VEGETATION STUDIES FOR PROPOSED SENDELINGSDRIF MINE AND ASSOCIATED INFRASTRUCTURE

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Sarcocaulon multifidum

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1. Introduction

The river terraces at Sendelingsdrif, which lie within Namdeb's Orange River Mining Licence harbour a potentially economically viable deposit of diamonds. These diamond bearing gravel deposits are situated on the northern bank of the lower Orange River, which is the only permanent river in southern Namibia. In the recent past similar deposits have been exploited from similar terraces at Auchas and Daberas, which lie further down the river towards Oranjemund. Consideration is being given to mining these deposits.

In the event of them being mined a number of new linear infrastructure projects will be necessary:

- A powerline from Rosh Pinah to Sendelingsdrif, in which two alternatives are being considered (Appendix 1). The first (Nampower alternative) departs from the existing route at the Sperrgebiet fence and runs alongside the road before turning east towards the deposit. The second (Namdeb alternative) continues along the existing route until near the old police station at Sendelingsdrif before curving south and west around the deposit.
- An optic fibre route from Sendelingsdrif deposit connecting to the existing optic fibre route to Oranjemund.
- A pylon-based ropeway transport system to carry ore from Sendelingsdrif to Daberas, to avoid the construction of a new plant at Sendelingsdrif.

The greater area concerned falls into the northern section of the Succulent Karoo Biome, which is regarded as a global biodiversity hotspot (Myers et al 2000), and is thus important in global as well as regional and national terms. This makes only absolutely unavoidable damage acceptable. It is extremely sensitive in terms of near-endemic, endemic and protected plant and animal species. Approximately 16% of the Namibian flora as a whole is thought to consist of endemic species (Craven & Vorster 2006), and over 30% of plants that occur in the Namibian section of the Desert Biome are believed to be endemic to that area. This is a remarkably high figure, with the areas of highest plant endemicity in the Namib being the Kaokoveld and the southern Namib, both regarded as major centres of endemicity in Namibia (Maggs et al. 1998). Furthermore, recent assessment by Burke and Mannheimer (2004) indicated that the Sperrgebiet (which excludes Aus) carries nearly 25% of the plant species known to occur in Namibia. Many of these have a highly restricted distribution. Elevated areas such as mountains and koppies are known to harbour many species of conservation concern, making them sensitive to environmental disturbance, some more than others. Many tend to congregate in small patches of suitable habitat, such as moisture-gathering south-west-facing slopes that are in shade for part of the day.

In addition to on-site damage the creation of obvious access roads promotes illegal access and plant removal by criminal collectors, and is of particular concern as it perpetuates and aggravates existing damage *ad infinitum*. An additional concern of great importance is the negative visual impact of roads

and infrastructure. This factor is of particular importance in an area such as the southern Namib, where open and relatively unspoilt vistas may be regarded as a major tourist attraction that will provide long-term income to the country.

The area concerned, which was considered to be of high conservation importance by Burke (2006), comprises a section of the Sperrgebiet National Park, in a zone earmarked to be managed mainly for nature-based tourism, such that generally no permanent structures should be erected. This obviously requires that the area be returned as far as is possible to its original state after mining activities cease. Nevertheless infrastructure such as the road to Oranjemund as well as an optic-fibre line and a power line already run through it.

Williamson (1997) included this area in his Lower Orange River Zone, which he regarded as a zone that receives regular moisture from fog moving up the river, particularly in winter. It falls within the Desert and Succulent Steppe as defined by Giess (1971). Winter rainfall predominates, although summer rains are possible, with rainfall averaging 51 mm per annum, and coastal fog playing an important role in the moisture regime of many organisms. As a result, it harbours a flora and fauna substantially different from the rest of the country. Due to oceanic influences temperatures are moderate compared with much of Namibia, with average annual temperature approximately 18°C, although temperatures up to 40°C may be experienced in the Orange River valley in summer. Winds, which are often very strong, occur throughout the year, mainly from the south-west, although warm north-easterly winds occur sporadically during winter. Furthermore, in common with most westward-flowing rivers in Namibia, the Orange River forms a linear oasis in an arid environment, with its well-developed riparian vegetation providing a favourable habitat for plants and animals. It also acts as a 'conduit' that carries fog deeper inland more regularly than might otherwise be the case. Moisture deposition by fog against mountain slopes and gullies is thought to be an important ecosystem driver in the area, providing a relatively reliable source of moisture in contrast to rainfall, which is temporally and spatially extremely variable and unpredictable.

Further information on climate and geomorphology of the area have been provided by many others (e.g. Burke 1998) and will not be repeated in this report unless specifically pertinent to the discussion.

2. Terms of reference and objectives

The consultant was requested to:

- Review existing relevant information available on the area.
- Obtain quantitative data on composition and cover in the various habitats on the deposit to inform the rehabilitation plan.
- Survey the vegetation composition in the surroundings of the deposit to establish whether it differs substantially from that on the deposit, ie: How unique is the vegetation on the deposits?
- Survey the two proposed alternative routes for the powerline and the optical fibre route to identify sensitive areas and make recommendations where necessary.
- Identify particularly sensitive areas, if any, along the pylon route.
- Identify and suggest mitigation measures and methods that could be considered to minimise impacts during construction and operation of the pylon system.

3. The affected habitats

Habitats that were investigated in this study include:

- Relict meso- and proto-gravel terraces at Sendelingsdrif, for quantitative data and to assess powerline routes
- Rocky outcrops and mountains near Sendelingsdrif and as far as Daberas along the proposed pylon route
- Sandy slopes along the proposed pylon route
- Sandy-gravelly plains and foothills north of the deposit area and at the western end of the proposed pylon route

3.1 Meso- and proto-gravel terraces at Sendelingsdrif

These terraces are sparsely vegetated, particularly the meso-terraces, and especially during the dry season. Highest species diversity, as well as most species of conservation concern lie on the south, west and south-western facing slopes of the gullies (Figure 1). Mannheimer (2002) did a detailed baseline study during which it was found that a number of species of conservation concern would be affected by mining of the deposit. The only one of high concern was *Juttadinteria albata.* Mitigation recommendations were made at the time. These terraces were only addressed during this study for the purpose of obtaining quantitative data to inform the restoration plan.

Figure 1: On the river terraces vegetation diversity is higher, and species of concern are concentrated, on south, west and south-western facing slopes of the gullies.

3.2 Rocky outcrops and mountains

The mountains that border the Orange River from Sendelingsdrif to Daberas exhibit a diverse structure and surface geology. They vary from quite gentle, quartzitic-sandy base slopes to steep, craggy schistose slopes (Figure 2) incised by deep gullies, providing a high niche diversity by virtue of substrate, moisture and aspect variability. As a result they exhibit a far higher species diversity than the plains or terraces, and harbour numerous endemic, near-endemic, range-restricted and protected species, both on their slopes and on their footslopes. These include numerous protected species of high conservation concern and very restricted distribution including, *inter alia, Hartmanthus pergamentaceus, Astridia citrina, Cephalophyllum herrei, Juttadinteria albata, Psammophora saxicola, Cheiripdopsis* spp. and *Conophytum* spp. as well as many other highly restricted-range species, such as *Sarcocaulon multifidum* and *Zygophyllum patenticaule*. A number of these species show a tendency to congregate in considerable numbers in small patches of suitable habitat (pers. obs.), making them vulnerable to destruction if those patches lie in the path of infrastructural development.

Figure 2: By virtue of varying substrate, slope and geology the mountains along the Orange River provide a high niche diversity and supports numerous plant species with highly restricted ranges.

These outcrops and mountains comprise the lower sections of the Schakalsberge Dwarf-shrubland and the Obib Mountain succulent-shrubland as described by Burke (2006), who regarded their conservation

importance as VERY HIGH. In addition it is highly likely that they will be of considerable tourism value in the future, as they offer a high diversity of unusual plants, succulents in particular, and very scenic vistas.

3.3 Sandy slopes with mobile sands

Between the two mountainous areas described above there is an intrusion of the Southern dune grassland (Figure 3) as described by Burke (2006), who listed its conservation importance as LOW. Generally speaking areas of mobile sand and dunes are not very sensitive because they are largely colonised by annual plant species, and tracks and damage are usually gradually obscured and restored by wind-borne sand blowing in. Nevertheless vehicle tracks do tend to remain visible for a considerable time, particularly where perennial vegetation has been disturbed. Subsequent visitors tend to assume that there is an existing track and reinforce the damage by utilising it. There were transition areas between the rocky and sandy slopes where species such as *Juttadinteria albata* were found, but numbers were very low.

Figure 3: The Southern dune grassland, an area of relatively mobile sand, intrudes between the southernmost extents of the Schakalsberge Dwarf-shrubland and the Obib Mountain succulent-shrubland as described by Burke (2006).

3.3 Sandy-gravelly plains and foothills

The area north-west of the terraces is largely a sandy-gravelly drainage plain with a low species diversity and cover (Figure 4), although species of potential concern such as *Euphorbia melanohydrata* do occur in low numbers (pers. obs.). Most of the area comprises a stabilised gentle slope dissected by shallow braided channels and is characterised by the presence of grasses and species such as *Euphorbia gummifera* and *Sarcocaulon patersonii* in the case of the sandy-gravel plains and *Brownanthus arenosus, Hermannia stricta* and *Sisyndite spartea* in the channels.

Figure 4: The drainage plain north-west of the Sendelings deposit area supports a low species diversity. It is dissected by braided drainage channels.

The plains and foothills at the western end of the pylon route, near Daberas, carry a low plant diversity, mostly composed of common species such as *Brownanthus marlothii, B. arenosus* and *Euphorbia gummifera* (Figure 5). No species of conservation concern is expected to be substantially affected by the pylon route though this area.

Figure 5: The western section of the proposed pylon route, near Daberas

4. Approach

- Review of existing specialist vegetation and ecological studies done for this area, e.g. Burke 1998, 2006; Burke & Mannheimer 2004; Giess 1971; Mannheimer 2002; Ministry of Environment and Tourism 2001; Pallett 1995, 2004; Williamson 1997.
- Field visit between 27 July and 1 August 2010. Eighteen walked transects were done on the Sendelingsdrif terraces. The proposed pylon route was hiked throughout the approximately 8.5 km of the mountainous zone. The foothills and plains near Daberas were randomly spot-checked, as was the drainage plain north of Sendelingsdrif. The Namdeb alternative for the power line was also randomly checked.
- Preparation of report.

5. Legal and policy requirements

5.1 Acts and ordinances

Namibia's Constitution provides for the protection of the environment in Article 95, which says: "The State is obliged to ensure maintenance of ecosystems, essential ecological processes and biological diversity and utilisation of living natural resources on a sustainable basis for the benefit of Namibians both present and future".

Plant species are protected by various mechanisms in Namibia, including Nature Conservation Ordinance No. 4 of 1975, including amendments, and Forest Act 12 of 2001, as amended in 2005. Because the latter has no regulations as yet, the list of protected species from Forestry Act No. 72 of 1968 has been applied. This list is commonly applied in Namibia as a precaution, including use by the Directorate of Forestry. A new list is pending, and is likely to include most of the same species with few exclusions and will probably be expanded to include a number of additional species (G. Maggs-Kölling, Deputy Director of Research, Directorate of Forestry, pers. comm.).

The area falls within the Sperrgebiet National Park, and is therefore subject to restrictions as applied to such parks as well as to requirements and recommendations of the park management plan.

Minerals (Prospecting and Mining) Act 33 of 1992 provides for EIAs in mining activities, including requirements for rehabilitation of prospecting and mining areas.

5.2 Namibian commitment to international standards and/or guidelines

Namibia is a signatory to the Convention on Biodiversity, committing it to the preservation of species, particularly rare and endemic species, within its boundaries. As a signatory also to the Convention to Combat Desertification it is also bound to prevent excessive land degradation that may threaten livelihoods.

A permit will be needed for removal or destruction of protected species. The forms can be obtained from Mr T. Uahengo in the permit office at the Ministry of Environment and Tourism, Windhoek. A period of three months should be allowed for obtaining this permit. Species and numbers/quantities involved will need to be specified.

tuahengo@met.na

Ministry of Environment and Tourism, FGI Building Post Street Arcade

P/Bag 13306 Windhoek

Box 5.1 Permit requirements and timeframe for Nature Conservation Ordinance

6. Results

6.1 Quantitative data collection on the deposit

The data have been given to Dr Theo Wassenaar for analysis.

6.2 Vegetation composition in the area surrounding the deposit

As previously mentioned, the rocky ridges, foothills and mountains surrounding the Sendelingsdrif deposit are highly diverse, far more so than the terraces themselves. All the species presently recorded for the terraces occur in these surrounds as well, where, with the exception of *Juttadinteria albata,* they are far more common. Thus the surrounding area will serve very well as a source of material to re-establish species on the terraces in future. The only species of concern is *Juttadinteria albata*.

6.3 Power line route alternatives

From a vegetation point of view there is very little difference between the two alternatives. Neither will cause any unacceptable additional damage to vegetation in general or cause any substantial negative impact on any species of serious conservation concern. The Nampower alternative might be visually more intrusive along the road.

6.4 Optic fibre route extension

The proposed route for the extension of the optic fibre route will not cause any substantial negative impact to any species of serious conservation concern.

6.5 Pylon route

Although the pylon route runs through a mountainous area (Appendix 3) that carries numerous species of conservation concern, the nature of the project (linear, interrupted), makes the total impacted area very small in relation to the whole. No dense patches of species of conservation concern were observed, although there was a tendency for them to be somewhat more common on the wetter and shadier slopes. It is thus not anticipated that any species of high conservation concern will substantively negatively impacted by the development of the pylon system, providing collateral damage is controlled.

7. Recommendations

- The restoration plan for Sendelingsdrif should address the problem of *Juttadinteria albata*.
- The alternative routes for the power line should be considered in the light of their visual impact.
- As far as possible damage to sheltered west, south and south-west facing slopes should be held to a minimum when choosing final placement of pylon bases.
- Collateral damage during construction and operation of the pylon system, power line and optic fibre route should be minimized as far as possible. Access routes should be restricted to a minimum and wherever possible a common servitude should be used.
- Construction and other staff should be forbidden to collect any plant material, dead or alive (including seed), for any purpose whatsoever and should be provided with fuel (preferably gas) for both heating and cooking from outside the park. Even dead wood is a resource for animals in such an extreme habitat.

7. Assumptions and Constraints

The 2010 rainy season was poor, which may have resulted in some species being missed or under-recorded.

No specific engineering information was available on the power line, optic fibre line or pylon towers. In the light of verbal information received from Namdeb staff it was assumed that no service road would be developed along the pylon route.

8. Summary of project impact on vegetation

The project will have a negative impact on vegetation, and will affect populations of protected, endemic and near-endemic species. There will be contraventions of Nature Conservation Ordinance No. 4 of 1975, including amendments. Strictly speaking permits would be required to destroy protected species, but this would be very complicated given that exact numbers and species involved would be required and thus far this requirement has not been enforced by the Ministry of Environment and Tourism once an environmental clearance has been granted.

6.1 Mined area

Within the mined zone all plants will certainly be completely destroyed, and thus there will be a negative environmental impact. However this destruction should be limited largely to the deposit zone only, and should thus be very localised and affect only part of the license area. On a regional scale and higher it is a localised and limited impact.

Due to the nature of the activity the impact will be extremely high, and the damage will virtually be permanent unless restoration measures are taken. Even then then at least some localised damage will be long-term.

Providing that:

- Strict measures are taken to limit the area damaged as far as possible, to preserve the rest of the license area and to facilitate rescue of species of conservation concern
- Serious consideration be given to landscape restoration

the broader significance of the impact is low, and should not influence the decision to go ahead with the project.

DESTRUCTION OF VEGETATION IN THE MINED AREA	CONSTRUCTION		OPERATION	
	Before Mitigation	**After Mitigation**	**Before Mitigation**	**After Mitigation**
Extent	LIM	LIM	L	L
Duration	P	LT	P	LT
Intensity	L	L	VH	H
Probability	D	D	D	D
Significance	M	M	M	M
Status	—	—	—	—
Degree of confidence in predictions	95%	95%	95%	95%

6.2 Construction and permanent infrastructure sites

Plants in peripheral areas such as temporary construction laydown sites and sites for permanent structures will probably also be severely damaged or lost completely, resulting in a negative environmental impact.

The extent of damage will depend upon the efforts made to restrict the area affected. The area affected could be extremely limited and localised if sufficient control is imposed. On a regional scale and higher it is a localised and limited impact.

Due to the nature of the activity the impact will be high. The damage to temporary sites will be relatively short-term while that to permanent sites will virtually be permanent unless restoration measures are taken.

Providing that:

- Strict measures are taken to limit the area damaged as far as possible, to preserve the rest of the license area and to facilitate rescue of species of conservation concern
- Serious consideration be given to landscape restoration.

the broader significance of the impact is low, and should not influence the decision to go ahead with the project.

DESTRUCTION OF VEGETATION IN TEMPORARY SITES	**CONSTRUCTION**		**OPERATION**	
	Before Mitigation	**After Mitigation**	**Before Mitigation**	**After Mitigation**
Extent	LIM	LIM		
Duration	MT	ST		
Intensity	M	L		
Probability	D	D		
Significance	M	L		
Status	—	—		
Degree of confidence in predictions	95%	95%		

DESTRUCTION OF VEGETATION IN PERMANENT SITES	**CONSTRUCTION**		**OPERATION**	
	Before Mitigation	**After Mitigation**	**Before Mitigation**	**After Mitigation**
Extent	LIM	LIM	LIM	LIM
Duration	P	LT	P	LT
Intensity	VH	H	VH	H
Probability	D	D	D	D
Significance	M	M	M	M
Status	—	—	—	—
Degree of confidence in predictions	95%	95%	95%	95%

6.3 Powerline and optic fibre routes

Impact on vegetation outside the zone of the deposit will be greatly influenced by mitigation measures taken to control collateral damage, such as that caused by vehicles. It will also be affected by decisions upon where to locate infrastructure and roads.

If collateral damage is controlled and infrastructure is sited in previously damaged areas or along existing roads and servitudes damage will be slight.

Potential impacts include damage to gravel plains and vegetation due to uncontrolled vehicle activity, siting and construction of infrastructure and removal of or damage to plants for firewood or other (e.g. ornamental) purposes.

DESTRUCTION OF VEGETATION IN NON-DEPOSIT AREAS	**CONSTRUCTION**		**OPERATION**	
	Before Mitigation	**After Mitigation**	**Before Mitigation**	**After Mitigation**
Extent	L	LIM	L	LIM
Duration	MT	none	MT	none
Intensity	M	none	M	none
Probability	U	U	U	U
Significance	L	L	L	L
Status	—	—	—	—
Degree of confidence in predictions	95%	95%	95%	95%

6.4 Pylon route

Impact on vegetation along the pylon route, particularly in the mountainous sections will be greatly influenced by mitigation measures taken to control collateral damage, such as that caused by construction vehicles and crews. It will also be affected by whether or not access/service roads are required. It is assumed here that they will not be required.

If collateral damage is controlled and infrastructure is sited in previously damaged areas or along existing roads and servitudes damage will be slight.

Potential impacts include damage to vegetation due to uncontrolled vehicle activity, cxonstruction laydown and removal of or damage to plants for firewood or other (e.g. ornamental) purposes.

DESTRUCTION OF VEGETATION ALONG PYLON ROUTE	**CONSTRUCTION**		**OPERATION**	
	Before Mitigation	**After Mitigation**	**Before Mitigation**	**After Mitigation**
Extent	L	LIM	L	LIM
Duration	LT	MT	U	U
Intensity	M	L	M	L
Frequency			I	I
Probability	HP	HP	U	U
Significance	M	L	M	L
Status	—	—	—	—
Degree of confidence in predictions	95%	95%	95%	95%

Description	The type of effect that a proposed activity will have on the environment. A narrative of the impact.
Extent	Geographic area. Whether the impact will be within a limited area (on site where construction is to take place, LIM)), locally (within the site; L), regionally (R), nationally (N) or internationally (I).
Duration	Whether the impact will be temporary (during construction only; T), short term (1-5 years; ST), medium term (5-10 years; MT), long term (longer than 10 years, but will cease after operation LT) or permanent (P).
Intensity	Quantify the magnitude of the impact and outline the method(s) used in the quantification process. Low (L) where no environmental functions and processes are affected, Moderate (M) where the environment continues to function but in a modified manner or High (H) (environmental functions and processes are altered) VH Environmental processes cease completely. May also be measured in accordance with International standards, applicable conventions, best practice policy, levels of social acceptance, etc.
Mitigation	Discusses mitigation options, and whether such options would lessen the impact to an acceptable level.
Frequency of occurrence	A description of any repetitive, continuous or time-linked characteristics of the impact(s). Continuous (C), Intermittent - occurring from time to time, without specific periodicity (I), Periodic – occurring at more or less regular intervals (P), Time-linked – occurring only or mostly at specific times of the day or week (T).
Probability	The probability that a certain impact will in fact realise; Uncertain (U), Improbable (I), Probable (P); Highly Probable (HP); Definite (D). If the probability is uncertain, then there is not sufficient information to determine its probability. Because the precautionary principle is followed, this increases the significance of the impact. Attempt to quantify the probability in statistical terms (e.g. >75% certain)
Significance	Significance is given before and after mitigation. **Low** if the impact will not have an influence on the decision or require to be significantly accommodated in the project design, **Medium** if the impact could have an influence on the environment which will require modification of the project design or alternative mitigation (the route can be used, but with deviations or mitigation) **High** where it could have a "no-go" implication regardless of any possible mitigation (an alternative route should be used).
Status of the impact	A statement of whether the impact is positive (a benefit), negative (a cost), or neutral. Indicate in each case who is likely to benefit and who is likely to bear the costs of each impact.
Legal requirements	An identification and list of specific legislation and permit requirements related to the specialist study that potentially could be infringed upon by the proposed project or which is required to enable the project to proceed. Reference to the proper

	procedures required to obtain appropriate permits should also be provided.
Degree of confidence in predictions	A statement of the degree of confidence in the predictions, based on the availability of information and the specialist's knowledge and expertise.

9. REFERENCES

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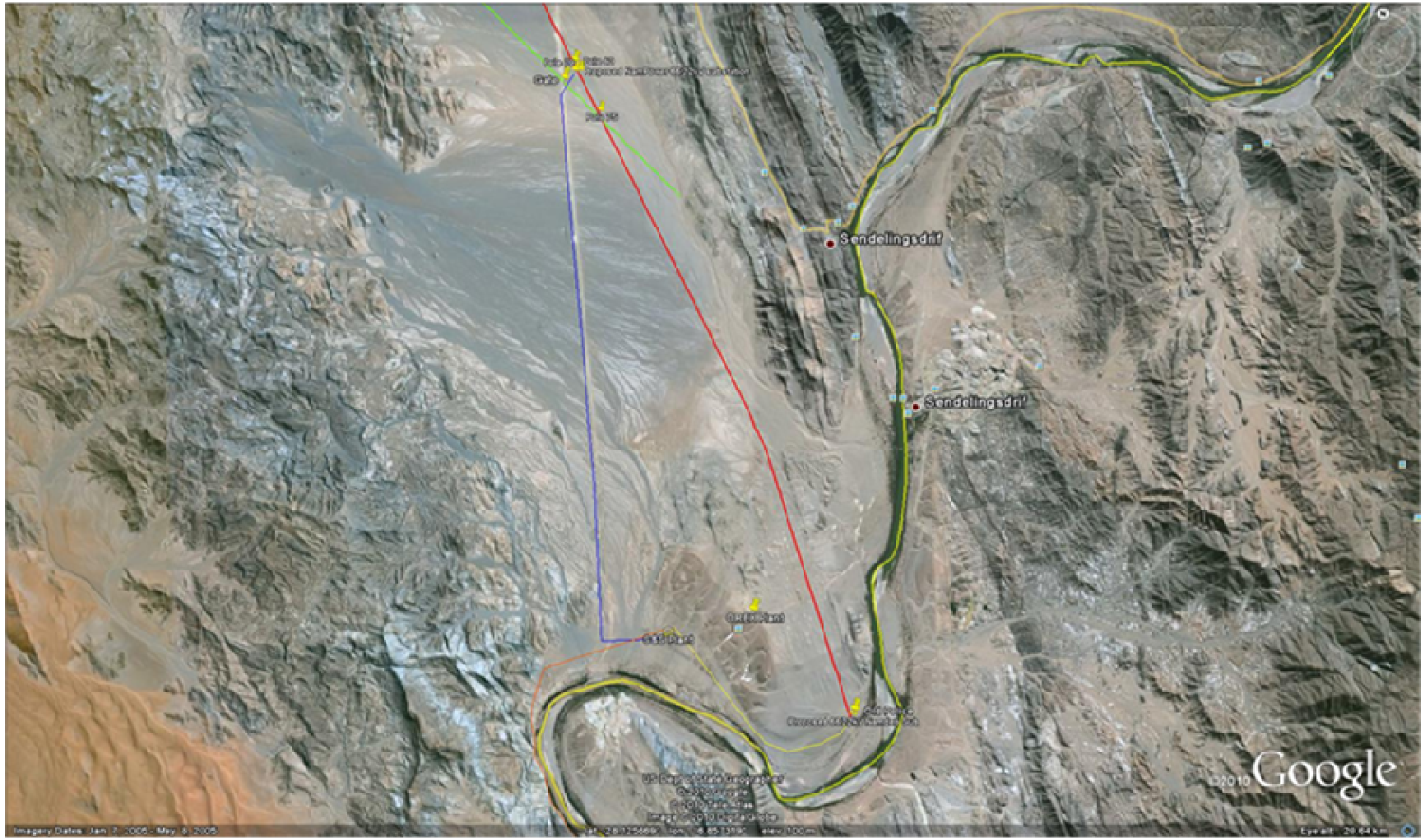
Appendix 1: Proposed powerline routes. Blue = Nampower preferred route. Yellow = Namdeb proposed route to first travel via red, which is an existing route.



Appendix 2: Optical fibre route extension at Sendelingsdrif (green)

Appendix 1: Pylon route