT BOUNDARY
- SOIL PROFILE BOUNDARY
- DIFFUSE SOIL PROFILE BOUNDARY
- ROOTS
- CHARCOAL
- STONES

CLIENT
ENERGYCO

PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

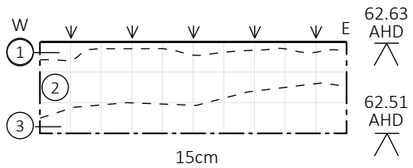
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

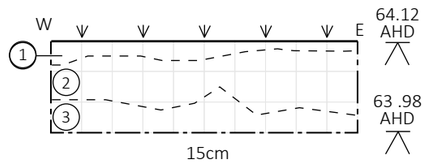
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	001
PROJECT NO.	**VERSION**	
E220595	0.1	

TPS 132-1 to 132-9 - Elevated terraces and associated slopes

TP 132-1
NORTH SECTION



TP 132-9
NORTH SECTION



1 DARK BROWN DISTURBED SILTY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON)

3 ORANGE/BROWN HEAVY CLAY (B2 HORIZON)

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Level 10, 201 Pacifc Highway
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T 02 9493 9500
E info@emmconsulting.com.au
www.emmconsulting.com.au

VERSION	DESCRIPTION	DATE
0.1	DRAFT	18/07/2025

LEGEND

- PIT BOUNDARY
- SOIL PROFILE BOUNDARY
- DIFFUSE SOIL PROFILE BOUNDARY
- ROOTS
- CHARCOAL
- STONES

CLIENT
ENERGYCO

PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

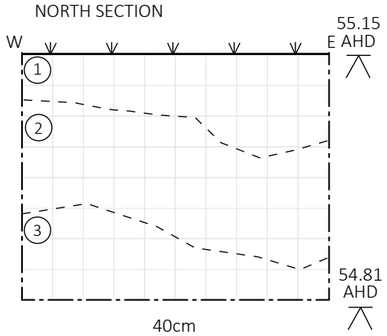
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

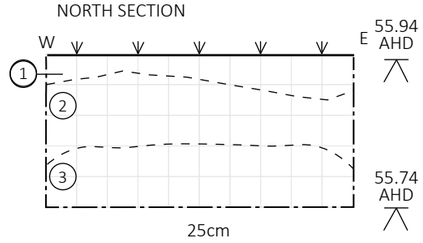
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	002
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 133-8 to 133-11 - Elevated terraces and associated slopes

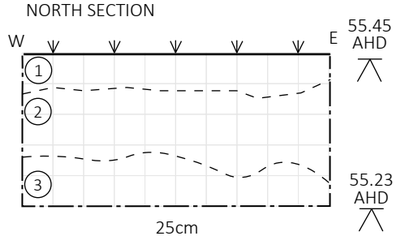
TP 133-8
NORTH SECTION



TP 133-10
NORTH SECTION



TP 133-11
NORTH SECTION



1 DARK BROWN DISTURBED SILTY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON)

3 ORANGE/BROWN HEAVY CLAY (B2 HORIZON)

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VERSION	DESCRIPTION	DATE
0.1	DRAFT	18/07/2025

LEGEND

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- ROOTS
- CHARCOAL
- STONES

CLIENT
ENERGYCO

PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

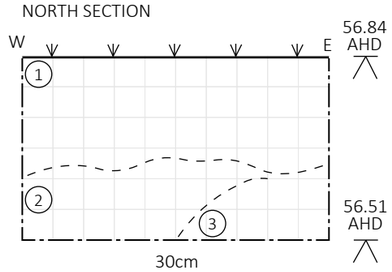
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

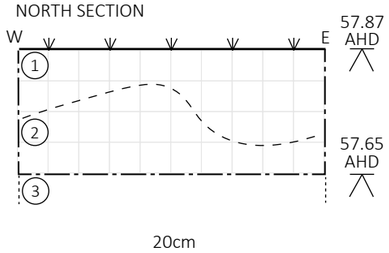
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	003
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 134-2 to 134-11 - Elevated terraces and associated slopes

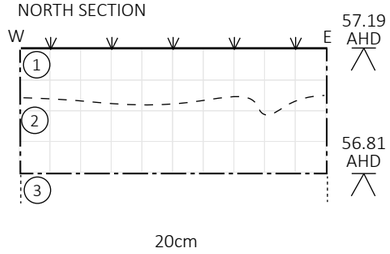
TP 134-2
NORTH SECTION



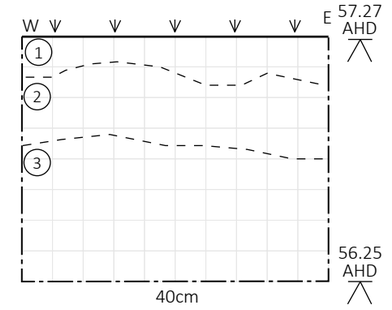
TP 134-3
NORTH SECTION



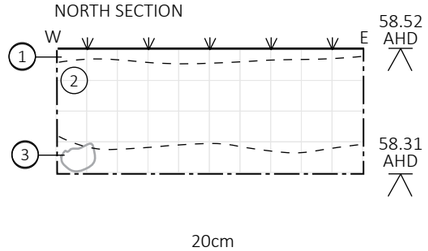
TP 134-4
NORTH SECTION



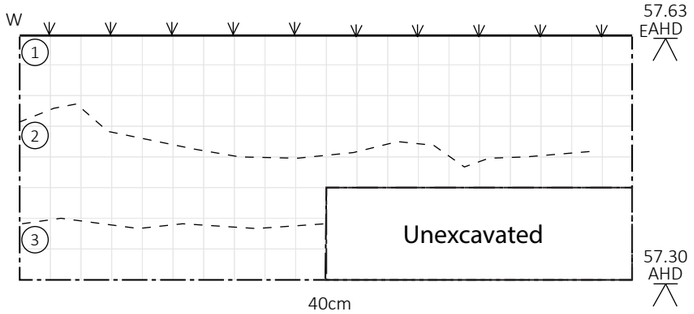
TP 134-5
NORTH SECTION



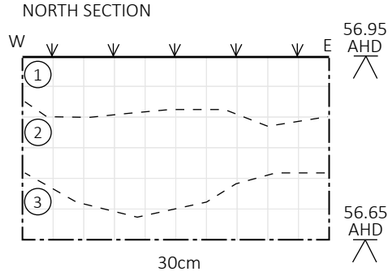
TP 134-8
NORTH SECTION



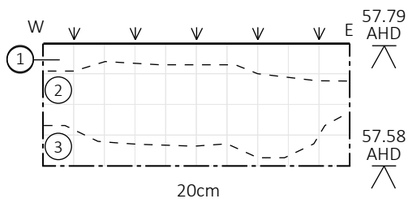
TP 134-9
NORTH SECTION



TP 134-10
NORTH SECTION



TP 134-11
NORTH SECTION



1 DARK BROWN DISTURBED SILTY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON)

3 ORANGE/BROWN HEAVY CLAY (B2 HORIZON)

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VERSION	DESCRIPTION	DATE
0.1	DRAFT	18/07/2025

LEGEND

- PIT BOUNDARY
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- ROOTS
- CHARCOAL
- STONES

CLIENT
ENERGYCO

PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

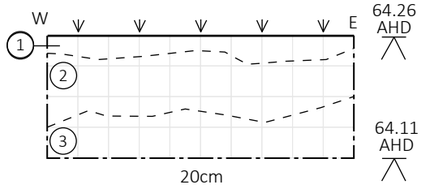
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

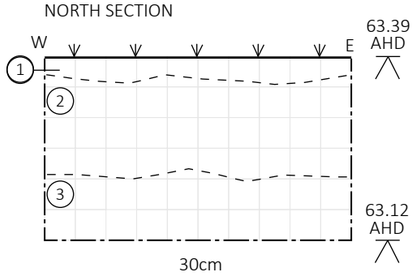
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	004
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 135-11 to 135-19 - Elevated terraces and associated slopes

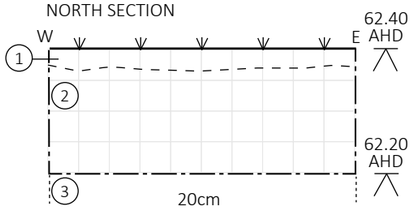
TP 135-11
NORTH SECTION



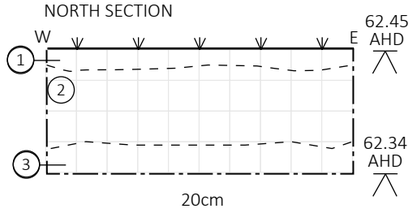
TP 135-13
NORTH SECTION



TP 135-15
NORTH SECTION



TP 135-19
NORTH SECTION



1 DARK BROWN DISTURBED SILTY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON)

3 ORANGE/BROWN HEAVY CLAY (B2 HORIZON)

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VERSION	DESCRIPTION	DATE
0.1	DRAFT	18/07/2025

LEGEND

- PIT BOUNDARY
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- CHARCOAL
- STONES

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PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

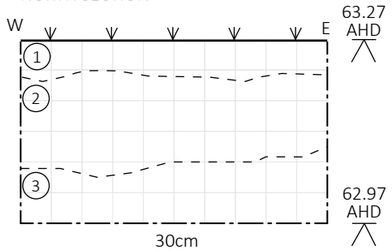
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

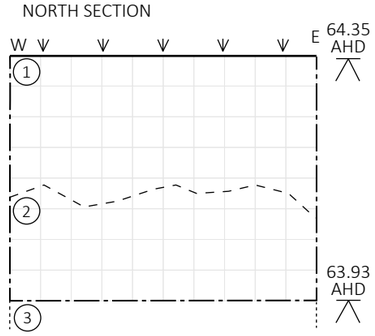
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	005
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 136-2 to 136-19 - Elevated terraces and associated slopes

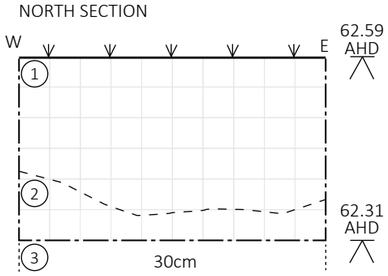
TP 136-2
NORTH SECTION



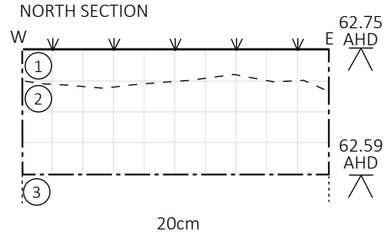
TP 136-5
NORTH SECTION



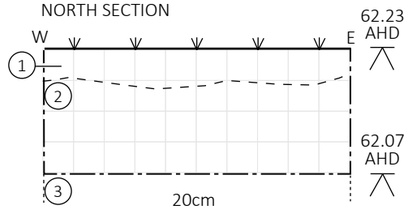
TP 136-7
NORTH SECTION



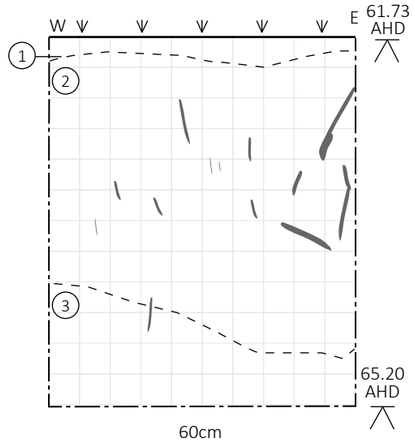
TP 136-9
NORTH SECTION



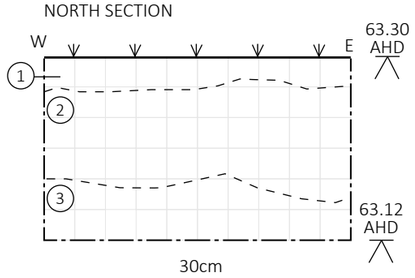
TP 136-13
NORTH SECTION



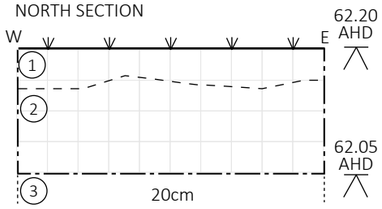
TP 136-15
NORTH SECTION



TP 136-17
NORTH SECTION



TP 136-19
NORTH SECTION



1 DARK BROWN DISTURBED SILTY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON)

3 ORANGE/BROWN HEAVY CLAY (B2 HORIZON)

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VERSION	DESCRIPTION	DATE
0.1	DRAFT	18/07/2025

LEGEND

- PIT BOUNDARY
- SOIL PROFILE BOUNDARY
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- ROOTS
- CHARCOAL
- STONES

CLIENT
ENERGYCO

PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

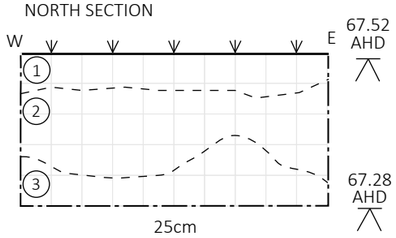
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

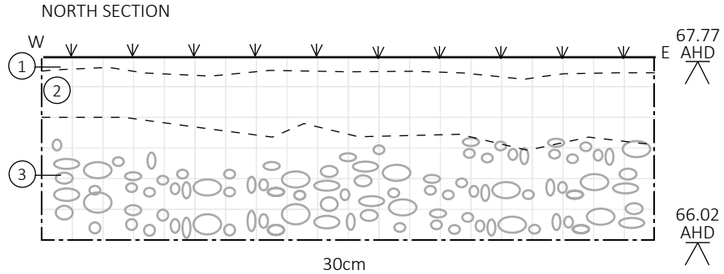
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	006
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 140-5 to 140-19 - Elevated terraces and associated slopes

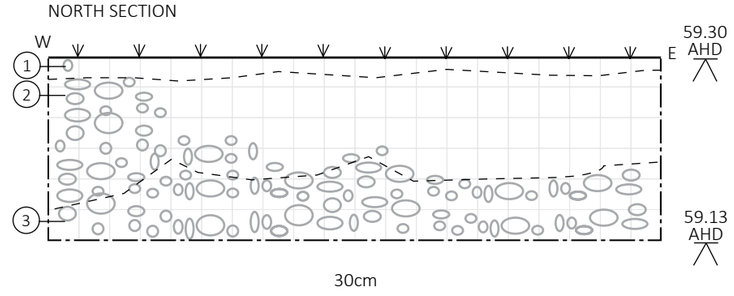
TP 140-5
NORTH SECTION



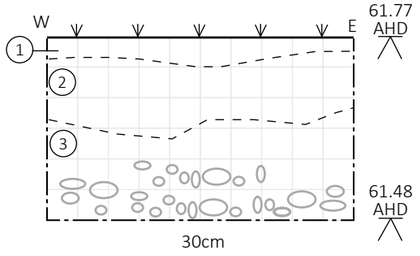
TP 140-11
NORTH SECTION



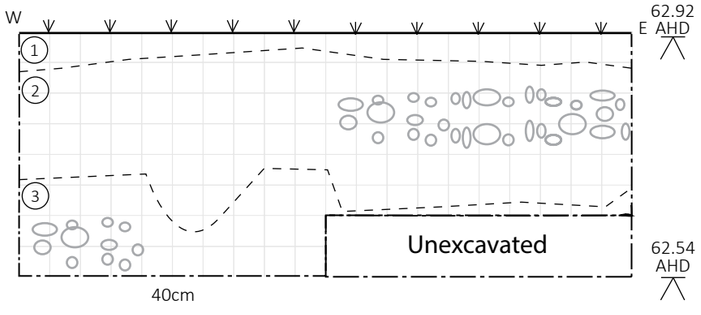
TP 140-16
NORTH SECTION



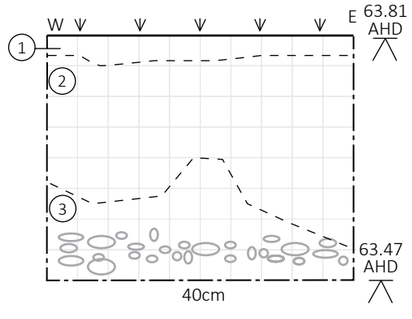
TP 140-17
NORTH SECTION



TP 140-18
NORTH SECTION



TP 140-19
NORTH SECTION



1 DARK BROWN DISTURBED SILTY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON)

3 ORANGE/BROWN HEAVY CLAY (B2 HORIZON)

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VERSION	DESCRIPTION	DATE
0.1	DRAFT	18/07/2025

LEGEND

- PIT BOUNDARY
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- ROOTS
- CHARCOAL
- STONES

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ENERGYCO

PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

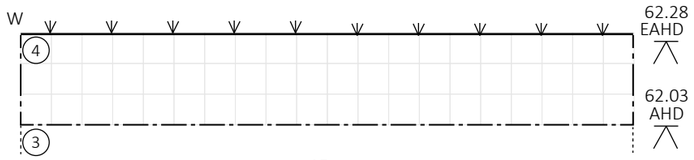
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

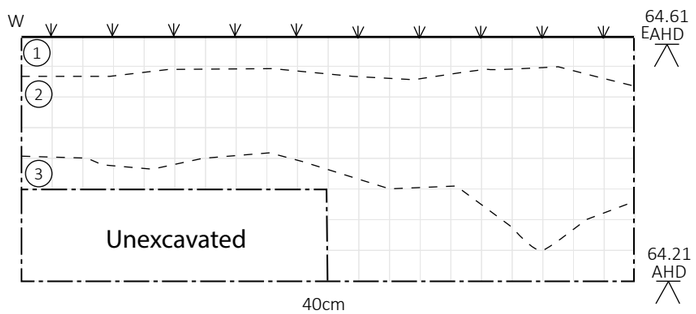
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	007
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 141-2 to 141-15 - Elevated terraces and associated slopes

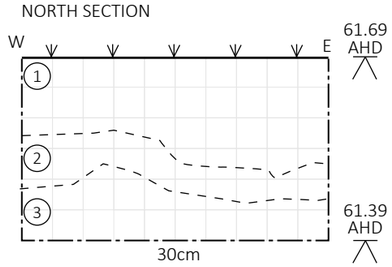
TP 141-2
NORTH SECTION



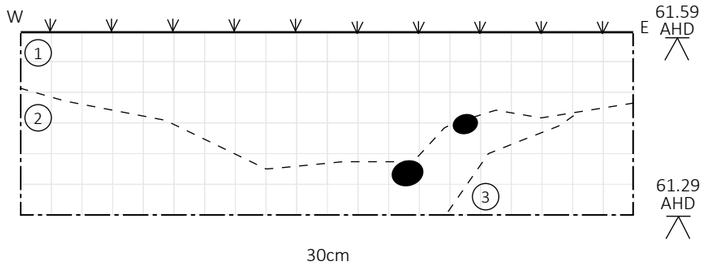
TP 141-3
NORTH SECTION



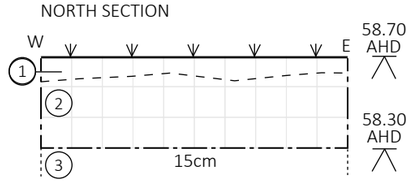
TP 141-7
NORTH SECTION



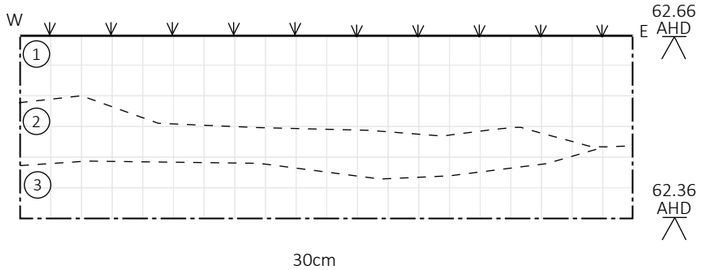
TP 141-8
NORTH SECTION



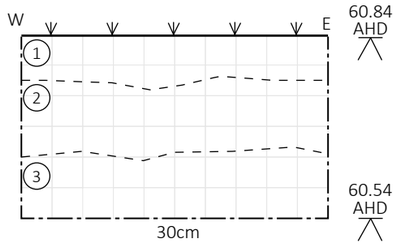
TP 141-9
NORTH SECTION



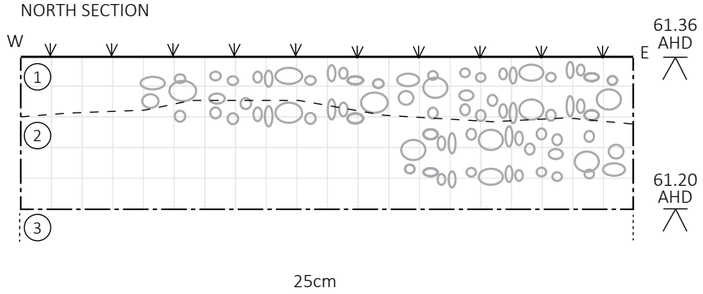
TP 141-10
NORTH SECTION



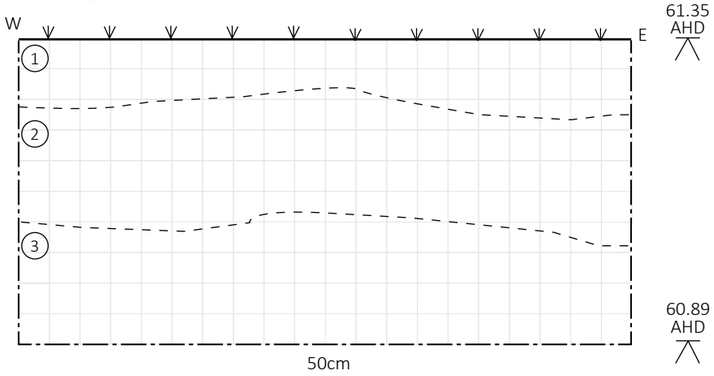
TP 141-13
NORTH SECTION



TP 141-14
NORTH SECTION



TP 141-15
NORTH SECTION



1 DARK BROWN DISTURBED SILTY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON)

3 ORANGE/BROWN GRAVELLY HEAVY CLAY (B2 HORIZON)

4 PALE YELLOW SAND (A1 HORIZON)

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VERSION	DESCRIPTION	DATE
0.1	DRAFT	18/07/2025

LEGEND

- PIT BOUNDARY
- SOIL PROFILE BOUNDARY
- DIFFUSE SOIL PROFILE BOUNDARY
- ROOTS
- CHARCOAL
- STONES

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PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

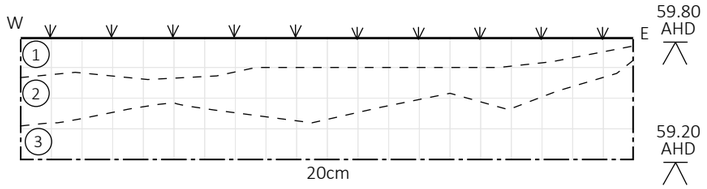
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

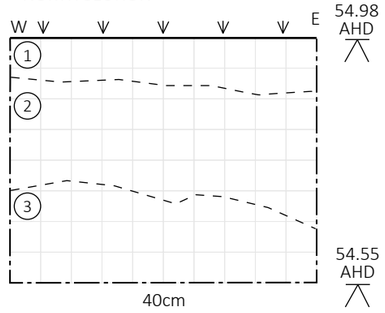
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	008
PROJECT NO.	VERSION	
E220595	0.1	

TPs 141-16 to 141-21 - Elevated terraces and associated slopes

TP 141-16
NORTH SECTION



TP 141-21
NORTH SECTION



1 DARK BROWN DISTURBED SILTY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON)

3 ORANGE/BROWN GRAVELLY HEAVY CLAY (B2 HORIZON)

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- CHARCOAL
- STONES

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PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

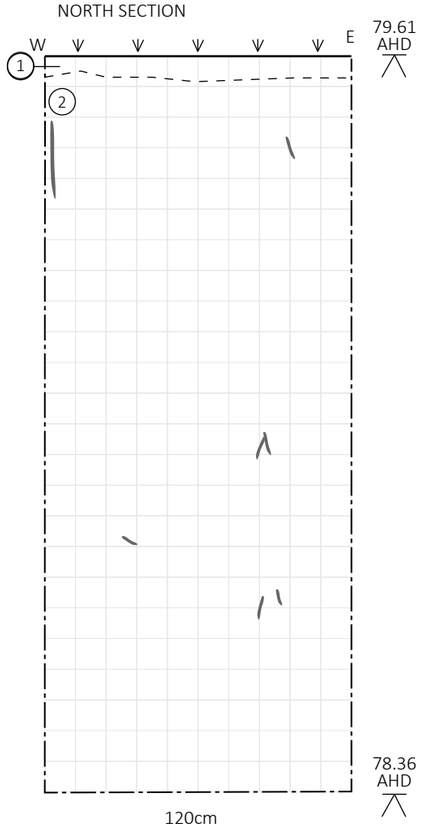
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

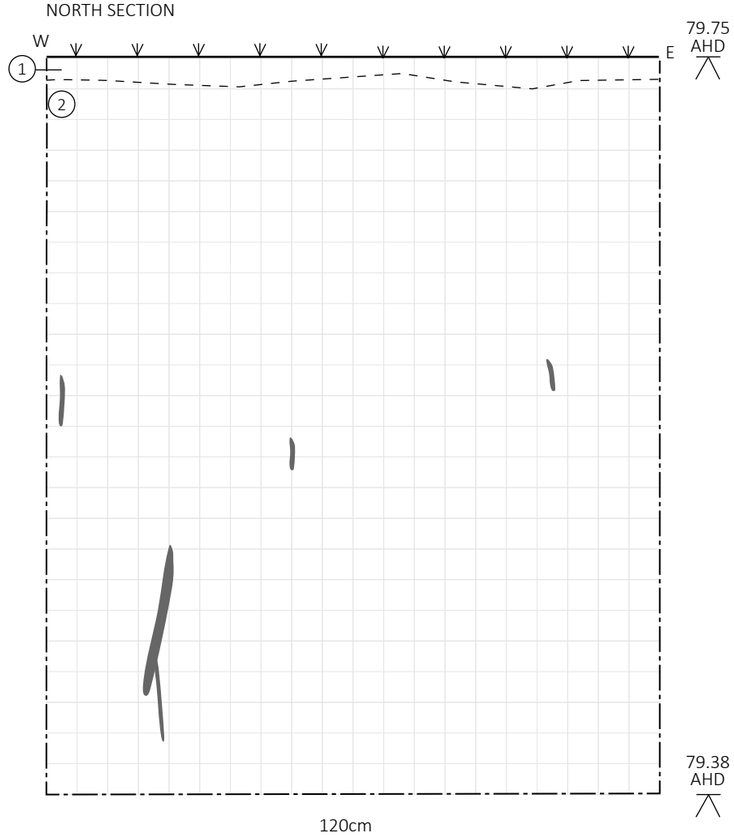
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	009
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 155-1 to 155-6 - Source bordering dunes

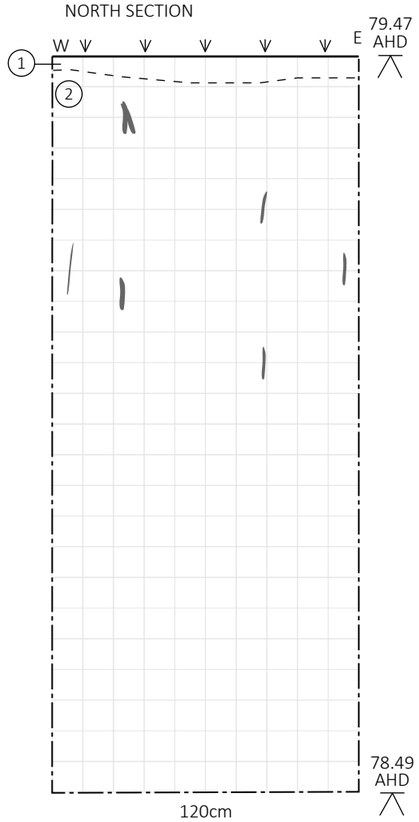
TP 155-1
NORTH SECTION



TP 155-4
NORTH SECTION



TP 155-6
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B2 HORIZON)

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- STONES

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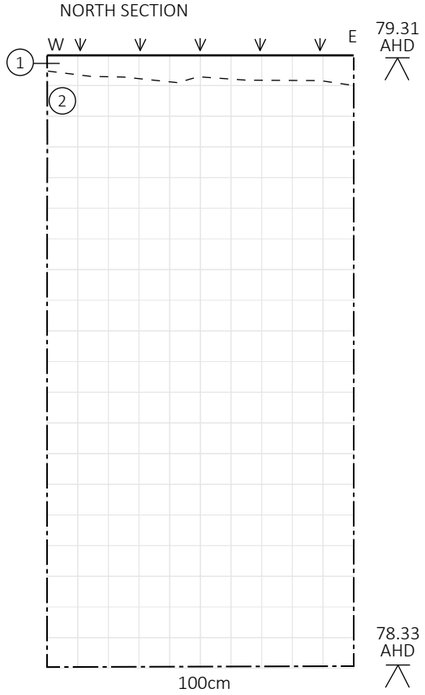
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

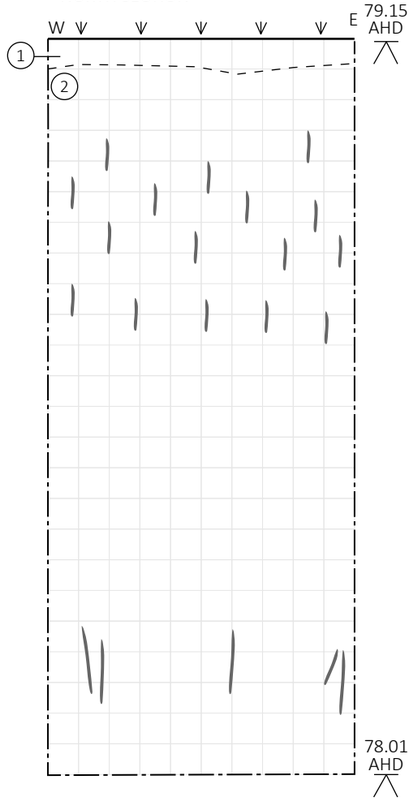
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	010
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 155-9 to 155-12 - Source bordering dunes

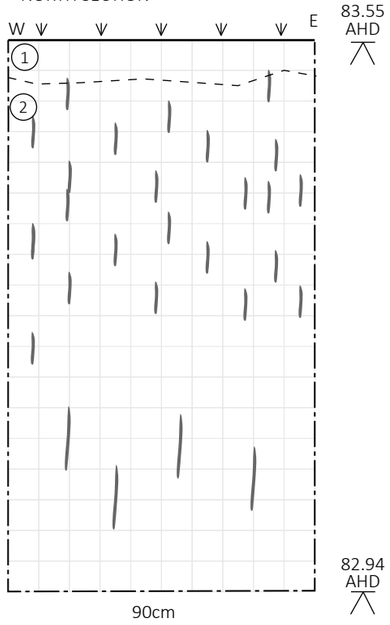
TP 155-9
NORTH SECTION



TP 155-10
NORTH SECTION



TP 155-12
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B2 HORIZON)

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HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

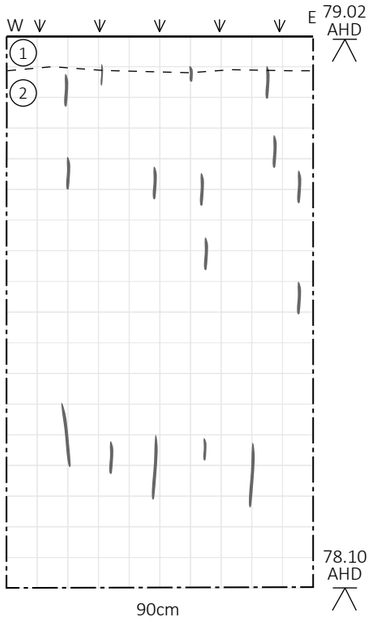
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

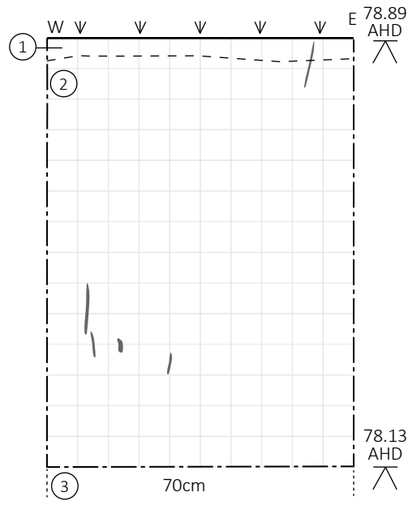
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	011
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 155-14 to 155-16 - Source bordering dunes

TP 155-14
NORTH SECTION



TP 155-16
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B2 HORIZON)

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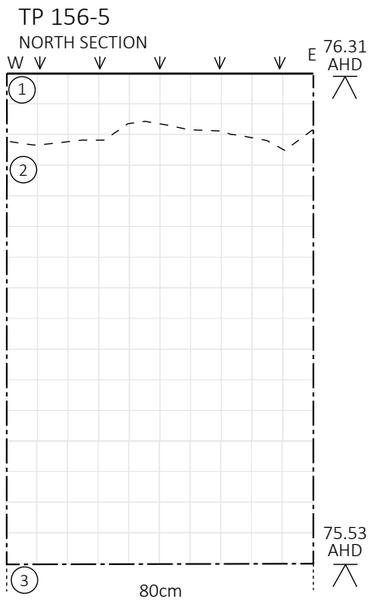
PROJECT
HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

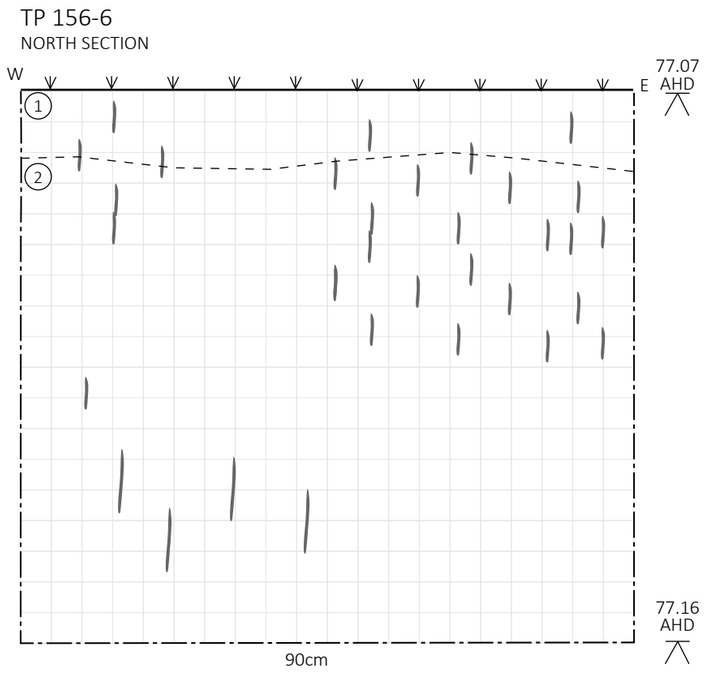
TITLE
TEST PIT SECTION DRAWINGS

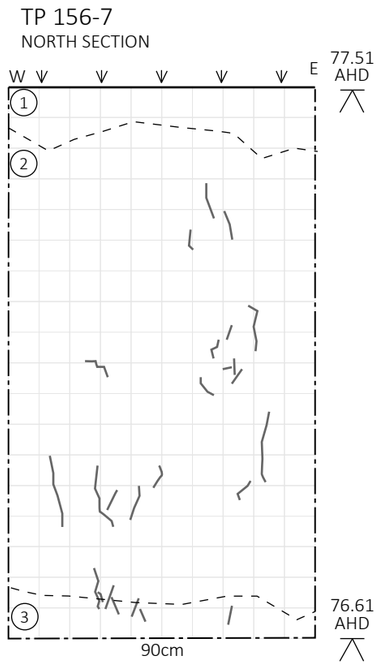
TP SECTION DRAWINGS

SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	012
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs156-5 TO 156-7 - Source bordering dunes







1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B2 HORIZON)

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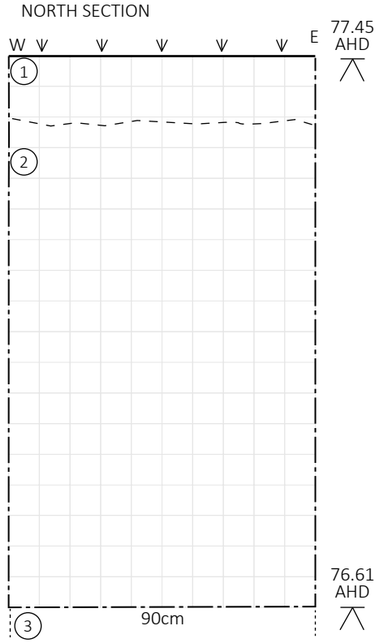
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

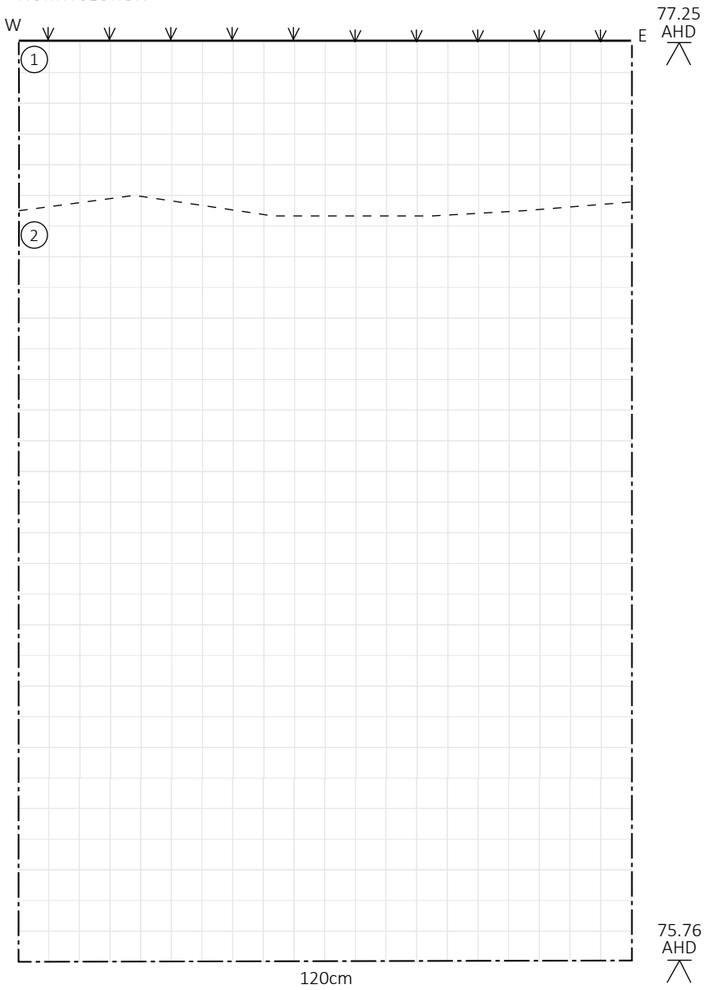
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	013
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 156-11 to 156-13 - Source bordering dunes

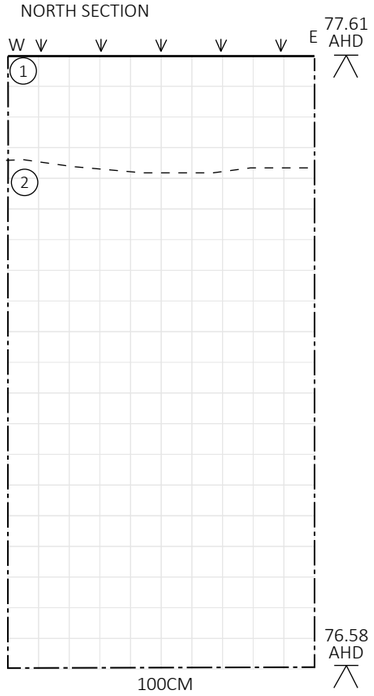
TP 156-11
NORTH SECTION



TP 156-12
NORTH SECTION



TP 156-13
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B2 HORIZON)

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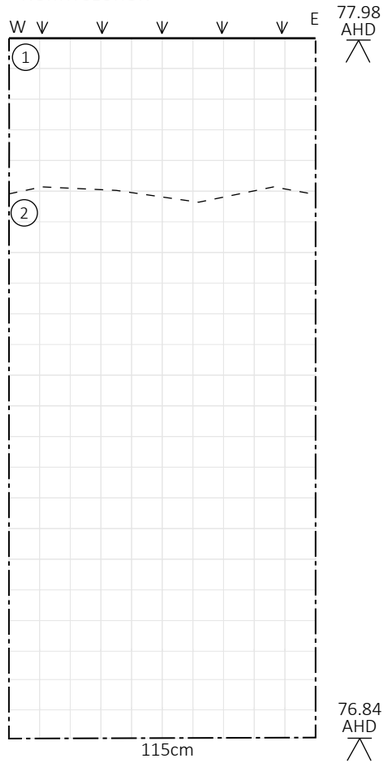
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

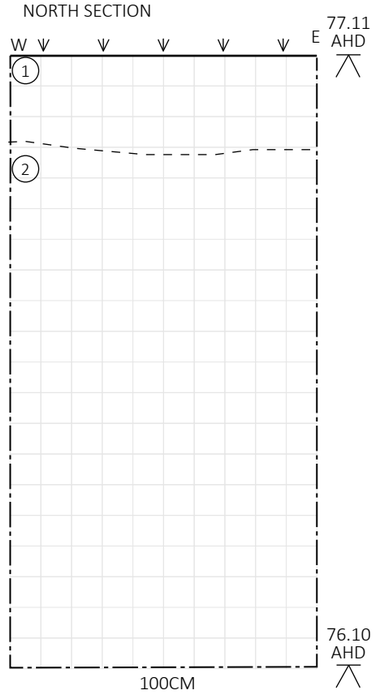
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	014
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 156-14 to 156-17 - Source bordering dunes

TP 156-14
NORTH SECTION



TP 156-17
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B2 HORIZON)

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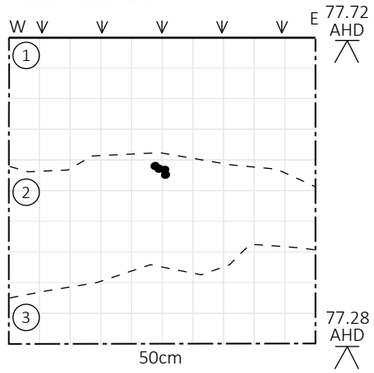
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

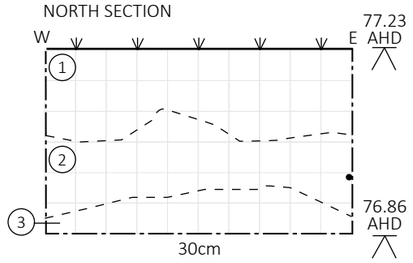
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	015
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 157-4 to 157-14 - Source bordering dunes

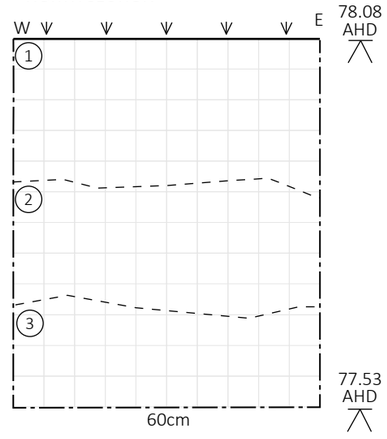
TP 157-4
NORTH SECTION



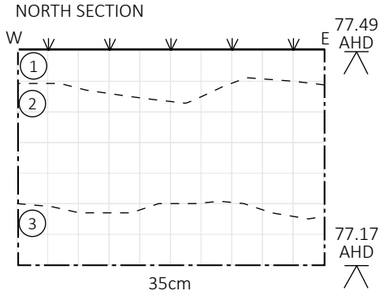
TP 157-10
NORTH SECTION



TP 157-12
NORTH SECTION



TP 157-14
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B2 HORIZON)

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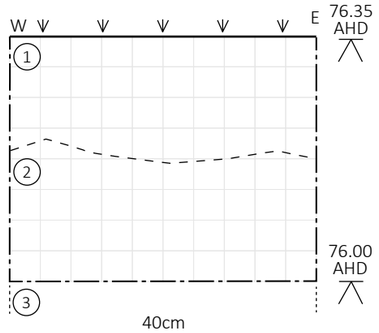
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

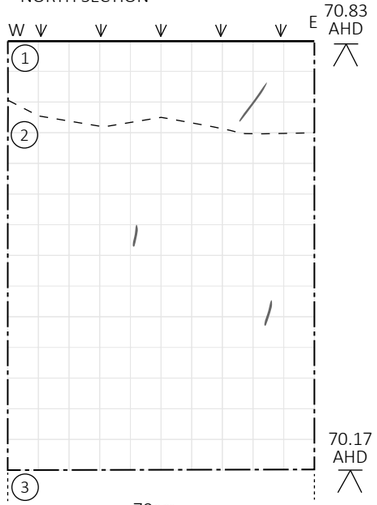
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	016
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 158-3 to 158-10 - Source bordering dunes

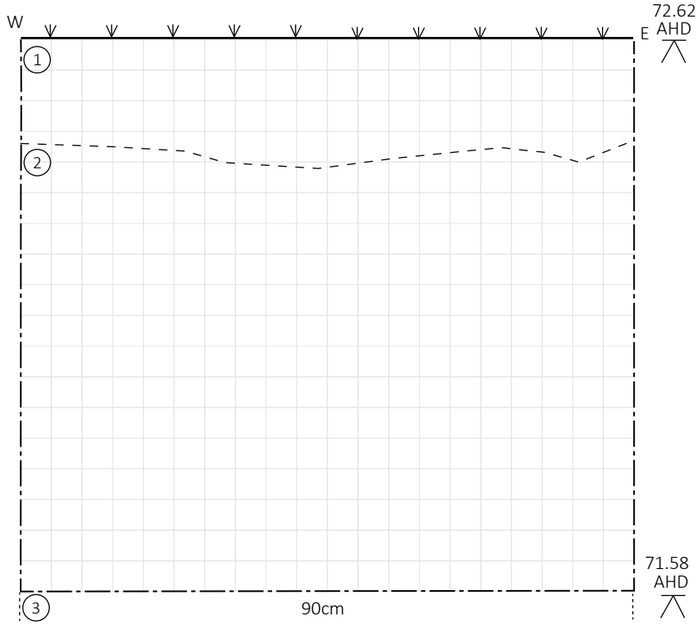
TP 158-3
NORTH SECTION



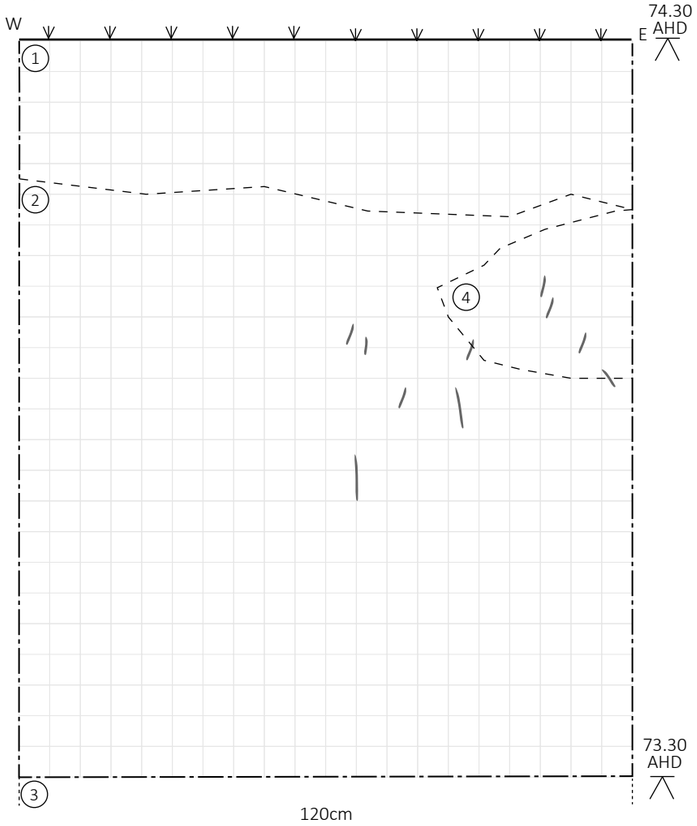
TP 158-8
NORTH SECTION



TP 158-9
NORTH SECTION



TP 158-10
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B1 HORIZON)

4 ORANGE/BROWN HEAVY CLAY (B2 HORIZON)

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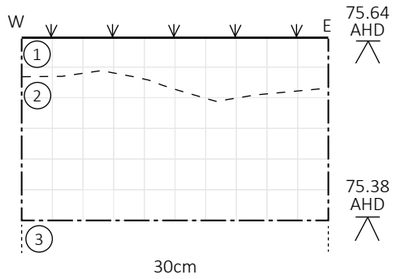
TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

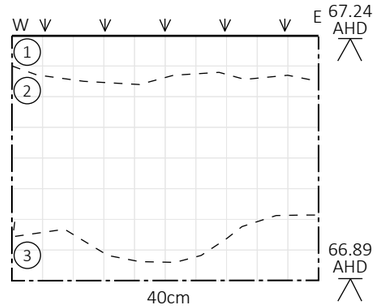
SCALE	DRAWN/CHECK	DRAWING NO.
1:5	AL	017
PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 158-11 to 158-17 - Source bordering dunes

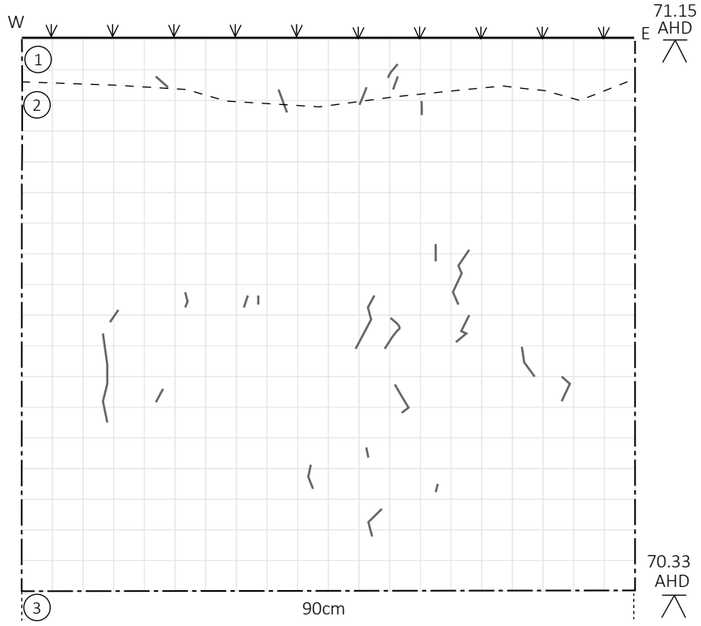
TP 158-11
NORTH SECTION



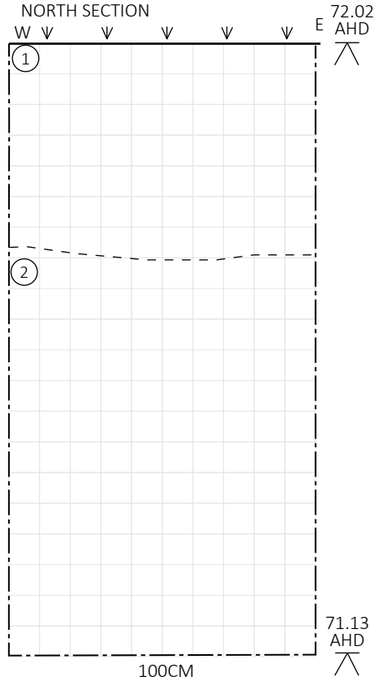
TP 158-13
NORTH SECTION



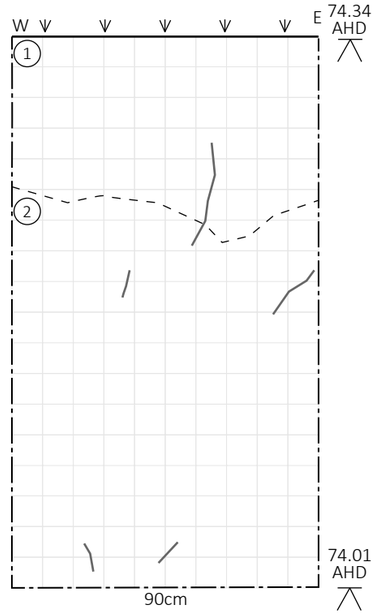
TP 158-15
NORTH SECTION



TP 158-16
NORTH SECTION



TP 158-17
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B1 HORIZON)

4 ORANGE/BROWN LIGHT CLAY (B2 HORIZON)

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HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

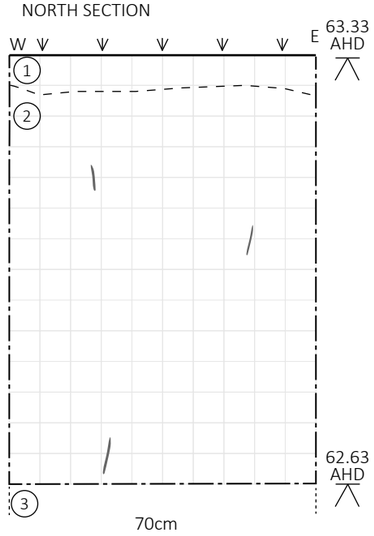
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TP SECTION DRAWINGS

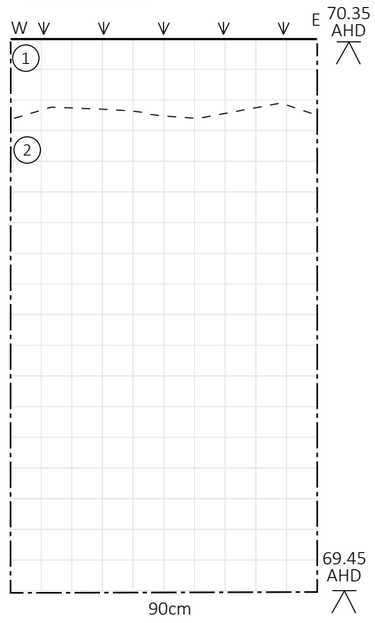
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PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 158-20 to 158-22 - Source bordering dunes

TP 158-20
NORTH SECTION



TP 158-22
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B1 HORIZON)

4 ORANGE/BROWN LIGHT CLAY (B2 HORIZON)

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VERSION	DESCRIPTION	DATE
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LEGEND

- PIT BOUNDARY
- SOIL PROFILE BOUNDARY
- DIFFUSE SOIL PROFILE BOUNDARY
- ROOTS
- CHARCOAL
- STONES

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HUNTER TRANSMISSION PROJECT HUNTER VALLEY OPERATIONS SOUTH TEST EXCAVATIONS

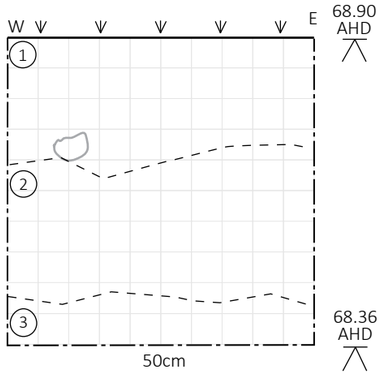
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TP SECTION DRAWINGS

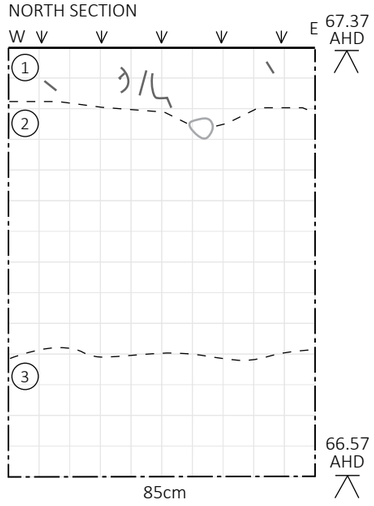
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PROJECT NO.	**VERSION**	
E220595	0.1	

TPs 169-4 to 169-11 - Floodplains

TP 169-4
NORTH SECTION



TP 169-11
NORTH SECTION



1 LIGHT BROWN DISTRUBED LOAMY TOPSOIL (A1 HORIZON)

2 LIGHT BROWN LOOSE SAND (A2 HORIZON)

3 BROWN SANDY CLAY (B2 HORIZON)

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LEGEND

- PIT BOUNDARY
- SOIL PROFILE BOUNDARY
- DIFFUSE SOIL PROFILE BOUNDARY
- ROOTS
- CHARCOAL
- STONES

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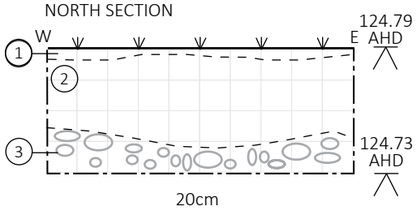
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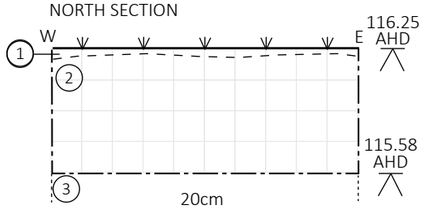
TP 172-10

NORTH SECTION



TP 172-20

NORTH SECTION



1 LIGHT BROWN DISTURBED/ABSENT SILTY TOPSOIL (A1 HORIZON) 2 LIGHT BROWN SILTY CLAY LOAM (A2 HORIZON) 3 BEDROCK (R HORIZON)

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LEGEND

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- CHARCOAL
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TITLE
TEST PIT SECTION DRAWINGS

TP SECTION DRAWINGS

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PROJECT NO.	**VERSION**	
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C.2.5 Optically Stimulated Luminescence dating report

VICUS

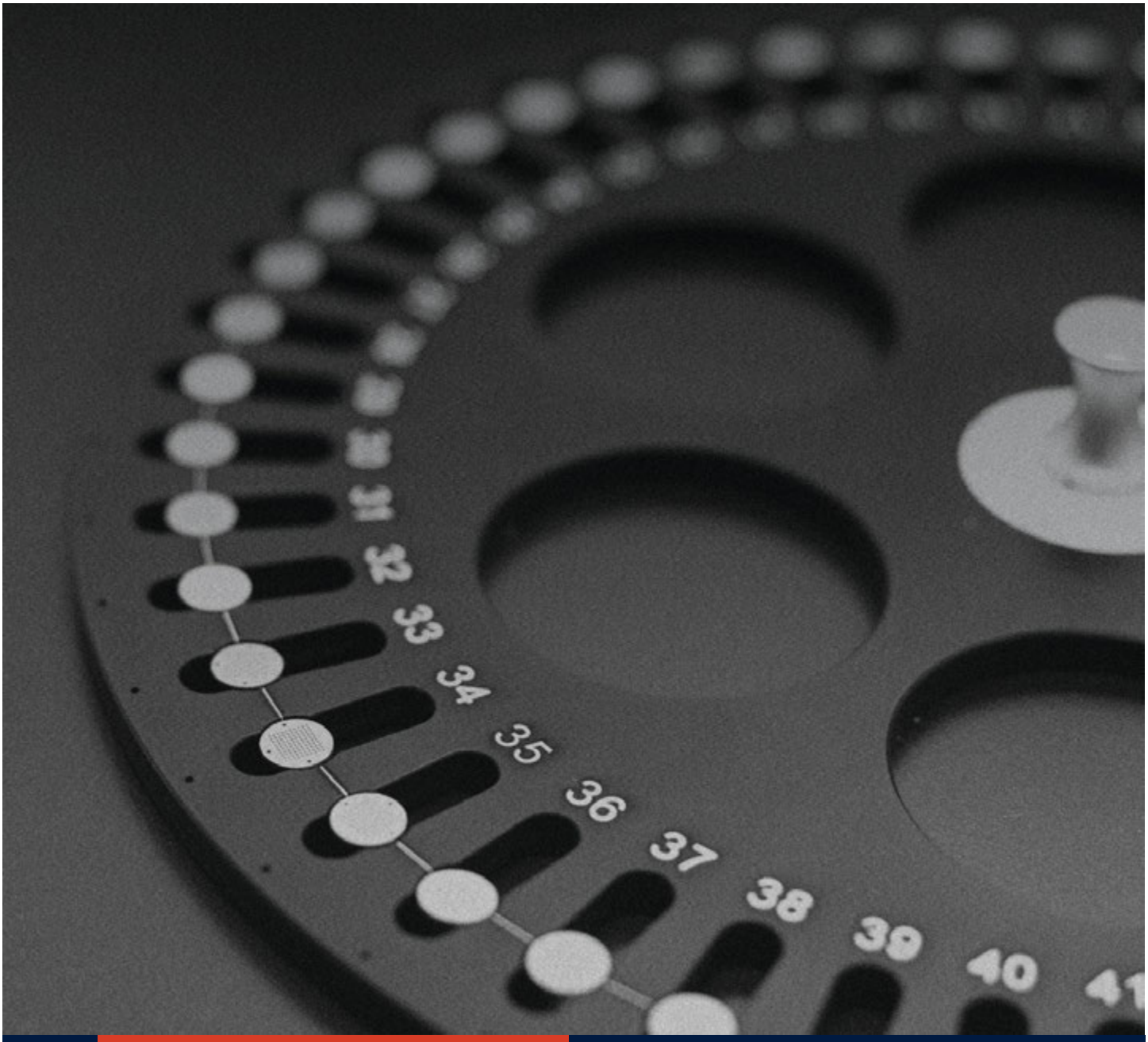


HTP - HVO TEST EX

LUMINESCENCE DATING REPORT

VICUS PTY LTD

13 OCTOBER 2025



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REPORT PREPARED BY:
Dr. Luke Gliganic – Scientific Director

REPORT REVIEWED BY:
Dr. Christina Neudorf – Laboratory Manager

REPORT PREPARED FOR:
EMM, William Truscott

EXECUTIVE SUMMARY

Laboratory Sample Number	Sample Code	Age (ka)
VCS-25005-003	HTP-HVO-02	0.06 ± 0.01
VCS-25005-002	HTP-HVO-04	0.07 ± 0.01
VCS-25005-006	HTP-HVO-06	0.23 ± 0.01
VCS-25005-005	HTP-HVO-07	1.35 ± 0.10
VCS-25005-007	HTP-HVO-08	2.41 ± 0.17
VCS-25005-008	HTP-HVO-09	2.24 ± 0.12
VCS-25005-004	HTP-HVO-10	2.43 ± 0.15
VCS-25005-009	HTP-HVO-16	2.26 ± 0.13
VCS-25005-010	HTP-HVO-20	0.85 ± 0.05
VCS-25005-011	HTP-HVO-22	43.67 ± 2.52
VCS-25005-012	HTP-HVO-24	47.28 ± 2.56
VCS-25005-013	HTP-HVO-26	52.21 ± 2.78
VCS-25005-014	HTP-HVO-33	0.56 ± 0.03
VCS-25005-015	HTP-HVO-35	48.00 ± 2.65
VCS-25005-016	HTP-HVO-36	52.95 ± 2.78
VCS-25005-017	HTP-HVO-37	49.86 ± 2.69
VCS-25005-018	HTP-HVO-38	56.20 ± 2.93
VCS-25005-019	HTP-HVO-40	0.72 ± 0.04
VCS-25005-020	HTP-HVO-43	39.09 ± 2.70
VCS-25005-021	HTP-HVO-46	71.80 ± 5.58
VCS-25005-001	HTP-HVO-49	0.75 ± 0.04

Twenty-one single-grain optically stimulated luminescence (OSL) samples were collected from a suite of test-excavation sites in the Hunter Valley (HTP–HVO project) to establish the timing of sediment deposition and inform site-formation histories. Samples were processed and analysed at the Vicus Luminescence Laboratory (Rocklea, QLD) using single-grain quartz OSL techniques.

Key results include:

- OSL signal quality was high across samples, dominated by the fast component, supporting reliable age estimation.
- Several floodplain sites (e.g. 141-20, 144-2) yielded very young ages (< 1 ka), consistent with recent floodplain deposition or reworking.
- Hillslope site 141-15 preserves evidence for two Holocene depositional events at ~2.3 ka and ~5.8–6.5 ka, overprinted by post-depositional mixing.
- A subset of deeper samples from dune contexts (e.g. 158-9, 158-10, 156-12) record much older Pleistocene ages, representing active dune deposition from ~40 ka to ~72 ka.

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DEFINITIONS

The following definitions apply to the terms used in this report.

ABSORBED DOSE refers to the total radiation dose the sample has been exposed to since burial, measured in Gray (Gy).

ALPHA PARTICLES (α) are emitted during radioactive decay and comprise of two protons and two neutrons bound together. These particles have low penetrating power in sediment and rock, typically only up to a few microns.

BETA PARTICLES (β) are high energy, high speed particles emitted during radioactive decay. These particles have moderate penetrating power in sediment and rock of a few millimetres.

CENTRAL AGE MODEL (CAM) or CENTRAL DOSE MODEL is the statistical model used to calculate the D_e value of a sample, assuming that all sediment grains were completely reset by sunlight prior to burial (Galbraith et al., 1999).

COSMIC RAY is a high-speed particle (either an atomic nucleus or an electron) that travels through space, originating from either the sun or from other sources in the Milky Way.

DOSE RATE (D_r) refers to the radiation dose the sample is exposed to per year, measured in Gy/ka. Radiation comes naturally from the soil and from cosmic rays.

DOSE RESPONSE CURVE (DRC) plots the relationship between absorbed radiation dose of a mineral and its luminescence signal brightness. Created by measuring the luminescence response of a single-grain or multi-grain aliquot to a series of increasing laboratory-induced radiation doses.

EQUIVALENT DOSE (D_e) is the laboratory radiation dose required to produce a luminescence signal equivalent to the signal produced by the natural dose of radiation the target mineral absorbed since last exposure to heat or light. Expressed in Gray (Gy), where 1 Gy = 1 Joule/kg.

FELDSPAR refers to the aluminosilicate mineral containing various levels of potassium, sodium, and calcium and makes up ~60% of Earth's crust.

FINITE MIXTURE MODEL (FMM) is a statistical model used to identify distinct D_e components in samples that have experienced mixing between two or more sedimentary units of different age (Roberts et al., 2000).

GAMMA RAY (γ) is the high-energy, high-speed particle emitted during radioactive decay. The particle comprises of a packet of electromagnetic energy (photon) and has high penetrating power.

GRAY (Gy) is one of the two units used to measure the amount of radiation absorbed by an object or person, known as the "absorbed dose," which reflects the amount of energy that radioactive sources deposit in materials through which they pass. One gray (Gy) is the international system of units (SI) equivalent of 100 rads, which is equal to an absorbed dose of 1 Joule/kilogram.

INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP-AES) is an analytical technique used to determine how much of certain elements are in a sample. Uses an optical spectrometer to measure the light emitted from elements as they pass through a plasma.

INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY (ICP-MS) is a technique used to identify the elemental composition of a substance. Uses an argon (Ar) plasma – the ICP – to convert the sample into ions that are then measured using a mass spectrometer – the MS. Offers lower detection limits than ICP-AES and is a better choice for trace element analysis.

“ka” means kilo annum, representing one thousand years.

LUMINESCENCE means the photons of light that are emitted when electrons are evicted from their crystalline traps by light or heat. The intensity is proportional to the number of trapped electrons, which in turn is determined by the burial duration.

MINIMUM AGE MODEL (MAM) is also known as the Minimum Dose Model, calculates the D_e value from a sample that was partially bleached prior to deposition.

OPTICALLY STIMULATED LUMINESCENCE (OSL) is luminescence that results from stimulation of the sample using photons of any wavelength. The OSL dating method was invented by D.J. Huntley in 1985.

OVERDISPERSION (OD or σ) is the spread in D_e data beyond that expected based on analytical uncertainties. Laboratory dose recovery experiments using a uniform gamma-delivered given dose show that overdispersion

values can be dose dependent and dependent on the thermal history of the grains, with overdispersion values up to 46.7% for unheated grains given 208 Gy (Thomsen et al., 2012). It is common for overdispersion values of samples from well-bleached, unmixed settings to be up to 40% (Carr et al., 2007; Arnold and Roberts, 2009). Sigma-b (σ_b), more specifically, refers to the overdispersion in a dataset from a sample where all grains have received the same dose.

PARTIAL BLEACHING means the incomplete resetting of a luminescence signal due to insufficient sun or heat exposure.

POST-DEPOSITIONAL MIXING is the displacement or remobilisation of grains in a sedimentary column through disturbance (e.g., soil processes, freeze-thaw processes, plant roots, insect or animal burrowing).

QUARTZ is silica, the mineral with the formula SiO_2 and the second most abundant material in Earth's continental crust after feldspar.

1. INTRODUCTION

Twenty-one single-grain optically stimulated luminescence (OSL) samples were collected by EMM from a series of sites in the Hunter Valley as part of the HTP–HVO test-excavation project. The samples were submitted by William Truscott (EMM) to Vicus Pty Ltd for analysis. Sample preparation, measurements, and data analysis were carried out at the Vicus Laboratory in Rocklea, QLD. This report describes the laboratory sample preparation and analytical procedures and provides final age estimates. The interpretations of the luminescence data in this report take into account the site geomorphic context and stratigraphy as provided by Truscott. Details for each sample are presented in Table 1.

Table 1: Sample information

Laboratory Sample Number	Sample Code	Site Name	Depth (cm)	Latitude	Longitude	Altitude (m)
VCS-25005-003	HTP-HVO-02	141-20	20	-32.55	151.05	56
VCS-25005-002	HTP-HVO-04	141-20	40	-32.55	151.05	56
VCS-25005-006	HTP-HVO-06	141-15	5	-32.55	151.05	63
VCS-25005-005	HTP-HVO-07	141-15	20	-32.55	151.05	63
VCS-25005-007	HTP-HVO-08	141-15	30	-32.55	151.05	63
VCS-25005-008	HTP-HVO-09	141-15	45	-32.55	151.05	63
VCS-25005-004	HTP-HVO-10	141-15	55	-32.55	151.05	63
VCS-25005-009	HTP-HVO-16	134-9	22	-32.56	151.08	60
VCS-25005-010	HTP-HVO-20	158-10	20	-32.50	151.02	76
VCS-25005-011	HTP-HVO-22	158-10	60	-32.50	151.02	76
VCS-25005-012	HTP-HVO-24	158-10	102	-32.50	151.02	76
VCS-25005-013	HTP-HVO-26	158-10	146	-32.50	151.02	76
VCS-25005-014	HTP-HVO-33	158-9	15	-32.50	151.02	75
VCS-25005-015	HTP-HVO-35	158-9	55	-32.50	151.02	75
VCS-25005-016	HTP-HVO-36	158-9	77	-32.50	151.02	75
VCS-25005-017	HTP-HVO-37	158-9	95	-32.50	151.02	75
VCS-25005-018	HTP-HVO-38	158-9	108	-32.50	151.02	75
VCS-25005-019	HTP-HVO-40	156-12	25	-32.50	151.03	79
VCS-25005-020	HTP-HVO-43	156-12	85	-32.50	151.03	79
VCS-25005-021	HTP-HVO-46	156-12	150	-32.50	151.03	79
VCS-25005-001	HTP-HVO-49	144-2	98	-32.54	151.05	57

OSL dating is a method that can be used to determine an estimate of the time elapsed since luminescent minerals, such as quartz, were last exposed to sunlight (Huntley et al., 1985; Rhodes 2011). If a quartz grain is exposed to a few seconds of sunlight, its latent OSL signal can be depleted. When the grain is subsequently buried, charge will accumulate in the crystal lattice of the grain at a rate that is proportional to the flux of cosmic rays and ionising radiation from the surrounding environment (i.e., the dose rate). When the grain is stimulated with light in the laboratory, the stored energy is released, and photons (i.e., OSL) are emitted. The brightness of this natural OSL signal is proportional to the charge that has accumulated in the grain during burial. This signal can be compared to the OSL signals measured following known laboratory-induced irradiations to estimate the equivalent dose (D_e) absorbed during burial. OSL ages are calculated by dividing the measured D_e by the corresponding dose rate.

$$\text{OSL age (ka)} = \frac{\text{Equivalent dose (Gy)}}{\text{Dose rate (Gy/ka)}}$$

In practice, OSL dating can be used to determine when sediments were last exposed to sunlight and then buried. This enables the dating of sedimentary deposits that comprise landforms and, by stratigraphic association, the materials buried in those deposits such as artefacts.

In this study, D_e values were measured from individual grains of quartz (single-grain OSL dating). Measuring D_e values from individual quartz grains has many benefits, including:

- the identification and elimination of grains with aberrant luminescence characteristics; and
- high-resolution D_e distributions that can be used to investigate landform and site formation processes, such as:
    - partial bleaching of sediments during transport and deposition; and
    - post-depositional mixing of sediments by various processes (bioturbation, pedoturbation, human disturbance, etc.).

2. METHODS

The aim of sample preparation was to recover pure, fine sand-sized fractions of quartz without depleting the natural luminescence signal. Consequently, all laboratory procedures were undertaken at the Vicus Luminescence Laboratory under dim amber lighting conditions.

Tubes were opened and the sediments within 2 cm of both ends were removed and used for measurement of water content and geochemistry. A small portion of the sample was removed and stored in light safe conditions.

The sediment sample material from the light-safe inner portion of the tube was prepared for measurement using the following steps:

- Wet sieve through 90, 180, and 212 µm sieve meshes. Target grain sizes (90-180 µm and 180 – 212 µm were progressed through the remaining preparation steps.
- Treatment with 10% HCl and 30% H_2O_2 to remove carbonates and organics, respectively.
- Etch in 48% hydrofluoric acid (HF) for 40 minutes to remove contaminant feldspar grains and remove the alpha-irradiated outer rim of the quartz grains.
- Soak with 10% HCl overnight to remove precipitated fluorides.
- Wet sieve a second time to remove grains that were reduced in size by the HF acid etch and retain 90-180 µm and 180-212 µm purified quartz fractions.
- Quartz grains were mounted onto single-grain discs (10 mm diameter with a grid of 10 x 10 300 µm diameter holes, into which individual grains are mounted) for measurement.

All luminescence measurements were made on Risø DA22 TL/OSL readers equipped with blue LEDs (470 nm delivering 80 mW/cm^2 to samples) infrared (IR) LEDs (850 nm IR LEDs providing up to 300 mW/cm^2 to samples) and a focused 10 mW stabilised diode pumped solid state green laser (532 nm). Ultraviolet luminescence emissions were isolated using Hoya U-340 filters and detected using a Hamamatsu H11870-01 photomultiplier tube. Laboratory irradiations were delivered to samples using a calibrated ^{90}Sr/^{90}Y beta source mounted on the Risø DA22 TL/OSL reader. Sources are calibrated using gamma-irradiated quartz.

Single-grains were stimulated by the green laser for 1 s at 125°C and the signal photon counts were calculated from the first 0.2 s of stimulation minus a background calculated from the final 0.3 s. Dose-response curves were constructed and D_e values were determined using the single-aliquot regenerative dose (SAR) procedure (Murray and Wintle, 2000). The SAR procedure consists of the measurement of the OSL from the natural (burial) dose (Ln)

and from a series of 'regenerative doses' (Lx). The measurement of Ln and each Lx is followed by the measurement of the OSL from a small, standardised test dose (Tn and Tx, respectively) to track and correct for sensitivity changes. Each Lx is then divided by its subsequent Tx (Lx/Tx) to create a series of sensitivity-corrected regenerative-dose points. These values are used to construct a sensitivity-corrected dose-response curve onto which the sensitivity-corrected natural (Ln/Tn) is projected to obtain the D_e. The SAR procedure used to measure D_e values for HTP - HVO test ex samples is shown in Table 2. Between six and nine different regenerative doses of between 6 and 214 Gy and a 2 Gy test dose were used to construct dose response curves.

Table 2: Step-by-step outline of the SAR procedure used for HTP - HVO test ex samples. Steps 1 to 5 are used to obtain the sensitivity-corrected natural (Ln/Tn). Steps 6 through 12 are used to obtain the sensitivity-corrected regenerative-dose points, which are used to construct a sensitivity-corrected dose-response curve.

Step	Treatment	Designation
1	Preheat (220°C, 10 s)	
2	Green laser (125°C, 1 s)	Ln
3	Test dose (~2 Gy)	
4	Preheat (200°C, 0 s)	
5	Green laser (125°C, 1 s)	Tn
6	Regenerative Dose	
7	Preheat (220°C, 10 s)	
8	Green laser (125°C, 1 s)	Lx
9	Test dose (~2 Gy)	
10	Preheat (200°C, 0 s)	
11	Green laser (125°C, 1 s)	Tx
12	Repeat steps 6 to 12	

The appropriateness of the SAR procedure was assessed using standard tests, including a recycling ratio test, zero-dose (recuperation) test (Murray and Wintle, 2000), an OSL-IR depletion ratio (Duller, 2003), and dose recovery tests (Murray and Wintle, 2003). The statistical models that were used to analyse sample D_e distributions include the central age model (CAM; Galbraith et al., 1999), minimum age model (MAM; Galbraith et al., 1999), and the finite mixture model (FMM; Roberts et al., 2000). The MAM was calculated using an assumed sigma-b (σ_b) value of 20%. The FMM is a statistical approach that fits a specified number of normally distributed components (k) for a given OD to a single-grain D_e dataset, estimating for each component its mean D_e and relative proportion. A systematic approach was used to determine the age model that best fits the D_e distribution for each sample. This approach uses each sample's environmental context and stratigraphic position, the OD of CAM and FMM results, two statistical measures (the maximum log likelihood and the Bayes Information Criterion: Roberts et al., 2000; Jacobs et al., 2008), and the shape and modality of the D_e distribution (Cohen et al., 2015; Gliganic et al., 2015; Slack, et al., 2020; Wilkins et al., 2021). Where mixing was expected, the most populous FMM component was often inferred to reflect burial (e.g., Bateman et al., 2007; Jacobs et al., 2008; Gliganic et al., 2015; Wilkins et al., 2021).

The total environmental dose rate for each sample is derived from alpha and beta particles and gamma rays emitted due to the decay of ^{238}U, ^{235}U, ^{232}Th (and their decay products) and ^{40}K in the surrounding sediment and from cosmic rays. The alpha-affected regions of each grain were removed by HF acid etching.

Samples for dose rate measurement were dried and sent to ALS Geochemistry for geochemical analysis of U, Rb, Th, and K_2O. Subsamples used for U, Rb and Th measurement were fused with lithium borate and measured with inductively coupled plasma-mass spectrometry (ICP-MS). K_2O was measured from the bulk sample with inductively coupled plasma-atomic emission spectrometry (ICP-AES) and converted to % K. Beta and gamma dose rates (Gy/ka) were calculated using the conversion factors of Liritzis et al. (2013) and an allowance was made for attenuation based on grain size (Brennan, 2003). An effective internal alpha dose rate of 0.03 ± 0.01 Gy/ka was assumed, based on previous measurements made on quartz from Australia (Bowler et al., 2003). The cosmic-ray dose rate was calculated following Prescott and Hutton (1994) based on the modern depth below surface. Measured water contents (expressed as the percentage of the mass of dry sediment) were used to calculate dose rate attenuation by moisture. All sample dose rates were calculated using the measured water contents ±50% to account for fluctuations during the burial history of the samples.

Dose rates and final age calculations were made using the Dose Rate and Age Calculator (DRAC; Durcan et al., 2015). Ages are reported as thousands of years (ka) before A.D. 2025 with 1σ uncertainties.

3. RESULTS

The OSL signal from the quartz grains analysed in this study is bright, decays sharply, and results in low error on regenerative and test dose measurements that comprise the dose response curve (Figure 1). This is consistent with a signal that it is dominated by the fast component, which is most desirable for dating.

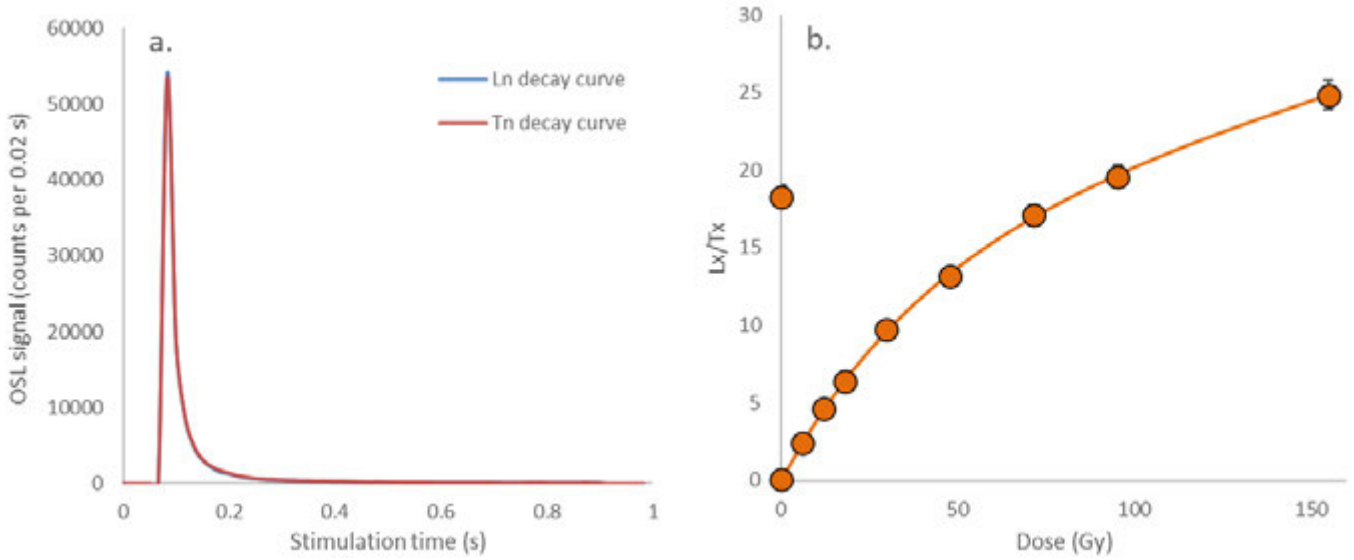


Figure 1: A typical OSL signal (a) and dose response curve (b) for a single grain of quartz from sample VCS25005-013.

Dose recovery experiments were conducted for three samples to test whether a known dose can be determined using the measurement procedure: VCS25005-01, -04, and -13. These samples were chosen based on their locations and sedimentary contexts suggesting they may have different sediment sources and, thus, different luminescence behaviours. Results show that the measured/given dose (M/G) ratios (i.e., measured dose divided by the given dose) of each sample are consistent with unity within 10%, and the M/G ratio of all grains is consistent with unity at 1σ (Table 3). This indicates that the measurement procedure can be used to accurately estimate known radiation doses for the samples in this study.

Table 3: Results of dose recovery experiments. "n" refers to the number of single-grain D_e values.

Sample	Sample Code	n	Overdispersion (%)	M/G ratio
All		149	8.6 ± 1.1	0.99 ± 0.01
VCS25005-13	HTP-HVO-26	48	4.2 ± 2.2	0.94 ± 0.01
VCS25005-04	HTP-HVO-10	57	9.8 ± 1.9	0.99 ± 0.02
VCS25005-01	HTP-HVO-49	44	6.3 ± 2.0	1.04 ± 0.02

For each sample, D_e values were measured for 500 individual grains of quartz. Samples were measured at the single-grain level to eliminate those with unsuitable OSL properties and to identify evidence of post-depositional sediment mixing or partial bleaching prior to age calculation. Grains with unsuitable OSL characteristics were identified and then discarded from the data set using a set of standard and tested criteria. For each sample, the number of grains measured, excluded according to specific criteria, and retained for D_e calculation are reported in Appendix A.

Dose rates, D_e values, and age data for the main depositional D_e components are shown in Table 4. D_e distributions plotted as abanico plots and D_e and age data for all components are shown in the Discussion. A full table of dose rate data for all samples is shown in Appendix A.

Table 4: D_e and age data for the main depositional D_e component from each sample.

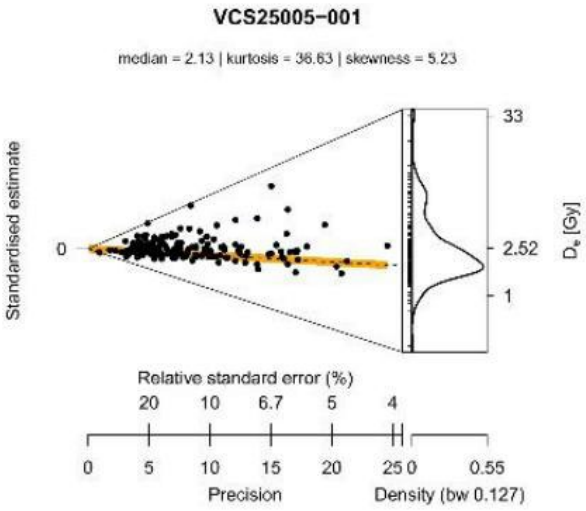
Laboratory Sample Number	Sample Code	Grain Size (µm)	Dose Rate (Gy/ka)	CAM OD (%)	Age Model	D_e (Gy)	Age (ka)
VCS-25005-003	HTP-HVO-02	180-212	2.32 ± 0.11	0	CAM	0.14 ± 0.00	0.06 ± 0.01
VCS-25005-002	HTP-HVO-04	180-212	2.66 ± 0.12	0	CAM	0.17 ± 0.00	0.07 ± 0.01
VCS-25005-006	HTP-HVO-06	180-212	2.44 ± 0.11	62	MAM	0.56 ± 0.02	0.23 ± 0.01
VCS-25005-005	HTP-HVO-07	180-212	2.43 ± 0.11	85	FMM3	3.27 ± 0.20	1.35 ± 0.10
VCS-25005-007	HTP-HVO-08	180-212	3.01 ± 0.14	71	FMM4	8.00 ± 0.40	2.41 ± 0.17
VCS-25005-008	HTP-HVO-09	180-212	2.98 ± 0.14	55	FMM2	6.68 ± 0.18	2.24 ± 0.12
VCS-25005-004	HTP-HVO-10	180-212	3.59 ± 0.18	53	FMM2	8.73 ± 0.34	2.43 ± 0.15
VCS-25005-009	HTP-HVO-16	90-180	2.25 ± 0.11	63	FMM3	5.08 ± 0.17	2.26 ± 0.13
VCS-25005-010	HTP-HVO-20	180-212	1.37 ± 0.06	60	MAM	1.17 ± 0.04	0.85 ± 0.05
VCS-25005-011	HTP-HVO-22	180-212	1.28 ± 0.06	97	FMM3	56.06 ± 2.10	43.67 ± 2.52
VCS-25005-012	HTP-HVO-24	180-212	1.27 ± 0.06	30	CAM	59.87 ± 1.81	47.28 ± 2.56
VCS-25005-013	HTP-HVO-26	180-212	1.38 ± 0.06	27	CAM	72.18 ± 2.14	52.21 ± 2.78
VCS-25005-014	HTP-HVO-33	180-212	1.38 ± 0.06	104	MAM	0.77 ± 0.02	0.56 ± 0.03
VCS-25005-015	HTP-HVO-35	180-212	1.28 ± 0.06	113	FMM4	61.18 ± 2.09	48.00 ± 2.65
VCS-25005-016	HTP-HVO-36	180-212	1.25 ± 0.06	25	CAM	66.40 ± 1.88	52.95 ± 2.78
VCS-25005-017	HTP-HVO-37	180-212	1.23 ± 0.06	29	CAM	61.42 ± 1.85	49.86 ± 2.69
VCS-25005-018	HTP-HVO-38	180-212	1.21 ± 0.06	25	CAM	68.17 ± 1.78	56.20 ± 2.93
VCS-25005-019	HTP-HVO-40	180-212	1.11 ± 0.05	102	MAM	0.80 ± 0.03	0.72 ± 0.04
VCS-25005-020	HTP-HVO-43	180-212	1.20 ± 0.05	78	FMM2	46.88 ± 2.54	39.09 ± 2.70
VCS-25005-021	HTP-HVO-46	180-212	1.34 ± 0.06	61	FMM2	96.09 ± 6.15	71.80 ± 5.58
VCS-25005-001	HTP-HVO-49	90-180	2.39 ± 0.11	62	MAM	1.79 ± 0.07	0.75 ± 0.04

4. DISCUSSION

In this section, D_e and age data are shown for each site. In each table, depositional ages are shown in bold. Single-grain D_e distributions for each sample are shown as abanico plots (see Appendix B for a guide to interpreting abanico plots). The interpreted depositional component of each sample is shown in the abanico plot as an orange dispersion bar. Minor components identified using the FMM are shown using grey dispersion bars.

4.1. 144-2





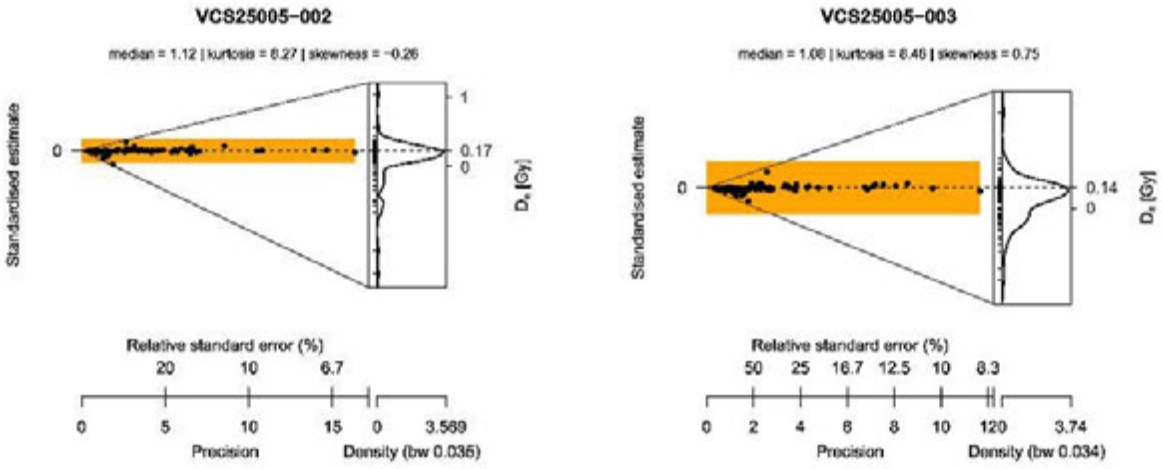
Laboratory Sample Number	Sample Code	Depth (cm)	Age Model	OD (%)	Age (ka)
VCS-25005-001	HTP-HVO-49	98	MAM	20	**0.75 ± 0.04**

Site 144-2 is described as a floodplain and the stratigraphy is described as floodplain clays.

Sample VCS-25005-001 (98 cm) yields a single-grain MAM age of 0.75 ± 0.04 ka. The D_e distribution is positively skewed and, given the geomorphic setting, is best described by the MAM. This interpretation is consistent with partial bleaching of grains during turbid flood transport and deposition in a floodplain. We therefore interpret this MAM age as the depositional age of the sampled horizon.

4.2. 141-20





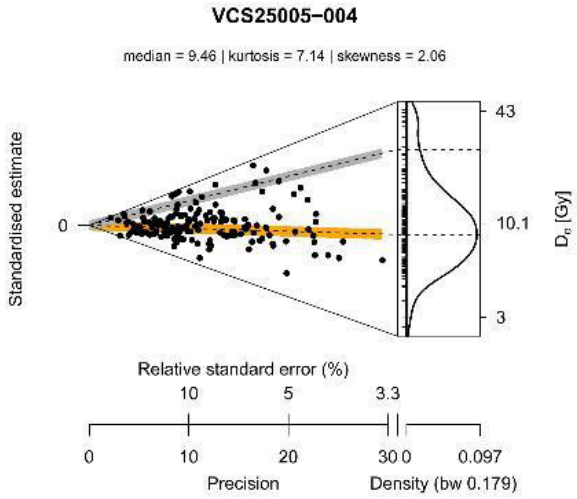
Laboratory sample number	Sample Code	Depth (cm)	Age Model	OD (%)	Age (ka)
VCS-25005-003	HTP-HVO-02	20	CAM	0	**0.06 ± 0.01**
VCS-25005-002	HTP-HVO-04	40	CAM	0	**0.07 ± 0.01**

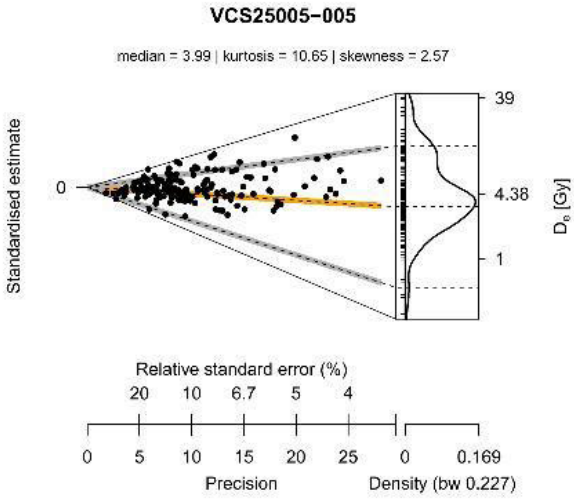
Site 141-20 is described as located on floodplain near the junction of Wollombi Brook and Hunter River. The site is currently used for pasture. The stratigraphy is described as sandy soils coming onto sandstone.

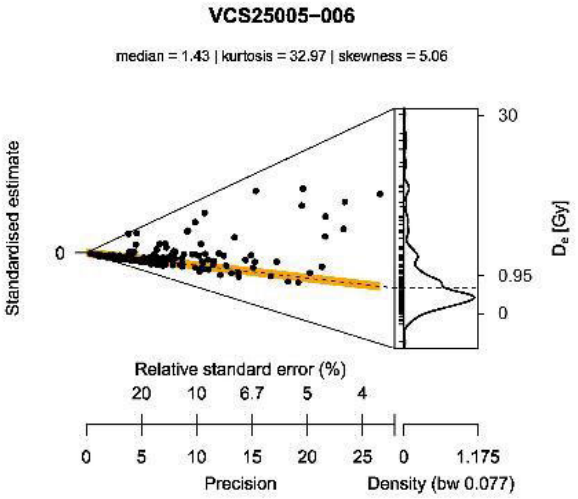
Samples VCS-25005-003 and VCS-25005-002 (20 and 40 cm) yield CAM ages of 0.06 ± 0.01 ka and 0.07 ± 0.01 ka, respectively. The single-grain D_e distributions are tightly clustered with many grains indistinguishable from zero and negligible overdispersion, indicating complete bleaching and very recent floodplain deposition or surface reworking within the last century.

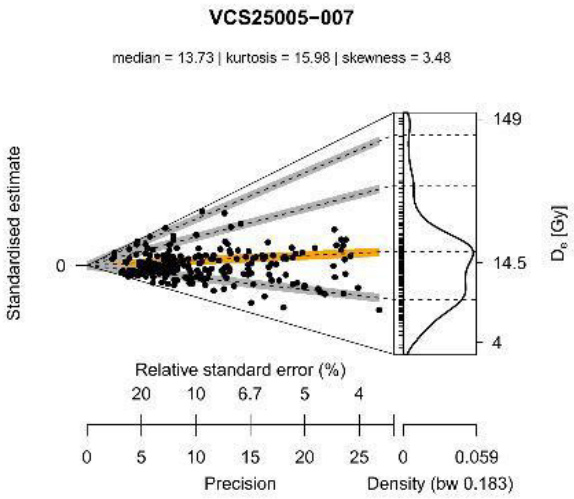
4.3. 141-15

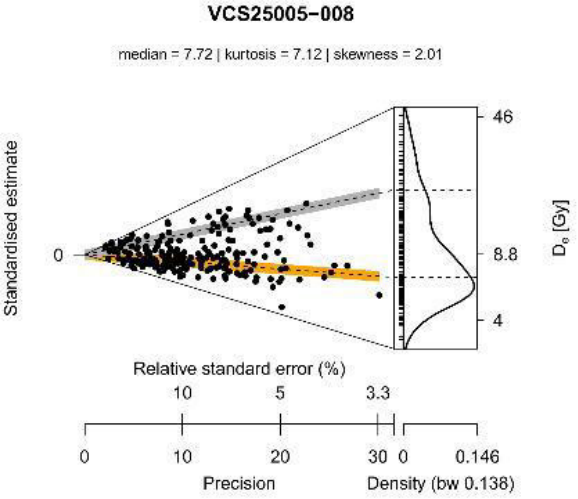



VCS25005–004
median = 9.46 | kurtosis = 7.14 | skewness = 2.06
Standardised estimate
0
43
10.1
3
D_e [Gy]
Relative standard error (%)
10
5
3.3
0
10
20
30
0
0.097
Precision
Density (bw 0.179)


VCS25005–005
median = 3.99 | kurtosis = 10.65 | skewness = 2.57
Standardised estimate
0
39
4.38
1
D_e [Gy]
Relative standard error (%)
20
10
6.7
5
4
0
5
10
15
20
25
0
0.169
Precision
Density (bw 0.227)


VCS25005–006
median = 1.43 | kurtosis = 32.97 | skewness = 5.06
Standardised estimate
0
30
0.95
0
D_e [Gy]
Relative standard error (%)
20
10
6.7
5
4
0
5
10
15
20
25
0
1.175
Precision
Density (bw 0.077)


VCS25005–007
median = 13.73 | kurtosis = 15.98 | skewness = 3.48
Standardised estimate
0
149
14.5
4
D_e [Gy]
Relative standard error (%)
20
10
6.7
5
4
0
5
10
15
20
25
0
0.059
Precision
Density (bw 0.183)


VCS25005–008
median = 7.72 | kurtosis = 7.12 | skewness = 2.01
Standardised estimate
0
46
8.8
4
D_e [Gy]
Relative standard error (%)
10
5
3.3
0
10
20
30
0
0.146
Precision
Density (bw 0.138)

Laboratory Sample Number	Sample Code	Depth (cm)	Age Model	OD (%)	k*	Age (ka)
VCS-25005-006	HTP-HVO-06	5	MAM	20		**0.23 ± 0.01**
VCS-25005-005	HTP-HVO-07	20	FMM3	48	0.72	**1.35 ± 0.10**
					0.25	*4.88 ± 0.57*
					0.03	*0.20 ± 0.06*
VCS-25005-007	HTP-HVO-08	30	FMM4	28	0.48	5.82 ± 0.40
					0.42	***2.41 ± 0.17***
					0.06	*15.38 ± 2.84*
					0.04	*34.92 ± 5.91*
VCS-25005-008	HTP-HVO-09	45	FMM2	28	0.74	**2.24 ± 0.12**
					0.26	*5.82 ± 0.41*
VCS-25005-004	HTP-HVO-10	55	FMM2	37	0.86	**2.43 ± 0.15**
					0.14	*6.54 ± 0.94*

*k is the proportion of D_e values that belong to a given FMM component.

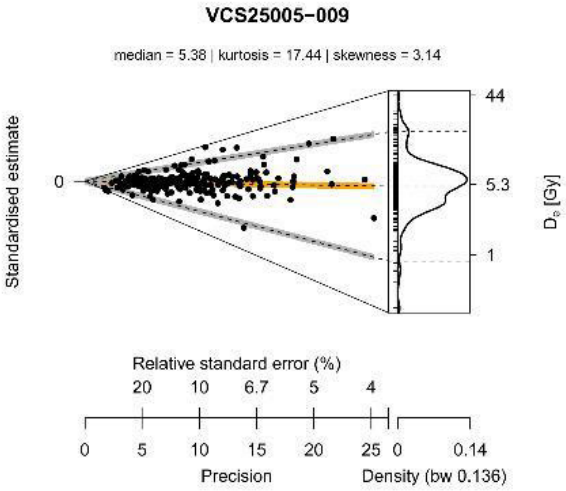
Site 141-15 is described as located on an elevated hillslope landform overlooking the confluence of Wollombi Brook and the Hunter River. Modern disturbance was noted, with some historical material (glass) being recovered at a depth of 30 cm. The stratigraphic evidence for post-depositional mixing is supported by the OSL D_e distributions.

The upper sample (VCS-25005-006) is best fit by the MAM and shows evidence for partial bleaching. Given the D_e distribution and the depth below surface, it is likely that the MAM age reflects modern mixing processes, rather than deposition of sediments. The remaining samples are best fit by the FMM and exhibit broad KDE peaks in the KDE portion of the abanico plots, suggesting that their D_e distributions have been affected by post-depositional mixing processes. VCS-25005-005 was best fit by a 3 component FMM, with a dominant component at 1.35 ka and mixed components at 4.8 and 0.2 ka. The remaining three samples (VCS-25005-007, -008, and -004) are best fit by FMMs with consistent components; one at 2.2-2.4 ka and the other at 5.8-6.5 ka. Two older components represent a combined total of 10% of sample VCS-25005-007's D_e distribution.

The single-grain FMM ages present evidence for two Holocene depositional events at ~2.3 ka and ~5.8–6.5 ka. These FMM age components occur across the 20–55 cm depth interval but with varying proportions, which we attribute primarily to post-depositional mixing (bioturbation and hillslope reworking) and localised lensing due to colluvial processes. The persistence of substantial ~2.3 ka and ~5–6 ka components in multiple samples argues for at least two depositional pulses preserved in the profile, subsequently modified by redistribution of younger and older material. The presence of multiple older D_e tails (15–35 ka) also points to a complex supply and reworking history rather than a single clean depositional event.

4.4. 134-9





Laboratory Sample Number	Sample Code	Depth (cm)	Age Model	OD (%)	k*	Age (ka)		
VCS-25005-009	HTP-HVO-16	22	FMM3	39	0.88	**2.26**	±	**0.13**
					0.08	*7.45*	±	*1.01*
					0.04	*0.35*	±	*0.08*

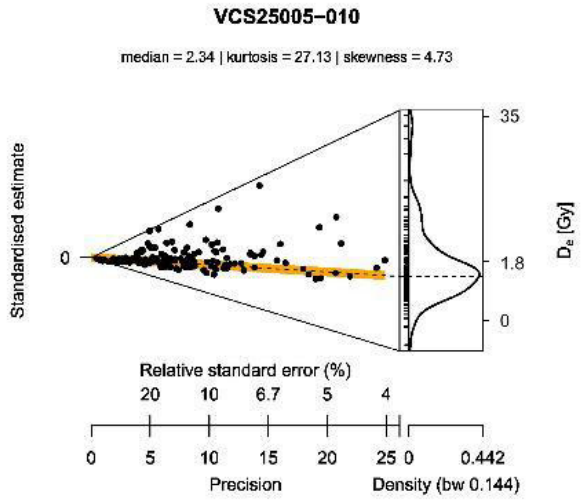
*k is the proportion of D_e values that belong to a given FMM component.

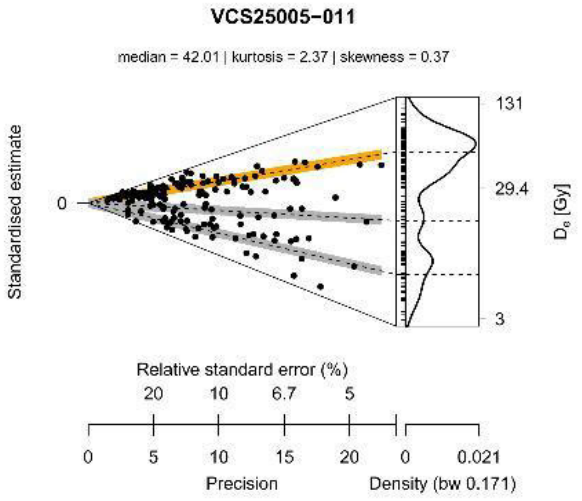
Site 134-9 is described as located on a gentle to moderate hillslope in a pasture. The stratigraphy is described as three sedimentary units, as shown in the stratigraphic photo. The sample was taken from a grey, silty sand between the topsoil and the underlying clay.

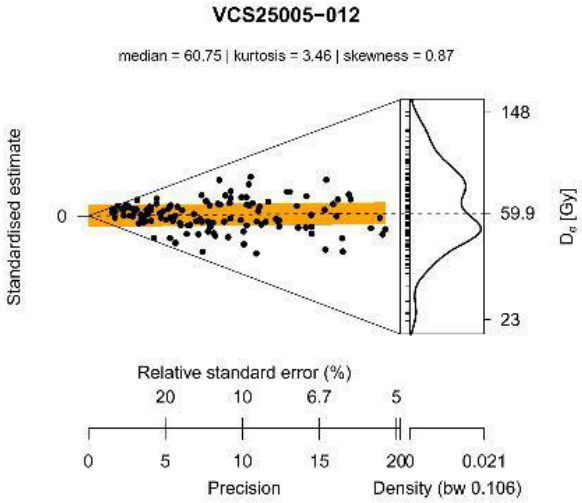
Sample VCS-25005-009 (22 cm) is best fit by a three-component FMM where the dominant component (88%) yields an age of 2.26 ± 0.13 ka, interpreted as the depositional age of the grey silty sand horizon. Minor components at 7.45 ± 1.01 ka (8%) and 0.35 ± 0.08 ka (4%) likely reflect reworked/inherited older grains and recent surface mixing (due to pastoral disturbance and bioturbation), respectively. Despite a high OD (39%) indicating a mixed grain population, the strong dominance of the ~2.3 ka component supports its use as the primary chronostratigraphic marker for this unit.

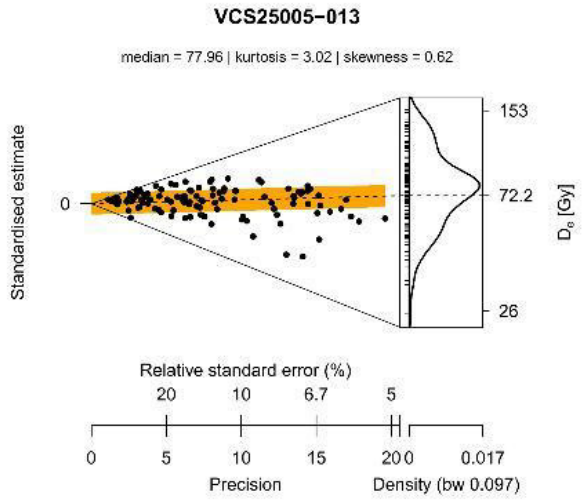
4.5. 158-10




VCS25005-010
median = 2.34 | kurtosis = 27.13 | skewness = 4.73
Standardised estimate
0
35
1.8
0
D_e [Gy]
Relative standard error (%)
20 10 6.7 5 4
0 5 10 15 20 25
Precision
0 0.442
Density (bw 0.144)


VCS25005-011
median = 42.01 | kurtosis = 2.37 | skewness = 0.37
Standardised estimate
0
131
29.4
3
D_e [Gy]
Relative standard error (%)
20 10 6.7 5
0 5 10 15 20
Precision
0 0.021
Density (bw 0.171)


VCS25005-012
median = 60.75 | kurtosis = 3.46 | skewness = 0.87
Standardised estimate
0
148
59.9
23
D_e [Gy]
Relative standard error (%)
20 10 6.7 5
0 5 10 15 20
Precision
0 0.021
Density (bw 0.106)


VCS25005-013
median = 77.96 | kurtosis = 3.02 | skewness = 0.62
Standardised estimate
0
153
72.2
26
D_e [Gy]
Relative standard error (%)
20 10 6.7 5
0 5 10 15 20
Precision
0 0.017
Density (bw 0.097)

Laboratory Sample Number	Sample Code	Depth (cm)	Age Model	OD (%)	k*	Age (ka)		
VCS-25005-010	HTP-HVO-20	20	MAM	20		**0.85**	±	**0.05**
VCS-25005-011	HTP-HVO-22	60	FMM3	31	0.64	**43.67**	±	**2.52**
					0.23	*4.69*	±	*0.38*
					0.13	*12.06*	±	*1.73*
VCS-25005-012	HTP-HVO-24	102	CAM	30		**47.28**	±	**2.56**
VCS-25005-013	HTP-HVO-26	146	CAM	27		**52.21**	±	**2.78**

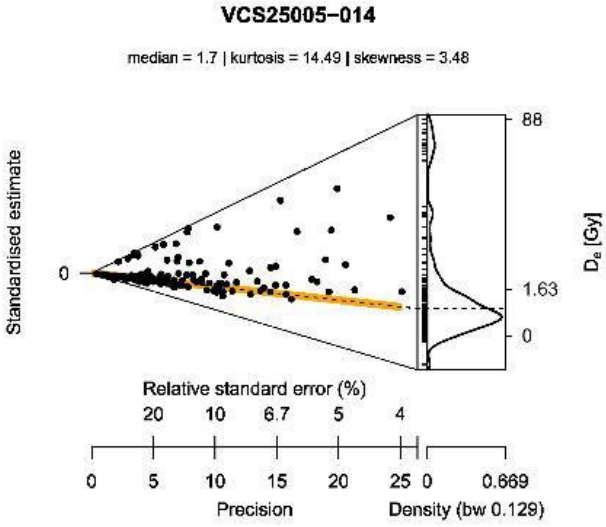
*k is the proportion of D_e values that belong to a given FMM component.

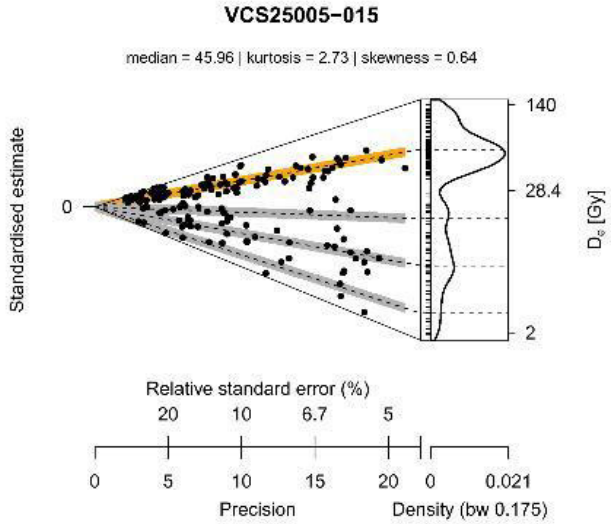
Site 158-10 is described as located on a source bordering dune adjacent to Hunter River. The stratigraphy is described as sand with clays lenses.

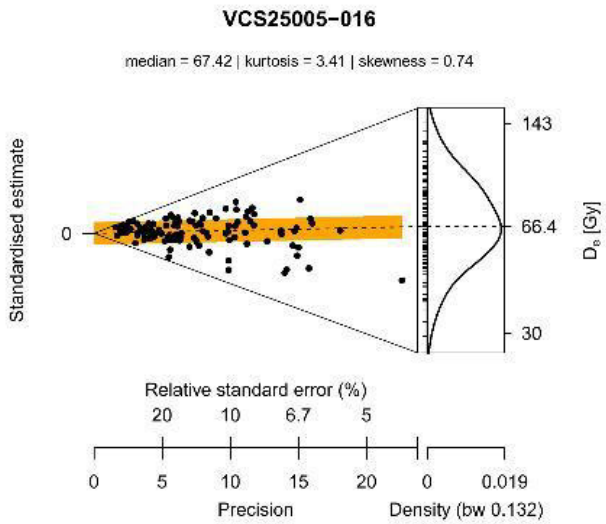
The upper sample (VCS-25005-010) is best fit by the MAM. Given its shallow depth below surface, it is likely that the 0.85 ka MAM age represents recent mixing processes. Sample VCS-25005-011, at 60 cmbs, is best fit by a three component FMM. The most populous component (64%) is 43.7 ka and is statistically consistent with the dune formation age (see below). The two younger, minor components likely represent phases of enhanced mixing at the site and could derive from later surface inputs (aeolian reworking, slope-wash) or downward movement of young grains via bioturbation, root action, burrows, or modern soil mixing events. The deepest two samples (VCS-25005-12 and -013) are best fit by the CAM with low overdispersion values, suggesting that they represent well-bleached primary dune deposits that are not affected by post-depositional mixing. These samples yield ages of 47.3 ka and 52.2 ka that are consistent at 2σ. Together, these data suggest dune formation 49.7±1.9 ka (weighted mean of deepest two samples), with the upper 60 cm retaining the signal of dune deposition, but having been overprinted by Holocene post-depositional mixing.

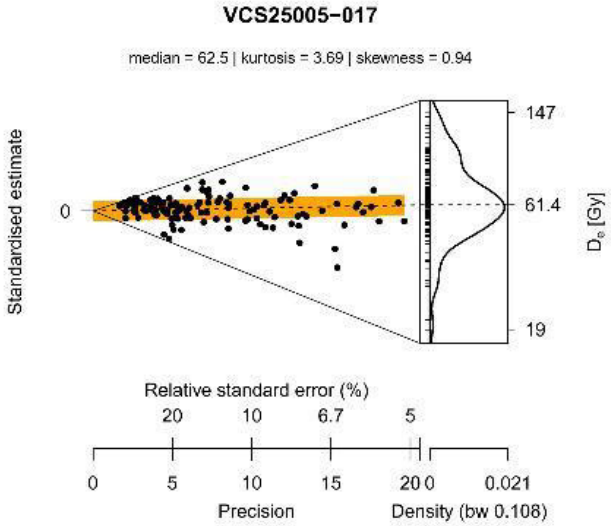
4.6. 158-9

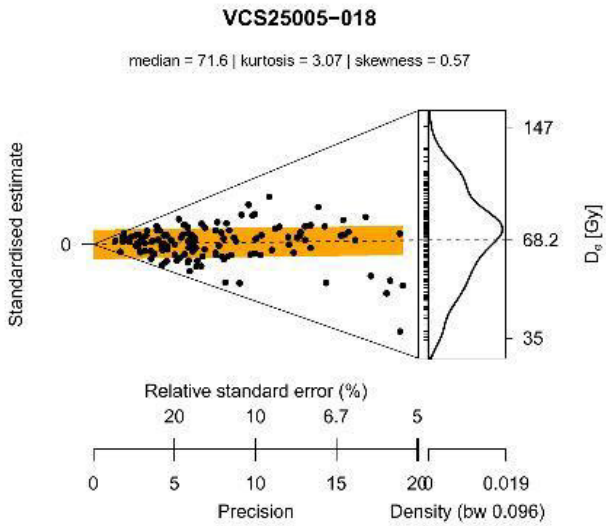



VCS25005-014
median = 1.7 | kurtosis = 14.49 | skewness = 3.48
Standardised estimate
0
88
1.63
0
D_e [Gy]
Relative standard error (%)
20 10 6.7 5 4
0 5 10 15 20 25
Precision
0 0.669
Density (bw 0.129)


VCS25005-015
median = 45.96 | kurtosis = 2.73 | skewness = 0.64
Standardised estimate
0
140
28.4
2
D_e [Gy]
Relative standard error (%)
20 10 6.7 5
0 5 10 15 20
Precision
0 0.021
Density (bw 0.175)


VCS25005-016
median = 67.42 | kurtosis = 3.41 | skewness = 0.74
Standardised estimate
0
143
66.4
30
D_e [Gy]
Relative standard error (%)
20 10 6.7 5
0 5 10 15 20
Precision
0 0.019
Density (bw 0.132)


VCS25005-017
median = 62.5 | kurtosis = 3.69 | skewness = 0.94
Standardised estimate
0
147
61.4
19
D_e [Gy]
Relative standard error (%)
20 10 6.7 5
0 5 10 15 20
Precision
0 0.021
Density (bw 0.108)


VCS25005-018
median = 71.6 | kurtosis = 3.07 | skewness = 0.57
Standardised estimate
0
147
68.2
35
D_e [Gy]
Relative standard error (%)
20 10 6.7 5
0 5 10 15 20
Precision
0 0.019
Density (bw 0.096)

Laboratory Sample Number	Sample Code	Depth (cm)	Age Model	OD (%)	k*	Age (ka)		
VCS-25005-014	HTP-HVO-33	15	MAM	20		**0.56**	±	**0.03**
VCS-25005-015	HTP-HVO-35	55	FMM4	28	0.62	**48.00**	±	**2.65**
					0.18	*5.04*	±	*0.58*
					0.12	*12.10*	±	*1.55*
					0.08	*2.07*	±	*0.30*
VCS-25005-016	HTP-HVO-36	77	CAM	25		**52.95**	±	**2.78**
VCS-25005-017	HTP-HVO-37	95	CAM	29		**49.86**	±	**2.69**
VCS-25005-018	HTP-HVO-38	108	CAM	25		**56.20**	±	**2.93**

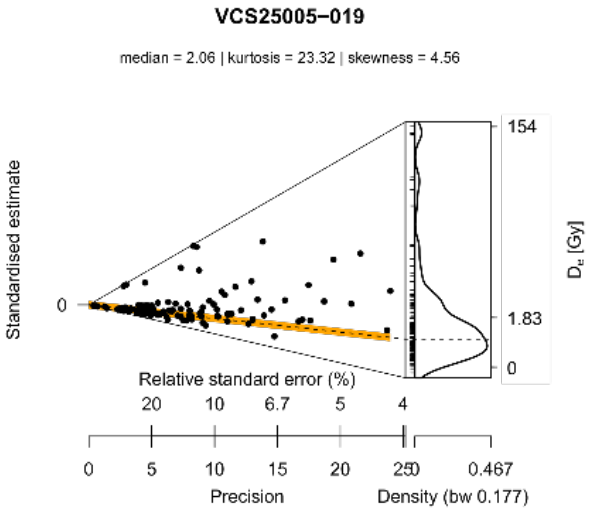
*k is the proportion of D_e values that belong to a given FMM component.

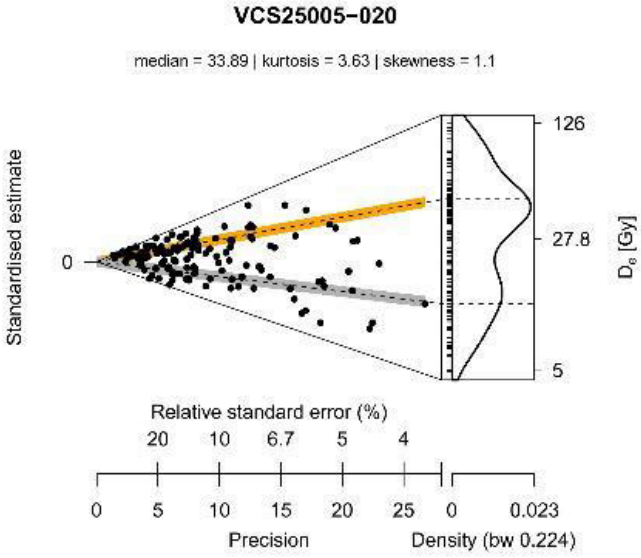
Site 158-9 is described as located on a source bordering dune adjacent to Hunter River. The stratigraphy is described as sand with clays lenses.

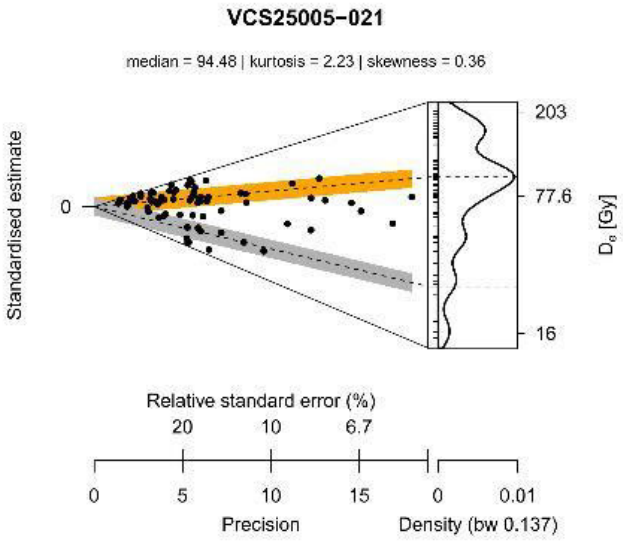
The upper sample (VCS-25005-014) is best fit by the MAM. Given its shallow depth below surface, it is likely that the 0.56 ka MAM age represents recent mixing processes. Sample VCS-25005-015, at 55 cmbs, is best fit by a four component FMM with a clear dominant component. The most populous component (62%) is 48.0 ka and likely reflects deposition. The three younger, minor components likely represent phases of enhanced mixing at the site. The deepest three samples (VCS-25005-016, -017, and -018) are best fit by the CAM with low overdispersion values, suggesting that they are not affected by post-depositional mixing. These samples yield ages of between 50.0 and 56.2 ka that are consistent at 2σ. Together, these data suggest dune formation 52.8±1.6 ka (weighted mean of deepest three samples), with the upper 55 cm having been affected by Holocene post-depositional mixing.

4.7. 156-12









Laboratory Sample Number	Sample Code	Depth (cm)	Age Model	OD (%)	k*	Age (ka)		
VCS-25005-019	HTP-HVO-40	25	MAM	20		**0.72**	±	**0.04**
VCS-25005-020	HTP-HVO-43	85	FMM2	39	0.62	**39.09**	±	**2.70**
					0.38	*9.24*	±	*0.75*
VCS-25005-021	HTP-HVO-46	150	FMM2	35	0.83	**71.80**	±	**5.58**
					0.18	*18.73*	±	*3.05*

*k is the proportion of D_e values that belong to a given FMM component.

Site 158-12 is described as located on a source bordering dune adjacent to Hunter River. The stratigraphy is described as sand with clays lenses.

The upper sample (VCS-25005-019) is best fit by the MAM. Given its shallow depth below surface, it is likely that the 0.72 ka MAM age represents recent mixing processes. The deepest two samples (VCS-25005-020 and -021) are best fit by a two component FMM, and both have a dominant and minor component. Sample VCS-25005-020 has a dominant component of 39.1 ka and a minor component of 9.2 ka. Sample VCS-25005-021 has a dominant component of 71.8 ka and a minor component of 18.7 ka. The shape of the D_e distributions and the best-fit FMM suggest that both lower samples had been affected by post-depositional mixing in the past. The broad distribution of VCS-25005-020 suggests a potentially long duration of mixing or deeper mixing through a thicker unit.

Combined, the single-grain D_e distributions indicate a basal dune component at ~71.8 ± 5.6 ka (dominant at 150 cm) overlain by a younger dune component at ~39.1 ± 2.7 ka (dominant at 85 cm). Both intervals contain minor younger admixtures (~9–19 ka), and the surface yields a modern MAM age (~0.72 ka), consistent with recent disturbance. The pattern most parsimoniously reflects at least two episodes of dune accumulation/activation (c. 72 ka and c. 39 ka) with subsequent partial reworking and post-depositional mixing.

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APPENDIX A

Table A1: Full dose rate data for all samples.

Laboratory Sample Number	Sample Code	Water content (%)	U (ppm)	Th (ppm)	K (%)	Rb (ppm)	Beta Dose Rate (Gy/ka)	Gamma Dose Rate (Gy/ka)	Cosmic Dose Rate (Gy/ka)	Total Dose Rate (Gy/ka)[a]
VCS-25005-003	HTP-HVO-02	1.3	1.68	6.61	1.22	61.90	1.26 ± 0.09	0.79 ± 0.05	0.24 ± 0.02	2.32 ± 0.11
VCS-25005-002	HTP-HVO-04	2.4	2.09	7.56	1.39	73.50	1.46 ± 0.11	0.95 ± 0.06	0.22 ± 0.02	2.66 ± 0.12
VCS-25005-006	HTP-HVO-06	2.7	2.07	8.37	1.26	67.70	1.38 ± 0.10	0.75 ± 0.05	0.28 ± 0.03	2.44 ± 0.11
VCS-25005-005	HTP-HVO-07	2.7	1.90	8.65	1.15	52.40	1.28 ± 0.09	0.89 ± 0.05	0.24 ± 0.02	2.43 ± 0.11
VCS-25005-007	HTP-HVO-08	2.7	2.21	10.15	1.53	100.00	1.63 ± 0.12	1.12 ± 0.07	0.23 ± 0.02	3.01 ± 0.14
VCS-25005-008	HTP-HVO-09	2.0	2.22	10.90	1.46	90.10	1.60 ± 0.12	1.14 ± 0.07	0.22 ± 0.02	2.98 ± 0.14
VCS-25005-004	HTP-HVO-10	2.8	2.43	10.60	2.05	131.50	2.06 ± 0.16	1.29 ± 0.08	0.21 ± 0.02	3.59 ± 0.18
VCS-25005-009	HTP-HVO-16	2.3	1.58	5.95	1.18	52.10	1.24 ± 0.10	0.74 ± 0.04	0.24 ± 0.02	2.25 ± 0.11
VCS-25005-010	HTP-HVO-20	1.9	1.08	3.76	0.60	27.90	0.66 ± 0.05	0.44 ± 0.03	0.24 ± 0.02	1.37 ± 0.06
VCS-25005-011	HTP-HVO-22	2.0	0.96	3.65	0.57	26.40	0.62 ± 0.05	0.43 ± 0.03	0.20 ± 0.02	1.28 ± 0.06
VCS-25005-012	HTP-HVO-24	1.7	0.96	3.30	0.60	29.40	0.64 ± 0.05	0.42 ± 0.02	0.19 ± 0.02	1.27 ± 0.06
VCS-25005-013	HTP-HVO-26	2.0	1.04	4.25	0.64	30.10	0.70 ± 0.05	0.48 ± 0.03	0.18 ± 0.02	1.38 ± 0.06
VCS-25005-014	HTP-HVO-33	1.7	1.10	4.09	0.58	28.80	0.66 ± 0.05	0.44 ± 0.03	0.25 ± 0.03	1.38 ± 0.06
VCS-25005-015	HTP-HVO-35	1.7	0.93	3.92	0.55	25.40	0.61 ± 0.04	0.43 ± 0.03	0.21 ± 0.02	1.28 ± 0.06
VCS-25005-016	HTP-HVO-36	1.8	0.94	3.45	0.57	26.80	0.62 ± 0.05	0.41 ± 0.02	0.19 ± 0.02	1.25 ± 0.06
VCS-25005-017	HTP-HVO-37	1.7	0.92	3.28	0.57	26.70	0.61 ± 0.05	0.40 ± 0.02	0.19 ± 0.02	1.23 ± 0.06
VCS-25005-018	HTP-HVO-38	1.8	0.78	3.52	0.57	27.10	0.60 ± 0.04	0.40 ± 0.02	0.18 ± 0.02	1.21 ± 0.06
VCS-25005-019	HTP-HVO-40	2.0	0.82	3.02	0.45	23.10	0.50 ± 0.04	0.34 ± 0.02	0.24 ± 0.02	1.11 ± 0.05
VCS-25005-020	HTP-HVO-43	2.0	0.93	3.81	0.50	26.60	0.57 ± 0.04	0.41 ± 0.03	0.19 ± 0.02	1.20 ± 0.05
VCS-25005-021	HTP-HVO-46	2.3	1.08	3.84	0.61	32.80	0.68 ± 0.05	0.46 ± 0.03	0.18 ± 0.02	1.34 ± 0.06
VCS-25005-001	HTP-HVO-49	2.0	1.98	7.49	1.15	56.40	1.31 ± 0.10	0.87 ± 0.05	0.19 ± 0.02	2.39 ± 0.11

[a] Includes a small internal alpha dose rate of 0.03 ± 0.01 Gy/ka.

Table A2: The number of single grains measured, rejected and included in the calculation of the final D_e estimate and overdispersion value for each sample.

Laboratory Sample Number	Sample Code	Number of Grains Measured	Dim OSL Signal[a]	Recycling Ratio[b]	Recuper-ation[c]	OSL-IR Depletion Ratio[d]	Poor Dose Response Curve Fit[e]	Saturated or Class-3 Grains[f]	Total Rejected Grains	Total Accepted Grains[g]
VCS-25005-003	HTP-HVO-02	500	354	12	1	5	28	0	400	100
VCS-25005-002	HTP-HVO-04	500	357	6	3	12	19	0	397	103
VCS-25005-006	HTP-HVO-06	500	247	22	3	9	22	1	304	196
VCS-25005-005	HTP-HVO-07	500	253	16	7	10	29	9	324	176
VCS-25005-007	HTP-HVO-08	500	216	19	5	13	24	12	289	211
VCS-25005-008	HTP-HVO-09	500	193	11	4	12	31	22	273	227
VCS-25005-004	HTP-HVO-10	500	222	14	7	16	30	43	332	168
VCS-25005-009	HTP-HVO-16	500	162	33	1	27	32	2	257	243
VCS-25005-010	HTP-HVO-20	500	267	23	3	12	27	10	342	158
VCS-25005-011	HTP-HVO-22	500	266	12	12	6	27	3	326	174
VCS-25005-012	HTP-HVO-24	500	293	12	4	14	35	7	365	135
VCS-25005-013	HTP-HVO-26	500	277	22	6	20	37	18	380	120
VCS-25005-014	HTP-HVO-33	500	261	11	6	12	24	1	315	185
VCS-25005-015	HTP-HVO-35	500	265	21	6	12	29	9	342	158
VCS-25005-016	HTP-HVO-36	500	306	9	4	4	46	10	379	121
VCS-25005-017	HTP-HVO-37	500	296	10	6	15	27	13	367	133
VCS-25005-018	HTP-HVO-38	500	298	12	4	9	23	14	360	140
VCS-25005-019	HTP-HVO-40	400	256	5	4	4	10	0	279	121
VCS-25005-020	HTP-HVO-43	500	274	18	5	14	28	7	346	154
VCS-25005-021	HTP-HVO-46	500	321	19	5	15	34	28	422	78
VCS-25005-001	HTP-HVO-49	500	215	23	1	18	60	2	319	181

[a] Tn signal 3σ below background, the ratio of Tn signal to background is <3, or the relative standard error (RSE) of Tn exceeds 20%.

[b] The ratio of Lx/Tx for repeated regenerative doses differs significantly from unity at 2σ.

[c] The ratio of Lx/Tx for the 0-Gy and maximum regenerative doses is greater than 5%.

[d] The OSL-IR depletion ratio (the ratio of Lx/Tx for a post-IR regenerative dose measurement and an identical regenerative dose measurement without IR stimulation) is 2σ below unity.

[e] Figure-of-merit value >10% or reduced chi-squared (RCS) value >5.

[f] Ln/Tn projects onto the saturated portion of the dose response curve or above the dose response curve.

[g] Total number of grains used for D_e analysis.

APPENDIX B

The abanico plot is designed to display several key aspects of single-grain luminescence data in one figure: the individual D_e estimates, their relative uncertainties and precision, and the overall shape and modality of the D_e distribution (Dietze et al., 2016). It builds on the familiar radial plot commonly used in luminescence dating (Vermeesch, 2009) by combining it with a univariate representation of the distribution—typically a kernel density estimate (KDE) or histogram.

An abanico plot has two integrated components (Fig. A1):

- the bivariate section (left panel), which plots each grain's standardised D_e estimate against its precision, allowing both the spread and the measurement uncertainties to be visualised; and
- the univariate section (right panel) displays the D_e distribution as a frequency-based plot such as a KDE.

Both panels share a common z-axis, shown as a straight vertical scale, with gridlines or isochrons radiating from the standardised estimate of 0 the bivariate plot. This axis represents the D_e (or age) scale and links the two parts of the figure. In traditional radial plots the same scale is shown as an arc on the right-hand side, but the abanico layout straightens it to align with the frequency distribution below.

Each measured grain, indexed $i = 1...n$, is plotted as a point defined by its D_e value (z_i) and associated standard error (σ_i). If a log transformation is applied, the D_e is represented as $\ln(D_e)$ and the standard error is that of the log-transformed value.

Additional visual elements help summarise the data:

- a scatter polygon often highlights the interquartile range of the univariate distribution and the corresponding isochrons in the bivariate section; and
- a dispersion bar indicates the range of values that are statistically indistinguishable at a specified confidence level. Grains falling within this bar agree with the reference value within their analytical uncertainties.

It is important to note that the scatter polygon describes the distributional shape (e.g. where most data lie), while the dispersion bar reflects statistical equivalence; the two do not necessarily overlap.

The KDE curve provides a smoothed, non-parametric estimate of the probability density function for the sample's D_e values (Galbraith & Roberts, 2012). It is created by replacing each measured D_e value with a Gaussian kernel centred on that value and of width proportional to its standard deviation; the sum of these kernels reveals the underlying distribution when the dataset is sufficiently large.

Together, these components allow the viewer to assess the population structure of the sample, identify skewness or multimodality, and evaluate whether grains form a single consistent population or include outliers and mixed-age components.

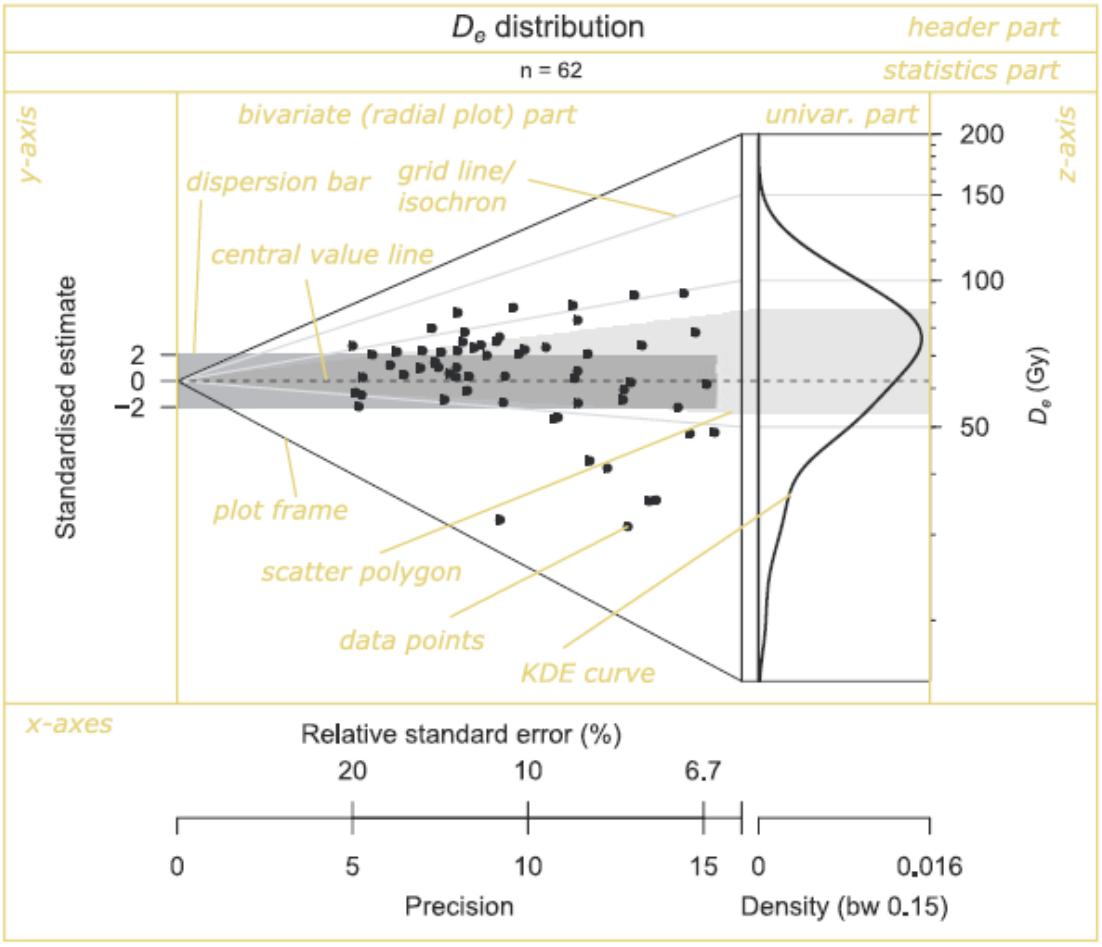


Figure A1. The abanico plot with example data provided by the R package "Lumiescence" (ExampleData.DeValues$CA1) reproduced from Dietze et al. (2016). D_e values are from single-grain (200-250 µm) quartz measurements performed on a Risoe TL/OSL DA-20 reader at the University of Cologne. The plot consists of two parts: a bivariate plot (a radial plot) on the left side and a univariate plot (such as a kernel density estimate) on the right side. D_e values are shown on a log-scale. For further details on plot construction, see Deitze et al. (2016).

APPENDIX B REFERENCES

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VICUS

C.2.6 Lithics report

ARTEFACT ANALYSIS OF HTP-WARKWORTH

HUNTER VALLEY OPERATIONS

Dr Trudy Doelman

Introduction

The analysis of the Hunter Transmission Project (HTP) transmission line at Warkworth follows a series of research questions which can broadly be divided into seven main categories:

1. **Site occupation/chronology**. When was the area occupied? Was the assemblage the product of repeated occupations or a single event? Do the characteristics of the excavated assemblage change with time? How intensive was the occupation? Is there evidence of a Pleistocene occupation?
2. **Lithic Source Procurement**. Which raw material resources were used? What types of raw material sources were used (primary and secondary)? Does a preference for a raw material occur? Can we infer the distance from the sources based on artefact size and the frequency and amount of cortex?
3. **Stone reduction technology**. How were cores prepared and worked? Were systematic core reduction strategies employed? The analysis will be broken down into descriptions of the:
    a. Core attributes
    b. Flake attributes
    c. Tools
4. **Site Function**. What types of activities occurred on-site/s? Do discrete areas of stone working occur? Can site function be related to environmental factors i.e. distance to sources? This analysis includes comparisons of the artefact density by location, the assemblage composition (number of cores, complete flakes, split flakes, broken flakes, tools and other artefact types e.g., grinding stone, axes, hammerstones) and frequencies of artefact types.
5. **Regional Comparisons**. How does this assemblage compare with others in the surrounding region?
6. **Spatial patterning** Data from the technological analysis allows a spatial analysis of the artefact attributes.
7. **Site Disturbance**. A further analysis was undertaken on the excavated assemblage to assess the nature and integrity of the sub-surface deposit. What post-depositional influences have impacted on the assemblage (e.g. size-sorting, burning, historical disturbance)?

Analysis Methodology

The selection of the artefact attributes addresses the above research questions. The analysis will follow those relevant to a technological and/or spatial analysis (Table 1). Comparisons will be made between landforms and by depth.

The attributes recorded for each artefact are dependent on the technological class (i.e., if a complete flake, core or tool etc). Artefacts such as cores and tool generally represent a small fraction of an assemblage but can offer the greatest amount of information. These additional attributes provide further information to examine the types of technological strategies used to prepare and reduce cores, the intensity of core reduction (curation) and can contribute to an understanding of the product/s manufactured, patterns of mobility and the transportation of artefacts (Table 1).

Artefacts were cleaned, sorted, individually analysed and entered into the software program E4 loaded with a configuration file written for this specific purpose. This program prompts the user to record all relevant attributes through a series of menus based on the artefact type (e.g. core, complete flake, complete tool etc) which is then stored in a Microsoft Access database. In this way a comprehensive typological, technological and metrical analysis of the excavated assemblage was undertaken. The location of the excavated artefacts was also recorded by spit/depth and test pit. Analysis was aided by the use of a 15x hand lens and a standard digital vernier calliper. Measurements were made in millimetres to one decimal place. Individual weights of each artefact were also recorded to two decimal places.

Attributes	
Technological class	Artefact type (e.g. core, complete flake, longitudinal split, flake fragmentation, retouch, angular fragments/lithic fragments, other (axe, grindstone etc)
Material	Raw Material type (silcrete, indurated mudstone, chert, quartz, quartzite etc)
Colour	Raw material colour
Cortex	Percentage of cortex (if on a flake – amount on the dorsal surface of a flake)
Cortex Type	Type of cortex (rough/terrestrial, water-rolled/tabular)
Platform Type	unifacial, crushing/missing, Flaked (>2 flake scars), Facetted (3 or more small, systematic flake removals), Cortical (with cortex), n/a
Termination Type	Feather, hinge, step, plunge, step, cortical, platform, abrupt
Tool Type	Select the type of tool – usewear, concave scraper, convex scraper, straight scraper, elouera (backed artefact), notched scraper, endscraper, saw, stepped scraper, drill, backed (generic), bondi point, thumbnail scraper, denticulate, burin, geometric microlith, nosed scraper
Maximum Dimension	All artefacts (in size groupings)
Length Complete Flake	Axial length of the complete flake/complete tool (in mm to 1 dp)
Weight	Weight of the artefact in grams to 1dp
Complete and Broken Flakes	
Form	Form of the flake – Indeterminate, Expanding, Block (angular Fragment), Blade, N/A, Platform Rejuvenation Flake (tablet), Bipolar, Errailure, Ridge straightening flake, elongated flake. These attributes reflect core reduction strategies.
Complete Flakes	Showing intensity of retouch or systematic core preparation
Overhang removal	Exterior platform preparation indicates systematic core reduction (complete flakes and proximal flakes)
Scar Direction	The direction of the dorsal flake scars – 1 (initiated from the platform only), 90 (initiated at right angles to the platform), 180 (initiated at the distal end of the flake), radial (initiated from 90 and 270 degrees from the platform)
Complete Tools	(examines measures of curation)
Retouch Edge	The number of retouched quadrants (on complete tools only)
Retouch Type 1, 2, 3, 4	Select the retouch type for quadrants 1, 2, 3 and 4

Cores	Identifying technological strategies and intensity of reduction
Core Type	Uni-, bi-, and multi-platform, prismatic, burin-blade core, test, bipolar, bifacial
Core Body	Core body form – block, flake, nodule, non-diagnostic
Scar Form	Primary scar form? – elongated, expanding, blade, mixed
Core Platform No.	Number of platforms on the core
Step Termination	Number of step terminations on the core
Hinge Termination	Number of hinge terminations on the core
Core scar Length	Length of the longest core scar
Core scar Width	Width of the longest core scar at maximum
Number of Core Scars	Number of core scars
Metrical Attributes	(in mm to 1 dp)
Maximum length	All artefacts
Length Complete Flake	Axial length of the complete flake/complete tool
Width	Maximum width of the complete flake/tool/core
Thickness	Maximum thickness of the complete flake/tool/core at mid-point
Core Length	Maximum length from the working platform
Platform width	Platform width – proximal and complete flakes and tools
Platform Thickness	Platform thickness – proximal and complete flakes and tools (and complete splits)
Weight (g)	Weight of the artefact in grams to 1dp

Table 1 Artefact Attributes recorded for the Lakeside assemblage

Assemblage Distribution

The archaeological assessment of the Hunter Transmission Project (HTP) at Warkworth was divided geographically into four landform units: floodplain, Terrace/Rise, Source Bordering Dune and hillcrest. A series of 180 50x 50 cm test pits were excavated from 17 locations on the four landforms (Table 2). Artefacts were recovered from 80 test pits (44.4%). Twenty test pits with >5 artefacts were expanded to 1 x1 m. A total of 563 artefacts were recovered with most found in test pits along the terraces/rises (n=335, 59.5%). The Source Bordering Dune also had a high number of artefacts (n=222, 39.4%). This area has the highest density of artefacts (7.9 per m^2). Few artefacts were found on the flood plains or hillcrests (Table 2). Several (n=31) heat shattered fragments were also found. Glass and ceramic fragments found in spits 1-6 of TP158-9 and show post-depositional disturbance.

Landform	*Associated Locations*	*Soil Description*	*No. Artefacts*	*Total Area m^2 Excavated/density*
Floodplain	143, 144, 169, 173 (n=4)	A disturbed silty topsoil (A1 horizon), overlying a silty clay loam (A2 horizon). Generally, depths of 50cm with several to 70cm and 1m, confirming that the soil profile remained unchanged at depth.	2 (0.4%)	5 (0.4)
Terrace and rise	131-136, 141, 140 (n=8)	A disturbed silty topsoil (A1 horizon), overlying a silty clay loam (A2 horizon) with a clear horizon onto indurated heavy orange/brown clay (B2 horizon). Some localised gravels in the A2 horizon (140 and 141). Average depth of 27cm	335 (59.5%)	50.2 (6.7)
Source bordering dunes	155-158 (n=4)	A disturbed loamy topsoil (A1 horizon), overlying a deep layer of loose brown sand (A2 horizon), diffusing into sandy clay and/or light clay (B2 horizon). Depths averaging 80cm and often exceeding 1m.	222 (39.4%)	28.25 (7.9)
Hillcrest	172 (n=1)	A disturbed but mostly absent topsoil (A1 horizon), overlying a very shallow clayey loam (A2 horizon), with a clear horizon onto indurated heavy orange/brown clay (B2 horizon) or bedrock (R horizon). Pits were dug to depths of 25cm with depths averaging 15cm.	4 (0.7%)	8.5 (0.5)

Table 2 Distribution of artefacts and test pits in the excavated tests pits by landform

The highest concentration of artefacts was found in TP141 (n=20, 3.6%) and TP141-15exp (n=64, 11.4%). TP141-3 also has a high artefact density (n=35, 6.2%) along with TP140-16 (n=17, 3.0%). These locations are all found on the Terraces/Rises. On the Source Bordering Dune TP158-9 (n=50, 8.9%) and TP156-6 (n=22, 3.9%) have a higher artefact density (Table 3).

Terrace/Rise	*Count*	*%*	*Source Bordering Dune*	*Count*	*%*	*Flood Plain*	*Count*	*%*	*Hillcrest*	*Count*	*%*
131-12	4	0.7	155-1	1	0.2	169-11	1	0.2	172-10	3	0.5
131-16	1	0.2	155-10	3	0.5	169-4	1	0.2	172-20	1	0.2
131-17	1	0.2	155-12	1	0.2						
131-8	1	0.2	155-14	2	0.4						
132-1	1	0.2	155-4	5	0.9						
132-9	1	0.2	155-4exp	3	0.5						
133-10	1	0.2	155-6	2	0.4						
133-11	1	0.2	155-9	1	0.2						
133-8	1	0.2	156-11	2	0.4						
134-10	1	0.2	156-12	4	0.7						
134-11	1	0.2	156-12exp	8	1.4						
134-2	1	0.2	156-13	3	0.5						
134-3	1	0.2	156-14	2	0.4						
134-5	1	0.2	156-17	4	0.7						
134-9	8	1.4	156-5	2	0.4						
134-9exp	14	2.5	156-6	22	3.9						
135-11	4	0.7	156-7	2	0.4						
135-13	1	0.2	157-10	1	0.2						
135-15	2	0.4	157-12	1	0.2						
135-19	2	0.4	157-14	1	0.2						
136-13	1	0.2	157-16	2	0.4						
136-15	3	0.5	157-4	1	0.2						
136-17	1	0.2	158-10	16	2.8						
136-19	1	0.2	158-10exp	12	2.1						
136-2	2	0.4	158-11	1	0.2						
136-5	4	0.7	158-13	2	0.4						
136-7	3	0.5	158-15	2	0.4						
140-11	3	0.5	158-15exp	16	2.8						
140-11exp	4	0.7	158-16	2	0.4						
140-16	17	3.0	158-16exp	31	5.5						
140-16exp	8	1.4	158-17	4	0.7						
140-17	4	0.7	158-20	3	0.5						
140-18	8	1.4	158-22	2	0.4						
140-19	1	0.2	158-24	3	0.5						
140-5	1	0.2	158-3	2	0.4						
141-10	5	0.9	158-8	3	0.5						
141-10exp	23	4.1	158-9	50	8.9						
141-13	1	0.2									
141-14	5	0.9									
141-14exp	5	0.9									
141-15	20	3.6									
141-15exp	64	11.4									
141-16	5	0.9									
141-16exp	7	1.2									
141-2	5	0.9									
141-21	2	0.4									
141-2exp	11	2.0									
141-3	35	6.2									
141-3exp	2	0.4									
141-7	3	0.5									
141-8	11	2.0									
141-8exp	21	3.7									
141-9	1	0.2									
Sub-total	335	59.5		222	39.4		2	0.4		4	0.7

Table 3 Artefact counts by landform and test pit

Heat shattered fragments were also found in the assemblage (Table 4). Most of these were found in test pits on the Terrace/Rises (n=24) with 22 found in Area 140. Seven heat shattered fragments were found in the Source Bordering Dune with six of these were found in Area 158. Differences in raw materials were seen between the those on the Source Bordering Dune and those from the Terrace/Rises. All the heat shattered fragments on Terrace/Rises are silcrete and probably associated with heat treatment. In contrast, a variety of raw materials were found in the Source Bordering Dune and these are more likely from hearths.

Test Pit	*Spit*	*Depth*	*Total Weight (g)*	*%*	*Count*	*%*	*Material*
Source Bordering Dune							
156-12exp	6	50-60	6.53	1.1	1	3.2	fine-grained silcrete
158-9	clean		36.61	6.2	1	3.2	volcanic
158-10	5	40-50	5.87	1.0	1	3.2	Quartzite
158-16	6	50-60	118.2	20.1	1	3.2	volcanic
158-15exp	9	80-90	4.33	0.7	1	3.2	indurated mudstone
158-10exp	4	30-40	52.38	8.9	1	3.2	volcanic
158-10exp	6	50-60	44.96	7.7	1	3.2	volcanic
Terraces/Rise							
140-7	2	10-20	6.02	1.0	1	3.2	fine-grained silcrete
140-11	1	0-10	77.56	13.2	5	16.1	fine-grained silcrete
136-9	1	0-10	49.04	8.4	2	6.5	medium-grained silcrete
140-11	1	0-10	50.3	8.6	3	9.7	fine-grained silcrete
140-20	1	0-10	34.69	5.9	3	9.7	matrix-dominated silcrete
140-19	1	0-10	40.52	6.9	3	9.7	fine-grained silcrete
140-11exp	2	10-20	59.76	10.2	7	22.6	fine-grained silcrete
Total			586.77		31		

Table 4 heat shattered fragments in the assemblage

Table 5 shows the distribution of the assemblage by depth and landform. On the Terrace/Rises most of the artefacts were found in spits 1 and 2 (n=283, 86.5%). In contrast on the Source Bordering Dune most of the artefacts were found in spits 4 and 5 (n=85, 41.1%) of the test pits at area 158. Backed artefacts were found in three TPs.

Landform *Spits*	*Test Pits*							
Flood Plain	169							
1	2							
Terrace/Rise	131	132	133	134	135	136	140	141
1	3	2	1	2	6	3	33	134
2	4		1	7	3	6	11	67
3			1	14		5	2	11
4				4		1		1
5								5
Source Bordering Dune	155	156	157	158	158-9			
1		2	1	3	2			
2		3	1	10	2			
3		10	1	11	2			
4		7		21	10			
5		6	1	50	24			
6	1	3	1	11	2			
7	1	9	1	12				
8	3	5		13				
9	11	4		9		Disturbed		
10	2					Backed artefacts		
Hillcrest	172							
1	3							
2	1							

Table 5 Distribution of Artefacts in the excavated tests pits areas in the assemblage

Table 6 shows the mean maximum lengths and weights of the artefacts in assemblage. The differences in total weight below spit 7 suggests a downwards movement or size-sorting occurred within the stratigraphy on the Source Bordering Dune. In spits 6, 7 and 8 the mean lengths and weights are larger than those in spits 4 and 5. A comparison of the artefacts by maximum length shows a decrease in size on both the Terrace/Rise test pits and the Source Bordering Dune (Figure 1). This difference hints at size sorting.

Spit	*Count*	*Mean Maximum Length (mm)*	*Std Dev.*	*Mean Axial Length (mm)*	*Std Dev.*	*Mean Weight (g)*	*Std Dev.*	*Total Weight (g)*
Source Dune Bordering								
1	6	31.1	20.8	22.4	20.9	8.7	18.4	52.4
2	14	20.3	8.0	3.8	6.9	1.6	1.9	21.8
3	22	27.0	30.2	7.3	10.3	54.2	211.7	1192.3
4	28	24.5	17.8	9.3	13.5	20.2	63.1	566.0
5	57	24.6	18.1	7.5	12.8	16.2	79.4	923.4
6	16	30.4	31.6	8.8	12.7	37.9	99.8	605.7
7	25	29.9	20.5	13.0	20.0	12.9	27.6	321.4
8	29	27.6	14.1	11.0	15.8	6.5	10.7	188.5
9	15	23.4	12.6	7.4	9.7	4.3	7.4	64.0
10	1	21.8		0.0		1.0		1.0
Terrace/Rise								
1	184	22.5	10.3	6.6	10.7	3.9	11.0	717.5
2	99	26.8	12.8	10.7	14.9	5.4	8.5	531.7
3	33	22.5	12.5	9.3	12.2	3.4	6.2	110.8
4	6	22.1	9.8	15.6	10.0	2.5	2.6	15.2
5	5	18.9	11.2	13.4	14.1	2.9	5.3	14.3

Table 6 Artefact counts by spit and maximum length of all artefacts in the assemblage

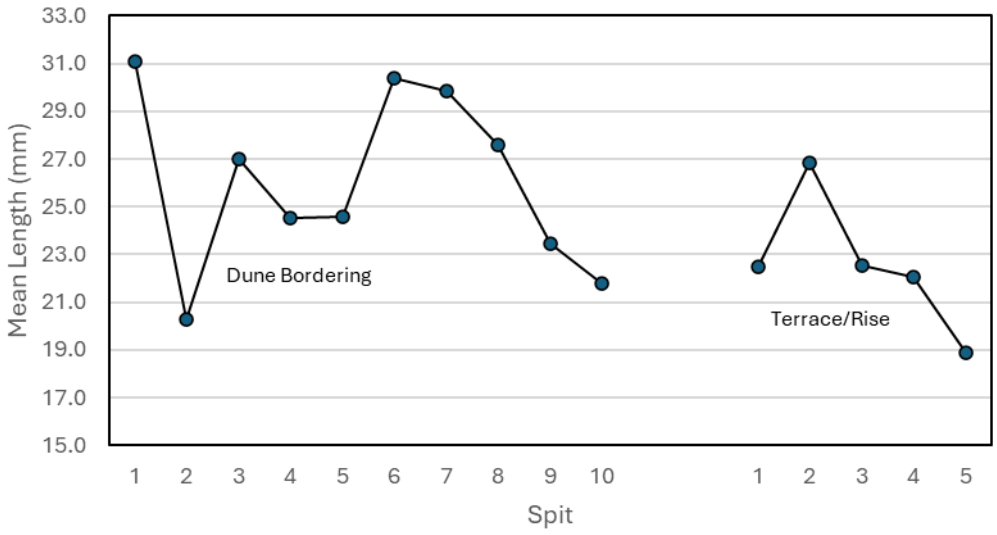


Figure 1 Comparison of raw material types by depth in the assemblage

Site Chronology/Occupation

The timing of the occupation needs to be assessed prior to the technological analysis. A useful guide for assessing site age is the presence or absence of backed artefacts. These artefacts are typically only found in mid to late Holocene sites (<5000 years BP) throughout most of eastern Australia (Attenbrow 2002: 115-159, Hiscock 2008). The presence of backed artefacts is compared with depth to establish the timing of occupation in the project area. Backed artefacts were found in two test pits on the

Terrace/Rises; TP141-8 (clean and spit 1n) and TP134-9exp. (spit 4). Only one test pit on the Source Bordering Dune had backed artefacts. These were found in spits 3 and 4 of TP156-6.

The presence of a glass in spit 3 of 141-15exp on the Terrace/Rise suggests a post-contact occupation (Figure 2).



Figure 2 Glass artefact found in the assemblage

Heavily weathered and concreted artefacts were found in the lower levels of the Source Bordering Dune assemblage suggests a possible early Holocene/Pleistocene assemblage. This possibility will be explored throughout the report.

Stone Procurement

Available Stone Sources

A variety of raw materials can be seen in the assemblages (Table 7). Individual material types were further classified by colour to potentially distinguish sources and/or individual cobbles. Hughes and Hiscock (2000) note that extensive supplies of both indurated mudstone (indurated mudstone/tuff) and silcrete cobbles in the gravel bed of the Hunter River and its tributaries (i.e. Wollombi Brook). Other raw materials include varieties of microcrystalline quartz (chert, CCQ, chalcedony) and macrocrystalline quartz (e.g. milky quartz). Sources will also be compared by depth and landform. Descriptions of each raw material are provided below.

Silcrete

Silcrete is a brittle, very strongly cemented rock containing at least 85% SiO2 (by weight). Silcrete forms by surface or near-surface low-temperature silicification of soil or unconsolidated sediments sometimes associated with basalts. It takes on the characteristics of the parent rock which may be a claystone, siltstone, sandstone, or conglomerate/breccia (Doelman et al. 2015) and dictates the physical properties of silcrete and its classification. Silcrete is classified into four types according to the relative proportions of detrital quartz grains, quartz cement, and microcrystalline matrix: grain-supported, matrix-supported, microcrystalline, and conglomeratic/breccia (Webb et al. 2013).

Material	*Source Bordering Dune*		*Terrace/Rise*		*Hillcrest*	*Floodplain*
	Count	%	Count	%	Count	Count
CCQ	20	9.0	19	5.7		1
Chalcedony	7	3.2	5	1.5		
Chert		0.0	4	1.2		
Highly silicified Indurated mudstone	84	37.8	64	19.1	3	
Indurated mudstone	69	31.1	116	34.6		
Milky Quartz	1	0.5	7	2.1		
Quartzite	6	2.7	6	1.8	1	
Coarse-grained silcrete		0.0	6	1.8		
Medium-grained silcrete	2	0.9	10	3.0		
Fine-grained silcrete	16	7.2	22	6.6		
Matrix-dominated silcrete	13	5.9	72	21.5		1
Total	31	14.0	110	32.9		
Glass			1	0.3		
Silicified Wood			3	0.9		
Volcanic	4	1.8		0.0		

Table 7 Raw material types in the assemblages

The colour can vary at a source or even in an individual cobble. Silcrete sources can also be influenced by controlled heating (heat treatment) or uncontrolled heat (e.g. bush fires). Colour was also analysed to distinguish possible sources of silcrete and heat treatment. During heat treatment silcrete can change from yellow to red (Corkill 1999; Domanski et al. 1994; Flenniken and White 1985). It is unlikely that the colours of the silcrete artefacts represent individual sources as these colours have been observed together, although in different frequencies, in many sources (Doelman et al. 2015; Doelman 2008).

Indurated Mudstone

Mudstone is a sedimentary rock composed primarily of clay- or silt-sized particles (less than 0.063 mm in diameter) whereas a siltstone must contain over 50% silt-sized material. Silt is any particle smaller than sand, 0.06 mm, and larger than clay, > 0.0039 mm. A simple test to determine whether a rock is a mudstone is to if it feels gritty or chalky. In the assemblage the indurated mudstone graded to a highly silicified cryptocrystalline quartz depending on the amount of induration from silica. These artefacts are also subject to chemical weathering. A red/brown patina can form on the exterior surface of the artefacts. Depending on the amount of silica the artefacts become chalky and fragment.

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Quartz

Quartz is a mineral composed of silicon dioxide (SiO_2) and is the second most abundant mineral in the Earth's crust (after feldspar); it is common in igneous, metamorphic, and sedimentary rocks (Lapidius 1990:429). Due to its abundance, hardness and often excellent flaking properties, quartz varieties are frequently found in archaeological sites throughout the world (Seong 2004:76-77).

Microcrystalline or cryptocrystalline quartz scatters more light and has a dull or sub-vitreous lustre. Microcrystalline quartz can be divided into a number of varieties distinguished by colour, banding or degree of translucency. Chalcedony is a term used collectively to distinguish translucent, monochromatic varieties of microcrystalline quartz. As already noted, indurated mudstone grades to an almost cryptocrystalline appearance, depending on grain size and degree of induration, this material was called CCQ (cryptocrystalline quartz).

Microcrystalline quartz artefacts (milky quartz) were often manufactured from small highly water-rolled nodules. These are typically flaked using a bipolar technique. The resulting flakes usually have a crushed platform and termination, lack a bulb of percussion and create a hackly fracture (Doelman & Webb 2024).

Raw Materials

Seven raw material types were found in the assemblage (Table 8). Here, silcrete accounts for only 32.8% (n=110) of the total assemblage. Most of the artefacts were made on indurated mudstone (n=180, 53.7%). By weight indurated mudstone still dominates with large cobbles of quartzite and volcanic also present. The weight of the silcrete artefacts accounts for only 9.8% of the assemblage. This result indicates that cobbles of indurated mudstone, quartzite and volcanic were found nearby whereas high quality silcretes (matrix-dominated and fine-grained) were selected, higher in number but small indicating the use of a distant source.

Material	*Count*	*%*	*Mean Maximum Length (mm)*	*Std Dev.*	*Weight (g)*	*%*
CCQ	19	5.7	25.2	14.1	294.2	4.9
Chalcedony	5	1.5	23.4	12.1	25.4	0.4
Highly silicified Indurated mudstone	64	19.1	24.3	9.9	597.4	9.9
Indurated mudstone	116	34.6	24.5	11.7	1381.0	22.9
sub-total	180	53.7			1978.4	32.8
Coarse-grained silcrete	6	1.8	28.1	7.8	39.0	0.6
Matrix-dominated silcrete	72	21.5	21.4	10.3	240.8	4.0
Medium-grained silcrete	10	3.0	24.3	15.6	55.4	0.9
Fine-grained silcrete	22	6.6	20.7	11.1	255.4	4.2
sub-total	110	32.8			590.5	9.8
Quartzite	6	1.8	40.9	27.3	2221.4	36.8
Volcanic		0.0			882.4	14.6
Silicified Wood	3	0.9	42.8	14.7	12.7	0.2
Milky Quartz	7	2.1	16.6	9.7	12.4	0.2
Glass	1	0.3	19.1		1.1	0.0
Chert	4	1.2	24.3	13.3	10.6	0.2
	625				6029.0	

Table 8 Counts and weights of artefacts in the assemblage

A comparison of raw material types by landform and depth shows differences in the assemblage composition. On the Source Bordering Dune in Spits 1-4 while indurated mudstone artefacts still dominate with higher number of silcrete artefacts found when compared to those found in spits 5-10 (Table 9). In these later spits indurated mudstone artefacts account for over 80% of the artefacts. In contrast, silcrete increases in frequency in the assemblage found on the Terrace/Rises (Table 10).

Material	*Count*	*%*	*Mean Maximum Length (mm)*	*Std Dev.*	*Total Weight (g)*	*%*
Spits 1-4						
CCQ	11	15.7	22.8	17.8	177.47	9.7
Chalcedony	2	2.9	10.4	1.4	0.2	0.0
Highly silicified Indurated mudstone	21	30.0	25.0	10.8	70.01	3.8
Indurated mudstone	10	14.3	21.1	13.4	34.63	1.9
sub-total	31	44.3			104.64	5.7
Matrix-dominated silcrete	8	11.4	13.5	5.5	3.82	0.2
Fine-grained silcrete	12	17.1	21.2	12.0	29.96	1.6
sub-total	20	28.6			33.78	1.8
Milky Quartz	1	1.4	11.6		0.38	0.0
Quartzite	3	4.3	95.7	42.5	1244.9	67.9
Volcanic	2	2.9	40.9	36.4	272.08	14.8
Sub-total	121				1833.45	
Spits 5-10						
CCQ	9	6.0	19.5	10.9	10.7	0.5
Chalcedony	5	3.3	25.1	13.5	15.39	0.7
Highly silicified Indurated mudstone	63	41.7	23.2	11.1	275.93	12.8
Indurated mudstone	58	38.4	29.7	21.5	863.35	40.1
sub-total	121	80.1			1139.28	53.0
Matrix-dominated silcrete	5	3.3	16.6	8.4	4.05	0.2
Medium-grained silcrete	2	1.3	20.9	6.7	2.88	0.1
Fine-grained silcrete	4	2.6	21.9	22.0	51.23	2.4
sub-total	11	7.3			58.16	2.7
Quartzite	3	2.0	69.6	24.6	316.49	14.7
Volcanic	2	1.3	81.8	34.6	610.32	28.4
Sub-total	151				2150.34	

Table 9 Counts and weights of artefacts in the Source Bordering Dune by depth

Terrace/Rise	*Count*	*%*	*Mean Maximum Length (mm)*	*Std Dev.*	*Total Weight (g)*	*%*
CCQ	19	5.7	25.2	14.1	105.9	3.8
Chalcedony	5	1.5	23.4	12.1	9.8	0.3
Chert	4	1.2	24.3	13.3	10.6	0.4
Highly silicified Indurated mudstone	64	19.1	24.3	9.9	236.1	8.4
Indurated mudstone	116	34.6	24.5	11.7	483.0	17.2
Sub-total	180	53.7			719.2	25.6
Milky Quartz	7	2.1	16.6	9.7	12.0	0.4
Quartzite	6	1.8	40.9	27.3	659.5	23.4
Coarse-grained silcrete	6	1.8	28.1	7.8	39.0	1.4
Fine-grained silcrete	22	6.6	20.7	11.1	174.2	6.2
Matrix-dominated silcrete	72	21.5	21.4	10.3	230.4	8.2
Medium-grained silcrete	10	3.0	24.3	15.6	52.5	1.9
Sub-total	110	32.9			496.0	17.6
Glass	1	0.3	19.1		1.1	0.0
Silicified Wood	3	0.9	42.8	14.7	12.7	0.5
Total	335				3241.93	

Table 10 Material types by maximum length and weights in the Terrace/Rise test pits

The silcrete grades from sorted to poorly sorted. The higher quality, matrix-dominated and fine-grained silcrete, were preferred for manufacture. A brecciated silcrete was also identified (e.g., ids=49, 54, 35). In the assemblage six colour varieties of silcrete (grey, grey/pink, light grey, pink, red/yellow, red) were found throughout the stratigraphic units (Table 11). The most common colours were yellow/red (n=31) pink (n=26) and red (n=41). The variety of silcrete colours indicates that artefacts were acquired from multiple cores. The presence of grey, yellow and light-yellow artefacts indicates that these artefacts were not heat treated. Most of the assemblage appears to have undergone heat-treatment shown by the high numbers of pink and red artefacts. Partly heat-treated artefacts are shown by the presence of yellow/red and red/grey or pink artefacts. Many of these artefacts (n=7) have red platforms (from a heat-treated surface)

Colour	*Count*	*%*
Brown	2	1.4
Grey/pink	6	4.2
Grey	1	0.7
Light grey	7	4.9
Light yellow	4	2.8
Pink	26	18.3
Red/Grey	14	9.9
Red	41	28.9
Yellow/Red	31	23.9
Yellow	6	4.2
Yellow/grey	1	0.7
Sub-total	142	

Table 11 Colours of silcrete in the assemblages

Assemblage Characteristics of Procurement

The cortex (or weathered exterior of the parent rock) provides information about the type of stone sources used (i.e. a primary or secondary source). Artefacts with a rough (also called terrestrial) cortex were acquired from a primary source (or an *in-situ* outcrop). Artefacts with a smooth or water-rolled cortex originate from a secondary source (e.g. a cobble from a waterway, having a smoothed surface). In addition, primary silcrete sources were affected by bush fires which have split cobbles and created crazed surfaces and these surfaces at times have subsequently been flaked. Post-depositional burning, also from bush fires or hearths, can damage artefacts. Lastly, the controlled use of heat treatment, using fire, is sometimes used to improve the fracture properties of silcrete (Flenniken and White 1985; Webb et al. 2008; Domanski et al. 1994; 2007). A cortex category, crazed, was used to assess whether cobbles/cores were burnt prior to flaking. The location of burning, i.e. if on the ventral/internal surfaces of flakes, was also recorded.

The amount of cortex on an artefact often indicates the distance artefacts were transported from the source (Hiscock and Mitchell 1993:12-17, Table 12). A high percentage of cortex on an artefact indicates that the source of stone was nearby while artefacts with less cortex or no cortex were typically transported further from the source. Equally, as cores are transported away from the source they are reduced further and the resulting flakes are also smaller. The amount of cortex can also reflect the type of core reduction with more systematic core preparation producing flakes that are smaller with less cortex e.g. burin-blade technology.

Material	*0%*	*%*	*Water-rolled*	*Weather*	*Crazed*	*Paleo-channel*	*Total*
CCQ	29	72.5	10	1			40
Chalcedony	10	83.3	2				12
Chert	2	50.0	2				4
Coarse-grained silcrete	5	83.3	1				6
Fine-grained silcrete	30	78.9	6		2		38
Matrix-dominated silcrete	64	75.3	8	4	6	3	85
Medium-grained silcrete	10	83.3	2				12
Highly silicified Indurated mudstone	76	50.3	65	10			151
Indurated mudstone	93	50.3	82	10			185
Milky Quartz	6	75.0	2				8
Quartzite	2	15.4	10	1			13
Silicified Wood	1	33.3	1	1			3
Volcanic	1	25.0	3				4

Table 12 Cortex amount and types on the artefacts in the assemblage

Differences in the raw material and the amount and type of cortex was seen in the assemblage. Silcrete artefacts have very little cortex. Those artefacts with cortex were mostly from water-rolled sources with smaller numbers from paleo-channel and primary outcropping sources. Eight silcrete artefacts have a crazed surface indicating heat treatment. Most of the indurated mudstone artefacts were from secondary, water-rolled sources. Other raw material types (e.g. CCQ, chalcedony, chert, milky quartz, quartzite and volcanic) were also from water-rolled sources and rarely from primary sources. Figure 3 shows the mean maximum length and standard deviations of the indurated mudstone artefacts in spits 1-4 and spits 5-10 from the source bordering dune. Clear differences are seen in range of sizes in spits 5-10 indicating that much larger artefacts occur at depth.

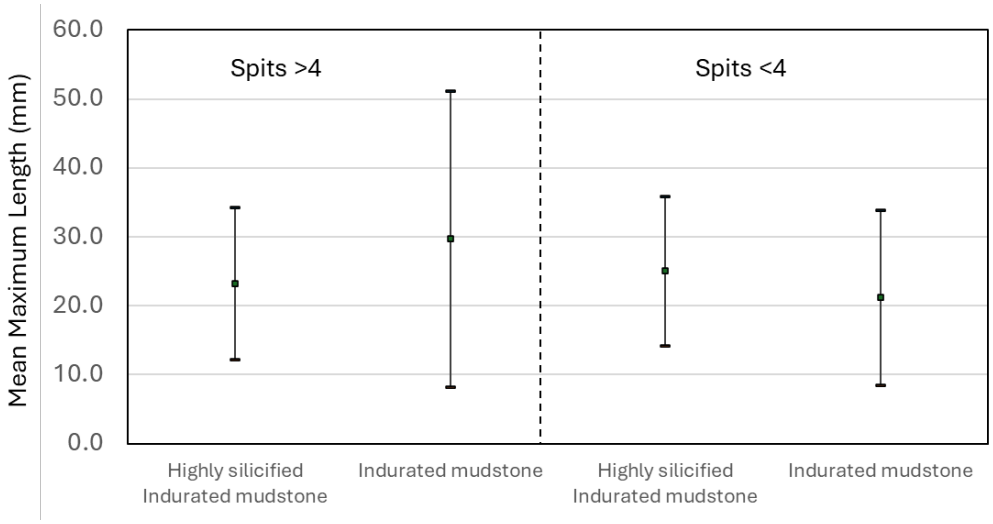


Figure 3 Size range of artefacts found in the Source Bordering Dune by spit

Stone Reduction Technology

The types of artefacts and their characteristics are used to establish how sources were worked, used and discarded on-site. Artefacts were classified as cores or flakes, broken or complete and retouched (tools) or non-retouched (Table 13). Artefacts that were shattered through extreme heat and could not be identified by type but had a flaked surface were called a heat-fractured artefact (HSA). Heat shattered fragments (HS) had no identifiable artefact features and cannot be considered artefacts but were typically made from silcrete or indurated mudstone. Fragmentation of indurated mudstone artefacts due to chemical weathering is common. HS was included in the analysis as they represent post-depositional influences on the assemblage. By-products of flaking include angular fragments (blocks). The composition of the assemblage will firstly be compared followed by an analysis of the cores, flakes and tools. The artefacts were compared by landform and depth.

Assemblage Composition

Source Bordering Dune

The excavated assemblage is dominated singularly by complete flakes in spits 1-4 (Table 13). Broken flakes (including proximal, broken and distal flakes) account for 40.0% (n=28) of the assemblage. Using

a MNF (Minimum Number of Flakes) Index (Hiscock 2002: 254) which takes into account the number of proximal fragments, complete flakes and complete splits a MNF of 35 complete flakes occurs in the assemblage. Only three (4.3%) tools were found in this assemblage, and these were made on a complete flake, core and angular fragment. A low number of angular fragments were present (n=4) in the assemblage. Little evidence for burning/heat treatment was seen in the assemblage. Three heat-shattered fragments (HS) were also found in spits 1-4. These fragments were made from a volcanic material, quartzite and indurated mudstone.

In spits 5-10 the assemblage is also dominated by complete flakes (n=53, 35.1). Broken flakes (including proximal, broken and distal flakes) account for 27.2% (n=41) of the assemblage. Few tools were found in the assemblage (n=5, 3.3%). A very high number of HSA were also found in the assemblage (n=33). These are weathered and cracked artefacts from chemical weathering rather than heating. The MNF (Minimum Number of Flakes) is 62 flakes.

Artefact Type	*Terrace/Rise*		*Dune Spits <5*		*Dune Spits >5*	
	Count	*%*	*Count*	*%*	*Count*	*%*
Core	8	2.4	1	1.4	2	1.3
Core Fragment	15	4.5	1	1.4	4	2.6
Complete Flake	119	35.5	30	42.9	53	35.1
Complete Split	6	1.8		0.0	4	2.6
Proximal Flake	19	5.7	5	7.1	7	4.6
Proximal split	3	0.9		0.0		0.0
Broken Flake	52	15.5	12	17.1	19	12.6
Distal Flake	34	10.1	11	15.7	15	9.9
Sub-total broken flakes	108	32.2	28	40.0	41	27.2
Complete Tool	12	3.6	1	1.4	3	2.0
Proximal Tool		0.0		0.0		0.0
Broken Tool	2	0.6		0.0		0.0
Distal Tool	4	1.2	1	1.4		0.0
Core tool	1	0.3		0.0	1	0.7
Angular fragment tool	1	0.3	1	1.4	1	0.7
Complete split tool	1	0.3		0.0		0.0
Sub-total tool	21	6.3	3	4.3	5	3.3
Angular Fragments	35	10.4	4	5.7	7	4.6
Heat Shattered artefact (HSA)	22	6.6	1	1.4	33	21.9
Mortar	1	0.3	1	1.4	1	0.7
Broken Hammer		0	1	1.4	1	0.7
Total	335	100	70		151	
MNF	143		35		62	

Table 13 Types of artefacts in the assemblages

Terrace/Rise

The excavated assemblage is dominated singularly by complete flakes (Table 13). Broken flakes (including proximal, broken and distal flakes) account for 32.2% (n=108) of the assemblage. The MNF (Minimum Number of Flakes) is 143 flakes. Higher numbers of cores and core fragments are also found in the assemblage (Table 13). A total of 21 (6.3%) tools were found in the assemblage, and these were mostly made from on complete flakes. A high number of angular fragments were present (n=35) in the assemblage. Evidence for burning/heat treatment was seen in the presence of the heat/weathered shattered artefacts. Heat-shattered fragments of silcrete (HS) were found in this assemblage (n=25). These fragments may be associated with heat-treatment.

The presence of complete split flakes also shows that core reduction occurred on-site (Table 13). These types of flakes usually occur early in core reduction when the aim is to remove a large flake and can be considered a flaking error produced when the force used to strike the core is too great and it is hit at an incorrect angle. Table 9 shows the frequency of complete splits. The frequency is higher in Source Bordering Dune spits 5-10.

Cores

Only eleven cores and 20 core fragments were found in the assemblages (Table 13). Most of the cores found in the Source Bordering Dune were made from large water-rolled cobbles. Only one core was had on a large flake (129.5 mm). No systematic cores were found in this assemblage and none were made from silcrete. The large number of core fragments is associated with heat fractures in the Terrace/Rise assemblage.

Most of the cores were found in the Terrace/Rise test pits (n=9, Table 14). Four systematic cores were found in this assemblage. These cores have elongated or blade scars. Five cores were made from silcrete and four were made on flakes which range in size from 28.7-51.7 mm. All the silcrete cores have evidence of heat treatment based on the presence of crazed cortex or heat treatment.

Systematic cores in the Terrace/Dune assemblage included burin-blade cores, radial-bifacial cores and prismatic cores (Table 14). These cores show preparation and planning in manufacture. Burin-blade cores were typically made on larger flakes (Figure 4). This technique is one way of manufacturing elongated flakes of the same size. Burin-blade cores are generally made on a large flake, typically one of the margins was prepared as a platform for the removal of flakes, usually across the termination of the original flake (Holdaway and Stern 2004:205-206). This technique has also been called the Redbank A Strategy and was observed in Hunter Valley assemblages (Hiscock 1993). The blades/elongated flakes produced will have a similar size in length and width. Alternate-blade core were also identified (Figure 4). This core was rotated 180^{o} to not only extend the uselife of the core but also to utilise the existing parallel flake scars to further remove elongated flakes. A radial-bifacial core was bifacially flaked around the circumference of a core face on both faces (Figure 4). These cores have a lenticular cross section. Prismatic cores are primarily flaked >50% around one platform, have step terminations causing the failure of the platform and the discard of the core (Figure 4). These cores are also associated with blade/elongated flakes (Holdaway and Stern 2004:196).

Source Bordering Dune	*Core Type*	*Core Body*	*Cortex Type*	*Material*	*Maximum Length (mm)*
Spit					
3	Uni-directional	Nodule	Water-rolled	CCQ	71
8	Uni-directional	Nodule	Water-rolled	indurated mudstone	56.2
5	Multi-directional	Nodule	Water-rolled	Highly silicified Indurated mudstone	59.6
6	Bi-directional	Flake	Water-rolled	Indurated mudstone	129.5
Terrace/Rise					
1	Uni-directional	Flake		CCQ	28.7
1	Uni-directional	Nondiagnostic	crazed	Fine-grained silcrete	59.4
1	Radial-bifacial	Flake	Water-rolled	Highly silicified Indurated mudstone	43.9
2	Prismatic	Nondiagnostic		Matrix-dominated silcrete	26.6
1	Multi-directional	Flake	crazed	Matrix-dominated silcrete	57.1
1	burin-blade	Flake	crazed	Matrix-dominated silcrete	47.7
1	Bi-directional	Nondiagnostic		CCQ	41.2
3	Bi-directional	Nondiagnostic	Water-rolled	Highly silicified Indurated mudstone	43
2	alternate-blade	Nondiagnostic	Water-rolled	Fine-grained silcrete	41.1

Table 14 Characteristics of the cores in the assemblage



Figure 4 Systematic cores found in the assemblage. Left to rights ids=132, 221, 241, 300. Scale=1cm

Flakes

The characteristics of the complete flakes are used to support and further enhance the results of the core analysis. The form of the complete flakes is used to determine how cores were reduced and what was manufactured on site.

Source Bordering Dune

Most of the flakes in spits 5-10 are expanding in form (49.1%), only six flakes are elongated, one blade and two having facetted platforms (Table 15). Cores were generally flaked in one direction from a cortical platform. High numbers of unifacial and cortical platforms were seen in this assemblage (Table 16). Many of the flakes also have step or hinge terminations.

In spits 1-5 again most of the flakes have an expanding form (Table 15). Four complete flakes have a blade form. Cores were mostly flaked in one direction with few cortical platforms (Table 16). Fewer steps and hinges were found on the complete flakes (Table 16).

Terrace/Rise

Platform rejuvenation and evidence of systematic core preparation is seen in Terrace/Rise (Table 15). Platform rejuvenation flakes (also known as a core rejuvenation flake) were used to both create a new platform and to limit flaking mistakes by reducing the angle of the striking platform thereby extending the life of a core (Odell 2003: 121). More core rotation is also seen in the assemblage seen in the presence of flaked platforms and dorsal scars (90° rotation). More blades and elongated flakes were seen in this assemblage along with few cortical platforms and more crushed platforms associated with more core reduction (Figure 5, Table 16). Four examples of elongated flakes with dorsal ridge (ids=159, 148, 109, 404) suggests blade core preparation.

Source Bordering Dune	*Count*	*%*	*Maximum Length (mm)*	*Std Dev.*
Spits 1-4				
Blade	4	13.3	31.2	14.8
Block	4	13.3	49.3	13.3
Elongated	3	10.0	25.7	11.1
Expanding	11	36.7	14.6	4.4
Indeterminate	6	20.0	21.0	9.9
Platform Rejuvenation	1	3.3	20.2	
Split cobble	1	3.3	66.7	
Sub-total	30			
Spits 5-10				
Blade	1	1.9		13.1
Block	5	9.4	11.6	12.2
Elongated	6	11.3	10.1	9.8
Expanding	26	49.1	11.0	11.3
Indeterminate	12	22.6	12.7	11.9
Platform Rejuvenation	3	5.7	35.6	29.7
Sub-total	53			
Terrace/Rise				
Bipolar	1	0.8	18.8	
Blade	5	4.2	33.8	9.4
Block	5	4.2	39.8	13.2
Contracting	1	0.8	25.8	
Elongated	23	19.3	28.7	12.9
Expanding	47	39.5	19.5	8.5
Indeterminate	28	23.5	21.6	8.9
Platform Rejuvenation	9	7.6	37.9	10.1
Sub-total	119			

Table 15 Form of the complete flakes in the assemblages.

Source Bordering Dune (<5 Spits)				
Platform Type	Count	%	Maximum Length (mm)	Std Dev.
Cortical	2	6.7	24.9	11.1
Crazed	1	3.3	66.7	
Crushed	4	13.3	18.5	14.4
Facetted	1	3.3	13.6	
Flaked	4	13.3	18.9	3.4
Missing	2	6.7	34.1	19.6
Unifacial	16	53.3	26.6	16.6
Dorsal Scars				
0	17	56.7	25.7	16.5
180	2	6.7	28.9	13.6
90	5	16.7	28.5	12.7
N/A	6	20.0	22.7	21.7
Distal End				
Abrupt	1	3.3	9.4	
Cortical	3	10.0	46.4	22.1
Feather	17	56.7	27.0	15.8
Hinge	5	16.7	23.1	8.9
Step	4	13.3	12.5	5.2
Source Bordering (spits 5-10)				
Platform Type				
Cortical	16	30.2	34.2	13.8
Crushed	9	17.0	19.0	7.4
Facetted	2	3.8	32.6	11.5
Flaked	2	3.8	49.1	34.5
Missing	7	13.2	26.0	19.0
N/A	1	1.9	57.3	
Unifacial	16	30.2	30.8	13.2
Dorsal Scars				
0	27	50.9	29.6	14.4
90	10	18.9	22.5	10.4
N/A	14	26.4	35.6	16.6
Radial	2	3.8	45.1	31.7
Distal end				
Abrupt	3	5.7	34.9	28.6
Cortical	4	7.5	43.0	18.9
Feather	22	41.5	29.2	13.9
Hinge	11	20.8	31.3	13.4
Platform	1	1.9	73.5	
Step	12	22.6	23.1	7.2
Terrace/Rise				
Platform Type				
Cortical	13	15.5	26.9	10.4
Crushed	19	22.6	17.8	7.7
Facetted	3	3.6	23.1	5.5
Flaked	9	10.7	24.8	8.5
Missing	11	13.1	22.6	8.1
Unifacial	64	76.2	26.7	13.3
Dorsal Scars				
0	57	67.8	22.4	10.1
180	6	7.1	28.3	8.9
90	34	40.5	29.2	12.5
N/A	16	19.0	19.5	11.5
Radial	6	7.1	31.1	15.0
Distal End				
Abrupt	8	9.5	31.4	14.5
Cortical	1	1.2	26.4	
Crushed	1	1.2	18.8	
Feather	61	72.6	25.5	12.2
Hinge	23	27.4	19.5	8.7
Platform	5	6.0	37.5	7.4
Plunge	3	3.6	28.3	4.1
Step	17	20.2	21.4	10.4

Table 16 Characteristics of the complete flakes in the assemblages by landform and depth.



Figure 5 Examples of blades found in TP140-16 and TP14016exp. Scale=1cm

Tools

A total of 30 tools were found in the assemblage (Table 17). Most of these were found on the Terrace/Rise (n=21). Only one tool, a utilised flake, was found one the hillcrest. The tools on the Terrace/Rise include a variety of scrapers, two geometric microliths, notched, a utilised blocky angular fragment and a drill indicating processing activities and backed artefact manufacture (Figures 6-8). Most of the tools were made from indurated mudstone. The backed artefacts were all made from high quality silcrete or CCQ (Figure 6).

One the Source Bordering Dune one Bondi point and a geometric microlith were found in spits 3 and 4 of TP156-6 (Figure 6). These were made from silcrete and CCQ. Large blocks, cores and a platform rejuvenation flake were used as step-scrapers, notched or utilised tools in spits 5-10 (Figure 9).

In addition, broken hammerstones and mullers/anvils were also identified (Figures 10 & 11).



Figure 6 Backed artefacts in the assemblage. Left to right id=2, id=99, id18 (scale=1cm)

Test Pit	*Spit*	*Form*	*Tool Type*	*Material*	*Maximum Length (mm)*
Source Bordering Dune					
158-13	3	N/A	Step-Scraper	Highly silicified Indurated mudstone	37.9
156-6	3	Elongated	Geometric microlith	CCQ	13.5
156-6	4	Elongated	Bondi	Matrix-dominated silcrete	17
158-16exp	5	Platform Rejuvenation	Step-Scraper	Chalcedony	41
158-9	5	Block	Utilised	Indurated mudstone	59.8
158-22	6	Coretool	Step-Scraper	Indurated mudstone	129.5
156-5	7	Block	Step-Scraper	Fine-grained silcrete	54.8
156-11	8	Block	Notch	Indurated mudstone	48
Terrace/Rise					
141-8	clean	Indeterminate	Geometric microlith	Matrix-dominated silcrete	17.6
141-2	1	Block	Utilised	Chert	36.1
140-16	1	Elongated	Notch	Matrix-dominated silcrete	19.6
141-10exp	1	Block	Step-Scraper	Indurated mudstone	60.9
141-10exp	1	Platform Rejuvenation	Scraper	Highly silicified Indurated mudstone	25.1
141-2exp	1	Indeterminate	Scraper	Chalcedony	24.3
140-16	1	Elongated	Scraper	Matrix-dominated silcrete	20.5
141-3	1	Block	Scraper	Highly silicified Indurated mudstone	35.3
141-3	1	Block	Scraper	Matrix-dominated silcrete	20.3
141-2	1	Expanding	Scraper	Indurated mudstone	18.5
141-16	1	N/A	Scraper	Indurated mudstone	23
141-15	1	Indeterminate	Scraper	Highly silicified Indurated mudstone	39.6
141-8exp	1	Block	Scraper	Indurated mudstone	53.9
141-15exp	2	Block	Notch	Indurated mudstone	37
141-8exp	2	Block	Notch	Quartzite	44.1
141-10	2	Block	Step-Scraper	Coarse-grained silcrete	39.6
141-15exp	3		Step-Scraper	Highly silicified Indurated mudstone	43
141-15exp	2	Platform Rejuvenation	Denticulate	Indurated mudstone	59.7
141-8	1	Blade	Backed Artefact	Fine-grained silcrete	15.2
134-9exp	4	Elongated	Geometric microlith	Matrix-dominated silcrete	12.1
141-15exp	5	Block	Drill	Highly silicified Indurated mudstone	32.2
Hillcrest					
172-10	1	Elongated	Utilised	Highly silicified Indurated mudstone	20.4

Table 17 Characteristics of the cores in the assemblage



Figure 7 Notched tools in the assemblage. Left to right id=267, id=183. Scale=1cm



Figure 8 Drill and scraper (thumb-nail sized, partly retouched) in the assemblage. Left to right id=242, id=287. Scale=1cm

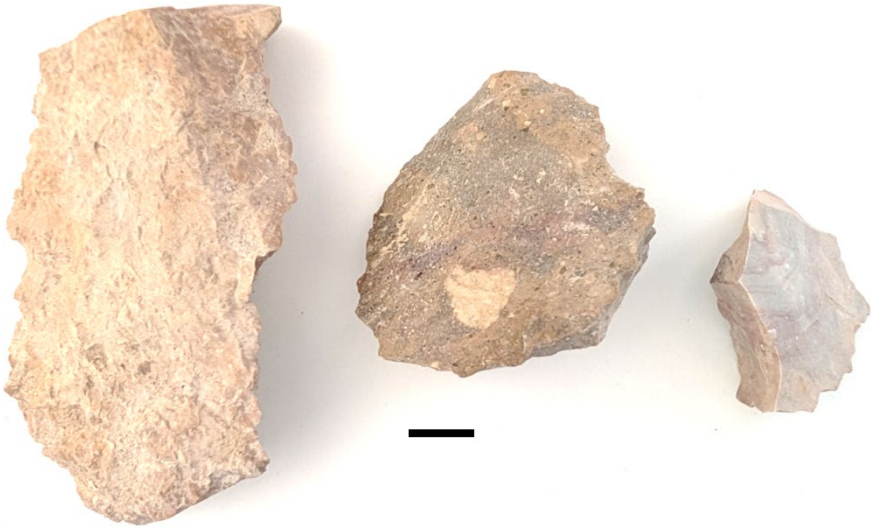


Figure 9 Large scrapers in spits 5-10 of the Source Bordering Dune assemblage. Left to right ids=386, 387, 511. Scale=1cm



Figure 10 Broken hammerstone found in the assemblage. Scale=1cm



Figure 11 Muller/Anvils found in the assemblage. Scale=1cm

Post Depositional Influences

Many processes affect archaeological remains after their initial discard. In this report the influence of heat damage and vertical displacement through conjoin analysis are considered.

Heat Damage

Only four artefacts in spits 5-10 of the Source Bordering Dune have heat damaged (e.g. blackening, cracking, pot-lidding, crazing). In contrast, in spits 1-4 16 artefacts have heat damage including a colour change, pot lids and fracturing. Forty-two artefacts in the Terrace/Rise test pits have evidence for heat damage.

Heat damaged can influence an assemblage in three ways. 1. Heat was responsible for shattering unworked cobbles/blocky fragments. Crazed platforms and heat damage on the dorsal surfaces of flakes (in association flake scars) also suggests that burning occurred prior to flaking. 2. Artefacts were also burnt after manufacture. The type of damage generally indicates an uncontrolled, post-depositional burning possibly the result of bush fires or from hearths (e.g. ids=229, 534). This can be seen in the presence of artefacts with pot-lids on their ventral surface and also heat-shattered artefacts (pot-lids, crazing, colour change) on the ventral or dorsal characteristics. 3. Heat treatment of artefacts to improve flake-ability.

It seems likely that heat-treatment, shown by the high numbers of pink and red silcrete artefacts, and some post-depositional accidental burning has influenced the assemblages.

Chemical Weathering

A process which may account for the fragmentation of indurated mudstone artefacts is chemical weathering which is caused by rainwater reacting with the mineral grains in rocks to cause fractures in the rock and subsequently breaks them apart (Allaby 2013). Smaller rocks (i.e. artefacts) found in humid climatic conditions are more susceptible to this process. During the analysis internal fracturing was observed on the surface of the indurated mudstone artefacts. Figure 12 shows an example of a weathered indurated mudstone artefact (id=x). large number of HSA were seen in the spits 5-10 of the Source Bordering Dune (n=35). Other artefacts have internal cracks present (e.g. ids=495, 39).

Concretions have formed on the surface of indurated mudstone artefacts at depth (e.g., ids=379, 371). These artefacts were found in spit 7 of TP156-17 and spit 8 of TP156-12exp. These artefacts were also rounded and weathered.



Figure 12 Flakes with concreted and/or rounded surface. Scale=1cm

Conjoin Analysis (Refitting)

Conjoining (or refitting artefacts) was not systematically undertaken across the assemblage but sometimes recognised during the analysis. This analysis can be used to assess a downward movement of artefacts or reconstruct core reduction. Five sets of conjoining artefacts were observed in the test pits from the Terrace/Rise and the Source Border Dune (Table 18). If conjoins are present in the same spit, then there is little evidence of for the downward movement of larger artefacts. Conjoining sets are post-depositional breakages ids=122, 111), from manufacturing (ids=390 & 392, 331 & 332) or

heat/weathering fractures (ids=438, 209 & 210). Two additional artefacts, same material type, colour and red cortex, were also considered part of the conjoining set (Figure 13).

Two test pits have concentrations of yellow/red artefacts. TP 140-16 has 10 artefacts concentrating in spit 1 while 8 artefacts concentrate in spits 3 and 4 of TP-9. Two other working areas were also identified in TP158-10 (highly silicified indurated mudstone) and TP158-16 (red CCQ).

Id	*Test Pit*	*Spit*	*Class*	*Material*	*Colour*
	Source Bordering Dune				
390	156-12	5	complete flake	Highly silicified Indurated mudstone	yellow/red
392	156-12	5	complete flake	Highly silicified Indurated mudstone	yellow/red
438	158-9	5	angular fragment tool/weathered spall	Indurated mudstone	Red/Grey
	Terrace/Rise				
331	141-3	1	core	Matrix-dominated silcrete	Red/Grey
332	141-3	1	medial flake	Matrix-dominated silcrete	Red/Grey
209	141-15exp	1	core fragment	Indurated mudstone	Red
210	141-15exp	1	core fragment	Indurated mudstone	Red
122	140-16	1	distal tool	Matrix-dominated silcrete	yellow/red
111	140-16	1	proximal flake	Matrix-dominated silcrete	yellow/red

Table 18 Conjoining artefacts by raw material in the assemblage



Figure 13 Examples of conjoining artefacts in the assemblage. Left to right ids=122 & 111, 438 &439, 390 &392. Scale=1cm

Spatial Distribution and Site Occupation

To examine whether spatial differences in reduction activities the location of the cores, tools, raw material and size were compared by landform and depth.

Table 19 summaries the key characteristics of the artefacts from the test pits on Terrace/Rises and Source Border Dune spits 1-4 and spits 5-10.m Clear assemblages can be identified in the assemblage composition, raw material types and tool types. These differences are coupled with the presence of heat-treated artefacts on the Terrace/Rises and the weathering of artefacts in spits 5-10 of the Source Border Dune.

Landform	***Terrace/Rise***	***Source Border Dune (spits 1-4)***	***Source Border Dune (spits 5-10)***
Cores	Systematic cores	Cobble cores	Cobble cores
Flakes	Higher frequency of blades/elongated flakes Few cortical platforms and more crushed platforms	Higher frequency of expanding flakes	Higher frequency of expanding flakes More cortical platforms
Tools	Backed artefacts	Backed artefacts	Large, stepped scrapers
Assemblage Composition	More tools and core fragments	Few tools and cores	Few tools and cores
Raw Material	Higher frequency of silcrete	Indurated mudstone dominates	Indurated mudstone dominates
Heat Fracture/Heat Treatment	High numbers	Low numbers	Low numbers Weathered and shattered artefacts

Table 19 Summary of key artefact characteristics by landform and depth

Archaeological Potential and Comparative Analysis

Considerable archaeological fieldwork has focused on the Hunter Valley resulting in the excavation of numerous archaeological assemblages typically dated to the mid-late Holocene (e.g., Hiscock 1993, Moore 2000). These assemblages share a number of key characteristics which include the procurement of silcrete and indurated mudstone cobbles from waterways, heat treatment, systematic core reduction (e.g. Redbank A/burin-blade core reduction strategy), blade manufacture and backed artefact production (i.e. Bondi points and geometric microliths). The assemblage from the Terrace/Rise also has many of these key characteristics. To a more limited degree these characteristics were also seen in the spits 1-4 of the Source Bordering Dune.

In other locations in the Hunter Valley (e.g. Betty's Creek, Hiscock 1993, Koetting 1994) where silcrete cobbles are larger flakes up to 30 cm in length are manufactured. The complete silcrete flakes in the Terrace/Rise assemblage have a mean length of 18.8±8.6 mm with a maximum size of 44.9 mm. In contrast on the Source Bordering Dune the mean length of the complete silcrete artefacts is 20.4±12.3 mm with a maximum size of 38.5 mm. For the Carrington sites the distribution and frequency of raw materials was depended on the distance from the silcrete sources (Mitchell and McCotter 1999). This observation is also a feature of this assemblage. Table 20 compares data from sites in the Hunter

Valley. The frequency of silcrete artefacts differs considerably between sites. These differences reflect the distance to the sources and the types of sources nearby, the on-site activities and the duration of occupation.

Kuskie and Kamminga's (2000) developed a model relating the assemblage composition to differing site types ranging from short-term, transitory to longer-term occupation, typically shown by higher numbers of processing tools. In comparison to other sites in the Hunter Valley a high frequency of retouched tools was found than most of the sites (Table 20). HTP-SMA and HTP-Wollombi have the highest frequency of retouched artefacts which may be associated with a longer occupation.

	Narama	*Mt Owen*	*Lemington*	*Mt Thorley*	*Bolwarra Heights*	*Cheshunt (Excavated)*	*Howick*	*HVO-2*	*HTP-SMA*	*HTP-Wollombi*	*Terrace/Rise*	*Source/Border Dune (spits 5-10)*
Material type (% of silcrete)	29.4	59.4	26.8	68.5	85.1	14.3	35	31.5	68.3	26.5	32.9	7.3
Ratio of complete flakes:cores	4.9:1	19.8:1	16.5:1	28.0:1	51.6:1	36.3:1	6.3:1	17:1	38:1	16:1	1:14.9	1:26.5
% of Backed tools	0.5	2.4	2	1.7	2.6	0.5	1.2	3.3	1	1	0.1	0
% of Retouched Tools	0	0.7	2.9	0.4	0.6	2.3	0	2.7	7.1	6.9	5.1	3.3
Cores	38	12	30	56	5	3	27	14	1	1	8	2
Complete flakes	188	238	494	1567	258	109	171	178	38	16	119	53
Total	1010	869	906	6730	823	217	644	564	101	98	335	151

Table 20 Comparison of sites in the Hunter Valley

Summary

It is now possible to return to the questions posed in the research design.

Site chronology. When was the site occupied? Was the assemblage the product of repeated occupations or a single event? Does any spatial patterning occur in the assemblage? Was there a Pleistocene occupation?

The Terrace/Rise were occupied between the mid to late Holocene based the raw material, core and tool types i.e. the presence of burin-blade cores and backed artefacts. Distinctive working areas were found in this location. Processing tools (scrapers, usewear, notched) were found in the assemblage that are typically more indicative of a longer-term occupation associated with heat treatment.

The flake form and tool types in spits 5-10 of the Source Bordering Dune suggests an early Holocene/Pleistocene occupation was seen in the assemblages. In spits 1-4 artefacts are more aligned with a mid-late Holocene assemblage. Movement of artefacts may have created mixed assemblages.

A glass flake in spit 3 of 141-15exp, located on the Terrace/Rise, shows a post-contact occupation.

Source Information. Which raw material resources were used?

The assemblage was dominated by indurated mudstone. Two types of raw material sources were mainly used - primary, exposures of outcrops (rough) and secondary from a waterway (smooth and rounded). It is likely the secondary source is the nearby Hunter River. A paleo-channel source of silcrete was also use along with primary and secondary sources. Small silcrete artefacts are present in higher numbers in the Terrace/Rise test pits, along with a variety of cryptocrystalline quartzes and macrocrystalline quartz (milky quartz). The size and quality of the silcrete indicates that the source was not nearby. Quartzite artefacts were also more common Source Bordering Dune.

***Stone reduction technology*.** How was the stone worked and used? Can the function of the site be inferred from the artefact assemblage?

Evidence for 'systematic' reduction of cores occurred on site in the Terrace/Rise test pits (i.e. the manufacture of elongated/blade flakes from prepared cores). The presence of burin-blade cores represents a systematic core reduction also known as the Redbank A strategy observed by Hiscock (1993) in the Hunter Valley. This strategy was also indicated by a number of other artefact characteristics e.g. facetted platforms, overhang removal and flakes with a blade/elongated form. Other systematic cores include prismatic, alternate-blade and radial-bifacial cores. It is likely that cores were used to make geometric microliths and Bondi points. These artefacts were predominately made from silcrete.

Large, expanding flakes of indurated mudstone were made from cobbles in spits 4-10 of the Source Bordering Dune. Larger artefacts were also used as step-scrapers. No evidence of systematic core preparation was seen in this assemblage.

Site Function. What types of activities occurred on-site/s? Do discrete areas of stone working occur? Can site function be related to environmental factors i.e. distance to sources?

The higher frequency of other processing tool types (e.g. usewear, notched and scraper) suggests that the Terrace/Rise was primarily associated with more camp site activity. The location was also used to "gear-up" i.e. an area used for the manufacture of backed artefacts. These tools were made, transported and used when necessary to maintain and replace broken parts of weaponry. It was also important to make time, prior to hunting, to have operational equipment. In this this heat-treating silcrete also occurred.

The presence of large scrapers in spits 4-10 of the Source Bordering Dune suggests on-site processing activities.

***Regional Comparative Analysis*.** How does this site compare with others in the surrounding region?

Mid-late Holocene sites are abundant in the Hunter Valley (Hughes et al. 2014). These sites are typified by systematic core reduction, blade production and backed artefact manufacture (Hiscock 1998; Moore 2000). The technological, metrical and typological characteristics of the assemblage from the Terrace/Rise are commonly seen in assemblages from the region. In the Hunter Valley ample raw material, in the form of water-rolled cobbles, are readily available in region thereby placing no restrictions on artefact manufacture. However, the distance from the source and type of raw material available has influenced the frequency of raw material types in the assemblage. A preference for indurated mudstone was seen in the assemblage, and the resulting artefacts are larger than those made from silcrete. The distance from silcrete sources and the availability of other sources is seen in the artefacts found in assemblage.

The Source Bordering Dune represents a visible and distinctive Pleistocene landform with associated artefacts.

***Conjoins & Post-depositional influences*.** What post-depositional influences have impacted on the assemblage?

Some evidence of size sorting which may be due to post-depositional processes, such as bioturbation, resulting in smaller artefacts found at depth within the excavated assemblage below spit 6 of the Source Dune Bordering Site and below spit 2 of the Terrace/Rise test pits. Weathering of indurated mudstone has fractured artefacts and these concentrate in spits 4- 10 of the Source Dune Bordering. One test pit, TP158-9, has ceramic and glass fragments at depth indicating a post-depositional disturbance.

Conjoins sets indicate an in-situ deposit in the Terrace/Rise test pits and upper spits of the Source Dune Bordering test pits.

Conclusion

The characteristics of the cores, flakes and tools in the assemblage indicates that cores were procured and worked from a nearby secondary sources of indurated mudstone. Water-rolled cobbles were used to manufacture large flakes, some used as tools or cores. A primary source of silcrete was also used. Silcrete was heat treated and evidence for systematic core preparation and backed artefact manufacture was also found in the test pits on the Terrace/Rises. The presence of processing tools (e.g. usewear, notched and scarper) also suggests that this location was used for a longer-term occupation. Differences in raw materials, artefact size and assemblage composition between the

landforms (Terrace/rises & Source Bordering Dune) are associated with a potential early Holocene/Pleistocene occupation of the Source Bordering Dune.

This report provides some understanding of site chronology, raw material selection, core preparation and reduction strategies and tool manufacture that contributes to understanding the archaeology of the Hunter Valley region.

Future research opportunities

1. *Understanding the Stone Sources*

This project would benefit from a source survey for primary and secondary sources along the Hunter River and Wollombi Brook to assess variability in the availability of raw materials and more fully.

2. Dating of the Source Bordering Dune would establish a time frame for occupation.

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C.2.7 Lithic catalogue

ID	Site	Area	landform	TestPit	new split	Split	Depth	DATACLASS	MATERIAL	COLOUR	HEAT DAMAGE	DISTAL END	CORTEX %	CORTEX TYPE	FORM	EX. PLATFORM	PLATFORM TYPE	DORSAL SCARS	TOOL TYPE	NO. RETOUCHED EDGES	EDGE 1	RETOUCH SHAPE 1	EDGE 2	RETOUCH SHAPE 2	EDGE 3	RETOUCH SHAPE 3	EDGE 4	RETOUCH SHAPE 4	CORE TYPE	CORE BODY	SCAR FORM	CORE PLATFORM NO.	NO. STEP TERMINATIONS	NO. HINGE TERMINATIO	MAXIMUM LENGTH	LENGTH	WIDTH	THICKNESS	PLATFORM WIDTH	PLATFORM THICKNESS	CORE SCAR LENGTH	CORE SCAR WIDTH	CORE SCAR NO.	WEIGHT	MODIF	COMMENTS
10	HTP-HVO	141	tr	141-10EXP	1	1	0-10	L	D	R/G	Y	FEATHER	1-25%	h	ejuvenatio	NA	CRAZED	90	Scraper	1	N/A	N/A	N/A	N/A	SCRAPER	convex	N/A	N/A				0			25.1	21.4	18.9	5.3	14.6	8.5	0	0		3.58	HT	
9	HTP-HVO	141	tr	141-10EXP	1	1	0-10	DISTFLAKE	mud	R/G	N	FEATHER	1-25%	h	ate					0												0			28.8	0	0	0	0	0	0	0		3.17	N/A	
8	HTP-HVO	141	tr	141-10EXP	1	1	0-10	CompFlake	mud	Red	N	FEATHER	51-99%	Weather	ate	NA	Uni	180		0												0			15.5	14	10.4	2.8	7.5	2.8	0	0		0.47	N/A	
7	HTP-HVO	141	tr	141-10EXP	1	1	0-10	CompFlake	D	Brown	N	ABRUPT	1-25%	Weather	Expanding	NA	Uni	90		0												0			22.8	7.8	20.7	5.4	22.8	8.1	0	0		1.84	N/A	
6	HTP-HVO	141	tr	141-10EXP	1	1	0-10	DISTFLAKE	mud	Red	N	ABRUPT	0%		Block					0												0			32.6	0	0	0	0	0	0	0		6.63	N/A	
5	HTP-HVO	141	tr	141-10EXP	1	1	0-10	MENT	D	Red	N		0%							0												0			25.7	0	0	0	0	0	0	0		2.57	N/A	
4	HTP-HVO	141	tr	141-10EXP	1	1	0-10	CompFlake	D	R/G	N	FEATHER	0%		ate	NA	Cortical	0		0												0			19.7	11.7	11.1	3.3	12.6	3.7	0	0		0.52	N/A	
3	HTP-HVO	141	tr	141-10EXP	1	1	0-10	CompFlake	CHERT	lgrey	N	HINGE	0%		Expanding	NA	Uni	0		0												0			12.6	7.3	12.1	1.5	7.7	1.3	0	0		0.2	N/A	NTUFF
2	HTP-HVO	141	tr	141-10EXP	1	1	0-10	E	D	R/G	N		0%		Expanding	NA	Uni			0												0			16.1	0	0	0	5.6	1.6	0	0		0.53	N/A	
1	HTP-HVO	141	tr	141-10EXP	1	1	0-10	T	mud	Red	N	FEATHER	100%	h	ate	NA	Uni			0												0			25.2	19.1	0	4.3	0	0	0	0		1.68	N/A	
17	HTP-HVO	141	tr	141-10EXP	1	1	0-10	MEDFLAKE	FSILCRETE	Red	N		0%		ate					0												0			18.9	0	0	0	0	0	0	0		1.29	HT	
16	HTP-HVO	141	tr	141-10EXP	1	1	0-10	RAG	D	Red	N		26-50%	h						0												0			27.9	0	0	0	0	0	0	0		4.31	N/A	
15	HTP-HVO	141	tr	141-10EXP	1	1	0-10	MEDFLAKE	mud	R/G	N		1-25%	h	ate					0												0			20.4	0	0	0	0	0	0	0		1.62	weathered	
14	HTP-HVO	141	tr	141-10EXP	1	1	0-10	MEDFLAKE	D	lgrey	N		0%		ate					0												0			8.8	0	0	0	0	0	0	0		0.05	N/A	
13	HTP-HVO	141	tr	141-10EXP	1	1	0-10	RAG	CCQ	Brown	N		26-50%	Weather						0												0			15.4	0	0	0	0	0	0	0		0.72	N/A	
12	HTP-HVO	141	tr	141-10EXP	1	1	0-10	MEDFLAKE	mud	Brown	N		0%		ate					0												0			22.5	0	0	0	0	0	0	0		2.09	weathered	
11	HTP-HVO	141	tr	141-10EXP	1	1	0-10	DISTFLAKE	CCQ	y	N	FEATHER	0%		ate					0												0			10.8	0	0	0	0	0	0	0		0.29	N/A	
18	HTP-HVO	141	tr	141-10EXP	1	1	0-10	CompFlake	D	Brown	Y	PLUNGE	26-50%	Weather	ejuvenatio	NA	Uni	90		0												0			30.9	27.3	16	9.3	2.8	3.2	0	0		3.67	HANGE	
19	HTP-HVO	141	tr	141-10EXP	1	1	0-10	L	mud	R/Y	N	ABRUPT	51-99%	h	Block	NA	Cortical	90	r	2	N/A	N/A	STEPPED	straight	N/A	N/A	STEPPED	convex				0			60.9	38.5	60.1	22.7	41	9.4	0	0		70.82	N/A	core prep
20	HTP-HVO	141	tr	141-10EXP	1	1	0-10	MEDFLAKE	mud	Brown	N		0%		ate					0												0			21.1	0	0	0	0	0	0	0		0.77	N/A	
21	HTP-HVO	141	tr	141-3EXP	surfac			MENT	mud	lgrey	N		26-50%	Weather						0												0			20.1	0	0	0	0	0	0	0		2.21	weathered	
22	HTP-HVO	141	tr	141-10EXP	2	2	10-20	RAG	mud	Brown	N		0%							0												0			19.1	0	0	0	0	0	0	0		0.66	N/A	
23	HTP-HVO	141	tr	141-10EXP	2	2	10-20	CompFlake	mud	Brown	N	ABRUPT	0%		ate	NA	Flaked	0		0												0			18.7	18.7	9.5	3.7	7.2	2.5	0	0		0.65	weathered	frac
24	HTP-HVO	141	tr	141-10EXP	spoil	spoil		MENT	mud	R/G	N		1-25%	h						0												0			25.9	0	0	0	0	0	0	0		2.03	N/A	
30	HTP-HVO	141	tr	141-2EXP	1	1	0-10	MENT	D	Red	N		1-25%	Weather						0												0			32.7	0	0	0	0	0	0	0		3.42	N/A	
29	HTP-HVO	141	tr	141-2EXP	1	1	0-10	RAG	mud	Brown	N		1-25%	Weather						0												0			29.3	0	0	0	0	0	0	0		7.54	weathered	hs
28	HTP-HVO	141	tr	141-2EXP	1	1	0-10	E	mud	Red	N		0%		ate	NA	Uni			0												0			15.8	0	0	0	13	1.6	0	0		0.91	N/A	tuff/hs
25	HTP-HVO	141	tr	141-2EXP	1	1	0-10	MEDTOOL	y	R/G	N		1-25%	h	ate				Scraper	2												0			24.3	0	0	0	0	0	0	0		2.92	N/A	
27	HTP-HVO	141	tr	141-2EXP	1	1	0-10	CompFlake	ETE	Red	N	FEATHER	0%		Expanding	NA	Uni	90		0												0			19.5	14	19.6	2.9	13.4	3.4	0	0		1.13	HT	
26	HTP-HVO	141	tr	141-2EXP	1	1	0-10	E	ETE	Pink	N		1-25%	Weather	ate	NA	Cortical			0												0			18.4	0	0	0	12.8	6.2	0	0		2.12	HT	
35	HTP-HVO	141	tr	141-2EXP	1	1	0-10	RAG	ETE	Red	N		0%							0												0			32.1	0	0	0	0	0	0	0		10.67	HT	breccia
34	HTP-HVO	141	tr	141-2EXP	1	1	0-10	MEDFLAKE	CCQ	Red	N		0%		ate					0												0			20.1	0	0	0	0	0	0	0		1.86	N/A	
33	HTP-HVO	141	tr	141-2EXP	1	1	0-10	MENT	CCQ	R/G	Y		0%							0												0			32.7	0	0	0	0	0	0	0		8.98	heat	frac heat
32	HTP-HVO	141	tr	141-2EXP	1	1	0-10	CORE	CCQ	R/G	Y		0%							0									Unifacial	Flake	Expanding	1	0	<5	28.7	0	16.4	10.5	0	0	10.6	16.7	1-2	6.52	HANGE	
31	HTP-HVO	141	tr	141-2EXP	1	1	0-10	CompFlake	D	Red	N	FEATHER	0%		Expanding	NA	Flaked	90		0												0			21.3	12.4	18.6	4.6	13.8	6.7	0	0		1.45	N/A	
36	HTP-HVO	141	tr	141-14	2	2	10-20	CompFlake	D	Red	N	HINGE	26-50%	h	Expanding	TRIMMING	Uni	0		0												0			28.5	19.2	20.9	5.4	16.7	4.7	0	0		2.89	N/A	
37	HTP-HVO	141	tr	141-14	2	2	10-20	CompFlake	mud	Red	N	PLATFORM	0%		ejuvenatio	NA	Crush	180		0												0			40.5	26.5	32.6	10.3	0	0	0	0		10.77	N/A	
38	HTP-HVO	141	tr	141-14exp	2	2	10-20	CompFlake	mud	Y/R	N	FEATHER	0%		ate	NA	Uni	0		0												0			28.8	21.2	12.4	5	14.2	9	0	0		1.73	N/A	
39	HTP-HVO	141	tr	141-14exp	2	2	10-20	MENT	D	R/G	N		0%							0												0			41.9	0	0	0	0	0	0	0		22.2	weathered	cracks
40	HTP-HVO	141	tr	141-14exp	1	1	0-10	CompFlake	mud	Red	N	FEATHER	0%		Elongated	NA	Uni	90		0												0			45.1	35.2	26.2	6	17.5	7.7	0	0		8.02	N/A	
41	HTP-HVO	141	tr	141-14exp	1	1	0-10	T	mud	Red	N	FEATHER	1-25%	Weather	Expanding	NA	Uni			0												0			48.4	48.5	0	4.5	0	0	0	0		6.95	N/A	
42	HTP-HVO	141	tr	141-14exp	1	1	0-10	PROXSPLIT	D	Brown	N		1-25%	h	ate	TRIMMING	Cortical			0												0			20.6	0	0	0	18.1	7.3	0	0		1.94	N/A	
43	HTP-HVO	141	tr	141-14	clean	clean		CompFlake	tz	Cream	N	STEP	1-25%	h	Block	NA	Cortical	180		0												0			35.5	26.3	28.7	10	10.6	3.8	0	0		9.35	N/A	
44	HTP-HVO	141	tr	141-14	1	1	0-10	CompFlake	D	Brown	N	FEATHER	0%		ate	NA	Uni	90		0												0			25.1	22.1	18.8	3	8.1	2.2	0	0		1.04	N/A	
45	HTP-HVO	141	tr	141-14	1	1	0-10	MEDFLAKE	mud	Red	Y		0%		ate					0												0			32.9	0	0	0	0	0	0	0		5.52	HANGE	
46	HTP-HVO	131	tr	131-12	2	2	10-20	MEDFLAKE	MSILCRETE	R/G	N		100%	h	ate					0												0			23.1	0	0	0	0	0	0	0		3.35	HANGE	
47	HTP-HVO	131	tr	131-12	2	2	10-20	MEDFLAKE	mud	Brown	N		0%		ate					0												0			11.4	0	0	0	0	0	0	0		0.21	N/A	
48	HTP-HVO	131	tr	131-12	1	1	0-10	MEDFLAKE	FSILCRETE	Pink	N		100%	craze	ate					0												0			13.8	0	0	0	0	0	0	0		0.84	HANGE	
49	HTP-HVO	131	tr	131-12	1	1	0-10	RAG	ETE	Red	N		0%							0												0			13.1	0	0	0	0	0	0	0		1.37	HANGE	breccia
50	HTP-HVO	131	tr	131-17	2	3	10-15	CompFlake	D	R/G	N	FEATHER	26-50%	h	Block	NA	Cortical	90		0												0			33.5	17.2	29	10.6	21.9	12.7	0	0		6.97	N/A	
51	HTP-HVO	131	tr	131-16	1	1	0-10	T	D	lyellow	N	FEATHER	51-99%	Weather	Expanding	NA	Uni			0												0			12.1	8.1	0	2.5	0	0	0	0		0.38	N/A	
52	HTP-HVO	131	tr	131-8	2	2	10-20	RAG	ood	Brown	N		0%							0												0			44.1	0	0	0	0	0	0	0		9.97	N/A	
53	HTP-HVO	169	fp	169-11	1	1	0-10	CompFlake	CCQ	yellow	N	FEATHER	100%	h	ate	NA	Missing	N/A		0												0			11.3	11.3	1.8	1.7	0	0	0	0		0.18	N/A	
54	HTP-HVO	169	fp	169-4	1	1	0-10	CompFlake	ETE	lyellow	N	FEATHER	51-99%	h	ate	NA	Missing	N/A		0												0			22	22	17.4	6.6	0	0	0	0		2.51	N/A	breccia
55	HTP-HVO	132	tr	132-9	1	1	0-10	MEDFLAKE	FSILCRETE	Y/R	Y		0%		ate					0												0			25.6	0	0	0	0	0	0	0		2.93	HANGE	
56	HTP-HVO	132	tr	132-1	1	1	0-10	E	CCQ	lyellow	N		0%		Elongated	NA	Crush			0												0			33.5	0	0	0	0	0	0	0		5.6	N/A	
59	HTP-HVO	172	hc	172-10	1	1	0-10	PROXTOOL	D	lgrey	N		0%		Elongated	NA	Uni		Utilised	2												0			20.4	0	0	0	12.1	2.7	0	0		1.74	N/A	
58	HTP-HVO	172	hc	172-10	1	1	0-10	CompFlake	D	Pink	N	HINGE	26-50%	Weather	ate	NA	Uni	N/a		0												0			17.9	17.2	12.9	5.6	9.2	3.5	0	0		13.01	HANGE	
57	HTP-HVO	172	hc	172-10	1	1	0-10	HSA	D	lgrey	N		0%		N/A					0												0			14.9	0	0	0	0	0	0	0		0.54	weathered	frac
60	HTP-HVO	172	hc	172-20	2	2	10-20	MEDFLAKE	Quartzite	lgrey	N		0%		ate					0												0			16.7	0	0	0	0	0	0	0		0.47	N/A	
61	HTP-HVO	135	tr	135-11	1	1	0-10	DISTFLAKE	mud	lgrey	N	FEATHER	0%		ate					0												0			12.6	0	0	0	0	0	0	0		0.21	N/A	
62	HTP-HVO	135	tr	135-11	1	1	0-10	DISTFLAKE	ETE	Red	Y	FEATHER	0%		Expanding					0												0			12.7	0	0	0	0	0	0	0		0.22	HT	
63	HTP-HVO	135	tr	135-11	1	1	0-10	RAG	FSILCRETE	Brown	Y		0%							0												0			14.3	0	0	0	0	0	0	0		0.31	HANGE	
64	HTP-HVO	135	tr	135-11	1	1	0-10	RAG	MSILCRETE	lgrey	Y		0%							0												0			17.6	0	0	0	0	0	0	0		1.6	HANGE	
65	HTP-HVO	135	tr	135-13	2	2	10-20	MEDFLAKE	D	R/G	N		1-25%	h	Expanding					0												0			37.6	0	0	0	0	0	0	0		8.06	N/A	
66	HTP-HVO	135	tr	135-19	2	2	10-20	E	FSILCRETE	Red	Y		0%		ate	NA	Uni			0												0			12.7	0	0	0	6.2	2.1	0	0		0.82	HANGE	
67	HTP-HVO	135	tr	135-19	2	3	10-15	DISTFLAKE	mud	Brown	N	HINGE	51-99%	h	Expanding					0												0			27.3	0	0	0	0	0	0	0		2.95	N/A	
68	HTP-HVO	135	tr	135-15	1	1	0-10	CompFlake	FSILCRETE	Red	Y	FEATHER	0%		ate	NA	Flaked	0		0												0			21.6	19.4	16.8	4	17	2.9	0	0		1.67	HANGE	
69	HTP-HVO	135	tr	135-15	1	1	0-10	RAG	FSILCRETE	Red	N		0%							0												0			20.2	0	0	0	0	0	0	0		1.51	HANGE	
70	HTP-HVO	141	tr	141-21	2	2	0-10	CompFlake	D	Red	N	FEATHER	0%		ate	NA	Uni	radial		0												0			29.6	23.3	20.7	6.4	14.3	5.7	0	0		3.81	N/A	
71	HTP-HVO	141	tr	141-21	2	2	0-10	RAG	CCQ	Brown	N		26-50%	h						0												0			39.6	0	0	0	0	0	0	0		20.87	N/A	
72	HTP-HVO	133	tr	133-8	3	3	20-30	E	D	Brown	N		0%		ejuvenatio	NA	Flaked			0												0			34.5	0	0	0	14.3	4.4	0	0		3.09	N/A	
73	HTP-HVO	133	tr	133-11	1	1	0-10	HSA	mud	Brown	N		51-99%	h	N/A					0												0			21.6	0	0	0	0	0	0	0		1.87	weathered	
74	HTP-HVO	133	tr	133-10	2	2	10-20	MEDFLAKE	CSILCRETE	R/G	N		0%		ate					0												0			24.6	0	0	0	0	0	0	0		2.07	N/A	
75	HTP-HVO	136	tr	136-13	1	1	0-10	RAG	FSILCRETE	lyellow	N		0%							0												0			18.7	0	0	0	0	0	0	0		2.01	N/A	
76	HTP-HVO	136	tr	136-19	1	1	0-10	RAG	FSILCRETE	Red	Y		26-50%	h						0												0			21.8	0	0	0	0	0	0	0		2.82	HANGE	
77	HTP-HVO	136	tr	136-15	2	2	10-20	E	ETE	Pink	N		0%		ate	NA	Uni			0												0			18.8	0	0	0	12.2	2.7	0	0		0.74	HANGE	
78	HTP-HVO	136	tr	136-15	4	4	30-40	MEDFLAKE	mud	Brown	N		0%		Expanding					0												0			12.2	0	0	0	0	0	0	0		0.11	N/A	na?
79	HTP-HVO	136	tr	136-15	3	3	20-30	DISTFLAKE	mud	lyellow	N	HINGE	0%		Expanding					0												0			22.1	0	0	0	0	0	0	0		0.58	weathered	
80	HTP-HVO	136	tr	136-5	3	5	20-25	CompFlake	FSILCRETE	Red	N	STEP	0%		Blade	NA	Facetted	0		0												0			28.3	26.2	12.1	4.7	11.1	2.4	0	0		1.72	HANGE	
81	HTP-HVO	136	tr	136-5	3	5	20-25	CompFlake	D	yellow	N	FEATHER	0%		Expanding	NA	Uni	0		0												0			9.3	6.8	9	1.3	2.2	1.2	0	0		0.14	N/A	
82	HTP-HVO	136	tr	136-5	3	6	25-30	DISTFLAKE	mud	Brown	N	HINGE	0%		Expanding					0												0			9.4	0	0	0	0	0	0	0		0.09	N/A	
83	HTP-HVO	136	tr	136-5	2	3	10-15	DISTFLAKE	ETE	R/G	Y	FEATHER	0%		ate					0												0			30.7	0	0	0	0	0	0	0		2.72	HANGE	
84	HTP-HVO	136	tr	136-7	2	2	10-20	RAG	ETE	g/p	Y		1-25%	LGRIND						0												0			40	0	0	0	0	0	0	0		31.89	HANGE	
85	HTP-HVO	136	tr	136-7	2	2	10-20	RAG	CCQ	Red	N		1-25%	LGRIND						0												0			46.4	0	0	0	0	0	0	0		25.29	N/A	
86	HTP-HVO	136	tr	136-7	3	3	20-30	DISTFLAKE	ETE	Red	N	FEATHER	1-25%	LGRIND	ate					0												0			24.4	0	0	0	0	0	0	0		1.78	HANGE	
87	HTP-HVO	136	tr	136-17	2	2	10-20	CompFlake	D	lgrey	N	STEP	0%		Blade	NA	Uni	0		0												0			45.8	45.4	25.6	7.7	12.6	3.1	0	0		9.96	N/A	
88	HTP-HVO	136	tr	136-2	1	1	0-10	CompFlake	D	yellow	N	FEATHER	0%		Expanding	NA	Uni	0		0												0			21.2	9	21.1	2.5	20.4	3.1	0	0		0.81	N/A	
89	HTP-HVO	136	tr	136-2	2	2	10-20	CompFlake	mud	yellow	N	FEATHER	26-50%	h	Elongated	NA	Uni	90		0												0			63.7	55.9	23.8	6	17.8	4.7	0	0		9.4	N/A	
90	HTP-HVO	140	tr	140-11	1	1	0-10	RAG	ETE	Red	N		0%							0												0			16.8	0	0	0	0	0	0	0		1.52	HANGE	
91	HTP-HVO	140	tr	140-11	1	1	0-10	E	mud	yellow	N		0%		Expanding	NA	Crush			0												0			16.8	0	0	0	0	0	0	0		0.38	N/A	
92	HTP-HVO	140	tr	140-11	1	1	0-10	PROXSPLIT	mud	R/G	N		0%		ate					0												0			14.9	0	0	0	0	0	0	0		0.78	N/A	
93	HTP-HVO	140	tr	140-11exp	3	3	20-30	MEDFLAKE	FSILCRETE	Red	N		0%		ate					0												0			13.7	0	0	0	0	0	0	0		0.25	HANGE	
94	HTP-HVO	140	tr	140-11exp	3	3	20-30	MEDFLAKE	FSILCRETE	Red	Y		0%		ate					0												0			15.7	0	0	0	0	0	0	0		0.83	HANGE	

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