

# **Infrastructure for the Square Kilometre Array**

## **Assessment of the South Africa Submission – Basic Infrastructure**

For SKA Program Development Office  
University of Manchester

**November 2011**

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# **Infrastructure for the Square Kilometre Array**

## **Assessment of the South Africa Submission – Basic Infrastructure**

**Version 2**

**Prepared for**  
University of Manchester  
SPDO  
Jodrell Bank Centre for Astrophysics  
Alan Turing Building  
Oxford Road  
Manchester M13 9PL

**Prepared by**  
Parsons Brinckerhoff  
Manchester Technology Centre  
Oxford Road  
Manchester M1 7ED  
+44 (0)161-200-5000 [www.pbworld.co.uk](http://www.pbworld.co.uk)



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## Executive Summary

This report summarises Parsons Brinckerhoff's review the SKA Africa Working Group's response to the 'Request for Information from the Candidate SKA Sites', produced by the SKA Siting Group.

The review was based on the Basic Infrastructure Components Chapter of the South Africa submission and reviews the submission for compliance with the requirements set out in the model configuration included in Annex 1 of the Request for Information (RfI). Section 3 of this report summarises the general observations made during the review and Appendix A provides a more detailed commentary on how the submission meets the requirements of the model configuration.

In general the provisions for basic infrastructure submitted by the candidate site seem feasible. They mostly meet the requirements of the model configuration and where requirements are not met there is usually a justifiable alternative. The information provided in the submission defines the provisions for basic infrastructure in a good level of detail and provides supporting backup. The proposed solutions draw on a combination of existing infrastructure or infrastructure that is due to be constructed under the MeerKAT project.

The location of the proposed site in relation the MeerKAT project provides confidence in the feasibility of the site. Furthermore, the model configuration for provision of basic infrastructure does not introduce any requirements that are beyond the scope of standard infrastructure design. It is reasonable to assume that normal design practices and construction methods in the region will be applicable.

Construction of the MeerKAT project has also been used in the development of cost estimates for the submission. Detailed information has been included to support the capital cost estimates however the basis of the operational and maintenance costs is much less clear. They appear to be based on a fixed percentage of the capital cost. Without further clarification on the basis of operational and maintenance costs it is not possible to comment in the credibility of the estimates.

The following general conclusions are drawn from our review of the candidate site submission:

- Overall the submission provides solutions based on experience of similar smaller scale projects in the area giving confidence in the approaches adopted.
- Solutions appear to be in line with common practice for the region.
- The submission draws on existing infrastructure which offers opportunities to reduce capital costs.
- In places the submission has deviated from the requirements of the model configuration. The justification and assumptions for these deviations are usually clear and the impact on costs is likely to be modest.
- The submission generally provides a good level of detail and supporting background information. A detailed review of the background information is beyond the scope of this study however a reasonable level of confidence can be taken from the depth of information for this stage of design.
- The estimates for capital cost are based on detailed bills of quantities that on the basis of limited spot checks, appear to be largely aligned with the provisions detailed in the main submission.
- Only limited information is provided on the operational and maintenance costs which appear to be based on a fixed percentage of the capital costs. Further clarification is recommended if a greater level of confidence is to be held in the cost estimates.
- It is not obvious how the detailed cost estimates relate to the summary tables provided in section 2.11 of the main submission therefore it is not possible to comment on the credibility of the overall summary costs. Further clarification is recommended.





## 1 Introduction

Parsons Brinckerhoff (PB) was commissioned by SKA Program Development Office (SPDO) to undertake a preliminary review of basic infrastructure provisions from the candidate sites for the Square Kilometre Array Radio Telescope (SKA).

This report summarises the review of the South Africa submission. Detailed review and verification of the submission is beyond the scope of this study. In reviewing the submission we have considered the following key areas:

- Feasibility of the solution
- Credibility of information provided
- Does the solution provide the required capability?
- Areas of design that have not been considered
- Sequencing of the roll-out
- Costs and costing methodology

## 2 Methodology and navigation

### 2.1 Documents used

Documents used in the review are summarised in Table 1

Document	Doc. Date	Date supplied	Source
Request for Information (RfI) from the candidate SKA sites (SSG-RfI-001)	22 Mar 2011	04 Oct 2011	Electronic via SKA Development office (GH)
Model of the SKA for site evaluation purposes (Annex 1 of the above)	22 Mar 2011	04 Oct 2011	Electronic via SKA Development office (GH)
Request for Information (RfI) from the candidate SKA sites – Rev 1 (SSG-RfI-001)	03 Sep 2011	28 Oct 2011	Electronic via SKA Development office (GH)
Model of the SKA for site evaluation purposes - Rev 1 incorporating revisions to sections 4.4 and 4.5 (Annex 1 of the above)	03 Sep 2011	28 Oct 2011	Electronic via SKA Development office (GH)
Republic of South Africa - Response to SSG Request for Information Chapter 1, 2 and 10 Annexure C	15 Sep 2011	20 Sep 2011	CD via SKA Development office

**Table 1 – Documents used**

## 2.2 Abbreviations

The following abbreviations or definitions are used throughout the document:

SKA	Square Kilometre Array
SPDO	SKA Project Development office
SSG	SKA Siting Group
Rfl	Request for Information
Submission	Republic of South Africa - Response to SSG Request for Information
Model configuration	Refers to the requirements in Annex 1 of the Rfl
MeerKAT	Radio Telescope currently under construction in South Africa's Karoo region
Astronomy Complex	Term used in the submission for the Operations Centre

## 2.3 Format of candidate site submission

Chapter 2 of the submission contains a summary for the basic infrastructure provisions made in response to the Rfl. This has been used as the first reference point for evaluation of the submission against the requirements given in the Rfl and model configuration. Chapter 10 has also been reviewed with reference to the security provisions requested under the model configuration for basic infrastructure.

Annexure C provides further detail on the basic infrastructure provisions. In preparing their response the SKA Africa Working Group engaged the services of Aurecon. Appendix C4.1 contains the Aurecon report on basic infrastructure which forms the basis of Chapter 2 of the main submission and has been drawn on during this study. Annexure C4 also contains detailed bills of quantities that inform the cost estimates summarised in Chapter 2.

## 2.4 Methodology and structure

In preparing this report we have undertaken a review of the information provided by the candidate site related to the provision of basic infrastructure. We have considered the underlying principles and assumptions in order to assess the provisions against the information requested in the Rfl and model configuration.

Section 3 provides an overview of our findings and general comments on the adequacy of provisions to meet the requirements of the model configuration. Comments are based on industry experience and best practice and are limited to infrastructure elements.

Appendix A contains a full table of comments including the following:

- A summary of requirements under the Rfl and model configuration as issued by SSG
- A summary of the corresponding provisions made by the candidate site
- References to relevant sections of the submission
- PB's commentary on the provisions for basic infrastructure
- PB's commentary on the costs elements and cost methodology where possible

This symbol  has been used throughout Appendix A to highlight areas of potential concern. This could be either due to a lack of information, a shortfall in capacity or an area of potential risk. Key risks are also summarised in Section 4.

### **3 Overview of findings**

#### **3.1 Feasibility of the solution**

In general the provisions for basic infrastructure submitted by the candidate site seem feasible. They mostly meet the requirements of the model configuration and where the requirements are not met there is usually a justifiable alternative. Section 4 summarises the risks including areas where the provisions do not specifically meet the requirements of the RfI.

Proposed solutions appear logical, drawing on existing infrastructure where possible and providing solutions that offer benefits in terms of reduced cost and proven capability. The proposed site is at the location of an existing facility, the MeerKAT project, therefore providing confidence in the feasibility of the site. Furthermore, the model configuration for provision of basic infrastructure does not introduce any requirements that are beyond the scope of standard infrastructure design. It is reasonable to assume that normal design practices and construction methods in the region will be applicable.

The scope of SKA is extensive and there may be other external factors that influence the feasibility of infrastructure provisions. The interface between partner countries is one example and the success of the wider infrastructure provision will be reliant on successful relationships being maintained. The submission provides information on the free movement of staff and equipment under Section 2.5.2 sighting various commitments and bi-lateral agreements. Investigating those aspects is beyond the scope of this study however it is a risk to the feasibility of the basic infrastructure roll out and operation and therefore is highlighted in Section 4.

#### **3.2 Credibility of the solution**

The provisions for basic infrastructure appear to be based on established practices and the submission generally provides a high enough level of detail to give confidence in the solutions offered. There will inevitably be a requirement for further refinement of options as the project progresses but on the basis of current information the principles and assumptions used seem valid. In some cases multiple options have been considered and justification provided for the selection of chosen solutions.

Construction of the MeerKAT project appears key to the credibility of provisions since a large proportion of background data has been drawn from the project. For example extensive geological data has been gathered as part of the MeerKAT project, increasing the level of geological knowledge for the proposed SKA site. It is therefore reasonable to infer a good level of confidence in the credibility of the basic infrastructure provisions.

The submission lists Standards and Codes relevant to the provision of basic infrastructure. A detailed review of the provisions against these standards is beyond the scope of this study however it is reasonable to assume that development of basic infrastructure in line with national Codes and Standards will generate credible solutions.

### **3.3 Does the solution provide the required capability?**

Section 4 and Appendix A highlight aspects of the submission that do not meet the specific requirements of the model configuration and could have a potential impact on capability or capacity. Where the provisions deviate from the requirements a basis for the deviation is usually given and generally relates to the assumptions being used. For example the construction camp has been designed to accommodate 300 staff instead of the specified 600 assuming 50% of the work force will be local residents and therefore not require accommodation.

There were no examples identified where proposed solutions did not meet the required capacity without a corresponding justification and change in assumption. There were some areas where further clarification may be required to confirm the requirements of the model configuration are being fully met. For example the clarification that shielding has been included for the electronics workshop in the operations centre. These areas are highlighted in Section 4 and Appendix A.

### **3.4 Areas of design that have not been considered**

There were no identified areas of basic infrastructure that were included in the model configuration but not included in the submission. In general the solutions presented in the submission appear to be supported by a good level of background work and reasonable assumptions.

### **3.5 Sequencing**

The RfI and model configuration does not explicitly ask for information on roll out plans or sequencing as part of the basic infrastructure requirement however the following points are noted:

- The provisions for basic infrastructure rely heavily on the existing road network including infrastructure that is being upgraded and constructed as part of the MeerKAT project. These elements should be in place to meet the SKA programme.
- Provisions for the construction camp include suitable accommodation that can be used for permanent staff during the operations phase. This reduces any risk of potential delays in the readiness of permanent accommodation following construction.

There were no specific issues identified during the review which it was felt presented a significant risk to sequencing or roll out at this early stage.

### **3.6 Costs and cost methodology**

#### **3.6.1 Capital Costs**

Section 2.11 of the main submission summarises the estimated capital costs in Tables 2.9 to 2.11. The main body of the submission does not provide sufficient detail to comment on the credibility or feasibility of the cost estimates however further data is contained in the spreadsheets included in Annexures C4.3 to C4.8. Annexure C14 also contains a summary of unit rates for material and labour.

Annexures C4.3 to 4.8 appear to be detailed bills of quantities that demonstrate a good depth of background work has been done in producing the cost estimates. However it is generally not clear how these costs corresponds to the summary tables in the main submission and it has proved difficult to trace the origin of the summary figures. There does not appear to be a logical and consistent structure to the presentation of costs related to the basic infrastructure components and the requirements laid out in the model configuration.

A full review of the detailed information and local cost rates is beyond the scope of this study. Where possible quantities used in building up the cost estimates have been reviewed. Comments have been made in relation to the provisions detailed in the model configuration, the submission and those

included in the cost estimates. Where it has been possible to include specific comments on the cost estimates against the requirements for basic infrastructure, these have been included in Appendix A.

The submission states that estimates are based on industry rates and data from previous projects. The MeerKAT project has been drawn on in the estimation of costs for this submission as well as MERKEL's Builders' Pricing and Management Manual. MERKEL's is a commercially available electronic costing tool. It is reasonable to assume that cost rates taken from this, together with those from the MeerKAT project would provide representative estimates however a detailed verification of the MERKEL's manual is beyond the scope of this study.

The full cost of basic infrastructure has been estimated and then discounts have been included to account for the use of existing infrastructure. The basis of these discounts is not clearly stated and while the key items appear to be included, without further information on the build up of discounts, it is not possible at this time to comment on their credibility.

### 3.6.2 Operational and maintenance costs

Section 2.11 of the main submission summarises the estimated operational and maintenance (O&M) costs in Tables 2.12 to 2.14. The main body of submission does not provide sufficient detail to comment on the credibility or feasibility of the cost estimates. Section 5.3 of Annexure C4.1 also contains some cost information related to O&M. The cost estimates for operations and for maintenance appear to be based on an annual fixed rate which is a percentage of the capital cost. It is not clear from the submission what the basis of these costs is or the percentage of capital cost used. Further clarification and explanation is required before confidence can be held in the cost estimates for operations and maintenance.

### 3.6.3 Confidence in cost estimates

Section 5.4 of Annexure C4.1 includes a summary of assumptions used in building up the cost estimates. In principle the assumptions appear in line with Section 2.2 of the RfI. The assumptions state that travel costs have not been included as part of the salary costs as this is not common practice in South Africa.

Section 5.7 of Annexure C4.1 summarises the level of confidence in the cost estimates. It states an 85% level of confidence in the capital cost estimates and a 75% level of confidence in the operational and maintenance cost estimates. The confidence levels appear to be based on the perceived quality and accuracy of data included in the RfI.

A higher level of confidence in the capital cost estimates compared to the O&M costs seems justified given that the data has been drawn from comparative projects in the region and the model configuration is relatively well defined. The basis of O&M cost is not clear from the submission so at this time it is difficult to justify a high level of confidence in the estimates.

## 4 Key risks

Table 2 provides a summary of the potential risks identified through the review of basic infrastructure provisions. The risks have been categorised under the following areas:

Category	Title	Description
RC1	Deviation from the model Configuration	The provisions outlined in the submission do not explicitly meet the requirements of the model configuration
RC2	Clarification required	The assumptions or provisions in the submission are not clear and further clarification or explanation is justified
RC3	Design/Specification risk	The design or specification of proposed provisions do not meet the requirements of the model configuration or present a risk to successful operation
RC4	Operational risk	The assumptions or provisions in the submission present a risk to successful operation

Category	Risk	Description	Potential implication
RC1	Layout of major roads	There are differences between the road layout included in the submission and the model configuration.	Road network is not sufficient to meet the requirements of SKA. Potential additional cost and disruption required to upgrade
RC1	Provision of minor roads	The provision for minor roads outside the inner zone is 12% of the estimated values in the model configuration.	Insufficient road network to serve the needs of SKA. Additional cost and disruption required to upgrade.
RC1	Construction accommodation	The submission assumes 50% of the work force will be based locally and hence the provision of construction accommodation does not explicitly meet the requirements of the model configuration.	The assumptions are not valid and additional accommodation is required to meet demand. Increased cost and potential delays in programme.
RC2	Maintenance assumptions	Section 2.11 states the assumption that maintenance costs “ <i>exclude replacement of elements at end of life and exclude SKA workforce for the maintenance of receivers, software, super computer, data processor etc.</i> ” A full understanding of the implications of this assumption is recommended.	Under estimate of maintenance cost and required provisions.

Category	Risk	Description	Potential implication
RC2	Restrictions on overhead obstructions	The submission does not make reference to the additional restrictions on overhead obstructions for the major roads to receptors and minor roads. Clarification is recommended.	Restrictions on movement of parts due to overhead restrictions.
RC2	Electronics workshop shielding	It is not clear from the submission if shielding has been included for the electronics workshop in the operations centre. Clarification is recommended.	Building does not meet the requirements of the model configuration and additional cost is required to upgrade.
RC2	Vehicle parking	The main submission does not make reference to vehicle parking at the operations centre however it is included in Annexure C4.1. It is also not clear in the cost estimates where parking is included. Clarification is recommended.	Additional costs will be incurred to provide parking if this is not already included.
RC2	Remote station buildings	The submission includes the provision of a workshop which is not explicitly included as a requirement in the model configuration. Clarification is recommended	The cost of remote stations is over estimated.
RC2	Head office	Relatively little information is provided for the head office. The allocation of space per person appears high and clarification of the assumptions is recommended. No information is given on construction type.	The estimated cost is not accurate
RC2	Remote stations in partner countries	A weighing factor has been applied for the cost of remote stations in partner countries however the basis of the factor is not clear.	The estimated cost is not accurate
RC3	Width of roads	The proposed width of roads (both major and minor) is considered narrow with insufficient room for two heavy vehicles to pass comfortably. The implications may be less significant for the minor farm roads however for major roads this may lead to rutting in the verge and possible break-up of the road edge. There could also be potential implications from dust generated.	Increased risk of accidents and increased maintenance liability.

Category	Risk	Description	Potential implication
RC3	Array platforms	The submission does not make reference to treatments to prevent plant growth.	Increased and ongoing maintenance liability if not included
RC3	Locally sourced material	The submission states the use of locally sourced material. There is a risk that the material will not be of suitable quality.	The quality of roads does not meet the required specification or additional cost is required to source suitable material from further away.
RC4	Main Access Road Ownership	The majority of the main access road will be the responsibility of the Northern Cape Provincial Department of Roads. While this offers opportunity for reduced maintenance liability for SKA it will be important to understand any potential implications and risks to operations that could result from SKA not having full control over the road.	Maintenance does not meet the requirements of SKA or unacceptable traffic volumes use the road.
RC4	Airstrip location	The proposed location and specification for the MeerKAT airstrip means that it does not meet the 30km exclusion zone requirement given in the Rfl.	Restrictions on the use of the airstrip as a result of the proximity to the SKA core.
RC4	Partner countries	The provision of a complete basic infrastructure programme is dependent on successful collaboration with partner countries.	A breakdown of collaboration could affect the operational capability of SKA through not being able to construct or maintain the infrastructure.
RC4	MeerKAT programme	Many of the elements of the MeerKAT project form part of the provisions for SKA.	Amendments to the MeerKAT programme could potentially impact on the construction and operation of SKA.
RC5	Maintenance costs	There appears to only be limited information provided on the operations and maintenance costs.	The cost estimates may not be accurate and the true cost could be significantly more or less than predicted.

**Table 2 – Summary of key risks**







## 5 Conclusions

Based on the discussion in Section 3, the risks outlined in Section 4 and the comments in Appendix A, the following general conclusions are drawn from our review of the candidate site submission:






- Overall the submission provides solutions based on experience of similar smaller scale projects in the area giving confidence in the approaches adopted.
- Solutions appear to be in line with common practice for the region.
- The submission draws on existing infrastructure which offers opportunities to reduce capital costs.
- In places the submission has deviated from the requirements of the model configuration. The justification and assumptions for these deviations are usually clear and the impact on costs is likely to be modest.
- The submission generally provides a good level of detail and supporting background information. A detailed review of the background information is beyond the scope of this study however a reasonable level of confidence can be taken from the depth of information for this stage of design.
- The estimates for capital cost are based on detailed bills of quantities that on the basis of limited spot checks, appear to be largely aligned with the provisions detailed in the main submission.
- Only limited information is provided on the operational and maintenance costs which appear to be based on a fixed percentage of the capital costs. Further clarification is recommended if a greater level of confidence is to be held in the cost estimates.
- It is not obvious how the detailed cost estimates relate to the summary tables provided in section 2.11 of the main submission therefore it is not possible to comment on the credibility of the overall summary costs. Further clarification is recommended.



**Appendix A - Assessment of provisions against requirements**

Element	Requirements (if applicable)	Summary of submission (inc. document reference)	Comment on provisions	Comment on costs included in submission
Provide a visual representation of the central core area containing the three cores	Not applicable	<b>2.2.1</b> Representation is provided in Figure 2.1	Submission provides the requested information.	Not applicable
Provide a visual representation of the Operations Centre near the centre of the array	Not applicable	<b>2.4.1 and Annexure C2</b> Representation is provided in Figure 2.5 and further drawings in Annexure C2.	Submission provides the requested information.	Not applicable
Provide a visual representation of a remote station	Not applicable	<b>2.4.3 and Annexure C2</b> Representation is provided in Annexure C2	Submission provides the requested information.	Not applicable
Describe site specific plans for the following items: <i>(Include in these descriptions, and specifically identify, any existing infrastructure to be incorporated (including any significant upgrade or modification) in the implementation of the SKA infrastructure)</i>				
Major roads. (include construction, layout, width, load bearing capacity, design speed, vehicle frequency)  <b>approx 180km</b>	<b>Main access road</b> <ul style="list-style-type: none"> <li>• All weather</li> <li>• All year access</li> <li>• 100kph</li> <li>• Min or no dust within 13km</li> <li>• Construction traffic then maintenance</li> <li>• Flood resistant</li> </ul>	<b>2.3</b> <b>2.1.1 of Annexure C4.1</b> <b>Annexure C5</b> The submission confirms the upgrade of existing roads to meet the requirements of the model configuration.  The main access road will be 6m wide and have a design speed of 100kph. The submission allows for 10 year construction traffic based on 20-30 light trucks per	The provisions appear to meet the requirements outlined in the Rfl. Existing roads are being used where possible and upgraded to meet the requirements.  There is already substantial infrastructure in place or due to be completed as part of the MeerKAT project suggesting a good level of confidence in the basic infrastructure provisions.  The technical specification included in Annexure C5 appears adequate for this stage of design subject to the ground	<b>2.11</b> <b>2.1.1 of Annexure C4.1</b> <b>Annexure C4.6</b> A total of 180.4km of major road is included in the cost estimates. This aligns with the provisions made in the submission and the model configuration.  A cost per km is derived and included in Annexure C4.6. While the individual local rates for items have not been checked, the items included in the build

Element	Requirements (if applicable)	Summary of submission (inc. document reference)	Comment on provisions	Comment on costs included in submission
		<p>day. Occasional heavy vehicles have been allowed for. Details of pavement layers are given and specification.</p> <p>The submission confirms a sealed road to eliminate dust.</p> <p>Design of the access road is in accordance with relevant design Standards.</p> <p>The submission estimates 180.4km of major road in total of which 71km is existing gravel access road to be upgraded.</p>	<p>conditions on site. A review of TRH14 has not been undertaken.</p> <p> The proposed width of major roads is considered narrow. If two heavy vehicles needed to pass it is likely that one would need to drive over the verge, causing rutting in the verge and break up of the road near the edge. 7m is suggested as a more appropriate width to allow heavy vehicles to pass.</p> <p> The submission states that the majority of the main access road will be the responsibility of the Northern Cape Provincial Department of Roads. This would potentially result in a reduced maintenance liability for SKA but possible less control over use. The full implications and risks to operation should be understood.</p>	<p>up appear credible.</p> <p> The cost per km appears to be based on new construction and not upgrade. Table 2.15 includes a discount for the existing major road infrastructure however the basis of the discount is not clear.</p> <p> Cost estimates have been included for maintenance. The basis of these estimates is not clear from the summarised costs therefore it is not possible to comment on the credibility.</p>




Element	Requirements (if applicable)	Summary of submission (inc. document reference)	Comment on provisions	Comment on costs included in submission
	<p><b>Major Roads to receptors as above plus:</b></p> <ul style="list-style-type: none"> <li>• No overhead obstructions</li> <li>• 80kph</li> <li>• Dust suppression required</li> <li>• Will pass within approx 2km of receptors in the core area</li> </ul>	<p>2.3.2 2.1.1 of Annexure C4.1 Annexure C5</p> <p>Major roads to the receptors are designed to the same specification as the main access road.</p> <p>The submission confirms that the requirement for a maximum distance of 2km between a main road and a receptor is met.</p> <p>The overall length of major roads allowed for is 109km (excluding the existing main access road)</p>	<p>The provisions outlined in the submission meet the requirements detailed in the Rfl in terms of specification.</p> <p>⚠ There are differences in the proposed layout between Figure 3 in the model configuration and Figure 2.4 in the submission. The impact of this on operation of the SKA should be reviewed but the proposal is feasible from an infrastructure perspective.</p> <p>⚠ The proposed width of major roads is considered narrow. If two heavy vehicles needed to pass it is likely that one would need to drive over the verge, causing rutting in the verge and break up of the road near the edge. 7m is suggested as a more appropriate width to allow heavy vehicles to pass.</p> <p>⚠ There are no comments addressing the additional restrictions on overhead obstructions.</p>	<p>2.11 2.1.1 of Annexure C4.1 Annexure C4.6</p> <p>The cost estimates for major roads to receptors appear to be included with the main access road cost estimates. A total of 180.4km is included in the cost estimates. This is in line with the provisions in the main submission and also the model configuration.</p> <p>A cost per km is derived and included in Annexure C4.6. While the individual local rates for items have not been checked, the items included in the build up appear credible.</p> <p>⚠ Cost estimates have been included for maintenance. The basis of these estimates is not clear from the summarised costs therefore it is not possible to comment on the credibility.</p>
<p>Minor roads. (include construction, layout, width, load bearing capacity, design speed, vehicle frequency)</p>	<p><b>Minor roads to receptors:</b></p> <ul style="list-style-type: none"> <li>• <b>Approx 100km</b></li> <li>• Available most of the time</li> <li>• May be subject to flooding and need minor repair after heavy rain</li> <li>• Dust suppression required</li> <li>• No overhead obstructions</li> <li>• Minimise road side</li> </ul>	<p>2.1.4 of Annexure C4.1 Annexure C5</p> <p>The submission confirms 95km of minor roads to receptors and includes a specification based on 5m wide road and a 30kph design speed. This type of road is referred to as a 'farm road'</p> <p>Approximately 8km of the proposed road network for</p>	<p>The specification included in Annexure C4.1 and C5.2 does not explicitly meet the requirements detailed in the Rfl. The specification does not mention dust suppression and it is not clear from the document if this is included.</p> <p>⚠ Clarification should be sought on the specification to confirm an appropriate surfacing material is used.</p>	<p>2.11 2.1.4, 5 and 6 of Annexure C4.1 Annexure C4.6</p> <p>Cost estimates allow for 294.8km of minor roads within South Africa and a further 60.5km of road in partner countries. The cost estimates do not appear to distinguish between the different types of minor road referred to in the model configuration.</p>

Element	Requirements (if applicable)	Summary of submission (inc. document reference)	Comment on provisions	Comment on costs included in submission
	<p>obstructions</p> <ul style="list-style-type: none"> <li>Will connect receptor sites with major roads referred to above.</li> </ul>	<p>MeerKAT will be used as part of the minor roads requirement of the SKA project.</p>	<p> There are also no comments addressing the additional restrictions on overhead and roadside obstructions.</p> <p> The proposed width of minor roads is considered narrow. If two heavy vehicles needed to pass it is likely that one would need to drive over the verge, causing rutting in the verge and break up of the road near the edge. 7m is suggested as a more appropriate width to allow heavy vehicles to pass.</p>	<p>The total length of minor road included in the cost estimates is in line with the provisions detailed in the main submission.</p> <p>A cost per km is derived and included in Annexure C4.6. While the individual local rates for items have not been checked, the items included in the build up appear credible.</p> <p> Cost estimates have been included for maintenance. The basis of these estimates is not clear from the summarised costs therefore it is not possible to comment on the credibility.</p>
	<p><b>Roads outside the inner zone:</b></p> <ul style="list-style-type: none"> <li><b>Approx 750km</b></li> <li>As above</li> <li>Local roads may be used &gt;100km from the centre</li> </ul>	<p>2.3.2 2.1.6 of Annexure C4.1 Annexure C5</p> <p>For roads outside the inner zone the submission states the use of local infrastructure where possible and assumes the same quality as the farm roads noted above.</p> <p>The submission assumes a reduced requirement of 89km up to a distance of 180km from the Skirt region based on the expected suitability of existing infrastructure.</p> <p>Allowance is also included for 37km of minor roads to remote stations in South Africa and 60.5km for remote stations in</p>	<p>The provisions in the submission largely meet the requirements of the model configuration.</p> <p>Section 2.3.2 'Roads beyond the skirt region' states a reduction of 661km against the 750km requirement given in the model configuration giving a requirement of only 89km.</p> <p> This is a significant reduction on the model configuration and while feasible might warrant further validation.</p>	<p>2.11 2.1.4, 5 and 6 of Annexure C4.1 Annexure C4.6</p> <p>Cost estimates allow for 294.8km of minor roads within South Africa and a further 60.5km of road in partner countries. The cost estimates do not appear to distinguish between the different types of minor road referred to in the model configuration.</p> <p> The total length of minor road included in the cost estimates is in line with the provisions detailed in the main submission. This is approximately 35% of the estimated length of minor roads given in the model configuration and has a corresponding reduction in</p>


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		partner countries.		<p>overall cost.</p> <p>A cost per km is derived and included in Annexure C4.6. While the individual local rates for items have not been checked, the items included in the build up appear credible.</p> <p> Cost estimates have been included for maintenance. The basis of these estimates is not clear from the summarised costs therefore it is not possible to comment on the credibility.</p>
<p>Equipment and office buildings. Describe the building to be used in each case including size, construction type and facilities</p>	<p><b>Operations centre:</b></p> <ul style="list-style-type: none"> <li>• Temperature and humidity controlled data processor building - 1600m<sup>2</sup></li> <li>• Power building</li> <li>• Offices for total of 40 people</li> <li>• 2 meeting rooms</li> <li>• Canteen for 100 staff</li> <li>• Workshops and storage including large mechanical workshop, shielded electronics workshop, parking for site vehicles including cranes and cherry pickers</li> <li>• Vehicle parking in the vicinity of all buildings</li> <li>• 15-20km from the centre of</li> </ul>	<p>2.4.1 Table 2.5 2.2 of Annexure C4.1</p> <p>The submission refers to the Operations centre as the Astronomy Complex. The proposed location is 24.1km from the array core. The submission also includes the super computing building at the same location (see below)</p> <p><b>Allowances made:</b></p> <p>Date processing building – 1600m<sup>2</sup> Power building – 786m<sup>2</sup> Office space – 600m<sup>2</sup> Hardware support – 150m<sup>2</sup> Meeting rooms – 70m<sup>2</sup> Recreational – 220m<sup>2</sup></p>	<p>The provisions meet the requirements given in the model configuration.</p> <p>Discussion with PB's power division suggests the provision of space for the power building (housing the rotary UPS system) is reasonable given the stated power provision and co-location of the super computing building.</p> <p>An allocation for recreational space has been included that is not explicitly requested in the model configuration.</p> <p>The allowance per person for office/meeting space is relatively high. 600m<sup>2</sup> equates to 15m<sup>2</sup> per person. A typical value used for UK design might be 10m<sup>2</sup> to include meeting room and circulation space.</p> <p>Table 2.5 of Section 2.4.1 gives a detailed breakdown of the various space allocations where they are not given in the Rfl. They appear to be reasonable for this stage of design.</p>	<p>2.11 2.2.1 of Annexure C4.1 Annexure C4.3</p> <p>Annexure C4.2 provides a detailed breakdown of cost elements for the Operations Centre. It is not immediately clear how the summary tables in the main submission relate to Annexure C4.3.</p> <p>Cost rates are based on per m<sup>2</sup> and in most cases the quantities (m<sup>2</sup> of floor space) included in the cost estimates match the provisions in the main submission.</p> <p> The allocation included in the cost estimates for offices is 1340m<sup>2</sup> compared to the 600m<sup>2</sup> specified in the submission. There do not appear to be separate items in the cost spreadsheets to cover the meeting rooms, canteen,</p>




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	the array unless shielded	Canteen – 300m <sup>2</sup> Workshops and storage – 300m <sup>2</sup> Parking – Approx 2000m <sup>2</sup>	<p>⚠ It is not clear from the description of the operations centre in 2.4.1 or Annexure C4.1 if shielding of the electronics workshop has been included.</p> <p>⚠ Section 2.4.1 of the main document does not make reference to vehicle parking however the visual representations show parking at the site and reference is made in Annexure C4.1</p> <p>The proposed location for the operations building is 24.1km from the core therefore shielding is not required.</p>	<p>Hardware support offices and recreational areas. The sum of these areas is 1340m<sup>2</sup> and it is assumed that this is the total allocation under 'offices'. Confirmation of the items that make up the 'office' allocation together with the applicability of one rate for all types of space is recommended.</p> <p>⚠ The cost estimates for the workshop building do not appear to include any provision for shielding of the electronics workshop. Clarification should be sought.</p> <p>⚠ It is not clear where parking is accounted for in the cost estimates for the operations centre.</p>
	<p><b>Staff welfare</b></p> <ul style="list-style-type: none"> <li>• Approx 160 staff at any one time (260 total) predominantly for the operations centre</li> <li>• Accommodation complex</li> <li>• Requirement dependent on proximity of work force to site</li> </ul>	<p>2.4.1 and 2.5.2 2.4 of Annexure C4.1</p> <p>The submission states the provision of accommodation for 30 people at the operations centre based in 15 two bedroom sleeping units. Recreational and catering facilities are also included.</p> <p>In deriving the accommodation requirements it has been assumed that only 30 people will be permanently based at the operations centre.</p> <p>Staff not permanently based at the operations centre or local residents will be housed in a new</p>	<p>The provisions included in the submission meet the requirements of the model specification. The submission states the use of higher specification construction accommodation to form the basis of permanent accommodation. Plans are included in Annexure C3 and seem reasonable in relation to space and facilities.</p> <p>Carnarvon is approximately 57km from the operations centre therefore the proposal to have the majority of staff based there seems reasonable from the perspective of travel time to work. This equates to a journey time of approximately half an hour.</p> <p>⚠ Transportation of staff to the operations centre is not discussed in the submission. It</p>	<p>2.11 Annexure C4.3</p> <p>A rate and associated breakdown of items for a single two bedroom sleeping unit is included in Annexure C4.3.</p> <p>⚠ C4.3 specifies 15 units which aligns with the provisions made in the main submission. It is not however clear how this is carried forward to the summary tables in Section 2.11 of the main submission.</p> <p>The remaining permanent accommodation is constructed as part of the construction camp. Cost estimates are included in Annexure</p>






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		<p>complex built on vacant land in Carnarvon. Section 2.5.2 provides details of the accommodation which provides 188 rooms.</p> <p>Of the 260 staff in total, it has been assumed 25% (65) will be local residents.</p> <p>The permanent accommodation will be built during the construction phase as part of the construction camp.</p>	<p>is included for the construction phase and it would seem sensible to employ a similar system for permanent staff.</p> <p>Basing permanent staff at Carnarvon appears to offer benefits in reduced capital investment in bulk infrastructure and recreational facilities.</p> <p> Several of the proposed layouts for residential accommodation appear to be family type units. It might be reasonable to expect more single occupancy units. Verification of the underlying assumptions is recommended.</p>	<p>C4.5 and are in line with the provisions given in section 2.4 of Annexure C4.1. Verification of individual unit rates for the region is beyond the scope of this study.</p>
	<p><b>Remote station building:</b></p> <ul style="list-style-type: none"> <li>Storage shed for fork lift and supplies</li> </ul>	<p><b>2.4.3</b></p> <p>Remote station buildings will be constructed 2km from receptors to mitigate against self generated electromagnetic interference.</p> <p>Two separate buildings will be provided</p> <p>1) A steel frame storage shed (107m<sup>2</sup>)</p> <p>2) A precast concrete electrical room and workshop (81m<sup>2</sup>)</p>	<p>The model configuration does not place a requirement on the distance between the remote station building and the receptor but the submission states 2km.</p> <p>2km between the building and the receptor seems unnecessary. The model configuration does not specify an electrical room and it is unclear why this has been included. It does not seem practical to transport supplies and a fork lift 2km to the location of the receptor in the event of maintenance if a clearance of 2km is not required.</p> <p>The 107m<sup>2</sup> allocation for the storage shed should provide adequate space for a fork lift, supplies and emergency equipment.</p> <p> The proposed construction type is reasonable subject to the verification of requirements for an electrical building.</p>	<p><b>2.11</b></p> <p><b>Annexure C4.4</b></p> <p>Annexure C4.4 provides a detailed breakdown of costs for remote station buildings and includes a 'Type 1' and 'Type 2' remote station.</p> <p> It is unclear what Type 1 and Type 2 refer to. It possibly relates to the storage shed and electrical room and workshop referenced in section 2.2.2 of Annexure C4.1 however the total areas included in the cost estimates do not appear to align with the provisions in the main submission. There also appears to be overlap between the two cost estimates for Types 1 and 2 (such as a fee for site clearance). It is reasonable to assume if the buildings were at the same location, these costs</p>







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				<p>would not require duplication. Further clarification is recommended.</p> <p>A weighting factor has been applied for the remote stations in partnering countries. The basis of these factors is not clear.</p>
	<p><b>Head office</b></p> <ul style="list-style-type: none"> <li>• Off site location</li> <li>• Small scale computing and communications</li> <li>• Capacity for 190 people</li> </ul>	<p><b>2.4.4</b></p> <p>The head office will be located in Cape town in a new 3500m<sup>2</sup> Grade A building.</p> <p>The submission states the building will be sufficient to accommodate the 190 staff specified in the model configuration and states an assumed reduction of 20-30 due to the co-location of the super computing building at the operations centre.</p>	<p>Based on 190 staff the allocation of space per person is approximately 18.5m<sup>2</sup>. This seems relatively high compared to a typical value used for UK design which might be 10m<sup>2</sup> including meeting room and circulation space.</p> <p>However the submission is not specific about the provision of small scale computing and communications facilities at the head office. Taking this into account may make the allocation of 18.5m<sup>2</sup> per person more reasonable.</p> <p> Clarification of the assumptions used in deriving the total space allocation would be beneficial.</p> <p>Details of the type of construction are also not included in the main submission.</p>	<p><b>2.11 Annexure C4.3</b></p> <p>Limited information is provided relating to the cost of the head office in Cape Town. An allocation has been included in Annexure C4.3 based on a single rate per m<sup>2</sup> and a total area of 3500m<sup>2</sup>. This total area is aligned with the provisions stated in the main submission however a more detailed breakdown could provide greater confidence in the cost estimates.</p>
	<p><b>Super computing building</b></p> <ul style="list-style-type: none"> <li>• 1600m<sup>2</sup> area for computing</li> <li>• Additional office space if not co-located with the head office.</li> </ul>	<p><b>2.4.1</b> <b>2.2.1.1.2 of Annexure C4.1</b></p> <p>The super computing building is co-located with the data processing building at the operations centre.</p> <p>A provision of 1600m<sup>2</sup> has been included for the super computing</p>	<p>The provisions in the submission meet the requirements of the model configuration.</p> <p>The submission highlights the high cost associated with provision of a data connection for distances in excess of 80km as justification for the super computing building not being located with the head office.</p>	<p><b>2.11 Annexure C4.3</b></p> <p>Annexure C4.3 includes cost estimates for a 1600m<sup>2</sup> building. This is aligned with the provisions in the main submission and the model configuration.</p> <p>Additional office space is not included</p>


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		<p>building. Additional office space has been included in the operations centre to accommodate the increased staff associated with the computing building.</p> <p>The form of construction is consistent with the adjoined data processing building with structural masonry /concrete walls and a flat well insulated concrete roof.</p>	<p>The proposed form of construction is appropriate in principle and uses well established, traditional materials and methods.</p>	<p>in the cost estimate however the office allocation in the operations centre should include for the extra requirement that results from the super computing building not being co-located with the head office.</p>
<p>Construction camp or camps (including details of lay-down and assembly areas, storage areas, power supply, accommodation and welfare facilities)</p>	<ul style="list-style-type: none"> <li>Office buildings, warehouses and accommodation</li> <li>Approx 600 staff capacity</li> </ul>	<p><b>2.5.1</b> Annexure C3 <b>2.4 of Annexure C4.1</b></p> <p>The submission assumes 35-50% of the construction workforce will be local and hence the provisions allowed for in the main construction camp are based on 300 people.</p> <p>Plans are included for a range of accommodation types and an overall layout plan for the main construction site is provided which includes recreational facilities.</p> <p>The proposed location for the main camp is in Carnarvon and uses existing power, water and sewer services.</p> <p>Additional construction yards are included with associated laydown areas, workshops, stores and</p>	<p> The plans provided for construction site accommodation seem adequate. They do not specifically meet the requirements of the model configuration due to the assumption of 50% local labour who are assumed to already live near the site. As a result the submission only provides accommodation for 300 and not the specified 600 staff.</p> <p>The location of the construction site in Carnarvon offers benefits in relation to existing infrastructure.</p> <p>The proximity of the camp to the construction sites is unlikely to be prohibitive and plans are included in the submission for daily transportation of personnel to site.</p> <p> Proposals appear to include two bedroom units with a shared bathroom. The size is considered small, smaller than a typical 2 or 3 star hotel and it. En-suite facilities might also normally be expected..</p>	<p><b>2.11</b> <b>2.4.1 of Annexure C4.1</b> <b>Annexure C4.5</b></p> <p>Detailed costs estimates are provided for the construction camp and are in line with the provisions given in the main submission. Costs estimates are included to cover construction yards, laydown areas and land provision.</p> <p>Cost estimates for a number of options (as outlined in Section 2.4.1 of Annexure C4.1) are included in Annexure C4.6 however it is not clear which option is taken forward to the cost summaries.</p> <p> The construction accommodation provisions are 50% of the requirements detailed in the model configuration. While the underlying assumptions for this reduction may be feasible and valid, the associated reduction in cost is likely</p>

Element	Requirements (if applicable)	Summary of submission (inc. document reference)	Comment on provisions	Comment on costs included in submission
		<p>other facilities as required. 4 are to be provided during Phase 1 construction and 6 for Phase 2. 2 of the sites are already in place for the MeerKAT project.</p> <p>Water will be supplied from boreholes and on site sewage treatment plants will be put in place.</p> <p>Power will be supplied by existing infrastructure or diesel generators.</p>		<p>to be reflected in the overall estimates. This may result in an underestimation of costs compared to what might be expected based on the model configuration.</p>
<p>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</p>	<ul style="list-style-type: none"> <li>• Minimum requirement is for emergency evacuation</li> <li>• Gravel runway to satisfy local standards</li> <li>• Any additional capacity would impose a 30km exclusion requirement from the centre of the array.</li> </ul>	<p>2.6.1 2.5 of Annexure C4.1 Annexure C5</p> <p>Two airstrips will be available for use during the construction and operation of SKA.</p> <p>The MeerKAT airstrip will be located at the site of the SKA core and be able to transport cargo and personnel as well as emergency evacuation. The minimum capacity requirement is for a PC-12 size aircraft. The airstrip is being constructed to a higher specification to enable a wider range of aircraft to use it.</p> <p>The second airfield is located at Carnarvon and has 3 airstrips, hangars and large apron. The landing strips are being upgraded with lighting as part of the</p>	<p>The provision of airstrip(s) meet the requirements of the model configuration. Section 2.5 of Annexure C4.1 provides details on the specification for the MeerKAT airstrip.</p> <p>The MeerKAT airstrip is being built to a higher specification than required by the model configuration. The Rfl states that any additional capacity imposes a 30km restriction zone from the array core.</p> <p> The current proposed position of the MeerKAT airstrip does not therefore meet this requirement.</p>	<p>2.11 2.5 of Annexure C4.1 Annexure C4.7</p> <p>Annexure C4.7 includes cost estimates for the airstrip. These are in line with the provisions given in the main submission.</p> <p>Table 2.9 in Section 2.11 of the main submission includes the cost of the airstrip. Table 2.15 includes a discount of the same amount in recognition that the capital and maintenance costs of the airstrip are covered under the MeerKAT project.</p>

Element	Requirements (if applicable)	Summary of submission (inc. document reference)	Comment on provisions	Comment on costs included in submission
		MeerKAT project.		
Dish foundations (including assumptions about underlying ground conditions, foundation types and materials)	<ul style="list-style-type: none"> <li>Tailored to meet sub surface geology at each location</li> <li>Designed to accommodate variation in ground level and withstand flooding</li> <li>Designed to meet the criteria in Section 4.4 of the model configuration (updated 03 Sep 2011)</li> </ul>	<p>2.8 2.6 of Annexure C4.1</p> <p>Details are provided in Annexure C4.1 where it states; "Loading and performance requirements have been defined in the New Wording for RDI Document on Foundations as received from SKA South Africa".</p> <p>The submission confirms that foundations will be tailored to meet the sub surface geology at each location. It is expected that variations in ground level can be accommodated and that they will withstand flooding.</p> <p>Design criteria are given for static conditions, precision operations, degraded operations and survival position.</p> <p>The 'precision operation' case governs the design of the foundation due to the limits on rotation. A piled foundation has been specified with varying pile depths to accommodate variation in geology.</p>	<p>The proposed foundation solutions appear reasonable however a detailed structural verification is beyond the scope of this report.</p> <p>The design criteria given in Section 2.6.1.1 is in line with the modified design criteria included in the model configuration.</p> <p>It appears that geological surveys and reports have been undertaken as part of the MeerKAT project and supplemented by further topographical surveys as part of this project (section 2.8.2 of the main submission and 2.6.2 of Annexure C4.1). It is therefore reasonable to assume an acceptable level of confidence in the geotechnical information used to generate the outline foundation designs.</p> <p>A good summary of geological data is provided in Section 2.6.2 of Annexure C4.1 although a detailed review of the information has not been undertaken as part of this study.</p>	<p>2.11 2.6 of Annexure C4.1 Annexure C4.4</p> <p>Detailed cost estimates are included in Annexure C4.4. A full review of the data has not been undertaken.</p> <p>Sample quantities have been checked against the provisions made in Section 2.6 of Annexure C4.1.</p> <p>The quantities of concrete used to build up the cost estimates for the foundations bases are in line with dimensions stated in the main submission.</p> <p> Cost estimates are provided for both the long (10m) pile and short (5m) pile option. The cost estimates for the short pile option appear to also be based on 10m long piles. Clarification of the correct value is recommended.</p>
Aperture array site preparation and bunkers (including assumptions about	<p><b>AA-Low</b></p> <ul style="list-style-type: none"> <li>Raised and levelled 180m diameter platform for each</li> </ul>	<p>2.7 Annexure C4.1</p> <p>AA-low stations consist of a 180m diameter raised platform made</p>	<p> The provisions largely meet the requirements set out in the model configuration however no reference is made</p>	<p>2.11 2.7 of Annexure C4.1 Annexure C4.4</p>

Element	Requirements (if applicable)	Summary of submission (inc. document reference)	Comment on provisions	Comment on costs included in submission
underlying ground conditions)	array <ul style="list-style-type: none"> <li>• Treated to prevent plant growth</li> <li>• One signal processing shielded enclosure for each array sized to contain 10 racks of digital electronic equipment. Bunker to be located near the edge of the array.</li> </ul>	from 200mm thick imported gravel. 12x3x2.4m containers are specified for the bunkers for AA-low stations in order to accommodate 10 racks. The specification is based on the RFI shielded containers currently in use on the KAT 7 site.	to treatments to prevent plant growth.	Detailed cost estimates are included in Annexure C4.4. The cost estimates appear to include preparation and installation of the bunker and water catchment tank.   It is not clear where the cost of the raised platform is captured and this should be clarified.
	<b>AA-Mid</b> <ul style="list-style-type: none"> <li>• Raised and levelled 60m diameter platform for each array</li> <li>• Treated to prevent plant growth</li> <li>• 4 bunkers per station to house electronic equipment. Shielding to be included.</li> </ul>	<b>2.8 Annexure C4.1</b> AA-mid stations consist of a 60m diameter raised platform made from 200mm thick imported gravel. 6x3x2.4m containers are specified for the bunkers for AA-mid stations. Containers are imported from Europe and are fully equipped with the required RFI shielding. They are the same specification as the RFI shielded containers currently in use on the KAT 7 site.	 The provisions largely meet the requirements set out in the model configuration however no reference is made to treatments to prevent plant growth.	<b>2.11</b> <b>2.7 of Annexure C4.1</b> <b>Annexure C4.4</b> Detailed cost estimates are included in Annexure C4.4. The cost estimates appear to include preparation and installation of the bunker and water catchment tank.   It is not clear where the cost of the raised platform is captured and this should be clarified.
Construction methods and material sources (including proposals for usage of locally won materials and local techniques and labour/plant	Not applicable	<b>2.9</b> <b>2.9 of Annexure C4.1</b> Construction methods are based on construction norms and specifications used in South Africa. Materials will be sourced from	The provisions appear in line with approved practice for the region and draw an experience gained through construction of the MeerKAT project.  A comprehensive list of standards and specifications is included in Section 2.10 of Annexure C4.1. A detailed review of these	<b>2.11</b> Costs associated with construction are incorporated into the unit rates used in the build up of cost estimates. A detailed review of the cost estimates is beyond the scope of this study. Cost estimates appear to be based on

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availability etc)		<p>borrow pits, quarries and commercial sources around the sites. Assumptions are made including the provision of material from within 15km of construction sites except for base and surfacing stone which will be from commercial sources within 100km of construction sites.</p> <p>Further investigation will be undertaken during construction of the MeerKAT project to identify suitable sources close to the construction site.</p> <p>The submission assumes the use of between 35% and 50% local labour during construction based on experience through the MeerKAT project.</p>	<p>Standards is beyond the scope of this report.</p> <p> The use of locally won material offers benefits in terms of reduced transportation distances and there appear to be contingencies in place if the material is not high enough quality.</p> <p>Ongoing investigations through construction of the MeerKAT project should offer further confidence in the proposed approaches.</p>	<p>typical construction in the region and recent experience of similar construction in the area. A reasonable level of confidence in the cost estimates can therefore be justified.</p>
Describe measures to be taken to ensure the security of the infrastructure components.	Not applicable	<p>No information is provided in the infrastructure Chapter of the submission regarding security.</p> <p>Chapter 10 provides details on the security risk assessment, threat assessment, case studies and the security model.</p>	<p>Section 10 of the submission provides a full summary of the security provisions which appear to be largely based on local experience gained through the MeerKAT project. It is reasonable to assume that this is a sensible basis at this stage of design.</p>	<p>Items relating to security have been included in the cost estimates for individual elements. For example the costs of CCTV and security fencing.</p>
Summarise the relevant national building codes and standards for each infrastructure component;	Not applicable	<p><b>2.10 of Annexure C4.1 and Annexure C7</b></p> <p>A list of Building Standards and Codes is included in 2.10 of Annexure C4.1 and Annexure C7</p>	<p>Annexure C7 provides the information requested in the Rfl and appears to provide a comprehensive list of Codes and Standards.</p> <p>A detailed review of these Standards is beyond the scope of this report. Standards</p>	Not applicable

Element	Requirements (if applicable)	Summary of submission (inc. document reference)	Comment on provisions	Comment on costs included in submission
			<p>relating the provision of accommodation, for example specification of size, do not appear to be included.</p> <p> The provisions for accommodation during construction and operation are thought to be reasonable however validation against relevant codes, standards or guidelines for the region could provide further confidence in the allowances.</p>	

*Note: A summary of cost and labour rates used in the build up of cost estimates is included in Annexure C14 of the submission.*