AECOM

Square Kilometre Array Radio Telescope

Department of Industry, Innovation and Science

24-Jan-2017

SKA EP Act Referral

Supporting Document

SKA EP Act Referral

Supporting Document

Client: Department of Industry, Innovation and Science

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Glossary

SKA	Square Kilometre Array
ASKAP	Australian SKA Pathfinder
MRO	Murchison Radio Observatory
SKAO	SKA Organisation
SKA1-Low	SKA1-Low Frequency Aperture Array
SKA1-Survey	SKA1-Survey Radio Telescope

1.0 Introduction

1.1 Background and Justification

The SKA Organisation (SKAO) proposes to develop the Square Kilometre Array (SKA) radio telescope, which comprises the SKA1-Low Frequency Aperture Array, herein referred to as the proposal. This SKA1-Low Frequency Aperture Array infrastructure will be added to the Australian SKA Pathfinder (ASKAP) and Murchison Widefield Array which are already constructed on the current Murchison Radio-astronomy Observatory (MRO) within the bounds of the Boolardy Station in the Murchison region in the midwest of Western Australia, approximately 315km northeast of Geraldton. It includes construction of approximately 130,000 antennas in 512 clusters and will be located south-east of the MRO on Boolardy Station.

The SKA is an international endeavour to build the world's largest and most sensitive radio telescope. The SKA will provide a great leap in sensitivity, resolution and survey speed compared to existing radio telescopes, enabling it to revolutionise our understanding of the universe. As with all big science projects, the SKA project will draw on the skills, experiences and support of 10 countries working collaboratively to construct and operate elements of the SKA project, with the first phase of the project being hosted by South Africa and Australia. To build the SKA will require vigorous technological developments in computing, communications and radio frequency devices. The international SKA project is led by the SKAO which is currently established as a non-profit company incorporated in the United Kingdom. This is expected to transition to an International Government Organisation (IGO) around 2019.

1.2 Proponent Information

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is the Proponent for the Proposal here in Australia, with the project funded by the Department of Industry, Innovation and Science. CSIRO will manage the project in Australia for the SKAO.

AECOM has been contracted by Department of Industry, Innovation and Science as the consultant for the Environmental Approvals of the Proposal. The consultant contact for the referral is:

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1.3 Location

The Proposal will be located on Boolardy Station. Boolardy Station is a 346,748 ha pastoral property (pastoral lease no. 3114/406) located on the Pindar-Berringarra Road in the arid rangeland region of mid-Western Australia (Crown lease 3146/1966) approximately 194 km north-north-east of Pindar and 200 km west-south-west of Meekatharra (Figure 1).

Boolardy Station is shown as Lot 502 on deposited plan 55945.

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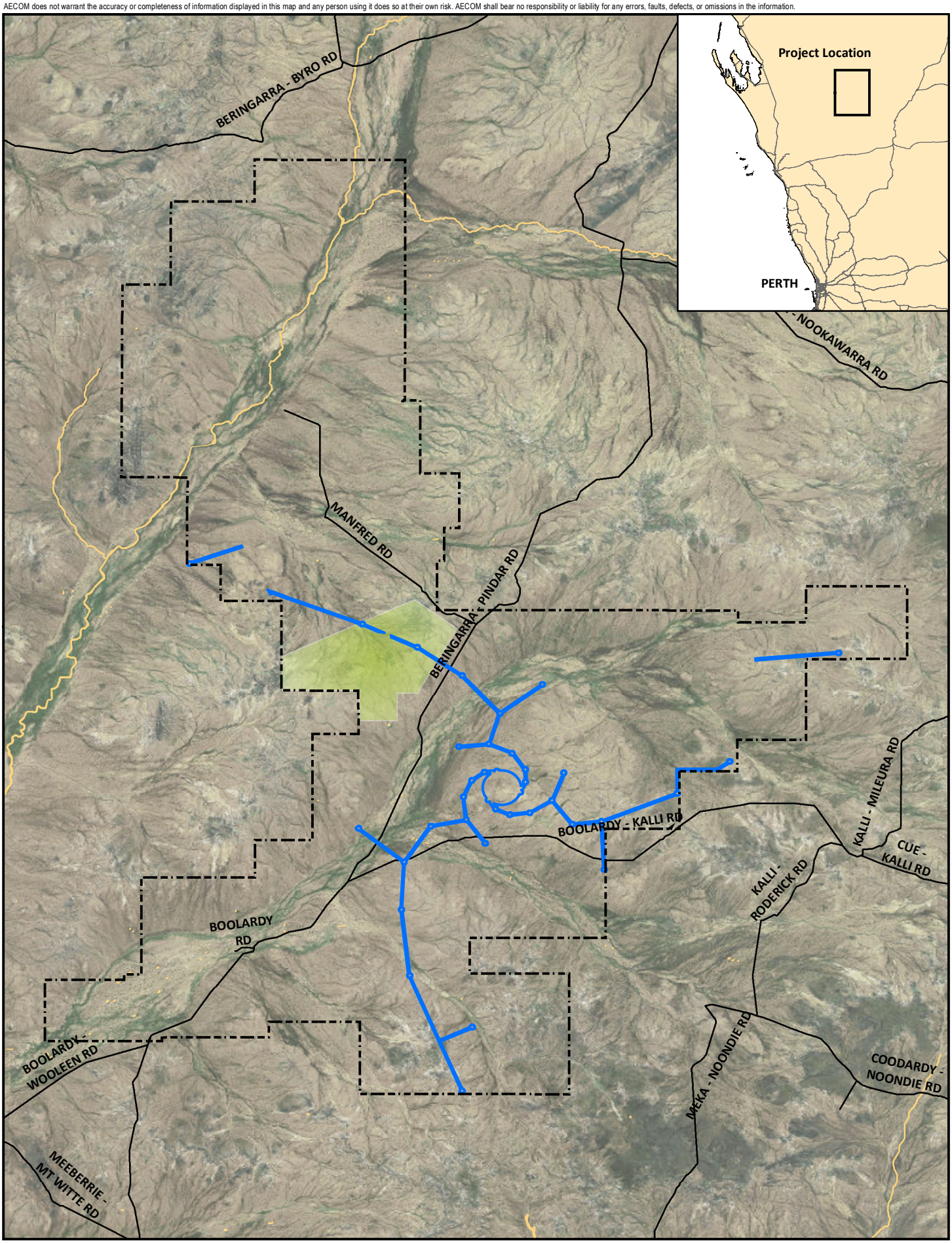

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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 4,700 9,400 14,100 18,800

metres

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LEGEND

- SKA1 - Low
- Boolardy Station
- Murchison Radio Astronomy Observatory
- Watercourses
- Lakes

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Project Location

DEPARTMENT OF INDUSTRY

SQUARE KILOMETRE ARRAY
EPA REFERRAL

Figure
1

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2.0 The Proposal

2.1 Proposal Description

The SKA1-Low pre-construction design considers various factors, including avoiding sources of radio frequency interference and avoiding geophysical, environmental and cultural constraints based on desktop analysis. This infrastructure will be at the same location (Boolardy Station) as the Australian Square Kilometre Array Project (ASKAP) and Murchison Widefield Array (MWA) already constructed on the MRO (within the bounds of Boolardy Station).

The SKA1-Low baseline design considers various factors, including avoiding sources of radio frequency interference and avoiding geophysical, environmental and cultural constraints based on desktop analysis. The design for the SKA1-Low telescope provides locations for of up to 512 individual array stations of approximately 35-45m in diameter. The majority (296) of the 512 array stations will form a densely populated core approximately 1km in diameter, with another 180 array stations in a region about 6km in diameter around this and the final 36 along 3 spiral arms, each extending out approximately 35km. Each array station will consist of approximately 256 individual antennas, each standing approximately two metres tall (Plate 1). The array stations will be configured in the following way:

- The majority (296) of the 512 array stations will form a densely populated core approximately 1km in diameter, with another 180 array stations in a region about 6km in diameter around this and the final 36 along 3 spiral arms, each extending out approximately 35km.
- Beyond the core there will be 180 stations in three tightly wound spiral corridors extending to about 6km from the core. The corridors will also provide the land required for access, power and data reticulation.
- Three additional (less tightly wound spiral corridors) would extend from the core to approximately 35 km comprising 12 stations along each of the spiral arms. Approximately seven “super-stations” will be located along each corridor, each comprising of eight individual array stations. Each “super station” will be approximately 120 x 120 metres. The corridors could also provide the land required for access, power and data reticulation.
- The flatness and ground levels for the core is yet to be determined. It may be that minor levelling of the 1-2 km diameter core will be required, but this will depend on the surface flatness accuracy required and the elevations of the selected site. The density of the SKA1-Low antennas in the 1-2 km diameter core region is such that you can assume that all this ground is disturbed.
- It is not yet certain how SKA1-Low antennas will be anchored to the ground. A possible scenario is that the central pole will be concreted into a hole (rather like a fence post concrete foundation) or it may be driven into the ground with a hydraulic ram. Another possibility is that the antennas will be attached to heavy duty Rebar metal mesh, which will act as a grounding agent, and will also minimise ground disturbance.
- There will be minimal access tracks within the densely populated core, as there will be restricted room between the antennas. All the land will effectively be cleared. From the core to the Control Processor Facility (CPF) there will be a track and buried high density cable management structure that will carry approximately 300 fibre optic cables over about a 1km distance. This combined track and cable management structure will be about 8 - 10 metres wide in terms of surface impact.
- The access tracks along the spiral arms for SKA1-Low will be approximately 4-6 m wide. Where possible, trenches for power and data reticulation cables will run next to these tracks. The trenches will be approximately 0.35 m wide and 1 m deep with both power and optic-fibre cable in the same trench. Additional initial disturbance is expected several metres either side of the track / trench corridor to allow for construction vehicles work to establish the track/trenches. Trenches will get wider as they approach the control building. There will be a network of tracks connecting the antennas in the core area and then extending along the arms. The tracks will be constructed such that they mimic the existing ground levels to minimise channelling of rainfall run-off.

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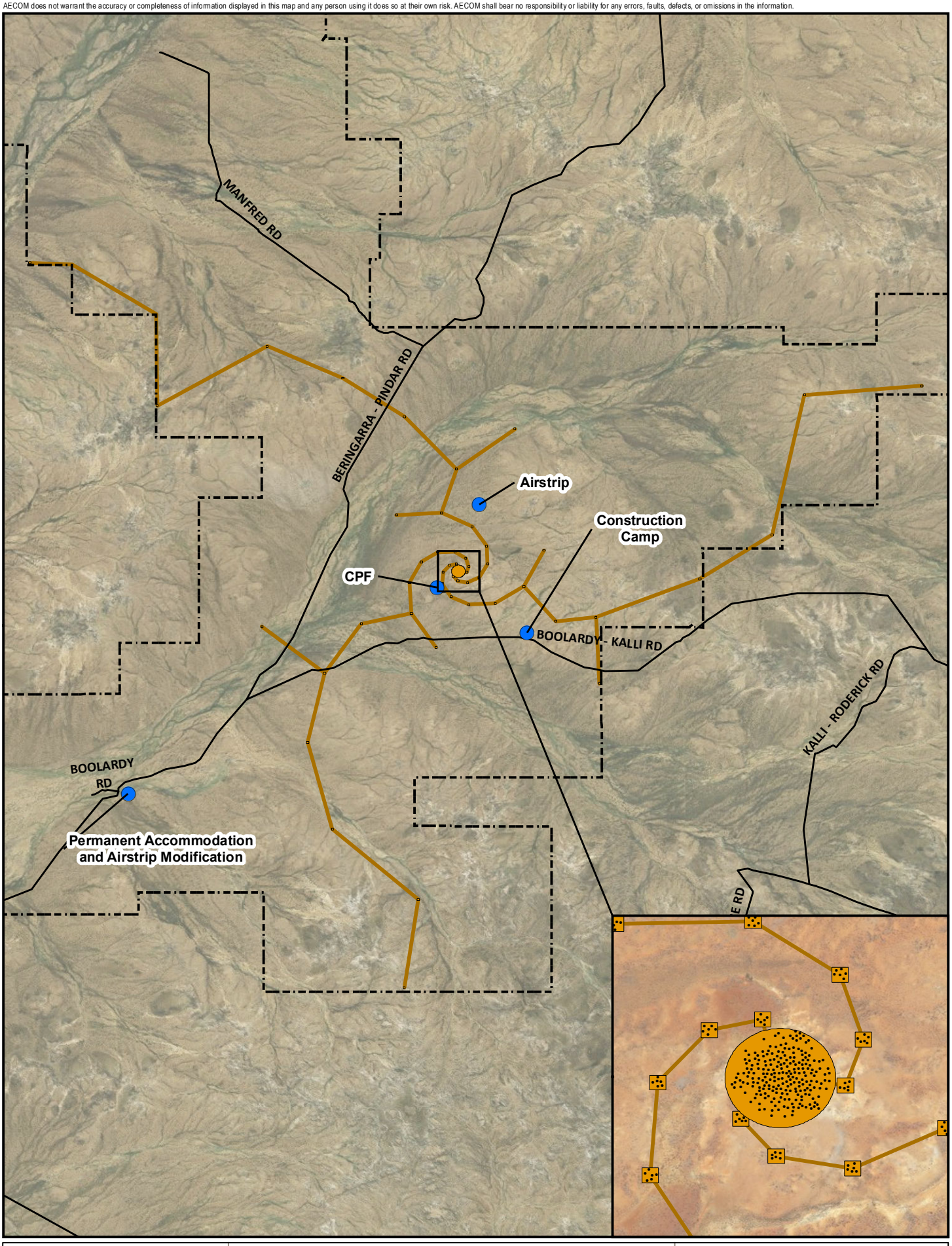

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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 3,400 6,800 10,200 13,600
metres

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Legend

- Indicative Infrastructure
- SKA1-Low Configuration
- Cluster Envelopes
- Approximate Tracks
- Boolardy Station

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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SKA1-Low Project Area

DEPARTMENT OF INDUSTRY

SQUARE KILOMETRE ARRAY
EPA REFERRAL

Figure

2

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Plate 1 SKA1-Low Antenna example

Clearing footprint

The densely populated core of the SKA1-Low array means that the entire core will be cleared of native vegetation to accommodate access tracks, trenches for cabling, and associated infrastructure.

In addition to the antennas there will be other areas where clearing is likely to be required. These are:

- Control and Processor Facility (CPF).
- Temporary construction camp
- Permanent accommodation facility
- Power Station
- Airstrip modifications.

The Control and Processor Facility (CPF) will probably be a single story building of approximately 1100 – 1500 sq metres within a fenced compound of up to 2 hectare area, along with minor storage facilities, delivery facilities, etc. It will be located about 1 – 2 km from the centre of the core area. It may have a geo-exchange cooling area associated with it, which would be approximately 14 hectares in area.

The temporary construction camp will be a self-contained camp for up to 250 people (estimate) and will be located appropriately to minimise distance for the construction teams to travel – the exact location is not yet decided but it will probably be near the Kaili Road about 6 – 10 km from the centre of the Low core .

The permanent accommodation facility is likely to be located near the Boolardy homestead. This will require approximately 4 hectares of land.

It is likely that the power station will be a diesel and solar hybrid, requiring up to 15 hectares, along with an access road and power corridor for trenched power cable of approximately 10 km length and 10 metres (10 ha).

It is possible that modifications to the existing airstrip at Boolardy Station homestead will be required. This would add an additional (2 times 500 metres length extension by 100 metres width (10 ha). Also an emergency use only airstrip close to the Low core area for RFDS access may be built. This would be a 1200 metre long by 100 metre wide for a total of 12 hectares.

Therefore it is estimated that:

- SKA1-Low antenna locations telescope pads and access tracks with a 10 m width will have a footprint of 549 ha
- the CPF may need up to 14 ha
- the construction and permanent camps may need up to 8 ha
- power station with access tracks will need up to 15 ha
- Airstrip extensions may require up to 22 ha.

The density of antennas in the SKA1-Low core areas is such that it has been anticipated that the entire core area will be cleared of native vegetation. The total envelope, including all antenna and access tracks is anticipated to be 608 ha. The indicative locations of the antennas and access tracks are shown in Figure 2. Flexibility will be required, particularly with access track construction, to enable the project to avoid any sensitive habitats. Construction is proposed to start in 2018.

2.2 Key Characteristics of Proposal

The Proposal will include the construction of:

- SKA1-Low aperture array, including 130,000 antennas that are located in “stations” of 256 antennas each station 35-45 m in diameter. There will be a core area of 296 stations in a 1 km diameter area, then three tightly wound spiral corridors extending to about 6 km of the core. Along each corridor there will be four “super-stations”, made up of six individual array stations. Three more less tightly wound spiral corridors will extend for 35 km from the core, with eight super stations along these arms. Access tracks and cabling will be required for each array super station.
- Control and Processor Facility (CPF).
- Temporary construction camp
- Permanent accommodation facility
- Power Station
- Airstrip modifications.

The densely populated core of the SKA1-Low array is such that it is anticipated that the entire core will be cleared of native vegetation to accommodate access tracks, trenches for cabling, and associated infrastructure.

Table 1 Proposal Summary

Proposal title	SKA Radio Telescope
Proponent Name	CSIRO representing SKAO in Australia
Short Description	Construction of the Low Frequency Aperture Array telescope.

Table 2 Location and Extent of Physical Elements of the Proposal

Element	Indicative footprint (ha)
SKA1-Low array	186
Access tracks and trenches	363 ha (@ 10 m wide)
CPF	14
Construction and permanent camps	8
Power generation	15
Airstrip extensions	22
TOTAL	**608**

3.0 Significance of Environmental Factors

Environmental Assessment Guideline (EAG) 8 describes environmental factors that may be affected by Proposals. There are 15 environmental factors plus two integrating factors included in EAG 8, Table 3 presents the environmental factors of EAG 8 and identifies those which may be relevant to the SKA Proposal.

Table 3 Environmental factors and objectives – EPA EAG 8

Factor	Objective	Relevance to Proposal
Sea		
Benthic Communities and Habitat	To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats at local and regional scales.	**Not relevant** – No proximity to marine or coastal environments.
Coastal Processes	To maintain the morphology of the subtidal, intertidal and supratidal zones and the local geophysical processes that shape them.	
Marine Environmental Quality	To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected.	
Marine Fauna	To maintain the diversity, geographic distribution and viability of fauna at the species and population levels.	
Land		
Flora and Vegetation	To maintain representation, diversity, viability and ecological function at the species, population and community level.	Relevant – refer to Section 5.1
Landforms	To maintain the variety, integrity, ecological functions and environmental values of landforms.	Not relevant – unlikely to have significant impact.
Subterranean Fauna	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	Not relevant – unlikely to have significant impact.
Terrestrial Environmental Quality	To maintain the quality of land and soils so that the environment values, both ecological and social, are protected.	Not relevant – unlikely to have significant impact.
Terrestrial Fauna	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	Relevant – refer to Section 5.2
Water		
Hydrological Processes	To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.	Relevant – refer to Section 5.3
Inland Waters Environmental Quality	To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.	Relevant – refer to Section 5.4
Air		
Air Quality and Atmospheric Gases	To maintain air quality for the protection of the environment and human health and amenity, and to minimise the emission of greenhouse and other atmospheric gases through the application of best practice.	Not relevant – unlikely to have significant impact.

Factor	Objective	Relevance to Proposal
People		
Amenity	To ensure that impacts to amenity are reduced as low as reasonably practicable.	Not relevant – unlikely to have significant impact.
Heritage	To ensure that historical and cultural associations, and natural heritage, are not adversely affected.	Not relevant – unlikely to have significant impact.
Human Health	To ensure that human health is not adversely affected.	Not relevant – unlikely to have significant impact.
Integrating Factors		
Offsets	To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.	Not relevant – unlikely to have significant impact.
Rehabilitation and Closure	To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner.	Not relevant – unlikely to have significant impact.

3.1.1 Significance Framework – EAG 9

In EAG 9 (*Environmental Assessment Guideline for Application of a significance framework in the environmental impact assessment process focusing on the key environmental factors)* the OEPA detail that it only intends to assess projects with impacts on key environmental factors.

The guidance goes on to state that key environmental factors are those where the EPA's objectives may be met, but there is a lack of confidence, data or conditions related to implementation. If there is early confidence that none of the factors are key factors or that another regulatory process can ensure that the EPA objective can be met then that factor will receive no further consideration by the EPA. The proponent is only required to carry out further necessary studies for the preliminary key environmental factors. The application of significance framework for the proposal is discussed in Section 6.0.

4.0 Regulatory considerations

4.1 Other Environmental Approvals

Other Environmental approvals will be attained for the project, as required including:

- Submission of a referral under the *Environment Protection and Biodiversity Conservation Act 1999.*
- Heritage approvals will be sought if necessary although impacts on sites will be prevented by providing a buffer around known sites.
- Building approval will be sought from the Murchison Shire for the power supply if necessary.

4.2 Previous approvals and management

The WA State Government has created a Mining Act Section 19 declaration to prevent mining activities within a radius of at least 30 kilometres of the core Boolardy site and has issued a Mineral Resource Management Area notice to control the radio frequency interference (RFI)-emitting activities generated by mining operations within 80 kilometres of the core site.

4.2.1 Previous referrals

The ASKAP and MWA have been previously assessed under the 2009 Commonwealth and State Referrals. The ASKAP telescope was referred under Section 38 of the *Environment Protection Act 1986 (*EP Act*)*. The EPA set the level of assessment as 'Not Assessed – Public Advice Given' on 17 August 2009. A clearing permit was issued by the Department of Environment and conservation 03 December 2009 (Purpose Permit CPS 3317/1) authorising the permit holder to clear 57ha. This permit expired on 03 January 2015 with clearing incomplete and the area cleared less than 57ha. CSIRO received a new Purpose permit on 30 April 2015 (CPS 6465/1) authorising the permit holder to clear 18ha, the area not cleared under permit 3317/1. A separate clearing permit was issued by the Department of Parks and Wildlife (DPaW) on 5 September 2011 (Purpose Permit CPS 4439/1). The permit holder was authorised to clear no more than 30 ha of native vegetation, with the undertaking that priority flora or conservation significant fauna was not to be impacted by construction, for the purpose of installing the Murchison Widefield Array Project on Lot 502 on Plan 55945. The final clearing footprint was up to 87 ha with a new application for a purpose permit is being lodged by CSIRO on behalf of MWA for approval to clear additional area for a new prototype instrument.

A Purpose permit for a related activity is held by AARNet Pty Ltd for construction of the fibre optic cable (completed) connecting the MRO to its support facility in Geraldton. The permit expires on 28 February 2017.

The proposal is located within the Mid-West Radio Quiet Zone Area. In a Memorandum of Understanding on the SKA Project between the Government of Western Australia and the Commonwealth Government, the Governments agree to "Establish and safeguard a radio quiet zone in the Mid-West of Western Australia, with appropriate development and other controls for 30 km radius, 70 km radius and up to 260 km radius." The Mid West Radio Quiet Zone area has already been established by the Australian Communications and Media Authority (refer Attachment A), through Spectrum Embargo 41 and Radio communications Assignment and Licensing Instruction MS32, 'Coordination of Apparatus Licensed Services within the Mid-West Radio Quiet Zone'.

4.2.2 Existing environmental management

The construction of infrastructure, antennas and buildings at the existing MRO site utilised a site management document "HSE and Site Information for Contractors" (2013) that sets out environmental management requirements for anyone entering the site based on an environmental guidance document prepared for CSIRO by Parsons Brinkerhoff, (April 2010). Management protocols were established for:

- Chemicals – Storage, Management and Spill Response
- Dust Generating Work – Erosion and Sediment control

- Environmentally Sensitive Areas – Flora
- Vegetation – Clearing and Revegetation
- Groundwater
- Waste management and Recycling
- Weed Control – Earthmoving Vehicle Inspections.

Those documents have informed the preparation of HSE documents currently in use at the MRO.

In order to minimise erosion and maintenance CSIRO prepared access tracks with the objective of maintaining existing ground levels and minimising windrows so channelling and erosion due to stormwater flows did not occur (Pers. Comm. Antony Schinckel, 2016). This methodology also minimises the requirement for regular maintenance of the access tracks and the potential for any additional disturbance during this process.

In terms of water use, the existing geo-exchange cooling uses rainwater collected from the roof and this has proved to be sufficient to maintain operation of the facility.

5.0 Environmental Factors

5.1 Flora and Vegetation

5.1.1 EPA Objective

The EPA Objective for Flora and Vegetation is:

To maintain representation, diversity, viability and ecological function at the species, population and community level.

5.1.2 Guidance

Guidance relevant to flora and vegetation includes:

- EPA Guidance Statement 51 – *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in WA*
- EPA Position Statement 2 – *Environmental Protection of Native Vegetation in WA*
- EPA Position Statement 3 – *Terrestrial Biological Surveys as an Element of Biodiversity Protection*
- EPA Guidance Statement No. 6 – *Rehabilitation of terrestrial ecosystems*
- EPA Guidance Statement No. 10 – *proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of System 1 region*
- Environmental Protection Bulletin 20 - *Protection of naturally vegetated areas through planning and development.*

5.1.3 Consultation

CSIRO has attended and spoken at forums and town hall meetings with Mid-West residents about the SKA and other projects at the MRO. MRO Indigenous Land Use Agreement Liaison meetings have been held annually since 2009/10. The project has held regular meetings and additional meetings when required, with the following WA Government agencies:

- Department of Premier and Cabinet
- Department of Main Roads
- Department of Lands
- Department of State Development
- Department of Local Government
- Shire of Murchison
- Shire of Geraldton.

The project has set up a Stakeholders Group and holds regular meetings every three to six months. Members of this group are:

- Chamber of Minerals and Energy of WA (Mid-West Region)
- City of Greater Geraldton
- Department of Premier and Cabinet (Office of Science)
- Durack Institute of Technology
- Geraldton Universities Centre
- International Centre for Radio Astronomy Research (ICRAR)
- Main Roads WA (Mid-West Region)
- Meenangu Wajarri Aboriginal Corporation (MWAC)

- Mid-West Chamber of Commerce & Industry
- Mid-West Development Commission
- Mitsubishi Development/Oakajee Port and Rail
- Murchison Country Zone of WALGA
- Murchison Shire
- Regional Development Australia Mid-West Gascoyne
- Sinosteel Midwest Corporation Limited
- West Australian Museum Geraldton
- Yamatji Marlpa Aboriginal Corporation (YMAC).

5.1.4 Baseline information

5.1.4.1 Surveys completed

A single phase Level 2 flora and vegetation assessment was conducted by AECOM in 2014 for the indicative project area. The AECOM (2014) assessment collated information to create a baseline dataset for the Proposal Area including detailed targeted flora searches.

Previously, Alexander Holm & Associates undertook flora and vegetation surveys within the MRO in 2007 (report prepared in 2008).

5.1.4.2 Regional vegetation significance

The Proposal is located in the Western Murchison subregion of the Murchison bioregion. The Western Murchison subregion, described by Desmond et al. (2001), supports low Mulga woodlands with bunch grasses and ephemerals (annuals). Landscape features include outcrop and extensive fine-textured hardpan washplains. Quaternary sandplains support hummock grasslands, calcareous soils support Saltbush and saline alluvia support *Halosarcia* low shrublands. The subregion contains the headwaters of the Murchison and Wooramel Rivers which drain westwards to the coast. Rare features of the area include calcrete aquifers with short-range endemics, rare fauna, and flora.

Beard's (1976) vegetation series map for the Murchison region shows nine broad terrestrial vegetation types that occur within the Project areas. According to the comprehensive, adequate and representative (CAR) reserve system, the ten vegetation associations each have more than 98% of their original pre-European extent remaining.

5.1.4.3 Threatened and Priority Ecological Communities

There are no EPBC listed Threatened Ecological Communities (TECs) on Boolardy Station. This was confirmed by the EPBC Protected Matters Search report and the DPaW database search. No State-listed TECs were identified in the study area, however, eight Priority 1 Priority Ecological Communities (PECs) have been defined adjacent to the Proposal area (Table 4), Figure 2.

Table 4 Priority Ecological Communities identified in the desktop review

PEC name	Cons status	Location
Mount Dugel/Mount Narin vegetation complexes (banded ironstone formation).	P1	<1 km from SKA1-Survey north arm.
Mount Narryer calcrete groundwater assemblage type on Murchison paleodrainage on Mt Narryer Station.	P1	34 km from SKA1-Low north arm.
Meeberrie calcrete groundwater assemblage type on Murchison paleodrainage on Meeberrie Station.	P1	20 km west from SKA1-Survey south arm.
Meka calcrete groundwater assemblage type on Murchison palaeodrainage on Meka Station.	P1	11 km south from lowest SKA1-Low north arm.
New Forest (including Twin Peaks and Barloweerie Range) vegetation complexes (BIF).	P1	17 km south of SKA1-Survey south arm.
Jack Hills vegetation complexes (BIF)	P1	30 km east of SKA1-Survey north arm.
Curbur calcrete groundwater assemblage type on Curbur Station.	P1	32 km west of SKA1-Survey north arm.
Milly Milly calcrete groundwater assemblage type on Milly Milly Station.	P1	21 km northeast of SKA1-Survey north arm.

5.1.4.4 Vegetation communities

No TECs or PECs were recorded in the Proposal area during the field survey. A total of 15 vegetation communities were mapped in the Proposal area. The vegetation of Boolardy station is comprised predominantly of Mulga (*Acacia aneura* complex species) low woodlands over mixed *Eremophila* and *Senna* species on flat terrain. The landscape is dissected by the Murchison River and an unnamed major channel fringed with *Eucalyptus victrix* and occasional *Melaleuca glomerata*. Smaller drainage channels were characterised by chenopods and *Allocasuarina campestris.* Scattered granite outcrops, domes and breakaways were observed in the south and east arms of the array areas. The complete list of vegetation communities is provided in Appendix A, Table 8).

Vegetation composition was predominantly low woodland over scattered to isolated tall shrubs over mid to low open shrubland. Some communities consisted of only two strata, lacking low shrubs, herbs and grasses.

There were four communities considered locally significant as they provide habitat for Priority flora species. These include:

- AfSa: supports populations of *Eremophila simulans* that are potentially the P3 *Eremophila simulans* subsp. *megacalyx* and *Hemigenia tysonii* (P3)
- ArEf: supports populations of *Eremophila simulans* that are potentially the P3 *Eremophila simulans* subsp. *megacalyx* and *Sauropus* sp. Woolgorong (P1)
- AvEp: supports populations of *Gunniopsis divisa* (P3)
- AiTdPb: supports populations of *Ptilotus beardii* and *Verticordia jamiesonii* (both P3 species).

Local/regional significance: riparian vegetation:

- AcAsTd: riparian and supports *Frankenia confusa* (P3)
- ArEd: riparian
- EvAsEb: riparian and Murchison

Nationally significant: Granite outcrops:

- ArCc: Skink habitat and supports populations of *Ptilotus beardii* (P3)
- ApTh: Trapdoor Spider habitat

5.1.4.5 Vegetation condition

The condition of the Murchison region was assessed by Curry et al. (1994) by surveying 'condition sites' throughout the region. Patterns of variation existed partially as natural variation but mostly as a consequence of changes related to cumulative impact by grazing animals and pastoral management. The loss of perennial vegetation has led to accelerated soil erosion. The most common forms of erosion are scalding and surface sheeting over 10-50% of the surface. Approximately 42% of vegetated areas are considered to be in poor to very poor condition, 37% was in fair condition and 21% was in good to very good condition (Curry et al., 1994).

The general symptoms are (Curry et al., 1994):

- loss of perennial plant diversity and numbers per unit area
- loss of palatable perennial diversity and density
- general loss of vegetation structure, cover and subsequent denudation
- increases and invasions by unpalatable species such as Prickly Acacia (*Acacia victoriae*) and needle bush (*Hakea preissii*) are common on disturbed or deflated soils
- most widely degraded vegetation types are halophytic shrublands (Saltbush and Bluebush), hardpan Mulga shrubland and calcrete shrubby grasslands.

The field survey showed that the majority of the project areas are considered in 'Very Good' condition. Evidence of disturbance included:

- cattle
- erosion
- infrastructure (roads and associated culverts, tracks, air strips, fences)
- loss of perennial vegetation.

A decline in condition was particularly evident near operational mills and bores. Livestock commonly congregate near these freshwater sources causing soil degradation resulting in the loss of all palatable flora species.

5.1.4.6 Flora

A total of 199 native flora species from 82 genera and 36 families were recorded during the SKA surveys. A breakdown of species collected from both project areas are provided in Table 5.

Table 5 Floristics of the SKA survey areas

Classification	SKA1-Survey	SKA1-Low	Total
Native species	151	127	199
Native genera	67	52	82
Native family	34	25	36
Common native families	Fabaceae (37) Myoporaceae (15) Chenopodiaceae (15) Asteraceae (11)	Fabaceae (32) Myoporaceae (19) Chenopodiaceae (14) Asteraceae (8)	Fabaceae (43) Myoporaceae (25) Chenopodiaceae (20) Asteraceae (14)
Weed species	4	2	6
Weed genera	4	2	6
Weed families	4	2	6

5.1.4.7 Threatened and Priority Species

No species listed under the EPBC Act or the *Wildlife Conservation Act 1950* (WC Act) were identified during the desktop assessment as occurring in the vicinity of the project areas and none were recorded during the field survey. The desktop review identified 26 Priority species that may occur in the project area including:

- six Priority 1 species
- three Priority 2 species
- 15 Priority 3 species
- two Priority 4 species.

Five Priority flora species and one potential Priority flora species was recorded in the proposal areas and seven were considered likely to occur as detailed below:

- species recorded
  - *Sauropus* sp. Woolgorong (M. Officer s.n. 10/8/94) (P1)
  - *Gunniopsis divisa* (P3)
  - *Ptilotus beardii* (P3)
  - *Hemigenia tysonii* (P3)
  - *Verticordia jamiesonii* (P3)
  - *Eremophila simulans* subsp. *megacalyx* (P3) known from the MRO (Alexander Holms & Associates, 2008)
- likely to occur
  - *Angianthus microcephalus* (P2)
  - *Calytrix verruculosa* (P3)
  - *Eremophila muelleriana* (P3)
  - *Micromyrtus placoides* (P3)
  - *Goodenia berringbinensis* (P4)
  - *Goodenia neogoodenia* (P4).

Furthermore, nine species “May” occur and six were considered “Unlikely” to occur. A comprehensive species list of conservation significant species and their likelihood of occurrence is provided in Appendix A.

5.1.4.8 Introduced weed species

Four introduced weed species were recorded during the field survey. None of these species are Declared Pests under the *Biosecurity and Agriculture Management Act* 2007 or Weeds of National Significance.

5.1.5 Impact Assessment

The Proposal area (shown in Figure 2) is the envelope in which the road will be constructed. The Proposal Footprint is the indicative footprint of the road. The direct impacts have been quantified based on the indicative footprint.

The impacts of developing the SKA1-Low on Boolardy Station will include:

- clearing of native vegetation
- impact on riparian vegetation (Roderick River, Mudgianna Creek)
- impact on locally significant vegetation (supporting populations of Priority flora species)

- impact on nationally significant vegetation (habitat for EPBC listed species)
- spread of weeds.

Locally significant vegetation was defined as vegetation that supports populations of Priority flora species.

Table 6 Impacts associated with clearing native vegetation

Impacts on flora and vegetation	Proposal Area (ha)*	Footprint (ha)
Clearing native vegetation	608	463
Clearing riparian vegetation AcAsTd, ArEd, AiAbSa (shallow drainage)	9.8	7.1
Nationally significant vegetation (Spider, Skink)	6.56	4.49
Priority species populations AfSa, ArEf, AvEp, AiTdPb	175.2	151.44
Locally/regionally significant vegetation AfSa, ArEf, AvEp, AiTdPb, ArCc, AcAsTd,	183.54	156.44

*These areas overlap

The area of Boolardy Station is 346,748 ha of largely very good condition native vegetation. The vegetation mapping focussed on the disturbance envelope to assist with defining areas of importance. This data will then be used to define the quantum of impact and to enable the project to avoid areas of conservation significance. Clearing will comprise an envelope of 602 ha within which 452 ha will be affected. This amounts to 0.13% of the vegetation on Boolardy Station. The avoidance of areas of significance, whether local or regional will reduce the impact to one that is not significant.

5.1.6 Mitigation measures

Where potential impacts have been quantified this has been calculated based on the design provided with no mitigation or avoidance. Residual impacts have been quantified following all avoidance and mitigation measures.

The mitigation hierarchy is as follows:

- Avoidance: avoiding the adverse environmental impact altogether
- Minimisation: limiting the degree or magnitude of the adverse impact
- Rehabilitate: restoring the maximum environmental value that is reasonably practicable
- Offsets: actions that provide environmental benefits to counterbalance significant residual environmental impacts or risks of a project or activity.

CSIRO will endeavour to avoid and minimise clearing of native vegetation, however some clearing will be required. Justification of the chosen project design was based on:

- the size and shape of footprint to accommodate the array
- serviceability and full seasonal access.

The clearing impacts for the project will be minimised by:

- using previously disturbed areas to avoid additional clearing where possible
- limiting clearing of vegetation to that which is absolutely necessary for construction and safe operation of the project
- clearly demarcating all clearing boundaries to avoid over clearing.

CSIRO have policies and procedures in place to reduce the risk of adverse environmental impacts occurring during construction and operation of the project. Project-specific management plans to manage and mitigate impacts are included in the MRO HSE and Site Information for Contractors (2013) document:

The environmental management plans include sub-plans:

- Chemical Storage Management and Spill response
- Erosion and Sediment Control
- Environmentally Sensitive areas – flora
- Groundwater Management
- Vegetation – Clearing and Revegetation
- Waste Management and Recycling
- Weed Control – Earthmoving Vehicle Inspections.

5.1.7 Residual Outcomes

The residual impact will include the clearing of the individual telescope array sites and the access tracks / trenches. Any additional clearing during construction will be rehabilitated to reduce the project footprint.

Following implementation of the measures detailed above, the total predicted residual loss of remnant native vegetation is presented in Table 7.

Table 7 Residual impacts associated with clearing native vegetation

Impacts on flora and vegetation	Proposal Area (ha)*	Footprint (ha)
Clearing native vegetation	602	452
Locally/regionally significant vegetation	183	151
Priority species populations	175	156

*Areas overlap with 602 being the absolute maximum

Consistent with the EPA objectives, the representation, diversity, viability, and ecological function at the species, population and community level of flora and vegetation will be maintained.

5.1.8 EPA's Objective

EPA's Objective – from your perspective and based on your review, which option applies to the proposal in relation to this factor? Refer to EAG 9	☐ *meets the EPA's objective* ☒ *may meet the EPA's objective* ☐ *is unlikely to meet the EPA's objective*

5.1.9 Assumptions

For this project the assumption is that changes to surface flow to construct access tracks will not have impacts on vegetation communities and windrows will be minimised to encourage natural flows.

5.2 Terrestrial Fauna

5.2.1 EPA Objective

The EPA objective for fauna is:

To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.

5.2.2 Guidance

All fauna species in Western Australia are protected under the *Wildlife Conservation Act 1950*, making it an offence to remove or harm native fauna species without approval. If a project has the potential to disturb habitat or threaten a population of native fauna, this disturbance may require assessment under the EP Act. Where EPBC Act listed threatened species are present within the proposed disturbance area, referral under the EPBC Act is likely to be required.

Relevant State and Commonwealth policies and guidance that specifically relate to this factor include:

- EPA Position Statement 3 - Terrestrial Biological Surveys as an Element of Biodiversity Protection
- EPA Guidance Statement No. 20 - Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia
- EPA Guidance Statement No. 56 - Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia
- EPA and DEC 2010 Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment
- Matters of National Environmental Significance – Significant impact guidelines 1.1.

5.2.3 Consultation

Consultation will be undertaken with:

- local station owners
- DPaW
- any other interested parties.

5.2.4 Baseline information

5.2.4.1 Surveys completed

A detailed fauna assessment was conducted by AECOM in 2014 for the proposed footprint area (Appendix A). Previously, Alexander Holm & Associates undertook fauna surveys within the MRO in 2007 (report prepared in 2008). An additional detailed investigation was undertaken of the vulnerable, Shield-backed Trapdoor Spider (*Idiosoma nigrum*) in 2015 (Phoenix, 2015).

5.2.4.2 Fauna species

A total of 82 fauna species were recorded during the field survey (AECOM 2014) including:

- 55 birds
- 12 mammals (including 7 introduced species)
- 14 reptiles
- one potential Threatened invertebrate (*Idiosoma nigrum*).

5.2.4.3 Conservation significant fauna species

Two conservation significant species were recorded during the field survey as below:

- *Egernia stokesii badia* (Western Spiny-tailed Skink), Endangered EPBC Act and Vulnerable WC Act
- *Idiosoma nigrum* (Shield-backed Trapdoor Spider), Endangered EPBC Act a potential burrow was recorded.

Western Spiny-tailed Skink (*Egernia stokesii* subsp. *badia*): Endangered

The Western Spiny-tailed Skink belongs to the cunninghamii group; a group of moderately large, rock-dwelling reptiles. *E. stokesii* subsp. badia (Black Form) are restricted to massive granite exposures with variable cover of loose boulders and pockets of soil and low shrubland vegetation (DEC 2012). These outcrops are separated by open low woodland and shrubland. All the black form populations are important due to their overall small geographic range and ongoing degradation of habitat from uncontrolled grazing (DEC 2012).

Granite outcrops were subject to intense searches during the field survey, during which four pieces of scat were recorded at three granite outcrop locations. The Skink, and evidence of its presence, was recorded at two locations in the SKA1-Low project area on one granite outcrop. A Skink was also recorded at one location within an area demarcated as SKA1-Survey. This area is also now intercepted by the SKA1-Low Project area. The fourth record was from a granite outcrop located south of the MRO originally surveyed by Alexander Holm & Associates (2008). This record was reconfirmed during the field survey where evidence was recorded. This indicates this species' continued survival at this location since 2008 during which time the ASKAP, Control Building, and Fibre Optic cabling has been constructed.

The Western Spiny-tailed Skink is listed under the EPBC Act as Endangered and under the WC Act as Vulnerable. Granite outcrops were subject to intense searches during the field survey, during which four pieces of scat were recorded at three granite outcrop locations.

Shield-back Trapdoor Spider (*Idiosoma nigrum*): Vulnerable

Idiosoma nigrum is commonly known as the Shield-backed (or Black Rugose) Trapdoor Spider and is endemic to the Murchison region in WA (Main 2003). *Idiosoma nigrum* was first described by Main in 1952 (cit. in. Avon Catchment Council 2007). The key distinguishing feature is the distinctive thick and hard cuticle on the abdomen.

They typically inhabit clay soils of *Eucalypt* woodland and *Acacia* vegetation (Australian Government 2013). Leaf litter and twigs are extremely important to the species as it provides material for the burrows, reduced soil moisture loss and increased prey availability (DotE 2015). The DotE (2015) population information states that in 2010 there were seven locations where populations of *I. nigrum* exceeded 30 spiders. Total population reduction has not been investigated, but data from a study in East Yorkrakine Reserve from 1989 to 1999 showed a 95% reduction in abundance at the site (Main 2003). Future reductions are possible due to ongoing threats in the Wheatbelt and mining in the vicinity of populations at Karara, Weld Range and Jack Hills (DotE 2015).

The Level 1 fauna assessment (AECOM 2014) identified potential evidence of the Shield-back Trapdoor Spider at one location in the lower saline footslopes habitat, below rocky breakaways. Following this, a reconnaissance survey was conducted in December 2014 (Phoenix 2015, Appendix B). The survey confirmed the presence of three *I. nigrum* individuals at one location. This location is situated along the SKA1-Low south arm within the 'access track' footprint. The site was characterised by sparse mulga woodland with rocky ground-cover; however the species was absent at other sites of similar habitat.

It has been identified that the local habitat preferences of *I. nigrum*, make it difficult to extrapolate the distribution of the species in the study area. Habitat mapping alone should not be used to infer the distribution of the species (Phoenix 2015, Appendix B). The confirmed location of the Spider is shown in Figure 3.

A number of migratory species listed under international agreements to which Australia is signatory are predicted to occur on Boolardy Station based on the EPBC Act protected matters search and the Level 1 fauna assessment, but were not observed or recorded during the field survey. These species are presented in Table 8.

Table 8 Conservation significant fauna species considered likely to occur in the project areas

Name	Status	Details
Australian Bustard (*Ardeotis australis*)	Priority 4 (DPaW)	Once a widespread species, the Australian Bustard is still common in northern Australia and is associated with grassland, spinifex, open scrubland, grassy woodland and burned habitats (Pizzey & Knight 2007).
Bush Stone-curlew *Burhinus grallarius*	Priority 4 (DPaW)	This species is known to occur in open woodlands of Mallee and Mulga, grasslands and sandplains, particularly where there is a cover of small sparse shrubs (Morcombe 2003).
Major Mitchell's Cockatoo *Cacatua leadbeateri*	Schedule 4 (WC Act)	Major Mitchell's Cockatoo ranges across much of western, central and eastern Australia, utilising timbered watercourses, casuarinas, mallee eucalypts, gibber plains, among other environs. Though widespread, this species is less abundant than other species of white cockatoo (Pizzey & Knight 2007).
Peregrine Falcon *Falco peregrinus*	Schedule 4 (WC Act)	A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and migratory (Pizzey & Knight 2007). This species lays its eggs in recesses of cliff faces, tree hollows or large abandoned nests.
Rainbow Bee-eater *Merops ornatus*	Migratory (EPBC Act); Schedule 3 (WC Act)	The Rainbow Bee-eater is a common species which occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests. It is possible that this species will occupy open woodland areas within the survey area. The Rainbow Bee-eater avoids heavy forest that would hinder the pursuit of its insect prey (Morcombe 2003).

5.2.4.4 Fauna habitat

Eight fauna habitats were delineated and described in the SKA1-Low project areas. The most common fauna habitat was the hardpan plain with intermittent sandplain making up 3,038.4 ha and 69.3% of the indicative SKA1-Low project envelope Hardpans can persist for several kilometres within this habitat. The hardpan plain habitat supports a diverse range of common bird species in the area and some reptiles and macropods. The habitat is not considered to be significant and is extensive throughout the landscape. Brush-tailed Mulgara may possibly occur in the sandplains within this habitat, however the likelihood is low.

The second most common habitat was the non-saline stony or gritty surfaced plains comprising 1007 ha and 23.1% of SKA1-Low areas. This fauna habitat supports the common species of the area as recorded during the field survey. Historically, the Western Pebble-mound Mouse may have occurred in this habitat, but no observations were made during this survey. The delineation of fauna habitats was based on the vegetation mapping and field survey observations by the zoologist.

Habitats considered conservation significant are the channels and creek-line, granite boulders and heaps, and rocky breakaway and plateau edges, which provide habitat for Threatened fauna, locally significant fauna and provide habitat linkages in the landscape.

The granite boulders and tor heaps support populations of the saxicolous EPBC Act listed *Egernia stokesii badia* (Western Spiny-tailed Skink). *E. s. badia* was located and confirmed at three locations within granite outcrops, and is expected to occur at other granite outcrops in the SKA1-Low areas. *E. s. badia* occurs within the granite boulder habitat, which comprises 172.3 ha of the SKA1-Low area. Combined, habitat for the *E. S. badia* constitutes 3.9% of the total area.

Threats include degradation/destruction of habitat and increased grazing in habitat areas which increases competition for food.

5.2.4.5 Introduced fauna

Seven introduced fauna species were recorded in the project areas, all of which are listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act), including:

- Camel (*Camel dromedaries*)
- Cat (*Felis catus*)
- Cattle (*Bos Taurus*)
- Dog/Dingo (*Canis lupus* subsp. *familiaris* or *Canis lupus* subsp. *dingo*)
- Goat (*Capra hircus*)
- Horse (*Equus ferus* subsp. *caballus*)
- Rabbit (*Oryctolagus cuniculus*).

5.2.5 Impact Assessment

Impacts on fauna species as a result of the proposal include:

- Clearing/loss of fauna habitat.
- Degradation and increased local erosion.
- Light/noise pollution during construction.
- Vibration during construction.

There will be no impact on species of national significance identified in Table 8 that are considered unlikely to occur. No significant earth moving will be required for the SKA1-Low infrastructure.

The construction of the project will involve:

- clearing native vegetation for the antenna structures and access tracks (tracks 4-6m wide, antennas within 150m x100m clusters) for a footprint of 452 ha within the 602 ha envelope
- vibration from construction including digging trenches and installing antenna ‘anchors’ (if necessary)
- open trenches between the control building and all antenna (included in access track calculation).

The **Western Spiny-tailed Skink** has a very distinctive habitat including large granite outcrops. These granite outcrops also support regionally significant fauna, flora, habitat-specialists and a high diversity of flora. The proposed action footprint will not include granite outcrops, domes, or breakaways as construction requires trenches, access tracks and concrete slabs. Therefore all Western Spiny-tailed Skink habitat is to be avoided and as such, impacts on this species are considered negligible.

The **Shield-back Trapdoor Spiders** (three individuals) were located in the SKA-Low south arm. The known location of this population can be easily avoided as it is situated in a proposed access track. The final project footprint will use spider habitat mapping as an indication of where potential populations occur so that the areas can be avoided. The access tracks linking the antenna are such that they are easily shifted to avoid significant impacts conservation significant fauna.

Vibration is considered a potential threat to the spiders and will need to be managed during construction and operation of the proposal. This has been exhibited through studies at Jack Hills and Weld Range which displayed a possible reduction in emergents and juveniles within 50 m of exploration drilling pads (Anonymous 2010). Potential vibration impacts will be avoided by applying a 50 m exclusion zone around the spider population on Boolardy Station. Impacts can be further mitigated for this species by erecting an exclusion zone fence to prevent damage by stock and feral animals, which have also been recognised as potential threats to this species (Australian Government 2013).

The open trenches are unlikely to impact on conservation significant species. The Skink and the Spider have very unique habitat requirements and are limited in their mobility. It is unlikely that open trenches will impact these species.

Three **migratory species** are considered to be a seasonal visitor with low occupancy in the area (Table 8) including *Apus pacificus, Ardea alba* and *Ardea ibis*. The Rainbow Bee-eater (*Merops ornatus*) is also considered likely to occur. However, Boolardy Station is not considered as an 'important habitat' for this species which is distributed across much of mainland Australia, and Indonesia. The banks of the Murchison River may provide nesting habitat, however given the extent of the Murchison River (and associated riparian vegetation), it remains unlikely to be considered an 'important habitat' in the Murchison region.

Boolardy Station is not considered as an 'important habitat' as defined under the EPBC Act Policy Statement 1.1 Principal Significant Impact Guidelines because Boolardy station does not contain:

a. habitat used by migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species

b. habitat that is of critical importance to the species at particular life-cycle stages

c. habitat utilised by a migratory species which is at the limit of the species range

d. habitat within an area where the species is declining.

As such the project is unlikely to have a significant impact on these three migratory species.

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DATUM GDA 1994, PROJECTION MGA ZONE 50

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LEGEND

- Cluster Envelopes
- Approximate Tracks
- Shield-back trapdoor spider confirmed location
- Western Spiny Tailed Skink Location
- Western Spiny Tailed Skink Habitat

Species

- Eremophila simulans
- Hemigenia tysonii (P3)
- Ptilotus beardii (P3)
- Sauropus sp. Woolgorong (M. Officer s.n. 10/8/94) (P1)
- Verticordia jamiesonii (P3)

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

SKA1-Low Project Significant Fauna

DEPARTMENT OF INDUSTRY

SQUARE KILOMETRE ARRAY
EPA REFERRAL

Figure

3

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5.2.6 Mitigation measures

Where potential impacts have been quantified this has been calculated based on the design provided with no mitigation or avoidance. Residual impacts have been quantified following all avoidance and mitigation measures.

The mitigation hierarchy is as follows:

- Avoidance: avoiding the adverse environmental impact altogether
- Minimisation: limiting the degree or magnitude of the adverse impact
- Rehabilitate: restoring the maximum environmental value that is reasonably practicable
- Offsets: actions that provide environmental benefits to counterbalance significant residual environmental impacts or risks of a project or activity.

CSIRO will endeavour to avoid and minimise clearing of native vegetation and fauna habitat, however some clearing will be required. Justification of the chosen project design was based on the feasibility of footprint to accommodate the array and serviceability and full seasonal access.

The Western Spiny-tailed Skink has a very distinctive habitat including large granite outcrops. These granite outcrops also support regionally significant fauna, flora, habitat-specialists and a high diversity of flora. The proposed action footprint will not include granite outcrops, domes, or breakaways as construction requires trenches, access tracks and concrete slabs. Therefore all Western Spiny-tailed Skink habitat will be avoided and as such impacts on this species are considered negligible.

The Shield-back Trapdoor Spiders (three individuals) were located in the SKA-Low south arm. The known location of this population can be easily avoided as it is situated in a proposed access track. The final project footprint will use spider habitat mapping as an indication of where potential populations occur and avoid these areas. The access tracks linking the Antenna are such that they are easily shifted to avoid significant impacts.

Vibrations will need to be managed during construction and operation of the SKA telescope. Vibrations are considered a potential threat. This impact will be avoided by applying a 50m exclusion zone around the spider population on Boolardy Station. Impacts can be further mitigated for this species by erecting an exclusion zone fence to prevent damage by stock and feral animals which have been recognised as potential threats to this species (Australian Government, 2013).

The open trenches are unlikely to impact on conservation significant species. The Skink and the Spider have very unique habitat requirements and are limited in their mobility.

5.2.7 Residual Impacts

The proposal will result in the unavoidable disturbance of 452 ha of native vegetation, some of which may provide habitat for conservation significant species, such as the Shield-backed Trapdoor Spider. The fauna habitats recorded within the proposal envelope are not considered unique to the impact area. The final project footprint will use spider habitat mapping as an indication of where potential populations occur and avoid these areas. Furthermore, given the linear and clustered nature of the project, and distribution of similar habitats in adjacent areas, the proposed infrastructure is not considered likely to have a significant impact on fauna habitat on a regional or local scale.

Consistent with EPA objectives, the abundance, species diversity, geographic distribution and productivity of terrestrial fauna at species and ecosystem levels will be maintained, thereby conserving regional biological diversity. The ecological surveys undertaken for the proposal and implementation of the proposed management measures will ensure that direct disturbance to important fauna habitat is kept to that which is necessary and that fauna and fauna habitat are protected from indirect disturbance as far as practicable.

5.2.8 EPA's Objective

EPA's Objective – from your perspective and based on your review, which option applies to the proposal in relation to this factor? Refer to EAG 9	☒ *meets the EPA's objective* ☐ *may meet the EPA's objective* ☐ *is unlikely to meet the EPA's objective*

5.2.9 Assumptions

The key assumption in regards to fauna is that impacts on fauna will be avoided by moving elements of the project including access tracks and antennas away from conservation significant fauna habitats.

5.3 Hydrological Processes

5.3.1 EPA Objective

The EPA Objective for Hydrological Processes as per EAG 8 is:

To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.

5.3.2 Guidance

The following Legislation, Guidance, Policy and Standards were used to guide the impact assessment on inland waters environmental quality:

- *Rights in Water and Irrigation Act 1914* (RIWI Act)
- EPA Position Statement 4 – *Environmental Protection of Wetlands*
- EPA Guidance Statement 33 – *Environmental Guidance for Planning and Development.*

5.3.3 Consultation

Consultation with regulatory agencies in relation to the potential environmental impact on hydrological processes will be conducted. Relevant agencies will include:

- Department of Parks and Wildlife
- Department of Water.

5.3.4 Baseline information

5.3.4.1 Surface water

Drainage lines originate at Boolardy and overland flow passes through these channels westerly towards the Murchison River and southerly towards Roderick River, although there appears to be no direct connection with these rivers.

5.3.4.2 Groundwater

The project did not investigate groundwater at Boolardy as the project comprises the placement of wide-spaced antennae across the landscape and does not expect to interact with or impact upon groundwater.

5.3.4.3 Waterways

There are no wetlands of National or sub-regional significance on Boolardy Station, however two wetlands of national significance are located within the surrounds of the proposal. Wooleen Lake is located approximately 42 km to the southwest and Breberle Lake lies approximately 55 km to the northwest of the SKA1-Low.

5.3.5 Impact Assessment

The natural landscape features of the site will not be significantly altered and will not include large scale excavation, thereby having little interaction with surface or groundwater.. However, it is possible that the placement of tracks across the landscape may reduce the velocity and volumes of overland and channellised flows to lower parts of the landscape outside the main proposal areas, which may result in the following impacts:

- Diminish flows supporting primary production underpinning the ecosystem functions
- Result in plant losses
- Result in increases in soil erosion
- Result in changes to groundwater recharge rates and groundwater levels
- Increase in water-dependent species if additional watering points are established and this may change the abundance of other species
- Increase in feral species and weed distribution as a result of altered overland flows.

The geoexchange cooling activities would also require the abstraction of minor volumes of groundwater per annum. The existing cooling system for the MRO geoexchange facility is currently functioning on an initial charge of water trucked in from Geraldton, combined with rainwater collected from the roof of the unit (Pers. Comm. Antony Schinckel 2016) and therefore does not require the extraction of groundwater.

5.3.6 Mitigation measures

Mitigation measures include:

- Careful planning and construction of roads to minimise capture and channelling overland flows, particularly on hardpan plains.
- Rehabilitation of any cleared areas no longer required for construction.

5.3.7 Residual Impacts

The final footprint is likely to be smaller than the proposal area, thereby reducing the direct impacts on hydrology. The project is located in a flat area and hydrology of the site is not expected to be impacted. Hydrological studies will be undertaken to assist in the management and mitigation of hydrology. The completion of these studies will assist with:

- project specific management requirements relating to surface-water management
- additional engineering requirements needed to mitigate impacts on hydrology or hydrogeology
- opportunities to further mitigate impacts
- appropriate management to ensure there is no change to hydrological function of waterways.

As such, the predicted residual impacts are predicted to be minimal on hydrological flows and surface water flows.

5.3.8 EPA's Objective

EPA's Objective – from your perspective and based on your review, which option applies to the proposal in relation to this factor? Refer to EAG 9	☒ *meets the EPA's objective* ☐ *may meet the EPA's objective* ☐ *is unlikely to meet the EPA's objective*

5.3.9 Assumptions

The key assumption with regards to hydrological processes is that existing mitigation is equally as effective in the low array area as it has been in the MRO area.

5.4 Inland Waters Environmental Quality

5.4.1 EPA Objective

The EPA Objective for Inland Waters Environmental Quality as per EAG 8 is:

To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.

5.4.2 Guidance

The following Legislation, Guidance and Policies are relevant to the impact assessment on inland waters environmental quality:

- *Metropolitan Water Supply, Sewerage and Drainage Act 1909*
- *Country Areas Water Supply Act 1947*
- EPA Guidance Statement 33 – Environmental Guidance for Planning and Development.

The following strategies and guidelines are also applicable to this impact assessment:

- National Water Quality Management Strategy
- ANZECC/ARMCANZ (2000) Guidelines
- DER Acid Sulfate Soils Guidelines Series (DEC 2011b; DEC 2013).

5.4.3 Consultation

Consultation will be undertaken with Department of Water, the station owners and other interested parties.

5.4.4 Baseline information

5.4.4.1 Surface water

Drainage lines originate at Boolardy and overland flow passes through these channels westerly towards the Murchison River and southerly towards Roderick River, although there appears to be no direct connection with these rivers.

5.4.4.2 Groundwater

The project did not investigate groundwater at Boolardy as the project comprises the placement of wide-spaced antennae across the landscape and does not expect to interact with or impact upon groundwater.

5.4.4.3 Waterways

As discussed in Section 5.3.4, there are no wetlands of National or sub-regional significance on Boolardy Station, however two wetlands of national significance Wooleen Lake is located approximately 42 km to the southwest and Breberle Lake lies approximately 55 km to the northwest of the SKA1-Low.

5.4.5 Impact Assessment

The project will not involve large scale excavation and therefore will not significantly alter the features of the natural landscape. However, activities associated with the proposal such as clearing, construction of access roads and trenches, and installation of the antennae may result in additional erosion and if not adequately managed, this may result in decreased surface water quality.

The project will not discharge water from geoexchange cooling activities to the environment, which is expected to avoid impacts on ground or surface water quality.

There may be potential contamination from hydrocarbons and chemicals during construction, but this will be managed effectively as has been the case with the MRO.

5.4.6 Mitigation measures

Mitigation measures include:

- Management during construction to control and manage erosion.
- Management during construction to prevent spills of any contaminating materials
- Rehabilitation of any cleared areas no longer required for construction
- Management during construction to prevent spills of any contaminating materials, to be detailed in the Construction Environmental Management Plan.
- Ongoing monitoring of surface and groundwater quality during operations if necessary
- Chemicals and hydrocarbons will be stored at the MRO central compound site appropriate management and mitigation measures will be implemented through the construction and operation environment management plan.

5.4.7 Residual Impacts

There are not expected to be any residual impacts of the project on water quality.

5.4.8 EPA's Objective

EPA's Objective – from your perspective and based on your review, which option applies to the proposal in relation to this factor? Refer to EAG 9	☒ *meets the EPA's objective* ☐ *may meet the EPA's objective* ☐ *is unlikely to meet the EPA's objective*

5.4.9 Assumptions

The key assumption with regards to water quality is that existing mitigation is equally as effective in the low array area as it has been in the MRO area.

5.5 Heritage

5.5.1 EPA Objective

The EPA Objective for Heritage as per EAG 8 is:

To ensure historical and cultural associations are not adversely affected

5.5.2 Guidance

The following Legislation, Guidance and Policies are relevant to the impact assessment of Heritage:

- *Aboriginal Heritage Act 1978*
- EPA Guidance Statement No.41 – Assessment of Aboriginal Heritage.

5.5.3 Consultation

The Proponent has been in consultation with the *Wajarri Yamatji* people and has undertaken a preliminary inspection of the proposal area. An Indigenous Land Use Agreement (ILUA) is in place with the *Wajarri Yamatji* native title claim group for the existing MRO. A positive relationship exists between CSIRO and the *Wajarri Yamatji* community and a new ILUA will be prepared for the SKA Low array. A comprehensive heritage survey will be undertaken of the SKA prior to any disturbance.

5.5.4 Baseline information

A search of the Department of Indigenous Affairs (DIA) Aboriginal Heritage Inquiry System identified there are no known aboriginal heritage sites within the SKA1-Low project area. Using the external Boolardy lease as the search area, an examination of the Register of Aboriginal Sites (the Register) indicated that there are three registered Aboriginal sites, two of which are archaeological. There is one registered ethnographic Aboriginal site purported to be within the Project Area (Survey Area). This Closed site file, Site ID 8327 “Coocoowilya Pool” is registered as a ceremonial site, and is actually not located within the Boolardy lease, but on the Pia Reserve. The extended boundary of the Closed site crosses into the Boolardy lease, however this DAA boundary does not represent the actual area of cultural significance. The DAA boundary is extended to mask the actual boundary of the site.

A preliminary Ethnographic Heritage Survey was undertaken of Boolardy Station and the MRO Lease in January 2015 (Haydock 2015). This confidential survey identified 15 sites across Boolardy Station that should be avoided by the project.

Boolardy Homestead Group is listed as a Heritage Place in Western Australia.

5.5.5 Impact Assessment

The installation of the SKA Low array and access tracks are not expected to impact upon Aboriginal Heritage sites.

The upgrades and modifications to the Boolardy Homestead Group have already been conducted as part of the ASKAP project in 2009. At that time, no impacts from the proposed modifications were anticipated. This proposed action does not involve any works on the Boolardy Homestead Group, therefore no impacts to the heritage value of the homestead is expected.

5.5.6 Mitigation measures

The Following management and mitigation measures will be undertaken with regards to Heritage:

- Known Aboriginal Heritage Sites will be avoided during the construction of the SKA Low Array.
- Once the final design is complete further Aboriginal heritage surveys will be undertaken.
- An unexpected finds plan will be in place prior to any ground disturbance activities to outline management should an artefact of site be uncovered during works
- Ongoing consultation with local Aboriginal Groups MWAC and YMAC.

5.5.7 Residual Impacts

There are not expected to be any residual impacts on Heritage as a result of the proposal.

5.5.8 EPA’s Objective

EPA’s Objective – from your perspective and based on your review, which option applies to the proposal in relation to this factor? Refer to EAG 9	☒ *meets the EPA’s objective* ☐ *may meet the EPA’s objective* ☐ *is unlikely to meet the EPA’s objective*

5.5.9 Assumptions

The key assumption with regards to heritage is that none of the sites are located where critical infrastructure is to be built. Surveys to date support this assumption.

6.0 Application of Significance Framework

The EPA uses a 'Significance Framework' to determine the likely significance of a proposal and to make decisions throughout the EIA process.

Where EPA objectives for a factor can be met, then the proposal is considered unlikely to have a significant impact on the environment. Where a proposal may or may not meet one or more of the EPA objectives, then the proposal is likely to have a significant impact on the environment.

As outlined in Section 3.0, the preliminary key environmental factors identified as likely to be impacted by the proposal are as follows:

- Flora and Vegetation
- Terrestrial Fauna.

For referred proposals, the OEPA conducts a significance assessment in line with the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012* to determine whether the potential impacts on environmental factors will require formal assessment under the EP Act. The criteria considered in this significance assessment were applied to the Project to determine the need for a referral to the OEPA (Table 9).

Table 9 Assessment of the Significance of the Proposal against the OEPA significance criteria

EPA Significance Criteria	Assessment of Proposal
Values, sensitivity and quality of the environment which is likely to be impacted	• Vegetation outside the area of impact is above the 10% critical threshold for constrained areas • Priority Flora are well represented outside of the proposal area and will not be directly impacted • TEC will not be directly impacted • Habitat for conservation significant species will be managed closely to minimise any impacts
Extent (intensity, duration, magnitude and geographic footprint) of the likely impacts	The proposal requires a disturbance of 463 ha This includes: • 404 ha for array and access tracks • 14 ha for CPF • 8 ha for construction and permanent camps • 15 ha power generation • 22 ha for airstrip extensions
Consequence of the likely impacts (or change)	• Disturbance is not likely to result in any reduction in the local and regional availability of habitat and extent of significance species and vegetation. • Disturbance is not likely to result in a reduction in groundwater availability.
Resilience of the environment to cope with the impacts or change	Most of the Proposal area is already significantly disturbed from pastoral activities.
Cumulative impact with other projects	As the impact of this Proposal on conservation significant flora and fauna is predicted to be avoided, it will not result in any cumulative impacts.
Level of confidence in the prediction of impacts and the success of proposed mitigation	• CSIRO and DISS have undertaken sufficient investigations to understand the nature of flora, fauna, groundwater and sub-surface geology and the potential impacts on these factors.
Objects of the Act, policies, guidelines, procedures and standards against which a proposal can be assessed	All relevant policies, guidelines, procedures and standards have been considered in the assessment of the environmental value of the area.
Presence of strategic planning policy framework	Not Relevant. The Project is not a Strategic Proposal.

EPA Significance Criteria	Assessment of Proposal
Presence of other statutory decision-making processes which regulate the mitigation of the potential effects on the environment to meet the EPA's objectives and principles for EIA	Aspects of the Project able to be appropriately assessed and managed through the following regulatory mechanisms: • Clearing impacts – Part V of the EP Act • Impacts of groundwater extraction
Public concern about the likely effect of the proposal, if implemented, on the environment.	Community Stakeholder and Agency consultation has been undertaken.

7.0 References

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Appendix A

AECOM Ecological Surveys 2014

Appendix B

Phoenix Targeted Spider Survey 2015