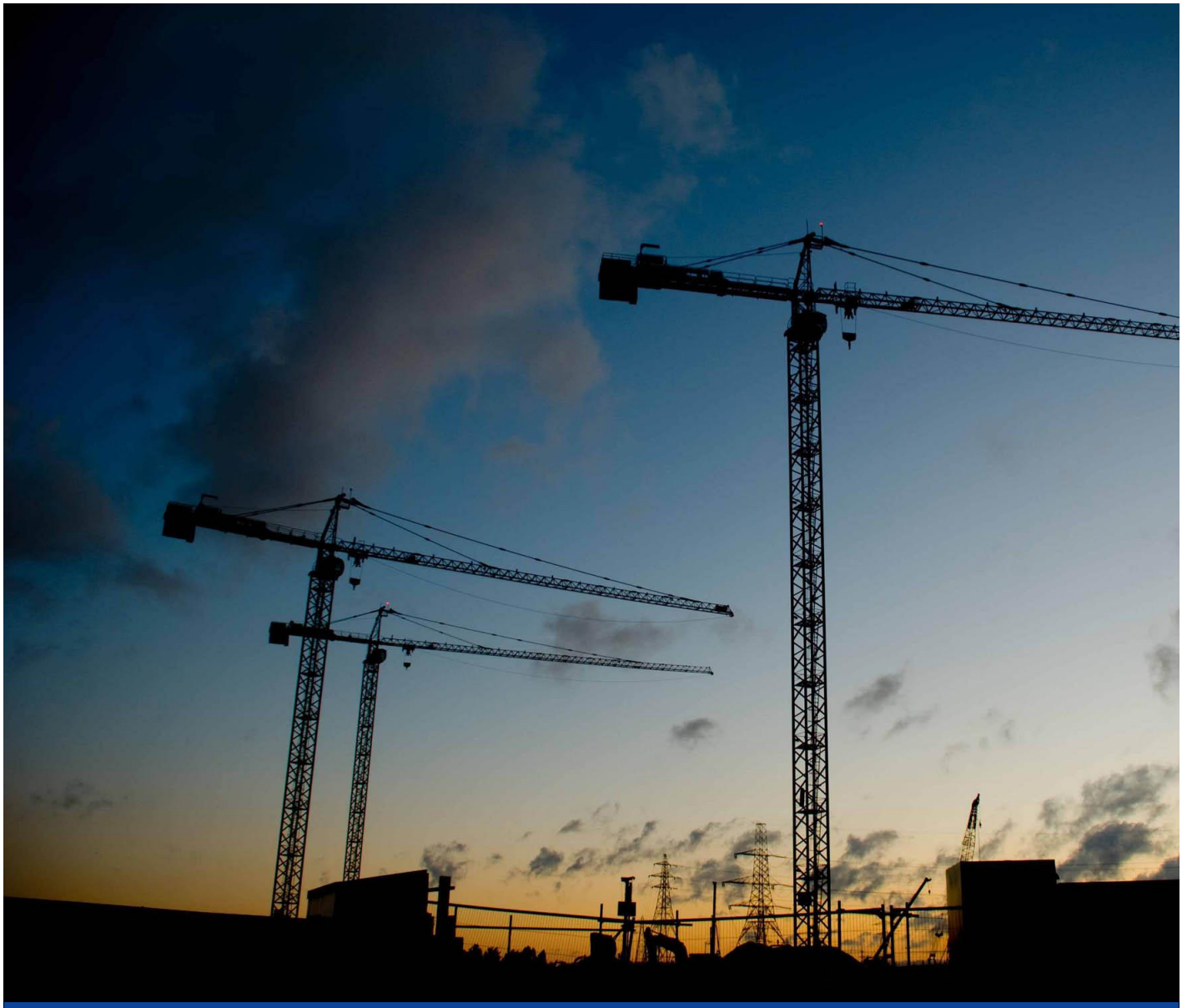

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WSP

PREFEASIBILITY STUDY FOR BIOMASS POWER PLANT, NAMIBIA

ENVIRONMENTAL SCREENING REPORT

31/07/2012

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PREFEASIBILITY STUDY FOR BIOMASS POWER PLANT, NAMIBIA

ENVIRONMENTAL SCREENING REPORT

31/07/2012

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Executive Summary

Introduction

This report presents a review of the environmental aspects associated with the proposed Encroacher Bush to Power (EBtP) project. A number of scenarios and technologies have been identified, comprising:

- Scenario 1: A 5 MW biomass combustion power plant located near Otjiwarongo, in partnership with the Cheetah Conservation Fund (CCF);
- Scenario 2a/2b: A 20 MW biomass combustion facility located at Ohorongo Cement, in partnership with Schwenk;
- Scenario 2c/2d: A 20 MW biomass combustion facility located at Otjikoto Substation; and
- Scenario 3: A torrefaction facility and co-firing at Van Eck power station (where NamPower is the client of a private sector torrefaction developer).

Each scenario involves a different physical location, different technology or power plant size, and different harvesting approach, which has added substantial complexity to the environmental screening process.

The approach has been to assess the project in terms of the Equator Principles, relevant Namibian environmental legislation and International Finance Corporation (IFC) environmental guidelines.

Findings

The environmental screening process has identified that Scenarios 1 and 2 will trigger an Environmental Impact Assessment (EIA) under Namibian legislation, both for the power plant facilities as well as for the harvesting component. For Scenario 3, it is not entirely clear as to whether a commercial scale torrefaction facility will trigger any Namibian EIA clauses; however the harvesting component will nevertheless require an EIA to be undertaken.

No obvious “fatal” flaws have been identified in terms of successfully obtaining EIA approval under either Namibian or IFC standards.

Water: All scenarios demonstrate relatively low demand for water (due to the selection of air cooled technology for the EBtP combustion plants) and Scenarios 1 and 2 (where the proposed locations are reasonably well known) are located in areas which should be able to meet the water demand through the use of treated groundwater or possibly even municipal supply. Scenarios 2a/2b would be expected to have the easiest route to water availability via the already installed groundwater boreholes at the cement plant (the water requirements would be expected to add around 10% onto the cement facility’s existing water demand).

Through the debushing activities, the project would be expected to have a net positive impact (not quantified as part of this study) on water resources in Namibia, provided that the debushed land remains clear.

Air Quality: Technical modelling indicates that air emissions are expected to meet World Health Organisation (WHO) guidelines for combustion plant air emissions. However, it is noted that baseline air quality data may not be available for any of the proposed locations, and there is a distinct possibility that baseline air quality data would be required for meeting IFC assessment specifications. While obtaining baseline data should not present any technical challenges, a lengthened environmental assessment lead time to obtain the baseline data (one years’ worth of continuous air quality data is required as per IFC assessment guidelines). It has been noted that NamPower would like to commission a power plant by 2017.

Biodiversity: There is some debate regarding whether debushing can really be justified on the basis of improving the ecological value of the land and returning it to a more “natural” state. However, it does appear to be broadly accepted that the encroacher bush phenomenon is largely due to anthropogenic influence (over-grazing, reduced soil fertility, parcelling of Savannah land into discrete farms and limiting movement of game etc.) and that it would be preferable to debush much of the land to return it to a mixed woodland-Savannah landscape. The CCF, for example, promotes debushing as part of its activities to improve cheetah habitat. It is

also noted that there is a precedent for approving an EIA for debushing, namely for the Energy For Future (EFF) harvesting operation associated with Ohorongo Cement. Hence, biodiversity issues are not considered to present a significant obstacle for environmental authorisation.

It should be notes that the biodiversity benefits will differ depending on the harvesting technique adopted. The EFF approach involves clear cutting most bushes but leaving tree "islands" to create an acceptable mix of grassland and bush. This is considered an acceptable approach. However, the CCF approach is considered to be more selective and involves a genuine "thinning" of the bush, resulting in a far more natural Savannah landscape. CCF is confident that by adopting a more sustainable approach, they can obtain an EIA with far fewer conditions than the EFF EIA.

Waste: All scenarios result in the production of relatively benign and small (by industrial standards) quantities of waste. A small amount of hazardous waste will be produced by the combustion plants, however the majority of waste will comprise post-combustion ash mixed with some lime and some other inputs. Waste management options include re-using the ash waste as a land amendment (i.e. fertilizer), re-using it as an input into building materials (ash bricks etc.), disposing of it to a nearby (non-hazardous) landfill, or building an on-site disposal facility to store the waste. For Scenario 2a/2b the ash could most probably be used as an input into the cement process (this was indicated as acceptable in principle by Ohorongo Cement) which would result in a zero waste outcome (in terms of ash).

Various other aspects have also been evaluated (visual impacts, heritage, health & safety etc.) however none are considered to present serious difficulties.

Summary of Likely Environmental Permits

A summary of the environmental permits required for each scenario is shown in the table below:

Aspect	Permit Type	Scenario 1	Scenario 2a	Scenario 2b	Scenario 2c	Scenario 2d
Water Usage	Water Abstraction Permit	Possible	Yes[1]; application submitted with EIA technical report	Yes; application submitted with EIA technical report	Yes; application submitted with EIA technical report	Yes; application submitted with EIA technical report
Water Discharge	Water Discharge Permit	Very unlikely (no discharge anticipated)	Very unlikely (no discharge anticipated)	Very unlikely (no discharge anticipated)	Very unlikely (no discharge anticipated)	Very unlikely (no discharge anticipated)
Forestry	Harvesting Permit	Yes, CCF to obtain	Yes	Yes	Yes	Yes
	Transportation permit	Yes, CCF to obtain	Yes	Yes	Yes	Yes
Air quality	Air Pollution Permit	Permit no longer enforced, therefore, notification of department would be best practice.	Permit no longer enforced, therefore, notification of department would be best practice.	Permit no longer enforced, therefore, notification of department would be best practice.	Permit no longer enforced, therefore, notification of department would be best practice.	Permit no longer enforced, therefore, notification of department would be best practice.
Indicative cost of permitting applications		***~ N$ 40,000 – 50,000***				

[1] Possible extension of existing permit at Ohorongo Cement

Other requirements may also exist, for example, in relation to the storage of the woodchip material which may require a Major Hazard Installation risk assessment (in relation to fire risk etc.).

Impact on Timelines and Project Costs

The impact of the environmental authorisation process is summarised in the table below:

Indicative Timeframe (Namibian EIA)	~ 0.8 Months - 1 year
Indicative Cost (Namibian EIA)	~1,500,000 – 2,500,000 N$
Indicative Timeframe (IFC EIA)	~ 1 – 1.5 years
Indicative Cost (IFC EIA Process)	~1,800,000 – 3,500,000 N$[2]

While the costs are modest in terms of the overall project investment, the impact on timelines is of greater significance. NamPower has indicated a strong preference for having a power plant commissioned by 2017. In view of the fact that an IFC compliant EIA is likely to be required (due to the involvement of international development agency funding), **this means that the EIA process should start as soon as possible**.

In this regard, an environmental consultant (i.e. an Environmental Assessment Practitioner – EAP) should be formally appointed as soon as possible in order to:

- Undertake early consultation with the Namibian authorities;
- Determine availability of baseline data:
  - Air Quality – one year continuous baseline air quality monitoring data for all major emission parameters. Please note that installation of air quality monitoring stations may be required if this is not available and this can result in considerable expense (~N$ 350,000). It is noted that as far as WSP is aware, no baseline air quality data is available at any of the sites being considered, although data from a nearby source may prove to be acceptable (once identified).
  - Biodiversity – one year seasonal biodiversity monitoring. If this data is not available a biodiversity assessment will be required.
  - Geohydrology – Annual wet and dry season borehole monitoring data, borehole monitoring may be required.
- Liaison with design team engineers to ensure that design meets IFC guideline specifications ;
- Development of a detailed stakeholder engagement resister for consultation process required as part of the EIA; and
- Liaise with various departments identified regarding future permitting requirements, and the potential to extend existing forestry and water abstraction permits where possible.

[2] The most expensive elements are expected to be geohydrological studies (geophysics, well drilling and pump testing) and, for the IFC option, air quality monitoring. Figures are indicative only.

1 Introduction

The development of a renewable energy project in Namibia has the potential to provide the country with a number of environmental and social opportunities, including climate change mitigation, improved resilience to climate change (i.e. climate change adaptation), job creation and, in the case of the Encroacher Bush to Power Plant (EBtP), a boost to the rural economy. Conversely, the EBtP Project, if not effectually managed, also presents a number of potential risks to the natural and social environment. The most effective time to identify and respond to such opportunities and risks is during the early project design phase. By ensuring that all potential environmental and social impacts (both positive and negative) are identified early on policies and management plans can be developed to ensure the most gain is achieved and risks mitigated throughout the project's lifecycle.

WSP Environment & Energy (WSP) has been appointed by NamPower to undertake a Prefeasibility Study focused on the use of encroacher bush as a biomass feedstock for electricity generation. This document is one of several inter-related reports undertaken by WSP for the EBtP Pre-Feasibility Study. The objective of the pre-feasibility study is to undertake an initial analysis of all aspects of the renewable energy opportunity including the identification of possible sites for the positioning of EBtP plants, undertaking preliminary investigations into suitable supply chain and technological solutions as well as providing stakeholders (from the energy sector to potential investors and developers) with a clear indication of further requirements in developing such projects. The Prefeasibility Study covers key technical, economic, financial, social and environmental aspects of the proposed EBtP Project, including the associated supply chain. Reference should be made to the companion reports for further details.

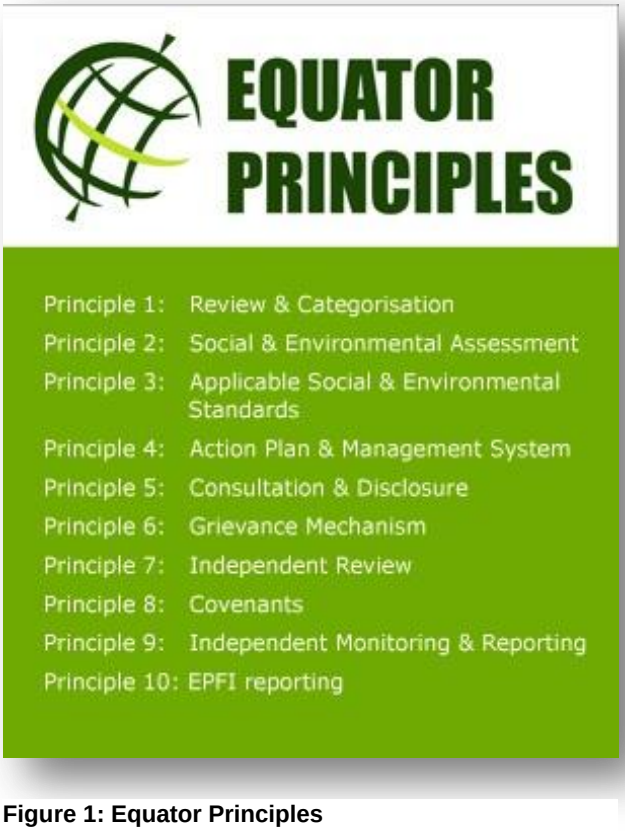

Figure 1: Equator Principles

1.1 International Financing

The international funding community has long since realised the potential associated with early impact identification followed by structured and continuous management. Driven by the need to ensure that environmental and social sustainability criteria is incorporated throughout an investments projects life, and not just during the development phase, leaders in the banking community developed a banking industry framework for addressing environmental and social risks in project financing that could be applied globally and across all industry sectors. The principles developed, known as the Equator Principles (Figure 1), are based on the International Finance Corporation (IFC) Performance Standards on Social and Environmental Sustainability and on the World Bank Group Environmental, Heath, and Safety Guidelines (EHS Guidelines). All projects where total project capital costs exceed US$10 million are required to apply the Principles.

1.2 EBtP and Sustainability

Being in the early investigative stages, it has not yet been confirmed whether NamPower will seek support from a funding organisation for the EBtP project. However, the assumption has been made that such funding will be sought for at least some portion of project financing To this end every effort will be made to adhere to the 10 Equator Principles, as well as its founding documentation.

1.2.1 Project Review

Following guidance provided by the Equator Principles, IFC Performance Standards and the EHS Guidelines a project should be subjected to a social and environmental review early on in the projects lifecycle. The objective of this review being to allow for environmental and social considerations to be incorporated into the site selection process, product design process, engineering planning process for capital requests, engineering work orders, facility modification authorisations, and layout and process change plans.

Consequently an environmental and a social screening of the EBtP Project has been undertaken as part of the prefeasibility study. The screenings form the foundation for the projects sustainability framework and provide project developers with a clear understanding of the environmental and regulatory requirements associated with the project. The Social Screening is provided as an addendum to the main report in Appendix D.

2 Environmental Screening

2.1 Scope of Screening

To assess the environmental impacts, risks and opportunities of the proposed project an Environmental Screening has been undertaken with the aim to provide the project team with a clear indication of the environmental impacts and permitting requirements of the various locations, technologies and supply chain components of the proposed scenarios. The scenarios utilised in the study are formed on the basis of an initial post-inception study and subsequent site visit by the technical team on the 11 – 15th June.

The scope of the Environmental Screening included:

- A high-level assessment of potential environmental risks and opportunities associated with the technology and supply chain alternatives (Section 4);
- Baseline assessments of the proposed power plant sites, comprising the identification of environmental constraints and potential specialist study requirements (Section 5); and
- A review of relevant national and international environmental legislation and best practice pertaining to the supply chain and technology alternatives, and providing details regarding prospective authorisation requirements (Section 6).

2.1.1 Screening Methodology

The contents of the screening report are based upon a desktop review of available literature, as well as meetings and site visits undertaken during an in-country visit (4 – 8th June 2012) carried out by the environmental project team. A summary of the engagement carried out as part of the process is provided in Table 1.

Table 1: Stakeholder's informing the environmental screening study

Name	Query	Form of Interaction
Joseph Hailwa, Director Forestry, Ministry of Agriculture, Water and Forestry (MAWF).	■ Forestry permitting processes	■ Meeting
Leon Lubbe, MAWF (Forestry Research)	■ Impacts of bush harvesting	■ Meeting
Gerald De Waal, MAWF (water permitting)	■ Water permitting	■ Meeting
Teo Ngithila, Director Ministry of	■ Confirmation of EIA requirements	■ Meeting

Environment & Tourism (MET)	and Namibian processes.	
Gershon Ben Tovim, Green Coal	■ Torrefaction site visit	■ Meeting, site visit
Dr Bruce Brewer, Cheetah Conservation Fund	■ Harvesting impacts	■ Meeting, site visit
Kuande Utale, Otavi Town Council	■ Social Impact Assessment	■ Meeting
A Benjamin CEO Tsumeb Town Council	■ Social Impact Assessment	■ Telephone interview
Hugo Rust & Jomo Shikogo, WDH Municipality Department of Planning	■ Planning permissions/ town planning	■ Meeting
Piet Heyns, Former Head of Department at Department of Water Affairs	■ Groundwater supply, legal and practical considerations	■ Meeting
Ms Sibanda, Ministry of Ag. Water and Forestry – water planning	■ Further information on Subterranean Water Control Areas.	■ Passed query on to colleagues.
Dr Harald Koch, Director of MAWF	■ Query relating to The Tsumeb Ground water study	■ No Response
Franz Uirab	■ Query relating to availability of climatic data for study areas (wind data, hourly)	■ Able to provide 10 year hourly wind data for Grootfontien.
Aina Mutota Ileka, Chief Hydrogeologist: Groundwater Management, MAWF	■ Attempt to obtain Tsumeb Groundwater Study.	■ Not successful, issue not closed.

3 Project Scenarios

As part of the Prefeasibility Study a high-level alternatives assessment has been carried out in order to limit the potential project alternatives to those sites that are viewed by the project team as the most viable. As a result of this assessment five alternatives have been identified, namely Scenario 1, Scenario 2a, Scenario 2b, Scenario 2c, Scenario 2d and Scenario 3. As Scenarios 2a to 2d only differ in a few characteristics they are not viewed as completely separate alternatives. Table 2 provides a summary of the parameters included in the assessment as well as the parameters included in each scenario.

3.1 Scenario 1

Alternative 1 involves the initial development of a small scale direct combustion facility (5MW) incorporating **grate boiler technology**. The supply chain is characterised by a partnership between NamPower and the Cheetah Conservation Fund (CCF) who have indicated a willingness to sign a supply contract.

3.1.1 Cooperating Organisation

In 2001, the CCF and the United States Agency for International Development (USAID) collaborated to find a habitat improvement programme that would be ecologically and economically viable. Research identified a business opportunity to process encroaching bush into compacted fuel logs for use as a cooking fuel or for home heating. CCF Bush (PTY) Ltd. was established to manufacture the Bushblok product.

The CCF operation is currently a very small operation, harvesting around 10 tonne of biomass wood per day. The project team has consulted with Dr Bruce Brewer, head of Bushblok, who has indicated that the company would be interested in developing a supply partnership with NamPower. CCF currently has approximately 45 000 ha of encroached land under its control and the opportunity to expand into a further 45 000ha.

3.1.2 Supply Chain

The supply chain that will be adopted by this alternative is illustrated in Figure 3. CCF will be responsible Harvesting and potentially also transportation of biomass (represented in green), dependant on the final supply contracts.

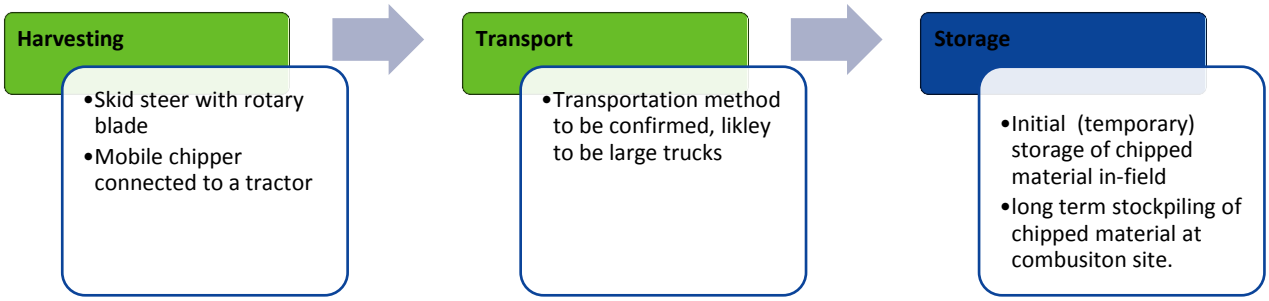

Figure 2: Scenario 1 supply chain

3.1.3 Conversion Technology

Since large-scale harvesting by CCF is un-tested and therefore riskier from a commercial perspective, the concept would be to develop a small scale facility (2-5MW) utilising **fluidised bed technology**, with the potential to increase this capacity with a series of modular units, potentially to a maximum of 20MW in the future.

Fluidised bed furnaces are the newest furnace technology, although the technology has been widely used for several decades. The furnace bed consists of particles of sand and limestone or other inert materials. These furnace bed materials are fluidised (suspended) by high-velocity high-temperature air, and the fuel is injected into the turbulent mixture. Fluidised bed combustors can be classified as bubbling fluidised bed (BFB) or circulating fluidised bed (CFB), depending on the air velocity. CFB combustors operate at high enough air velocities that the bed material is carried out of the combustion chamber with the hot gases and must be circulated back into the combustion chamber through cyclone separators.

Fluidised bed furnaces are able to achieve among the highest thermal conversion efficiencies of any boiler technology due to higher fuel combustion efficiency, and have the advantage of being able to handle a wide range of fuels and moisture content (Beck, 2003).

3.1.4 Site Location

The exact combustion site has yet to be determined but would likely fall within the industrial area of Otjiwarongo, or be placed near to/immediately adjacent to the Otjiwarongo substation. The harvesting operations would be based at CCF approximately 40km to the east of the town. See Section 5 for details on baseline conditions associated with the site locations.

Table 2 Summary of biomass to power scenarios

Parameters			Scenario					
Stage	**Component**	**Variations**	**1**	**2a**	**2b**	**2c**	**2d**	**3**
			Otjiwarongo	**Ohorongo Cement**	**Ohorongo Cement**	**Otjikoto**	**Otjikoto**	**Omaruru**
Cooperating Institutions		■ Cheetah Conservation Fund	X					
		■ Energy for Future		X	X			
		■ Green Coal						X
		■ None					X	
Supply Chain	Harvesting	■ Cutter-Chipper		X	X			
		■ Skid Steer	X					
		■ Motor Manual						
	Transport	■ Tractor and trailer						
		■ Lorry	X					
		■ Skidloader						
	Storage & Handling	■ In-field storage & handling	X	X	X		X	X
		■ On-site storage & handling	X	X	X		X	X
Treatment		■ Torrefaction						X
		■ None	X	X	X		X	
Conversion		■ Fluidised bed			X		X	
		■ Grate Boiler	X	X		X		
		■ Co-firing at Van Eck						X
Capacity		■ 5 MW	X					
		■ 2 x 10MW		X	X		X	

3.2 Scenario 2

Alternative 2 involves a modular approach of 2 x 10MW (20MW output) combustion units. Three variations involving the supply chain management and technology have been proposed.

3.2.1 Cooperating Organisation

- **Variations 2a and 2b**

Ohorongo Cement is currently operating the only large-scale encroacher bush to energy operation within Namibia. The bush is harvested as a means to fire the operation's cement kilns. The harvesting operations supplying Ohorongo Cement are managed by the company Energy for the Future (EFF), a wholly owned subsidiary of Schwenk Zement KG, the majority owner and operator of Ohorongo Cement.

Initial consultations with Schwenk and EFF have indicated that the company would potentially be amenable to NamPower becoming a risk sharing partner in the expansion of existing harvesting operations by EFF. Schwenk has proposed a commercial arrangement entailing the establishment of a new company, "EFF2", to supply the proposed EBtP Plant.

- **Variation 2c and 2d**

In this variation of Scenario 2 no cooperative agreements will be entered into with EFF. NamPower will manage the process itself or find alternative partners.

3.2.2 Supply Chain

All three of the variations included under Scenario 2 will make use of the same technology in order to provide the EBtP Plant with wood chips (Figure 4).

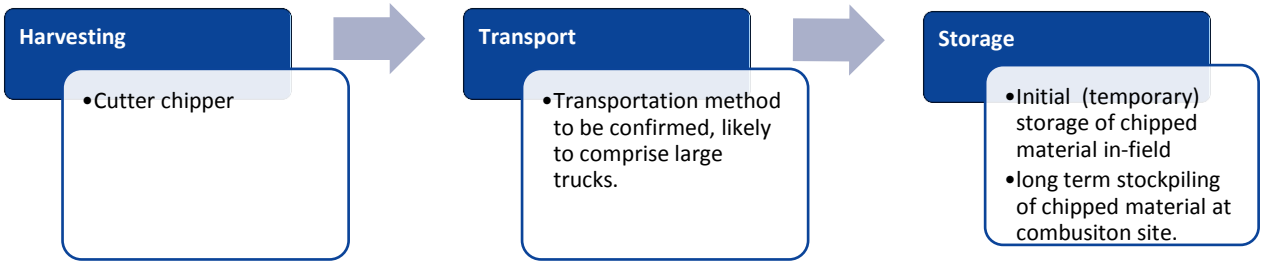

Figure 3: Scenario 2 supply chain

3.2.3 Conversion Technology

- **Variation 2a and 2d**

Stoker furnace technology is proposed as the technology option to be considered as part of variation 2a. Stoker (grate) furnaces have traditionally dominated the biomass combustion industry due to their proven track record and lower construction and maintenance costs which can offset the possible incremental gains from fluidised bed technology (Beck, 2003).

Stoker-fired furnaces can have sloping fixed grates, traveling grates, or vibrating grates. Fixed sloping grates are the simplest design, but have the least amount of fuel control. Traveling grates provide an improvement in fuel control, but have higher maintenance due to the moving parts. Vibrating grates, sometimes called "reciprocating grates," are very common in modern biomass combustion facilities. Of all the stoker designs, vibrating grates can handle the greatest variations in fuel types and mixtures, fuel size, and moisture content.

- **Variations 2b and 2c**

Variations 2b and 2c will make use of the **fluidised bed furnace** technology as described in Scenario 1. For all variation in Scenario 2 a modular approach of 2 x 10 MW (total output 20 MW) combustion units is proposed.

3.2.4 Site Location

- **Variations 2a and 2b**

Schwenk has indicated that the construction of the EBtP Plant directly adjacent to the kiln on the Ohorongo Cement property may be a viable option. This alternative would have the added advantage of waste heat produced from the kiln being utilised within the combustion process to improve the process efficiency.

- **Variation 2c and 2d**

An alternative to constructing the EBtP Plant at the Ohorongo Cement facility is to position the plant at the Otjikoto Substation, approximately 42 km north of the cement facility, and 7km to the west of Tsumeb. An exact site footprint has not been established for the facility as yet, but is likely to be as close to the substation as possible.

3.3 Scenario 3

Alternative 3 involves the supply of torrefied biomass to be co-fired with coal at the Van Eck coal fired power station in Windhoek. This scenario involves entering into a supply contract with Green Coal, a company currently producing torrefied pellets on a pilot scale in Namibia. It is envisaged that around 50,000 tonnes of torrefied experience can be provided to Van Eck for a proposed full-scale facility (and assuming two thirds off-take agreement).

3.3.1 Cooperating Organisation

Green Coal, a relatively new venture, specialises in the production of torrefied wood pellets and briquettes from encroacher bush. The company currently only has a pilot plant in operation but has carried out tests in collaboration with NamPower to determine the feasibility of utilising torrefied biomass in the boilers at Van Eck Power Station.

3.3.2 Supply Chain

Obtaining torrefied biomass on a contractual basis from Green Coal will reduce NamPower's control on supply chain parameters upstream of the treatment process. The supply chain scenario illustrated in Figure 4 is based on the process currently being undertaken by Green Coal. Green-shaded segments represent activities falling within Green Coal's area of control (with transport also potentially being under Green Coal's control).

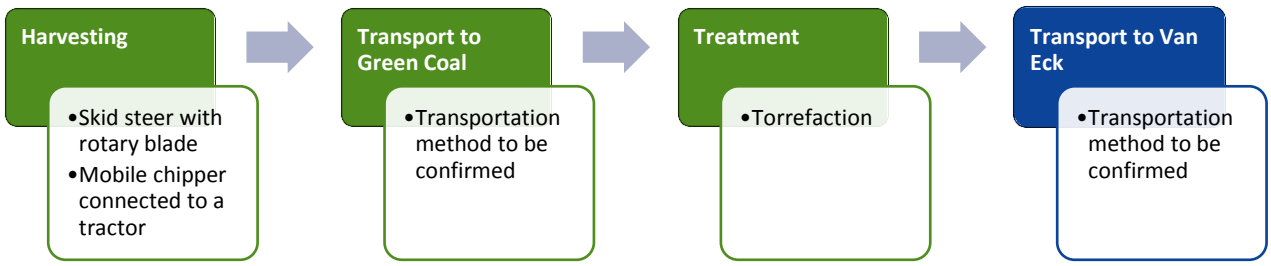

Figure 4: Scenario 3 supply chain

3.3.3 Treatment & Conversion Technology

Torrefaction involves the initial drying of unprocessed biomass followed by exposure to temperatures typically in the region of 200 – 300°C (Green Coal uses a slightly higher temperature). The heat serves to removes the majority of the water as well as drive off volatile compounds. The resulting biomass typically retains around 90% of the input energy, but is very dry, hydrophobic, highly friable and with a significantly greater energy density than the input material. The material exits the torrefier in the form of chips or powder, but is usually reformed into pellets prior to delivery to the customer. The scenario aims to (ultimately) supply up to 40% of the total energy for Van Eck from torrefied pellets, accounting for approximately 50 - 60MW energy. However this will not be achieved with only a single full-scale plant.

3.3.4 Site Location

The positioning of the harvesting operation and the greenfield torrefaction facility is currently not known. Green Coal's existing torrefaction facility is situated 30km west of Omaruru.

4 Technology Environmental Impact Screening

To ensure environmental sustainability criteria is incorporated within all stages and phases of the EBtP project a screening of potential environmental impacts associated with the technology alternatives was undertaken. This section outlines potential environmental impacts, applicable during project development, operation and decommissioning phases, associated with the following activities:

- Harvesting;
- Transport;
- Storage and Handling; and
- Combustion.

4.1 Harvesting

The harvesting stage of the proposed EBtP project has the potential to be one of the most environmentally detrimental stages of the project process if the impacts are not managed appropriately. To ensure that all potential positive and negative impacts were identified, the impacts of harvesting techniques currently being carried out in Namibia have been investigated (details of the case studies investigated are provided in Box 1).

For the harvesting process, only the "operational" element is considered to be relevant. The environmental impacts likely to be experienced during the "operational phase" are summarised in Table 3. An analysis of the potential impacts and mitigation techniques is provided in Table 4.

Table 3. Summary of the potential for impacts to occur during Harvesting phases (+ denotes positive impacts; - denotes negative impacts)

Parameters	Operation	
	+	-
Soil		✓
Biodiversity	✓	✓
Water Resources	✓	✓
Health & Safety		✓

Case Study 1:

The Cheetah Conservation Fund

The Cheetah Conservation Fund (CCF) is currently operating a small, FSC certified, encroacher bush harvesting project from which they produce a biomass briquette for commercial purposes.

The harvesting technique employed by the CCF involves a mixture of mechanical (skid steer) and manual harvesting. Harvesting is carried out using a thinning technique, where mature trees (as well as protected species) are left standing creating a natural savannah type matrix. The technique involves in field supervision. Trees with a trunk circumference of approximately 40cm are left standing as these provide valuable shade and habitat for various faunal and avian species. Cleared areas are treated with the arboricide, 'Access', which reportedly prevents 90% of regrowth from occurring.

Figure 4: Area cleared by CCF 7 years prior

Concerns were raised with both manual and mechanised harvesting techniques. Manual harvesting involves large numbers of labour entering the field resulting in disturbance to the natural habitat, including littering and increased chance of injury from the machinery. Skid steer harvesters are reportedly advantageous due to their easy manoeuvrability. The machinery, however if used insensitively (i.e. when driven too fast) can result in disturbance to the topsoil. Therefore strict speed limitations

Case Study 2:

Ohorongo Cement

Ohoronogo Cement operates an industrial scale harvesting project, managed by EFF, utilising eight large cutter chippers, generating around 10,000 tonnes each per month. The scale and utilisation rate of the bush is much greater in this operation compared to the CCF operation.

Private farms are harvested following an "Island" technique which involves leaving long strip islands or stands of bush. The approach is less selective and it is accepted that some protected tree species are lost. The approach is however accepted by the Forestry department as a recognised forestry technique.

Figure 5: Recently cleared area by EFF

In this approach the landowners (farmers) pay for the benefit of having bush removed by EFF and aftercare is carried out at the farmer's discretion. Evidence from recent clearing shows a fair amount of soil damage, however from older stands, the re-bound does however appear to be acceptable.

Permitting

Permit conditions granted restrict harvesting according to recommendations from the EIA. For EFF the EIA conditions (reviewed at 15 years) include that a maximum of 50% of any farm and a maximum of 500 ha per farm may be harvested per annum. In addition, 15% slopes cannot be harvested. It is unclear what authorisation conditions CCF currently holds, however due to the selective nature of the CCF harvesting operations, CCF report (personal communication) that they are confident to be able to obtain a permit to harvest 100% of their land without restrictions.

Box 1: Harvesting Case Studies

Figure 5. Harvesting techniques - cutter chipper (left) and rotary skid steer (centre and right)

Table 4. Harvesting: Impacts and Mitigation

Impact	Description	Potential Mitigation Options
Soil: potential to damage soil structure, loss of nutrients, organic material (-)	The impacts of harvesting are primarily concerned with the long term effects of bush removal on the soil structure, nutrient content (fertility) and ultimately the long term carrying capacity of the land. The type of soil has a bearing on the impact of harvesting, for example, sandy soils are more prone to disturbance and erosion. Bush removed in an over–extensive or insensitive manner has the potential to disturb the topsoil, destroy soil structure and potentially result in the loss of valuable soil nutrients (Hutchings et al, 2006), decreasing the long term viability of the soil. This situation can be exacerbated during intense rainfall when the bare soils are prone to erosion as well as in sandy and steep areas.	■ Impose speed and vehicle handling limitations on harvesting machinery ■ Use of brash mats to reduce soil damage ■ Some plant debris should be left on harvested areas. This serves to help prevent soil erosion, decomposes realising nutrient back to soil, and provides a niche for germinating grasses as well as insects. ■ Avoid harvesting on land with a gradient of greater than 5% (Christian & Associates,2010)
Biodiversity: enhanced biodiversity from removal of bush (+)	The primary advantage of bush removal includes the potential to improve the biodiversity of the natural rangelands. Removal of competitive encroacher bush and tree species allows natural grassland to increase in extent. If clearing is carried out in a 'thinning' method, a 'savannah-like' rangeland may be restored. This has potential to benefit wild and captive animal populations as grazing potential and ability of wildlife to range, and hunt is improved.	■ Thinning of trees is recommended. The rule of thumb for bush thinning is "the number of tree equivalent per hectare after thinning should be in the order of 1.4 to 2.0 times the long term average rainfall' (Teague et al. 1981). However, as the rate of soil fertility decline is dependent on soil type, with sandy soils experiencing the greatest decline, thinning rate is also dependent on soil characteristics (Christian & Associates, 2010) ■ Leave all trees larger than 4m in height (Christian & Associates, 2010) ■ Development of an appropriate harvest rate (e.g. % per 500 ha) which is dependent on the type (selectivity) of harvesting used.
Biodiversity: removal of protected tree species (-)	Many species of Protected trees are frequently found amongst dense encroacher bush and are at risk of being destroyed by bush harvesting practices. The Forestry Act, 2001 (Act No. 12 of 2001) provides a list of species which are to be excluded from harvesting. Furthermore, In order not to fall foul of any of the provisions of the Nature Conservation Ordinance of 1975, it is stated that the harvesting operations should take all steps to ensure that protected plant species as well as eggs of protected and huntable bird species are not disturbed or destroyed.	■ Selective harvesting (i.e. to avoid areas of high conservation value, to prevent removal of protected tree species) ■ Mature browsing tree species should be left for the benefit of browsing species. ■ Provision of adequate (ecological) trained supervision must be provided to direct harvesters. ■ It is recommended that the Forest Stewardship Council (FSC) standards are used to guide

		management and harvesting, but certification would not necessarily be advised. ■ In any target site if a tree is locally uncommon or unidentifiable – leave it. (Christian & Associates, 2010) ■ With every machine, a suitably trained person must walk (in the cleared strip) in advance of the machine to identify trees, bush clumps, raptors nests etc. to be avoided. (Christian & Associates, 2010)
Biodiversity: effects bush regrowth and increased bush density (-)	Some species display vigorous regrowth patterns. For example, *D. Cinerea* grows from seeds stored in the soils which germinate in contact with light. These seedlings grow out coppiced, and potentially denser than the original version. However species such as *A mellifera* experience a higher mortality rate. In order to achieve long term benefits from harvesting, Aftercare Programs are frequently recommended. Consultation with experts reveals that the most recommended options are likely to be treatment with arboricides. The Ministry of Agriculture, Water and Forestry is shortly to release a study on the long term effects of Bromacil in Namibia. The results should be reviewed in further detail a further assessment stage. The cost of aftercare can be extremely expensive. As a ball park figure, the cost of R400 per hectare would not be unreasonable, but is dependent on the type of arboricide applied and the application method (e.g. manual or aerial).	■ The use of aftercare techniques should be recommended at the farmer's discretion and cost.
Groundwater Recharge & Surface Water Runoff (+)	Research suggests that removal of encroacher bush species may help to improve ground water recharge owing to the reduction of evapotranspiration losses via interception and transpiration. (Bockmuhl, 2009), (Vegter 1993). The Namibian hydrogeological map, developed by the Department of Water Affairs (DWA & GSN, 2001), divides Namibia into six zones according to geology and groundwater potential. Of the areas mapped as having low, moderate and high groundwater potential approximately 33% of the low groundwater potential areas are bush encroached, 52% of the moderate groundwater potential areas, and 89% of the high groundwater potential areas in Namibia are bush encroached (Christian & Ass., 2010).	■ N/A

	The process of thinning within areas of moderate and high groundwater potential should theoretically augment Namibia's groundwater resource.	
Water Quality	Harvesting machinery used near open water has the potential to increase soil erosion and siltation of the water course and cause degradation of water resources for downstream users. Petroleum leakages from machinery present further risk of contamination to soil and water resources.	■ Harvesting machinery used near open water has the potential to increase soil erosion and siltation of the water course and cause degradation of water resources for downstream users. Harvesting should not be carried out within 100m of a water course as per the Forestry Act, 2001 (Act No. 12 of 2001). ■ Avoid all watercourses / springs by at least 100m ■ Refuelling must be carried out in an area with hard standing, and fuel must be kept within a properly contained, bunded area.
Health and Safety (-)	Risk of death and injury when working with harvesting machinery, tractors, chippers or any other mechanical device.	■ Ensure adequate trained supervision is provided for harvesting team ■ Personal protective equipment such as high visibility jackets, hard hats, gloves ■ Strict conditions for working within daylight hours and good visibility ■ Provision of first aid and emergency response protocols ■ Trained on-site maintenance assistance for machinery.

4.2 Transport

A biomass energy project will involve harvested bush (most likely in chipped form) being transported to the combustion facility for long term storage.

The three options considered at the post inception stage and undergoing economic analysis includes:

- Tractor and trailer;
- Lorry; and
- Skidloader
-


Figure 6. Lorry with tarpaulin covering preparing to transport biomass chips (left) Skidloader (centre) Tractor Trailer (right)

Transport is often considered to be the most costly stage of the supply chain, therefore running cost will be the primary determinant of the final transport logistics scenario considered. Environmental assessment will need to take into account the effects of the additional road-use. The major impacts associated with transport occur during the operational phase (Table 5). Analysis of the major impacts and possible mitigation is provided in Table 6. It is noted that some of the scenarios may require upgrading of the Namibian road network i.e. around the northern parts of Otjiwarongo for Scenario 1. A specialist traffic impact study is likely to be required for all the scenarios.

Table 5: Summary of the potential for impacts to occur as a result of Transport project phases (+ denotes positive impacts; - denotes negative impacts)

Parameters	Operation	
	+	-
Soil		✓
Air Quality		✓
Visual		✓
Noise		✓
Health & Safety		✓

Table 6. Transport: Impacts and mitigation

Impact	Description	Potential Mitigation Options
Air Quality: release of emissions (-)	The main impact from transportation includes the release of air pollutants (i.e. hydrocarbons, carbon monoxide, nitrogen oxides, particulate matter, sulphur oxide and volatile organic compounds) as well as GHGs (i.e. carbon dioxide, nitrous oxide and methane). The equipment used and the distance travelled will impact on the quantity and composition of emissions released. Further information regarding	■ Encourage use of tarred roads wherever possible. ■ Utilise bypass roads to avoid hauling through towns/villages where possible. ■ Enforce speed limitations on dirt roads to limit dust and emissions e.g. 30km/hr, and 80km/hr on tarred roads. ■ No not overload trucks ■ Adherence to transport standards which encourage use of modern (low emission) engines, high quality maintenance programs as well as driver training.

	the carbon emissions is provided in the **Carbon Balance Report.**	
Air Quality: dust/ particulate matter (-)	Dust emissions associated with travel on dirt roads.	■ Encourage use of tarred roads wherever possible. ■ enforce speed limits e.g. 30km/hr on dirt roads.
Health & Safety: nuisance and ingestion (-)	Risk of windblown debris of woodchips during hauling. This may pose a nuisance and hazard to other road users, pedestrians or local receptors.	■ Use of tarpaulin, container or covered transport for travel on public roads or for long distances.
Soil: damage to soil structure (-)	Use of heavy machinery within the bush encroached areas may result in damage to topsoil and natural vegetation.	■ Ensure that vehicular access routes are restricted to demarcated areas to lessen the impact on natural habitats.
Soil: contamination (-)	Potential soil contamination from spilt diesel	■ Ensure vehicles well maintained ■ Diesel stored in bunded area ■ Use of drip trays when carrying out maintenance work
Visual: disturbance (-)	Increase of vehicular movements creates localised visual disturbance	■ Avoid travelling through towns/villages.
Noise: Nuisance (-)	Increase of vehicular movements increases noise levels on the roads and nuisance to residents living at the roadside	■ Avoid travelling through towns/villages particularly between 6am and 6pm.

4.3 Storage and Handling

The majority of the impacts associated with storage and handling phase of the project will occur during the operational phase. A summary of the impacts is provided in Table 8.

Table 7 Summary of the potential for impacts to occur during the Storage and Handling project phases (+ denotes positive impacts; - denotes negative impacts)

Parameters	Construction/Development		Operation	
	+	-	+	-
Air Quality		✓		✓
Health & Safety		✓		✓

Some minimal air quality and health & safety impacts can be expected during the construction phase when the stockpile storage area is being constructed, however this is not regarded as particularly significant (standard civils works) and is not dealt with further.

4.3.1 Infield storage and handling environmental impacts

Chipped wood will be cut and stockpiled at the harvesting site while awaiting transport to a permanent stockpile at the combustion facility.

The stockpiles will be temporary since the harvesting operations will be continuously moving. The use of containers could be considered a useful means for collecting chipped biomass in terms of ease of transfer to biomass facility.

Table 8 Impact and mitigation options at the in-field storage and handling stage

Impact	Description	Potential Mitigation Options
Air Quality: dust (-)	The primary impacts resulting from this stage include the potential for windblown dust from the woodchip piles, potentially causing degradation of local air quality, as well as nuisance to workers and farm owners.	■ Use of containers for storage of woodchips in field ■ Covering stockpiles with Tarpaulin or situating stockpile in a well-protected area. (e.g. use of natural wind barrier)
Health & Safety: ingestion (-)	Windblown wood may present a health and safety risk to labourers through inhalation and eye contact.	■ Labourers working near the stockpile must be properly supplied with personal protective equipment (PPE) such as goggles and masks
Health & Safety: environmental risks (-)	In field risks to workers (e.g. lack of sanitation facility, water availability, heat, bites, injury)	■ Adequate sanitary provision as well as access to water and food and trained first aid.
Health & Safety: dangerous machinery (-)	Safety risk to workers due to operation of heavy machinery.	■ Labour must be adequately trained in the risks associated with the heavy machinery as well as appropriate handling techniques. ■ Labour must be accompanied by senior supervision deployed in numbers appropriate to the harvesting type and scale. ■ Labour must be provided with the appropriate PPE (safety boots, goggles, gloves and facemasks)

4.3.2 On-site storage and handling environmental impacts

Permanent stockpiling areas will need to be developed at the facility prior to combustion; the impacts and risks from such storage are assessed in **Error! Reference source not found.**.

Table 9 Impact and mitigation options at the on-site storage and handling stage

Impact	Description	Potential Mitigation Options
Air Quality/ Health & Safety: dust (-)	Potential for stockpiles to result in windblown dust.	■ Stockpile should be maintained in a demarcated area which while allows for breathability (i.e. not completely enclosed) of

		the wood stockpile, whilst remaining protected from wind.
Air Quality/ Health & Safety: fire from woodchips (-)	Fire risk from wood stockpiles. Wood chip piles have the potential to heat internally and spontaneously combust when stored on a long term basis if not managed correctly. This results from exothermic microbial reactions. Stockpiles can reach critical temperatures of over 70°C increasing the likelihood of ignition. This risk increases with the presence of decaying material.	■ A Major Hazard Installation (MHI) assessment would be recommended to fully address the extent of this risk and determine appropriate mitigation measures. ■ Stockpiles should not be allowed to accumulate for longer periods of time, and should be regularly turned over. ■ Storage area which is protected from direct sunlight by a roof. ■ If biomass is stored in chipped form it may be sieved to remove fine dust which can increase risk form explosion.
Air Quality/ Health & Safety: fungal/ bacterial (-)	Release of fungal spores and bacteria (from organic decomposition through microorganisms) can be emitted if wood chips are stored in high humidity. Exposure to fungal spores and bacteria can occur during.	■ Provision of adequate PPE equipment (e.g. mask) ■ Ensure that stockpiles are not allowed to accumulate for long time periods i.e. that they are regularly turned over.
Reduced process efficiency/ Health & Safety: moisture content of wood (-)	Increased moisture content of biomass material. High moisture content can accelerate biological reaction and increase risk of high stockpile temperatures. Wet biomass also decreases the efficiency of the combustion process.	■ Dry wet biomass before adding to stockpiles ■ Roof covering of stockpiles is advised
Health and Safety: hazards (-)	Risks of death and injury due to incorrect handling of machinery	■ Ensure adequate training and supervision
Health & Safety: waste (-)	Risk Hazardous Waste Materials: e.g. Waste solvents; Rags contaminated with solvent/lubricant; Any collected dried paint (e.g. on dry filters) ; Solid off-spec. materials; Empty chemical/ lubricant containers.	■ Development of a waste management plan ■ Provision of adequate training for storage of and handling of hazardous materials

4.4 Combustion

The combustion scenario is being developed on the basis of commercial feasibility. The torrefaction technology is not under consideration in this section since the technology will not require development from NamPower. The three technology options under consideration for the combustion facilities include **bubbling fluidised bed**

(BFB), **circulating fluidised bed (CFB)** and **stoker grate technologies (SG)**. Impacts are likely to occur throughout all phases of project development (construction, operation and decommissioning) (Table 10), a summary of impacts is provided in Table 11.

Table 10. Summary of the potential for impacts to occur during the Combustion project phases (+ denotes positive impacts; - denotes negative impacts)

Parameters	Construction/Development		Operation		Decommissioning	
	+	-	+	-	+	-
Air Quality		✓		✓		
Water				✓		
Visual		✓		✓		
Health & Safety		✓		✓		✓
Noise		✓		✓		✓
Waste		✓		✓		✓
Biodiversity		✓				

It is noted that the project may potentially deliver significant benefits in terms of reduced carbon emissions. However this has been assessed in the **Carbon Balance Report** and is not included here.

4.4.1 Combustion environmental impacts

A list of the general impacts expected from the combustion phase is provided in **Error! Reference source not found.** below:

Table 11 Impact and mitigation options at the combustion stage

Impact	Potential Impact	Potential Mitigation Options
Biodiversity: localised disturbance to fauna and flora	Construction of the EBtP on a greenfield site has the potential to disturb local populations of animal and plant life. Prior to construction biodiversity survey must be carried out to determine presence of protected species under the Nature Conservation Ordinance (4 of 1975) or Forestry Act(2001).	■ Care should be taken to ensure that protected plant species and eggs of protected and game bird species are not disturbed or destroyed. If disturbance or destruction is inevitable, a permit must be obtained from MET.
Air Quality: release of air emission during combustion process (-)	The air emissions resulting from biomass combustion vary according to the precise fuel and technology used. The main pollutant of concern includes oxides of nitrogen (NOx) which vary significantly among combustion facilities depending on their design and controls. Carbon monoxide (CO) is also emitted - sometimes at levels higher than those for coal plants. Similarly, combustion of biomass results in very little Sulphur Dioxide (SO_2). Biomass plants also release carbon dioxide (CO_2), during	■ The technology applied should therefore be a “low NOx” technology, i.e. utilising mitigation technology for NOx emissions. ■ Further purification

combustion. A breakdown of the annual emission is provided in Table 12.

Urea and Limestone have been identified as the preferred emissions abatement reluctant for NO_x and SO_2 respectively

Table 12 Annual emissions per scenario (tonnes/annum)

Scenario	Tech	NO_x	SO_2	SO_3	HCL	NH_3	CO_2	PM
1	5 MW Grate	72	54	13	46	37	69543	6
2a, 2c	2x10 MW Grate	247	185	44	158	127	237252	21
2b, 2d	2x10 MW BFB	249	36	0	155	128	230076	7
2b, 2d	2x10 MW CFB	249	18	0	155	129	230542	7

In order to be IFC compliant the plant will be designed according to IFC performance standards for air emissions (Appendix B). The performance of the technologies identified according to these thresholds is provided in Table 13. The scenarios identified appear to fall within the international best practice (World Health Organisation) guidelines.

In order to control key emissions

Table 13 Emission rates (mg/m3 (6% O_2 dry basis)

Scenario	Technology	Particulates	SO_2	NO_x
	WHO guideline values[3]	*50*	*2,000*	*650*
1	5 MW Grate	25	225	299
2a, 2c	2x10 MW Grate	25	225	299
2b, 2d	2x10 MW BFB	9	46	311
2b, 2d	2x10 MW CFB	8	23	311

of flue gas for ash particles is likely to be required. i.e. use of mitigations such as fabric filters for particulate matter (PM), or limestone for SO_2 abatement,

- Abatement of emissions must conform to WHO standards for point source and ambient emissions (as well as Namibian legislation.
- Regular process efficiency optimisation during operation.
- Detailed baseline monitoring (two seasons worth of data) followed by a detailed operational monitoring program for point source emissions as well as ambient air quality.
- Development of a rigorous monitoring and management program.

Materials storage: contamination (urea)

Urea [$(NH_2)_2$ CO] will be used as a reductant (abatement option) to control NO_x emissions. The process results in the reduction of NO_x to N_2, H_20. The volume of urea required will be in the region of 100 - 400 tonnes/annum consumption depending on the scenarios (listed in Table 14)

Table 14. urea consumption

Scenario	Technology	Urea Consumption (tonnes/annum)

- In the event of major spills, urea should be prevented from entering drains and watercourses.
- If the product has gained moisture, an absorbent material such as sand may aid in recovery. Sweeping and shovelling the spilled product into labelled containers

[3] WHO limits for solid fuel boilers <50 MWth in non-degraded areas

1	Grate Boiler + Steam Turbine (ST)	119
2a, 2c	Grate Boiler + ST	407
2b, 2d	BFB or CFB + ST	389 (BFB) / 390 (CFB)

Solid urea granules will be slurried for use as a reductant. Urea is not classified as a hazardous or carcinogenic substance according to the US-EPA, however nitrification (and potential exceedance of nitrate concentration in water resources) may result if urea is leached to ground or surface water (Fable et al, 2002).

- for recycling or salvage is recommended.
- Recovered product is considered non-hazardous waste by EPA and the Resource Conservation and Recovery Act and may be used as fertilizer or disposed of as necessary.

Water: consumption (-)

Withdrawals of surface or groundwater would be required during the operational phase of an EBtP facility. The amount of water needed will depend upon the technology type. The primary consumptive use of water will be to support the cooling system used to condense spent steam for reuse. Two major types of cooling technology exist:

- ***Wet recirculating cooling systems*** recycle cooling water through cooling towers where some portion of water is allowed to evaporate and must be continuously replenished. Wet recirculating cooling systems also periodically discharge small volumes of water as blow down and replace that amount with fresh water to control chemical and biological contaminants to acceptable levels.
- ***Air cooling systems*** condense and cool steam using only ambient air and require water primarily for steam losses. However, some air cooling systems can also be hybridized into wet/dry systems that use minimal amounts of water that is allowed to evaporate to improve performance.

The initial technology designs are working towards minimisation of water consumption through use of air cooled technology. Estimations are provided in the Table 15 below, which provides an indication of water usage in cubic meters per annum (m^3/annum) for each scenario.

Other consumptive uses of water at a biomass power plant include the initial filling and maintenance of the steam cycle, sanitary applications to support the workforce, and a wide variety of maintenance-related industrial applications, including dust prevention and fire prevention.

Table 15. Water consumption per scenario

Scenario	Technology	Cooling type	Water cooling Consumption (m^3/annum)
1	Grate Boiler + Steam Turbine (ST)	Air	2,606
2a and 2c	Grate Boiler + ST	Air	8,584
2b and 2d	FB + ST	Air	2,854 (BFB)

- Use of dry cooling or hybrid cooling technology would likely be recommended in an arid/semi-arid country such as Namibia, although wet cooling can be considered if proven water resource is available.
- Process efficiency optimisation assessment for water re-use opportunities e.g. re-use of water for cooling; toilet flushing or dust suppression.

<table>
<tr>
<td>Water: discharge (-)</td>
<td>Most new thermal plants operate on a zero water discharge basis. However, depending on the quality of the groundwater input there may be a requirement for water treatment of the raw well water (e.g. reverse osmosis) to lower the mineral content. In this case, a side stream (reject water) containing higher mineral content that can either be discharged or evaporated/crystallised (for disposal) will be produced. In addition, blow down of the cooling towers and boilers will also produce a wastewater stream requiring disposal.</td>
<td>■ Re-use process water whenever possible
■ Ensure solid waste from any evaporation ponds is disposed of in an appropriate manner.</td>
</tr>
<tr>
<td>Visual: visual disturbance
(-)</td>
<td>The magnitude of visual impacts from operation of a biomass facility is dependent upon the distance of the facility from sensitive receptors (viewers), the view duration, and the scenic quality of the landscape. Plumes from stacks may also be visible.</td>
<td>■ Site should not be located close to areas of any touristic, cultural or conservation importance.</td>
</tr>
<tr>
<td>Noise/ Health & Safety: Nuisance (-)</td>
<td>Operations of heat recovery systems of a biomass power plant and steam turbine generators would likely result in elevated occupational noise levels. Other noise sources would include exhaust stacks, mechanical-draft cooling systems, switchgear at substations, corona noise from transmission lines, vehicular traffic, and maintenance facilities.
Table 16 Noise Level Guidelines [One Hour L_{aeq} (DBA)]
<table>
<tr><th></th><th>Daytime</th><th>Nighttime</th></tr>
<tr><td>Receptor</td><td>0700h - 2200h</td><td>2200h - 0700h</td></tr>
<tr><td>Residential; institutional; educational</td><td>55</td><td>45</td></tr>
<tr><td>Industrial; commercial</td><td>70</td><td>70</td></tr>
</table>
</td>
<td>■ Combustion facility should ideally not be located close to other sensitive receptors (residential dwellings, lodges).
■ Noise impacts, control measures, and recommended ambient noise levels are presented in in Table 16 from Section 1.7 of the General EHS Guidelines (2007).
■ Personnel working in these areas would be required to wear hearing protection.</td>
</tr>
<tr>
<td>Waste: production of hazardous and general waste (-)</td>
<td>The main waste includes ash produced during the biomass combustion, and small amounts of unburnt carbon (within the ash). Industrial wastes will also be generated during routine operations (dielectric fluids, cleaning agents, and solvents).
In addition there may be small quantities of minerals from evaporation processes. These are expected to accumulate in ash dams and hence will form part of the ash waste stream. There will not be any tars produced by the combustion technologies considered within this assessment. Management of the ash is considered further in the Ash Disposal Plan.
A summary of potential waste products will be produced which are listed in the table below.
Table 17 Waste production
<table>
<tr><th>Type</th><th>Category</th><th>Qty/annum</th><th>Disposal</th></tr>
<tr><td>Ash (including unburnt carbon</td><td>Unlikely to be hazardous</td><td>2,500 – 10,000 tonnes</td><td>Various Options Available</td></tr>
</table>
</td>
<td>■ Adequate provision of waste storage facilities and appropriate containers
■ Training in storage and handling of waste materials
■ Hazardous wastes delivered to hazardous landfill facilities and a chain of custody of the hazardous waste maintained.
■ Non-hazardous solid waste – which</td>
</tr>
</table>

	and some evaporative minerals)				cannot be re-used or recycled – would be transported to a general landfill, or collected by the municipality if this service exists.
	Paints/solvents Chemicals	Hazardous	low volumes	Hazardous Landfill site (Windhoek or Walvis Bay)	
	Oil wastes/ filters	Hazardous	low volumes	Hazardous Landfill site (Windhoek or Walvis Bay)	
Waste: production of ash (-)	For combustion it is estimated that around 2,500 – 10,000 tons of ash will be produced at the site per annum, depending on the scenario. The make-up of the ash content will be determined once the final location (and encroacher bush mix) has been determined. The ash will also contain un-burnt carbon and potentially calcium sulphate from lime required for SO_2 abatement. The development of an **Ash Disposal Plan** (Appendix C) has been carried out as part of the pre-feasibility and will determine whether there is potential for re-use e.g. as a fertiliser or as a cement feedstock. The nature of the ash (i.e. whether hazardous or not) will only be determined once the final biomass feedstock is determined. This will be dependent on the concentrations of heavy metals within the ash predominantly. Waste Disposal Options are explored briefly in Section 4.4.2. Impacts could result if this waste is not properly handled and were released to the environment.				■ Adequate storage facilities must be provided for the ash waste prior to re-use or disposal; and should be in within an appropriately contained area to prevent dust/windblowing. ■ Recommendations regarding application rates and methodologies should be provided in the final ash disposal plan, should utilisation of feedstock as a fertiliser for the bush encroached areas be considered. ■ Management of ash disposal and reclamation so as to minimise environmental impacts – especially the migration of toxic metals, if present, to nearby surface and groundwater bodies, in addition to the transport of suspended solids in surface runoff.
Health & Safety	Possible impacts to health and safety during operation include accidental injury or death to workers. Health impacts could result from exposures to chemicals and products used and produced in the biomass facilities, air emissions, and noise. Dry dust produced from chipped biomass feedstock, may be combustible. Explosion hazard can exist with the storage of wood				■ Adequate training and supervision in H&S practices ■ Provision of necessary PPE

	chips, and fire risk when freshly torrified material is removed from the boiler.	equipment ■ Major Hazard installation assessment should be carried out and recommendations regarding fire and explosion risk prevention implemented.
Health & Safety (noise)	Principal sources of noise in thermal power plants include the turbine generators and auxiliaries; boilers and auxiliaries, such as pulverisers; reciprocating engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers; and cooling towers.	■ Noise impacts, control measures, and recommended ambient noise levels are presented in Section 1.7 of the General EHS Guidelines (2007). ■ Use of noise control techniques such as: using acoustic machine enclosures; selecting structures according to their noise isolation effect to envelop the building; using mufflers or silencers in intake and exhaust channels; using sound-absorptive materials in walls and ceilings etc.

4.4.2 Ash Disposal Options

The main waste product resulting from the combustion process will be ash. When ash is produced in industrial combustion systems, the temperature of combustion, cleanliness of the fuel wood, the collection location, and the process can also have profound effects on the nature of the ash material. Therefore, wood ash composition can be highly variable depending on geographical location and industrial processes. This makes analytical testing of the ash extremely important.

Ash residues are not typically classified as a hazardous waste due to their inert nature. However, the ash residues should be analysed to ensure that they do not contain potentially significant levels of heavy metals. (For example there is evidence that the use of tambotie trees as a biomass feedstock can result in toxic/ hazardous residues (Christian & Associates, 2010)).

Classification of the ash as hazardous or non-hazardous must be carried out according to internationally recognized standards[4].

The major consideration with ash stockpiling is the storage method. Alternatives for storage and disposal require consideration, and well as eventual disposal routes. High-volume combustion-ash wastes are typically managed in landfills or surface impoundments or, increasingly, may be applied to a variety of beneficial uses. Cost benefit analysis and feasibility of these options of required.

Table 18 Options for ash handling

Ash handling	Comments
Wet handling	■ Ash is mixed with water to form a sludge ■ Less fugitive dust emissions
Dry handling	■ Does not involve surface impoundments and therefore less risk in terms of leaching into soil/groundwater. ■ Potential fugitive dust emissions

Table 19 Options for ash disposal

Option for final disposal	Details
Landfill (general or hazardous external)	■ Ash is delivered to municipal landfill, either general (likely) or hazardous (of which there are only two in Namibia). ■ Cost implications of transportation
Landfill (general or hazardous – onsite)	■ An impermeable landfill is developed on site ■ Cost/space implications ■ Will require authorisation in terms of National legislation potentially according to IFC Performance standards if applicable.
Re-use Most preferable option	■ IFC (2008) recommends re-use waste ash in other applications as most preferable option; some options are provided below: • Concrete production, as a substitute material within Ohorongo Cement's feedstock • Road sub-base construction • As an aggregate substitute material (e.g. for brick production)
Land	■ Agricultural uses: soil amendment, fertilizer, cattle feeders, soil stabilization in stock feed yards, and agricultural stakes (provided trace metals or other potentially hazardous materials levels are within accepted thresholds), ■ Ash is good source of calcium, potassium, phosphorus, magnesium, and aluminium. ■ Testing required to determine if safe to apply to soil (note: preliminary assessment of lab results suggest that it will be).

[4] E.g. US EPA hazardous waste listing descriptions found in 40 CFR Part 261 Subpart D. Additional information about the classification and management of hazardous and non-hazardous wastes is presented in Section 1.6 of the General EHS Guidelines (2008).

	■ Applications should be limited to a level that maintains the soil pH within the optimum range for the intended soil productivity. The liming ability of wood ash is usually estimated using a laboratory measured parameter called the calcium carbonate equivalent (CCE).

5 Assessment of Site Alternatives

Three main site locations are considered in the environmental screening in terms of site suitability, and any potential red-flag scenarios. The three scenario site locations considered in the screening are highlighted in green in Table 20. Final site location will be a factor of economic and social conditions as well as the results of the farmer engagement process.

Table 20 Site Locations

Identifying Characteristic	Combustion Scenario			
	Scenario 1	**Scenario 2a, 2b**	**Scenario 2c, 2d**	**Scenario 3**
Location	Harvesting 40km west of Otjiwarongo (a) at CCF with combustion facility in (b) Otjiwarongo Industria. Circa 250 km north Windhoek.	Ohorongo Cement, 18km north-east of Otavi. Circa 375 km north of Windhoek.	Otjikoto Substation, 7km north-west of Tsumeb, Circa 50km north of Ohorongo Cement, and 425 km north of Windhoek.	Green Coal torrefaction facility is located 30km west of Omaruru, Circa 260 km north west Windhoek, however final site location not known.
Approximate coordinates	(a) 20°29'1.62"S 17° 1'51.53"E (b) 20°27'36.82"S 16°38'8.34"E	19°13'12.77"S 17°38'17.83"E	19°30'53.79"S 17°27'7.57"E	Unknown
Electrical Output	5MW	20MW	20MW	-
Cooperating Institutions	Cheetah Conservation Fund.	Ohorongo Cement, Energy for Future		Green Coal

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5.1 Environmental Baseline

The environmental baseline conditions of the three proposed combustion facilities were developed through desktop analysis of the locations as well as through the site visit which took place from 4th – 8th June 2012.

5.1.1 Otjiwarongo Town (Scenario 1)

Table 21. Environmental Baseline for Otjiwarongo

Scenario 2	Description	Opportunities/ Constraints
Location	**Otjiwarongo Town**	
Location Description	Otjiwarongo is located 250km north of Windhoek on the B1, 400km east of Walvis Bay. The city has a population of 20,000 inhabitants and is the capital of the Otjiwarongo electoral constituency. The town is well developed with a well maintained road and rail network. The primary employment in the town is the agriculture sector which employs approximately 36.7% of the municipal population. The Cheetah Conservation Fund, located 40km east of Otjiwarongo operates a small bush harvesting to briquette business. The encroacher bush is harvested from the CCF estate and transported to their facility in the Otjiwarongo General Industrial Zone (on the western boundary of the town) where it is compacted to form a woodchip briquette. The Otjiwarongo Sub-station is also located near to the bushblok factory, on the northwestern boundary of the industrial zone.	***Opportunities:*** *None identified.* ***Constraints:*** *Transport of woodchip biomass likely to traverse the northern portion of the town, causing potential nuisance to the community. This will require further assessment in the scoping phase.* *Impact of truck movements on town may need to be assessed. Some road infrastructure upgrades may be needed for the northern portion of the town.*

Figure 7 Location of Otjiwarongo and the CCF facility

	 **Figure 8. Otjiwarongo Town showing Industrial zone**	
Geology, soils & terrain	Otjiwarongo lies on the rocky central plateau of Namibia, and is centrally located between the landforms “Plateau with ridges”, in the south, and “Karst and hard Damara limestone” to the north. The geological map of the area shows the area to be underlain by rocks of the Damaran Sequence, predominantly schist, marble and quartzite. Kopjies dotted all over the region rise above a surrounding matrix of flatland, which has virtually no exposed rock. The Waterberg Plateau (a 4100 km^2 sandstone uplift), approximately 15km of the west of the CCF facility is the dominant geological feature of the region.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified*
Climate	The region has a semi-arid climate and lies between the 400 mm and 450 mm annual rainfall. On average there are 45 rain days per year in Otjiwarongo with the Namibian rainy season extending from October to April. The average daily maximum temperature for the hottest month is 33 °C - 34 °C, and the average daily minimum temperature for the coldest month is 4°c - 5°c (Van der Merwe, 1983). The dominant wind directions through-out the year are from the north, north-east and east. However, strong westerly winds occur during two pre-summer months August, of September and October.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified*

Air Quality	Air quality impacts in the region of Otjiwarongo are expected to be predominantly from vehicles and light industry. No data was available; however these would be expected to be low to insignificant.	***Opportunities:*** *None identified.* ***Constraints:*** *Availability of ambient baseline data unknown. Two seasons of ambient baseline air quality data would be for IFC standard assessment.*
Floral biodiversity	Otjiwarongo lies within Thornbush Savannah vegetation zone defined by Geiss (1971). Vegetation is typical of xero-morphic thornbush savannah with dominant woody plant genera consisting of Acacia, Dichrostachys (sickle-bush), Grewia (brandybush), Terminallia (Silver Terminalia), and Boscia. Understory vegetation is relatively sparse, although ephemeral forbs are present following rain. This region has been extensively modified over the last century through human mediated causes compounded by natural climatic fluctuations (Louw, 1982; Prins and van der Jaeugd, 1993; Hoffman, 1997; Pallett, 1997). Some native woody species such as A. mellifera, A. tortillis, and D. cinerea have proliferated, and perennial grasses have been reduced throughout this area (Bester, 1996; Rhode, 1997) to the ex-tent that remnant patches of historic open savannah habitat exist only where livestock grazing has been limited (Meik, 2002).	***Opportunities:*** *None identified.* ***Constraints:*** *None identified*
Faunal biodiversity	No data was obtained for the faunal diversity of the area. A site specific biodiversity assessment will be required for further information.	***Opportunities:*** *None identified.* ***Constraints:*** *No baseline data obtained, there will likely be a requirement for biodiversity survey (with seasonal observations).*
Hydrology	The area is not characterised by surface water features, and the development will be reliant on groundwater or municipal supply. The site is situated within the Platveld Aquifer of the Kuneme South groundwater basin. The majority of the basin is a Subterranean Water Controlled Area, and Otjiwarongo falls into this category. The area around Otjiwarongo varies in terms of groundwater potential, but the potential at Otjiwarongo is moderate to high (~ 3 - 15 m^3/hour) (Christian & Associates, 2009).	***Opportunities:*** *Possibility of running from municipal supply on agreement with local authority.* ***Constraints:*** *If groundwater is to be utilised, a geohydrological assessment will be required to assess the water availability in the site locality. A water abstraction permit will be required.*

Cultural Heritage	Unlikely due to location, however unknown at this stage. Namibia is endowed with rich cultural and archaeological heritage therefore this will need to be assessed at the scoping phase of the environmental assessment.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified*
Visual	Unknown but the combustion facility is likely to be located within industrial area and therefore not likely to be of concern.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified*

5.1.2 Ohorongo Cement (Scenario 2a, 2b)

Table 22 Environmental Baseline

Scenario 2a, 2b	Description	Opportunities/ Constraints
Location	Ohorongo Cement	
Description of location	The Ohorongo Cement facility is situated approximately 20km north of the small town of Otavi and 45km south of Tsumeb. The site is situated 10km from the B1, the main road linking Windhoek with the north of the country. The facility is currently utilising encroacher bush as an energy feedstock for the kilns. The bush harvesting is carried out by Energy for Future (EFF), which has a stockpiling facility approximately 10 km south-west of the substation on Farm Schumanstal. The land surrounding the cement plant is dominated by private farmland, and the area has an extremely low population density. The nearest inhabitants include a small cluster of around 3-4 farmhouses in Tsobis approximately 5km north east of the facility. The farmland is marginal and predominantly used for grazing purposes. The only concentrated inhabitation near the site is Otavi, which is 15km away. Within the study area, the land use on the affected plains and foothills is limited grazing that has been severely degraded by bush encroachment The nearby area has does not appear to have any unique scenic features that could be of interest to tourists.	***Opportunities:*** - *Not in close proximity to any sensitive receptors (e.g. noise, visual, H&S concerns).* - *Close to existing EFF facility.* - *Most preferable location in terms of siting to reduce electricity transmission losses to Ohorongo.* - *Transport routes will not likely need to traverse towns (Otavi or Tsumeb) assuming biomass can be sourced within existing footprint.* - *Labour availability from Otavi and Tsumeb.*

Figure 9. Location of Ohoronogo Cement

Constraints:

- *None identified.*

Geology, soils & terrain	The site is situated within the plains of the Otavi Mountain Lands (OML), the gradient of the area is around 0-5%. The soils in the area are generally sandy, shallow and poor in nutrients. The local soil appears to be sandy, ranging in colour from pale brown and grey with broken calcrete pieces in it, to fine red sand – apparently of aeoloian origins. Sandy soils rely on recycling organic nutrients and lose fertility if vegetation is cleared. This high erodibility may pose a problem in terms of soil erosion when bush encroacher species are removed, particularly during periods of high rainfall (Christian & Associates, 2010).  **Figure 10. Farmland currently under harvest by EFF showing Otavi Mountains in the background.**	***Opportunities:*** *None identified.* ***Constraints:*** *Sandy soils - increased risk of soil erosion and loss of nutrient from soil if harvesting operations not managed correctly.* *Geotechnical investigations will need to include shallow, sandy soil characteristics as well as the potential for sinkhole formation.*

Climate	The site is situated within one of the highest rainfall bands in Namibia. The mean annual rainfall for the area is 500–550 mm, almost all the rain falls between October and April, with the wettest months being January and February. There is high variability, with most rainfall falling in short and intense storms. The hottest temperatures are in December, and range from 32-34ºC. The average minimum temperatures during the coldest month, July, are in the range of 4–6 ºC. The nearest wind data available is for Grootfontein. The data indicates that there is no prevailing wind direction, the wind blows from any direction with only a slightly greater frequency from the east. Calm conditions occur for 41% of the time, more commonly at night.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified.*
Air Quality	The Ohorongo Cement facility represents the only major emissions source in the vicinity of the site. Although air emission concentrations are not known, It would be expected that the area exhibits elevated concentrations of SO_2 from the cement manufacture process.	***Opportunities:*** *Baseline ambient air quality data (one years' continuous) will likely be available from Ohorongo cement for EIA process.* ***Constraints:*** *None identified.*
Floral biodiversity	The area is situated within the Thornbush savannah biome. Some 24 species of trees occur in the Ohorongo Cement study area that is protected by law under the Forest Act (Christian & Associates, 2010). The main encroacher species in the study area are indigenous woody plants. These include, Dichrostachys cinerea (Sickle bush), Acacia mellifera (Black thorn), Terminalia prunioides (Purple pod terminalia) and Acacia luederitzii / Acacia reficiens (False umbrella thorn). Acacia nilotica and Catophractes alexandri may also be thicket forming and can be taken along with the bush encroacher species (Christian & Assoc).	***Opportunities:*** *None identified.* ***Constraints:*** *Presence of protected tree species a biodiversity assessment should be carried out for expansion to harvesting activities.* *Two seasons of baseline data will be available from Ohorongo Cement.*
Faunal biodiversity	The area is high in faunal diversity (Christian & Associates, 2010). Of some 92 species of mammals that occur vicinity of Ohorongo Cement, 19 are of conservation concern or data deficient. Generally species diversity is lower in densely bush encroached areas, but many mammals use bush for shade, browsing, refuge, foraging, and nesting. Several small mammals, e.g. cavity dwellers and bats, use large trees, even dead trees. Some 278 species of birds have been recorded in the study area, but many are not found in dense bush. Of the total 11 are Red Data species – all of them raptors. Raptors are not favoured by dense bush, but they may use large trees. Seven near-endemic species occur but all are widespread in Namibia. Of 77 species of reptiles in the study area, 8 are of conservation concern or data deficient.	***Opportunities:*** *None identified.* ***Constraints:*** *Presence of protected species in area a biodiversity assessment should be carried out for expansion to harvesting activities.* *Two seasons of baseline data will be available from Ohorongo Cement.*

	Of 23 species of amphibians, 4 are of concern or data deficient.	
Hydrology	The site is situated on the Karst Aquifer which forms part of the Tsumeb-Otavi-Grootfontein Subterranean Water Control Area, or Karst Water Control Area (KWCA). The area is generally reliant on groundwater and no major surface water features exist in the vicinity of the site. The site falls within compartment G of the Grootfontein-Tsumeb-Otavi, for which the total abstraction permits are limited to 1.5Mm3/year (GKW Consult, 2002). According to the specialist groundwater study for the Ohorongo Cement Facility, the facility abstracts approximately 70,000m^3 per year, from four boreholes drilled to a depth of 31,52m below the ground surface, with a yield rate of 4m^3 per hour and a drawdown of 9,72m.	***Opportunities:*** *The Karst aquifer is a productive aquifer; however assessment will be required to determine possibility of expanding existing abstraction from on-site boreholes or drilling for new boreholes.* ***Constraints:*** *Operation will require a water abstraction permit under Water Act.*
Cultural Heritage	The site is not known to be of significant cultural or heritage importance. However, Namibia is endowed with rich cultural and archaeological heritage therefore this will need to be assessed at the scoping phase of the environmental assessment.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified.*
Visual	The site is not located in an area of unique visual interest or importance.	***Opportunities:*** *Site within boundary of existing industrial operation and not visible form the B1 and will produce little or no visual disturbance other than very localised impacts.* ***Constraints:*** *None identified.*

5.1.3 Otjikoto Substation (Scenario 2c, 2d)

Table 23 Environmental Baseline for Otjikoto Substation

Scenario 2c, 2d	Description	Opportunities/ Constraints
Location	**Otjikoto Substation**	
Location Description	The Otjikoto substation is north-west of the town of Tsumeb, in the Oshikoto Region of northern Namibia. The substation is reached via the B1, the main road joining Windhoek in the south to the Angolan border in the north. The town is situated at an altitude of approximately 1300 metres above sea level (masl). Tsumeb is the capital city of the Oshikoto region and is the closest town to Etosha National Park, and a popular stop off point for tourists visiting the Park. The town is important economically for its mineral resources particularly copper. The town is well known for the number of mines and smelter complexes in the area. The Namibian Smelter Complex is currently operating in the North West of the town and provides a large proportion of the employment in Tsumeb Site is approximately 7km to the west of the town centre. There is one homestead approximately 1.5 km from the site, and two buildings within a fortified property (unknown purpose) located 1km to the north on the adjacent side of the road. The land surrounding the substation consists of a stone crusher, quarry and private farmland.	***Opportunities:*** *Good transport links: The site is very well connected with tar-roads, sited on the B1 close to Tsumeb - a transport hub between Windhoek to south, Etosha to the north west , the M75 (to the north) and Grootfontein to the east. Peripheral roads surrounding town mean that trucks do not necessarily need to traverse the town.* *The site itself is well serviced with a number of dirt roads which run throughout the farm land immediately adjacent to the substation.* *Good labour employment opportunities from Tsumeb.* ***Constraints*** *None identified.*

	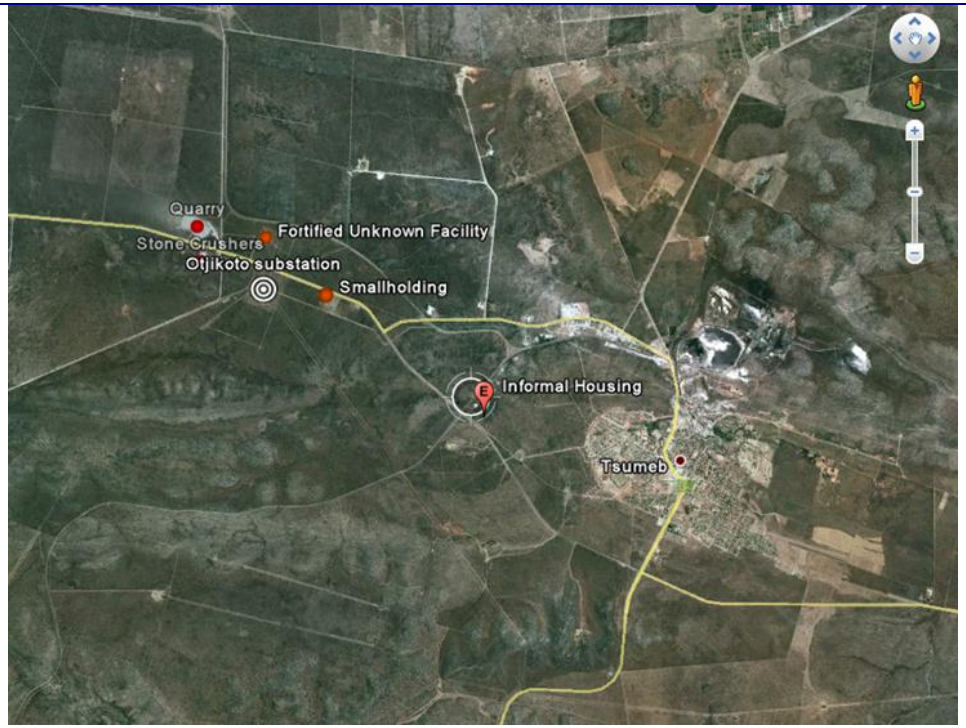 **Figure 11. Location of Otjikoto Substation**	
Geology, soils & terrain	Tsumeb is notable for the huge mineralized pipe that led to its foundation as a mining town well known for its high base metal potential, mainly copper, lead, zinc, silver and vanadium. The area is situated within what is termed the Karstveld. This is the name given to extensive dolomite and limestone formations located to the southeast and east of the Etosha Pan in Namibia. The site is situated within the Otavi Mountainlands. The Otavi Mountains are steep (slopes >12.5%), rugged, relatively inaccessible, and environmentally sensitive, with little or no bush encroachment. Although the site itself is situated on a flat land, the area is undulating making the potential for harvesting more limited. The local soils are very rocky, owing to the dolomitic lithology. The soil around Tsumeb varies in quality from very fertile red loam through black turf to chalky clay and loam. The district is thus suitable for intensified farming and crop production. The highly variable rainfall in the area typically falls in heavy storms, although rates of evaporation are extremely high. Intense storms present a risk of soil erosion, particularly in areas with sandy soils.	***Opportunities:*** *None identified.* ***Constraints:*** *The lithology of the area means that the area may also be associated with sinkholes/ soil ground stability assessment will require assessment in construction.* *The area is dotted with rocky outcrops which may present difficulties for harvesting machinery.*

	 **Figure 12**. **Cleared land just next to substation (left), typical rocky outcrops around Tsumeb (right)**	
Climate	Although the climate in Tsumeb is classed as semi-arid to arid, Tsumeb experiences amongst the highest rainfall nationwide with an average annual rainfall of 524mm, falling predominantly in summer (December to February). This is approximately double compared to the national average mean. There is an extreme variation of about 50-60% of the mean annual rainfall. Rain typically falls in heavy storms, presenting a risk of soil erosion. The mean annual temperature for Tsumeb is 25 degrees Celsius. Potential evaporation is almost three times higher than annual rainfall however, making infiltration of water into the soil and underground aquifer limited. The nearest wind data available is for Grootfontein. The data indicates that there is no prevailing wind direction, the wind blows from any direction with only a slightly greater frequency from the east. Calm conditions occur for 41% of the time, more commonly at night.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified.*
Air Quality	Although traditionally air pollution has not been considered as a significant issue in Namibia, the mining (particularly copper smelting) industry in and around Tsumeb has led to some concerns regarding ambient Sulphur Dioxide (SO_2) levels e.g. from the Namibian Custom Smelter (NCS) currently operating out of Tsumeb. Although Namibia does not have legislation relating to ambient air quality (therefore obtaining data can be difficult) larger industrial/mining corporations are starting to monitor and report according to international standards. In an attempt to tackle the problem, NCS has recently installed three air quality monitoring units in Tsumeb to monitor ambient AQ (mainly SO_2) to US-EPA standard reporting. Localised air quality impacts include dust (PM) emissions form the adjacent quarry and	***Opportunities:*** *None identified.* ***Constraints:*** *Availability of baseline data unknown. One years' continuous baseline air quality data is required if the assessment is to be carried out to IFC standards.*

	crushing facilities.	
Floral biodiversity	The Karstveld area of the north-east Namibia, around Tsumeb is notable for its high terrestrial diversity (Mendelsohn et al, 2002). Tsumeb falls under the dry woodland, savanna vegetation zone. The diverse assemblage of plants found in the area is owing to the variety of soils which exist in the area. The dominant woody plants are Colophospermum mopane trees, and shrubs, Acacia species and Catophractes alexandri. The dominant encroacher species in the area is Terminalia prunioides and Acacia Mellifera.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified.*
Faunal biodiversity	A total of 658 species of birds have been recorded in Namibia and of these, 201-230 bird species and 71 reptile species and 76 mammal species around the Tsumeb area (Mendelsohn et al., 2002). Common mammalian species may occur around the Tsumeb area include kudu, steenbok, springbok, damara dik-dik, hyena, wild cat and other small predators (Geo-Consult, 1996). There are likely to be a large number of red-list data species or protected species also inhabiting the area. The Otavi Mountainlands are famous for the Karstveld sinkhole lakes and caves, which form distinctive subterranean habitats, supporting a substantial number of endemic aquatic species within several taxonomic groups.	***Opportunities:*** *None identified.* ***Constraints:*** *A biodiversity assessment will likely be required as a specialist study within an ESIA report.* *Availability of baseline data unknown. Two seasons of baseline biodiversity data may be required.*
Hydrology	There is no surface water at or within the vicinity of the site. Small ephemeral streams may exist in the harvesting areas but this will need to be assessed one the final harvesting footprint has been determined. The site is situated within the Karst Aquifer which forms part of the Tsumeb-Otavi-Grootfontein Subterranean Water Control Area, or Karst Water Control Area (KWCA), a fractured porous dolomitic aquifer (Mendelson, 2002). The Karst Aquifers host the most important groundwater resource in the region and the water is generally of good quality. The aquifer is defined as having moderate to high potential. The site falls within the Tsumeb Sub-basin. The Tsumeb Sub-Basin is defined by the drainage of surface and groundwater from the Otavi Mountain Land in the south towards the Etosha Pan in the north. Surface water is very limited in the area due to infiltration or evaporation, therefore groundwater is the main source of water supply in the sub-basin, as no major dams or pipeline routes exist. The groundwater in the sub-basin is used for large-scale stock farming but also for crop irrigation, mainly in the area of the dolomite synclines to the north and east of Tsumeb. Groundwater monitoring over the wider area of the Otavi Mountain Lands (OML) in the past indicates a steady decline in the water levels in the Otavi Mountain Lands. The aquifer is already extensively used, and has a sustainable yield of 36 mm³/a, currently allocated up to 32.8 mm3/a (KWMA). The MAWF has divided the Karst aquifers in the Grootfontein-Tsumeb-Otavi area into compartments for administrative purposes. The site	***Opportunities:*** *The groundwater resources from the Karst aquifer has good potential, however it is extensively utilised. Investigations will be required to determine whether localised water resources will be sufficient to serve needs of combustion facility.* ***Constraints:*** *Water Abstraction Permit Required.*

	falls on the border of compartment B1 and B2, for which the total abstraction permits are limited to 2.4 Mm3/year and 5.2 Mm3/year respectively (Mazambani et al). According to Christian & Associates, (2009) the area around Tsumeb has high groundwater potential (~15m^3/ hour >360m^3/day).	
Visual	The site is not situated near to any areas of touristic or conservation value. However the site will be extremely visible driving from downhill out of Tsumeb towards Etosha on the B1. The visual landscape of the site locality is already diminished by the quarry and substation.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified.*
Cultural heritage	Unlikely due to location, however unknown at this stage. Namibia is endowed with rich cultural and archaeological heritage therefore this will need to be assessed at the scoping phase of the environmental assessment.	***Opportunities:*** *None identified.* ***Constraints:*** *None identified.*

6 Legislative Framework

A review of Namibia's environmental legal framework has been undertaken to ensure that the proposed EBtP project is designed in accordance with Namibian laws, policies and environmental objectives (ref. Section 6.1). In addition a review of relevant international standards and best practice was carried out e.g. IFC standards (Section 6.2).

6.1 National Legislation

Bush encroachment has long since been recognised by the Namibian government as a matter of concern and is consequently reflected in several policies and laws; notably the National Agricultural Policy, the Soil Conservation Act, the Forest Act 2001 and the draft Rangeland Strategy. A detailed review of all relevant environmental legislation and policies is provided in Appendix A. The Acts summarised in this section are limited to those **that place direct permitting requirements on the proposed project**; namely the:

- Environmental Management Act (No. 7 of 2007);
- Atmospheric Pollution Prevention Ordinance (No. 11 of 1976);
- Water Act (No 4 of 1956);
- Water Resources Management Act, 2004 (Act No. 24 of 2004);
- Forest Act (No. 21 of 2001); and the
- National Heritage Act (No. 27 of 2004);
- Pollution Control and Waste Management Bill of 1999 (in preparation)
- Nature Conservation Ordinance (No. 4 of 1975)

Additional legislation, policies and conventions relevant to the proposed project, but which do not contain direct permitting requirements, are provided in Appendix A:

- The Constitution of Namibia;
- The Soil Conservation Act No 76 of 1969 & the Soil Conservation Amendment Act No38 of 1971;
- The Labour Act (No. 11 of 2007);
- National Agricultural Policy;
- Draft Rangeland Policy (forthcoming);
- Draft Bush Encroachment Policy;
- Namibia's National Development Plan – Vision 2030); and
- Town and Regional Planning Considerations

6.1.1 Environmental Management Act (No. 7 of 2007)

The Environmental Management Act (No. 7 of 2007) (EMA) requires adherence to the principle of optimal sustainable yield in the exploitation of all natural resources and includes provision for equitable use of natural resources; the requirement for assessments to be undertaken for projects which may have significant effects on the environment or the use of natural resources; and introduces the 'polluter pays' principle.

The EMA came into effect on 6 February 2012. At this time, the Minister issued a Notice on the basis of Section 27 of the Act, listing various activities that require Environmental Clearance Certificates (ECC) (Government Notice No. 29, 2012). In addition, the Minister issued Environmental Impact Assessment Regulations:

Environmental Management Act (2007) (EIAR), detailing the application process for the ECC's (Government Notice No. 30, 2011).

WSP has undertaken a preliminary review of the applicability of the 2012 ECC regulations relative to the proposed EBtP project. This review considered the regulations in terms of the supply chain (**harvesting – H**; **transport – T**; **storage – S**), treatment (**torrefaction – To**) and processing (**straight combustion – SC**; **co-firing at Van Eck – Co**) (Table 24). It must be noted that in certain scenarios (e.g. Torrefaction), the project developer would be responsible for the environmental authorisation process.

Table 24. Relevant Listed activities within the EMA potentially applicable to the EBtP project (red denotes the potential triggering of an activity)

No.	Trigger – GN R 29 (2012)	H	T	S	To	SC	Co
1	The construction of facilities for- - (a) the generation of electricity; (b) the transmission and supply of electricity;						
		Development of a greenfield biomass power station will trigger this activity. An amendment of the existing Environmental Clearance Certificate (ECC) at Van Eck power station will likely be required for the co-firing scenario.					
2.1	The construction of facilities for waste sites, treatment of waste and disposal of waste						
		Potentially applicable in the event that waste management facilities are constructed.					
2.2	Any activity entailing a scheduled process referred to in the Atmospheric Pollution Prevention Ordinance, 1976						
		Development of a greenfield biomass straight combustion or co-firing power station is a scheduled process listed in the 1976 Ordinance & will therefore trigger this activity.					
2.3	The import, processing, use and recycling, temporary storage, transit or export of waste.						
		Should waste ash be utilised (recycled) as a cement feedstock at the Ohorongo site, this would be applicable.					
4	The clearance of forest areas, deforestation, afforestation, timber harvesting or any other related activity that requires authorisation in term of the Forest Act, 2001 (Act No.12 of 2001) or any other law						
		The harvesting of encroacher bush will require a license in terms of the Forestry Act, 2001.					
5.1	The rezoning of land from*: (a) residential use to industrial or commercial use; (b) light industrial use to heavy industrial use; (c) agricultural use to industrial use; and (d) use for nature conservation or zoned open space to any other land use.						
		Triggering of this activity will depend on the current zone classification of the site chosen for development.					
8.1	The abstraction of ground or surface water for industrial or commercial purposes.						
		Groundwater abstraction may be required, in which case this listed activity will be triggered. In the case of the torrefaction this would be the responsibility of the developer, not NamPower.					

8.2	The abstraction of groundwater at a volume exceeding the threshold authorised in terms of a law relating to water resources*	Potentially applicable, however it is unclear what these thresholds are.
8.9	Construction and other activities within a catchment area	Potentially applicable, however the definition of "catchment area" is unclear.
9.1	The manufacturing, storage, handling or processing of a hazardous substance defined in the hazardous substances ordinance, 1974	Potentially applicable, however the listing of hazardous materials was not sourced.
9.2	Any process or activity which requires a permit or licence or other form of authorisation or the modification of or changes to existing facilities for any process or activity which requires an amendment to an existing permit, licence or authorisation or which requires a new permit in terms of a law governing the generation or release of emissions.	Potentially applicable

Based on the findings of the preliminary review **the proposed EBtP will require an Environmental Clearance Certificate** and will therefore require that an Environmental and Social Impact Assessment (EIA) be carried out. In addition, if funding is sourced from international development finance institutions, there will likely be a requirement to conform to International Finance Corporation (IFC) performance standards in the application of the EIA process.

6.1.2 Summary of the Namibian Environmental Assessment Process

The Namibian Environmental Assessment Process is overseen by the Ministry Environment & Tourism (MET). The requirement for an EIA is outlined as above, listed in Government Notice No. 29 of 2012 (GN 29) containing a list of activities which trigger the need for environmental authorisation. No further thresholds within these triggers apply.

The EIA process is detailed in Government Notice No. 30 of 2012 (GN 30). An application for an Environmental Clearance Certificate (ECC) is submitted to the Environmental Commissioner detailing title, nature, location, scale and scope of activity. In the case of the EBtP project, the proponent must also notify the Ministry of Mines and Energy regarding the project, as the relevant competent authority.

Following submission of the application, the proponent and designated Environmental Assessment Practitioner (EAP) proceed with the development of a Scoping Report as detailed in Section 7 of the Act, and as part of the process must conduct a public consultation process in accordance with Regulation 22 of the EMA.

Following submission of the Scoping Report, the environmental commissioner (EC) considers the contents of the report, scale and magnitude of impacts and determines the need for further assessment. The EC must determine the scope procedures and methods for the detailed (EIA) assessment in terms of Section 35(1) of the Act.

The EIA will be accompanied by an Environmental Management Plan which outlines how the project proponent will mitigate environmental impacts at each stage of the project (construction, operation and decommissioning). Should the impacts be shown to be adequately mitigated, satisfying the needs of the Act and the relevant authorities, an ECC will be issued.

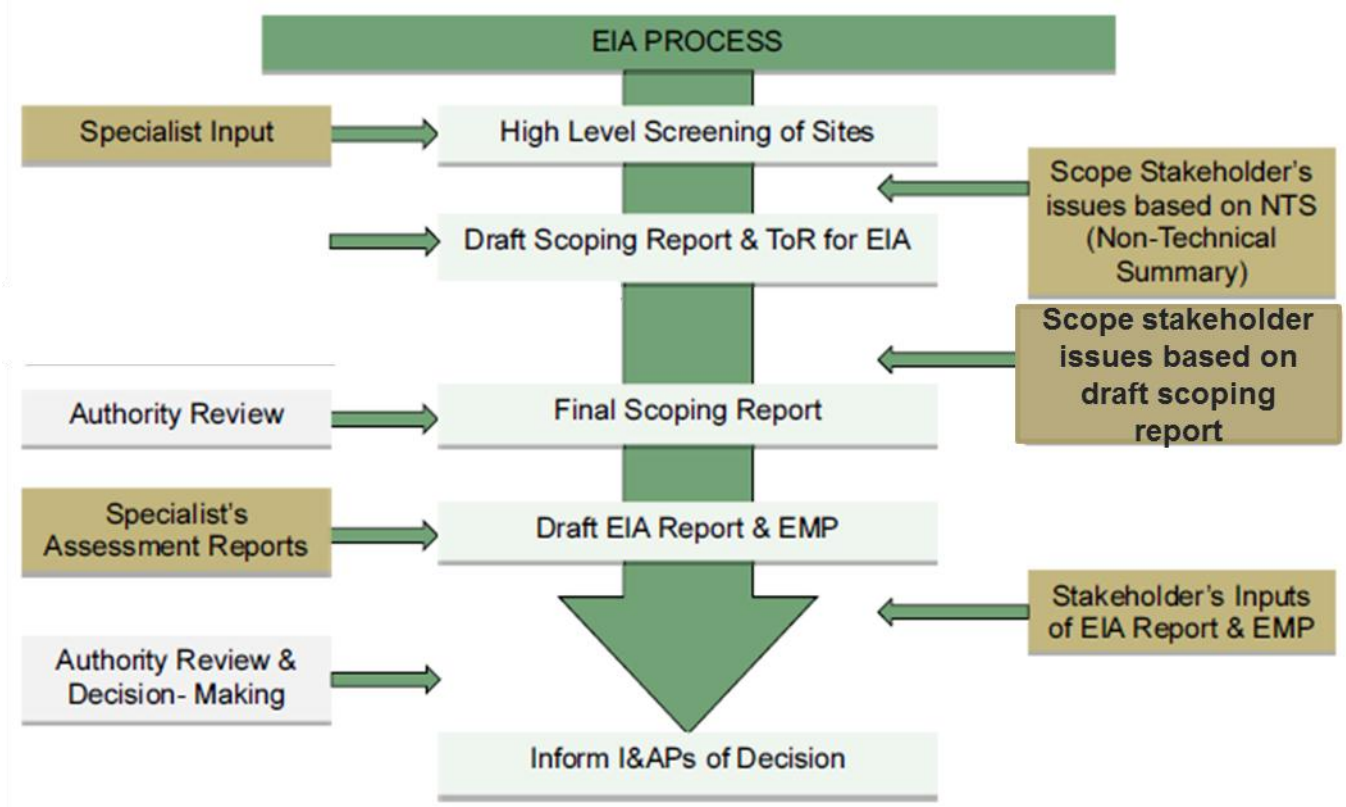

Figure 13 Namibian EIA Process

6.1.3 Atmospheric Pollution Prevention Ordinance (No. 11 of 1976)

Line Ministry: Ministry of Health and Social Services

Namibia has adopted the old South African air pollution legislation for air quality control in the form of the Namibian Atmospheric Pollution Prevention Ordinance (Ordinance No. 11 of 1976). Based on the stipulations of this Act, the following parts are applicable:

- Part II: Controls of noxious or offensive gases;
- Part III: Atmospheric pollution by smoke;
- Part IV: Dust control; and
- Part V: Air pollution by fumes emitted by vehicles.

The Namibian Atmospheric Pollution Prevention Ordinance (Ordinance No. 11 of 1976) does not include any ambient air standards to comply with, but the Chief Air Pollution Officer (CAPCO) provides air quality guidelines for consideration during the issuing of Air Pollution Certificates (APCs). Air Pollution Certificates are only issued for so called "Scheduled Processes" which are processes resulting in noxious or offensive gasses and typically pertain to point source emissions.

WSP has undertaken a preliminary review of the applicability of the APC regulations relative to the proposed EBtP project. This review considered the regulations in terms of the supply chain (harvesting – H; transport – T; storage – S), treatment (torrefaction – T) and processing (straight combustion – SC; co-firing at Van Eck – Co) (Table 4).

Table 25 Listed activities within the Ordinance potentially applicable to the EBtP project (red denotes the potential triggering of an activity)

No.	Trigger – Schedule 2	H	T	S	To	SC	Co
29	Power stations: That is to say, processes in which – a) Solid or liquid fuels are burned to raise steam for the generation of electricity for distribution to the public or for purposes of public transport.						
		Both conversion alternatives, straight combustion and co-firing at Van Eck, will require an APC. However, Van Eck is expected to already process an APC in which case an amendment to the existing APC may be required.					

Note: Although the EBtP project triggers a Scheduled Process in terms of the Atmospheric Pollution Prevention Ordinance and will therefore require an APC, knowledge gained through the stakeholder consultation process suggests that at present the Ministry does not grant any certificates as no procedures or guidelines to facilitate the authorization process are in place. In line with best practice it is recommend that, if the project is to go ahead, an air quality assessment be undertaken and the Ministry notified of the anticipated emissions. Further to this as no legislated ambient emission standards for Namibia currently exist; ambient guidelines published by the World Health Organization (WHO) should be applied.

6.1.4 Water Act (No 54 of 1956)

Line Ministry: MAWF

A key component of the Water Act (no 54 of 1956) is the creation of Subterranean Water Controlled Areas (SWCA), dealt with in sections 27 to 55 for which authorisation from the Ministry must be sought for the abstraction of groundwater using a borehole. Should the project be situated within a SWCA, a Water Abstraction Permit will be required.

Table 26. Listed activities within the Act potentially applicable to the EBtP project (red denotes the potential triggering of an activity)

No.	Trigger – Chapter III	H	T	S	To	SC	Co
28	*Any person who plans to sink, enlarge, deepen or alter any borehole or well or to open up or clean any spring or to abstract or use subterranean water, shall apply for a permit.*						
		Potentially applicable.					

The process is such that a Water Abstraction Permit Application should be submitted together with the Environmental Impact Assessment adequately detailing the impact upon the environment, existing water users and water resources. The permit application will detail the nature of the activity, the volume of water required and the exact location of boreholes amongst others. The permit application will usually be reviewed over a period of 4-6 weeks. The licence is valid for a period of five years, upon which renewal must be sought.

In terms of effluent disposal, if required, a disposal permit shall be obtained from the Ministry of Agriculture, Water and Forestry. Disposal shall succumb to disposal standards, as per the Namibia water quality guidelines and the common practice South Africa's (SABS) standards are normally sanctioned in these permits.

Note: The MET is the custodian of Namibia's natural environment and discharges this duty via environmental regulations. The MET is thus the lead agent for Environmental Impact Assessment (EIA); however licensing of

water abstraction, use and disposal is only considered once an EIA acceptable to MAWF has been submitted and a Record of Decision has been handed down.

The process for obtaining a Water Abstraction Permit Application should be submitted together with the Environmental Impact Assessment adequately detailing the impact upon the environment, existing water users and water resources. The permit application will detail the nature of the activity, the volume of water required and the exact location of boreholes amongst others. The permit application will usually be reviewed over a period of 4-6 weeks. The licence is valid for a period of five years, upon which renewal must be sought.

In terms of effluent disposal if required, a disposal permit shall be obtained from the Ministry of Agriculture, Water and Forestry. Disposal shall succumb to disposal standards, as per the Namibia water quality guidelines and the common practice South Africa's (SABS) standards are normally sanctioned in these permits.

It should be noted that the MET is thus the lead agent for Environmental Impact Assessment (EIA); however licensing of water abstraction, use and disposal is only considered once an EIA acceptable to MAWF has been submitted and a Record of Decision has been handed down.

6.1.5 Water Resources Management Act, 2004 (Act No. 24 of 2004)

Line Ministry: MAWF

The new Water Resources Management Act, (no 24 of 2004) has been approved and was published and gazette, however, it has not yet come into force as a date for commencement of the Act as prescribed by Section 138(1) (b) of the same Act has not yet been determined by the Minister. The Act is currently being amended to take into account practical aspects of implementation. No date has been put forth for a gazette of amendments. The Water Act (No 56 of 1956) therefore technically remains in force until the new Water Resources Management Act comes into force upon signature by the Minister.

Table 27 has been included for the event that the new Act comes into force, although essentially, the requirements for permitting will not change. The main point of difference from the old legislation will be an expansion of subterranean water controlled areas to cover all aquifers in the country.

Table 27. Listed activities within the Act potentially applicable to the EBtP project (red denotes the potential triggering of an activity)

No.	Trigger – Part VIII	H	T	S	To	SC	Co
32	(1) Unless this Act provides otherwise, a person may not abstract water, except in accordance with a licence issues under this Act.						
38	(1) A license containing terms and conditions referred to in Section 37 of this Act may be issued as a combined license to abstract and use water and to discharge effluent.						
46	A person may not drill, construct, enlarge or otherwise alter a borehole, or engage in a borehole drilling programme, for the purpose of exploring for groundwater, except in accordance with a permit issued under subsection (4).						

3.1.6 The Forest Act (12 of 2001) Amended Act 13 of 2005

Line Ministry: MAWF

The Forest Act (no 21 of 2001) is aimed at the sustainable management of forests, and clearly states: "the purpose for which forest resources are managed and developed … is to conserve soil and water resources, maintain biological diversity…" Although much of the Act relates to classified forests, the above provisions apply not only to classified forests but also to "any piece of land". This Act is therefore highly relevant to any bush clearing activities, and it makes specific provisions in regard to permitting requirements.

Table 28 Listed activities within the Act potentially applicable to the EBtP project (red denotes the potential triggering of an activity)

No.	Trigger - Part V	H	T	S	To	SC	Co
22	(1) Unless otherwise authorised by this Act, or by a licence issued under subsection (3), no person shall on any land which is not part of a surveyed erven of a local authority area as defined in section 1 of the Local Authorities Act, 1992 (Act 23 of 1992) cut, destroy or remove- (a) vegetation which is on a sand dune or drifting sand or on a gully unless the cutting, destruction or removal is done for the purpose of stabilising the sand or gully; or (b) any living tree, bush or shrub growing within 100 metres of a river, stream or watercourse. (2) A person who wishes to obtain a licence to cut and remove the vegetation referred to in subsection (1) shall, in the prescribed form and manner, apply for the licence to a licensing officer who has been designated or appointed for the area where the protected area is situated.						
		Harvesting of encroacher bush from private farms will potentially be subject to this clause.					
23	(1) Unless approval has been given by the director, no person shall: (b) clear the vegetation on more than 15 hectares of any piece of land or several pieces of land situated in the same locality (c) cut or remove more than 500 cubic metres of forest produce from any piece of land in a period of one year						
		Harvesting of encroacher bush from private farms will trigger this activity.					
24	(1) Forests and forest produce shall, in Namibia, subject to the permission of the owner of the land or the management authority of a classified forest and to the terms of a license issued under this Act, be used in accordance with an applicable management plan.						
		Harvesting of encroacher bush from private farms will trigger this activity.					
24	(3) The owner or legal occupier of any land, including communal land may, subject to						
		Harvesting of encroacher bush from private farms					

	any applicable management plan, in which harvesting limits are set in or an agreement entered into under this Act and Section 26, without a licence, harvest forest produce from the land he or she owns or occupies and dispose of that forest produce in any way he or she likes.	will trigger this activity.
26	Subject to a relevant management plan, the Director shall determine the quantity of forest produce for which a license may be issued in a forest reserve or a community forest and the maximum quantity of forest produce which may be harvested under Section 24 (3)	Harvesting of encroacher bush from private farms will trigger this activity.

The Forest Act (12 of 2001) Amended Act 13 of 2005 specifically refers to the need for a permit to harvest. Section 48 stipulates that the Minister may make regulations in relation to-

(l) The transportation, processing, sale and exportation of forest produce and the issuing of permits, licences or other documents required for those activities;

Although no specific mention for the need to obtain a permit for harvesting can be sourced within the Act, it is listed on the MAWF website and referred to in the National Forest Policy Statement,

"The transport permit is required for applicants that are selling the Forest Produce whereas the own use is for those applicants that need the produce for their own consumption".

In specific reference to protected Species under the Act, the species *Colosupheum Mopane* is a protected species but also acknowledged as a species associated with bush encroachment. Liaison with the Forestry Department indicates that this species can be removed as part of bush clearing activities; however a sensitive approach should be adopted with regards to removal rate.

6.1.6 National Heritage Act (No. 27 of 2004)

Line Body: National Heritage Council

The National Heritage Act (No. 27 of 2004) provides for the protection of places and objects of heritage significance, including any remains of human habitat that are more than 50 years old, and rock art. "Heritage significance" means aesthetic, archaeological, architectural, cultural, historical, scientific or local significance (i.e. items such as ruins, archaeological artefacts, rock art, military objects, meteorites or possibly even fossils).

Such items or sites containing them shall not be disturbed and no such material shall be moved, removed or sold. Should any such items or places be found they have to be reported immediately to the National Heritage Council. It also makes provision for archaeological 'impact assessments' (Part V: Permits, paragraphs 51 and 52).

Table 29. Activities within the Act potentially applicable to the EBtP project (red denotes the potential triggering of an activity)

No.	Trigger - Part V	H	T	S	To	SC	Co
Para 51/52	A permit must be obtained before disturbing or destroying a heritage site as set out in the Act.	Potential for this clause to be triggered at both the harvesting and combustion sites.					

6.1.7 Nature Conservation Ordinance 4 of 1975 and Amendments

This Ordinance covers game parks and nature reserves; the hunting and protection of wild animals (including game birds), problem animals and fish; and the protection of indigenous plants. Section 73 of the Ordinance provides that no person is permitted to pick a protected plant without a permit issued by the Minister of Environment and Tourism. *Picking* includes as including damaging or destroying:

No.	Trigger	H	T	S	To	SC	Co
73	(1) No person other than the lawful holder of a permit granted by the Minister shall at any time pick or transport any protected plant: Provided that – (a) the owner [of] a nursery licensed under section 75 may without such permit pick and transport any protected plant cultivated on the premises of such nursery and cause such protected plant to be picked and transported; (b) the owner or lessee of land may on that land without such permit pick the flower of a protected plant for use as a decoration in his home; (c) the owner or lessee of land may without such permit pick a protected plant on that portion of such land – (i) Which he needs for cultivated lands, the erection of a building, the construction of a road or airfield or any other development which necessitates the removal of vegetation; or (ii) on which such protected plant has been specially cultivated.						
		Potential for this clause to be triggered at both the harvesting and combustion sites.					

6.1.8 Hazardous Substances Ordinance (1974)

Line Ministry: Drug Law Enforcement Unit (DLEU) of the Namibian Police, within the Ministry of Safety and Security

The Hazardous Substances Ordinance of 1974 provides for control of toxic substances (including manufacture, use, disposal, import and export). Under the Ordinance it is an offence to dump of hazardous matter that may be detrimental to the environment.

The ordinance will eventually be repealed by the Pollution Control and Waste Management Bill of 1999 (in preparation) Prevention and regulation of air, water and land pollutants; establishment of an appropriate framework for integrated pollution prevention and control, regulation of noise, dust and odour, as well as an establishment of a system of waste planning and management (see Section 6.1.9).

Note: Control of waste Handling and storage is primarily handled through the environmental authorisation process. Hazardous waste should be disposed on landfill site that make provision for hazardous waste management. For disposal purposes, a permit shall be granted from the relevant local authority normally at the land fill site. Currently only two places in Namibia can handle hazardous waste - Windhoek and the Walvis Municipal landfill sites. In terms of the EMA 2007, these land fill sites should be certified by the Ministry of Environment. It is understood that Windhoek Municipality is currently undergoing this registration process.

6.1.9 Pollution Control and Waste Management Bill of 1999.

Line Ministry: Ministry of Environment & Tourism

The Pollution Control and Waste Management Bill, which is currently in preparation and therefore not yet enforceable, aims to promote sustainable development; to provide for the establishment of a Pollution Control and Waste Management Unit; to prevent and regulate the discharge of pollutants to the air, water and land, to regulate noise, dust and odour pollution, to make provision for the establishment of an appropriate framework for integrated pollution prevention and control, to establish a system of waste planning and management and to enable Namibia to comply with its obligations under international law in this regard.

The Act regulates the validity of licences or registration referred to in Section 5. It deals with hazardous substances of Groups I to IV. However, while environmental aspects are not really explicitly stated, guidelines for the importing, storage, handling, etc. of hazardous substances are set out.

The Bill also requires under Section 58, that the application for a Waste Management Licence (WML) must be applied for in order to collect transport store or recover or dispose of the hazardous waste. The application must be accompanied by details of the activity to which the application relates, including the nature and location of the activity and its actual and potential effects on the environment. Section 60 states that every person that owns a waste site shall hold and comply with the conditions of waste site licence. Members of the public must be given the opportunity to comment on all licence applications. The inspectors, who will be appointed for the purposes of this Bill, will have wide ranging powers including the power to enter and search any premises or vehicle without a warrant or court order and to collect evidence as required.

6.2 International Best Practice

6.2.1 IFC Performance Standards

Although the Environmental Assessment for the Nampower EBtP would not require formal submission to the IFC, project funding agencies typically refer to IFC assessment guidelines for the level of environmental and social assessment required. To this end, the IFC has an established a set of standards that need to be met by the investee throughout the life of the investment. The IFC Performance Standards (PS) focus on the applicant's capacity to manage environmental and social risks and opportunities throughout the projects lifetime. A comprehensive EIA at the outset of the project is just one part of it.

There are eight IFC Performance Standards with each Standard providing a set of requirements to ensure sustainable performance in relation to criteria specified. The IFC has published complimentary guidance notes that facilitate the interpretation of the application of these standards (IFC, January 2012).

Table 30. Summary of IFC Performance Standards

Principle	Requirement
Performance Standard 1: Assessment and management of environmental and social risks and impacts	
The applicant, in coordination with other responsible government agencies and third parties as appropriate, will conduct a process of environmental and social assessment, and establish and maintain an Environmental and Social Management System (ESMS) appropriate to the nature and scale of the project and commensurate with the level of its environmental and social	The ESMS will incorporate the following elements: (i) policy; (ii) identification of risks and impacts; (iii) management programs; (iv) organizational capacity and competency; (v) emergency preparedness and response; (vi) stakeholder engagement; and (vii) monitoring and review.

risks and impacts.

Performance Standard 2: Labour and working conditions	
The applicant will be responsible to ensure promotion of the fair treatment of workers and compliance with national labour laws and occupational health and safety.	The requirement will be placed on the applicant to develop a Labour Policy and Management Plan which encompasses the following elements: (i) Human Recourse Policies and Procedures; (ii) Working Conditions and Terms of Employment, (iii) Workers Organisations, (iv) Non-Discrimination and Equal Opportunity, (v) Retrenchment, (vi) Grievance Mechanisms, (vii) Child Labour, (viii) Forced Labour, (ix) Occupational Health & Safety, (x) Workers Engaged by Third Party and (xi) Supply Chain
Performance Standard 3: Resource Efficiency and Pollution Prevention	
During the project life-cycle, the applicant will need to consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimize adverse impacts on human health and the environment. The principles and techniques applied during the project life-cycle will be tailored to the hazards and risks associated with the nature of the project and consistent with good international industry practice (GIIP), as reflected in various internationally recognized sources, including the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines).	In order to ensure that this performance standard is adhered to requirements will need to be considered during the project design phase for: (i) resource efficiency; (ii) greenhouse gas emissions; (iii) water consumption; (iv) pollution prevention; (v) waste management; and (vi) hazardous materials management.
Performance Standard 4: Community health, safety and security	
The applicant will need to evaluate the risks and impacts to the health and safety of the Affected Communities during the project life-cycle and establish preventive and control measures consistent with good international industry practice (GIIP), such as in the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) or other internationally recognized sources. The client will identify risks and impacts and propose mitigation measures that are commensurate with their nature and magnitude. These measures will favor the avoidance of risks and impacts over minimization.	In meeting these requirements the applicant will need to undertake a Health and Safety Assessment encompassing the design, operation and decommissioning phases of the project which includes the following elements: (i) infrastructure and equipment design and safety; (ii) hazardous materials management and safety; (iii) ecosystem services; (iv) community exposure to disease; (v) emergency preparedness and response; and (vi) security personnel.
Performance Standard 5: Land Acquisition and Involuntary Re-settlement	
Although an unlikely scenario, due to the fact that the applicant will utilise private farmland, The applicant will need to sure that any acquisition or restrictions on land-use do not adversely affect communities and persons utilising this land.	Should involuntary resettlement (replacement of livelihood or loss of shelter) be occur as a result of the project Resettlement Action Plan or Livelihood Restoration Plan will be formulated during the EIA phase to minimise the adverse social and economic implications of the project on displaced communities, ensuring that resettlement is accompanied by the appropriate compensation which ultimately improves

	or restores the livelihood of the resettled individuals. The scope of the assessment will include, i) project design, ii) compensation and benefits for displaced persons, iii) community engagement iv) grievance mechanisms iv) resettlements and livelihood restoration planning.
Performance Standard 6: Conservation, Biodiversity and Natural Resource Management	
The performance standard recognises that conserving biodiversity and managing natural resources are fundamental to sustainable development. Projects located in modified, *natural and critical habitats* or that potentially affect *ecosystem services* will undergo assessment to ensure management of such critical resources.	In order to meet these requirements a Biodiversity Impact Assessment will be undertaken during the EIA phase of the project to identify species that require protection and conservation and the appropriate management regime. The scope of assessment includes listing and quantification of the following: i) critical habitat definition ii) endemic and restricted range species iii) migratory and congregatory species iv) highly threatened or unique ecosystems v) client requirements in critical habitat vi) development of a biodiversity action Plan (BAP).
Performance Standard 7: Indigenous peoples	
During the project lifecycle, the applicant will need to consider social groups with identities that are distinct from mainstream groups in national societies (indigenous peoples).	Where communities of Indigenous Peoples are affected or impacted by the project within the project's area of influence a Community Development Study must accompany the EIA process to anticipate potential adverse impacts of the project on communities of Indigenous peoples, and minimize and compensate for such impacts as well as to promote on on-going relationship based on a stakeholder engagement process. The study would entail very detailed cultural and baseline information, including i) environmental and social risks ii) risk and opportunity analysis iii) stakeholder consultations iv) mitigations V) grievances vi) forward planning (costs budgets) following: The outcome of the process would be an informed consent form the community with a plan for continued dialogue.
Performance Standard 8: Cultural Heritage	
Performance Standard 8 aims to ensure that clients protect natural cultural heritage in the course of project activities. The applicant will need to ensure protection and preservation of cultural heritage resources and promote equitable sharing of the benefits.	Where there is the potential for adverse impact on cultural heritage resources (tangible and non, i.e. landscapes) a heritage impact assessment and Archaeological Impact Survey must be conducted to identify any sites of potential cultural and heritage significance in order to protect them from the adverse impacts of project activities. The general process includes: (i) a detailed description of the proposed project including its alternatives; (ii) heritage baseline conditions in the project's area of influence; (iii) an analysis of project alternatives in relation to the baseline conditions to determine potential impacts; and (iv) proposed impact mitigation measures, which may include avoidance or reduction of impacts by project design changes and/or the introduction of special construction and operational procedures, and compensatory mitigations such as data recovery and/or detailed study.

The IFC EHS Guidelines serve as a technical reference source to support the implementation of the IFC Performance Standards, particularly in those aspects related to Performance Standard 3: Pollution Prevention and Abatement, as well as certain aspects of occupational and community health and safety.

6.2.2 World Bank EHS Guidelines – Industry Specific (Thermal Power Plants)

In addition to the General EHS Guidelines (2007), the IFC EHS Guidelines for Thermal Power Plants (2008) is a technical reference document with general and industry specific examples of good international industry practice. The industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document. The industry sector EHS guideline for thermal power plants includes information relevant to combustion processes fuelled by gaseous, liquid and solid fossil fuels and biomass and designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type (except for solid waste which is covered under a separate Guideline for Waste Management Facilities), with a total rated heat input capacity above 50 Megawatt thermal input (MW) on Higher Heating Value (HHV) basis. It applies to boilers, reciprocating engines, and combustion turbines in new and existing facilities.

The EHS Guidelines contain the performance levels and measures that are normally acceptable and are generally considered to be achievable in new facilities at reasonable costs by existing technology. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets with an appropriate timetable for achieving them. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to IFC, become project- or site-specific requirements.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

The project will in the feasibility study have to commit itself to a design which demonstrably meets the IFC H&S Guidelines for Thermal Power plants. Refer to Appendix B for a copy of the standards relevant to this project.

7 Way Forward

7.1.1 Environmental Assessment

As determined in Section 6, NamPower (or the IPP or Special Purpose Vehicle) will be required to receive authorisation in terms of the Environmental Management Act (No.7 of 2007). Once the site and engineering design have been finalised, an application to the Ministry of Environment and Tourism for an Environmental Clearance Certificate will be required. Depending on investor requirements the ESIA may be required to conform to IFC standards (and potentially the Equator principles). A suitably qualified team of independent environmental consultants will be required to complete the environmental assessment process.

The final ESIA for submission may have to include additional elements necessary to fulfil the requirements of an IFC standard ESIA. This consolidated ESIA can be submitted to the Namibian authorities. However, if time constraints exist it is possible to submit a basic EIA as required by national legislation to the authorities in order to receive an authorisation and while a decision is pending, update the document with the additional IFC requirements for assessment by the investor.

Typically an ESIA requires a holistic vision of the project and therefore in the case of Scenario 1 (partnership with CCF), the project proponent will need to include the harvesting activities (envisaged under a contract supply basis) in the ESIA even if this is not part of the funded component.

The assessment process required to conform to IFC standards is more detailed, therefore time-consuming and costly than the national ESIA process. There is a strong emphasis on social aspects of the assessment under the IFC guidelines and a whole life-cycle approach is required to unpack the detail and knock on impacts of the study.

The estimated minimum time frame for the completion for completion of an IFC standard of this nature is approximately 1 – 1.5 years.

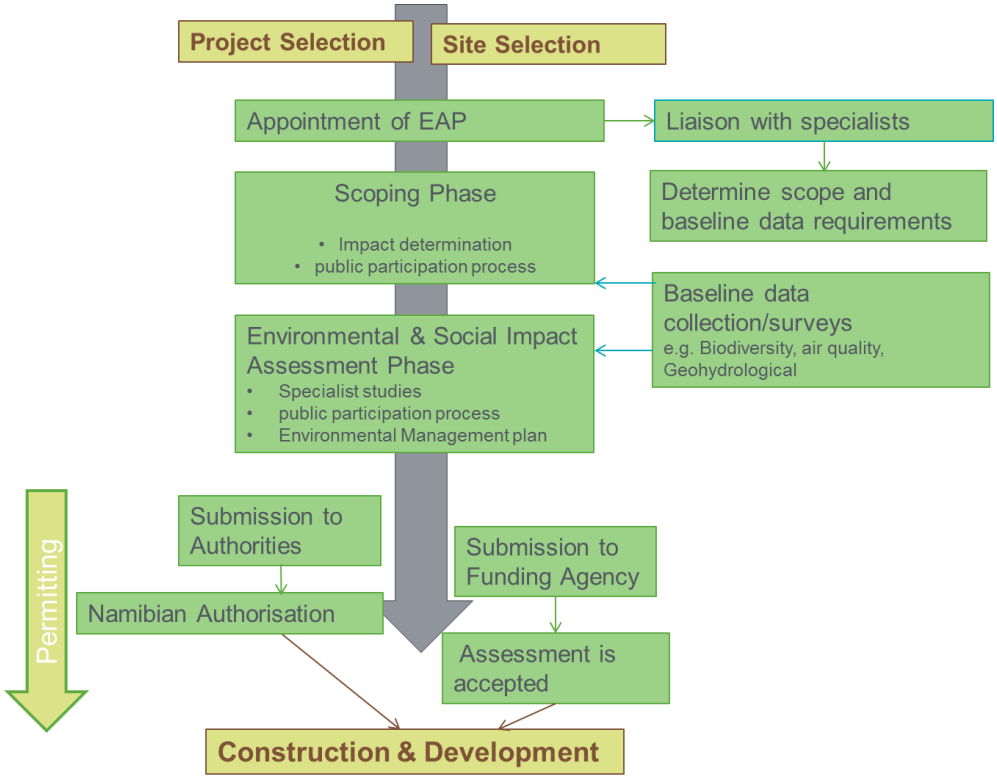

Figure 14. Schematic diagram of way forward

7.1.2 Specialist studies

Taking into account the impacts identified during the screening phase, as well as the site specific conditions associated with each site a high-level analysis of the specialist study requirement is provided in Table 31. These requirements will be confirmed during the scoping stage of the assessment.

Table 31 Specialist Study (Y= Probable requirement, N = probable no requirement, L = likely, UL = unlikely, UN = unknown)

Scenario EIA/ Specialist Study	1 SC (5MW)	2a/2b SC (20MW)	2c/2d SC (20MW)
Environmental Impact Assessment	**Y**	**Y**	**Y**
Air Quality Specialist Study	**Y**	**Y**	**Y**
Biodiversity Specialist Study	**Y**	**Y**	**Y**
Land Use-Land capability (soils & geology) Specialist Stud	**Y**	**Y**	**Y**

Geohydrology Specialist Study	**Y**	**Y**	**Y**
Social Impact Assessment Specialist Study	**Y**	**Y**	**Y**
Traffic Specialist Study	**Y**	**UN**	**UN**
Visual Specialist Study	**UL**	**UL**	**UL**
Waste Management Plan	**Y**	**Y**	**Y**
IFC Specialist Study Requirement			
1. Social and environmental assessment and management system/ ESIA	**Y**	**Y**	**Y**
2. Labour and working conditions/ Labour Plan	**Y**	**Y**	**Y**
3. Pollution Prevention and abatement/ Specialist studies	**Y**	**Y**	**Y**
4. Community health and safety/ H&S Assessment	**Y**	**Y**	**Y**
5. Land acquisition and involuntary resettlement/ Resettlement Plan	**UL**	**UL**	**UL**
6. Conservation, Biodiversity and Natural Resource Management/ Biodiversity Study	**Y**	**Y**	**Y**
7. Indigenous peoples/ Community development study	**UL**	**UL**	**UL**
8. Cultural heritage/ heritage impact assessment and archaeological impact survey	**UL**	**UL**	**UL**
Indicative Timeframe (Namibian EIA)	**~ 8 months -1 year**		
Indicative Cost (Namibian EIA)	**~1,500,000 – 2,500,000 N$**		
Indicative Timeframe (IFC EIA)	**~ 1 - 1.5 years**		
Indicative Cost (IFC EIA)	**~1,800,000 – 3,500,000 N$**[5]		

7.1.3 Permitting Requirements

A summary of likely permitting requirements is provided in Table 33.

Table 32. Permitting requirements per scenario

Aspect	Permit Type	Scenario 1	Scenario 2a	Scenario 2b	Scenario 2c	Scenario 2d
Water Usage	Water Abstraction Permit	Possible	Yes[6]; application submitted with EIA technical report	Yes; application submitted with EIA technical report	Yes; application submitted with EIA technical report	Yes; application submitted with EIA technical report
Water Discharge	Water Discharge Permit	Very unlikely (no discharge anticipated)	Very unlikely (no discharge anticipated)	Very unlikely (no discharge anticipated)	Very unlikely (no discharge anticipated)	Very unlikely (no discharge anticipated)
Forestry	Harvesting Permit	Yes, CCF to obtain	Yes	Yes	Yes	Yes

[5] The most expensive elements are expected to be geohydrological studies (geophysics, well drilling and pump testing) and, for the IFC option, air quality monitoring. Figures are indicative only.

[6] Possible extension of existing permit at Ohorongo Cement

	Transportation permit	Yes, CCF to obtain	Yes	Yes	Yes	Yes
Air quality	Air Pollution Permit	Permit no longer enforced, therefore, notification of department would be best practice.	Permit no longer enforced, therefore, notification of department would be best practice.	Permit no longer enforced, therefore, notification of department would be best practice.	Permit no longer enforced, therefore, notification of department would be best practice.	Permit no longer enforced, therefore, notification of department would be best practice.
Indicative cost of permitting applications		***~ N$ 40,000 – 50,000***				

7.1.4 Gap analysis

Due to the tight timeframes associated with the project, there is a need to identify gaps in the knowledge base or data early particularly where seasonal baseline data gathering is required.

Early consultation with the EAP (i.e. the EIA consultant), the Namibian authorities is ***strongly*** recommended to take place as soon as possible to minimise delays and to ensure that there are no lapses in this respect. In particular, the following gaps need to be assessed:

- Determine availability of baseline data
  - Air Quality – one year continuous baseline air quality monitoring data for all major emission parameters. Please note that installation of air quality monitoring stations may be required if this is not available and this can result in considerable expense (~N$ 350,000).
  - Biodiversity – one year seasonal biodiversity monitoring. If this data is not available a biodiversity assessment will be required.
  - Geohydrology – Annual wet and dry season borehole monitoring data, borehole monitoring may be required.
- Liaison with design team engineers to ensure that design meets specifications (e.g. air emissions) required by IFC.
- Development of a detailed stakeholder engagement resister for consultation process required as part of the ESIA.
- Liaison with various departments identified regarding future permitting requirements, and the potential to extend existing forestry and water abstraction permits.

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Appendix A – Relevant Legislation

The pertinent legislation relating to permitting requirements was provided in Section 6 of the report. The following legislation is also considered in reference to the development of the plant.

National Legislation

The Constitution of Namibia

The constitution of the Republic of Namibia (GRN 1990) sets the scene for subsequent environmental legislation and policy in Namibia. The general principles for sound integrated management of the environment and natural resources have been formulated to give effect to Articles 91(c) and 95(l) of the Namibian Constitution. Article 95 is of particular relevance to

"The State shall actively promote and maintain the welfare of the people by adopting policies aimed at ... The maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future..." [Constitution of the Republic of Namibia - Article 95 (1)].

The Soil Conservation Act No 76 of 1969 & the Soil Conservation Amendment Act No38 of 1971

Line Ministry: MAWF

This Act makes provision for the prevention and control of soil erosion and the protection, improvement and conservation of soil, vegetation and water supply sources and resources.

The MAWF may issue directives to land owners in respect of, amongst others the:

- prevention of erosion, the denudation, disturbance or drainage of land; and
- any other disturbance of the soil which creates or may create conditions which cause or may cause any form of erosion or pollution of water by silt or drift sand.

The Labour Act (No. 11 of 2007)

Line Ministry: Ministry of Labour and Social Welfare

The Act aims to "promote and maintain the welfare of the people and ... to further a policy of labour relations conducive to economic growth, stability and productivity". It details basic conditions of employment, and health, safety and welfare requirements of employers.

Town Planning Considerations: The Town Planning Ordinance, 18 of 1954

Town and regional planning in Namibia is guided by two ordinances, namely the Township and Division of Land Ordinance, 1963 (Ordinance 11 of 1963), as amended, which generally regulates and spells out the subdivision and consolidation of land, and the Town Planning Ordinance, 1954 (Ordinance 18 of 1954), as amended, which guides and regulates the land uses permitted on each land parcel as registered with the Deeds Office. Although the Namibian Government: Ministry of Regional and Local Government, Housing and Rural Development (MRLGHRD) is the principal Line Ministry tasked with monitoring and controlling urban development within municipal areas, various powers and duties relating to urban planning within local authority jurisdiction areas as described in the Local Authorities Act, 1992 and Regional Councils Act (no 22 of 1992) have been assigned to villages, towns or municipalities.

Summary of the planning process developed through discussion with Windhoek Municipality Town Planning Department:

- If the development occurs within a Municipal area, the local authority is required to give a council resolution. From there, a recommendation is provided to the National Planning Commission. This process may be lengthy (up to 1 year).
- If the development occurs within town land, the decision resides with the township council.
- If the development occurs within private farmland, the ministry of Agriculture, Water and Forestry takes authority. This process is usually quicker administratively taking from ½ to 1 year.
- Should the development occur on unsurvey state land, the Regional Council must be consulted and give approval for the proposed development, prior to application to the Ministry of Lands and Resettlement (MLR). This ministry must provide the final approval for alienation of state land in order to formalise development on unsurvey state land.

A town planner is generally consulted to run this process and usually costs in the region of R100,000 (H Rust, pers. comm) . If re-zoning is required a considerable time and cost increase can be expected. Re-zoning may cost up to R35000 and subdivision may cost R12 000 - R14 000 per plot.

Policies and International Conventions

National Agricultural Policy

Line Ministry: MAWF

The overall aim of the National Agricultural Policy (RoN 199a) is to

"Increase and sustain the levels of agricultural productivity, real farm incomes and national and household food security within the context of Namibia's Fragile ecosystem. This includes the sustainable utilisation of the country's land and other natural resources".

The NAP also regards eradication of bush as an important part of the strategy to exploit the full potential in commercial and small stock farming area, and the policy proposes to establish mechanisms to support encroachment over the short and long term, and will endeavour to promote labour intensive and private sector initiatives which use bush products. This strategy could include the development of bush clearing and utilisation industries which may include charcoal, fuel briquettes and chipboard manufacture.

Draft Rangeland Policy (forthcoming)

Line Ministry: MAWF

Potentially one of the most relevant policies concerning bush encroachment is the Draft Rangeland Policy, The policy is currently under review and not available public review at present. It is however recommended that the Policy should form an important component of the following stages of environmental assessment.

Draft Bush Encroachment Management Policy

The draft Bush Encroachment Management Policy is based closely on De Klerk's Encroacher bush in Namibia. The draft policy was supposed to be submitted to Cabinet in 2005. The document was prepared under the auspices of the MET, where it was *internally* approved. Thereafter, the Directorate of Forestry (DF) moved to the MAWF, which appears to have derailed the policy's submission to Cabinet.

Although the draft policy has no legal force, it deals vigorously with the problem of bush encroachment and describes the link between bush encroachment and desertification. It goes on to analyse the existing law and policy, and identifies major problem areas.

In its recommendations, the draft policy also identifies the need to create a socio-economic environment that provides incentives for farmers to improve the productivity of their pastures by controlling intruder bush and preventing re-infestation in an environmentally sustainable way (Diekman & Muduva, 2010). At the same time,

improved pasture management practices need to be encouraged to minimise the risks of future bush encroachment

Furthermore, the draft policy calls for the formulation and implementation of a policy to manage savannas on both freehold and non-freehold land as a priority. However, the document does not recommend that separate legislation be introduced to deal with bush encroachment and its thinning. Instead, as a prerequisite, the provisions of the Forest Act and the Soil Conservation Act, 1969 (No. 76 of 1969) should be amended to incorporate issues pertaining to encroached savannas that fall outside the definition of forest and classified forest. This will ensure the directions that management of all savannas in Namibia will take are much clearer.

Namibia's National Development Plan – Vision 2030

The Namibian Government has adopted a five year development plan scheme to ensure effective decision making. The current National Development Plan (NDP-3) runs from 2007/8 – 2011/12, presents a vision for the future course of development up until the time of the target year 2030. The predominant theme of NDP-3 (2030 Vision) is the accelerated economic growth through intensified rural development, while the productive utilisation of natural resources and environmental conservation are key result areas. Chapter 5 of Vision 2030 states the following: "The integrity of vital ecological processes, natural habitats and wild species throughout Namibia is maintained whilst significantly supporting national socio-economic development through sustainable low-impact, consumptive and non-consumptive uses, as well as providing diversity for rural and urban livelihoods." Principal environmental concerns include water, land, marine, natural resources, biodiversity and ecosystems, drought, and climate change. Waste management and pollution will grow significantly with increasing industrialisation. NDP3 recognises that with the country's scarce and fragile natural resource base, the risk of overexploitation is considerable, and that sustained growth is highly dependent on the sound management of these resources.

Other Conventions

Namibia is a signatory to a number of international conventions and agreements relating to industry, environmental management and energy. In certain cases these have influenced policy, guidelines and regulations and must be complied with during the planning, construction and operation of the proposed development.

Namibia is signatory to the following Conventions and Protocols, *inter alia* and the principles of these should be applied to the project. The date in brackets indicates when Namibia signed.

- International Covenant on Economic, Social and Cultural Rights (1966)
- United Nations Convention on Biological Diversity (1992)
- United Nations Framework Convention on Climate Change (1992)
- United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Convention (1995)
- United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification (1997)
- Southern African Development Community (SADC) Protocol on Energy (1998)
- Convention Concerning the Protection of the World Cultural and Natural Heritage (2002)
- Kyoto Protocol on the Reduction of Greenhouse Gas Emissions (2003)

Appendix B – IFC Air Quality Guidelines for Thermal Power Plants

- **Air Quality**

Since Namibia does not have local ambient air quality, reference is made to international criteria. The IFC EHS Guidelines contain reference to the widely published WHO guidelines for most widely referenced international air quality criteria.

- Projects with significant sources[7] of air emissions should ensure that they do not result in pollutant concentrations that reach or exceed national or WHO guidelines (http://www.who.int/en/). Table below
- Design considerations: Stack height must be designed according to GIIP whether significant or not.
- Data Considerations: Monitoring requirements – the IFC guidelines strongly recommend that monitoring programmes include baseline calculations. Before a project is developed, baseline air quality monitoring at and in the vicinity of the site should be undertaken to assess background levels of key pollutants, in order to differentiate between existing ambient conditions and project-related impacts.
- Emissions from point sources should be avoided and controlled According to good international industry practice (GIIP) applicable to the relevant industry sector, depending on ambient conditions, through the combined application of process modifications and emissions controls, examples of which are provided in Annex 1.1.2 of the EHS guidelines. Guidelines relevant to the industry sector are provided for specific pollutants which typically include sulphur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), particulate matter (PM) and greenhouse gases such as carbon dioxide (CO_2).
- Impacts to local AQ at the facility level should be undertaken using internationally recognised dispersion modelling techniques using local[8] atmospheric and climatic data.

Point source emissions

Table 33. South African Standards[9] and WHO standards for point source emissions

	WHO Standards (@ 6% O2) Non-degraded areas			WHO Standards Degraded areas[10]		
Emission rates (mg/Nm^3)	Limit for boilers <50MWth fuel	Limit for (solid fuel) boilers >50 MWth to <600MWth fuel	Solid Boilers >600 MWth	Limit for boilers <50MWth fuel	Limit for (solid fuel) boilers >50 MWth to <600MWth fuel	Solid Boilers >600 MWth
PM	50	50	50	*Higher performance levels than these in the Table should be applicable to facilities located in urban / industrial areas with degraded airsheds or close to ecologically sensitive areas where more stringent emissions controls may be needed	30	30
SO_2	2000	900 - 1500	200-850		400	200
NO_x	510 Or up to 1,100 if volatile matter of	510 Or up to 1,100 if volatile matter of fuel < 10%	510 Or up to 1,100 if volatile matter of fuel < 10%			

[7] Significant sources of point and fugitive emissions are considered to be general sources which, for example, can contribute a net emissions increase of one or more of the following pollutants within a given airshed: PM10: 50 tons per year (tpy); NOx: 500 tpy; SO2: 500 tpy; or as established through national legislation; and combustion sources with an equivalent heat input of 50 MWth or greater.

8 "Nearby" generally considers an area within a radius of up to 20 times the stackheight.

[9] Applicable to new facilities (IFC, EHS Guidelines for Thermal Power Plants, 2008)

[10] NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly;

	fuel < 10%					

Ambient Air Quality Guidelines

Table 1.1.1: WHO Ambient Air Quality Guidelines[7,8]

	Averaging Period	Guideline value in µg/m³
Sulfur dioxide (SO_2)	24-hour	125 (Interim target-1) 50 (Interim target-2) 20 (guideline)
	10 minute	500 (guideline)
Nitrogen dioxide (NO_2)	1-year	40 (guideline)
	1-hour	200 (guideline)
Particulate Matter PM_{10}	1-year	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline)
	24-hour	150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Particulate Matter $PM_{2.5}$	1-year	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)
	24-hour	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
Ozone	8-hour daily maximum	160 (Interim target-1) 100 (guideline)

[12] US EPA Prevention of Significant Deterioration Increments Limits applicable to non-degraded airsheds.

Appendix C – Ash Disposal Plan

Ash Disposal

The combustion of encroacher bush biomass will result in the formation of ash, composed primarily of major (Al, Ca, Fe, K, Mg, Na, P, Si, Ti) and minor (As, Ba, Cd, Cl, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, S, Sb, Tl, V, Zn) elements. The quantity of ash produced will vary for each scenario due to the deviation in generation capacity and combustion technology proposed. Estimations of ash produced by the scenarios is provided in Table 1.

Table 34: Ash production for each scenario

Unit	Scenario 1	Scenario 2a	Scenario 2b	Scenario 2c	Scenario 2d
Tonnes per year	2 457	7 994	9 022	8 384	9 684

The principal ash classification used to delineate between ash displaying dissimilar physical and chemical composition is fly ash and bottom ash. Bottom ash is composed of chiefly larger particles that fall through the grate during combustion and fly ash primarily consists of very fine particles that are carried in the flue gases.

Chemical and Physical Properties

Fuel composition and installation type are the primary factors that influence ash quality. Differences in the inorganic fraction of the fuel being combusted are directly reflected in the ash produced. A chemical analysis of the ash from encroacher bush biomass was undertaken as part of the Prefeasibility Study. Results from this analysis are provided in Table 2.

Table 35: Elemental analysis of encroacher bush

Element	Run 1 (EFF1[11])	Run 2 (EFF2)	Run 3 (CCF[12]1)	Average
Analysis on air dried basis				
Moisture in analysis sample (%)	10.2	5.9	7.5	**7.9**
Volatiles (%)	68	70.5	72.1	**70.2**
Ash (%)	4.6	6.6	1.7	**4.3**
Fixed carbon (%)	17.2	17.0	18.7	**17.6**
Calorific Value (MJ/Kg)	16.38	16.9	17.36	**16.9**
Total Sulphur (%)	0.05	0.06	0.05	**0.1**
Total Carbon (%)	45.30	46.2	47.9	**46.5**
Hydrogen (%)	4.30	4.52	4.7	**4.5**
Nitrogen (%)	0.51	0.65	0.56	**0.6**
Analysis of ash on as received basis (% of ash)				
Total Silica (SiO_2)	64.5	48.5	52.1	**55.0**
Aluminium (Al_20_3)	21.7	29.13	24.54	**25.1**

[11] EFF = Raw chips harvested by Energy For Future, Ohorongo Cement

[12] CCF = Raw chips harvested Cheetah Conservation Fund, Otjiwarongo

Total Iron (Fe_2O_3)	1.93	10.17	6.15	**6.1**
Titanium (TIO_2)	2.23	1.14	1.27	**1.5**
Phosphorus (P_2O_5)	0.79	1.89	3.11	**1.9**
Calcium (CaO)	3.34	4.96	3.79	**4.0**
Magnesium (MgO)	0.57	0.58	0.9	**0.7**
Sodium (Na_2O)	0.36	0.81	0.45	**0.5**
Potassium (K_2O)	2.45	1.20	0.73	**1.5**
Sulphur (SO_3)	1.85	1.07	5.73	**2.9**

The ash analysis covers accounts for around 99.5% of the ash content, with practically no remaining organic elements. The remaining amount is presumably ascribed to various trace elements.

Management Options

Following best practice the waste management plan developed for the management of biomass ash should take into account the waste management hierarchy, which dictates that waste management should consider prevention, reduction, reuse, recovery, recycling, and finally disposal of waste, with prevention being the most sustainable option and disposal the least (Figure 1).

During the Prefeasibility Study a range of potentially viable management options were identified. These options are discussed below in the order prescribed by the waste management hierarchy.

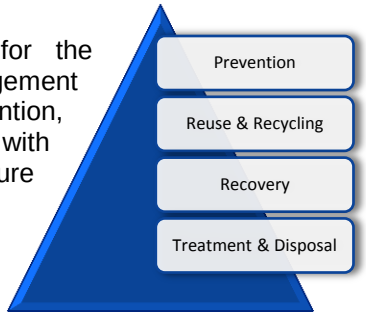

Figure 15: Waste Management Hierarchy

Reuse and Recycling

A number of options are potentially available for the reuse or recycling of ash. The viability of these options will depend on primarily the physical and chemical characteristics of the ash produced from each scenario as well as financial viability of the management option.

- **Direct Soil Application as a Soil Improver**

Returning of biomass ash, and consequently minerals, to **the location where the biomass was harvested** is considered the most sustainable ash management option. Benefits of ash recycling include the return of potassium, calcium, magnesium, sodium and sulphur to the soil. The addition of limestone in the fluidised bed installation will also provide the ash with liming benefits.

The option to recycle ash however, should be dependent on the sustainable conditioning of the soil, for example ash recycling should not result in an uncontrolled pH shock. The quality of the ash is also an important factor. Ash can display a high heavy metals content (cadmium, lead and zinc), with fly ash characteristically containing a higher concentration of heavy metals but also nutrients compared to bottom ash.

Despite recycling of ash being considered the most sustainable option, it is also likely to be the most impractical financially and logistically due to the requirements associated with returning ash to the location where the biomass was harvested. To overcome this impediment alternative recycling models are available involving the use of ash as a fertilizer.

- **Use as a Fertilizer or Fertilizer Raw Material**

Biomass ashes may be used directly as a fertilizer or as a raw material in the production of mineral fertilizer. The **ashes are returned to the soil, but the location is not necessarily the same as where the biomass originated**.

As nitrogen levels are negligible and phosphorus is present in a form that has a very poor solubility at soil conditions, biomass ash can only be a significant source of potassium when used as a direct general-purpose fertilizer. The blending of ash with complementary materials containing phosphorous and nitrogen can produce a beneficial fertilizer. Other elements within the biomass ash, such as significant amounts of calcium, magnesium, sodium and sulphur can improve the agricultural value of the fertilizer produced. However, overly high concentrations of cadmium, zinc and lead can prohibit the use of biomass in fertilizer production. At present, however, and based on a preliminary analysis of the laboratory results, there is no reason to expect that the ash will not be suitable for use as a soil amendment, if managed correctly.

- **Utilization as building material**

Utilization of biomass ashes as building material or as raw material in the manufacture of building products, such as road construction material and concrete, can provide a sustainable ash management option.

Bottom ashes are the most amenable to utilisation in or as building material. Bottom ashes from fluidised bed combustion have a high concentration of sand and may directly replace other kinds of sand in road construction or landscaping. Bottom ash from grate stokers can be made into granulate and used as an input in cement production.

Conversely, fly ash is to fine to be used as a direct sand or gravel replacement. Utilization as a binding agent in concrete or a filler in cement blends and mortar are feasible option; however, the alkali, chlorine and phosphate components of typical biomass fly ash can present an environmental risk.

Recovery

- **Additive within Ohorongo Cement Kiln**

Ohorongo Cement has indicated that the disposal of ash in the companies cement kiln is potentially an option. The presence of chlorine and heavy metals in the ash can have both direct and indirect implications on cement kiln emissions and performance if not effectively managed. However, as Ohorongo Cement is currently utilising encroacher bush as a fuel feedstock to power the cement kiln the chemical properties of the current feedstock should not significantly deviate from that of the ash.

Two potential benefits place the option to dispose of ash within the cement kiln above landfilling. The most significant benefit is the recovery of energy value from the waste. In order to constitute legitimate energy recovery the ash must have the ability to contribute heat to the cement manufacturing process during combustion. If this is not the case then combustion of ash in the cement kiln should be classified as direct disposal and not recovery.

An additional benefit is gained from the cement kilns not generating ash as the ash from the combustion of fuel is incorporated into the clinker or cement kiln dust (CKD). CKD, which is captured in the air pollution control device, consists primarily of partially calcinated raw material. Most cement kiln operators normally return the majority of the CKD to the kiln to complete the calcination and sintering process. When reintroduced, CKD does not contribute any constituents to clinker production that are not already present in the production process. Thus disposal by cement kiln results in zero waste to landfill.

Disposal

- **Landfill**

The last option in the waste hierarchy, and the most common, is disposal of ash straight to landfill. Two options are available for landfilling, the disposal of ash in an existing, approved landfill or the development of an onsite landfill. As the disposal of wood ash can result in a very alkaline leachate (pH>13) the landfill utilised must be designed to manage any potential environmental impacts. If a greenfields landfill is developed for the EBtP facility this will need to be done in compliance with national legislation as well as international best practice.

Although landfilling (to a general waste site) is likely to be financially feasible it is the least sustainable of the options and a last resort in terms of the waste management hierarchy. The close proximity of all the supply chain Scenario's to urban areas does however, provide the opportunity to dispose of ash within an existing, approved landfill while NamPower investigates more sustainable management options.

Preliminary Management Plan

The most applicable waste management option will depend on the supply chain scenario implemented. A high level assessment of the two potentially most sustainable options for further assessment, applicable to each scenario, was under taken in order to provide a way forward once a Scenario has been delineated (Table 3).

Table 36: Summary of sustainable ash management options potentially applicable to each scenario

Management Type	Details	Scenario			
		1	2a	2b	2c
Recycling / Reuse	Return to harvested area	■			
	Fertilizer – unmixed				■
	Fertilizer – mixed	■			■
	Cement raw material		■	■	
Recovery	Ohorongo Cement Kiln		■	■	

Scenario 1 and 2c/2d

- **Return to harvested area for direct application to soil**

The limited quantity of ash produced in Scenario 1 (2,457 tonnes/yr) as well as the direct access to land from which the bush has been harvested[13] makes this option potentially viable.

- **Use as a fertilizer or fertilizer raw material**

The Ministry of Agriculture, Water and Forestry has highlighted the need to develop a domestic fertiliser industry within Namibia. The use of biomass ash within any future or existing fertilizer manufacturing operations is undetermined. Alternatively, direct application to private land may be an option.

In order to assess the feasibility of these options further analysis is required. These requirements are summarised in Table 4.

Table 37: Analyses required to assess the feasibility of using ash as a soil improver or fertilizer

Environmental Analysis
Ash Chemical Analysis Elemental makeup of ash specific to the combustion installation employed, with focused place on heavy metals (i.e. Cd, Zn and Pb) content.
Site-specific, Ash-specific Investigations Impact of ash or fertilizer application to harvested bush encroached areas and agricultural operations with focused placed on the projected change to soil pH resulting from the liming properties of the ash and any potential resultant impacts on species composition.
Economic Analysis
Market Opportunities Analysis A prefeasibility assessment into the accessibility and willingness of fertilizer manufactures in Namibia to purchase or take on the ash.
Financial Analysis Financial implications of using ash a soil improver, fertilizer or fertilizer raw material including the transporting of

[13] Bush will be harvested from CCF property

ash to:

- Harvested areas
- Agricultural operations
- Fertilizer manufacturing facility

Scenario 2a and 2b

- Utilization of a raw material in the cement industry or disposal within the cement kiln

The proposed supply chain partnership between Ohorongo Cement and NamPower provides an excellent opportunity for ash disposal, whether it involves the use of ash a cement raw material or disposal within the cement kilns.

In order to assess the feasibility of these options further analysis is required. These requirements are summarised in Table 5.

Table 38 : Analyses required to assess the feasibility of using ash as a building material

Chemical Analysis
■ Alkali, chlorine and phosphate content in fly ash
Market Opportunity Analysis
■ Potential utilisation in the cement industry.

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