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Environmental and Social Impact Assessment (ESIA) for the Proposed Establishment and Operation of the African Millimetre Telescope on Farm Göllschau, Khomas Region

Environmental Management Plan

ECC Application No.: 251103006603

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Radboud University,
Nijmegen
Netherlands

TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS

Abbreviations used in this report.

AMT	Africa Millimetre Telescope
EAP	Environmental Assessment Practitioner
EAPAN	Environmental Assessment Professionals of Namibia
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EHT	Event Horizon Telescope
EMA	Environmental Management Act
EMP	Environmental Management Plan
GG	Government Gazette
GN	Government Notice 30 of 2012
HIA	Heritage Impact Assessment
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
I&APs	Interested and Affected Parties
IUCN	International Union for Conservation of Nature
MAWF	Ministry of Agriculture, Water and Land Reform
MEFT	Ministry of Environment, Forestry and Tourism
NHC	National Heritage Council
Regulations	Environmental Impact Assessment Regulations, GN 30 of 2012

1 INTRODUCTION

Radboud University proposes to establish and operate the Africa Millimetre Telescope (AMT) as part of an international research project to see into the 'shadow' of a black hole. To see such an image, there is a need for a worldwide network of radio telescopes, called the Event Horizon Telescope (EHT). This will effectively create a virtual telescope almost the diameter of the earth. The project is being initiated by Radboud University in The Netherlands, in collaboration with UNAM and other Namibian and international institutions.

1.1 This document

This Environmental Management Plan (EMP) is part of a scoping level Environmental Impact Assessment (EIA) and will be submitted to the Ministry of Environment, Forestry and Tourism (MEFT) in support of an application for an Environmental Clearance Certificate (ECC). It was compiled in accordance with the Environmental Management Act (7 of 2007) (EMA) and the EIA Regulations of 2012.

A scoping study with impact assessment was conducted and found no highly significant impacts that cannot be prevented and/or mitigated to a low or low-medium significance. The potential impacts identified in the Scoping Report are summarised in this EMP (Chapter 4) and prevention and/or management actions are given for each impact in Chapter 5.

This EMP deals with the planning and construction, operational and decommissioning phases of the development.

1.2 Aims of the EMP

The Environmental Management Plan (EMP) has two main aims:

- Propose measures to prevent and/or mitigate any potential negative impacts, and enhance positive impacts that were identified in the Scoping Report.
- Detail the actions required to carry out the proposed mitigation measures.

2 PROJECT OVERVIEW

The project will comprise the construction of a new antenna (a dish), prefabricated buildings and renewable energy systems, plus upgrading of the track leading to the proposed site on the Göllschau farm. The largest part of the telescope is 6.2 metres wide and weighs 40 tons; the track must be adequate to carry this load during construction.

Current plans are that the AMT will be moved to a site on the Gamsberg plateau when the necessary conditions have been met, such as agreement on the route of the access road from the D1278 gravel road, and a significant improvement of the road to the top of the plateau. This is expected to take 5 – 10 years and is dependent on finding the necessary funds. The Göllschau site will therefore be used for only that period of time, unless funds are not found. Decommissioning of the AMT site at Göllschau is included as a component of this project, unless funds are not found in which case the antenna stays at Göllschau.

2.1 Infrastructure

The project footprint is 80m x 80m (0.64 ha) and will consist of a custom-made telescope dish with a diameter of 14 meters plus a 1 m high foundation and a total height of maximum 15.5 meters, as well as two prefabricated buildings for control rooms, IT equipment, meeting rooms, bedrooms and ablutions.

The existing access track from the C26 onto the boundary road and from there an existing farm road to the AMT site will be used. A photovoltaic solar plant is being investigated. A back-up system in case of emergency will likely be either a diesel generator or grid electricity.

2.2 Construction Phase

2.2.1 Workforce and Duration

The construction phase is expected to take 15 months in total. First, earthworks, foundations and buildings will be completed by approximately 10 people, who will be housed at the buildings of the Farmers' Association. This will take about three months. Then, over the next 12 months, the telescope will be assembled by a highly specialised team of four people, housed either in a guest house (at farm Göllschau) or on-site in the prefabricated buildings.

2.2.2 Services and Utilities

Road access

The existing road from the C26 along the farm boundary, and from there to the AMT site will be upgraded to allow the transport of abnormal loads (largest component is approximately 6.2 m wide and weighs 40 tonnes).

Water supply

The local boreholes do not have the capacity to supply construction activities and the engineering firm will source water in Windhoek and bring pre-mixed concrete to the site. The daily use of drinking water is not expected to exceed 10 m^3/month and will be supplied from an existing borehole on the farm or brought from Windhoek.

Fuel supply

A small amount of fuel (for backup generators) is anticipated to be stored either in a secure mobile storage tank or in a stationary tank on an impermeable bunded surface on-site.

Electricity

Electricity will be provided by generators supplied by the contractor.

Sewerage and sanitation

Portable toilets will be supplied by the contractor until the permanent sewerage system is established, and then they will be removed from the site. A standard septic tank system will be installed on site, with a French drain and soak-away for excess waste water.

Solid waste management

Solid waste will be collected on site and stored securely as appropriate for the type of waste, e.g. domestic waste in a wind- and animal-proof enclosure. All waste will be removed from the site and from the farm and disposed at an appropriate, registered landfill facility.

2.3 Operational Phase

2.3.1 Workforce

No-one will live on site permanently, except possibly a person to act as security in the capacity of a deterrent. The AMT does not require continuous human presence for its operation, and only during joint observations in the EHT campaigns, during periods of maintenance, and special observations will there be specialists on site.

2.3.2 Services and Utilities

Water

Water for domestic consumption will be provided by the land owner at an estimated volume of 10 m^3/month.

Sewerage and sanitation

The septic tank system installed during construction will handle sewage and waste water.

Solid waste

Waste will be kept in a secure location on site and removed from the farm in accordance with a schedule approved by the landowner.

Fuel

No fuel will be stored on site.

Electricity

A photovoltaic (PV) and battery system with back-up generator for emergency situations.

2.4 Decommissioning Phase

During decommissioning the telescope will be dismantled, prefabricated buildings removed, and the site rehabilitated. Disturbed areas will be reprofiled, and stored topsoil replaced and revegetated. A rehabilitation specialist will be engaged to draw up a rehabilitation plan in cooperation with the proponent, the engineers and the landowner. The objective of the

rehabilitation plan will be to return the site to a condition as close as possible to its pre-project state or a state that suits the landowner for their ongoing use of the land.

There are two possible stages in the project lifespan when decommissioning could take place, but the activities, risks, impacts and mitigation measures at the Göllschau site are identical for both scenarios.

2.4.1 Move AMT to Gamsberg

The target scenario is that funds are found in the next 5-10 years for access to Gamsberg (new road). The AMT will then be moved from Göllschau during its operational life, and decommissioning will take place at Göllschau.

2.4.2 AMT remains at Göllschau

The second scenario is if the new road to Gamsberg does not materialize. The telescope will remain at Göllschau for its entire operational life, targeted to be 30 years, and be decommissioned at Göllschau at the end of its life.

3 IMPLEMENTATION

Radboud University, in close collaboration with UNAM, is responsible for the day-to-day implementation of this EMP. All contractors, subcontractors, visitors and staff must be made aware of the contents of the EMP and their roles in following it.

The objectives of the (EMP) include:

1. Assuring MEFT (office of the Environmental Commissioner) that suitable and sufficient mitigation and monitoring measures are in place
2. Identifying potential impacts associated with the project
3. Proposing measures to prevent or mitigate negative impacts and enhance positive impacts
4. Providing a monitoring tool for MEFT and the landowner
5. Compliance with environmental legislation
6. Informing researchers, staff, contractors, MEFT and stakeholders how to implement environmentally sustainable practices
7. Raising awareness among staff and stakeholders of the importance of sustainable environmental practices

This EMP illustrates the commitment of Radboud University to follow construction and operational best practices in environmental management.

The EMP is a living document and in accordance with adaptive management principles, it should be updated in response to monitoring, and also as new information, policies, authority guidelines and technologies become available.

3.1 Training

Appropriate training, education and experience for the tasks that are expected of employees will result in competence of the workforce. All employees will receive induction training upon arrival on site, and the Director on site will keep a register of completed training. This includes contractors, sub-contractors and their personnel.

A site induction should contain at least the following components:

- Definitions of “environment”, “social”, “impact”, etc. in language that is understandable by the trainees
- The risks and potential impacts associated with the project
- How can risks and impacts be minimised
- Environmental rules of the project
- The roles and responsibilities of the trainee in relation to the environment and this EMP
- Procedures to follow in the event of an environmental incident
- The consequences of non-compliance, including the possibility that the ECC may be withdrawn, and the project forced to close.

3.2 Compliance

- Radboud University will avoid or minimise potential impacts on the environment by complying with the guidelines in this EMP.

- All required environmental authorisations, permits and licences will be obtained; their stipulations implemented; and renewal will be done before expiry.
- Contractors and new employees will be informed of the high value placed on the environment and they will be aware of the measures in the EMP as well as their own responsibility in implementing those measures.

3.3 Consequences of non-compliance

The responsibility for implementation of this EMP should be extended to contractors and subcontractors and could include incentives such as clauses imposing:

- Fines and penalties to the contractor
- Suspension of work
- Cancellation of contract with the contractor or subcontractor
- Legal action

Compliance with the EMP will be demonstrated to the MEFT through 6-monthly Monitoring Reports that need to be submitted to MEFT. The consequence of non-compliance can result in a demand by MEFT to comply, or, in the worst case, result in the ECC being revoked.

3.4 Environmental Awareness Training

Construction Phase

The proponent will ensure that all contractors and their personnel are aware of the contents of the EMP and their need to follow the provisions of the Management tables in Chapter 5.

Operational Phase

Establishing roles and responsibilities for project staff and delivering training in the execution of their duties will be an ongoing process. Job specific environmental awareness training will involve providing employees with the capacity to implement the actions of this EMP.

Decommissioning Phase

The management measures of the Construction Phase will apply. The proponent will ensure that all contractors and their personnel are aware of the contents of the EMP and their need to follow the provisions of the Management tables in Chapter 5.

3.5 Environmental incident reports

Environmental incidents will be reported to the Project Director (see Table 5-1)

3.6 Environmental statutory obligations

3.6.1 Environmental Clearance Certificate

Regulator: Ministry of Environment Forestry and Tourism, Department of Environmental Affairs
Statutes: Environmental Management Act 7 of 2007 and the EIA Regulations of 2012.

3.6.2 Harvesting permit

Regulator: MEFT, Department of Forestry
Statutes: Forest Act 12 of 2001 and the Regulations of 2015.

3.7 Contractual obligations

In addition to statutory requirements, the project will be regulated by a contract between the proponent and the landowner.

3.8 Environmental Control Officer (ECO)

An ECO will be identified in the project team, and their name and contact details will be communicated to the construction team. This person should be the member of the project team who spends the most time on site. S/he will report to the Project Director.

4 POTENTIAL IMPACTS

Table 4-1 presents a summary of the impacts identified and assessed in the Scoping Report for this project. Management measures for these impacts are given in Chapter 5.

Table 4-1: Potential impacts

Description of Impact	Description of significance	Mitiga-tion	Signifi-cance
Light pollution			
Light interference onto the HESS site. From construction and operational activities, and vehicles driving to AMT.	Any night light emanating from AMT activities, that shines directly onto the HESS apparatus or that gives a glow on the horizon, will interfere with operations of the HESS telescopes and could severely damage them.	without	- Med
		with	- L-Med
Road deterioration			
Deterioration of local roads. Increased risk of traffic accidents.	The project site is accessed from the C26 gravel road heading southwest from Windhoek. For the first three months of construction, concrete, building materials and the telescope components will be hauled from Windhoek to the site. This will increase the volume of traffic, and there will be an increase in heavy trucks, with some carrying abnormal loads. Increased dust generation, greater corrugations and other deterioration of the road surface can be expected.	without	- Med
		with	- L-Med
Dust			
Movements of vehicles on the gravel roads, especially in the dry season, will generate significant amounts of dust.	Reduced visibility on roads. Decrease in air quality.	without	- Med
		with	- L-Med
Clearing of vegetation and soil erosion			
Clearing the site of soil and vegetation, which exacerbates growth of weeds and carries risks of causing soil erosion.	Loss of soil and the possibility of erosion of dumped material, increased sedimentation into small ephemeral streams, and growth of weeds on disturbed patches.	without	- L-Med
		with	- Low
Loss of protected terrestrial flora. Loss of sensitive habitats during the construction phase: clearing of land.	Death of organisms and destruction of habitat represent permanent loss and degradation at the level of individual animals and small locations. No species is expected to be affected to any meaningful level. The extent of the impact is limited to the project site. Prevention and mitigation are addressed in Section 5.1, Table 5-2 of this EMP.	without	-L-Med
		with	- Low
Fauna			
Noise and activities during construction disturb fauna.		without	- L-Med

Description of Impact	Description of significance	Mitiga-tion	Signifi-cance
	The disturbance of animals in their foraging and movements may increase the risk of mortality. The impact is at the level of individual animals and no significant impact on populations or species is expected. The very small size of the project footprint limits the extent of significance.	with	- Low
Loss of vertebrate fauna (linked to habitat destruction) during construction. There may be attempted snaring and killing of wild animals by construction workers, or they may facilitate such illegal activities by other parties.	Death of organisms and destruction of habitat represent permanent loss and degradation at the level of individual animals and small locations. No species is expected to be affected to any meaningful level. The extent of the impact is limited to the project site.	without	- L-Med
		with	- Low
Soil and water pollution			
Lubricants, fuel and wastewater may contaminate soil and groundwater. Surface water pollution could occur through run-off of polluted water into water bodies and ephemeral drainages. Groundwater pollution could occur through leaching of liquid wastes into the soil and infiltrating into aquifers deeper underground.	Impacts during construction. Groundwater contamination from waste or polluted surface runoff is difficult to clean. Contamination can occur repeatedly during rainy season and accumulate if the source is not removed.	without	- L-Med
		with	- Low
Pollution from waste generation			
Various types of wastes will be generated during construction and operations, including domestic, general, construction and hazardous wastes.	Improper handling, storage and disposal of wastes may lead to environmental degradation/pollution	without	- L-Med
		with	- Low
Water availability			
Reduction in availability of local groundwater resources.	Groundwater over-abstraction can lead to dewatering of local aquifers. A minimal amount of water will be used for domestic purposes only and will be abstracted from an existing borehole. The impact is reversible depending on rainfall and recharge.	without	- Low
		with	- Low
Accidents and emergencies			
Veld fires, project-associated vehicle accidents during the construction phase.	Management and mitigation measures as provided in the EMP should be implemented.	without	- L-Med
		with	- Low
Occupational health and safety			
Injuries occurring during construction activities. Potentially hazardous equipment and activities include working with heavy vehicles, mobile crane, large components of the telescope, earthmoving equipment.	Activities associated with the project can cause accidental injury to the contractors, their employees, and project staff.	without	- Low
		with	-Low
Damage to heritage items			

Description of Impact	Description of significance	Mitiga-tion	Signifi-cance
Construction activities damage or destroy sites or artefacts of cultural significance	The archaeology assessment for this ESIA found no evidence of heritage items at or close to the AMT site	without	- Low
		with	- Low
Cumulative impacts			
Light interference affecting astronomy sites in the wider area	Night lights in the area surrounding the HESS telescopes carry increased risks of light interference, which could negatively impact the operations at HESS.	Without	- High
		With	- L-Med
Deterioration of the C26 road, added dust generation	As developments grow in the area, the C26 road will experience more traffic. This is likely to lead to deterioration of the road surface, and more generation of dust. This could lead to higher vehicle costs for road users, and increased risk of accidents.	without	-L-Med
		With	- Low
Disturbance to fauna, reduction of wildlife, increased incidence of stock theft	Growing number of people in the area, construction teams, vehicle deliveries, communications service providers, and growing numbers of tourist vehicles will add to the impact on wildlife and livestock. Road kills and illegal activities such as poaching are expected to rise. Combined, these are likely to reduce wildlife populations and increase stock losses of local farmers.	Without	- L-Med
		With	- Low
International recognition			
Encourage international funding for scientific projects	The Göllschau AMT will help to prove to international funders that Namibia is a politically stable country for international investment, encouraging funding to move the AMT to Gamsberg.		+ High
International profile of Namibian scientists and academic institutions is raised.	Namibian students and academic staff contribute to the international work of the AMT. This exposure raises the profile of Namibian scientists on the international stage.		
Raising capacity and expertise in Namibia			
Technological advances for Namibian companies	Consulting engineers, entrepreneurs, communication specialists, environmental scientists and other professionals will have the opportunity to build their own capabilities by reacting to the changing technological needs of the project with innovation, design and supply. This benefit will contribute to a stable Namibian economy.		+ Med-High
Academic capacity increases	Academic capacity in the Namibian teaching staff and student body in physical astronomy is increased.		
Educational outreach			
Mobile planetarium	Unam students operate a mobile planetarium at schools and events, where their shows raise awareness and excitement about astronomy in Namibian children and remote communities.		+ Med

5 MANAGEMENT ACTIONS

The management measures for each potential impact that was identified in the Scoping Report and summarised in Chapter 4 are given in this chapter in Table 5-2, Table 5-3, Table 5-4 and Table 5-5. The headings of the tables are discussed here.

Nature of impact

Description of potential risk sources (impacting activities) and the mechanisms through which an impact may occur are described.

Management measures

Management measures are proposed for each identified impact. These measures take the form of specific management actions that aim to avoid, minimise or remedy negative impacts, together with adjustments to respond to unforeseen impacts.

Responsibility

Successful implementation of an EMP relies on defined roles and responsibilities. Radboud University and UNAM have allocated duties to individuals and teams (

Table 5-1), and they are responsible for carrying out the management actions listed in the column “Management” in Tables 5-2 to 5-4.

Table 5-1. Responsible individuals and teams.

Person/Team	Responsibilities
Project Director (Dir) May act as the ECO	Overall responsibility for implementation of EMP. Provide financial and technical resources for the project and implementation of the EMP. Overall management of the project activities and management of the telescope and other infrastructure. Supervision of staff, including the maintenance team. Ensure that training, supervision and provision of equipment to employees are implemented so staff are able to fulfil their tasks. Keep a register of employees and contractor staff who completed site induction. Notify the relevant authorities in the event of a serious environmental incident. Ensure employees, contractors and contractors' staff understand and comply with this EMP. Keep record of environmental complaints and responses from, inter alia, the local community, public, NGOs, academic institutions and government agencies. Liaise with the landowner on issues that affect any activities or people on the property.
Maintenance team (Maint)	Monitor equipment for leaks, damage and general wear and tear. Maintenance of telescope and associated equipment. Report damage or issues to the Director.
Contractors & subcontractors (Contr)	Ensure all their staff are familiar with the provisions in this EMP and how they pertain to each employee's tasks. Implement the measures in this EMP. Adhere to any relevant statutory and legal requirements. Report environmental incidents to the Director. Identify potential risks and report them to the Director
Landowner	Liaise with the relevant parties above for smooth implementation of the project.

Tools / Monitoring

This column refers to actions, equipment, procedures, protocols and/or guidelines that enable the implementation and monitoring of the management actions.

5.1 Construction phase

Table 5-2. Management actions for the construction phase.

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
Light pollution			
Light interference onto the HESS site. From construction and operational activities, and vehicles driving to AMT.	Install locked gates along the access track to prevent vehicles from moving over the hilltop and shining their lights towards the HESS telescopes	Dir, Contr, Land owner	Gates, Locks
	Locate the AMT downhill and north of the access road for optimum position wrt not being visible from C26 road and for maximum visibility of sky.		Location of AMT
	No upward-facing lights to be installed at the AMT. If any outside lights are needed on site, they must be hooded on top and directed downwards.	Dir Contr	Site inspection
	Prohibit traffic at the project site from 15 minutes before sunset until 15 minutes after sunrise.	All	Visual inspections
	Always drive on dim. No spotlights on construction vehicles.	All	Visual inspections
Road deterioration			
Deterioration of local roads. Increased risk of traffic accidents	For as long as there is increased traffic along the C26, and particularly an increase in heavy loads, due to the AMT project, the project should contribute to increased frequency of blading of the road surface that is routinely carried out by Roads Authority (RA).	Contr	Blade the C26 road or facilitate bladings by RA
	All drivers of project vehicles should be in possession of valid and appropriate driving licenses to operate such vehicles and should adhere to standard road safety rules.	Contr	Driving licences
	Project vehicles should be in a roadworthy condition and serviced regularly, so that repairs (with risks of spillages and mess) are not required on site.	Contr	Visual inspections
	No heavy trucks or project-related vehicles should be parked outside the designated project site boundaries.	Contr	Demarcate site boundaries and allocate safe parking area within it.
Dust			
Movements of vehicles on the gravel roads, especially in the dry season, will generate	Dust suppression methods should be applied when and where necessary along the C26 and on site.	Contr	Dust suppression. Visual inspection

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
significant amounts of dust, reducing visibility on the roads, decreasing air quality, and negatively impacting on HESS observations.			
Clearing of vegetation and soil erosion			
Damage to vegetation, and possibility of soil erosion from earth-moving on a sloped surface and stockpiling of soil.	Site levelling and landscaping should only occur where required by the designs, inside the 80x80 m project site and on the access road. No construction activities may take place outside the defined infrastructure footprint areas.	Dir Contr	Approval from Dir
	Preparation and laydown area must be located in an area that is already disturbed, or where development will take place. It should be demarcated.	Dir Contr	Selection of laydown area. Demarcate area.
	If local rocks and sand will be used for construction, they must be sourced from predefined and already impacted areas. These sites must be pre-approved by the land owner and demarcated.	Dir Contr Land owner	Approval. Demarcate sources.
	Separate the topsoil when site clearing begins, and keep this aside for use when the site needs to be rehabilitated. If possible, keep this material on a flattish surface so that it won't be carried downslope by rains. Minimise earth moving to what is required and prevent unnecessary soil disturbance and grading. Wherever trenches or holes mut be dug, this should be done in such a way to minimize the chances of erosion. If any additional fill is required, do not create a new borrow pit on or near the AMT site. If it is suitable for purpose, use the soil that is heaped next to the C26 road close to the Gollschau farmhouse. If a borrow pit needs to be created, it should be as shallow as possible and all the sides should have slopes with a gentle gradient.		
	All project-related vehicles should be limited to existing tracks and defined development areas. No off-road driving is allowed under any circumstances.	Contr	Demarcation of construction areas. Signage. Visual inspections
	Once construction work is completed, all remaining work sites (e.g. laydown areas, temporary construction facilities, construction tracks) must be rehabilitated to a state as close as possible to their pre-construction condition.	Contr	Site inspections

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
Loss of protected terrestrial flora and loss of sensitive habitats when land is cleared	Trees near the site should be clearly marked as untouchable (eg encircled with hazard tape) so they are not accidentally damaged. This is to save any nearby trees which add to the natural beauty of the site, and their roots help hold the soil to prevent erosion.	Dir Contr	Mark trees
	Where tracks need to be upgraded, ensure water is directed away from the track at regular intervals and dispersed into natural vegetated veld so that erosion is prevented.	Dir Contr	Road camber. Mitre drains. Run-off drains on road shoulder.
	Gathering of firewood from the veld should be prohibited. Fuel for cooking should be provided to the construction team at their accommodation place, to deter workers from wandering on the farm for firewood.	Dir Contr	Visual inspections
	Identify and demarcate protected plants within and near the AMT footprint with hazard tape during construction to prevent any damage to them.	Dir Contr	Mark protected plants
	Use only indigenous plant species as part of the landscaping at the site.	Contr	Site inspections
Invasive vegetation causes a decline in habitat quality	Earth-moving machines (e.g. bulldozers, back-actors) should be washed and free of soil remains from the previous job, so they do not carry seeds of problem plants to the new site.	Contr	Site inspections
Landscape disturbance from construction activities	Upon closure of construction, site must be rehabilitated using only indigenous vegetation.	Contr Land owner	Inspection and sign-off by land owner
	Careful management during construction will help with effective rehabilitation when the AMT is moved to the Gamsberg plateau.		
Disturbance to fauna			
Killing of wild animals (e.g. antelope, hares, as well as snakes, tortoises, etc) and livestock. Snakes are particularly vulnerable because they are usually killed on sight.	Movement of vehicles and use of machinery should be restricted to existing roads and tracks, and should be restricted to daylight hours only, to prevent unnecessary disturbance to animals.	Contr	Induction Site inspections
	Movements of people associated with the AMT should be prohibited beyond the AMT access road and footprint. People staying at the construction accommodation should not be allowed to move around unauthorised on the rest of the farm.	Contr	Induction Site inspections
	Snakes should be removed from the site by an experienced person. Staff should be educated in the ecological value of snakes and how to avoid them.	Contr	Induction
Poaching of wildlife. Tortoises and small mammals are particularly vulnerable.	Site personnel should refrain from killing, poaching, snaring or intentionally disturbing any local animals that may be found on and around the site. Any contravention should be	Dir Contr	Induction Site inspections

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
	quickly dealt with, and offenders should be immediately dismissed from site, and charged.		
	The greater area around the site and road should be searched for snares during the construction phase and after construction is complete.	Contr Land owner	Site inspections
	Contractor staff housing should be randomly checked for any signs of poaching, animal parts and/or products.	Contr	Site inspections
	The Proponent should work together with local farmers and anti-poaching units in the area, if they exist, to combat this crime.	Contr Land owner	Site inspections
Soil and water pollution			
Hazardous substances (i.e. wastewater, fuel and lubricants) and other pollutants will be stored, handled and used on site. • Lubricants, fuel and wastewater may contaminate soil and groundwater. • Surface water pollution could occur through run-off of polluted water into water bodies and ephemeral drainages. • Groundwater pollution could occur through leaching of liquid wastes into the soil and infiltrating into aquifers deeper underground. • Accumulation of rainwater and runoff water in borrow pits is expected and could infiltrate underground or overflow and potentially contaminate surface flow.	Proper training of construction workers in the appropriate prevention measures is essential.	Contr	
	The mixing and use of concrete and cement must be only take place in designated areas so as not to contaminate the site.	Contr	Identify and prepare mixing sites.
	Hydrocarbons and chemicals must be stored, handled and dispensed over an impermeable surface and in a manner that prevents spillage and contamination.	Contr	Designated, lined, bunded area. Use of drip trays.
	Any spillage must be contained and cleaned up with 24hrs of occurrence. The resulting waste must be sealed in an appropriate container and taken off site for responsible disposal at a recognised authorised landfill site.	Contr	Spill kits. Drums with sealable lids.
	Portable toilets should be used until the septic tank sanitation system is established. Toilet water should be emptied before reaching capacity and transported to a wastewater treatment facility.	Contr	Portable toilets. Identify disposal facility.
	Effluent from septic tanks and the French drain must be dispersed in such a way that polluted water does not reach aquifers or springs, and it must not be allowed to accumulate on the surface.	Contr	Site inspections
	Washing and servicing of equipment and vehicles should not take place on the AMT site or the farm road.	Contr	Site inspections
	An emergency preparedness plan should be compiled and all personnel appropriately trained.	Contr	Induction. Emergency plan.
Pollution from generation of waste			

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
Various types of wastes will be generated during construction, including domestic, general, construction and hazardous wastes, potentially causing ecological damage including visual pollution, contamination of soil and groundwater, decline in the health of wildlife, mortality of animals that ingest waste, habitat deterioration, etc.	Personnel should be sensitised to dispose of waste in a responsible manner and not to litter. The AMT and accommodation sites should be equipped with different waste bins for each waste type. No waste should be left scattered on site; all should be disposed of in allocated waste bins and thereafter transported to the nearest authorised waste management facility. All waste receptacles should be animal-proofed so the contents are not scavenged or dispersed by animals such as crows and jackals.	Contr	Induction. Site inspections
	All general waste produced on a daily basis should be contained in the holding cage until it is transported to designated waste sites on a weekly basis or as required.	Contr	Holding cage
	A waste holding cage that is bird and animal proof should be used to store solid waste before it is transported to a municipal waste facility.	Contr	Animal-proof containers and cage.
	No burying or burning of waste is allowed on site or anywhere else.	Contr	Site inspection
	All waste that can be recycled should be kept separate and handled so that recycling is achieved.	Contr	Recycling bins and signage for separation of waste types, especially to prevent spoiling of recyclable material
	Building rubble should be consolidated in one, suitable location, removed from the area, and disposed of at an official waste facility.	Contr Land owner	Identify suitable location.
	Hygienic temporary ablutions of sufficient quantity should be provided for workers.	Contr	Site inspections
	Ablutions should be regularly serviced and the sewage disposed of at a designated location and in an environmentally appropriate manner.	Contr Dir	Identify suitable manner and location.
Unpleasant odours	There should be regular monitoring and maintenance of the ablution and sewerage system. The source of any odours should be investigated and rectified within 24 hours.	Contr	Site inspections
Water availability			
Reduction in availability of local groundwater resources.	Water use should be monitored. This requires installation of a water meter for the AMT.	Contr Dir	Water meter
	The designated borehole(s) should be pumped at a rate that is agreed on and managed by the land owner, so that excessive water use or wastage at the AMT site is prevented.	Contr Land owner	Water meter
	Use water saving measures such as flow restricters, taps with automatic shut-off and dual-action toilets.	Contr Dir	Water saving devices

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
Accidents and emergencies			
Bush fires destroy habitats and animals, and present a risk to life and health of humans.	Induction training should be provided for all staff coming to site, with emphasis on work safety and prevention of accidents.	Contr	Induction
	Take precautions to prevent the outbreak and spreading of fires and ensure all employees are aware of the precautions.	Contr	Fire training. Site inspections.
	Adequate firebreaks must be made around the work sites.	Dir Contr Land owner	Site inspection
	Fire extinguishers and other firefighting equipment should be strategically located throughout the work sites, and staff trained in their usage.	Contr	Firefighting equipment. Training.
Project-associated vehicle accidents.	Project vehicles should be in a roadworthy condition and serviced regularly, and drivers should be licenced and trained for their tasks.	Contr	Visual inspections. Job-specific training
	An emergency management and medical evacuation plan should be in place and all employees trained in its procedures.	Contr	Emergency plan. Training.
Occupational Health and Safety			
Injuries to persons occurring during construction activities. Potentially hazardous equipment includes heavy vehicles, mobile crane, large components of the telescope, earthmoving equipment.	There should be full compliance with the Health and Safety Regulations of the Labour Act	Contr	Labour Act (No 11 of 2007) and the Public Health Act (No. 36 of 1919)
	All personnel should be sensitised to the potential health and safety risks associated with their respective site jobs.	Contr	Job-specific training
	First aid kits should be readily available on site and staff trained in how to use the contents. Enough people on site should be trained in medical protocols to deal with an emergency.	Contr	First aid kit. Emergency and med-evac protocol. First aid certificates.
	Appropriate personal protective equipment should be provided to personnel.	Contr	PPE
	Prior to operating and using site machines and equipment, personnel should be trained on how to properly and correctly use these.	Contr	Specialised training
	Heavy vehicle, equipment and fuel storage sites should be properly secured and appropriate warning signage placed where visible.	Contr	Storage. Signage.
	An emergency management and medical evacuation plan should be in place and all employees trained in its procedures.	Contr	Emergency plan. Training.

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
	Train all employees and contractors on environmental awareness, the company's Environmental Health and Safety Policy, and the Environmental Management Plan	Contr	Training
Heritage			
Construction activities damage and/or destroy sites of cultural significance.	Report any find that may be of cultural or archaeological value to the National Heritage Council.	Dir, Contr	Chance find procedure (Section 4.4). Visual inspections
General site management and housekeeping			
Good housekeeping	The contractor and their employees shall adhere to all regulations prescribed by the relevant authority at all times, as well as to the management measures given in this EMP.	Contr	Induction Site inspections
	All employees should be educated about the need to refrain from the destruction of plants and animals, as well as from indiscriminate defecation, waste disposal and pollution of soil and water resources.	Contr	Induction
	The contractor will ensure the proper supervision of employees at all times and their compliance with rules and regulations.	Contr	Site inspections
	Access to the site and accommodation facilities will be restricted to AMT project partners and the contractor's employees only. No visitors will be allowed.	Contr	Site inspections

5.2 Operational phase

Table 5-3. Management actions for the operational phase.

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
Negative impacts			
Light pollution			
Light interference onto the HESS site from operational activities and vehicles driving to AMT.	Any vehicle driving at night should not proceed beyond the locked gate on the track going uphill westwards from the AMT.	All	Visual inspections
	Vehicles going to the AMT should park only at the site designated for parking.		
	Always drive on dim. Spotlights prohibited.	All	Visual inspections
Clearing of vegetation and soil erosion			
Damage to vegetation, leading to a loss of habitat integrity and disruption of ecosystem functions.	All project-related vehicles should be limited to existing tracks and defined development areas. No off-road driving is allowed under any circumstances.	Dir	Visual inspections
	AMT personnel should remain at the AMT site and leave it only under pre-arranged conditions.		
Soil erosion	Regular inspection for any soil erosion on slopes away from the AMT site and access road, especially during the rainy season. Repairs and rock-filling should be implemented on places where gullying starts.	Dir	Site inspections
Fauna			
Killing of amphibians, reptiles, birds, mammals. Snakes are particularly vulnerable because they are usually killed on sight.	Educate employees and visitors to be on the lookout for animals such as snakes and scorpions. Information should be provided on the ecological value of these animals and how to avoid getting bitten or stung.	Dir	Information sheets on site.
	Movements of people associated with the AMT should be prohibited beyond the AMT access road and footprint.	Dir	
	Snakes and scorpions at or in the AMT buildings should be removed by a competent person.	Dir	Training

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
Poaching of wildlife. Tortoises and small mammals are particularly vulnerable.	Site personnel should refrain from killing, poaching, snaring or intentionally disturbing any local animals that may be found on and around the site. Any contravention should be quickly dealt with, and offenders should be immediately dismissed from site, and charged.	Dir	Induction Site inspections
	The Proponent should work together with local farmers and anti-poaching units in the area, if they exist, to combat this crime.	Dir	Site inspections
Soil and water contamination			
Hazardous substances (i.e. wastewater, fuel and lubricants) and other pollutants will be stored, handled and used on site. • Lubricants, fuel and wastewater may contaminate soil and groundwater. • Surface water pollution could occur through run-off of polluted water into water bodies and ephemeral drainages. • Groundwater pollution could occur through leaching of liquid wastes into the soil and infiltrating into aquifers deeper underground.	Hydrocarbons and chemicals must be stored, handled and dispensed over an impermeable surface and in a manner that prevents spillage and contamination.	Dir , Maint	Designated, lined, bunded area. Use of drip trays.
	Any spillage must be contained and cleaned up with 24hrs of occurrence. The resulting waste must be sealed in an appropriate container and taken off site for disposal.	All	Spill kits. Drums with sealable lids.
	Polluted soil must be collected and transported away from the site to an approved and appropriately classified hazardous waste treatment facility.	All	Spill kits. Sealable containers.
	Effluent from septic tanks and the French drain must be dispersed in such a way that polluted water does not reach aquifers or springs, and it must not be allowed to accumulate on the surface.	Dir	Site inspections
Waste management			
Domestic waste will be generated during operations.	Personnel should be sensitised to dispose of waste in a responsible manner and not to litter. The AMT site should be equipped with different waste bins for each waste type. No waste should be left scattered on site; all should be disposed of in allocated waste bins and thereafter transported to the nearest authorised waste management facility. All waste receptacles should be animal-proofed.	All	Induction. Site inspections
	A waste holding cage that is bird and animal proof should be used to store solid waste before it is transported to a municipal waste facility.	Dir	Animal-proof containers and holding cage.
	All general waste produced on a daily basis should be contained in the holding cage until it is transported to designated waste sites on a weekly basis or as required.	Maint	Holding cage
	No burying or burning of waste is allowed on site or anywhere else.	All	Site inspection

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
	The Proponent should recycle all waste that can be recycled.	Dir	Recycling bins and signage for separation of waste types, especially to prevent spoiling of recyclable material
Sewage and human waste	Ablutions should be regularly serviced and the septic tank system regularly inspected, with maintenance and repairs carried out when needed.	Dir	Site inspections, ongoing repairs when necessary
	Continuous monitoring and maintenance of the ablution and sewerage systems. Any odours should be identified and repaired within 24 hours.		Site inspections
Water availability			
Reduction in availability of local groundwater resources.	The borehole(s) should be pumped at a rate that is agreed on and managed by the landowner, so that excessive water use or wastage at the AMT site is prevented.	Dir Land owner	Water meter
	Regular (at least weekly) inspection of pipes and water installations to detect and repair leaks.	Dir Maint	Inspections and upkeep of water saving devices.
Accidents and emergencies			
Bush fires destroy habitats and animals, and present a risk to life and health of humans.	Take precautions to prevent the outbreak and spreading of fires and ensure all employees are aware of the precautions.	All	Induction. Fire training. Site inspections.
	Adequate firebreaks must be made and maintained around the site.	Dir Land owner	Site inspection
	Gas canisters to be housed in Bureau of Standards approved structures.	Dir	Gas enclosures
	Fire extinguishers and other firefighting equipment should be strategically located throughout the site. Staff should be trained in their usage.	Dir	Firefighting equipment with signage. Training.
Project-associated vehicle accidents.	An emergency management and medical evacuation plan is in place and all employees are trained in its procedures.	Dir	Emergency plan. Training.
Occupational Health and Safety			
Injuries to persons occurring during the operational phase.	There should be full compliance with the Labour Act (No 11 of 2007) and its Health and Safety Regulations, and the Public Health Act (No. 36 of 1919)	Dir	

NATURE OF IMPACT	MANAGEMENT	RESPON-SIBILITY	TOOLS/ MONITORING
	An emergency management and medical evacuation plan is in place and employees are trained in its procedures.	Dir	Emergency plan. Training.
	Train employees on environmental awareness, the company's Environmental Health and Safety Policy, and the Environmental Management Plan	Dir	Training
	First aid kit is readily available on site and staff are trained in its usage. Enough people on site are trained in medical protocols to deal with an emergency.	Dir	First aid kit. Emergency and med-evac protocol. First aid certificates.

5.3 Closure and decommissioning

Moving the AMT to the top of the Gamsberg remains an objective for the next 5 – 10 years and is subject to conditions being met, including agreement on the access route from the D1278 road and significant construction work to improve the road to the top of the plateau. Should the road not materialise, the telescope remains at Göllschau for its estimated lifespan of 30 years.

At the time of moving or decommissioning, a decommissioning plan will be drawn up according to environmental management best practices. The priority for closure will be to return the condition of the land as closely as possible to its pre-construction condition, or to a condition that suits the ongoing land-use of the owner. Measures will be taken to prevent soil erosion and provide protection for colonising vegetation. A site assessment will be carried out by the land owner and the proponent after closure to ensure that site rehabilitation has been fully achieved.

There are four primary closure objectives:

1. Protect public health and safety, as well as health and safety of fauna and flora.
2. Alleviate or eliminate environmental damage.
3. Return the site to its original, pre-development condition, or to a condition that suits the ongoing land-use of the owner.
4. Ensure that social and economic benefits are sustainable after closure.

Table 5-4. Decommissioning plan at concept level.

NATURE OF IMPACT	MITIGATION
Infrastructure	
Buildings and support infrastructure	All structures will be completely removed, unless the landowner agrees otherwise in writing. Removing the foundation may cause more environmental damage than leaving it, and it may be left in situ provided the landowner agrees.
Roads and tracks	Access roads and tracks will be left in a state such that they can continue to be used, if so desired, or rehabilitated to a state as close as possible to the original condition of the area.
Vegetation: destruction of & damage to plants; disturbance of soil	
Soil erosion	Any bare land will be suitably re-vegetated. If this is not appropriate, then it should be covered with dead scrub to prevent soil erosion and to provide protection for colonising vegetation.
Alien plant invasion	Follow-ups will be done to clear any alien or invasive plants and weeds that may flourish on disturbed land.
Damage to vegetation	Construction guidelines will apply to ensure limited impact.
Fauna: disturbance to animals and habitat	
Killing and disturbance of animals, poaching, habitat disturbance	Construction guidelines will apply to ensure limited impact.
Soil	
Compaction of and damage to soils, and soil contamination	Construction guidelines will apply to ensure limited impact.

NATURE OF IMPACT	MITIGATION
Water	
Contamination of ground and surface water	Construction guidelines will apply to ensure limited impact.
Negative physical and visual impacts	
Sewerage system	Septic tanks will be drained and removed. The area (including soak-away) will be filled with rubble or with fill from an environmentally acceptable source.
Water pipes	All pipe lines, if not needed for future activities at the site, will be removed from the site.
Electricity lines	All electricity infrastructure, if not needed for future activities at the site, will be removed from the site.
Foundations, concrete slabs, holes in ground	All structures in or on the ground, if not needed for future activities at the site, will be removed. All holes, pits and depressions will be filled.
Ground surface retains signs of development	Any bare ground surface will be levelled as appropriate. Rocks, stones and vegetable matter will be scattered as appropriate to return the ground to a state as close as possible to its original condition.
Construction structures and facilities	Construction site office, facilities and structures to be dismantled and removed once decommissioning is completed.
Waste management	
Large volumes of rubble, materials and equipment	All waste material will be removed from the site. Nothing will be burnt or buried on the site.
Ecological damage	Construction guidelines will apply to ensure limited impact.
Machinery & vehicles: noise, contamination of soil and water by pollutants, erosion	
Noise, contamination of soil and water, erosion	Construction guidelines will apply to ensure limited impact.
Accidents and emergencies	
Outbreak of fire	Construction guidelines will apply to ensure limited impact.
Occupational Health and Safety	
Injury to persons	Construction guidelines will apply to ensure limited impact.
General work site management	
Disruption of ecological processes through physical acts and/or pollution	Construction guidelines will apply to ensure limited impact.

5.4 Heritage chance find procedure

When a heritage site or item of cultural significance is discovered during any phase of the development, it must be reported to the National Heritage Council to ensure compliance with the National Heritage Act (27 of 2004), section 55: “a person who discovers any archaeological object must as soon as practicable report the discovery to the Council”.

The process to follow when a potential heritage item is found, whether by a contractor, employee or visitor, is provided in Table 5-5.

Table 5-5: Heritage chance find procedure

Person	Actions
1. Responsibilities	
Finder	The person who discovers archaeological or heritage items
Supervisor	Secure site and advise management
Project Director	Report finding to NHC. Determine safe working boundaries
Archaeologist	Inspect, identify, advise management, and recover the items
2. Actions	
Finder	If operating machinery or equipment, stop work
	Demarcate the site
	Take GPS coordinates if possible
	Report findings to supervisor
Supervisor	Report findings, site location and actions taken to Director
	Cease any works in immediate vicinity
Project Director	Visit site and determine whether work can proceed without damage to findings
	Determine and mark exclusion boundary
	Site location and details to be added to Archaeological Heritage Geographical Information System (GIS) for field confirmation by archaeologist
Archaeologist	Inspect site and confirm addition to GIS
	Advise NHC and request written permission to remove findings from work area
	Recovery, packaging, and labelling of findings for transfer to National Museum
3. Discovery of human remains	
	Actions as above
	Advise and liaise with NHC and Police
	Recovery of remains and removal to National Museum or National Forensic Laboratory, as directed by the police and NHC

6 MONITORING

This EMP can only provide value in preventing and managing potential impacts if the proponent implements it. Compliance with the EMP must be monitored regularly, and adaptive management applied based on the results of monitoring. This information must be reported to MEFT as a basis for renewal of the ECC when that becomes due (every 3 years).

Table 6-1: Aspects to monitor

Component	Measurable aspect	Frequency	Responsibility
Lighting	Sufficient measures implemented to prevent light interference from AMT at HESS	- Ongoing during construction and decommissioning. - Quarterly during operations	Project Leader, Contractor
C26 road condition and dust	- Decent road surface quality, not badly degraded by AMT-related traffic. - Dust generation adequately suppressed for road safety.	Weekly during construction and decommissioning.	Contractor
Site preparation and clearing of vegetation	- Site limits adequately demarcated so that footprint is not expanded beyond that. - Source areas for any local resources (eg borrow pit, rocks) adequately demarcated. - Trees at and around the site not unnecessarily damaged	Weekly during construction and decommissioning.	Contractor, in collaboration with landowner.
Soil protection	- Separate top soil during site clearing, keep it aside on a level surface in preparation for decommissioning phase. Ensure it is not eroding away from heavy rainfall and winds. - Check for gullying and erosion along the access roads and at site. Make repairs and prevention measures when necessary.	- Weekly during construction and decommissioning. Monthly + after every rainfall event	Contractor, in collaboration with landowner.
Disturbance to local fauna	- Induction given on minimising disturbance to animals such as snakes, tortoises, birds, local wildlife.	- At start of construction, when team moves onto site.	Contractor, in collaboration with landowner.

Component	Measurable aspect	Frequency	Responsibility
	- Random inspections of work site and construction camp to be vigilant for any evidence of poaching. - Immediate and firm discipline of anyone caught being involved in snaring, poaching or any other disturbance of animals.	- Weekly during construction and decommissioning.	
Preventing pollution to soil and groundwater. Waste management	- Induction given on housekeeping measures for appropriate handling of polluting and hazardous substances (e.g. cement, fuels and oils), preventing spillages, cleaning up when they occur. - Adequate and appropriate disposal bins and clean-up kits on site. - Adequate separation of waste to prevent contamination of one type of waste by another; particularly to prevent spoiling of recyclable waste. - Regular removal of waste to appropriate disposal sites.	- At start of construction, when team moves onto site. - Weekly during construction and decommissioning. - Monthly during operations.	Contractor during construction. Project leader during operations.
Preventing pollution from human waste and sewage	- Adequate toilet facilities on site during construction. - Septic tank and sanitation system installed and kept functional.	- Weekly during construction and decommissioning. - Monthly during operations.	Contractor Project leader
Sustainable use of groundwater	- Water meter installed at supply borehole, and kept operational to record volumes used by AMT. Meter readings recorded. - Water-saving installations in place and kept functional on site.	- Weekly during construction and decommissioning. - Monthly during operations.	Contractor, in collaboration with landowner. Project leader, in collaboration with landowner.
Emergencies, preventing accidents	- Induction given on measures for preventing fires and general accidents, and on First Aid precautions. - Appropriate firefighting equipment in place and kept functional. - First Aid kits in place and kept functional.	- At start of construction, when team moves onto site. - Weekly during construction and decommissioning.	Contractor during construction. Project leader during operations.

Component	Measurable aspect	Frequency	Responsibility
		- Monthly during operations.	
Occupational health and safety	- Induction given on measures for workplace safety. - Appropriate PPE provided and used appropriately.	- At start of construction, when team moves onto site. - Weekly during construction and decommissioning.	

7 CONCLUSIONS

This Environmental Management Plan describes the management measures that can prevent or mitigate negative environmental impacts and enhance positive impacts that may result from the construction and operation of the telescope. The EMP will be implemented throughout the lifetime of the AMT at Göllschau, including decommissioning when that becomes necessary.

No fatal flaw was identified, and all potential impacts can be either prevented or mitigated to a low or low-medium significance by implementing the measures in this EMP.