INCEPTION REPORT

Study of the distribution, abundance and conservation status of common hippopotamus (*Hippopotamus amphibious*)

Prepared by BassAir

Updated November 2016

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Title of Consultancy:	Hiring of consulting services for the study on distribution, abundance and conservation status of common hippopotamus (*Hippopotamus amphibious*).
Place of Work:	Main river systems (rivers and lakes) and river basins of Mozambique
Duration:	12 months
Contract secured by:	BassAir Aviation, PO Box 43 746. Heuwelsig, South Africa, 9332
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Date submitted:	21 June 2016
Updated:	2 November 2016

1. Purpose of the project

The purpose of this project is to establish the distribution, abundance and conservation status of common hippopotamus (*Hippopotamus amphibious*) in the major river systems, lakes and river basins of Mozambique, as set out in the Terms of Reference issued by the National Administration of Conservation Areas (ANAC), Republic of Mozambique.

The project addresses Component 3 of the MozBio project, which seeks to strengthen the management of selected Conservation Areas in Mozambique through conducting wildlife research and monitoring. Specifically, this project addresses section (ii), (d) of Component 3:

Monitoring and Research: Conducting of wildlife research to assess the status of wildlife populations in the land and marine environment: a survey to establish the status and distribution of hippopotamus and Cordylus in Mozambique.

2. Primary deliverables by the consultants undertaking this project

As the consultant contracted to undertake this project, BassAir is required to undertake the following tasks, as agreed upon in the Terms of Reference and associated Contract signed by BassAir and ANAC:

- Designing the detailed Inventory Plan, schedule and river systems to estimate the distribution, size and abundance of *Hippopotamus amphibious*;
- Conducting an inventory in the fluvial systems (rivers and lakes) and other river basins of Mozambique, ensuring a significant extent;
- Analyzing the data and producing a detailed report with recommendations, which must be shared timely with ANAC, the conservation areas covered, and the CITES Authority, in order to be able to review and comment accordingly.

3. Study design for estimating the distribution, size and abundance of hippopotamus in Mozambique

The study will entail an aerial survey of the major rivers and lakes in Mozambique, for the purposes of estimating the distribution, size and local abundance of hippopotamus in the country. The survey will be carried out during the late dry season (September – December 2016), in order to maximize the visibility of hippo when the surface water levels are at their minimum. Given the climate forecast predictions of late rains, t was decided that the survey should be delayed until approximately midway through the late dry season, in order to avoid counting hippos that were unlikely to survive the current drought.

3.1 Survey method

Although a 2-seater fixed-wing aircraft, supplemented by boat surveys, has been used to conduct hippo and crocodile surveys in Mozambique in the past, this survey will make use of a Bell 206 Jet Ranger helicopter, which will make it possible to:

i. fly with the minimum requirement of four observers, enabling a more accurate count, as well as the inflight training of ANAC field staff in survey techniques;
ii. fly slower, turn back, or even hover, enabling observers to recount animals that may have been hidden or submerged when the aircraft first passed;
iii. reduce availability bias, which is one of the largest sources of error in surveys.

In general, each river will be flown along the centre channel at a speed of approximately 55 knots and a height of roughly 100m. Where the river is too wide to allow for both banks to be observed adequately, each shoreline will be surveyed separately.

The helicopter is equipped with a GPS with all the river systems and lakes to be surveyed pre-programmed, to ensure pilot accuracy. Observations will be logged directly onto a device with a GPS, ensuring that the data can be downloaded daily in a format ready for use in a Geographic Information System. This will also make it possible to provide counts daily during the survey, if required. The data are backed up at each refuelling stop, minimizing any possibility of data loss. Data will be plotted on a distribution map, showing densities of hippo (and crocodile) along each river system/lake. These distribution maps will be provided as soon as the survey is complete. If necessary, a correction factor (obtained from published previous studies) will be used to account for availability bias caused by variable levels of water turbidity (Mackie et al 2012).

A detailed report will follow with recommendations for the CITES listing of hippo, and using spatial analyses to identify hotspots of hippo and crocodile occupation, as well as primary drivers that influence their distribution. This will improve understanding of which factors may be used to mitigate reductions in hippo and crocodile populations, as well as which management interventions are likely to have the biggest impact in different conservation areas. For this component, available shape files of the areas in question are required from ANAC.

3.2 River systems, lakes and river basins to survey

For the sake of consistency, the survey will entail flying the same river systems, lakes and river basins as those undertaken during the 2010 survey (Mackie et al, 2012; Figure 1 & Table 1).

Figure 1 - Major rivers and lakes surveyed for hippopotamus during 2010 (Mackie et al 2012).

Table 1 - Survey areas for estimating the abundance and distribution of hippopotamus in Mozambique, following the survey conducted in 2010 (Mackie et al 2012).

Survey location	**Length of surveyed section (km)**
2010 survey	
Lake Malawi (southern section of Mozambique shoreline)	55
Lugenda & Luateze (Niassa NR)	338
Messalo River	177
Lurio River	184
Ligonha River	135
Cabora Bassa East (N bank)	53
Zambezi River (Cabora Bassa to Tete)	73
Zambezi River (Tete to Chemba)	210
Zambezi River (Chemba to Zambezi/Shire confluence)	84
Zambezi River (downstream of Zambezi/Shire confluence)	103
Shire River	75
Pungwe River and Lake Urema	131
Save River	201
Limpopo River	129
Massingir Dam and Elefantes River	70
Inhambane inland lakes	118
Incomati River	42
Lebombo Dam	39
Maputo River	117
Subtotal	**2334**
Additional areas flown during previous surveys:	
Rovuma and Luchulingo Rivers (Niassa NR)	435
Rovuma River (downstream of Niassa NR)	259
Cabora Bassa (S bank)	1033
Zambezi delta	ca. 30
Maputo Special Reserve	ca. 50
Subtotal	**1807**
TOTAL	**4141 km**

4. Logistical planning for estimating the distribution, size and abundance of hippopotamus in Mozambique

4.1 Approximate survey schedule, bases and refuelling points

Schedule

In total, the survey must cover approximately 4000km of river/lake shore at 24 different locations (see Table 1). The survey will start in the northern region of Mozambique, and work southwards. Table 2 outlines an approximate schedule for the survey, based on the distances that need to be covered during each of the survey components. In summary, the survey will consist of 3 days of ferrying from Bloemfontein, South Africa, to Mbatamila (Niassa NR; Figure 2), followed by 15 days of survey flights (excluding days on the ground due to bad weather or other unforeseen delays), and a day of ferrying back to the base in Bloemfontein. This schedule includes the additional days required to incorporate the areas covered by other surveys included in the 2010 results (e.g. the entire southern shore of Lake Caborra Basa; see Table 2). It is important to note that bad weather conditions (including windspeeds above 23 knots, temperatures above 38C and the occurrence of rain, fog or mist) will cause delays in the schedule, and hence the overall time taken to complete the survey. Since safety is a priority for BassAir, delays may also be caused in the unlikely event that the helicopter requires any repairs during the survey. It is therefore important for survey team members to be prepared for such delays in terms of their planning and availability.

Figure 2 - Proposed ferry routes from Bloemfontein, South Africa, to Mozambique in order to undertake a hippo survey during 2016.

Overnight bases

Bases will be set up along the route, allowing for daily ferrying to and from the particular river systems/lakes to be surveyed. The locations of overnight bases have been planned according to required fuel stops and the logistical feasibility of the ground staff member to get to the fuel sites timeously (see Table 2). The safety of the ground staff member while driving between bases and fuel stops, as well as the safety of the survey team at bases and refuelling sites, is a key priority and has been taken into consideration during the selection of overnight bases. Proposed overnight bases may therefore be subject to change pending local conditions at the time of the survey. In summary, **overnight bases** are proposed to be situated in **Mbatamila (Niassa NR headquarters), Pemba, Quelimane, Cabora Bassa, Beira, Vilankulos, Massingire, and Macanetta** (Table 2).

Fuel depots and refuelling sites

Whenever required, the ground crew member will drive to the nearest fuel depot between bases to refill the fuel drums for the next component of the survey, and may also have to stock up on food for the survey team from time to time. The **refuelling depots** are in **Lichinga, Pemba, Namapa, Nampula, Tete, Quelimane, Beira, Vilankulous, Inhambane** and **Maputo** (Table 2). Table 2 also details each of the refuelling sites between the fuel depots, although these have been kept to a minimum to maximize the efficiency of the survey. The ground crew member will meet the helicopter and survey team at each of these refuelling sites to provide fuel from drums on the vehicle and trailer. The safety of the ground crew member while travelling with large amounts of fuel between these refuelling sites is imperative. He will have to travel in convoy where necessary, and the routes may therefore be subject to change pending local conditions at the time of the survey.

Table 2 - Approximate schedule for the hippo survey to be carried out along the main rivers and lakes in Mozambique during the dry season of 2016.

Day	Prov date	Leg #	Description	Distance (km)	Total hrs	Base	Refuelling spots
1	14	Pos leg1	Tempe-Lanseria	383	2.13	**Vilancoulos**	Lanseria airport
		Pos leg2	Lanseria-KMIA	325	1.81		KMIA
		Pos leg3	KMIA-Maputo	159	0.88		Maputo airport
		Pos leg4	Maputo-Inhambane	368	2.04		Inhambane airport
		Pos leg5	Inhambane-Vilankulos	206	1.14		Vilankoulos airport
2	15	Pos leg6	Vilancolous-Beira	284	1.58	**Mbatamila**	Beira airport
		Pos leg7	Beira-Quelimane	321	1.78		Quelimane airport
		Pos leg8	Quelimane-Nampula	378	2.10		Nampula airport
		Pos leg9	Nampula-Mbatamila	374	2.08		Mbatamila
3	16	1	Mbatamila-Lichinga	274	1.55		Lichinga en route to Lake Malawi
		1b	Lichinga-Lmalawi-Tenente Valadum	291	1.91		Tenente Valadum after leg1b
		1c	Tenente Valadum-Lukulingo River-Wrovuma-Matondovela	371	3.08		Matondovela after leg1c
		1d	Matondevela-Mbatamila	58	0.32		Mbatamila after leg1d
4	17	3	Mbatamila-SLungenda River	367	2.85		Mbatamila after leg 4
		4	Mbatamila-CRovuma-Mbatamila	289	2.12		Mbatimila after leg 3
5	18	5a	Mbatmila-NLungenda-ERovuma in Niassa-Mapanda	274	2.58		Mapanda after leg 5a
		5b	Mapanda-ERovuma in Niassa-Mbatamila	113	0.79		Mbatimila after leg 5b
6	19	6a	Mbatmila-Gomba village	127	0.71		Gomba village after leg6a
		6b	Gomba village-Erovuma-EofNiassa-Gomba Village	426	3.33		Gomba village after leg6b
		6c	Gomba village-Mbatamila	127	0.71		Mbatamila after leg6c
7	20	7	Mbatamila-Messalo River-Pemba	405	2.81	**Pemba**	Pemba
		8	Pemba-NMessalo River-Pemba	378	2.60		Pemba

8	21	9	Pemba-Lurio River-Nampula	440	3.51	**Quelimane**	Namapa and Nampula airports
		10	Nampula-Lighona River-Quelimane	467	3.07		Quelimane airport
9	22	10b	Quelimane-southern Zambezi River-Chemba	390	3.42	**Mague**	Chemba
		11	Zambezi River from Chemba to Tete	188	1.88		Tete airport
		12	Zambezi River from Tete to Lake Caborra Bassa	233	1.74		Mague
10	23	13	south western Lake Caborra Bassa	405	3.06		Mague
11	24	14	southern Lake Caborra Bassa to Mague	336	2.95		Mague
12	25	15	south eastern Lake Caborra Bassa to Tete	454	3.85	**Beira**	Tete airport (top up en route?)
		16	Tete-Pungwe River-Gorongosa lakes-Beira	494	3.26		Beira
13	26	17	Beira-Vilankulos	296	1.69	**Vilancoulos**	Vilankoulos
		18	Vilankulos-Save River-Vilankulos FUEL FROM BERNARD VL??	497	3.51		MAY NEED FUEL ON ROAD CLOSER TO VILANKOULOS
14	27	19	Vilancolous-Inhambane	230	1.46	**Massingiri**	Inhambane airport
		20	Inhambane to lakes	59	0.38		none required
		21	Lakes near Inhambane	263	1.55		Macia from vehicle
		22	Macia-Massingiri	167	0.93		Massingiri
15	28	23	Zambezi along Limpopo NR	395	2.20		Massingiri
16	29	24	Massingiri-Macia	486	3.86	**Macanetta**	Maputo airport
		25	Macia-lakes around Maputo	299	2.06		none required
17	30	Return to base i	Maputo-KMIA	166	0.92		KMIA
		Return to base ii	KMIA-Lanseria	287	1.59		Lanseria airport
		Return to base iii	Lanseria-Tempe	424	2.36		

Survey routes

Figures 3 – 7 depict the routes to be taken for each component of the survey, as well as the refuelling sites. These routes have been selected to minimize movement of hippopotamus between survey legs, as well as unnecessary ferrying by the helicopter, and travelling by the ground crew member.

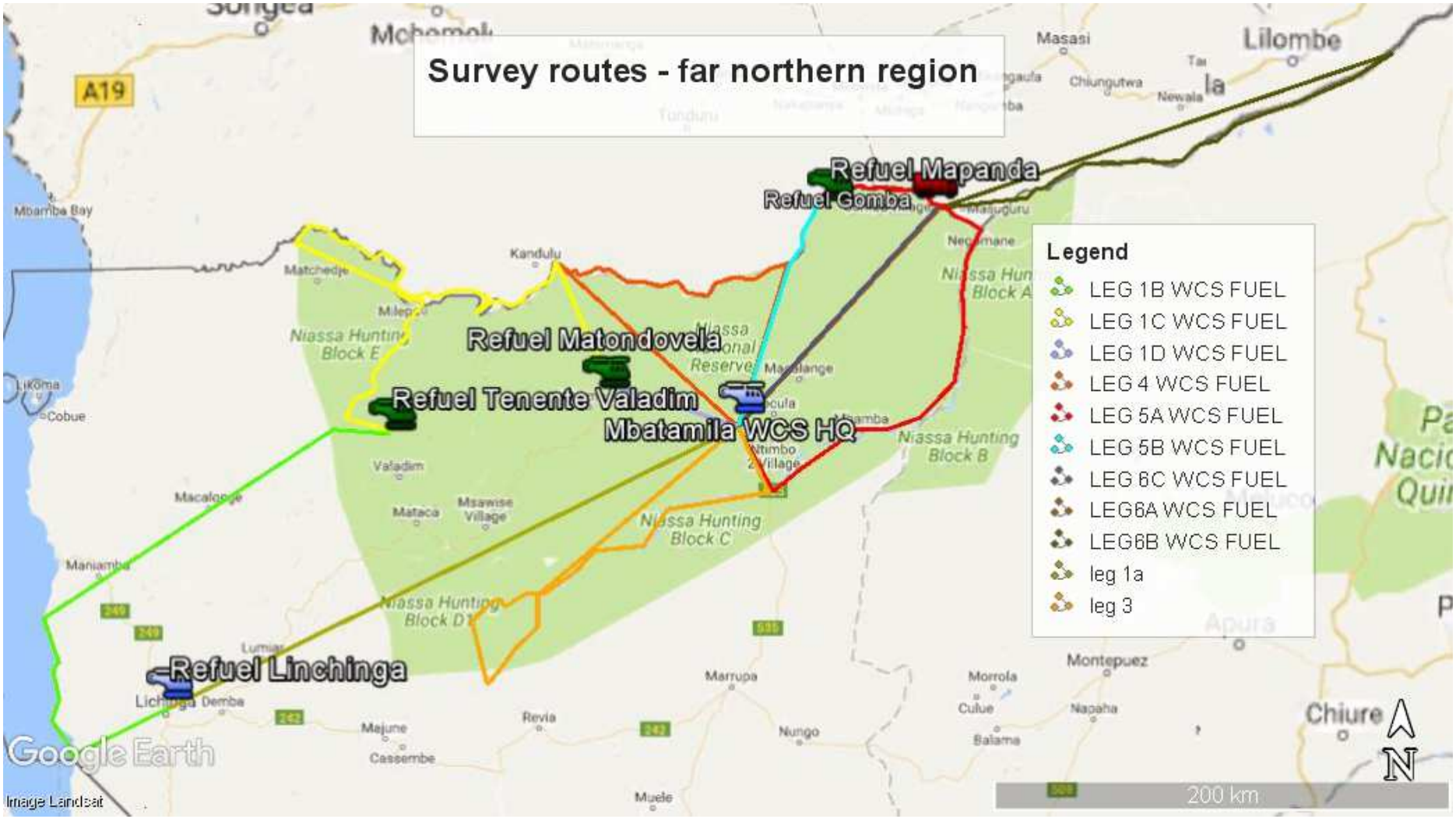


Figure 3 - Proposed survey routes and refuelling sites for the far northern region of Mozambique (green helicopters indicate WCS fuel depots; red trucks indicate refuelling from a ground support vehicle).

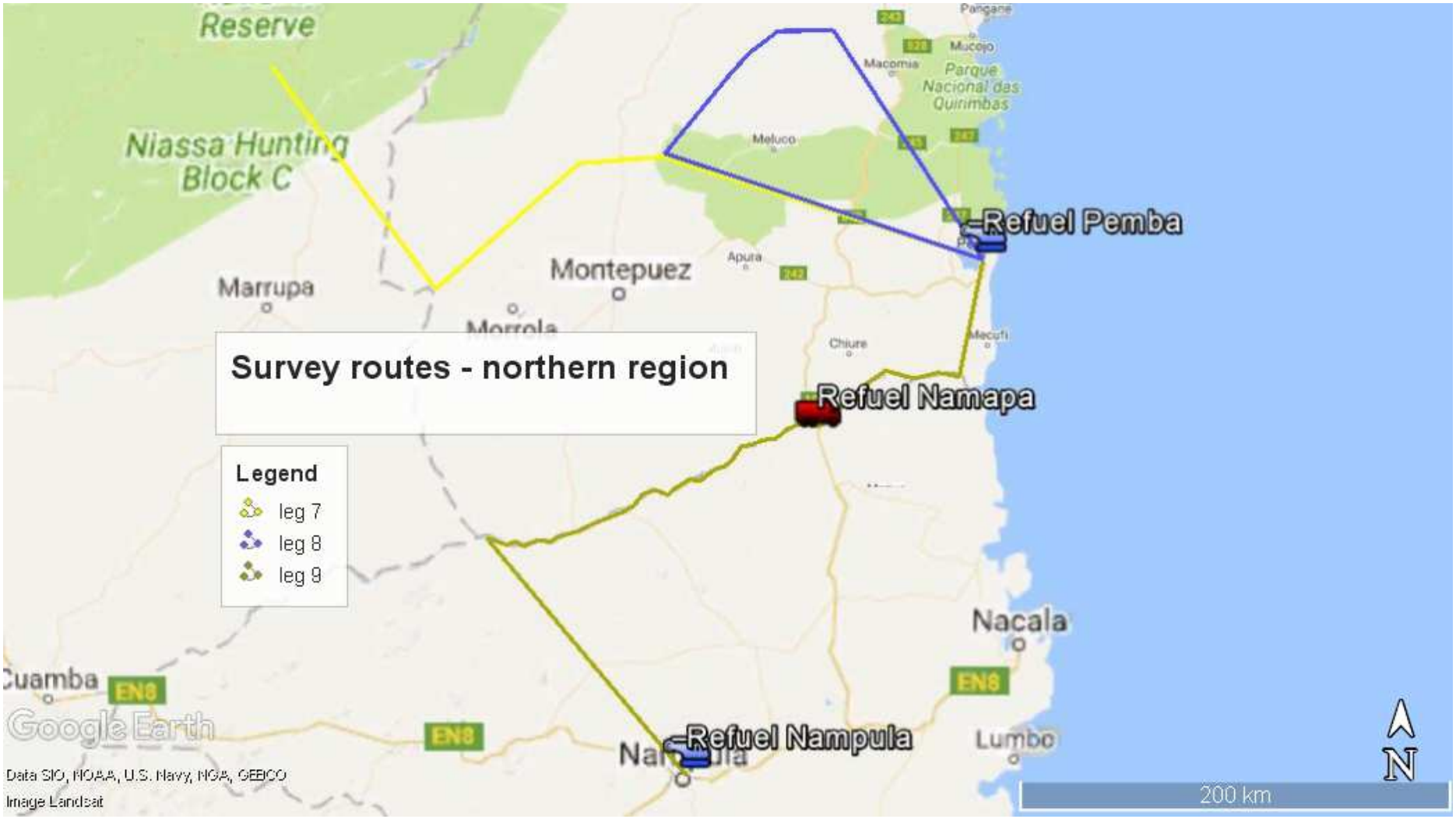


Figure 4 - Proposed survey routes and refuelling sites in northern region of Mozambique (red truck icons indicate refuelling from the ground support vehicle; blue helicopter icons indicate refuelling at an airport).

Figure 5 - Proposed survey routes and refuelling sites in central Mozambique (red truck icons indicate refuelling from the ground support vehicle; blue helicopter icons indicate refuelling at an airport).

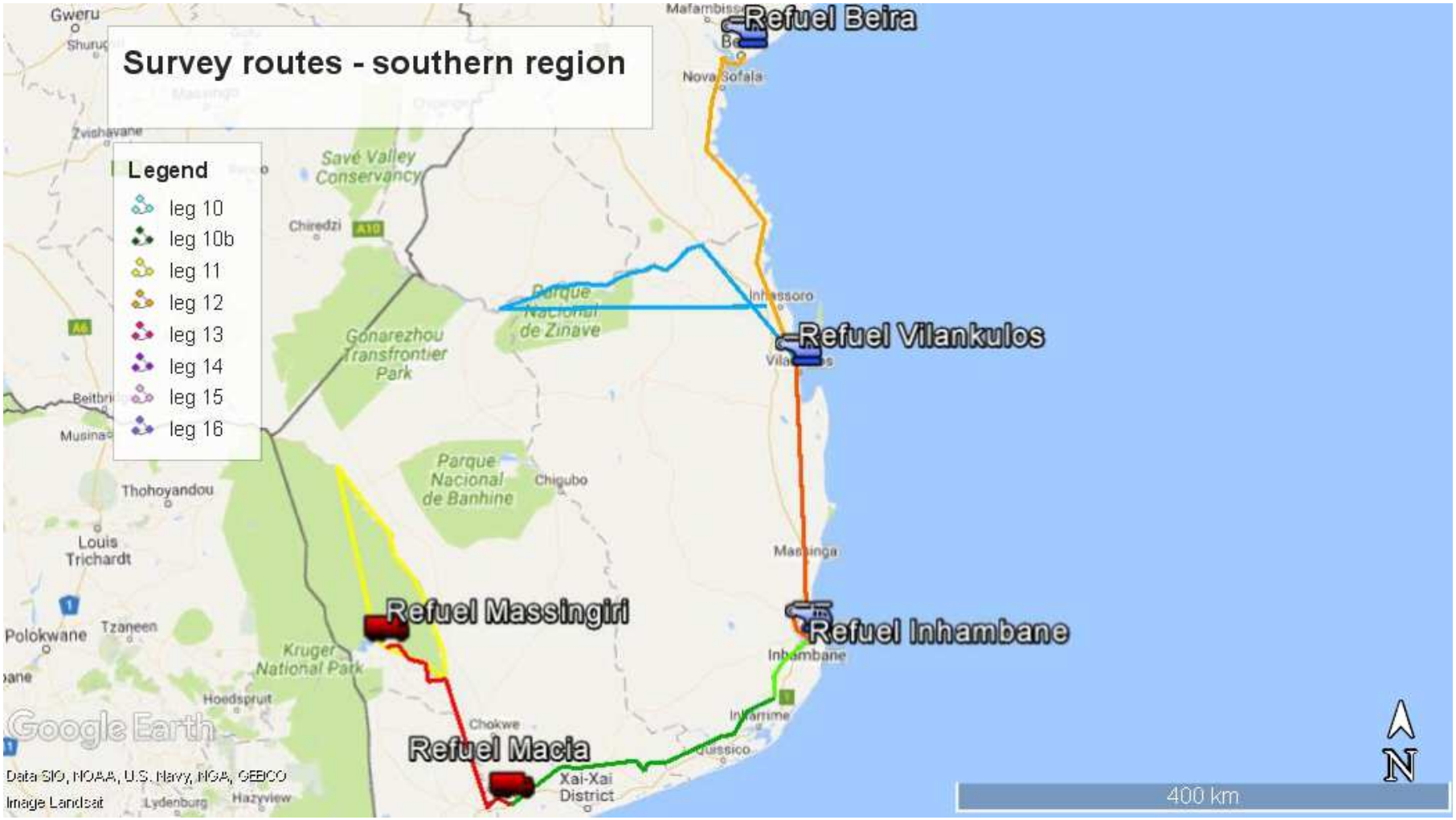


Figure 6 - Proposed survey routes and refuelling sites in southern Mozambique (red truck icons indicate refuelling from the ground support vehicle; blue helicopter icons indicate refuelling at an airport)

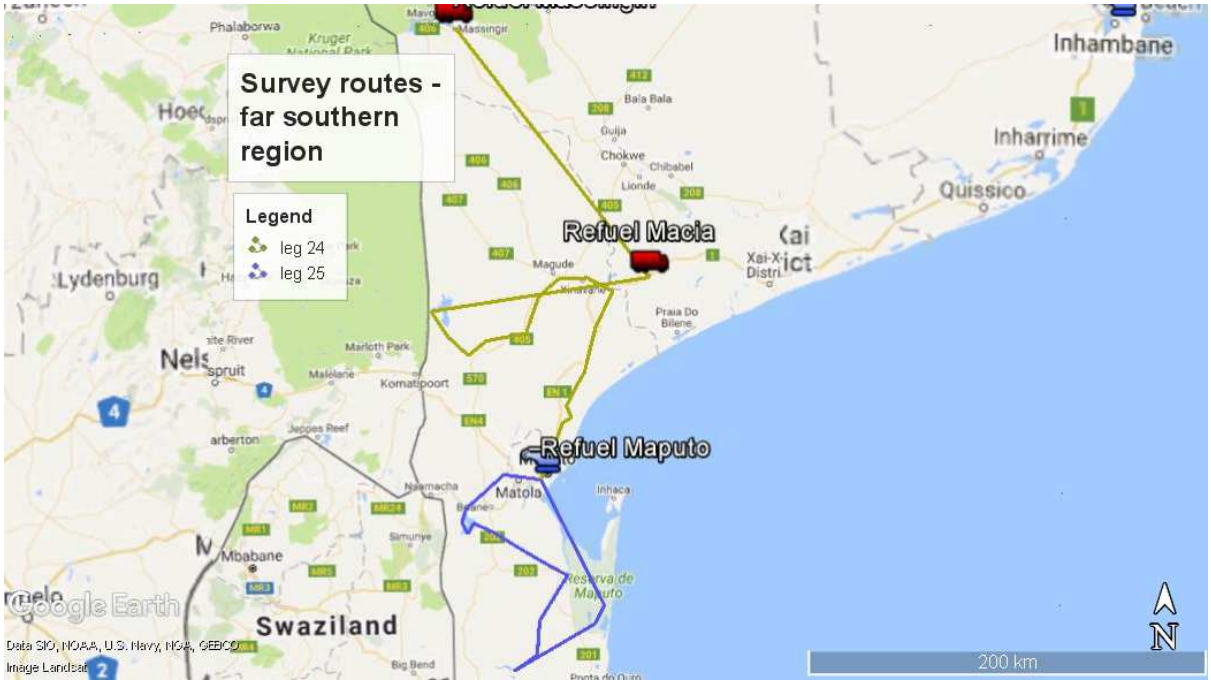


Figure 7 - Proposed survey routes and refuelling sites in the far southern Mozambique (red truck icons indicate refuelling from the ground support vehicle; blue helicopter icons indicate refuelling at an airport).

Ground crew routes for refuelling and provisioning

Figures 8 – 15 depict the road routes that the ground crew member will take to provision the helicopter with fuel, and the survey team with provisions and luggage. This route is subject to change, pending local conditions at the time of the survey.

The ground support vehicle will join the survey team either in Pemba or Nampula, in order that the survey is not delayed by the slower north-bound travel of the ground vehicle. For this reason, fuel for the helicopter will be purchased from WCS depots as depicted in Figure 3 (above). Thereafter the ground support vehicle will join the survey team at each overnight base (Table 3), unless the particular survey route is too far, or conditions too rough, for the vehicle to make it to the base on the same evening.

Table 3 - Schedule for ground support vehicle and staff member.

Day	Prov date (Nov)	Vehicle leg#	Ground route	Ground distance (km)	tanks of fuel required	hours	minutes	Ground base
1	14	g1	Bloemfontein-Nelspruit	743	1.65	6	54	Nelspruit
2	15	g2	Nelspruit-Maputo	210	0.47	2	58	Maputo/Macia
3	16	g3	Maputo-Vilankulos	708	1.57	8	48	Vilankulos
4	17	g3	Vilankulos-Beira	534	1.19	7	51	Beira
5	18	g4	Beira-Quelimane	479	1.06	8	8	Quelimane
6	19	g5	Quelimane-Nampula	546	1.21	6	35	Nampula
7	20	g6	stay in Nampula					
8	21	g7	Nampula-Quelimane	546	1.21	6	35	Quelimane
9	22	g8	Quelimane-Chemba	308	0.68	4	41	Panyame Lodge
			Chemba-Tete	373	0.83	5	30	
			Tete-Mague	237	0.53	4	21	
10	23	g9	STAY AT PANYAME					
11	24	g10	STAY AT PANYAME					
12	25	g11	Mague-Tete	237	0.53	4	21	Beira
			Tete-Beira	583	1.30	8	51	
13	26	g12	Beira-Vilankulos	534	1.19	7	50	Vilankulos
			Vilankulos-Inhassoro	55	0.12	0	56	Vilankulos
14	27	g13	Vilankulos-Inhambane	281	0.62	3	32	Massingiri
		g14	Inhambane-Macia	324	0.72	4	7	
		g15	Macia-Massingiri	190	0.42	2	36	

15	28	g16	STAY AT MASSINGIRI					Massingiri
16	29	g17	Massingiri-Macia	190	0.42	2	36	Macanetta
			Macia-Maputo	146	0.32	2	7	
17	30	g18	Maputo-Bloemfontein	946	2.10	10	3	Bloemfontein

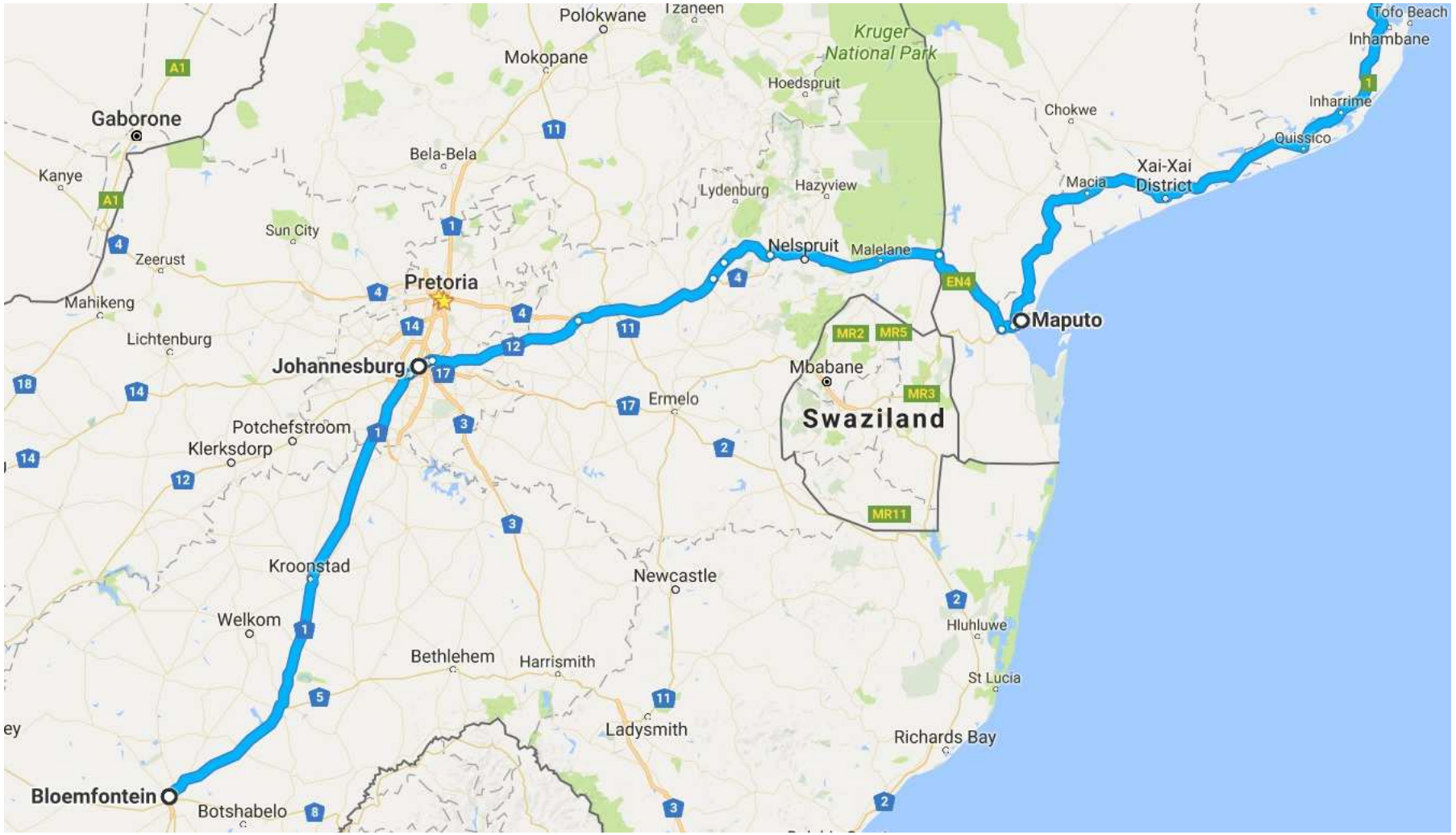


Figure 8 – NORTH-BOUND ground route to position the ground support vehicle to the far northern region of Mozambique – Bloemfontein to Inhambane.

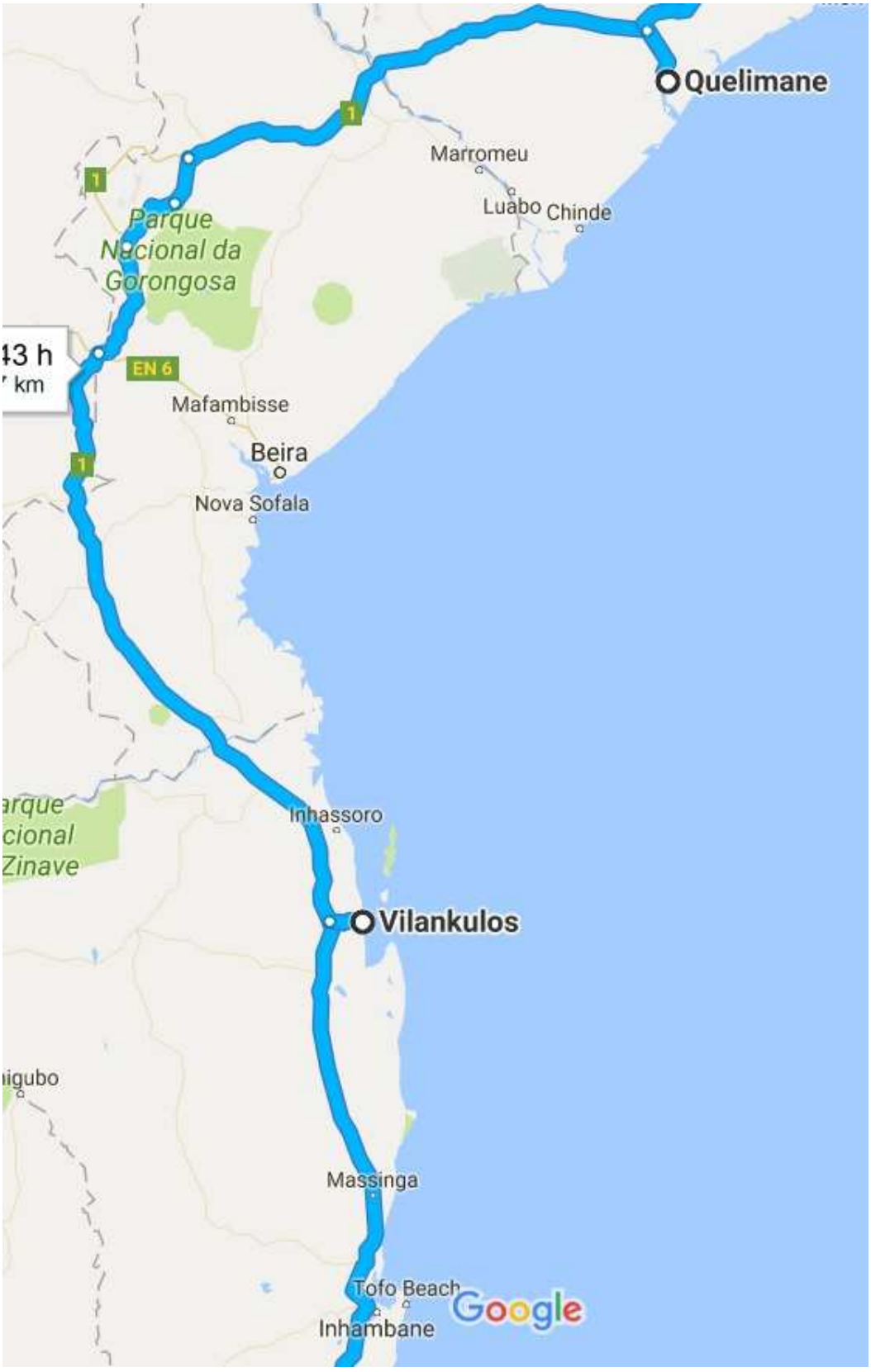


Figure 9 – NORTH-BOUND ground route to position the ground support vehicle to the far northern region of Mozambique –Inhambane to Quelimane.

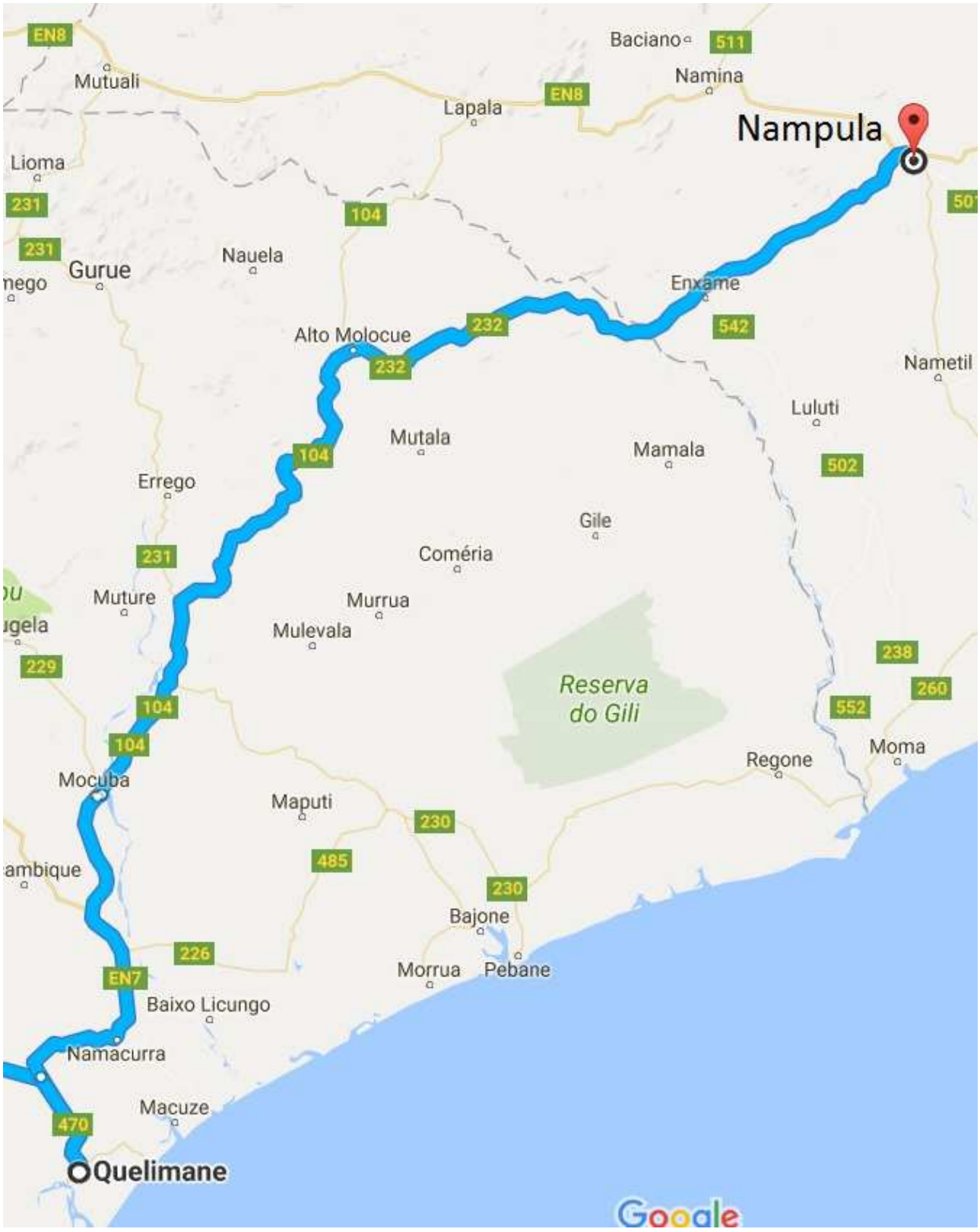


Figure 10 – NORTH-BROUND ground route to position the ground support vehicle to the far northern region of Mozambique – Quelimane to Nampula.

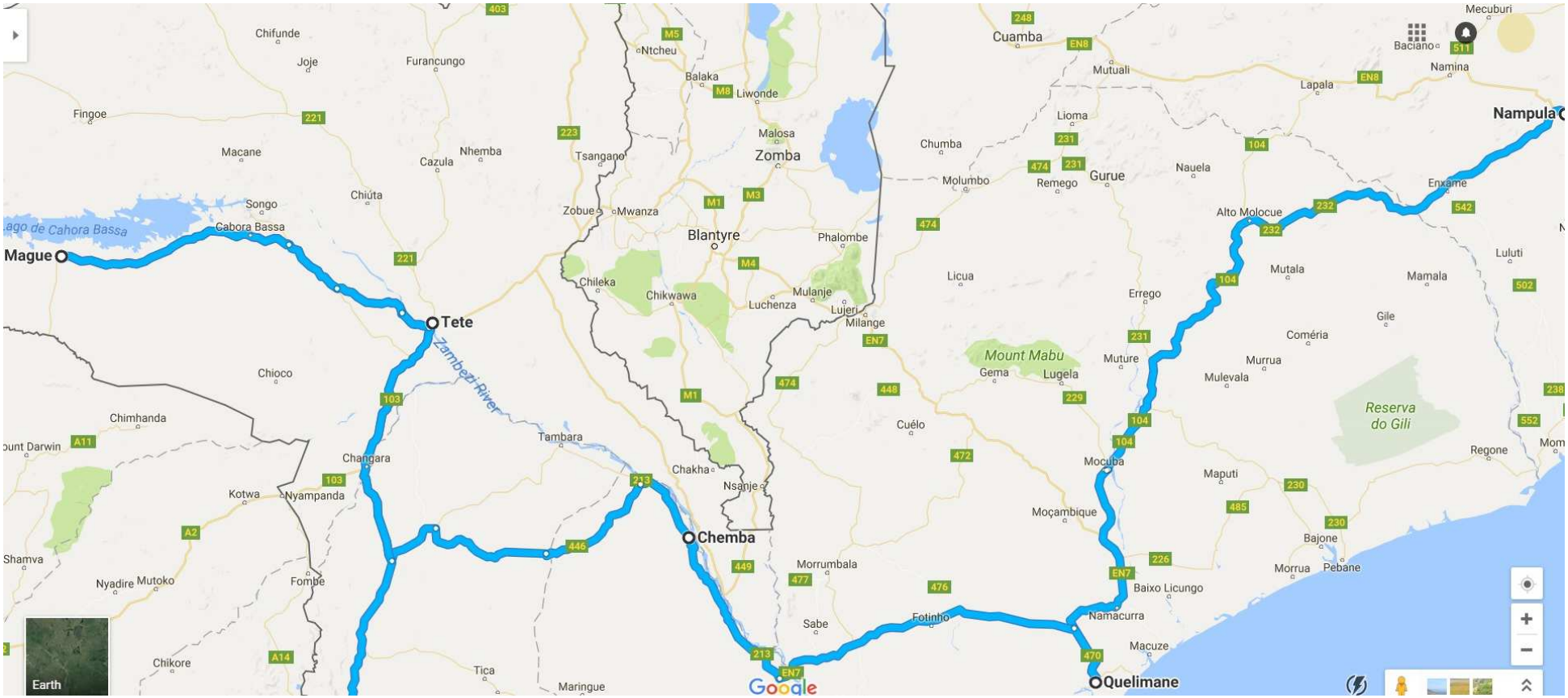


Figure 11 - SOUTH-BOUND ground route to position the ground support to Chemba and Cabora Bassa in the central region of Mozambique – Nampula-Quelimane-Chemba-Tete-Mague.

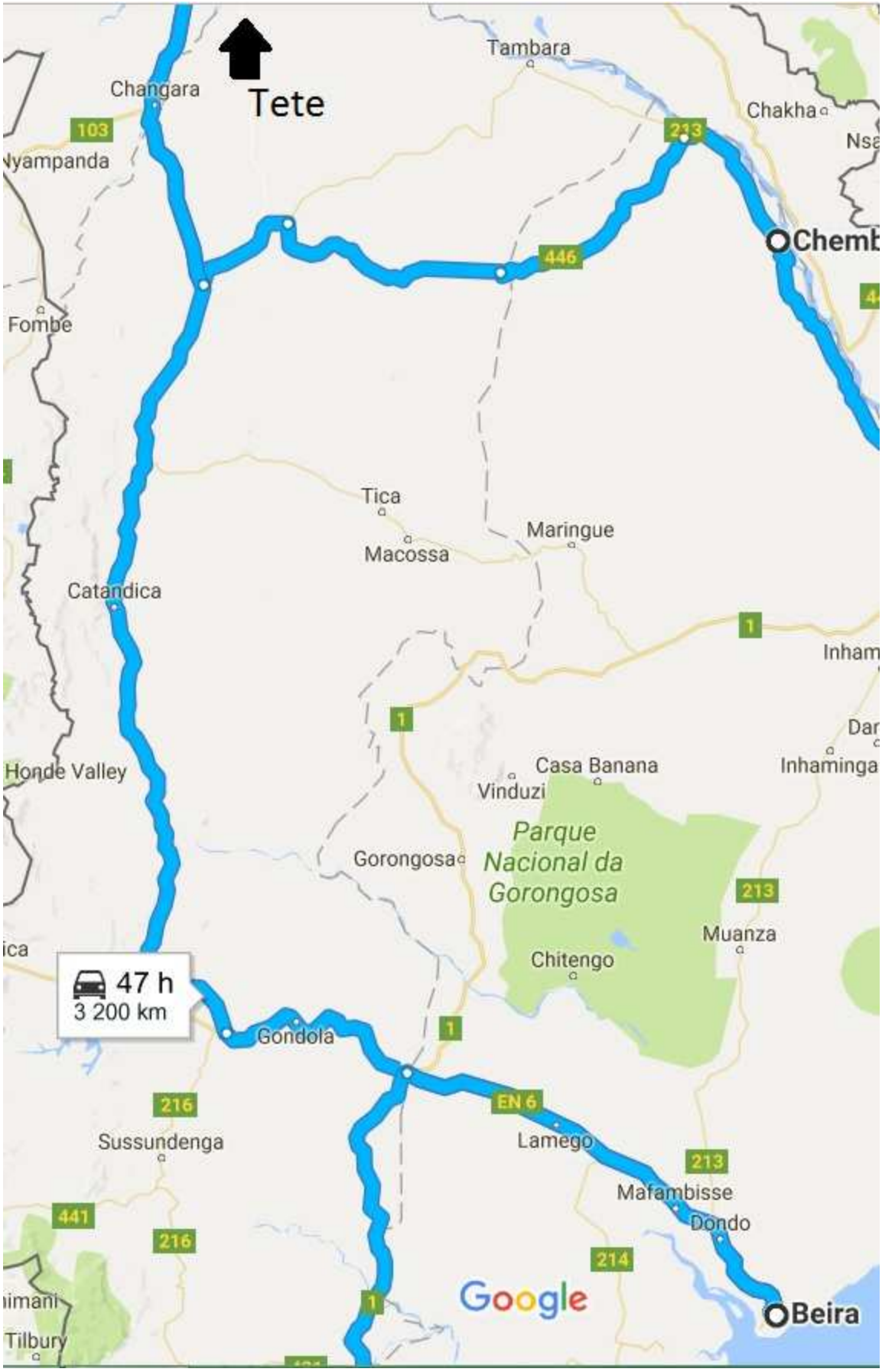


Figure 12 - SOUTH-BOUND ground route for ground support vehicle: Tete-Beira

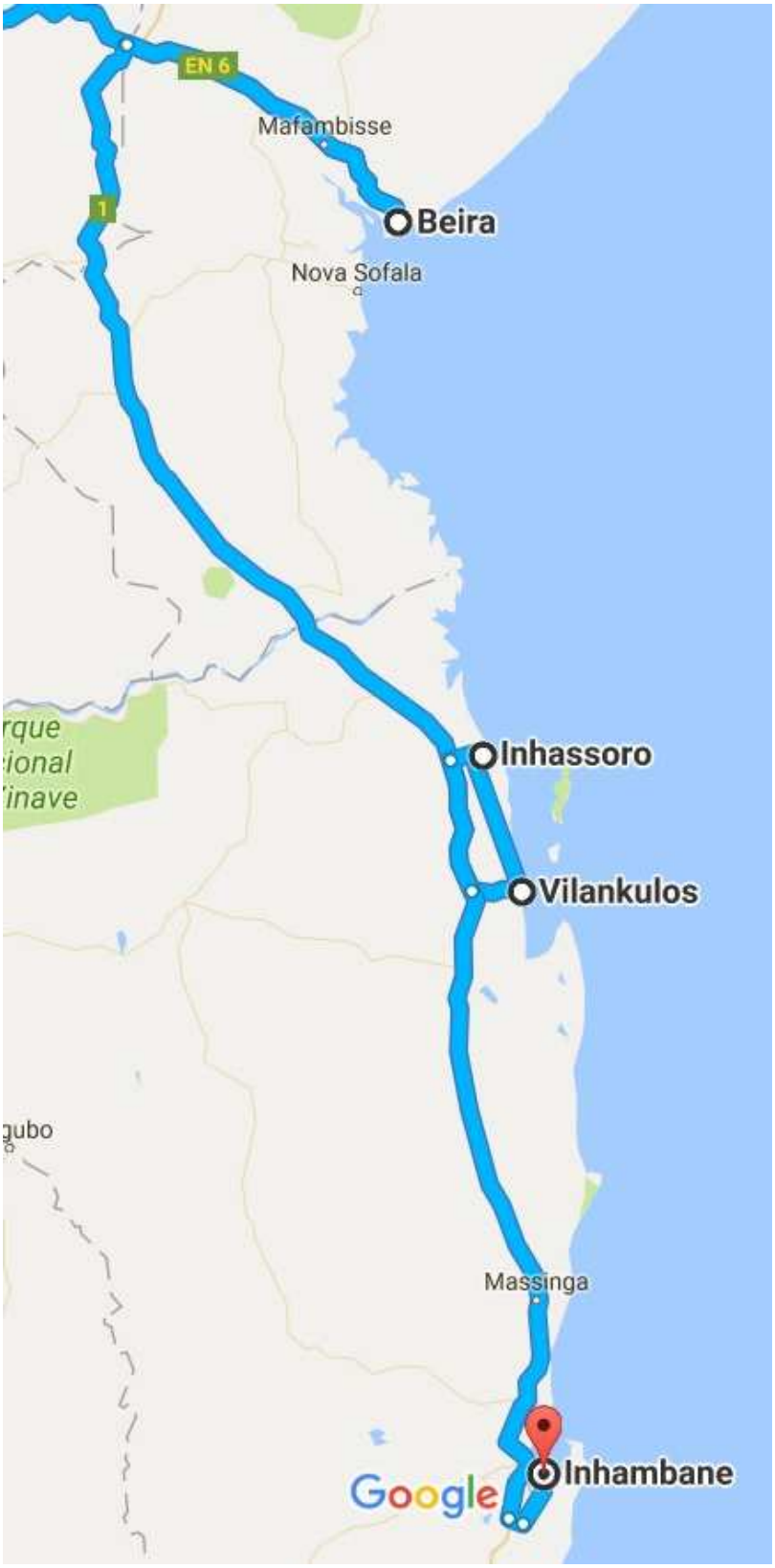


Figure 13 - SOUTH-BOUND ground route for ground support vehicle: Beira-Inhambane

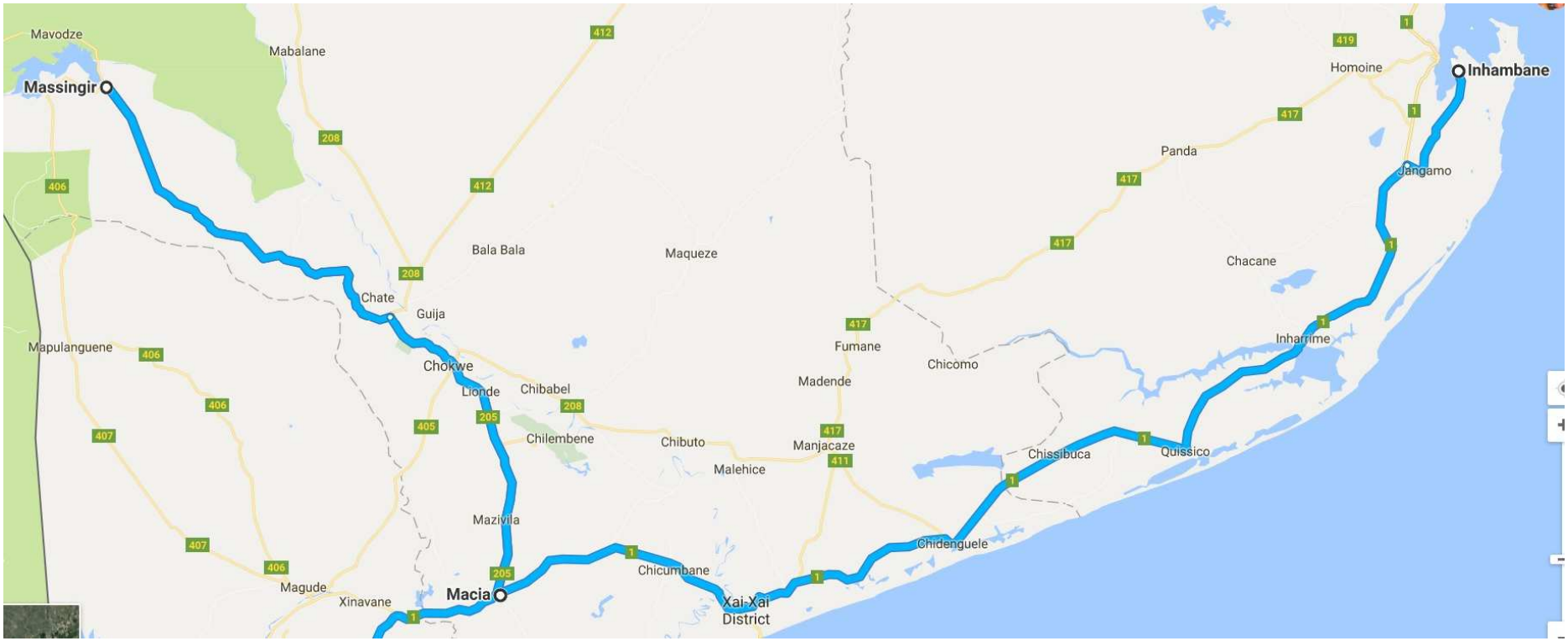


Figure 14 - SOUTH-BOUND ground route for ground support vehicle: Inhambane-Macia-Massingiri.

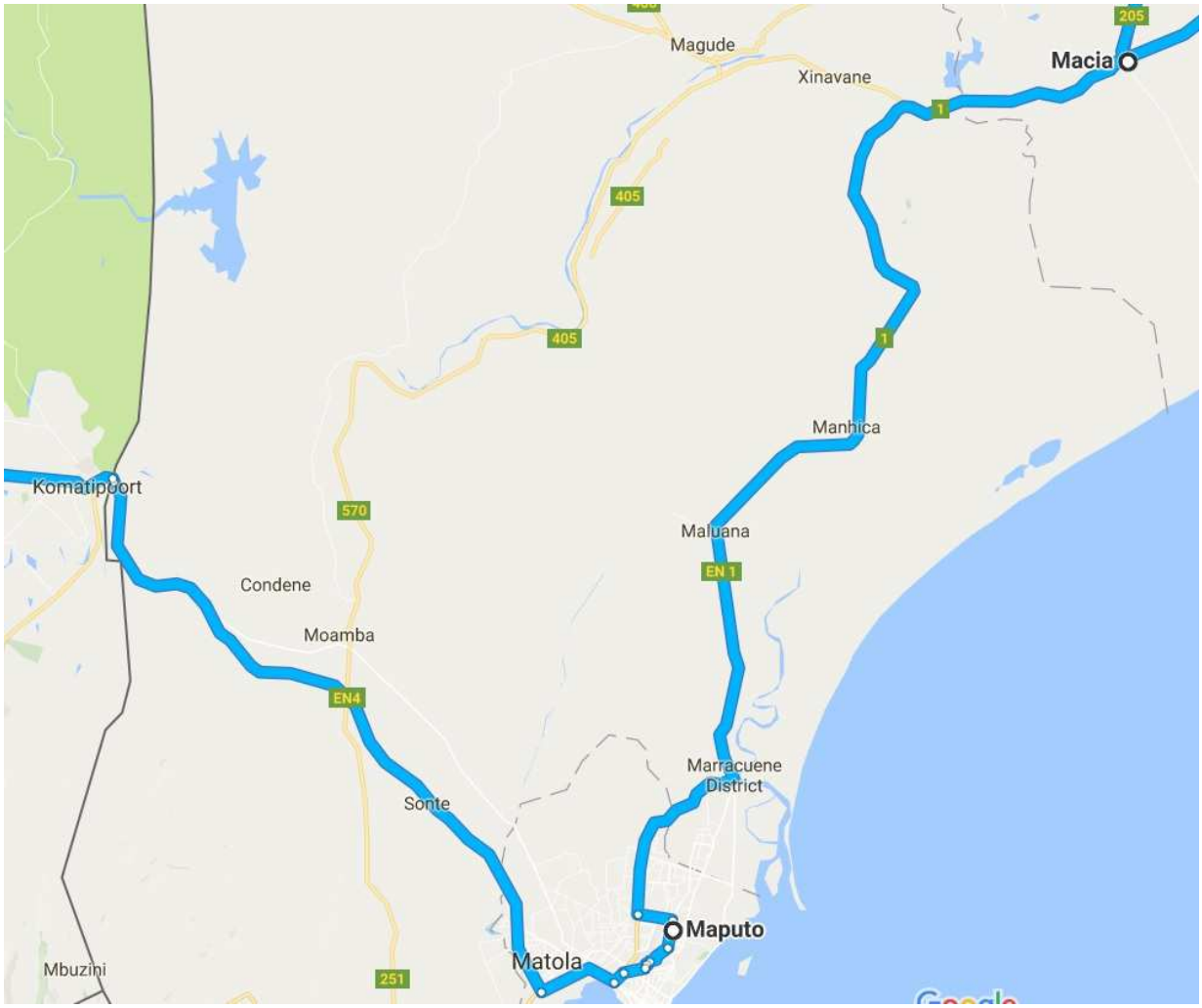


Figure 15 - SOUTH-BOUND ground route for ground support vehicle: Macia-Maputo-Komatipoort

4.2 Composition of survey team

At all times, the survey team will consist of the pilot, a technical adviser/data capturer and two local staff members from the conservation areas or associated departments. This will provide for four observers, which is the minimum number required for accurate counts during large mammal aerial surveys (Redfern and Viljoen, 2002, Trimble et al., 2011). In addition, a ground support staff member will drive the vehicle and trailer with fuel to the various bases along the survey transect, bring fuel to refuelling points along the survey, and refill drums with fuel between bases. In total the team will therefore consist of five team members. From time to time, local technicians will join the team en route to participate for the purpose of training.

It is important to keep the survey team as consistent as possible throughout the survey, not only to maximize the accuracy of the count, but also to improve the skills of the ANAC team members. Trainee observers should be able to maintain focus for extended periods (up to 8 hours of counting per day),

be able to detect hippo at a distance and to keep track of moving hippo while counting a particular area. It is critically important that observers do not suffer from motion sickness. Trainees that develop motion sickness during the survey will have to be replaced to avoid compromising the accuracy of the count.

ANAC has proposed the following observers to participate in the survey. These observers will be responsible for joining up with and leaving the survey team timeously. Observers suffering suffer from motion sickness will need to be replaced:

Agostinho de Nazaré (Headquarters)
Armindo Araman (Headquarters)
Rezia Cumbi (Headquarters)
Oraca Cuambe (Headquarters)
Paulo Barros (Headquarters)
Marcelino Denja (Gorongosa NP)
Pedro Pereira (Zinave (NP)
Paulo Malenga (Quirimbas NP)
Limpopo NP (name still to be supplied)
Niassa NR (name still to be supplied)

4.3 Roles and responsibilities of team members

It will be important for team members to be familiar with their responsibilities during the survey, which are as follows:

Pilot: safety briefing, flying of survey, providing instructions to ground crew, procurement of fuel, provision of fuel drums, removal and replacement of helicopter doors for survey flights, cleaning and maintaining helicopter. The name of the pilot is Mr John Bassi.

Technical advisor/data capturer/analyser: compilation of Inception Report, arrangement of survey team accommodation (with assistance from ANAC), arrangement and purchase of food (excludes cooking), operating computer and GPS during survey, daily downloading of GPS track and hippo observations, making backups of data, providing excel spreadsheet of entire survey (including spatial observations and totals), spatial analyses and mapping of results, provision of data capture and excel analysis training, compilation of Final Report. The name of the technical advisor, data capturer and an analyser is Dr Angela Gaylard.

Ground support: obtaining fuel and refilling of fuel drums, assisting with refuelling of helicopter, placing fuel at overnight bases and refuelling spots, assisting packing when moving base. The name of the ground support staff member is Ezekiel Nxusa.

Observers: purchase and preparation of own meals (including snacks/lunches and drinking water to be taken with during survey flights that do not return to base during the day), counting of hippo during the survey flights (according to the principles outlined in the training brief), taking care of own personal belongings and equipment.

Data capture and analysis trainees: provision of own laptop computers preloaded with MS Windows and MS Excel, working knowledge of GIS (if requiring basic training on mapping of results); any costs associated with offsite training will be for trainee's own expense.

4.4 Accommodation and meals

While every effort will be made to secure comfortable accommodation at the various bases along the survey transect, some of the areas may only have basic accommodation available. However, it will not be necessary to camp anywhere along the survey routes. BassAir will arrange accommodation on a shared basis.

BassAir will provide food and drinking water to its own crew, while each pair of ANAC observers is responsible for their own food and drinking water. ANAC observers will also be expected to prepare or purchase their own meals and provision themselves with snacks/food during survey flights.

Wherever possible, the following will be available at overnight bases:

- electricity for recharging laptop, helicopter power pack, cameras
- running water for cooking, bathing
- refrigerator and freezer for keeping food from spoiling

The following items must be supplied by the survey team members themselves:

Towels, cutlery and crockery, pots and pans for preparing meals during the survey, toiletries and items of a personal nature (including medication), soft drinks and any other specialized dietary items

Important information for ANAC team members

- Team members are responsible for travelling to and from the bases from which they will be counting
- Minimal luggage should accompany each team member, as the space in the ground vehicle is limited (each team member is restricted to one medium-sized tote bag and a laptop, if applicable; one medium-sized storage container per ANAC team will be permitted for cooking equipment, cutlery and crockery)
- Each team member is responsible for his/her own safety. BassAir will provide a safety briefing, but will not be held liable for any injuries or death during the course of the survey

5. Training for data capture and analysis

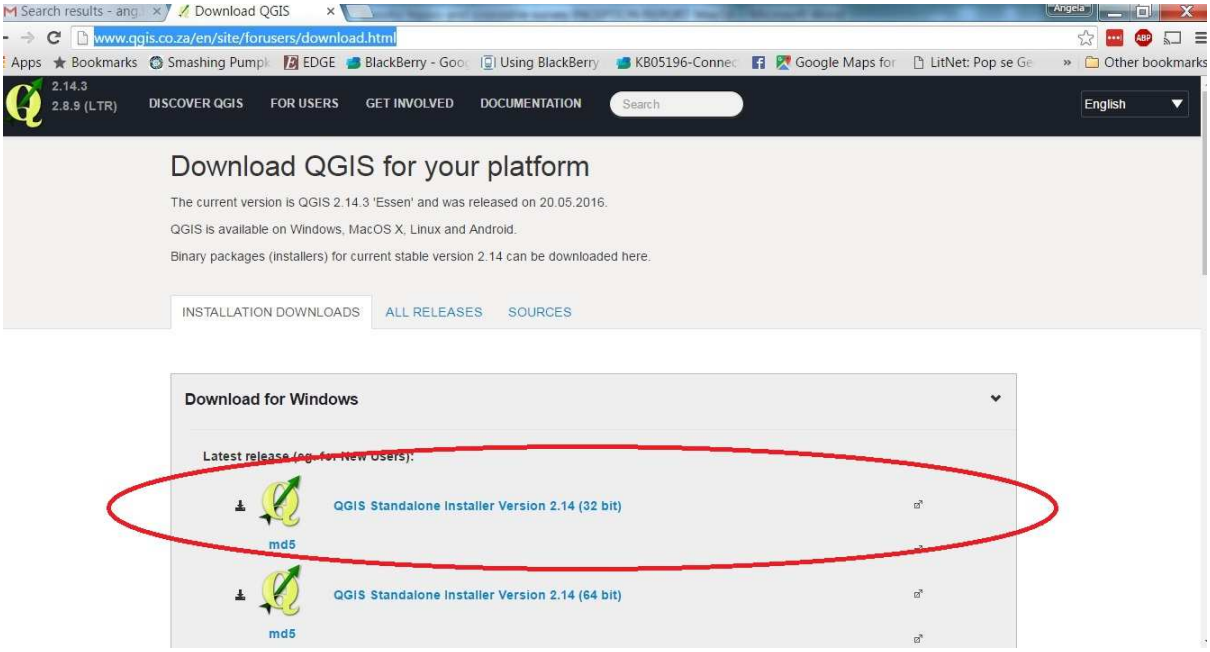
5.1 In-field training

In-field training will take the form of a safety briefing, as well as briefing on the principles of counting from a helicopter. These components of the training will take place prior to each pair of ANAC observers joining the survey team. The primary component of the in-field training will comprise the actual counting during the survey, at which time both the pilot and data capturer/technical adviser

will provide training on how to improve observation and counting skills. BassAir reserves the right to ask any observer to leave the survey team if they are deemed unfit to count, as this will negatively influence the survey results.

5.2 Data analysis training

Data analysis training will cover data capture, data download and data analysis in MS Excel. Additional training for mapping of results can be provided to team members who already have a basic knowledge of GIS. This training will be provided during the survey, when the data capturer/analyser downloads and stores the data daily. To maximize this training opportunity, team members who require data analysis training must have a working knowledge of MS Windows and MS Excel, and must bring their own laptops with Microsoft Windows, Microsoft Excel and either ArcGIS (version 9 or later) or Quantum GIS (available for free download at http://www.qgis.co.za/en/site/forusers/download.html)



6. Important contact numbers

Since the survey will be undertaken in remote areas, and logistical planning may need to change from time to time, it will be important to have a central contact person at ANAC, who is reachable for any problems that may be encountered.

In case of an emergency the following people should be contacted in South Africa:
For **John Bassi** – Personal Assistant to Mr Bassi, **Mrs Lisa Bennetts +27 82 336 6890**
For **Angela Gaylard** – next of kin, **Miss Alexandria Gaylard-Ralfe +27 72 408 9236**

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