

HERITAGE IMPACT ASSESSMENT FOR MULTIPLE PROPOSED SOLAR ENERGY FACILITIES ON DE AAR 180/1 (BADENHORST DAM FARM), DE AAR, NORTHERN CAPE

(Assessment conducted under Section 38 (8) of the
National Heritage Resources Act (No. 25 of 1999) as part of an EIA etc.)

Prepared for

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1st draft: 20th May 2013
Final version: 9th July 2013



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EXECUTIVE SUMMARY

ACO Associates cc was appointed by Aurecon South Africa (Pty) Ltd to assess the potential impacts to heritage resources that might be experienced through construction and operation of several solar energy facilities on the farm De Aar 180, just outside De Aar, Northern Cape. The farm is known locally as Badenhorst Dam. Alternative 1 includes the construction of four solar energy facilities and related infrastructure, while Alternative 2 involves construction of three larger facilities and related infrastructure.

The landscape is generally flat but a low dolerite ridge cuts the western part of the site and a cluster of hills lies in the southeast. South of the N10 (included in Alternative 2) the land is generally flat. The ground surface is covered in grass and small bushes.

Archaeological resources were encountered on the site. These include numerous small stone-built features of varying age along the dolerite ridge as well as a number of scatters of stone artefacts.

The built environment will not be impacted and historical archaeological material was scarce.

While the ridge must be avoided (and has been avoided in the planning thus far), the Middle and Later Stone Age sites in other areas should be avoided if possible. If avoidance is not possible, it is quite feasible to conduct mitigation of archaeological sites.. This would involve excavation and collection of artefacts.

The general landscape will also be impacted through loss of context and sense of place. These impacts would be experienced primarily from the surrounding roads which provide access to areas with good scenic qualities – the N10 is particularly relevant here. However, given the many other similar facilities planned for the immediate area (two are already under construction), there is little that one can do to mitigate these impacts. The dolerite hills in the southeast of the site will also shield much of the development from northwest-bound traffic on the N10.

Both Alternatives are acceptable although Alternative 1 is strongly preferred. The following recommendations apply:

- Where archaeological sites cannot be avoided, mitigation in the form of excavation and collection of artefacts should be carried out;
- The dolerite ridge with all its archaeological features must be avoided;
- If any human remains are encountered during the development they should be cordoned off and protected from further harm until they can be inspected and removed by an archaeologist under a permit issued for that purpose; and
- Once the exact lines have been identified for the linear components of the project they should be examined from the desktop then subjected to a walk-down if deemed necessary.

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Each of the proposed PV facilities would consist of the following:

- Numerous arrays of PV panels and associated support infrastructure to generate up to 75MW per facility through the photovoltaic effect;
- 132kV overhead transmission lines to connect each facility to the central onsite substation or an existing Eskom substation;
- An onsite 132kV, 3 bay substation; and
- A boundary fence for health, safety and security reasons (Aurecon 2013).

Furthermore, the project as a whole will require the following components which, it is envisaged, could be shared by all four facilities:

- One central 132kV substation and connection to Eskom grid. This central substation will connect the PV facilities with Eskom's Hydra substation via either an existing overhead 132kV Eskom line or by constructing a new 132kV transmission line directly to Hydra substation;
- An access road and internal access roads for servicing and maintenance of the site;
- Water supply infrastructure to carry water to the site and store it there;
- Stormwater infrastructure including drainage channels, berms, detention areas and kinetic energy dissipaters; and
- Buildings that would likely include onsite substations, a connection building, control building, guard cabin, an electrical substation and solar resource measuring substation (Aurecon 2013).

A single 75 MW facility (PV1) has already been approved for the farm and the present study considers a further four such facilities with a total area of 879 ha. These are known as PV2 to PV5. Several alternatives are being considered for the project as follows:

- Layout: At present legislation only permits development of 75 MW solar energy facilities but should this change then alternative layouts would see three facilities with capacities of up to 150 MW being considered. This alternative would introduce a new piece of land in the south of the farm, south of the N10 freeway;
- Technology: different types of solar panels and mounting alternatives are being considered, but, since these do not variably affect the impacts to heritage resources, they are not described further;
- Transmission lines and substations: corridors for the siting of these components have been identified for assessment; and
- The No-Go alternative assesses the status quo of the property (including the already authorised PV1; Aurecon 2013).

1.1. Terms of reference

A detailed terms of reference is available in the Draft Scoping Report but, briefly, it is required that ACO Associates identifies, maps and assesses the impacts to heritage resources on the site including archaeology, built environment and cultural landscapes. Palaeontological impacts will be assessed by an independent specialist. Mitigation measures to reduce the significance of impacts should also be recommended as well as details of how heritage resources should be managed on the site.

2. HERITAGE LEGISLATION

The National Heritage Resources Act (NHRA) No. 25 of 1999 protects a variety of heritage resources including palaeontological, prehistoric and historical material (including ruins) more than 100 years old (Section 35), human remains older than 60 years and located outside of a formal cemetery administered by a local authority (Section 36) and non-ruined structures older than 60 years (Section 34). Landscapes with cultural significance are also protected under the definition of the National Estate (Section 3 (3.2d)). Section 38 (2a) states that if there is reason to believe that heritage resources will be affected then an impact assessment report must be submitted. This report fulfils that requirement.

Since the project is subject to an Environmental Impact Assessment, Heritage Northern Cape and the South African Heritage Resources Agency (SAHRA) are required to provide comment on the proposed project in order to facilitate final decision making by the Department of Environmental Affairs (DEA).

3. METHODS

3.1. Literature survey

For the original report, a survey of available literature was carried out to assess the general heritage context into which the development was to be set. This literature included published material, unpublished commercial reports and online material. In the present report this same information has been used and updated as necessary.

3.2. Field survey

The site was examined through a combination of driving and walking (see Appendix 1). The latter was employed to examine specific locations considered to be of heritage interest and also to conduct random examination of other areas. The survey was carried out on 5th May 2013. During the surveys the positions of finds were recorded on a hand-held GPS receiver set to the WGS84 datum. Photographs were taken at times in order to capture representative samples of both the affected heritage and the landscape settings of the proposed developments.

3.3. Impact assessment

For consistency among specialists, the impact assessment ratings were done using a scale supplied by Aurecon. Each individual solar energy facility is given an assessment, while a cumulative assessment for all facilities proposed on the farm is also included.

It is also relevant to note that the estimation of mitigation requirements from the original 2011 report has been revised in view of the fact that far larger areas of the landscape will be developed with the current proposal.

3.4. Limitations & assumptions

Due to the large size of the study area it was not possible to cover all the ground via a detailed foot survey. The southern part of the site (incorporated within Alternative 2) was not

visited. However, given the nature of the site and the heritage resources located thereon, it is believed that the survey has captured a sufficient sample of all heritage resources to enable accurate prediction of impacts. Heritage resources (in particular archaeological ones) were found to be tied to landscape features that are easily located by vehicle. Assuming this pattern to hold true, this suggests that relatively few such resources will have been missed during the survey.

4. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The site is generally quite flat with very gently undulating terrain traversed by a number of existing power lines. The landscape is covered in low grass and bushes with bare patches in places. However, several dolerite ridges are present in and around the edges of the site. These form features of between 1 m and approximately 15 m high. The ground surface is generally sandy with a light covering of shale and/or dolerite gravel (Figure 4), but on the ridges it is more rocky (Figure 5).

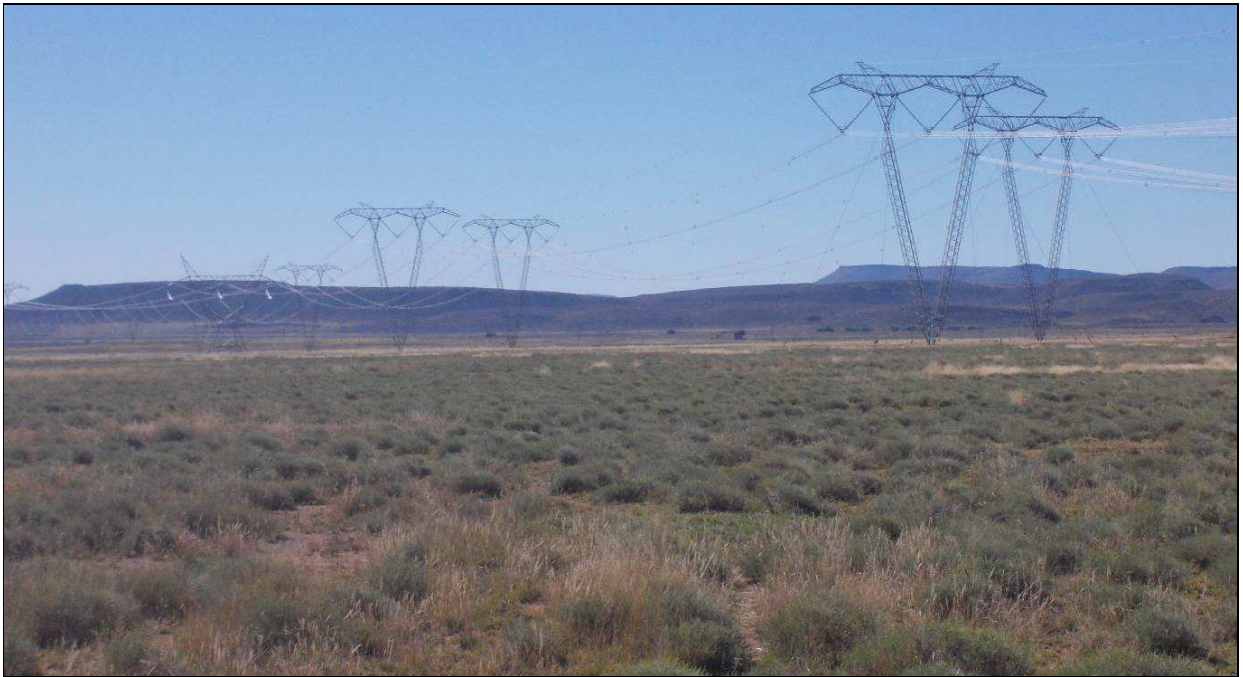


Figure 2: View across the study area showing level terrain and exiting power lines.



Figure 3: View towards the west from the top of one of the taller dolerite ridges.



Figure 4: Ground surface on the plains in the study area.



Figure 5: Ground surface on one of the rocky ridges in the study area.

5. HERITAGE CONTEXT

The Karoo has a long pre-colonial history as testified by the many thousands of stone artefacts that can be found among surface gravels in many areas. The vast majority of these artefacts are heavily weathered indicating great antiquity and relate to the Early (ESA) and Middle Stone Ages (MSA). However, of more significance, due to their better integrity, are the Later Stone Age (LSA) sites that occur from time to time. The stone artefacts from such sites are generally unweathered or else very slightly weathered and do not occur as widespread background scatters but are more concentrated indicating places where people actually camped. The assemblages also include distinctive retouched forms that can sometimes help to determine more precisely the age of the site. All these types of artefact scatters were located on the earlier survey (Orton 2011), while on other surrounding farms MSA artefacts (Fourie 2011; Kruger 2012) and LSA sites (Morris 2011) have been recorded. Sampson's (1985) work in the Seacow River valley has led to the identification of three phases of LSA archaeology based on the types of stone artefacts found. During the early Holocene larger scrapers typified what Sampson called the "Lockshoek" Industry. The "Interior Wilton" followed with the sorts of microlithic tools commonly found on mid-Holocene sites throughout South Africa. Pottery was present on the latest of these sites and on most of the "Smithfield" sites that followed. These three industries are similar to those described as "late Pleistocene – early Holocene non-microlithic", "Holocene microlithic" and "late Holocene assemblages with pottery" which are more generalised and widely applicable throughout the country (Deacon 1984) though sites dating to the latter period are frequently not associated with pottery and assemblages from this phase are better referred to simply as "Late Holocene assemblages" (Orton 2006).

Probably the most significant aspect of Karoo archaeology is the presence of many prehistoric stone kraals. Most notably, the Seacow River valley to the east of the present study area has revealed many such kraals (Sampson 1984, 1985, 1986, 2010) and enabled a kraal typology to be constructed (Hart 1989). The kraals are typically constructed on sloping ground against dolerite ridges and overlooking water sources. Domestic debris and stone artefacts are seldom associated with them, but when they are, they are taken to represent either the pastoralists camping alongside their kraals or else later re-occupation of

the kraals by hunter-gatherer people (Sampson 1985). While no kraals were located during the initial survey, a number of small circular stone features were found (Orton 2011). These could represent domestic spaces. Others have also located small archaeological stone-built features on the landscape (Fourie 2011; Morris 2012). Although pottery is often taken to signify pastoralist occupation, Sampson (2010) and others (Bollong *et al.* 1993, 1997; Rudner 1979) have shown that in the interior some pottery is tempered with fibre and was made by Bushmen hunter-gatherers rather than Khoekhoe pastoralists.

The LSA stone artefacts found in the Karoo are not very well understood, perhaps largely as a result of the general lack of datable occurrences. Very few rock shelters have been found and excavated (e.g. Hart 1989) and the vast majority of occurrences are open scatters of artefacts with no associated organic materials. It appears that the earlier periods of the LSA are poorly represented in the Karoo, if at all, while sites dating to the last few thousand years are routinely located. Most LSA artefacts in the central Karoo region are made from hornfels, a dark-coloured rock that forms through metamorphosis of the country rocks surrounding dolerite intrusions. Small thumbnail and end scrapers are frequently encountered and adzes and spokeshaves also form an important part of the retouched component. Rock art is also known from the area (De Aar, n.d.b) but further details are unknown.

The colonial period history of the area is not that old. While the town of De Aar only dates back to 1903, just after the cessation of the 1899-1902 Anglo-Boer War, farms were given out and surveyed in the 1800s. Unfortunately it was not possible to source the earliest survey diagrams from the Surveyor General, but, from references on later diagrams, De Aar 180 and Du Plessis Dam 179 go back at least to 1863. The railway junction dates to 1881 when Cape Town and Kimberley were linked by rail after diamonds were discovered at the latter town. It was very important to the British during the Anglo-Boer War since railway lines from Cape Town and Port Elizabeth joined here and extended on through Kimberly to Mafikeng (AngloBoerWar.com 2011). De Aar was also the site of the first use of wireless telegraphy in South Africa where the British employed it to maintain communications between their various columns operating in the area. However, owing to the climatic conditions in the Karoo, the wireless sets, which were designed for shipboard use, could not perform properly and were soon withdrawn from inland service (Baker 1998). The town was laid out around the railway junction on the farm De Aar which was purchased in 1889 by Isaac and Wolf Friedlander, who ran a trading store and hotel at the railway junction (Figure 6). After the war, the brothers established the town. Its municipality was formed in 1904 and the first mayor, Dr Harry Baker, was elected in 1907 (De Aar, n.d.a).

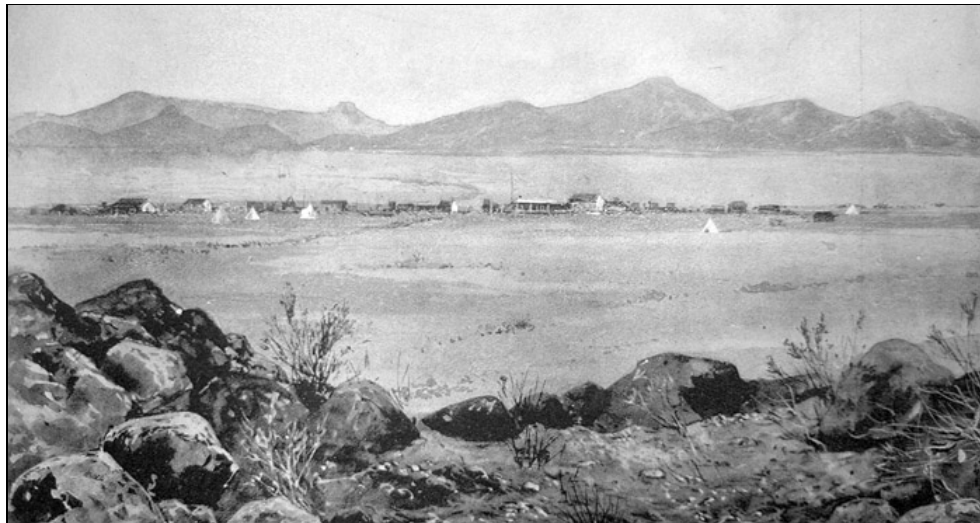


Figure 6: View of De Aar around the time of the Anglo-Boer War and showing the railway line and station hotel at De Aar (Source: AngloBoerWar.com 2011).

Two Provincial Heritage Sites occur in De Aar. These are the “Olive Schreiner house” and the “St Paul’s Church”. The Standard Bank building is listed on the heritage register (SAHRA, n.d.). Many of the older buildings in the town are early 20th century, including some art deco, but the majority of structures date to the mid- to late 20th century. De Aar is well known as one of the places where Olive Schreiner lived. She and her husband were there from 1907 to 1914.

6. FINDINGS

The initial survey presented a set of findings from the farm and, while those findings are also directly relevant here, this section illustrates further examples. All finds from both surveys are tabulated together in Appendix 2.

6.1. Archaeology

Archaeological resources, while not abundant, are fairly widespread across the site. The majority are Stone Age, dating to both the MSA and LSA. With one exception, good *in situ* sites were absent. The most common resources were scatters of highly patinated MSA artefacts in flat, low-lying areas where erosion has exposed and concentrated them. The artefacts are easily identified by the heavy patination that they have experienced through many millennia of lying in the open – their surfaces turn to a brown colour (the fresh rock is black; Figures 7 - 10). In our experience it is unusual to find dense concentrations of such older artefacts that are suited to mitigation, although others have recommended mitigation on such scatters on other farms in the area. Both the sites noted here (DAR2013/002 and DAR2013/004) had very high frequencies of blades among their flakes.

As expected, one of the sites was in an eroded low-lying area (DAR2013/002; Figure 4), but the other was spread over the side and crest of a low rise in the north-eastern part of the farm. This latter site was found to be quite extensive – it stretches 300 m north-south and 100 m east-west. Walking across the site it was quite clear that the artefacts drop off dramatically as one moves away from the foot of the hill (westwards and northwards) and similarly they

drop off towards the east as one crosses the crest of the hill. For whatever reason, the site is confined to the northern part of the low ridge. Within the southern part of the spatial extent of the scatter there is an overprinting of LSA artefacts. These include a lower grindstone found with the groove facing upwards (at J092). The difference between the older artefacts and the less patinated ones is shown by the three small artefacts at the lower right of Figure 10. No collection of artefacts from the LSA component of the site was made for photography since it was desirable not to disturb the site. However, Figure 11 shows a view of the ground surface at one of the densest patches (point J092).



Figures 7 & 8: Stone artefacts from the open scatter at DAR2013/002 (J068 & L062).



Figure 9: Stone artefacts from DAR2013/014 (point 081).

Figure 10: Stone artefacts from DAR2013/014 (point 089).

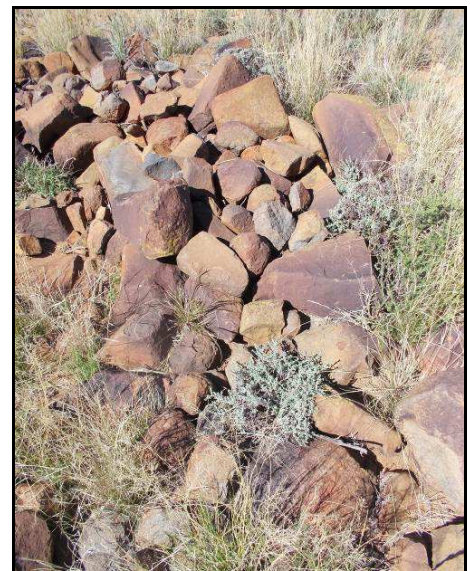
The earlier survey documented a number of stone-built features along the dolerite ridge crossing the western part of the farm (Orton 2011). On this survey we examined other parts of the ridges that were not checked before and many more similar features were documented. Given their lengthy treatment in the earlier report, these are not described further here save to mention that some were clearly historical due to being constructed via the ‘two skins and a rubble fill’ method (Figures 12 & 13), while others, from their ad-hoc ‘piled’ construction method may be pre-colonial. All the stone circles and features are confined to the ridges, either on top or at the foot – very few were found to be mid-slope.

Another archaeological feature of interest is the finding of a single ‘rock gong’. Such rocks have been documented in the Karoo before, particularly at Nelspoort, between Beaufort West and Three Sisters (Ouzman, n.d.). The example found at De Aar has a slab of rock perched

at an angle on other rocks and along the uppermost lip are three zones where the rock has been struck to produce a metallic ringing sound. The rock lies at the top of a dolerite ridge. Also on the slab is a fine-line engraving that looks to be of an animal. A little further along the same ridge was a 'scratched rock' of the sort found more commonly on the ridge crossing the western part of the farm (Orton 2011). The function of these rocks is unknown, but they can be classified as rock art in the broadest sense (Figures 15 & 16).



Figure 11: View of the ground surface at DAR2013/014 (point J092) showing the black LSA artefacts on the brown gravel.



Figures 11 & 12: The stone circle at DAR2013/004 (J071). The two skins and rubble fill can be seen, although the walls have collapsed to some degree.

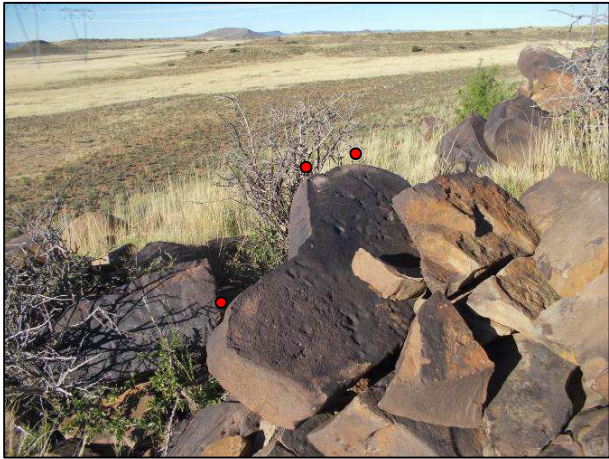


Figure 13: The rock gong at DAR2013/015 (point J093). The three places where it has been struck are marked with red dots.



Figure 14: Close-up photograph of a faint, fine-line engraving found on the rock gong. It was positioned near the middle red dot in Figure 13.



Figure 15: The scratched rock at DAR2013/016 (point J094). The book is 21 cm long.



Figure 16: Close-up of one of the four scratched patches illustrated in Figure 15.

Historical archaeological material was rather limited. In the south-eastern part of the main study area was a scatter of historical material. It lay directly across the railway line from a stone house which in turn is immediately alongside the railway line, within its servitude and thus outside of the study area. Given the proximity, the house probably relates to the railway line and it seems likely that the historical material in turn relates to the house. It consists of a few pieces of metal and glass. One tin was a sardine tin with “Norway” and “Norvège” embossed on it, while a larger tin bore the name “Tower Paraffin”. Another tin had been made into a small bucket through the addition of a wire handle. Others like it were seen on sites to the north of this farm (Orton & Webley in prep.). One stone circle contained a few fragments of dark green historical glass, while on the same hill where the extensive MSA and LSA scatters were found there were a few historical items including metal, glass and a Westley Richards No. 2 musket cartridge (Figure 17). This type of rifle was manufactured in the late 18th century. Alongside these artefacts was a small stone cairn that likely relates to the historical finds (Figure 18). Whether these pertain to the Anglo-Boer War cannot be said but it is possible.



Figure 17: Artefacts from DAR2013/014 (point J093). Scale in cm.



Figure 18: The stone cairn on the crest of the hill at DAR2013/014 (point J093).

At one of the stone circle sites there was a modern rifle cartridge and this suggests use of the stone walling as a hunting blind. Whether the walling was constructed recently or simply reused cannot be said with any certainty.

The earlier survey documented the extensive historical graffiti in the southern part of the Alternative 1 study area (Orton 2011). The discussion is not repeated here, but the site remains important and is considered during the impact assessment.

6.2. Built environment

Only one intact building (at the Badenhorst Dam farm werf) and one ruin (that previously mentioned along the railway line) were located – both are outside of the proposed development footprints and should not be impacted in any way. The Badenhorst Dam building appears to have been built in two phases with the earlier, intriguingly, being in brick and stone and the later just in stone. The joinery of the original structure suggests the 1930s or perhaps 1940s, while the stone addition to the east side is probably not much more recent. The house alongside the railway line was built of stone with at least those along the visible north-facing façade being well dressed (Figure 20). The artefacts noted above lay in the grass in the foreground of Figure 20, while the railway line is between the house and the fence.



Figure 19: The farm building at DAR2013/024 (point J112).



Figure 20: The stone house ruin at DAR2013/001 (point J067).

6.3. Cultural landscapes

The landscape around De Aar and on Badenhorst Dam has only been very minimally altered by humans. However, the town of De Aar lies immediately alongside the proposed development. Although the facility would pose a negative visual impact to the context of the town, including a graveyard, the part of town being impacted is entirely modern.

6.4. Scenic routes and sense of place

The landscape around De Aar is one of great natural beauty and has a very distinctive character with grasslands stretching for great distances, punctuated only by typical flat-topped Karoo hills (Figure 21). Any road traversing the area can be considered a scenic route – in this instance the N10 passing by the southern part of the site (and indeed through the site for Alternative 2) is relevant. For Alternative 1 the development will not be readily visible from the N10 except from a short stretch as one leaves the town travelling south-eastwards. Thereafter the natural topography will screen the site from view. Northwest-bound traffic will only see Alternative 1 briefly before reaching De Aar. Nevertheless, the addition of solar energy facilities with their distinct industrial character to the natural (and rural) landscape will result in a change of character and loss of context. Many other solar energy facilities have been planned in the area east of De Aar (two are already under construction) and this will provide a new cultural landscape to the area.



Figure 21: View towards the northwest across the study area from one of the hills in the southeast.

6.5. Graves

No graves or possible graves were found during the study. However, it should be noted that pre-colonial graves are often completely unmarked and can be located anywhere where the soil is suitable for digging a grave.

7. ASSESSMENT OF IMPACTS

Impacts to archaeological heritage resources will occur at the construction phase and thereafter remain unchanged through the operational and decommissioning phases. This is because once they are destroyed they cannot be recreated. For cultural landscapes impacts would be experienced during construction and operation but then, with rehabilitation, would revert to the status quo (assessed as the No-Go alternative) after decommissioning.

Archaeological resources are widespread but of generally limited significance. Those with research value are located in two main areas: one is along the dolerite ridge that runs from northwest to southeast across the western part of the farm and the second is the low ridge in the north-eastern corner (Figure 22). One other site requiring mitigation lies in the southwest. Only one stone cairn with a low chance of being a burial was located and this should be tested during the mitigation phase. It is in the north-eastern part of the farm. In terms of Alternative 2, the same archaeological sites would be impacted but in addition there is a small rocky hill at S30° 43' 06" E24° 03' 40" in the southeast corner of the Alternative 2 (PV4) site that should be avoided as it has a high likelihood of associated archaeological remains.

The mitigation measures required are as follows (indexed to Table 1):

1. All PV layouts for either Alternative should avoid the dolerite ridge which has a high density of archaeological remains associated with it. This has already been factored into the design and is thus not an issue;
2. For Alternative 1 PV3 and PV5 archaeological mitigation in the form of excavation, sampling and analysis should be carried out for the MSA and LSA sites that will be impacted (Figure 22). An estimate on the amount of time required on site for each archaeological site is indicated in Appendix 2. Note that avoiding and protecting these sites is always preferred when feasible, but they are not of such a nature that their protection should be required;
3. If Alternative 2 (PV4) is to be constructed then this area will need to be checked for archaeological remains. In any event, the rocky hill should be avoided (Figure 23); and
4. Once the exact lines have been identified for the linear components of the project they should be examined from the desktop then subjected to a walk-down if deemed necessary.

While visual impacts to the local landscape will undoubtedly be the most significant heritage-related impacts that would be experienced through implementation of the proposed developments, the significance of this impact is to a large degree off-set by the similar facilities currently being planned for the surrounding landscape. Two are already under construction to the north. This, and the fact that much of Alternative 1 is shielded from view from the N10, has resulted in a reduction in the significance of the impacts.

For Alternative 2 we would be looking at similar impact assessment rating to Alternative 1 but with Extended PV4 having a particularly high landscape and scenic route impact due to being located on both sides of the N10 (Table 1). While archaeological resources within the extended PV4 area have not been examined, the flatness of the terrain leads to the expectation that impacts will be low. Some mitigation may be required. The No-Go alternative would result in maintenance of the status quo. Impacts to archaeological resources would continue at a very limited scale through trampling by grazing livestock and possibly collection of artefacts by visitors to the farm, while the cultural landscape would remain entirely unchanged and experience neutral impacts.

Due to the relatively narrow width of the transmission corridors, the transmission lines will have the same level of impact no matter where in the corridors they are constructed. Archaeological impacts, too, will not differ since no sites requiring mitigation were identified in the corridors.

Cumulative impacts are not very easy to assess, since archaeological resources, in particular, are point-specific. Each is unique and, while the general locations of sites can often be predicted, there is no guarantee that a site will be found in an expected location. For this reason one cannot be sure how many sites will be lost relative to the number and type of sites occurring in the local and wider regions. A review of reports conducted for other renewable energy projects in the area suggests that the MSA and LSA sites found on Badenhorst Dam are fairly typical of the area. The significance of impacts has thus been kept the same at all scales (Table 2).

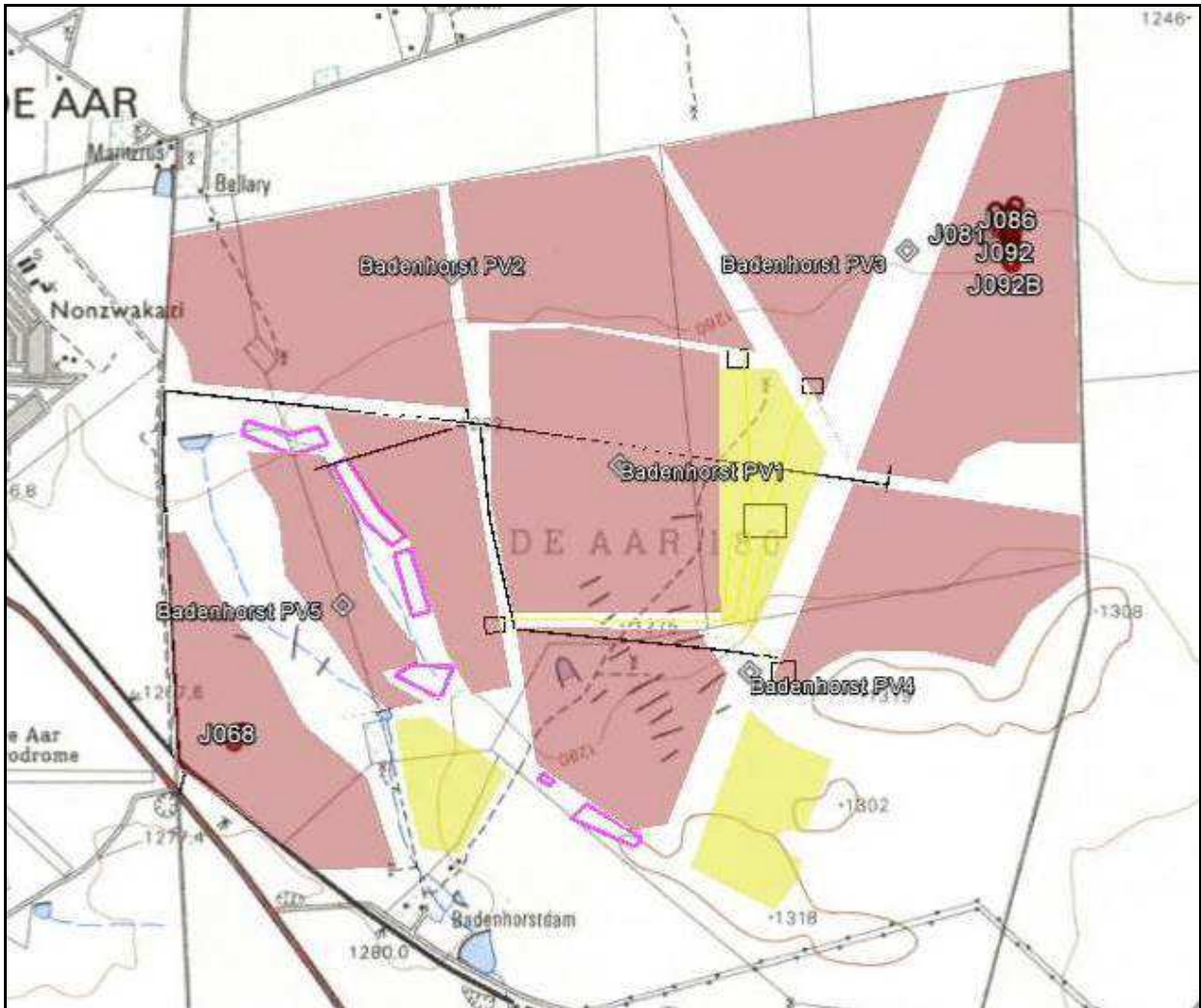


Figure 22: Map showing the locations of archaeological sites requiring mitigation (red numbered symbols at upper right and lower left) and those that should be avoided (pink polygons). The red shading indicates the Alternative 1 project footprints and the yellow areas are proposed laydown areas.

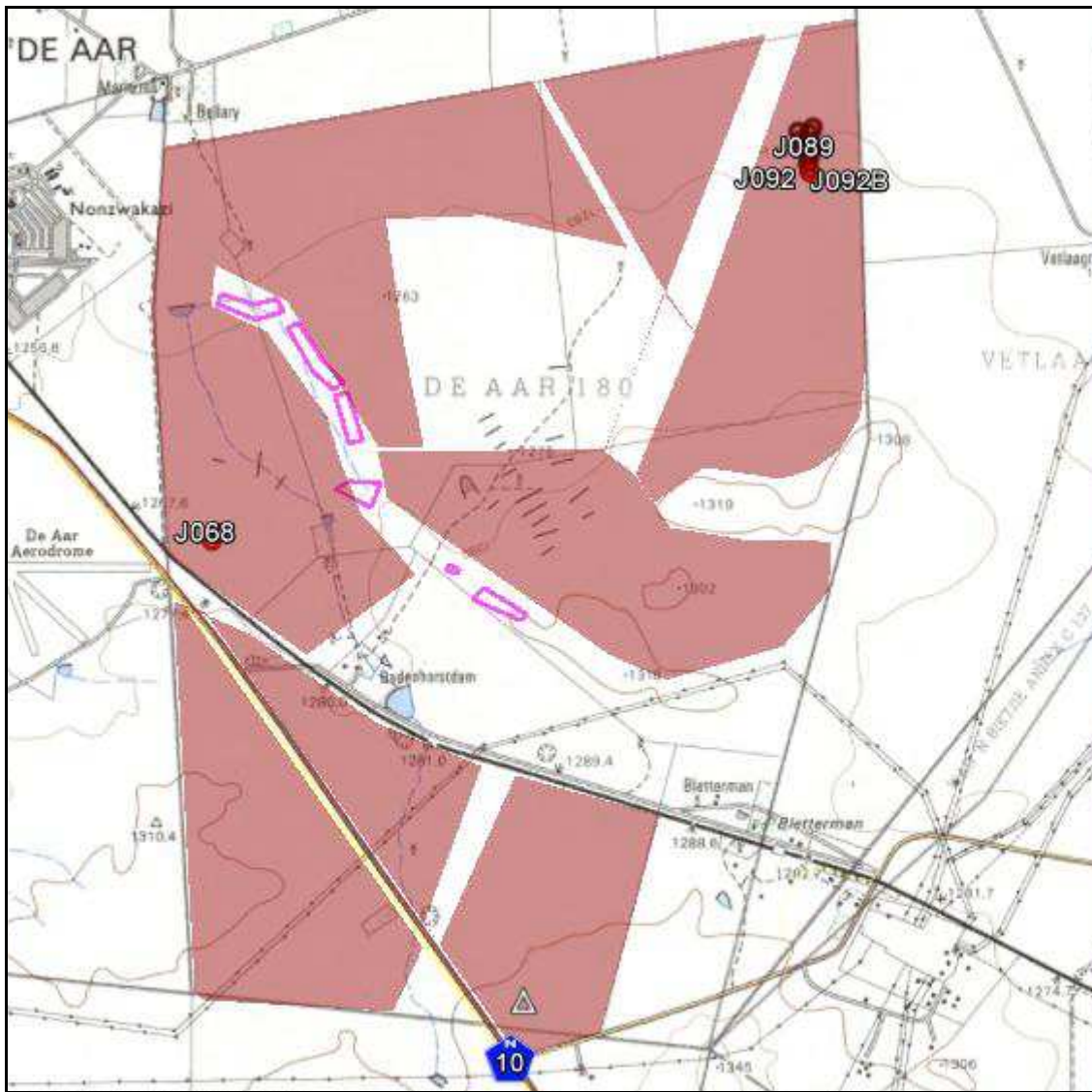


Figure 22: Map showing the locations of archaeological sites requiring mitigation (red numbered symbols at upper right and centre left) and those that should be avoided (pink polygons). The red shading indicates the Alternative 2 project footprints and the triangle near the bottom a small rocky hill that should be avoided.

Table 1: Assessment of heritage impacts for all Alternatives. Mitigation measures as described above.

Impact on Heritage Resources:

project	Key impacts	No mitigation /Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility	Mitigation measures
Alt. 1, PV2	Archaeology	No mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	None
	Cultural landscape	No mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	
		Mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	None
Alt. 1, PV3	Archaeology	No mitigation	Site specific	Medium	Permanent	Medium (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	2
	Cultural landscape	No mitigation	Local	Low	Long term	Low (negative)	Definite	Sure	Reversible	
		Mitigation	Local	Low	Long term	Low (negative)	Definite	Sure	Reversible	None
Alt. 1, PV4	Archaeology	No mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	1
	Cultural landscape	No mitigation	Local	Low	Long term	Low (negative)	Definite	Sure	Reversible	
		Mitigation	Local	Low	Long term	Low (negative)	Definite	Sure	Reversible	None
Alt. 1, PV5	Archaeology	No mitigation	Site specific	Low	Permanent	Low (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	1, 2
	Cultural landscape	No mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	
		Mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	None
Alt. 2, Ext. PV2	Archaeology	No mitigation	Site specific	Low	Permanent	Low (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	1, 2
	Cultural landscape	No mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	
		Mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	None
Alt. 2, Ext. PV3	Archaeology	No mitigation	Site specific	Medium	Permanent	Medium (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	1, 2
	Cultural landscape	No mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	
		Mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	None
Alt. 2, Ext. PV4	Archaeology	No mitigation	Local	Low	Permanent	Medium (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	1
	Cultural landscape	No mitigation	Local	High	Long term	High (negative)	Definite	Sure	Reversible	
		Mitigation	Local	High	Long term	High (negative)	Definite	Sure	Reversible	3
Alt. 2, Ext. PV4	Archaeology	No mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	None
	Cultural landscape	No mitigation	Local	Very low	Long term	Very low (neutral)	Definite	Sure	Reversible	
		Mitigation	Local	Very low	Long term	Very low (neutral)	Definite	Sure	Reversible	None

project	Key impacts	No mitigation /Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility	Mitigation measures
No-Go	Archaeology	No mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	None
	Cultural landscape	No mitigation	Local	Zero	Long term	Neutral	Definite	Sure	Reversible	
		Mitigation	Local	Zero	Long term	Neutral	Definite	Sure	Reversible	None

Table 2: Cumulative assessment of heritage impacts for all Alternatives.

Cumulative impact on Heritage Resources:

	Key impacts	No mitigation /Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility	Mitigation measures
Badenhorst Dam	Archaeology	No mitigation	Site specific	Low	Permanent	Low (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	1, 2
	Cultural landscape	No mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	
		Mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	
Local extent	Archaeology	No mitigation	Site specific	Low	Permanent	Low (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	2
	Cultural landscape	No mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	
		Mitigation	Local	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	
Regional extent	Archaeology	No mitigation	Site specific	Low	Permanent	Low (negative)	Definite	Sure	Irreversible	
		Mitigation	Site specific	Very low	Permanent	Very low (negative)	Definite	Sure	Irreversible	2
	Cultural landscape	No mitigation	Regional	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	
		Mitigation	Regional	Medium	Long term	Medium (negative)	Definite	Sure	Reversible	

8. CONCLUSIONS

This heritage impact assessment has found that there will be impacts to heritage resources if the proposed solar energy facilities are constructed. Two major types of heritage resources will be impacted: archaeological sites and the cultural landscape. While those archaeological sites not located on the dolerite ridge (i.e. the artefact scatters) can be easily mitigated if they are not protected and conserved, the landscape impacts will be more substantial and cannot easily (if at all) be mitigated. Given the scale of solar energy development planned for the region, there is little sense in attempting to shield the presently proposed developments from view.

Nevertheless, this report finds that construction of the proposed developments is feasible. Alternative 2 would result in a very high magnitude of visual impact to the landscape along the N10 scenic route. Alternative 1 is thus strongly favoured, since all impacts would be kept to one side of the road and the landscape to the south would remain free of industrial intrusions.

9. RECOMMENDATIONS

The proposed project could be allowed to proceed with either Alternative, although Alternative 1 is strongly preferred. The following recommendations apply:

- Where archaeological sites cannot be avoided, mitigation in the form of excavation and collection of artefacts should be carried out;
- The dolerite ridge with all its archaeological features must be avoided;
- If any human remains are encountered during the development they should be cordoned off and protected from further harm until they can be inspected and removed by an archaeologist under a permit issued for that purpose; and
- Once the exact lines have been identified for the linear components of the project they should be examined from the desktop then subjected to a walk-down if deemed necessary.

10. HERITAGE MANAGEMENT

In addition to the recommendations made above, the following management measures are suggested:

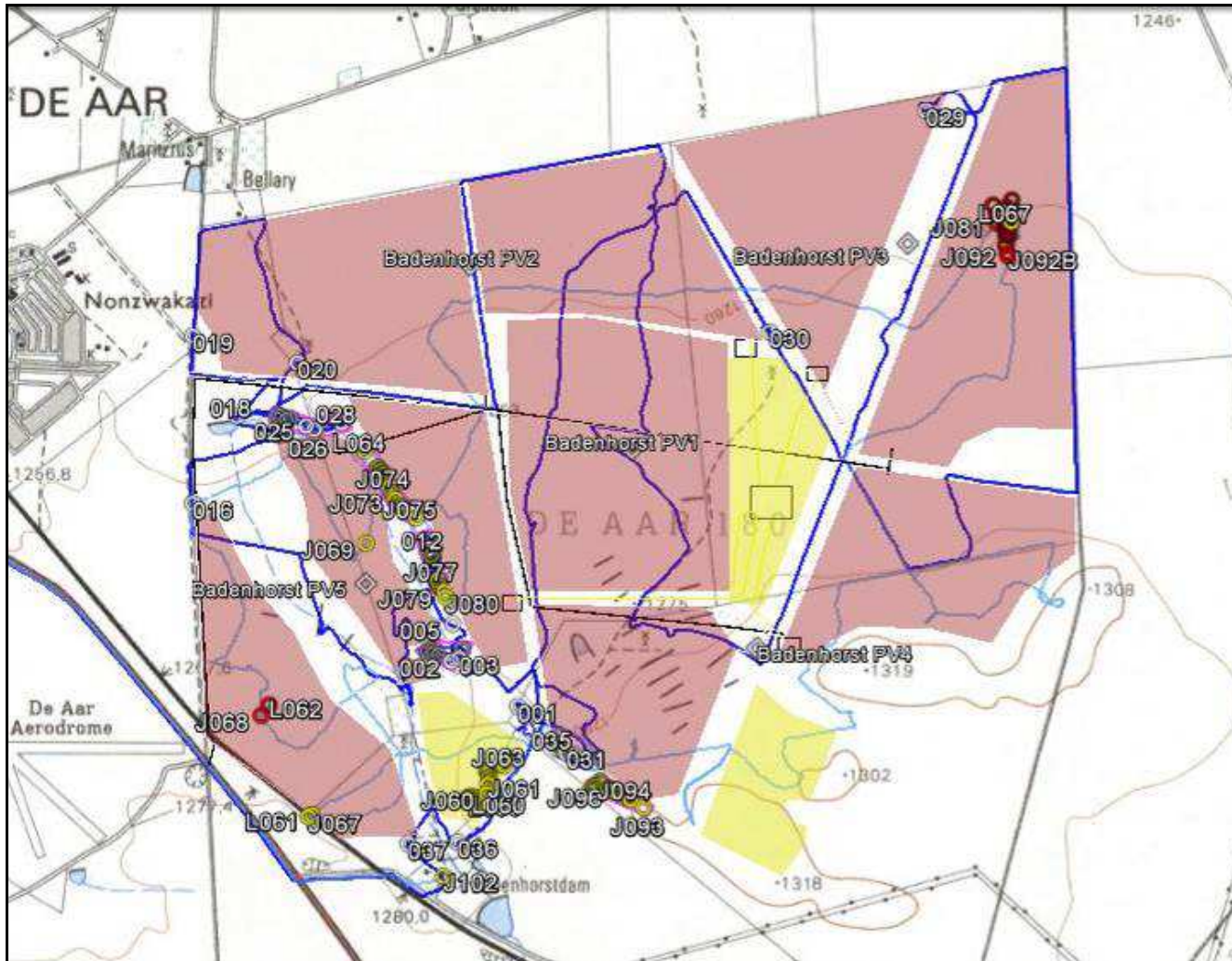
- All mitigation-worthy archaeological sites that are avoided by the development and are not mitigated should be protected from incidental damage (for example from vehicles driving over them or through the establishment of power line access tracks);
- Any dense subsurface concentrations of artefacts found during excavations should be protected *in situ* immediately reported to an archaeologist for assessment; and
- Any areas of the landscape, particularly the rocky hills, that are not to be developed should be protected so as to minimise unnecessary landscape scarring.

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APPENDIX 1: Mapping



Map showing the walk and drive paths from 2011 and 2013 and all plotted heritage finds.

APPENDIX 2: List of heritage findings

Field No.	Site No.	Co-ordinates	Description	Significance / Grade / Mitigation
001	DAR2011/001	S30 41 24.2 E24 03 13.2	Possible kraal at base of ridge.	Low
002	DAR2011/002	S30 41 16.3 E24 02 59.8	LSA scatter of hornfels plus a few MSA artefacts. Also some ostrich eggshell but association may not be real.	Low
003		S30 41 15.8 E24 03 01.4	MSA and LSA artefact scatter in the saddle on the ridge. Probably background scatter	Very low
004	DAR2011/003	S30 41 15.2 E24 02 57.1	MSA scatter in the saddle on the ridge. Mostly MSA but occasional LSA as well.	Very low
005		S30 41 09.8 E24 03 00.1	MSA hornfels scatter on the ridge. Probably background.	Very low
006	DAR2011/004	S30 41 14.9 E24 02 56.1	LSA hornfels scatter on the ridge.	Low
007	DAR2011/005	S30 41 03.1 E24 02 57.4	Three small stone circles, some stone artefacts and recent glass on the ridge.	Medium
008	DAR2011/006	S30 41 02.1 E24 02 56.9	Stone circle 2.5 x 3 m on the ridge.	Low-medium
009	DAR2011/007	S30 41 02.2 E24 02 56.7	Scratched rock on the ridge.	Low-medium
010	DAR2011/008	S30 41 00.1 E24 02 56.1	Stone circle and small section of adjacent walling on the ridge. Not closed.	Medium
011	DAR2011/009	S30 40 57.9 E24 02 55.8	Stone pile on the ridge.	Low-medium
012	DAR2011/010	S30 40 56.7 E24 02 55.1	Possible but dubious stone circle on the ridge. Also a scratched and/or ground rock nearby.	Very low
013	DAR2011/012	S30 40 55.2 E24 02 55.0	Stone semi-circle at the base of the ridge on its east side. 2 m diameter.	Medium
014	DAR2011/011	S30 40 58.1 E24 02 56.1	Stone circle on the ridge. 2 m diameter.	Medium
015	DAR2011/013	S30 40 58.6 E24 02 56.2	Stone circle, three scratched rocks and one rubbed/ground rock on the lower slope of the ridge on its east side.	Medium
016		S30 40 48.7 E24 02 07.4	MSA hornfels artefacts in "pan" area.	Very low
017		S30 40 36.8 E24 02 24.9	MSA hornfels artefacts in "pan" area.	Very low
018		S30 40 33.4 E24 02 16.3	Historical/recent dam with stone-packed overflow.	Very low
019		S30 40 19.4 E24 02 07.4	Nearest corner of the modern municipal graveyard just outside the farm.	n/a
020		S30 40 24.1 E24 02 28.6	Stone dam, cement dam, cement dam foundation.	Very low
021	DAR2011/014	S30 40 33.3 E24 02 24.6	Small 1.5 m diameter probable stone circle and, 10 m west, a short section of walling extending northwards from the ridge.	Low
022	DAR2011/015	S30 40 33.4 E24 02 25.2	Stone circle that utilises mostly natural outcrop on the ridge.	Low-medium
023	DAR2011/016	S30 40 34.0 E24 02 26.4	Ephemeral stone walling with no particular form on the ridge.	Low
024	DAR2011/017	S30 40 33.8 E24 02 27.2	Small stone circle on the ridge.	Low-medium
025	DAR2011/018	S30 40 35.2 E24 02 30.4	MSA hornfels scatter in a flat area on the ridge. Also some LSA including one CCS	Low

			flake.	
026	DAR2011/019	S30 40 35.7 E24 02 32.0	Large LSA hornfels scatter in a flat area on the ridge. Includes one thumbnail scraper. Also occasional MSA.	Low-medium
027	DAR2011/020	S30 40 35.8 E24 02 32.6	MSA hornfels scatter on a flat area on the ridge. Also occasional LSA artefacts.	Low
028	DAR2011/021	S30 40 34.6 E24 02 37.6	Historical stone circle made with two skins and rubble fill near the base of the ridge. Also a short (1m) section of probable walling about 6 m to the south.	Low-medium
029		S30 39 39.9 E24 04 36.1	MSA hornfels artefacts in "pan" area.	Very low
030		S30 40 18.7 E24 04 04.3	MSA hornfels artefacts in "pan" area.	Very low
031		S30 41 32.3 E24 03 23.0	LSA scratched rock on the ridge.	Low-medium
032	DAR2011/022	S30 41 32.1 E24 03 22.9	East end of historical graffiti.	Medium Avoid
033		S30 41 31.8 E24 03 21.9	LSA scratched rock here.	
034		S30 41 31.8 E24 03 22.4	More graffiti with one being over LSA scratches.	
035		S30 41 31.6 E24 03 21.3	West end of historical graffiti.	
036	DAR2011/023	S30 41 47.9 E24 03 01.0	Remains of a historical rectangular kraal up against a low dolerite ridge.	Low-medium
037	DAR2011/024	S30 41 48.2 E24 02 51.0	Two mid-20 th century outbuildings of unknown age but no heritage significance. Farm buildings all seem mid-20 th century and later.	Very low
R001		S30 41 14.1 E24 03 02.0	Scatter of hornfels and ostrich eggshell fragments on ridge.	Low
R004		S30 41 14.2 E24 02 56.0	Hornfels scatter on ridge.	Very low
R008		S30 41 14.6 E24 02 54.8	Hornfels scatter on ridge.	Very low
J060		S30 41 39.5 E24 03 06.9	Rock with ground surface that has striations visible on it.	Very low
J061		S30 41 37.9 E24 03 07.2	Scratched rock	Very low
J062		S30 41 36.5 E24 03 07.4	Possible ground rock (unlikely)	Very low
J063		S30 41 34.5 E24 03 10.5	Possible ground rock (unlikely), some recent engraving over the top	Very low
J064		S30 41 33.1 E24 03 10.9	Possible ground rock (unlikely)	Very low
J065		S30 41 34.4 E24 03 09.8	Possible ground rock (unlikely)	Very low
J066		S30 41 35.4 E24 03 06.9	Possible ground rock (unlikely)	Very low
J067	DAR2013/001	S30 41 43.4 E24 02 30.9	Stone house ruin on the south side of the railway line. Probably a railway building. The house was probably the source of the historical material recorded at L061.	Medium
J068	DAR2013/002	S30 41 25.8 E24 02 21.3	MSA hornfels scatter in an ephemeral pan area. The scatter has many blades and some classic triangular MSA flakes. Points are ends of exposure.	Low-medium (2 hours)
L062		S30 41 23.9 E24 02 22.9		
J069		S30 40 55.7 E24 02 42.6	MSA hornfels scatter in pan area.	Very low

J070	DAR2013/003	S30 40 43.0 E24 02 45.5	Stone circle about 1.5 m in diameter. Very clear.	Low
J071	DAR2013/004	S30 40 43.5 E24 02 46.0	Stone circle made with two skins and a rubble fill. It lies at the base of the ridge on its north side. Two metal fragments nearby.	Low
J072	DAR2013/005	S30 40 46.8 E24 02 47.7	Stone semi-circle made with two skins and a rubble fill. About 1.5 m diameter and it lies on the north side of the ridge crest, although the ridge is too low here to provide any shelter.	Low
J073	DAR2013/006	S30 40 48.0 E24 02 48.5	Remains of a probable stone semi-circle made with two skins and a rubble fill. It lies on the north side of the ridge crest, although the ridge is too low here to provide any shelter.	Low
J074	DAR2013/007	S30 40 45.9 E24 02 47.2	Remains of a probable stone semi-circle made with two skins and a rubble fill. It lies on the north side at the base of the ridge.	Low
J075	DAR2013/008	S30 40 51.3 E24 02 52.6	Possible stone walling/semi-circle on crest of ridge.	Very low
J076	DAR2013/009	S30 40 57.9 E24 02 55.8	Short section of stone walling on north side of ridge crest.	Low
J077	DAR2013/010	S30 41 02.2 E24 02 56.9	Stone circle on crest of ridge. Probably pre-colonial.	Low
J078	DAR2013/011	S30 41 03.0 E24 02 57.3	Two stone circles on the crest of the ridge. They partly use the natural outcrop and one has glass inside it.	Low
J079	DAR2013/012	S30 41 04.2 E24 02 58.4	Stone semi-circle on the north side of the ridge at its base.	Low
J080	DAR2013/013	S30 41 05.1 E24 02 58.6	LSA hornfels scatter spread over the crest and north side of the ridge. It is c. 20 m in diameter.	Low
J081	DAR2013/014	S30 39 59.8 E24 04 50.5	081: Dense MSA hornfels scatter on the side of a low, wide ridge/hill. Artefacts are very widespread. 082: More of 081. 083: Lower density at the foot of the hill. 084: Lower density at the foot of the hill. 085: Lower density at the foot of the hill.	Low-medium (8 hours)
J082		S30 39 58.2 E24 04 50.4		
J083		S30 39 56.5 E24 04 49.6		
J084		S30 39 56.9 E24 04 52.5		
J085		S30 39 55.6 E24 04 53.4		
J086		S30 39 59.5 E24 04 53.1	MSA and LSA artefact scatter on western slope and crest of the low ridge/hill.	Low-medium (8 hours)
J087		S30 39 59.9 E24 04 52.3		
J088		S30 40 00.5 E24 04 52.8		
L066		S30 40 00.4 E24 04 51.9		
J089		S30 40 01.8 E24 04 52.8		
J090	S30 40 01.8 E24 04 52.2	Stone cairn, LSA hornfels scatter and historical artefacts (glass, Martini Henry and Westley Richards cartridges, metal) on the crest of the low ridge/hill.	Low	
J091	S30 40 03.6 E24 04 52.1	LSA hornfels scatter on the crest of the low ridge/hill.	Low	
J092	S30 40 05.0 E24 04 52.5	MSA and LSA artefact scatter on the crest of the low ridge/hill. This area has good	Low-medium (4 hours)	

J092B		S30 40 05.5 E24 04 52.7	density and is quite extensive. 092B is a lower grindstone found lying face up.	
J093	DAR2013/015	S30 41 41.8 E24 03 38.6	Rock gong with faint line drawing engravings on it. Three striking areas. Makes a high pitched metallic sound.	Medium Avoid
J094	DAR2013/016	S30 41 40.3 E24 03 35.9	Ephemeral LSA (?mixed age LSA) hornfels scatter on ridge. Also four scratched rocks here, one with four scratched patches on it.	Low
J095	DAR2013/017	S30 41 39.9 E24 03 35.1	Historical/recent engraving of an animal and a rock with "RP" lightly scratched onto it.	Very low
J096	DAR2013/018	S30 41 38.9 E24 03 32.6	Stone circle with some dark glass fragments, a piece of metal and a hornfels flake.	Low-medium
J097	DAR2013/019	S30 41 38.7 E24 03 32.2	Small LSA hornfels scatter on the crest of the ridge.	Very low
J098	DAR2013/020	S30 41 38.6 E24 03 32.4	Two stone circles on the crest of the ridge. Each about 1.5 m in diameter. One is heavily collapsed but they are historical as they are made with two skins and a rubble fill.	Low
J099	DAR2013/021	S30 41 37.2 E24 03 29.9	Stone semi-circle on the summit of a small hill. Looks LSA but some glass fragments and a modern bullet cartridge (model: PMP 270 WIN) occur nearby.	Low
J100	DAR2013/022	S30 41 38.0 E24 03 28.9	Stone horse-shoe-shaped enclosure of about 2 m diameter on the south side of the ridge. It is rough-packed.	Low
J101	DAR2013/023	S30 41 38.2 E24 03 28.3	Stone circle of about 2 m diameter on the south side of the ridge. It is rough-packed. A small, white ?glass button lay alongside it.	Low
J102	DAR2013/024	S30 41 53.8 E24 02 58.1	Historical outbuilding at the farm werf. Windows and door suggest c. 1930s. Stone additions to east side probably not much more recent.	Low-medium
L058		S30 41 40.5 E24 03 05.0	Small rocky koppie near farmhouse contains one possible lower grinding surface on a large flat rock, nearby one possible hornfels flake and one fragment of dark green bottle glass.	Very low
L059		S30 41 40.5 E24 03 03.2	Another possible grinding surface	Very low
L060		S30 41 40.3 E24 03 03.9	Two possible grinding surfaces, one weathered hornfels flake, one ostrich eggshell fragment.	Very low
L061		S30 41 43.1 E24 02 31.6	Historic material (rusty tin cans, one piece of mauve glass and one piece of white ceramic) near railway line. South of railway line is the ruin of a stone building. Perhaps all related to railway activities.	Low
L063		S30 40 42.4 E24 02 44.8	Very small, circular area cleared of rocks on the top of a koppie, with some evidence of stone packing on one side. The cleared area is only 1m ² . No artefacts inside	Low
L064		S30 40 39.6 E24 02 42.3	Short section of packed stone walling, very rough packing, about 3m long, along the lower margins of a ridge, providing some cover as a hunting blind? No artefacts nearby	Low
L065		S30 40 49.2	Rough semi-circle of stone, roughly	Low

		E24 02 49.8	packed, with back to the wind on the edge of a rocky koppie. Circle about 2m in width, no artefacts nearby	
L067		S30 39 59.4 E24 04 53.3	One possible cairn on the same ridge – unlikely to be a grave	?High (Avoid / test)