



## SUMMARY REPORT ON COSTS

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## 1 Introduction

The purpose of this report is to provide a simple overview of the costings provided by the Australian and Southern African site proponents in a comparable format. A large volume of work has been carried out by both sites including substantial detailed analysis and both sites should be highly commended for this valuable contribution to the SKA project.

## 2 Scope

This report summarises the cost information for the two candidate sites in as comparable a manner as possible. The material is drawn from the site submissions and their extensive appendices. Costing information for both site submissions is distributed throughout their chapters and appendices at various levels of detail. Many of the appendices are in the candidate site's native currency and it has been, in some cases, difficult to make the connections between the material in the appendices and the costs quoted in the main body of the report.

In the Australian submission, top level costs are spread throughout the report. Attachment 28 provides an overview of the costs contributing to the top level report, in Australian dollars; it has been at times challenging to distinguish which cost had been used in which total. In addition, Attachment 28 is in locked PDF format which means that the data it contains could not be transferred directly for SPDO analysis. Furthermore, it does not include the maintenance and operations components of the costings, these are included in the main body of the submission. Table 4 in this report is a replication of Attachment 28 converted into 2007 Euros (€) together with the maintenance and operations costs that were distributed throughout the main body of the report. In order to help the reader, a second copy of Attachment 28 is included as Appendix 1 to this report with colour coding to show how the costs in the Attachment relate to the totals in the main body of Australian submission.

This report only makes reference to the costing data relating to the "Model Compliant" SKA, as mandated by the SSG. The costings for the alternative SKA configuration provided by Australia-NZ have not been included.

In the case of the submission from Southern Africa, high level costings are provided in the main body of the submission. More detailed costings are provided in the main body of the submission but some of these are categorised in a way that does not map easily onto the questions in the SSG's Request for Information (RfI). In these cases the Annexures were consulted in order to locate this information.

Extensive detailed costing is provided in the Annexures in Excel spreadsheet format giving the details of the components included in their costings. However, the Excel spreadsheets use macros some of which were not included with the submission, and this has made it difficult for us to replicate the calculations in those cases. Throughout Table 5 on Southern Africa's costs, references are made in the comments column to the relevant Annexure should the reader wish to find more detail.

We have attempted to ensure that where costing components have been presented for comparison, they are directly equivalent. As a consequence, the overview cost tables (Table 1 and Table 2) include totals which have been amalgamated in the pie charts in Section 6. Only where we were confident that the totals for both sites were directly equivalent have these been presented as separate segments of the pie chart.

### 3 Use of Colour Coding

The same colour coding is used in tables and pie charts in order to make it easier to see which line items are included in which totals. A summary of the colours used is shown below, Figure 1. It should be noted that the “Other Infrastructure” category (colour coded black) only occurs in the Southern African submission.



Figure 1: Colour Key

### 4 Currency Conversion

The Request for Information included the following instructions:

#### “2.3 Currency and Base Date

Cost estimates of construction and operations will be “present day values”. Whilst they may be prepared using local currency, the values presented must be in Euro to provide a common basis for comparison. The currency conversions for present day Australian dollars and South African Rand to present day Euros have been set as \$1.35/€ and ZAR9.27/€. Present day Euros must be converted to a base date of 1 January 2007 for estimation of costs. This date has been chosen for consistency with earlier SKA documents. Where indexation or adjustments have been used, the indexation series and approach used to adjust values to the base date must be described.”

The following two sections provide the methodology adopted by the two candidate sites.

## 4.1 Australasia

### “Currency and base cost

The basis of the cost estimate has costs and rates applicable to Australia, and in particular the appropriate region of Western Australia, using a cost base as at September 2011.

From this cost base (and in accordance with Clause 2.3 of the Request for Information we have taken the current Australian value construction costs and converted this to Euros at the stated rate of A\$1.35/Euro.

The Request for Information also requires that the cost base be converted to a cost base of 1 January 2007. To do this we have used the Australian Consumer Price Index as an appropriate and identifiable source of data. The Consumer Price Index is a calculation and publication by the Australian Bureau of Statistics (ABS) in Publication No. 6401.0.

Specifically we have used the 'weighted average of eight Capital cities' and the following specific published index in our calculation:

- CPI Index December 2006 155.5
- Calculated Index in January 2007 (one third of the increase to the March 2007 Index = 155.53
- CPI Index June 2011 178.3
- Assumed CPI increase from June 2011 to September 2011 based on the percentage movement in the previous 3 months ( $178.3/176.7 = 0.9\%$ ) giving a theoretical September 2011 index of 179.9
- Assumed September 2011 ABS Index 179.9
- CPI Cost Base Reduction to 1 January 2007 =  $155.53/179.9 = 86.45\%$ .

We note that historically the construction costs trend to shadow the CPI movement. In times of high construction activity the construction escalation will exceed the CPI 'trend line' and in times of sustained low construction activity will fall below the 'trend line'.

It is noted that in January 2007 construction activity in Australia and in particular Western Australia was at a high level.

Based on the 'strict' application of the CPI changes, costs in January 2007 would be 86.45% of current costs. Our calculation takes a more conservative position by also looking at the supply and demand impacts on the construction industry over this time, and have adjusted this to be only 90% of current costs.

Please refer to Attachment 31 for an extract from ABS Publication 6401.0 Consumer Price Index Australia, June 2011 for further information.

## Confidence Level

Uncertainty in the cost estimate was accounted by assigning a range of possible costs for each element, typically -15% to +30%. A mathematical methodology, known as 'Monte Carlo Simulation' was then implemented to determine the probability distribution of costs across the whole project. This enabled the calculation of the most probable cost, and a cost with an assigned confidence level. For example, a '70% confidence level' means that there is a 70% probability that the actual cost will be less than or equal to the estimated cost. A 90% confidence level provides a high level of confidence that the actual cost will be less than or equal to the estimate."

*Extract taken from Attachment 30, Page 944, of the Australian Submission*

## 4.2 Southern Africa

### "Currency and base date

**Table 5-18: Calculation of Conversion Factor**

Source	Eurostat	
Website	<a href="http://appsso.eurostat.ec.europa.eu/">http://appsso.eurostat.ec.europa.eu/</a>	
Data Field	HICP2005,NSA,CP-HI00,EU27	
Data	31-Dec-06	103.34
	31-Mar-11	114.84
Reference Exchange Rate (ZAR/Euro)		9.27
Conversion Factor to deflate Mar 2011 ZAR to 1 Jan 2007 Euro (i.e. multiply Mar 2011 Rands with this value)		0.0971
Example	R100 in March 2011 = how many Jan 2007 Euros?	9.71

The SSG requires that the cost estimates developed in local currency in 2011 be converted to Euros and deflated to 1 January 2007. The reference rate of exchange for the conversion in 2011 is given as ZAR 9.27/€. Once converted to Euros, the costs then have to be deflated for Eurozone inflation from March 2011 to January 2007. This is done with reference to the Eurozone CPI (consumer price index) as calculated by Eurostat. The index value at the end of March 2011 (practically 22 March 2011) is divided by the value at the end of December 2006 (practically 1 January 2007) to obtain the rate of inflation by which the 2011 costs are then deflated."

*Extract taken from Annexure C4.1 - Full SKA Report on Infrastructure Costs, Page 63, of the Southern African Submission*

## 4.3 Comment

Apparently the instructions in the RfI on currency conversion were ambiguous in that the ANZ submission used an Australian CPI to deflate the 2011 Euros to 2007 Euros whereas the Southern African submission used an estimate of the Eurozone CPI for the deflation correction. Fortuitously, both deflation corrections are the same to within one percent (10% Australia, 11% South Africa). The approach taken by the South Africans was the one intended to be used.

## 5 Overview Cost Totals

	Australia	South Africa
Capital Costs	1,004,595,881	██████████
Annual Operational Costs	130,690,652	██████████

Table 1: Overview Cost Totals

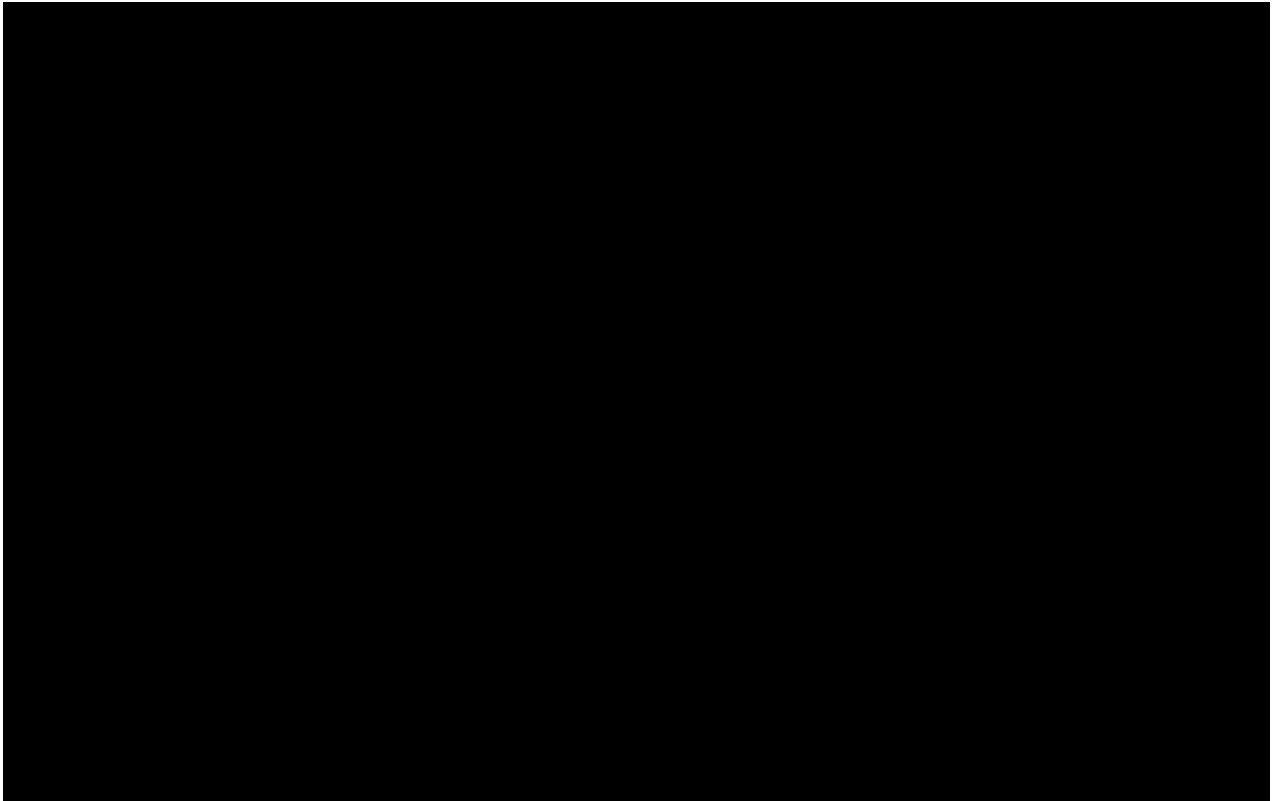


Figure 2: Comparative Costs for Australia and Southern Africa



## 6 Overview of Capital Costs

CAPITAL COSTS	Australia	Southern Africa
Roads (Major)	22,400,000	██████████
Roads (Minor)	48,565,001	██████████
Equipment and Office Buildings	29,292,501	██████████
Accommodation for Construction Crews	30,066,667 50% of accommodation discount applied	██████████
Accommodation for Operations & Maintenance Staff	17,133,333 50% of accommodation discount applied	
Airstrip	0	██████████
Dish Foundations	157,200,000	██████████
AA-Mid Site Prep and Bunkers	168,811,667	
AA-Low Site Prep and Bunkers	46,250,000	
Power	331,478,500	██████████
Data (to 180km)	75,258,279	██████████
Data (outside 180km)	78,139,933	██████████
Other Infrastructure	0	██████████
<b>SUM Capital Costs</b>	<b>1,004,595,881</b>	██████████

Table 2: Capital Cost Overview, including discounts

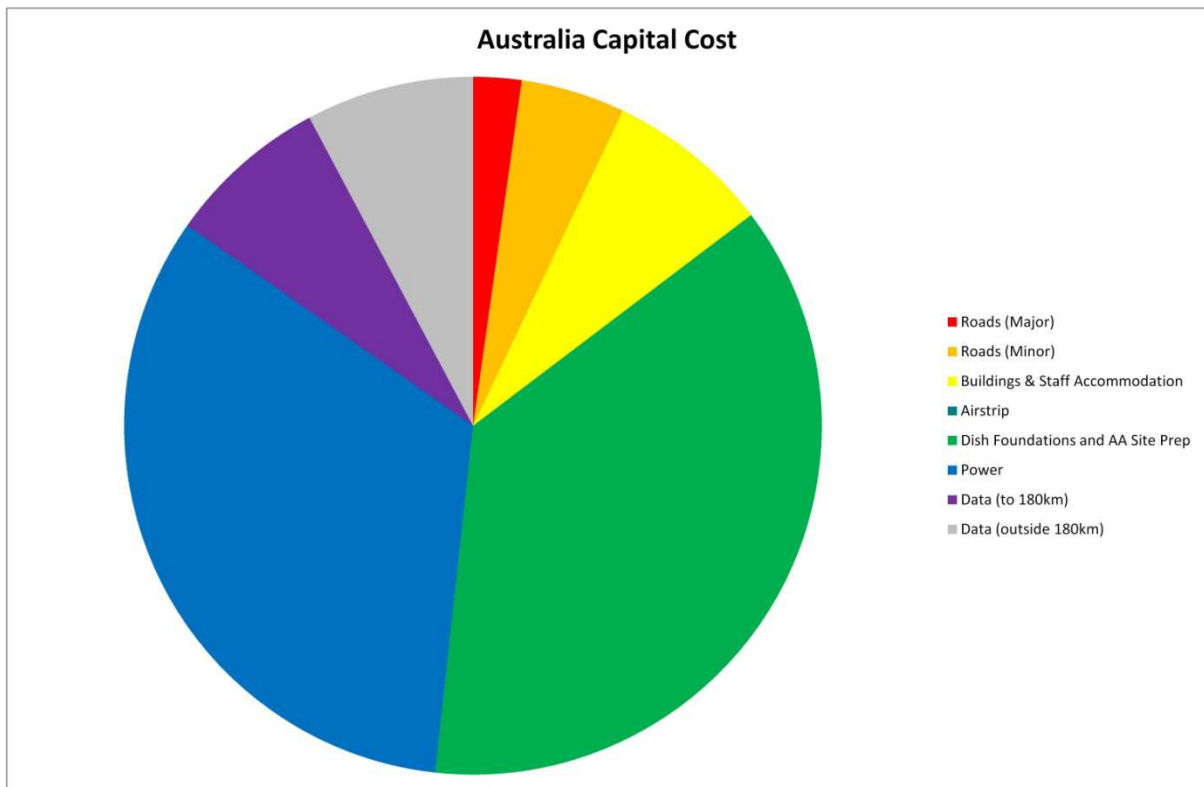


Figure 3: Australia Capital Costs

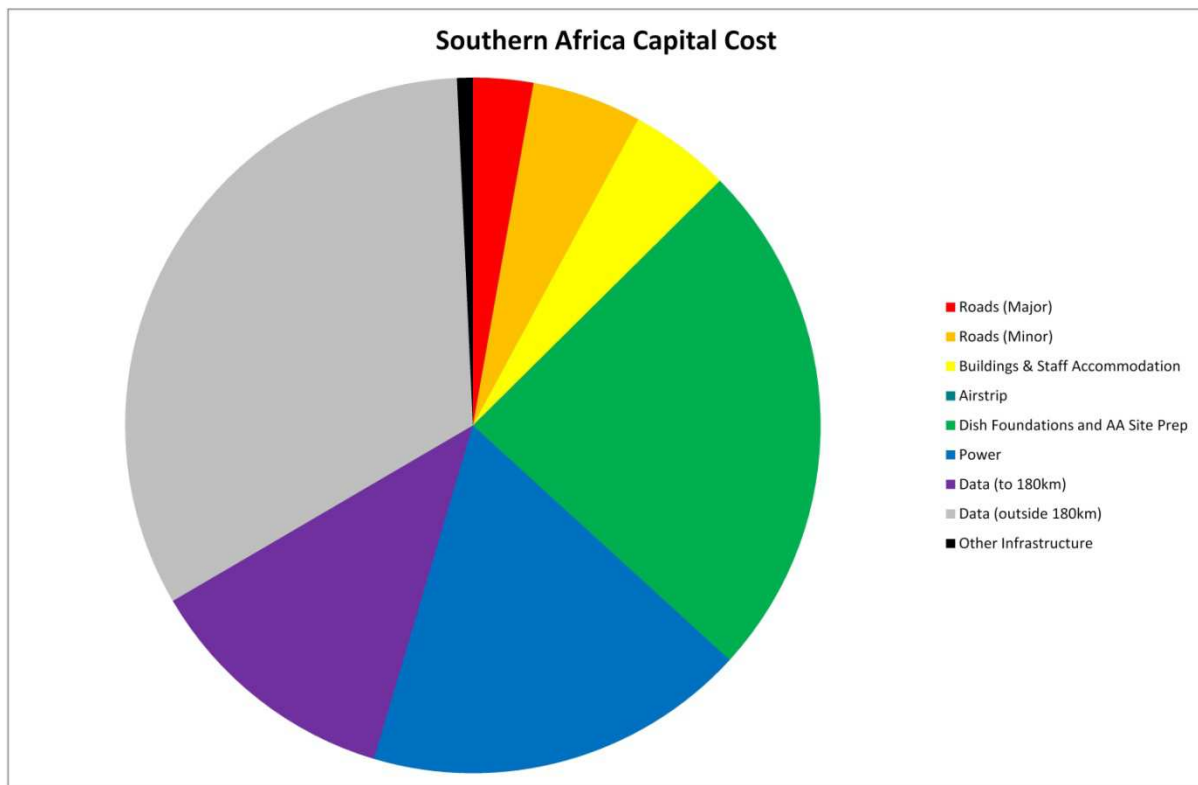


Figure 4: Southern Africa Capital Costs

## 6.1 Noteworthy differences

### 6.1.1 Accommodation Costs for Construction and Operation Phases

The cost data from the two sites differs considerably for the on- or near-site accommodation during construction and operation phases of the project. The Southern African submission gives a cost of ██████ as opposed to the Australian submission cost of €47M. This seems surprising given that both sites have complied with the provision of accommodation for the numbers of staff given in the Request for Information, especially as their costings for Equipment and Office buildings appear so similar.

### 6.1.2 Dish Foundations, AA-Low and AA-High Site Preparation and Bunker Costs

Another area of significant difference between the two costings is in Dish Foundations, AA-Low and AA-Mid Site Preparation and Bunker costs. The Southern African submission is totalled at ██████ whereas the Australian submission gives a figure of €372M in total.

The Australian submission provides separate estimates for these three components. Included is a cost estimate for the 250 AA-mid bunkers of \$250M (€167M). The submission (p. 95) makes the comment that “At this stage the cost of bunkers has not been optimised. A generous estimate is included in the budget to account for the specifications (including shielding requirements for the cooling systems) not being well known.”

It has not been possible to extract the individual costs for each of the three elements from the Southern African submission.

### 6.1.3 Power Infrastructure Costs

There is a significant difference in the costs presented by the two sites for power infrastructure. The costs of power provision in the Southern African submission is based on the extensive use of grid supplied power throughout the telescope, whilst the Australian submission includes a significant component of cost for generation infrastructure.

### 6.1.4 Data Transport Costs Outside 180km

The two sites have very different data transport infrastructure costs outside the central 180km. This is due to the use, in Australia, of the AARNet DWDM backbone for the transmission of data with the only costs to the SKA project being as follows.

- “... the fibre-optic tails, huts, transponders and the incremental equipment to house and integrate them into the existing carrier’s network.
- Over the next 12 years the AARNet fibre that is provided by the NBN and Nextgen Networks will be fully upgraded to DWDM, funded by its members and the Australian Government via a variety of mechanisms
- Only incremental costs associated with accessing the AARNet backbone and using the wavelengths are borne by the project”

*Extract taken from Attachment 36 of the Australian Submission*

The value of this discount in Australia has not been specified.

The Southern African submission includes the full commercial costs to construct the data transport infrastructure to support the SKA model and discounts where applicable.

## 7 Overview of Annual Operation and Maintenance Costs

Operations and Maintenance Costs	Australia	Southern Africa
Roads - Operations and Maintenance	944,607	
Buildings & Staff Accommodation - Operations and Maintenance	725,556	
Airstrip - Operations and Maintenance	6,120	
Dish Foundations and AA Site Prep - Operations and Maintenance	335,051	
Power - Operations and Maintenance	124,000,000	
Data (to 180km) - Operations and Maintenance	1,925,986	
Data (outside 180km) - Operations and Maintenance	2,753,333	
Other Infrastructure - Operations and Maintenance	0	
<b>Sum Operations and Maintenance Costs</b>	<b>130,690,652</b>	

Table 3: Operations and Maintenance Cost Overview

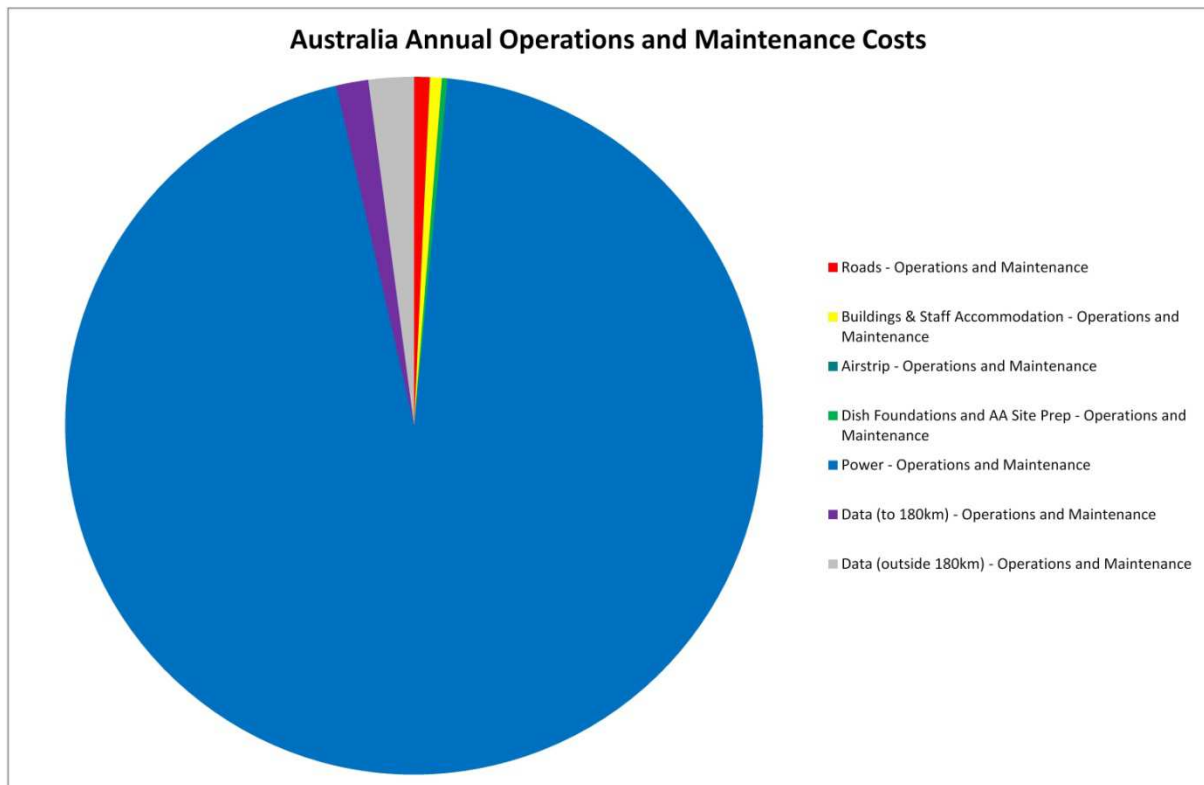


Figure 5: Australian Annual Operations and Maintenance Costs

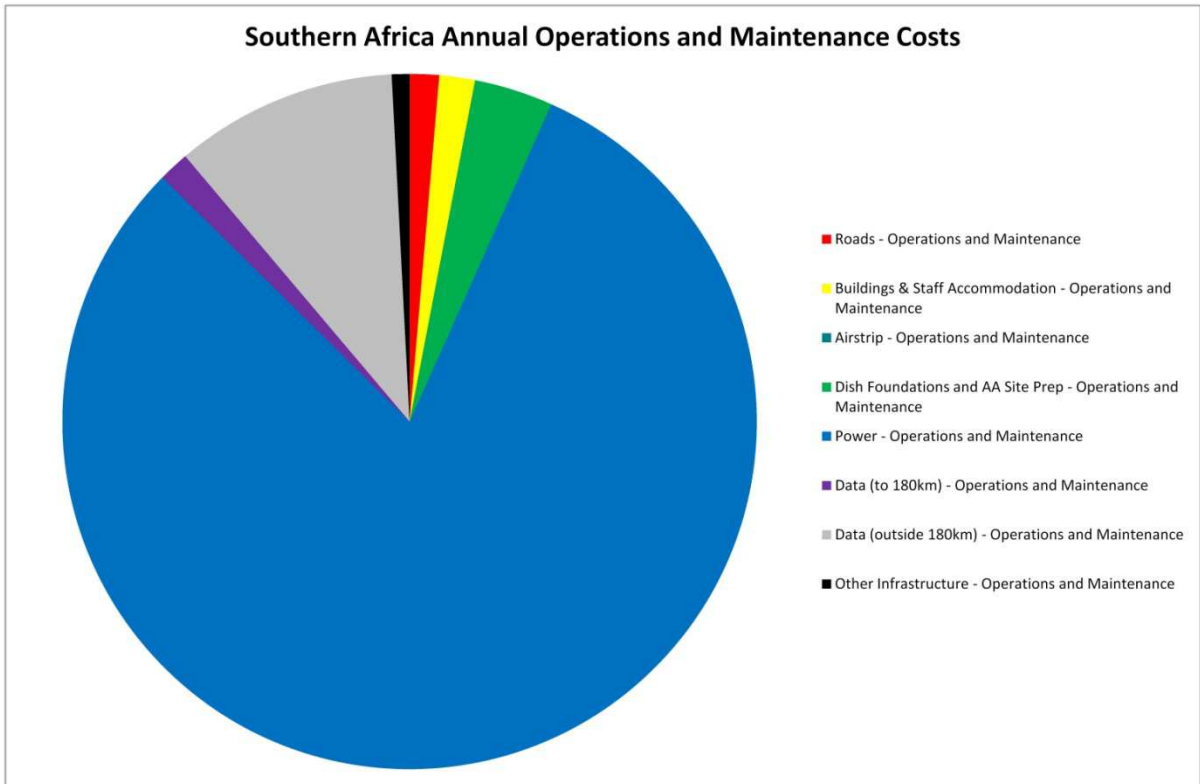


Figure 6: Southern African Annual Operations and Maintenance Costs

## 8 Cost Tables

The following tables have been prepared so that the information provided by both countries can be placed side-by-side to enable comparison. It is also intended that these tables act as a guide to the reader with references to the locations of further detailed information if needed.

The format of the two tables, whilst very similar, is not identical. This is due to the fact that each of the candidate sites chose how best to present costs in their reports. It might be considered a disadvantage to one site over the other if the presentation style of one were to dictate the presentation style used for the other in this report, hence both tables mirror the presentation styles from the original submissions.

## 8.1 Australian Cost Table

## Provision of Basic Infrastructure Components

Describe the total cost to the project of each major infrastructure component assuming a 10 year construction period for the SKA and 30 years of operations and maintenance. The cost should be based on industry estimates/quotes, backed by cost data on similar previous projects, and include the cost of owning or leasing the land required.

AUSTRALIA	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions	
		Unit	Quantity	Rate (€)	Value (€)			
a) Roads (including construction, layout, width, load bearing capacity, design speed and vehicle frequency) for: <ul style="list-style-type: none"> <li>• Major Roads</li> <li>• Minor Roads</li> </ul>	<b>TOTAL – Major Roads</b>				<b>22,400,000</b>	<b>944,607</b>		
	Lead in Road to central facility	km	210	106,667	22,400,000		Allowance to for chip sealed single lane road with graded shoulders including upgrading as required	
	<b>TOTAL – Minor Roads</b>				<b>48,565,001</b>		Annual Operation and Maintenance Cost for Major and Minor Roads allows for operational (staffing), maintenance and life cycle costs. Includes capex credit of €2,240,000 amortised over 30 years	
	Minor Roads (inside 5km cores)	km	180	16,667	3,000,000			
	Minor road (outside the 5km cores)	km	448	16,667	7,466,667			
	Minor roads	km	1,370	16,667	22,833,333			
	Clear central area including raising ground level and provision of gravel surface (2 No. 1 km diameter)	Ha	943	1,667	1,571,667		Minimal work required	
	Bridge / water crossing	No.	1	6,666,667	6,666,667		Indication of cost from Murchinson Shire	
	Minor Water crossings	No.	6	33,333	200,000		Estimated number	
	Minor road to individual station outside 13km	km	325	16,667	5,416,667		assume average 500m to each station from primary access	
	<b>Remote Sites - Within Australia (25 No.)</b>							
	Access to remote site	km	199	16,667	3,316,667		Minor road	
	Access within each remote site	No.	25	13,333	333,333		Assumed	



AUSTRALIA Page 2	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions
		Unit	Quantity	Rate (€)	Value (€)		

b) Equipment and Office Buildings • the Operations Centre near the Centre of the Array • equipment and office buildings. Describe the building to be used in each case including size, construction type and facilities equipment and office buildings.	<b>TOTAL – Buildings and Staff Accommodation</b>					<b>74,825,834</b>	<b>725,556</b>		
	<b>SKA Operations Centre - near centre of Array - Located 30 km from core (SKA OCCA)</b>								
	Data Centre & Operations Building	m2	1,500	5,167	7,750,000			Provision of 'white space' - no active equipment or associated cooling & power requirements	
	Fibre Collection & Management Building (60%)		500	4,000	2,000,000			Additional area included to allow for collection and staging area for fibre management	
	Operations Control Room		100	5,167	516,667				
	Power building		250	6,667	1,666,667			assumed size	
	Office - control building		300	3,333	1,000,000			Allowance for 20 staff x 15m2 per person	
	Sub-Total: Net Area	m2	2,650						
	Travel & Engineering		663	3,333	2,208,333			allowed 25% grossing factor	
	Total Gross Building Area	m2	3,313						
	RFI Shield to Data Centre & Power Building		1,750	2,333	4,083,333				
	<b>Sundry Building (700m from Operation Centre)</b>								
	Office space	m2	300	3,333	1,000,000			20 staff x 15m2 / person	
	Meeting Rooms	m2						included above	
	Canteen	m2	130	2,667	346,667			130 people	
	Canteen kitchen facility	m2	65	13,333	866,667			assumed size to be confirmed	
	Maintenance Facility	m2	750	1,000	750,000			assumed size	
	Sub-Total: Net Area	m2	1,245						
	Travel & Engineering	m2	311	3,333	1,037,500			assumed 25%	
	Total Gross Building Area	m2	1,556						
	RFI shielding							Assumed by A-NZ not to be required	
	Furniture Fitting & Equipment							Excluded - assumed this is active equipment	
	<b>Computing centre</b>								
Computer, Data storage, Etc. (1500m2 of 'active Floor is required)	m2	1,500	4,000	6,000,000			White space' shell no allowance for equipment or equipment cooling ; power filtering or UPS		
Data storage	m2	included		included			White space shell' space no allowance for equipment or equipment cooling; power filtering or UPS		
Data interconnect	m2	100	3,333	333,333					
Heating, cooling, ventilation - Plant Area	m2	2,000	2,000	4,000,000			500m2 as briefed appears to be insufficient - Increased to 2000m2 based on current experience with Pawsey Centre		

AUSTRALIA Page 3	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions
		Unit	Quantity	Rate (€)	Value (€)		
	Office related component	m2	1,050	2,667	2,800,000		Based on 70 People (based on 15m2/person)
	Equipment and Office Buildings Operations and maintenance					725,555.50	Allows for operational (staffing), maintenance and life cycle costs. Includes capex credit of €8,733,333 amortised over 30 years
c) Accommodation for construction crews, and operations and maintenance staff • construction camp or camps (including details of lay-down and assembly areas, storage areas, power supply, accommodation and welfare facilities)	<b>Accommodation for Construction Crews &amp; Operations &amp; Maintenance Staff</b>						
	Construction phase staff	No.	330	80,000	26,400,000		Peak construction workforce anticipated to be 400 persons of which 70 can access the various works sites from adjacent towns (330 accommodation units required)
	Fly camp to allow construction of Construction Camp	No.	30				Assumed they are able to use Boolardy Station Accommodation
	Credit for Permanently - Operations Phase	No.	130	80,000	-10,400,000		
	Operating Construction camp	Man Weeks	76,000	217	16,466,667		Based on an average of 145 persons for 5 years
	Operations Phase	No.	130	100,000	13,000,000		Modular style facilities with allowance for Wet mess, Recreation Facilities, Sports courts, etc.
	Water sanitation	Item			included		Included above
	Sewerage treatment	Item			included		Included above
	<b>Geraldton Support Office / facility</b>						
	Support facility in Geraldton to accommodate 10 Staff & small laboratory, workshop and stores	m2	800	2,667	2,133,333		Currently in construction award phase
	Head Office -Located in Perth	m2	1,650	2,667	4,400,000		(110 people x 15m2/person)
d) Airstrip • airstrip (including location(s) and assumptions about aircraft type, runway length, surface, navigational aids, frequency of usage and any on site facilities including fuel storage	<b>TOTAL – Airstrip</b>				<b>0</b>	<b>6,120</b>	
	Airstrip	Item			100,000		1200m long and meet Royal Flying Doctor Service standard • Newly constructed airstrip to service the MRO (5km from core) • Boolardy Station has two airstrips (30km from core)
	Airstrip operation and maintenance					6,120	Allows for operational (staffing), maintenance and life cycle costs. Includes capex credit of €100,000 per airstrip amortised over 30 years

AUSTRALIA Page 4	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions
		Unit	Quantity	Rate (€)	Value (€)		
e) Water and sanitation	<b>Remote Station Storage Facilities</b>						
	Remote station storage sheds - Australia	No.	25	66,667	1,666,667		80m2 per site allowed & includes water tank & First Aid equipment
f) Dish foundations • dish foundations (including assumptions about underlying ground conditions, foundation types and materials)	<b>TOTAL – Dish Foundations and AA Site Preparation</b>				<b>372,261,667</b>	<b>335,051</b>	
	<b>Dish Foundation</b>						
	Dish foundations - utilising 4 rock anchors and 5.5 x 5.5 x 0.80 concrete foundation	No.	1,800	48,000	86,400,000		
	Dish Foundation based on 7.0 x 7.0 x 1.0 concrete foundation	No.	600	59,000	35,400,000		
	Dish Foundation - Remote		600	59,000	35,400,000		
	<b>Security to Foundation sites</b>						
	Dishes	No.	400				No security deemed required
	Dishes - remote	No.	600				No security deemed required
g) Aperture Array site preparation and bunkers • aperture array site preparation and bunkers (including assumptions about underlying ground conditions)	AA-Low Stations Site Preparation	No.	250	66,667	16,666,667		180m dia. Cleared and graded area
	AA-Low RFI Shielded Bunker	No.	250	133,333	33,333,333		
	AA-Mid Station Site Preparations	No.	250	6,667	1,666,667		
	AA-Mid Bunker	No.	250	666,667	166,666,667		
	<b>Security to Foundation sites</b>						
	AA-Low	No.	250	1,000	250,000		stock fence to perimeter ad 60m diameter
	AA-Mid	No.	205	2,333	478,333		
	Aperture array site operations and maintenance					332,501.67	Allows for life cycle costs. Includes capex credit of €4,000,000 amortised over 30 years
	Security					2,549.17	Annual costs
<b>CREDIT FOR EXISTING INFRASTRUCTURE</b>	Minor road (outside the 5km cores)	km	134	16,667	-2,240,000		assumes 30% credit for existing minor roads
	Credit for Re-use of Existing ASKAP Facility Control Room (for the housing of equip to service 37 AA-low RFI shielded bunker functionality - by adding in a modular RFI shielded room into the existing RFI shielding building	Item	1	4,000,000	-4,000,000		
	Credit for using existing Boolardy Station Commercial Kitchen & facilities	m2	50	10,000	-500,000		
	Geraldton Support Facility Office	m2	800	2,667	-2,133,333		

AUSTRALIA Page 5	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions
		Unit	Quantity	Rate (€)	Value (€)		
<b>Permanent Accommodation Credits</b>							
	Boolardy	No.	30	100,000	-3,000,000		
	Meekatharra	No.	1	100,000	-100,000		
	Mullewa	No.	1	100,000	-100,000		
	Mt Augustus	No.	1	100,000	-100,000		
	Pia Wajarri Community	No.	4	100,000	-400,000		
	Gerladton	No.	6	100,000	-600,000		
	<b>Head Office - Credit for Utilising Motorola Building</b>	m2	1,650	2,667	-4,400,000		Lease costs to be accounted for with operating costs
	<b>Use of Pawsey High Performance Computing Centre (500m2 of active area &amp; 600m2 of associated)</b>	Item	1		-2,200,000		500m2 of the active floor & 600m2 of plant area
	<b>TOTAL - Airstrip</b>				<b>0</b>	<b>6,120</b>	
	<b>Airstrip Item</b>	<b>Item</b>	<b>1</b>	<b>100,000</b>	<b>-100,000</b>	<b>6,120</b>	Existing ASKAP Airstrip

AUSTRALIA Page 6	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions
		Unit	Quantity	Rate (€)	Value (€)		

## Provision of Electrical Power

In Annex 1 section 5, the model of electrical power consumption for the three main areas of SKA2 is as follows:

1. Central area out to 180 km: 65 MW
2. Remote stations (25 groups of 24 dishes): 2.4 MW total (96 kW each station)
3. Off-site super-computing centre: 40 MW

The equivalent power requirement for SKA1 is 5 MW for the central area of the array and 30 MW for the super-computer building (Annex 1, section 7). There is no requirement for remote stations in SKA1.

1)	Transmission of power to the central area of the array, remote stations, and super-computer building	<b>TOTAL - Power</b>				<b>331,478,500</b>	<b>131,968,000</b>	
		<b>Power Distribution</b>						
		<b>33kV SKA Site MSB</b>						
a)	A line diagram of the proposed transmission system	33kV SWBD CBs	No.	9	46,667	420,000		
		Trip & Close Batt & Charger	No.	1	13,333	13,333		
b)	Information about substations and transformers	250kVA Aux Tx	No.	1	16,667	16,667		
		Auxiliary SWBD	No.	1	73,333	73,333		
c)	Information about connecting to existing power infrastructure	L&P	No.	1	3,333	3,333		
		Comms/SCADA	No.	1	33,333	33,333		
		STBY gen set	No.	1	333,333	333,333		
	Costs to the project of the provision and operation of the power network	Building etc	No.	1	1,333,333	1,333,333		
		Installation	No.	1	1,333,333	1,333,333		
a)	Capital costs and associated uncertainties of the power generation system(s), and transmission, and distribution networks for the three main zones of the SKA	<b>33kV Core Substation 'Power Hub'</b>						
		33kV SWBD	No.	6	66,667	400,000		
		6.6kV SWBD #1	No.	36	33,333	1,200,000		
		6.6kV SWBD #2	No.	36	33,333	1,200,000		
		33/6.6kV Main transformer	No.	6	266,667	1,600,000		
b)	Indicative costs of 30 years of operation of power provision to the three main zones of the SKA, and associated uncertainties	Trip & Close Batt & Charger	No.	3	13,333	40,000		
		250kVA Aux Tx	No.	6	16,667	100,000		
		Auxiliary SWBD	No.	3	100,000	300,000		
		L&P	No.	3	66,667	200,000		
		Comms/SCADA	No.	3	66,667	200,000		
		STBY gen set	No.	3	500,000	1,500,000		
		Building	No.	3	1,333,333	4,000,000		
		Installation	No.	3	1,333,333	4,000,000		
		<b>33kV UG Cabling Supply to Power Hub's</b>						
		33kV UG Cabling (240sqm m AL) 2 cables in parallel	km	240	266,667	64,000,000		
		Trenching	km	120	33,333	4,000,000		

AUSTRALIA Page 7	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions
		Unit	Quantity	Rate (€)	Value (€)		

<b>Supply to Operations Centre</b>							
33kV UG Cabling (240sqmm AL)	km	40	133,333	5,333,333			
Trenching	km	120	20,000	2,400,000			
<b>Data Processing &amp; Operations Building</b>							
33/6.6kV 12.5MVA Substation							
33kV Main Switch CB	No.	1	66,667	66,667			
33/6.6kV 12.5MVA Transformer with OLTC	No.	1	316,667	316,667			
6.6kV CB	No.	1	53,333	53,333			
Protection	No.	1	33,333	33,333			
Trip & Close Batt & Charger	No.	1	13,333	13,333			
Comms/SCADA	No.	1	33,333	33,333			
Building	No.	1	133,333	133,333			
Installation	No.	1	233,333	233,333			
<b>Cost of Outer Spiral Arms</b>							
Outer Spiral Standalone Power Supply (Diesel Gen)							
Diesel Generating Set	No.	25	425,000	10,625,000			
Shielded generator building	No.	25	666,667	16,666,667			
415/6.6 250kVA kiosk	No.	25	133,333	3,333,333			
6.6/415 250kVA kiosk	No.	25	166,667	4,166,667			
6.6kV UG cable	km	63	66,667	4,166,667			
6.6kV Trenching	km	63	20,000	1,250,000			
Installation	No.	20	833,333	16,666,667			
LV reticulation	No.	20	166,667	3,333,333			
<b>Outer Spiral Networked Power Supply</b>							
33kV UG cabling (240sqmm AL)	km	250	133,333	33,333,333			
33kV Trenching	km	250	20,000	5,000,000			
33/6.6 250kVA kiosk	No.	25	133,333	3,333,333			
6.6/415 250kVA kiosk	No.	25	166,667	4,166,667			
6.6kV UG cable	km	88	66,667	5,833,333			
6.6kV Trenching	km	88	20,000	1,750,000			
Installation	No.	25	833,333	20,833,333			
LV reticulation	No.	25	166,667	4,166,667			
<b>Outer Spiral 33kV Ring Main</b>							

AUSTRALIA Page 8	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions
		Unit	Quantity	Rate (€)	Value (€)		
	33kV UG cabling (240sqmm AL) 30km dia UG ring main	km	95	133,333	12,666,667		
	33kV Trenching	km	95	20,000	1,900,000		
	33/33kV 10MVA Auto transformer voltage regulator	No.	2	100,000	200,000		
	33kV 3 circuit RMU	No.	4	16,667	66,667		
	Trip & Close Batt & Charger	No.	2	13,333	26,667		
	50kVA Aux Tx	No.	2	16,667	33,333		
	Auxiliary SWBD	No.	2	13,333	26,667		
	L&P	No.	2	23,333	46,667		
	Comms/SCADA	No.	2	16,667	33,333		
	Building	No.	2	333,333	666,667		
	Installation	No.	2	166,667	333,333		
	<b>Dish Central Core</b>						
	6.6kV/415 1MVA kiosks	No.	4	500,000	2,000,000		
	415V distribution	No.	4	500,000	2,000,000		
	Installation	No.	4	1,333,333	5,333,333		
	<b>AA Low Central Core</b>						
	6.6kV/415 250kVA kiosks @250k each	Item	4	166,667	666,667		
	415V distribution	Item	4	250,000	1,000,000		
	Installation		4	666,667	2,666,667		
	<b>AA Mid Central Core</b>						
	6.6kV/415 250kVA kiosks @250k each	Item	4	166,667	666,667		
	415V distribution	No.	4	250,000	1,000,000		
	Installation	Item	4	666,667	2,666,667		
	<b>Remote Clusters</b>						
	LV reticulation	No.	25	266,667	6,666,667		
	Additional service trenching	Km	600	20,000	12,000,000		
	<b>Sundry Buildings:</b>						
	Accommodation Buildings	Item	1		66,667		
	<b>Testing &amp; Commissioning</b>	Man week	348				Assume 15 men x 16 weeks + 4 weeks x 25 remotes
	Direct employees	Man week	174	3,333	580,000		
	Consultants	Man week	174	6,667	1,160,000		
	Remote LAHFA	Man week	348	2,333	812,000		Staff

AUSTRALIA Page 9	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions	
		Unit	Quantity	Rate (€)	Value (€)			
	Sundry Materials/ equipment / vehicles	Man week	348	1,333	464,000		Consultants	
	Cost of power supplied to the SKA site					74,900,000	Tariff based on AUD19.7 c/kWh delivered	
	Distribution System					2,800,000	Annual operations and maintenance for grid connected remote spiral arm sites	
<p>2) Generation of power for the central area of the array, remote stations, and super-computer building</p> <p>a) An overview diagram of each location where power is generated</p> <p>b) Estimates of the power provision quality</p> <p>c) Fuel delivery and storage</p> <p>d) Overview of operations for each power generation location</p> <p>e) Power availability for each generation location</p> <p>Costs to the project of the provision and operation of the power network</p> <p>a) Capital costs and associated uncertainties of the power generation system(s), and transmission, and distribution networks for the three main zones of the SKA</p> <p>Indicative costs of 30 years of operation of power provision to the three main zones of the SKA, and associated uncertainties</p>	<b>Power Generation</b>							
	<b>Central Area</b>							
		Central Area - power station	MW	65		included		
		Power transmission over land 132 KV	km	438	160,000	70,000,000		
		Terminal Sub-stations	Item			30,000,000		
		Horizon Power over head work	Item	1		included		
		Power upgrade at Geraldton	Item	1				
	<b>Remote Clusters</b>							
		Diesel Generating Set	km	25	354,167	8,854,167		
		Shielded generator building	No.	25	666,667	16,666,667		
		Installation	No.	25	666,667	16,666,667		
		<b>Offsite computing Centre - Perth</b>	Item	1	6,666,667	6,666,667		
		Diesel fuel and maintenance of remote spiral arm sites					11,700,000	Annual operations and maintenance for remote spiral arm sites not connected to the grid
		Remote array-stations power costs					2,400,000/ 2,800,000	2,400,000 for grid connected sites / 2,800,000 for diesel generator powered sites
	Supercomputer power costs					29,700,000	Based on 40MW and an expected tariff of AUD12.7 c/kWh delivered	
<b>CREDIT FOR EXISTING POWER INFRASTRUCTURE</b>	Grid Transmission line from Geraldton & item terminal sub-stations	Item	1			-100,000,000		
	Credit for power to Computing Centre - (costs will be converted to tariff)	Item	1	6,666,667		-6,666,667		



AUSTRALIA Page 10	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions
		Unit	Quantity	Rate (€)	Value (€)		

## Data Transport

There are three parts of the system in which large quantities of data are to be transported:

1. From receptors to the data processor near the physical centre of the array
2. From the data processor to the super-computer centre
3. From the super-computer centre to data centres in other parts of the world

Two further sub-systems utilize signal transport networks. These are:

1. Monitor and Control (M&C) services and
2. Timing/synchronization services

The characteristics and requirements of the networks of the SKA are provided in the model of the SKA in Annex 1 section 6. Key parameters describing the size of the network required in the inner and mid-zone have been derived, as an illustration, from an optimised connection and routing plan, generated using the generic configuration within 180 km of the core. These key parameters may be used as a proxy, in this process, for a site specific design.

The following requested information is designed to identify the technical and operational feasibility, suitability, availability and reliability of signal transport and network arrangements for the two sites.

1)	For the data connectivity plans submitted provide information on:	<b>TOTAL – Data (to 180km)</b>				<b>75,258,279</b>	<b>1,925,986</b>	
a)	The capital cost to the project of implementing and commissioning these networks	Receptors to Data Processor Out To 180km						
		Fiber Optic cable - 12 core	km	157	667	104,667		
		Fiber Optic cable - 24 core	km	361	867	312,867		
b)	The operational cost of running these networks	Fiber Optic cable - 36 core	km	264	1,000	264,000		
c)	The regulatory environment governing networks and of this type and the impact of any regulations on the described model of operation	Fiber Optic cable - 48 core	km	193	1,200	231,600		
		Fiber Optic cable - 72 core	km	196	1,667	326,667		
		Fiber Optic cable - 192 core	km	818	4,000	3,272,000		
		Fiber Splicing - small node	No.	1,062,000	11	11,745,721		
d)	The management and operations plans for these networks, including details of suggested service level agreements and typical mean time to repair times for comparable locations	Fiber splicing - medium node	No.	100,800	11	1,114,849		
		Fiber Splicing - large node	No.	124,000	11	1,371,441		
		Fiber Splicing - very large node	No.	105,000	11	1,161,301		
		Fiber Termination - Small node	No.	254,880	11	2,761,200		
		Fiber Termination - medium node	No.	21,504	11	232,960		
		Fiber Termination - large node	No.	23,808	11	257,920		
		Fiber Termination - very large node	No.	16,128	11	174,720		
e)	Examples of existing capability and capacity of local contractors if these are available	Fiber termination data processor	No.	5,080	11	55,033		
		Small splice pit	No.	2,665	2,000	5,330,000		
f)	Existing infrastructure to be incorporated into the implementation	Medium splice pit	No.	112	2,000	224,000		
		Large splice pit	No.	62	2,000	124,000		
		Very large splice pit	No.	21	6,667	140,000		
		Trenching for direct bury (5x170km)	km	850	13,333	11,333,333		

AUSTRALIA Page 11	Description	Capital Cost				Annual Operation and Maintenance cost (€)	Comment / Assumptions
		Unit	Quantity	Rate (€)	Value (€)		
	Trenching fibre drawn in conduit (inner 10km circle)	km	744	46,667	34,720,000		
	Testing & Commissioning						excluded - assumed to part of the active equipment
	Fibre System					505,651	Costs for maintaining the central area network only
	Patch and passive system					740,194	Costs for maintaining the central area network only
	Maintenance staff & provision for spares, tools, vehicles and fuel					680,141	Costs for maintaining the central area network only
	<b>TOTAL – Data (outside 180km)</b>				<b>44,806,600</b>	<b>2,753,333</b>	
	<b>Remote Stations</b>						
	Local fiber optical cable - 24 core	km	93	867	80,600		
	Station local fiber terminations	No.	26,400	11	286,000		
	Station local small splice pit	No.	25	2,000	50,000		
	Trenching fibre drawn in conduit	km	21	46,667	980,000		
	Fiber Optic tails to existing 'AARnet' fiber core network	Item	1	30,350,000	30,350,000		
	Transponders Remote station (Aarnet)	Item	1	13,060,000	13,060,000		
	Active Components	Item	1		excluded		
	Correlator Equipment	Item	1		excluded		
	<b>DATA PROCESSOR TO SUPER COMPUTER</b>						
	Correlator - Central Area	Item	1		excluded		
	Correlator - remote stations	Item	1		excluded		assumed part of existing local networks
	Dark Fibre Link From ASKAP Control Building to Pawsey Computing Centre	Item	1	20,000,000	20,000,000		
	Super Computer to the World (International Connectivity)					33,333,333	existing connections available (Costs not included in totals in main report or graphs)
	Estimated operational Cost of Running connection to AARNet backbone					2,753,333	
<b>CREDIT/COST FOR EXISTING DATA INFRASTRUCTURE</b>	Dark Fibre Link From ASKAP Control Building to Pawsey Computing Centre	Item	1	20,000,000	-20,000,000		

## 8.2 Southern African Cost Table

## Provision of Basic Infrastructure Components

Describe the total cost to the project of each major infrastructure component assuming a 10 year construction period for the SKA and 30 years of operations and maintenance. The cost should be based on industry estimates/quotes, backed by cost data on similar previous projects, and include the cost of owning or leasing the land required.

SOUTHERN AFRICA	Description	Capital Cost	Annual Operations Cost	Annual Maintenance Cost	Comments
a) Roads (including construction, layout, width, load bearing capacity, design speed and vehicle frequency) for: <ul style="list-style-type: none"> <li>Major Roads</li> <li>Minor Roads</li> </ul>	<b>TOTAL – Major Roads</b>	██████████		██████████	See Annexure C4.6 Road Infrastructure
	Main Access Road	██████████	█	██████████	
	<b>TOTAL – Minor Roads</b>	██████████		██████████	See Annexure C4.6 Road Infrastructure
	Core, Inner and Skirt Region	██████████	██	██████████	
	Intermediate Roads (out to 180km)	██████████	██	██████████	
	Remote Stations in South Africa	██████████	██	██████████	
	Remote Stations outside South Africa	██████████	██	██████████	
b) Equipment and Office Buildings <ul style="list-style-type: none"> <li>the Operations Centre near the Centre of the Array</li> <li>equipment and office buildings. Describe the building to be used in each case including size, construction type and facilities equipment and office buildings.</li> </ul>	<b>TOTAL – Buildings &amp; Staff Accommodation</b>	██████████	██████████	██████████	See Annexure C4.3 Operations Centre and C4.5 Construction Camp and Staff Accommodation
	Astronomy Complex and Cape Town Headquarters	██████████	██████████	██████████	
	Core, Inner and Skirt Region	█	█	█	
	Intermediate (out to 180km)	█	█	█	
	Remote Stations in South Africa	██████████	██	██████████	
	Remote Stations outside South Africa	██████████	██	██████████	
c) Accommodation for construction crews, and operations and maintenance staff <ul style="list-style-type: none"> <li>construction camp or camps (including details of lay-down and assembly areas, storage areas, power supply, accommodation and welfare facilities)</li> </ul>	Construction camp in Carnarvon (accommodation, ablutions, kitchen, dining, laundry, stores, recreation, etc. for 400 people)	██████████			See Annexure C4.5 Construction Camp and Staff Accommodation.
	SKA permanent staff accommodation in Carnarvon	██████████			See Annexure C4.5 Construction Camp and Staff Accommodation.

SOUTHERN AFRICA Page 2	Description	Capital Cost	Annual Operations Cost	Annual Maintenance Cost	Comments
d) Airstrip <ul style="list-style-type: none"> <li>airstrip (including location(s) and assumptions about aircraft type, runway length, surface, navigational aids, frequency of usage and any on site facilities including fuel storage)</li> </ul>	<b>TOTAL - Airstrip</b>	████████	████████	████████	
	Airstrip	████████	████████	████████	Assuming a runway of 1300 x 18m, a taxiway of 40 x 13m and an apron of 60 x 35m. (Annexure C4.7 SKA Airfield)
	Bulk water and sewer treatment plant to Operation Centre site	████████	████████	████████	Cost assumed to be part of Buildings and Staff Accommodation – Astronomy Complex and Cape Town Headquarters in submission document. See Annexure C4.3 Operations Centre and C4.5 Construction Camp and Staff Accommodation
	Remote Stations SA (13) Water (Enviroloo)	████████	████████	████████	Cost assumed to be part of Buildings and Staff Accommodation – Remote Stations in South Africa in submission document. See Annexure C4.3 Operations Centre and C4.5 Construction Camp and Staff Accommodation
	Remote Stations Botswana (3) Water (Enviroloo)	████████	████████	████████	Cost assumed to be part of Buildings and Staff Accommodation – Remote Stations outside South Africa in submission document. See Annexure C4.3 Operations Centre and C4.5 Construction Camp and Staff Accommodation
	Remote Stations Namibia (4) Water (Enviroloo)	████████	████████	████████	
	Remote stations Mozambique (2) Water (Enviroloo)	████████	████████	████████	
	Remote Stations Madagascar (2) Water (Enviroloo)	████████	████████	████████	
	Remote Station Zambia (1) Water (Enviroloo)	████████	████████	████████	
e) Dish foundations <ul style="list-style-type: none"> <li>dish foundations (including assumptions about underlying ground conditions, foundation types and materials)</li> </ul>	<b>TOTAL - Dish Foundations &amp; AA Site Preparation</b>	████████	████████	████████	See Annexure C4.4 Dishes Platforms and Remote Stations
	Core, Inner and Skirt Region	████████	████████	████████	
	Intermediate (out to 180km)	████████	████████	████████	
	Remote Stations in South Africa	████████	████████	████████	
	Remote Stations outside South Africa	████████	████████	████████	
f) Aperture Array site preparation and bunkers <ul style="list-style-type: none"> <li>aperture array site preparation and bunkers (including assumptions about underlying ground conditions)</li> </ul>	Included in (f) above	Component of cost in (f) above			AA-Mid and AA-Low Bunkers Assuming these containers are shielded from natural weather conditions. See Annexure C4.4 Dishes Platforms and Remote Stations
	<b>Other</b>	████████	████████	████████	

## Provision of Electrical Power

In Annex 1 section 5, the model of electrical power consumption for the three main areas of SKA2 is as follows:

1. Central area out to 180 km: 65 MW
2. Remote stations (25 groups of 24 dishes): 2.4 MW total (96 kW each station)
3. Off-site super-computing centre: 40 MW

The equivalent power requirement for SKA1 is 5 MW for the central area of the array and 30 MW for the super-computer building (Annex 1, section 7). There is no requirement for remote stations in

SOUTHERN AFRICA Page 3	Description	Capital Cost	Annual Operations Cost	Annual Maintenance Cost	Comments
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SKA1.

1) Transmission of power to the central area of the array, remote stations, and super-computer building	<b>TOTAL – Power</b>	██████████	██████████	██████████	More detailed costing information and calculations can be found in Annexure D2: SKA Power Cost Summary. This report references contractor reports as supporting documents.
	132kV Bulk Power Supply				
a) A line diagram of the proposed transmission system	(Kronos 400 kV / 132 kV transformer bay)	██████████			
b) Information about substations and transformers	(Kronos-Astronomy 132 kV overhead line with OPGW)	██████████	██████████	██████████	
c) Information about connecting to existing power infrastructure	(Astronomy substation with three 80 MVA transformers)	██████████			
	(Astronomy Complex switching station)	██████████			
	SKA Core reticulation (out to 35km)	██████████			
Costs to the project of the provision and operation of the power network	Intermediate Reticulation (spiral arms out to 180km)	██████████			
a) Capital costs and associated uncertainties of the power generation system(s), and transmission, and distribution networks for the three main zones of the SKA	Remote Stations in South Africa (reticulation and Eskom grid connections (13 stations))	██████████	██████████	██████████	
	Remote Stations outside South Africa (reticulation, grid connections and four off-grid solutions)	██████████	██████████	██████████	
b) Indicative costs of 30 years of operation of power provision to the three main zones of the SKA, and associated uncertainties	Critical Backup Rotary UPS (Rotary UPS backup of 5MVA for critical loads)	██████████	█	█	
2) Generation of power for the central area of the array, remote stations, and super-computer building					Submission assumes grid connection.
a) An overview diagram of each location where power is generated					
b) Estimates of the power provision quality					
c) Fuel delivery and storage					
d) Overview of operations for each power generation location					
e) Power availability for each generation location					

SOUTHERN AFRICA Page 4	Description	Capital Cost	Annual Operations Cost	Annual Maintenance Cost	Comments
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<p>Costs to the project of the provision and operation of the power network</p> <p>a) Capital costs and associated uncertainties of the power generation system(s), and transmission, and distribution networks for the three main zones of the SKA</p> <p>b) Indicative costs of 30 years of operation of power provision to the three main zones of the SKA, and associated uncertainties</p>					
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SOUTHERN AFRICA Page 5	Description	Capital Cost	Annual Operations Cost	Annual Maintenance Cost	Comments
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## Data Transport

There are three parts of the system in which large quantities of data are to be transported:

1. From receptors to the data processor near the physical centre of the array
2. From the data processor to the super-computer centre
3. From the super-computer centre to data centres in other parts of the world

Two further sub-systems utilize signal transport networks. These are:

1. Monitor and Control (M&C) services and
2. Timing/synchronization services

The characteristics and requirements of the networks of the SKA are provided in the model of the SKA in Annex 1 section 6. Key parameters describing the size of the network required in the inner and mid-zone have been derived, as an illustration, from an optimised connection and routing plan, generated using the generic configuration within 180 km of the core. These key parameters may be used as a proxy, in this process, for a site specific design.

The following requested information is designed to identify the technical and operational feasibility, suitability, availability and reliability of signal transport and network arrangements for the two sites.

1) For the data connectivity plans submitted provide information on:	<b>TOTAL – Data (to 180km)</b>	██████████	██████████	█	
a) The capital cost to the project of implementing and commissioning these networks	Core reticulation	██████████	██████████	█	This costing assumes that the supercomputer is housed on the SKA Core Site. For more detailed costing see Annexure G15 SKA SA Data Transport Costs.
b) The operational cost of running these networks	<b>TOTAL – Data (outside 180km)</b>	██████████	██████████	█	
c) The regulatory environment governing networks and of this type and the impact of any regulations on the described model of operation	Data Processor to Supercomputer	█	█	█	
d) The management and operations plans for these networks, including details of suggested service level agreements and typical mean time to repair times for comparable locations	Supercomputer to Headquarters - 50 Yr IRU	██████████	█	█	<b>Indefeasible Right of Use (IRU)</b> - shall mean the exclusive, unrestricted, and indefeasible right to use the relevant capacity (including equipment, fibres or capacity) for any legal purpose
e) Examples of existing capability and capacity of local contractors if these are available	13 Remote Sites in South Africa -50 Year IRU	██████████	█	█	
f) Existing infrastructure to be incorporated into the implementation	12 Remote Sites outside of South Africa - 20 Year IRU	██████████	██████████	█	
	International Connectivity	██████████	██████████	█	



## 9 Appendix 1

**AUSTRALIA**

Description		Unit	Quantity	Rate	Value	SUM	
<b>Roads</b>						70,965,000	<b>Roads (major and minor) total in Table 7 (Page 100) of Australian Submission</b>
<u>Central Area</u>							
	Minor Roads (inside 5km cores)	km	180	16,667	3,000,000		
4.1.1	Minor road (outside the 5km cores)	km	448	16,667	7,466,667		
4.1.2	Minor roads	km	1,370	16,667	22,833,333		
4.1.3	Clear central area including raising ground level and provision of gravel surface (2 No. 1 km diameter)	Ha	943	1,667	1,571,667		Minimal work required due to advantageous site selection
			0				
	Lead in Road to central facility	km	210	106,667	22,400,000		Allowance to for chip sealed single lane road with graded shoulders including upgrading as required
			0				
	Bridge / water crossing	No.	1	6,666,667	6,666,667		Indication of cost from Murchinson Shire
	Minor Water crossings	No.	6	33,333	200,000		Estimate number
			0				
	Minor road to individual station outside 13km	km	325	16,667	5,416,667		assume average 500m to each station from primary access
			0				
	<u>Remote Sites - Within Australia (25 No.)</u>	km	199	16,667	3,316,667		Minor road
	Access to remote site	No.	25	13,333	333,333		Assumed
	Access within each remote site						
<b>Buildings</b>							
Equipment & Office Buildings						35,825,833	<b>Equipment and Office Buildings total in Table 7 (Page 100) of Australian Submission</b>
4.2.1	<u>SKA Operations Centre - near centre of Array - Located 30 km from core (SKA OCCA)</u>						
4.2.2	Data Centre & Operations Building	m2	1,500	5,167	7,750,000		Provision of 'white space' - no active equipment or associated cooling & power requirements
	Fibre Collection & Management Building (60%)		500	4,000	2,000,000		Additional area included to allow for collection and staging area for fibre management
4.2.2	Operations Control Room		100	5,167	516,667		
4.2.3	Power building		250	6,667	1,666,667		assumed size
4.2.4	Office - control building		300	3,333	1,000,000		Allowance for 20 staff x 15m2 per person
	Sub-Total: Net Area	m2	2,650				
	Travel & Engineering		663	3,333	2,208,333		allowed 25% grossing factor
	Total Gross Building Area	m2	3,313				
	RFI Shield to Data Centre & Power Building		1,750	2,333	4,083,333		
	<u>Sundry Building (700M from Operation Centre)</u>						
4.2.4	Office space	m2	270	3,333	1,000,000		20 staff x 15m2 / person
4.2.4	Meeting Rooms	m2	0		included above		included above
4.2.4	Canteen	m2	130	2,667	346,667		130 people
4.2.4	Canteen kitchen facility	m2	65	13,333	866,667		assumed size to be confirmed
4.2.4	Maintenance Facility	m2	750	1,000	750,000		assumed size
	Sub-Total: Net Area	m2	-1,245				
	Travel & Engineering	m2	311	3,333	1,037,500		assumed 25%

Description	Unit	Quantity	Rate	Value	SUM	
Total Gross Building Area	m2	1,556				
RFI shielding				not required		
Furniture Fitting & Equipment						Excluded - assumed this is active equipment
4.2.5 Accommodation for Construction Crews & Operations & Maintenance Staff					40,666,667	<b>Construction Camps</b> total in Table 7 (Page 100) of Australian Submission
4.2.5.1 Construction phase staff	No.	330	80,000	26,400,000		Peak construction workforce anticipated to be 400 persons with 70 access the various works sites from adjacent towns (330 accommodation units required)
Fly camp to allow construction of Construction Camp	No.	30				Assumed they are able to use Boolardy Station Accommodation
Credit for Permanently - Operations Phase	No.	130	80,000	-10,400,000		
Operating Construction camp	Man Weeks	76,000	217	16,466,667		Based on an average of 145 persons for 5 years
4.2.5.2 Operations Phase	No.	130	100,000	13,000,000		Modular style facilities with allowance for Wet mess, Recreation Facilities, Sports courts, etc.
Water sanitation	Item			included		Included above
Sewerage treatment	Item			included		Included above
Geraldton Support Office / facility						
Support facility in Geraldton to accommodate 10 Staff & small laboratory, workshop and stores	m2	800	2,667	2,133,333		Currently in construction award phase
Remote Station Storage Facilities						
4.2.6 Remote station storage sheds - Australia	No.	25	66,667	1,666,667		80m2 per site allowed & includes water tank & First Aid equipment
4.2.7.1 Head Office - Located in Perth	m2	1,650	2,667	4,400,000		(110 people x 15m2/person)
4.2.7 Computing centre						
Computer, Data storage, Etc. (1500m2 of 'active Floor is required)	m2	1,500	4,000	6,000,000		White space' shell no allowance for equipment or equipment cooling ; power filtering or UPS
Data storage	m2	included		included		White space shell' space no allowance for equipment or equipment cooling; power filtering or UPS
Data interconnect	m2	100	3,333	333,333		
Heating, cooling, ventilation - Plant Area	m2	2,000	2,000	4,000,000		500m2 Briefed appears to be insufficient - Increased to 2000m2 based on current experience with Pawsey Centre
Office related component	m2	1,050	2,667	2,800,000		Based on 70 People (based on 15m2/person)
4.3 Airstrip	Item			100,000	0	<b>Airstrip</b> total in Table 7 (Page 100) of Australian Submission assumed to RFDS standard - include & show as credit
4.4 Dish Foundation					157,200,000	<b>Dish Foundations</b> total in Table 7 (Page 100) of Australian Submission
4.4 Dish foundations - utilising 4 rock anchors and 5.5 x 5.5 x 0.80 concrete foundation	No.	1,800	48,000	86,400,000		
Dish Foundation based on 7.0 x 7.0 x 1.0 concrete foundation	No.	600	59,000	35,400,000		
Dish Foundation - Remote		600	59,000	35,400,000		
Aperture Arrays					214,333,333	<b>Aperture Array Prep and Bunkers</b> total in Table 7 (Page 100) of Australian Submission

Description	Unit	Quantity	Rate	Value	SUM	
AA- Low Stations No.		250	66,667	16,666,667		180m dia. Cleared and graded area
AA-Low RFI Shielded Bunker		250	133,333	33,333,333		
AA - MID STATION No.		250	6,667	1,666,667		
AA MID Bunker No.		250	666,667	166,666,667		
<b>Security to Foundation sites</b>					728,333	<b>Security total in Table 7 (Page 100) of Australian Submission</b>
Dishes	No.	400				No security deemed required
Dishes - remote	No.	600				No security deemed required
AA-LOW	No.	250	1,000	250,000		stock fence to perimeter ad 60m diameter
AA- MID	No.	205	2,333	478,333		
<b>TOTAL</b>				539,592,500		
<b>CREDIT FOR EXISTING INFRASTRUCTURE</b>						
4.1.2 Minor road (outside the 5km cores)	km	134	16,667	-2,240,000		assumes 30% credit for existing minor roads
Credit for Re-use of Existing ASKAP Facility Control Room (for the housing of equip to service 37 AA-low RFI shielded bunker functionality - by adding in a modular RFI shielded room into the existing RFI shielding building)	Item	1	4,000,000	-4,000,000		
Credit for using existing Boolardy Station Commercial Kitchen & facilities	m2	50	10,000	-500,000		
Geraldton Support Facility Office	m2	800	2,667	-2,133,333		
<b>Permanent Accommodation Credits</b>						
Boolardy	No.	30	100,000	-3,000,000		
Meekatharra	No.	1	100,000	-100,000		
Mullewa	No.	1	100,000	-100,000		
Mt Augustus	No.	1	100,000	-100,000		
Pia Wajarri Community	No.	4	100,000	-400,000		
Gerladton	No.	6	100,000	-600,000		
Head Office - Credit for Utilising Motorola Building	m2	1,650	2,667	-4,400,000		Lease costs to be accounted for with operating costs
Use of Pawsey High Performance Computing Centre (500m2 of active area & 600m2 of associated)	Item	1		-2,200,000		500m2 of the active floor & 600m2 of plant area
4.3 Airstrip Item	Item	1	100,000	-100,000		Existing ASKAP Airstrip
<b>TOTAL CREDIT</b>				-19,873,333		
<b>Power Generation</b>					331,478,500	<b>Estimated Capital Costs for Power in Table 7 (Page 119) of Australian Submission</b>
<b>Central Area</b>						
Central Area - power station	mW	65		included		
Power transmission over land 132 KV	km	438	160,000	70,000,000		
Temninal Sub-stations	Item			30,000,000		
Horizon Power Headwork's	Item	1	0	included		
Power upgrage at Geraldton	Item	1	0	0		
<b>Remote Clusters</b>	item					
Diesel Generating Set	km	25	354,167	8,854,167		
Shielded generator building	No.	25	666,667	16,666,667		
Installation	No.	25	666,667	16,666,667		

Description	Unit	Quantity	Rate	Value	SUM
Offsite computing Centre - Perth	Item	1	6,666,667	6,666,667	
<b>Power Distribution</b>					
<u>33kV SKA Site MSB</u>					
33kV SWBD CBs	No.	9	46,667	420,000	
Trip & Close Batt & Charger	No.	1	13,333	13,333	
250kVA Aux Tx	No.	1	16,667	16,667	
Auxiliary SWBD	No.	1	73,333	73,333	
L&P	No.	1	3,333	3,333	
Comms/SCADA	No.	1	33,333	33,333	
STBY gen set	No.	1	333,333	333,333	
Building etc	No.	1	1,333,333	1,333,333	
Installation	No.	1	1,333,333	1,333,333	
Total					
<u>33kV Core Substation 'Power Hub'</u>					
33kV SWBD	No.	6	66,667	400,000	
6.6kV SWBD #1	No.	36	33,333	1,200,000	
6.6kV SWBD #2	No.	36	33,333	1,200,000	
33/6.6kV Main transformer	No.	6	266,667	1,600,000	
Trip & Close Batt & Charger	No.	3	13,333	40,000	
250kVA Aux Tx	No.	6	16,667	100,000	
Auxiliary SWBD	No.	3	100,000	300,000	
L&P	No.	3	66,667	200,000	
Comms/SCADA	No.	3	66,667	200,000	
STBY gen set	No.	3	500,000	1,500,000	
Building	No.	3	1,333,333	4,000,000	
Installation	No.	3	1,333,333	4,000,000	
<u>33kV UG Cabling</u>					
Supply to Power Hub's					
33kV UG Cabling (240sqm m AL) 2 cables in parallel	km	240	266,667	64,000,000	
Trenching	km	120	33,333	4,000,000	
Total					
<u>Supply to Operations Centre</u>					
33kV UG Cabling (240sqmm AL)	km	40	133,333	5,333,333	
Trenching	km	120	20,000	2,400,000	
Total					
<u>Data Processing &amp; Operations Building</u>					
33/6.6kV 12.5MVA Substation					
33kV Main Switch CB	No.	1	66,667	66,667	
33/6.6kV 12.5MVA Transformer with OLTC	No.	1	316,667	316,667	
6.6kV CB					
6.6kV CB	No.	1	53,333	53,333	

Description	Unit	Quantity	Rate	Value	SUM
Protection	No.	1	33,333	33,333	
Trip & Close Batt & Charger	No.	1	13,333	13,333	
Comms/SCADA	No.	1	33,333	33,333	
Building	No.	1	133,333	133,333	
Installation	No.	1	233,333	233,333	
Cost of Outer Spiral Arms					
Outer Spiral Standalone Power Supply (Diesel Gen)					
Diesel Generating Set	No.	25	425,000	10,625,000	
Shielded generator building	No.	25	666,667	16,666,667	
415/6.6 250kVA kiosk	No.	25	133,333	3,333,333	
6.6/415 250kVA kiosk	No.	25	166,667	4,166,667	
6.6kV UG cable	km	63	66,667	4,166,667	
6.6kV Trenching	km	63	20,000	1,250,000	
Installation	No.	20	833,333	16,666,667	
LV reticulation	No.	20	166,667	3,333,333	
Outer Spiral Networked Power Supply					
33kV UG cabling (240sqmm AL)	km	250	133,333	33,333,333	
33kV Trenching	km	250	20,000	5,000,000	
33/6.6 250kVA kiosk	No.	25	133,333	3,333,333	
6.6/415 250kVA kiosk	No.	25	166,667	4,166,667	
6.6kV UG cable	km	88	66,667	5,833,333	
6.6kV Trenching	km	88	20,000	1,750,000	
Installation	No.	25	833,333	20,833,333	
LV reticulation	No.	25	166,667	4,166,667	
Outer Spiral 33kV Ring Main					
33kV UG cabling (240sqmm AL) 30km dia UG ring main	km	95	133,333	12,666,667	
33kV Trenching	km	95	20,000	1,900,000	
33/33kV 10MVA Auto transformer voltage regulator	No.	2	100,000	200,000	
33kV 3 circuit RMU	No.	4	16,667	66,667	
Trip & Close Batt & Charger	No.	2	13,333	26,667	
50kVA Aux Tx	No.	2	16,667	33,333	
Auxiliary SWBD	No.	2	13,333	26,667	
L&P	No.	2	23,333	46,667	
Comms/SCADA	No.	2	16,667	33,333	
Building	No.	2	333,333	666,667	
Installation	No.	2	166,667	333,333	
Dish Central Core					
6.6kV/415 1MVA kiosks	No.	4	500,000	2,000,000	
415V distribution	No.	4	500,000	2,000,000	
Installation	No.	4	1,333,333	5,333,333	
AA Low Central Core					
6.6kV/415 250kVA kiosks @250k each	Item	4	166,667	666,667	

Description	Unit	Quantity	Rate	Value	SUM	
415V distribution	Item	4	250,000	1,000,000		
Installation		4	666,667	2,666,667		
AA Mid Central Core						
6.6kV/415 250kVA kiosks @250k each	Item	4	166,667	666,667		
415V distribution	No.	4	250,000	1,000,000		
Installation	Item	4	666,667	2,666,667		
Remote Clusters						
LV reticulation	No.	25	266,667	6,666,667		
Additional service trenching	Km	600	20,000	12,000,000		
<u>Sundry Buildings:</u>						
Accommodation Buildings	Item	1		66,667		
<b>Testing &amp; Commissioning</b>	<b>m/week</b>	<b>348</b>		<b>0</b>		Assume 15 men x 16 weeks + 4 weeks x 25 remotes
Direct employees	m/week	174	3,333	580,000		
Consultants	m/week	174	6,667	1,160,000		
Remote LAHFA	m/week	348	2,333	812,000		Staff
Sundry Materials/ equipment / vehicles	m/week	348	1,333	464,000		Consultants
				438,145,167		
CREDIT FOR EXISTING INFRASTRUCTURE						
Grid Transmission line from Geraldton & item terminal sub-station	Item	1		-100,000,000		
Credit for power to Computing Centre - (costs will be converted to tariff)	Item	1	-6,666,667	-6,666,667		
				-106,666,667		
<b>Receptors to Data Processor Out To 180km</b>					75,258,277	<b>Capital Cost of Passive Network Equipment and Installation total in Table 1 (Page 125) of Australian Submission</b>
Fiber Optic cable - 12 core	km	157	667	104,667		
Fiber Optic cable - 24 core	km	361	867	312,867		
Fiber Optic cable - 36 core	km	264	1,000	264,000		
Fiber Optic cable - 48 core	km	193	1,200	231,600		
Fiber Optic cable - 72 core	km	196	1,667	326,667		
Fiber Optic cable - 192 core	km	818	4,000	3,272,000		
Fiber Splicing - small node	No.	1,062,000	11	11,745,721		
Fiber splicing - medium node	No.	100,800	11	1,114,849		
Fiber Splicing - large node	No.	124,000	11	1,371,441		
Fiber Splicing - very large node	No.	105,000	11	1,161,301		
Fiber Termination - Small node	No.	254,880	11	2,761,200		
Fiber Termination - medium node	No.	21,504	11	232,960		

Description	Unit	Quantity	Rate	Value	SUM	
Fiber Termination - large node	No.	23,808	11	257,920		
Fiber Termination - very large node	No.	16,128	11	174,720		
Fiber termination data processor	No.	5,080	11	55,033		
Small splice pit	No.	2,665	2,000	5,330,000		
Medium splice pit	No.	112	2,000	224,000		
Large splice pit	No.	62	2,000	124,000		
Very large splice pit	No.	21	6,667	140,000		
Trenching for direct bury (5x170km)	km	850	13,333	11,333,333		
Trenching fibre drawn in conduit (inner 10km circle)	km	744	46,667	34,720,000		
<b>Remote Stations</b>						
Local fiber optical cable - 24 core	km	93	867	80,600		
Station local fiber terminations	No.	26,400	11	286,000		
Station local small splice pit	No.	25	2,000	50,000		
Trenching fibre drawn in conduit	km	21	46,667	980,000		
Fiber Optic tails to existing 'AARnet' fiber core network	Item	1	30,350,000	30,350,000		
Transponders Remote station (Aarnet)	Item	1	13,060,000	13,060,000		
Active Components	Item	1		excluded		
Correlator Equipment	Item	1		excluded		
<b>DATA PROCESSOR TO SUPER COMPUTER</b>						
Correlator - Central Area	Item	1		excluded		check is fibre upgrade required
Correlator - remote stations	Item	1		excluded		assumed part of existing local networks
Dark Fibre Link From ASKAP Control Building to Pawsey Computing Centre	Item	1	20,000,000	20,000,000		
<b>Super Computer to the World</b>				33,333,333		existing connections available
Testing & Commissioning						excluded - assumed to part of the active equipment
				173,398,208		
<b>CREDIT/COST FOR EXISTING INFRASTRUCTURE</b>						
Dark Fibre Link From ASKAP Control Building to Pawsey Computing Centre	Item	1	-20,000,000	-20,000,000		