REPORT

Central Térmica de Temane Project - Traffic Impact Assessment Report

Moz Power Invest, S.A. and Sasol New Energy Holdings (Pty) Ltd

Submitted to:

Ministry of Land, Environment and Rural Development (MITADER)

Submitted by:

Golder Associados Moçambique Limitada

6th Floor, Millenium Park Building, Vlademir Lenine Avenue No 174

Maputo, Moçambique

+258 21 301 292

18103533-321147-19

April 2019

Distribution List

12 x copies - National Directorate of Environment (DINAB)

4 x copies - Provincial Directorate for Land, Environment and Rural Development (DPTADER)-I'bane

1 x copy - World Bank Group

1 x copy - SNE, EDM and TEC

1 x copy - Golder project folder

Executive Summary

The purpose of this Traffic Impact Assessment report is to evaluate the suitability of the routes used to transport the necessary Gas to Power Equipment as abnormal heavy loads and to identify any potential traffic-related impacts during the Construction phase as well as the Operational phase of the CTT project.

It is concluded that the traffic impact of the additional vehicles during the construction and operational phases of the CTT on the existing road network is low in terms of traffic delay and therefore does not require infrastructure upgrades to reduce the impact. However, the impact of the construction traffic and abnormal loads movements in terms of vehicular and pedestrian safety is significant and various mitigation measures, such as road upgrades and improvements are required as detailed in the Beach Landing Report.

Based on the higher risk of pedestrian safety and extensive road upgrades that will be required for the Brisa Mar and Maritima Beach landing sites, the SETA beach landing site is preferred from a Traffic Impact point of view as it has the lowest impact on communities.

With the implementation of the mitigation measures recommended to reduce the Traffic Impact risks identified along the main Inhassoro (R241) and EN1 roads, this route is the preferred route compared to the alternative route along the North South Road and Shortcut Road (Southern route option).

It is further recommended that a detailed Traffic Management Plan should be developed by each contractor based on the guidelines provided in this Traffic Impact Assessment report.

Table of Contents

1.0 INTRODUCTION 1

2.0 DESCRIPTION OF THE KEY PROJECT COMPONENTS 3

2.1 Ancillary Infrastructure 5

2.2 Water and electricity consumption 7

2.3 Temporary Beach Landing Site and Transportation Route Alternative 7

3.0 STUDY OBJECTIVE 10

4.0 LITERATURE REVIEW 11

4.1 Transport of Gas to Power Heavy Equipment 11

4.1.1 Option A: Large Gas Engines 11

4.1.2 Option B-1: Gas Turbines (Maximum on-site assembly) 11

4.1.3 Option B-2: Gas Turbines (Minimum on-site assembly) 11

4.2 Beach Landing Locations 12

5.0 CONSTRUCTION AND OPERATIONAL VEHICLE TRIPS 14

5.1 Trip Generation Rates 14

5.2 Construction Phase – Abnormal vehicle loads 14

5.3 Construction Phase - Daily Traffic 16

5.4 Construction Phase – Peak Hour Traffic 17

5.5 Operational Phase – Peak Hour Traffic 17

5.6 Trip Distribution 18

5.7 Trip Assignment 18

5.8 Additional Traffic Impact on Intersection Level of Service 18

6.0 ROAD SURVEYS AND ROUTE EVALUATION 18

6.1 Beach Landing Access Roads 21

6.1.1 Seta Beach Landing Access 21

6.1.2 Maritima Beach Landing Access & Road Section J 23

6.1.3 Brisa Mar Beach Landing Access & Road Section C 26

6.2 Inhassoro Local Roads 28

6.2.1 Section C: Brisa Mar - From Intersection X to Brisa Mar Beach Landing (3.21km) 29

6.2.2 Section E: Local Road – From local road in Inhassoro to North South Road 29

6.2.3 Section G: From Brisa Mar Access to North South Road 29

6.2.4 Section I: Maritima Beach Landing to North South Road 30

6.2.5 Section J: Inhassoro Monument (R241) to Intersection X 30

6.3 Major Linking Sections 30

6.3.1 Section A: R241 – Inhassoro area 30

6.3.2 Section A: R241 – Govuro River Bridge 32

6.3.3 Section A: R241 & EN 1 Intersection 33

6.3.4 Section B: EN1 - From R241 Intersection to CTT Turnoff 34

6.3.5 CTT Access Road 39

6.3.6 EN1 / North South Road Shortcut 41

6.3.7 North South Road 43

6.4 Route Evaluation 44

6.4.1 Route Evaluation: Options Considered 44

6.4.2 Route Evaluation: CTT via Main Roads 46

6.4.3 Route Evaluation: CTT via Back Roads 48

6.5 Route Selection Impact and Traffic Management Plan 51

6.5.1 Impact on Existing Traffic in terms of Delay 51

6.5.2 Construction Vehicle Traffic Impact 52

6.5.3 Abnormal Vehicle Traffic Impacts 52

6.5.4 Traffic Management Plan / Traffic Impact Mitigating Measures 55

7.0 CONCLUSION 57

TABLES

Table 1: Large Gas Engines 11

Table 2: Option B-1 Gas Turbines (Max. assembly) 11

Table 3: Option B-2 Gas Turbines (Min. assembly) 11

Table 4: NTE Energy Sites 14

Table 5: Abnormal Vehicle Trips to the Laydown Area 14

Table 6: Abnormal Vehicle Trips from Laydown Area to the Site 15

Table 7: Construction Phase – Daily Traffic 16

Table 8: Construction Phase - Peak Hour Traffic 17

Table 9: Operational Phase - Peak Hour Traffic 18

Table 10: Option 1A – Seta Beach Landing to CTT via R241 & EN1 46
Table 11: Option 2A - From Brisa Mar Beach Landing Access to CTT via R241 & EN1 46
Table 12: Option 3A - From Maritima Beach Landing Access to CTT via R241 & EN1 47
Table 13: Option 1B – From Seta Beach Landing Access to CTT via Back Roads 48
Table 14: Option 2B-1 – From Brisa Mar Beach Landing Access to CTT via Back Roads (Dirt Roads) 48
Table 15: Option 2B-2 – From Brisa Mar Beach Landing Access to CTT via Back Roads (Sand Tracks) 49
Table 16: Option 3B – From Maritima Beach Landing Access to CTT via Back Roads 50
Table 17: Delay due to Development Traffic 51
Table 18: Construction Vehicle Traffic Impact 52
Table 19: Abnormal Load Impacts 54
Table 20: Traffic Management Plan / Mitigating Measures 55

FIGURES

Figure 1: Project Location 3
Figure 2: Examples of gas to power plant sites (source: www.industcards.com and www.wartsila.com) 4
Figure 3: Conceptual layout of CTT plant site 5
Figure 4: Typical beach landing site with barge offloading heavy equipment (source: Comarco) 6
Figure 5: Example of large equipment being offloaded from a barge. Note the levels of the ramp, the barge and the jetty (source: SUBTECH) 6
Figure 6: Heavy haulage truck with 16-axle hydraulic trailer transporting a 360 ton generator (source: ALE) 7
Figure 7: The three beach landing site options and route options at Inhassoro 8
Figure 8: The two main transportation route alternatives from the beach landing sites to the CTT site 9
Figure 9: Routes Considered (Source: Google Earth) 10
Figure 10: Seta Lodge (Source: Google Earth) 12
Figure 11: Brisa Mar (Source: Google Earth) 13
Figure 12: Maritima (Source: Google Earth) 13
Figure 13: Sections Surveyed (Source: Google Earth) 20
Figure 14: Seta Access Road – Monument 21
Figure 15: Seta Access Road – Road Reserve 22
Figure 16: Seta Access Road – Sea View 22
Figure 17: Seta Access Road – R241 23
Figure 18: Maritima Connecting Road to R241 24
Figure 19: Maritima Access Road to the left past the tree 24
Figure 20: Heavy Vehicles Delivering Goods along Road Section J 25
Figure 21: View towards Maritima Beach Landing 25

Figure 22: Intersection X before Road to Brisa Mar 26
Figure 23: Twisting Track to Brisa Mar along Road Section C....27
Figure 24: Turnoff to Brisa Mar along Road Section C 27
Figure 25: View towards Brisa Mar Beach Landing Point 28
Figure 26: Local Road Sections (Intersection X marked)....29
Figure 27: Section G to North South Road....30
Figure 28: R241 - 580m from Inhassoro Monument 31
Figure 29: R241 – Edge cracking and erosion 31
Figure 30: R241 – Govuro River Bridge – (Inhassoro towards EN1) 32
Figure 31: R241 – Govuro River Bridge – Side View....33
Figure 32:R241 / EN1 Intersection: Eastern Approach 33
Figure 33:R241 / EN1 Intersection (Source Google Earth) 34
Figure 34:EN1 1.6km from Intersection....35
Figure 35:EN1 2.8km from Intersection....36
Figure 36:EN1 10.9km from EN1/R241 Intersection near Jofane (Fill material) 36
Figure 37:EN1 10.9km from EN1/R241 Intersection near Jofane (Patch Work)....37
Figure 38:EN1/CTT Intersection – Northern Approach 37
Figure 39:EN1/CTT Intersection – Southern Approach....38
Figure 40:EN1/CTT Intersection – Western Approach....38
Figure 41: CTT Access Road 39
Figure 42: CTT security gate 40
Figure 43: Fuel Tanker Trucks 40
Figure 44: Shortcut road starting point on EN1 41
Figure 45: Shortcut road pipe bridge 42
Figure 46: Shortcut road power cables....42
Figure 47: North South Road 970m from shortcut road 43
Figure 48: North South Road near Inhassoro....44
Figure 49: Sections for Route Evaluation 45

APPENDICES

None

ACRONYMS

Acronyms	Description
PM	Project Manager
PE	Project Executive
TIA	Traffic Impact Assessment
CTT	Central Térmica de Temane
NMT	Non-Motorised Transport

DEFINITIONS

Definitions	
"infrastructure"	in relation to land transport, means fixed capital equipment and facilities in the land transport system
"midibus"	means a motor vehicle designed or modified solely or principally for conveying more than 16 but not more than 35 persons, including the driver
"minibus"	means a motor vehicle designed or modified solely or principally for conveying more than nine but not more than 16 seated persons, including the driver
"minibus taxi-type service"	means an unscheduled public transport service operated on a specific route or routes, or where applicable, within a particular area, by means of a motor car, minibus or midibus
"municipality"	includes all types of municipalities
"public transport service"	means a scheduled or unscheduled service for the carriage of passengers by road or rail, whether subject to a contract or not, and where the service is provided for a fare or any other consideration or reward
"transport plan"	includes the transportation plans for the area
"travel demand management"	means a system of actions to maximize the capacity of the transport system for the movement of people and goods rather than vehicles, among others, through increasing vehicle occupancy, developing priority measures for public transport, encouraging travel during off-peak periods, shifting demand between modes, restricting the space available for parking, adjusting the price of parking, and other appropriate measures

1.0 INTRODUCTION

The Mozambican economy is one of the fastest growing economies on the African continent with electricity demand increasing by approximately 6-8% annually. In order to address the growing electricity demand faced by Mozambique and to improve power quality, grid stability and flexibility in the system, Moz Power Invest, S.A. (MPI), a company to be incorporated under the laws of Mozambique and Sasol New Energy Holdings (Pty) Ltd (SNE) in a joint development agreement is proposing the construction and operation of a gas to power facility, known as the Central Térmica de Temane (CTT) project. MPI's shareholding will be comprised of EDM and Temane Energy Consortium (Pty) Ltd (TEC). The joint development partners of MPI and SNE will hereafter be referred to as the Proponent. The Proponent propose to develop the CTT, a 450MW natural gas fired power plant.

The proposed CTT project will draw gas from either the Sasol Exploration and Production International (SEPI) gas well field via the phase 1 development of the PSA License area, covering gas deposits in the Temane and Pande well fields in the Inhassoro District and the existing Central Processing Facility (CPF) or from an alternative gas source. Consequently, the CTT site is in close proximity to the CPF. The preferred location for the CTT is approximately 500 m south of the CPF. The CPF, and the proposed site of the CTT project, is located in the Temane/Mangugumete area, Inhassoro District, Inhambane Province, Mozambique; and approximately 40 km northwest of the town of Vilanculos. The Govuro River lies 8 km east of the proposed CTT site. The estimated footprint of the CTT power plant is approximately 20 ha (see Figure 1).

Associated infrastructure and facilities for the CTT project will include:

1) Electricity transmission line (400 kV) and servitude; from the proposed power plant to the proposed Vilanculos substation over a total length of 25 km running generally south to a future Vilanculos substation. [Note: the development of the substation falls outside the battery limits of the project scope as it is part of independent infrastructure authorised separately. (although separately authorised, the transmission line will be covered by the Project ESMP, and the Vilanculos substation is covered under the Temane Transmission Project (TTP) Environmental and Social Management Plans). Environmental authorisation for this substation was obtained under the STE/CESUL project. (MICOA Ref: 75/MICOA/12 of 22nd May)];

2) Piped water from one or more borehole(s) located either on site at the power plant or from a borehole located on the eastern bank of the Govuro River (this option will require a water pipeline approximately 11km in length);

3) Access road; over a total length of 3 km, which will follow the proposed water pipeline to the northeast of the CTT to connect to the existing Temane CPF access road;

4) Gas pipeline and servitude; over a total length of 2 km, which will start from the CPF high pressure compressor and run south on the western side of the CPF to connect to the power plant or from an alternative gas source;

5) Additional nominal widening of the servitude for vehicle turning points at points to be identified along these linear servitudes;

6) A construction camp and contractor laydown areas will be established adjacent to the CTT power plant footprint; and

7) Transhipment and barging of equipment to a temporary beach landing site and associated logistics camp and laydown area for the purposes of safe handling and delivery of large oversized and heavy equipment and infrastructure to build the CTT. The transhipment consists of a vessel anchoring for only approximately 1-2 days with periods of up to 3-4 months between shipments over a maximum 15 month period early in the construction phase, in order to offload heavy materials to a barge for beach landing. There are 3 beach landing site options, namely SETA, Maritima and Briza Mar (Figure 7). The SETA site is considered to be

the preferred beach landing site for environmental and other reasons; it therefore shall be selected unless it is found to be not feasible for any reason; and

8) Temporary bridges and access roads or upgrading and reinforcement of existing bridges and roads across sections of the Govuro River where existing bridges are not able to bear the weight of the equipment loads that need to be transported from the beach landing site to the CTT site. Some new sections of road may need to be developed where existing roads are inaccessible or inadequate to allow for the safe transport of equipment to the CTT site. The northern transport route via R241 and EN1 is considered as the preferred transport route (Figure 8) on terrestrial impacts; however, until the final anchor point is selected, and the barge route confirmed, the marine factors may still have an impact on which is deemed the overall preferable route.

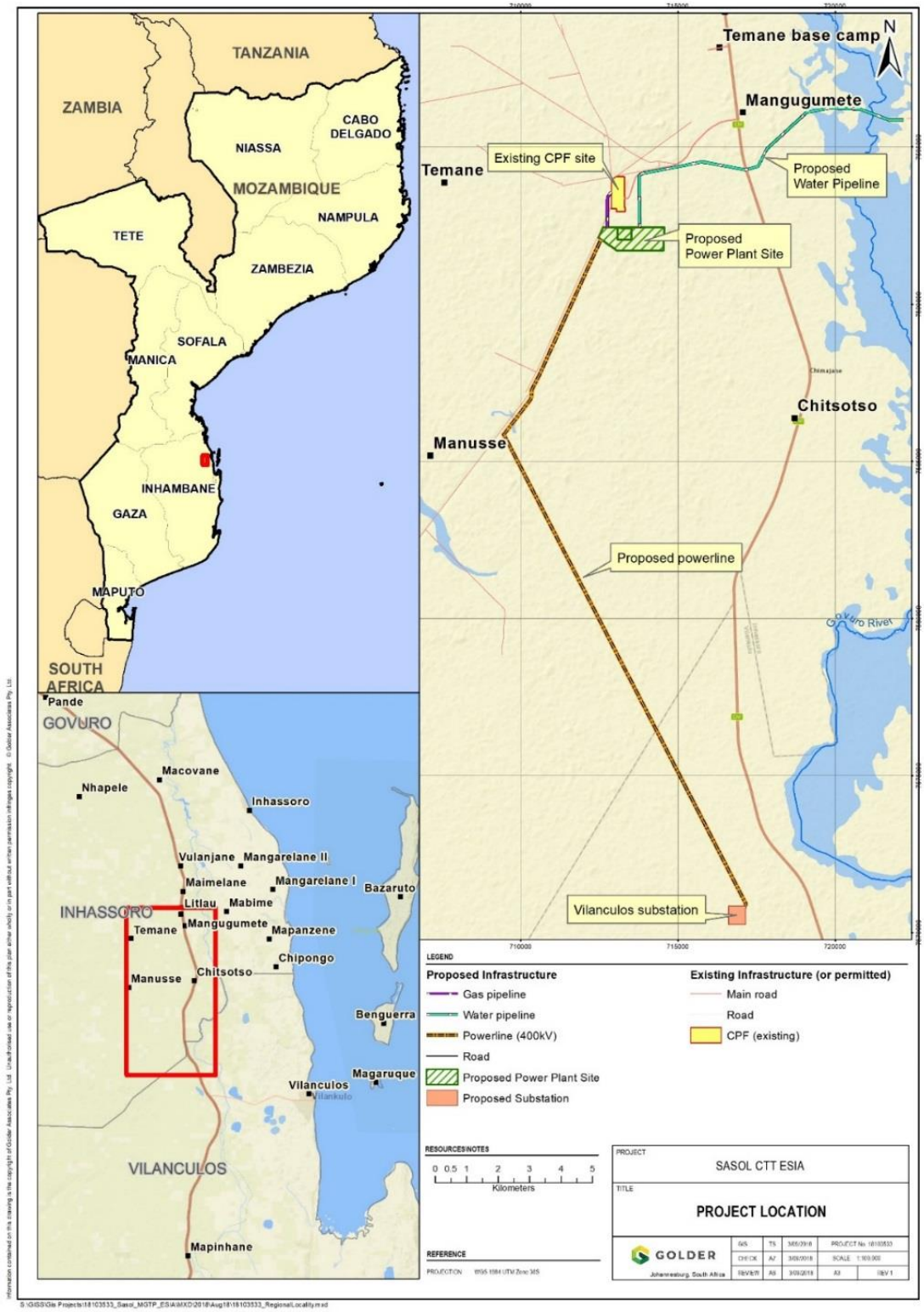

Figure 1: Project Location

2.0 DESCRIPTION OF THE KEY PROJECT COMPONENTS

The CTT project will produce electricity from natural gas in a power plant located 500m south of the CPF. The project will consist of the construction and operation of the following main components:

- Gas to Power Plant with generation capacity of 450MW;

- Gas pipeline (±2 km) that will feed the Power Plant with natural gas from the CPF or from an alternative gas source;
- 400kV Electrical transmission line (± 25 km) with a servitude that will include a fire break (vegetation control) and a maintenance road to the Vilanculos substation. The transmission line will have a partial protection zone (PPZ) of 100m width. The transmission line servitude will fall inside the PPZ;
- Water supply pipeline to a borehole located either on site or at borehole located east of the Govuro River;
- Surfaced access road to the CTT site and gravel maintenance roads within the transmission line and pipeline servitudes;
- Temporary beach landing structures at Inhassoro for the purposes of delivery of equipment and infrastructure to build the power plant. This will include transhipment and barging activities to bring equipment to the beach landing site for approximately 1-2 days with up to 3-4 months between shipments over a period of approximately 8-15 month;
- Construction camp and contractor laydown areas adjacent to the CTT power plant site; and
- Temporary bridge structures across Govuro River and tributaries, as well possible new roads and/or road upgrades to allow equipment to be safely transported to site during construction.

Figure 2: Examples of gas to power plant sites (source: www.industcards.com and www.wartsila.com)

The final selection of technology that will form part of the power generation component of the CTT project has not been determined at this stage. The two power generation technology options that are currently being evaluated are:

- Combined Cycle Gas Turbine (CCGT); and
- Open Cycle Gas Engines (OCGE).

Please refer to Chapter 4 of the main ESIA document for further details on the technology option.

At this early stage in the project a provisional layout of infrastructure footprints, including the proposed linear alignments is indicated in Figure 1. A conceptual layout of the CTT plant site is shown below in Figure 3.

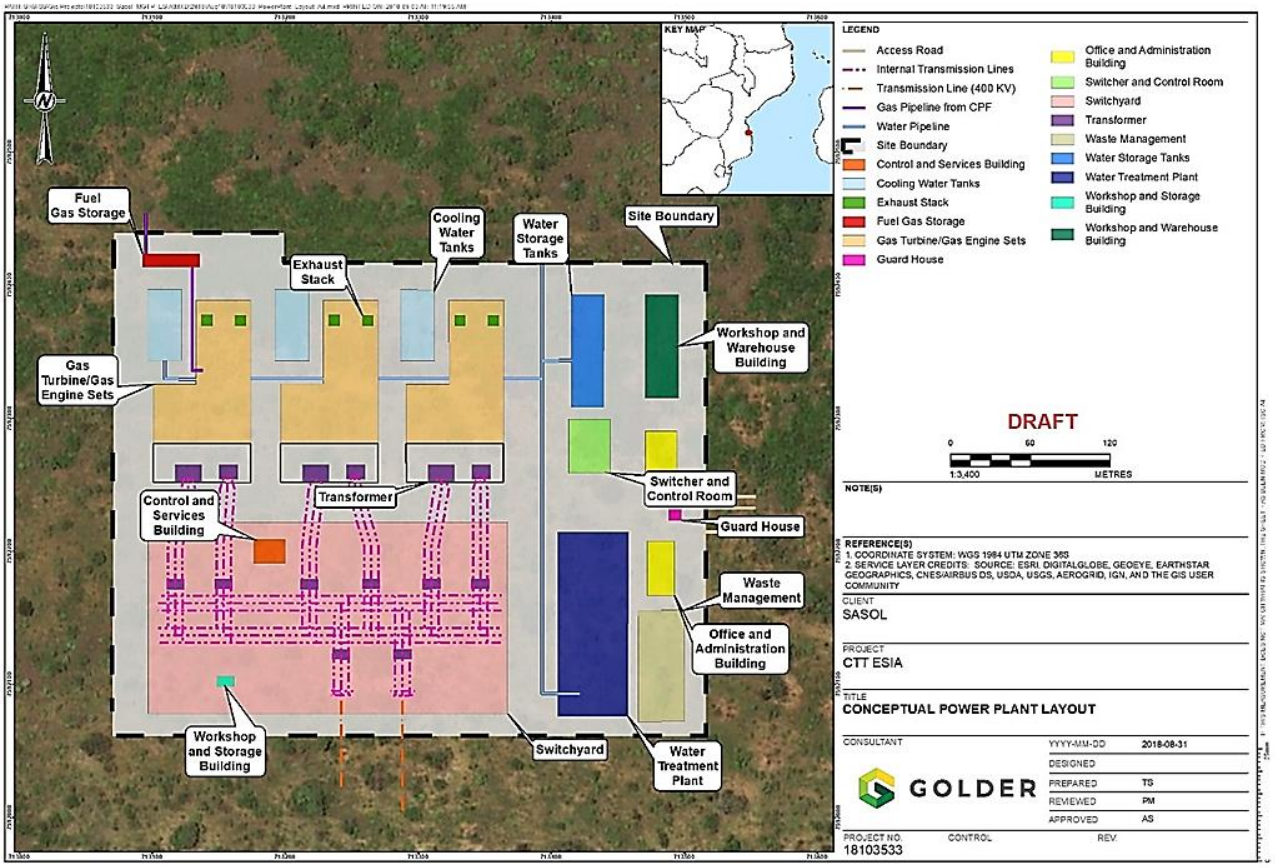

Figure 3: Conceptual layout of CTT plant site

2.1 Ancillary Infrastructure

The CTT project will also include the following infrastructure:

- Maintenance facilities, admin building and other buildings;
- Telecommunications and security;
- Waste (solid and effluent) treatment and/or handling and disposal by third party;
- Site preparation, civil works and infrastructure development for the complete plant;
- Construction camp (including housing/accommodation for construction workers); and
- Beach landing laydown area and logistics camp.

The heavy equipment and pre-fabricated components of the power plant will be brought in by ship and transferred by barge and landed on the beach near Inhassoro. The equipment and components will be brought to site by special heavy vehicles capable of handling abnormally heavy and large dimension loads. Figure 4, Figure 5 and Figure 6 show examples of the activities involved with a temporary beach landing site, offloading and transporting of large heavy equipment by road to site.

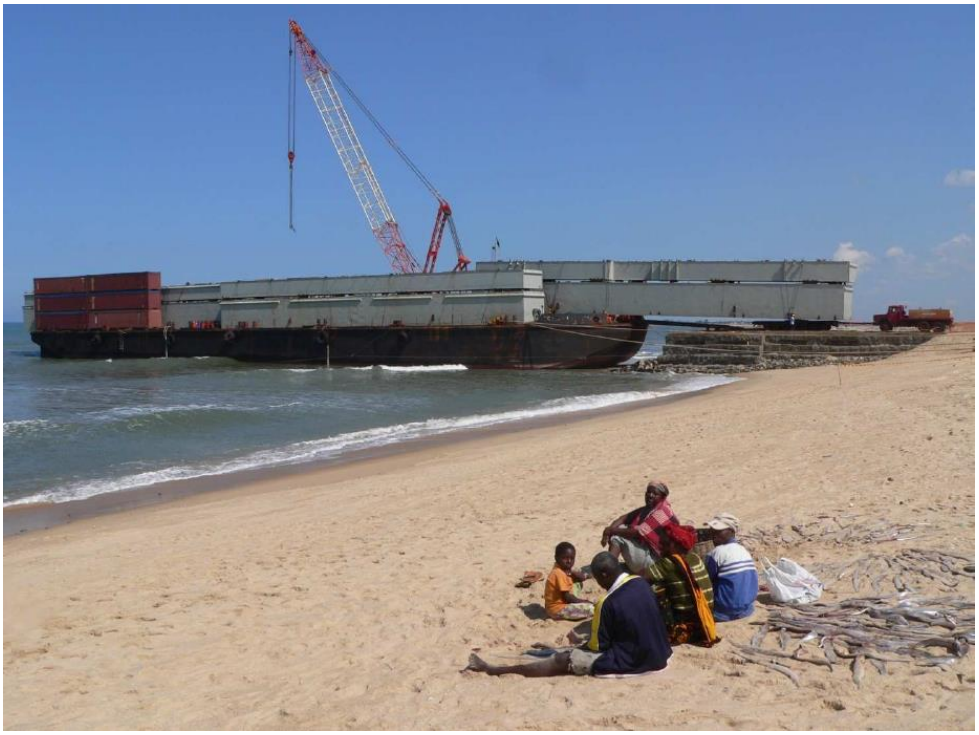

Figure 4: Typical beach landing site with barge offloading heavy equipment (source: Comarco)

Figure 5: Example of large equipment being offloaded from a barge. Note the levels of the ramp, the barge and the jetty (source: SUBTECH)

Figure 6: Heavy haulage truck with 16-axle hydraulic trailer transporting a 360 ton generator (source: ALE)

2.2 Water and electricity consumption

The type, origin and quantity of water and energy consumption are still to be determined based on the selected technology to construct and operate the CTT plant. At this stage it is known that water will be sourced from existing boreholes located on site or east of the Govuro River for either of the technology options below:

- Gas Engine: ± 12 m^3/day; or
- Gas Turbine (Dry-Cooling): ± 120 – 240 m^3/day.

2.3 Temporary Beach Landing Site and Transportation Route Alternative

As part of the CTT construction phase it was considered that large heavy equipment and materials would need to be brought in by a ship which would remain anchored at sea off the coast of Inhassoro. Equipment and materials would be transferred to a barge capable of moving on the high tide into very shallow water adjacent to the beach to discharge its cargo onto a temporary off-loading jetty (typically containers filled with sand) near the town of Inhassoro. As the tide changes, the barge rests on the beach and off-loading of the equipment commences.

Currently, the SETA beach landing site is the preferred beach landing site together with the road route option to be used in transporting equipment and materials along the R241 then the EN1 then via the existing CPF access road to the CTT site near the CPF. Figure 7 and Figure 8 indicate the beach landing site and route transportation option. The alternative beach landing sites of Maritima and Briza Mar are still being evaluated as potential options, as well as the southern transport route, which would also require road upgrades and a temporary bridge construction across the Govuro at the position of the existing pipe bridge. As part of the transportation route, the Govuro River bridge may need to be upgraded / strengthened to accommodate the abnormal vehicle loads. Alternatively, a temporary bypass bridge will be constructed adjacent to the existing bridge.

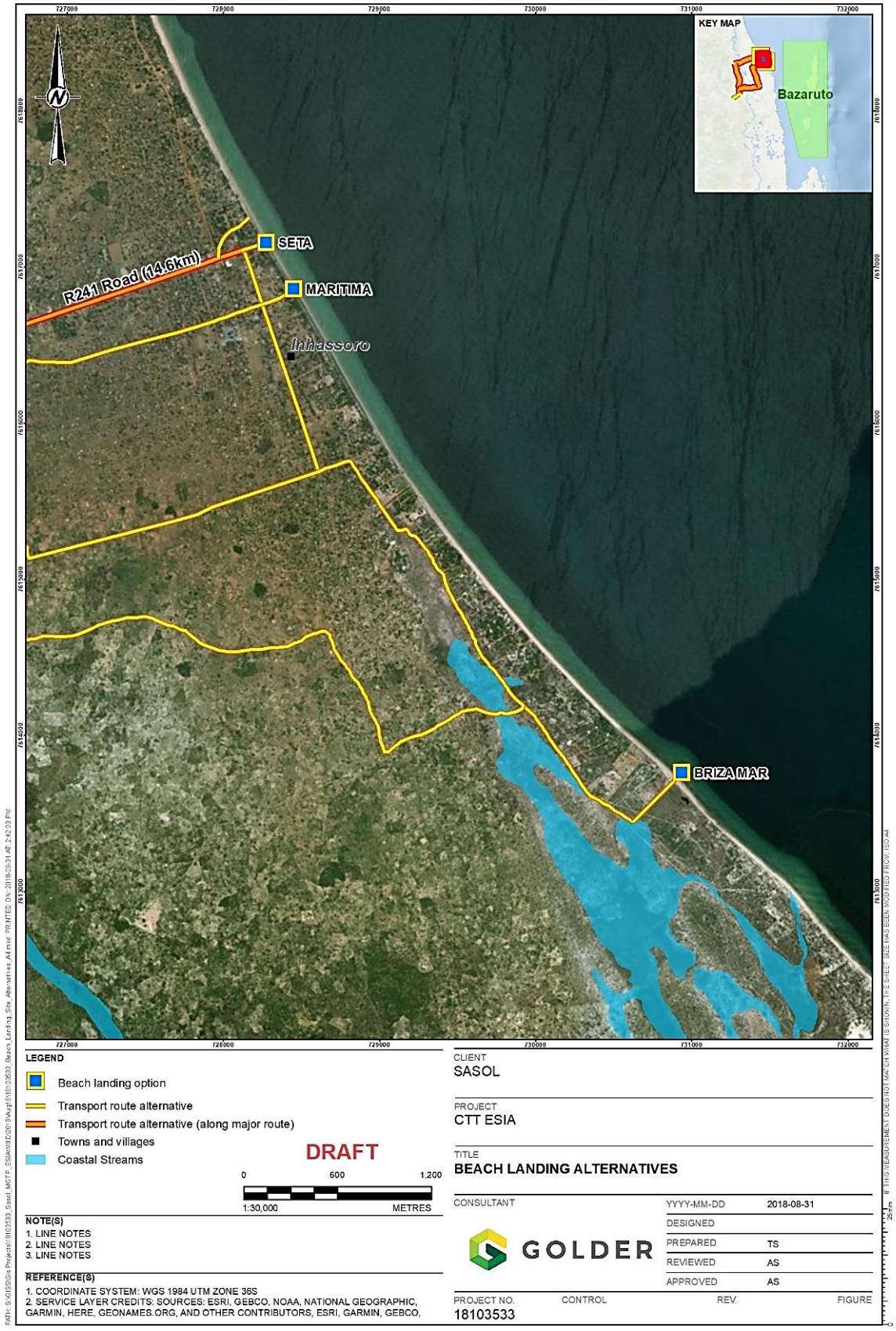

Figure 7: The three beach landing site options and route options at Inhassoro

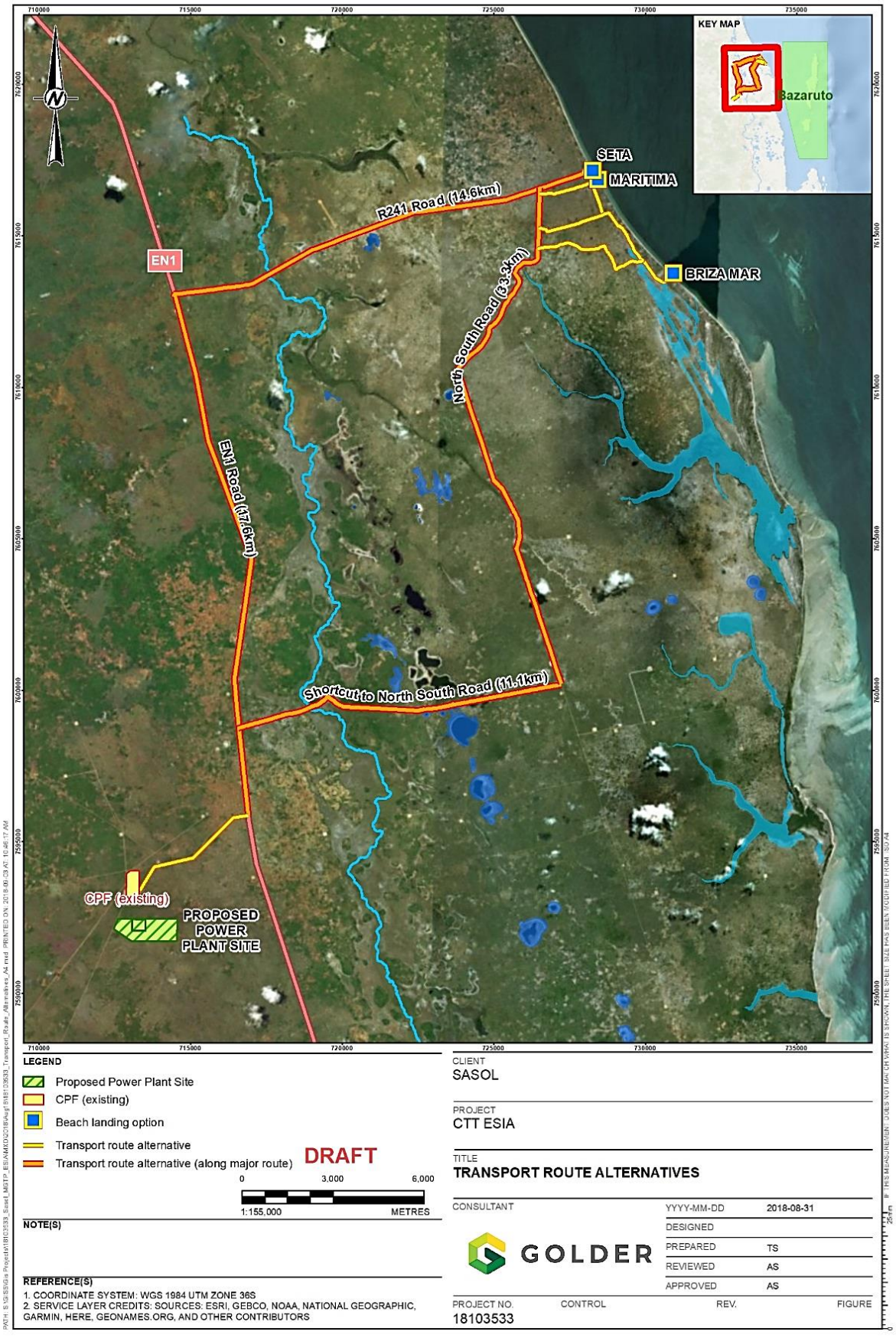

Figure 8: The two main transportation route alternatives from the beach landing sites to the CTT site

3.0 STUDY OBJECTIVE

GIBB (Pty) Ltd was appointed by Golder Associados Moçambique Limitada to undertake a Traffic Impact Assessment of the CTT that includes a review of the available project documentation such as the Road Evaluation Section of the Landing Assessment report by AECOM dated 28 November 2014. The previous report evaluated the various beach landing alternatives to transport equipment from Inhassoro, to a site near the Sasol *Central Térmica de Temane* (CTT) project. This report therefore evaluates the proposed access roads and routes by means of a survey and a review of the current available literature. An updated Traffic management and Safety section is included in this report.

The purpose of this study is to:

- Evaluate the suitability of the routes (as shown in Figure 9) used to transport the necessary Gas to Power Equipment as abnormal heavy loads;
- Identify any potential traffic-related impacts during the Construction phase of the project as well as the Operations phase.

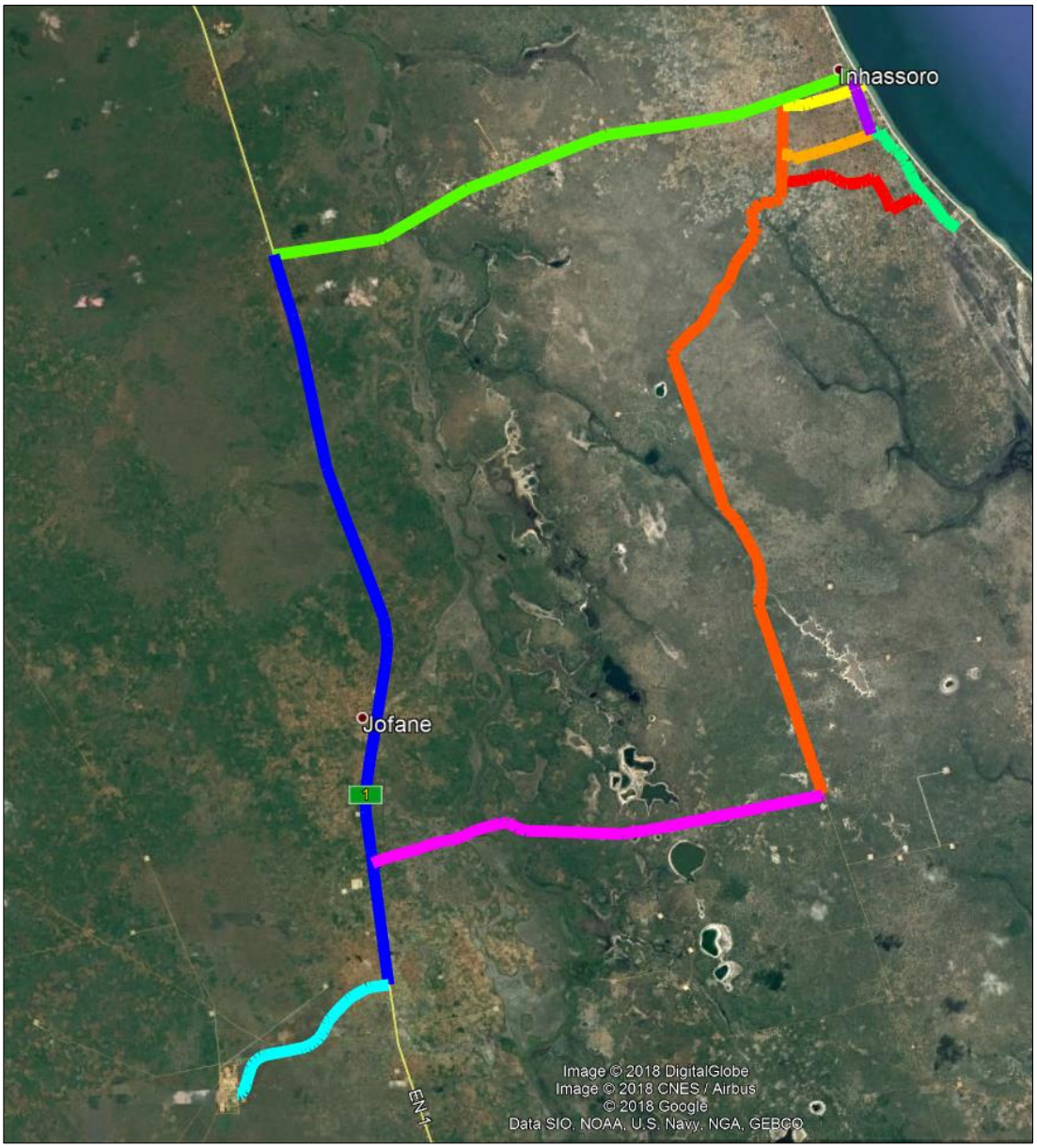

Figure 9: Routes Considered (Source: Google Earth)

4.0 LITERATURE REVIEW

A Beach Landing Assessment Report was completed by AECOM in 2014 a summary of some of the key elements; relevant to this study, is included in the following sections.

4.1 Transport of Gas to Power Heavy Equipment

In the previous report, three options were evaluated for heavy equipment to be transported as abnormal loads. The options relate to the type of Gas to Power Plant that would be built, and the type of assembly methodology followed.

4.1.1 Option A: Large Gas Engines

In this option all the equipment would be transported as complete units to the site and no assembly would be required for individual pieces to complete a unit.

Table 1: Large Gas Engines

Equipment	Quantity	Weight (T)	Width (m)	Length (m)	Height (m)	Number of Pieces per unit
Gas Engines	24	295	4.1	14.53	6.33	1
Transformers	6	91	3.5	7.5	4	1

4.1.2 Option B-1: Gas Turbines (Maximum on-site assembly)

In this option Gas Turbines and Heat Recovery Steam Generators (HRGS) units would be used in the plant. To minimize the axial load on the road surface the units would be disassembled into smaller parts for transport. Table 2 details the units to be transported for this scenario.

Table 2: Option B-1 Gas Turbines (Max. assembly)

Equipment	Quantity	Weight (T)	Width (m)	Length (m)	Height (m)	Number of Pieces per unit
Gas Turbines	9	93.5	4.45	10.82	5.3	1
Transformers	6	91	3.5	7.5	4	1
HRSG	6	130	2.7	20	6	4

4.1.3 Option B-2: Gas Turbines (Minimum on-site assembly)

In this option Gas Turbines and Heat Recovery Steam Generators (HRGS) units would be used in the plant. In this scenario the units would be transported whole. Table 3 details the units to be transported for this option.

Table 3: Option B-2 Gas Turbines (Min. assembly)

Equipment	Quantity	Weight (T)	Width (m)	Length (m)	Height (m)	Number of Pieces per unit
Gas Turbines	9	93.5	4.45	10.82	5.3	1
Transformers	6	91	3.5	7.5	4	1
HRSG	6	130	2.7	20	6	1

This information will be used to calculate a trip generation to determine the impact on the road network.

4.2 Beach Landing Locations

Heavy equipment will be transported by sea and then transferred to barge for a beach landing. A temporary Jetty will be constructed at one of the earmarked locations in Inhassoro. Three locations for this Jetty were identified as shown in Figure 10, Figure 11 and Figure 12.

- Seta Lodge on the R241;
- Brisa Mar 4.3 km south of Seta Lodge; and
- Maritima, located 350m south of Seta Lodge.

Figure 10: Seta Lodge (Source: Google Earth)

Figure 11: Brisa Mar (Source: Google Earth)

Figure 12: Maritima (Source: Google Earth)

The AECOM report concluded that the Seta Lodge option would be the preferred option in terms of cost and an EIA perspective. This new study will evaluate the access roads further.

5.0 CONSTRUCTION AND OPERATIONAL VEHICLE TRIPS

5.1 Trip Generation Rates

In order to determine the impact of the new facility during construction and afterwards during the operational phase a trip generation was calculated. Trip generation rates for this type of facility are not readily available and therefore desktop research was done to determine if there are similar facilities elsewhere that have publicised their traffic impact assessments.
NTE Energy, based in North America, has completed two similar facilities and two more will be built in the next 3 years.

Table 4: NTE Energy Sites

Site	Technology	Net Output	Start Construction	Commercial Operation Date	Construction Workers	Operational Staff
Kings Mountain Energy Centre, Cleveland County, North Carolina	Mitsubishi's GAC Turbine and Steam Turbines	475 MW	3Q 2015	Aug 2018	250 to 350	25 to 30
Middletown Energy Centre, Middletown, Butler County, Ohio	Mitsubishi's GAC Turbine and Steam Turbines	475 MW	Oct 2015	2018	300 to 400	25 to 30
Killingly Energy Centre, Connecticut	Combined Cycle Gas Turbine	650 MW	3Q 2019	2022	250 to 350	25 to 30
Reidsville Energy Centre, Rockingham County, North Carolina	Combined Cycle Gas Turbine	500 MW	2018	2021	200 to 300	15 to 25

A Traffic Impact Report was completed in June 2016 for the Killingly Energy Centre, available online from their website (http://killinglyenergycenter.com/site-evals-and-reports). The trip generation for the CTT site is based on this Traffic Impact Report's trip generation. It is however adapted to accommodate the lower vehicle ownership, on-site accommodation of construction workers and the increased number of local construction workers (850 maximum).

Abnormal vehicle traffic is determined by the shipments per barge that is assumed will arrive at Inhassoro at one of the three beach landing access points. The abnormal trips fall normally outside the Peak Traffic Hour.

5.2 Construction Phase – Abnormal vehicle loads

During the construction phase the heavy equipment as detailed in Chapter 4 will be transported to the site via abnormal load vehicles. This will be a two stage delivery as the equipment will first be transported from the barge to a laydown area and then later to the site. The number of trips over the construction period is shown in the following tables and based on a quote provided by the transport company ALE Heavy Lift during 2014. They further indicated that a maximum of 2 components could be shipped in a week to the site, thus Option A would take 15 weeks, Option B-1 and Option B-2 both 20 weeks. The duration would also be extended due to the waiting period of 4 months between some of the shipments.

Table 5: Abnormal Vehicle Trips to the Laydown Area

Equipment	Qty	Weight (T)	Length of unit (m)	No of Pieces per unit	Arrival Month	Number of Shipments	Days per Shipment	Weeks to Site	Trailer axles	Trailer Length (m)	No of Trips
Option A: Large Gas Engines											
Gas Engines	24	295	14.5	1	0	1	6	12	10	13.5	24
Transformers	6	91	7.5	1	6	2	2	3	6	7.5	6
Option B-1: Gas Turbines (Maximum on-site assembly)											
Gas Turbines	9	93.5	10.8	1	0	1	3	5	8	10.5	9
Transformers	6	91	7.5	1	4	2	2	3	6	7.5	6
HRSG	6	130	20	4	8	3	2	12	14	19.5	6
Option B-2: Gas Turbines (Minimum on-site assembly)											
Gas Turbines	9	93.5	10.8	1	0	1	3	5	12	16.5	9
Transformers	6	91	7.5	1	4	2	2	3	6	7.5	6
HRSG	6	130	20	1	8	3	2	12	14	19.5	6

Table 6: Abnormal Vehicle Trips from Laydown Area to the Site

Equipment	Qty	Weight (T)	Length of unit (m)	No of Pieces per unit	Arrival Month	Number of Shipments	Days per Shipment	Weeks to Site	Trailer axles	Trailer Length (m)	No of Trips
Option A: Large Gas Engines											
Gas Engines	24	295	14.5	1	0	1	6	12	20	28.5	24
Transformers	6	91	7.5	1	6	2	2	3	12	16.5	6
Option B-1: Gas Turbines (Maximum on-site assembly)											
Gas Turbines	9	93.5	10.8	1	0	1	3	5	12	16.5	9
Transformers	6	91	7.5	1	4	2	2	3	12	16.5	6
HRSG	6	130	20	4	8	3	2	12	14	19.5	6
Option B-2: Gas Turbines (Minimum on-site assembly)											
Gas Turbines	9	93.5	10.8	1	0	1	3	5	16	22.5	9
Transformers	6	91	7.5	1	4	2	2	3	12	16.5	6
HRSG	6	130	20	1	8	3	2	12	14	19.5	6

5.3 Construction Phase - Daily Traffic

The daily traffic during construction phase is shown in Table 7. The 2007 census data indicated the less than 4% of households in the Province of Inhambane owned a vehicle; a low vehicle ownership was therefore assumed. An 80% Public Transport and on-site accommodation factor plus vehicle occupancy of 1.8 was used to calculate the final worker vehicle trips. Trips are shown per month for the duration of the construction phase of the project.

Table 7: Construction Phase – Daily Traffic

Month	No of Construction Workers	Worker Vehicle Trips	Truck Deliveries / Day
1	110	12	55
2	160	18	75
3	160	18	80
4	210	23	105
5	210	23	110
6	270	30	135
7	320	36	160
8	360	40	180
9	510	57	240
10	510	57	240
11	560	62	260
12	610	68	275
13	680	76	305
14	680	76	305
15	730	81	325
16	780	87	345
17	850	94	375
18	730	81	375
19	730	81	325
20	610	68	320
21	510	57	270
22	460	51	230
23	410	46	210

Month	No of Construction Workers	Worker Vehicle Trips	Truck Deliveries / Day
24	360	40	190
25	270	30	165
26	150	17	125
27	150	17	75
28	100	11	70
29	100	11	50
30	100	11	40

5.4 Construction Phase – Peak Hour Traffic

A Peak hour trip generation was done for the construction phase as shown in Table 8 based on a maximum of 850 workers working in 3 shifts, thus 283 workers per shift.

Table 8: Construction Phase - Peak Hour Traffic

Type	Peak Hour Trips		AM Peak Trips		PM Peak Trips	
	Worker Trips	Vehicle Trips	IN	OUT	IN	OUT
Construction worker trips per shift (3 shifts)	283	42	42	42	42	42
Delivery Vehicles (10% during peak hour)		38	38	4	38	4
Total Vehicle Trips		**80**	**80**	**46**	**80**	**46**

It is assumed that workers will work in three shifts and that 10% of the construction vehicles would arrive during the Peak Hour.

The number of vehicles in the Peak hour is not significant and will not lead to a significant increase in congestion on the road network. However excessive right turning queue lengths during the peak period due to platoon forming might cause a safety risk to fast moving through traffic,

Additional improvements will also be required at the CTT facility to allow for queueing of vehicles as they wait to enter the facility under construction.

Should workers not work in shifts but rather all during a normal working day then the impact will be more significant but would be a maximum of 164 trips in the peak hour.

5.5 Operational Phase – Peak Hour Traffic

A Peak hour traffic trip generation was done for the operational phase as shown in Table 9**.** Information provided in the previous reports indicated a maximum of 75 workers working in 3 shifts, thus 25 people per shift. If is further assumed that 30% of the employees would have cars. This percentage is higher than the local

household car ownership due to international workers required on site that will have the use of private cars during their stay. The scenario below is a maximum as some of the employees would be housed in the facility itself and this could further reduce the number of trips.

Table 9: Operational Phase - Peak Hour Traffic

Type	Peak Hour Trips		AM Peak Trips		PM Peak Trips	
	Employees	Vehicle Trips	IN	OUT	IN	OUT
Employees with Cars (Trips per Shift)	8	8	8	8	8	8
Employees using Public Transport	17	4	4	4	4	4
Delivery Vehicles		5	5	1	5	1
Total Vehicle Trips		**17**	**17**	**13**	**17**	**13**

It is assumed that employees will work in 3 shifts during the operational phase.

The number of vehicles in the Peak hour is not significant and will not lead to a significant increase in congestion on the road network.

5.6 Trip Distribution

Worker trips would originate primarily from the site itself as workers are housed on the site during the construction phase. However, trips will also originate from Inhassoro, Maimelane and the surrounding areas due to population densities and trip lengths. Public transport busses and taxis start as early as 4 am from Vilanculos; thus, enabling workers to travel from as far as Vilanculos to the site.

5.7 Trip Assignment

In order to do a very high-level analysis it is assumed that 60% of all construction related trips would originate north of the CTT site and 40% from the south. This translates to an assignment of approximately 48 vehicles from the north on the EN1 and 32 vehicles from the south in the AM Peak Hour.

5.8 Additional Traffic Impact on Intersection Level of Service

The impact on the Level of Service of intersections by the additional vehicles on the road network in the peak hour is not significant and therefore does not warrant any upgrades to alleviate congestion or to improve the level of service at any intersection. However, the impact is rather in terms of the road pavement damage and safety and requires further detailed analysis to determine the improvements required.

There are however other factors that must be considered during the construction and operational phases of the development that are summarised at the end of Chapter 6.

6.0 ROAD SURVEYS AND ROUTE EVALUATION

The following road sections were surveyed as shown in Figure 13.

- Section A: Seta - R241 Inhassoro beach landing to EN1 (14.4km);
- Section B: EN1 - From R241 Intersection to CTT Turnoff (17.6km);
- Section C: Brisa Mar - From Intersection X to Brisa Mar Beach Landing (3.21km);
- Section D: Shortcut Road - From Point E (2,8km north of CPF turnoff) to North South Road (11km);
- Section E: Local Road – From Intersection X in Inhassoro to North South Road (2.3km);

- Section F: North South Road (18.3);
- Section G: From Brisa Mar Access to North South Road (4.15);
- Section H: CTT Access – From EN1 to CTT (4.7km);
- Section I: Maritima to North South Road (1.77km); and
- Section J: Inhassoro Monument (R241) to Intersection X.

Access routes from the beach landing areas were first evaluated, then other local internal sections and major sections and, finally, sections were combined into routes and analysed further.

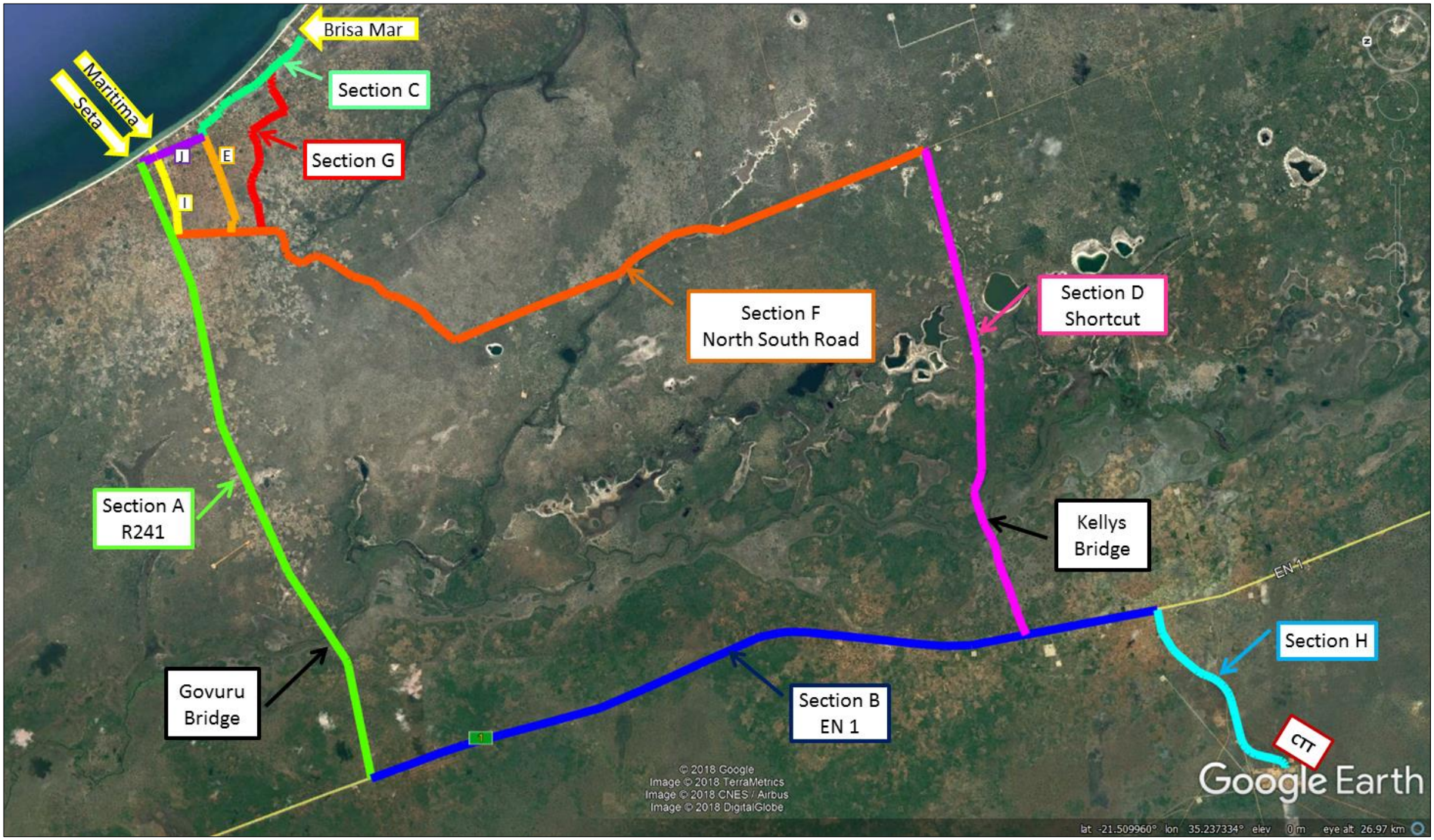

Figure 13: Sections Surveyed (Source: Google Earth)

6.1 Beach Landing Access Roads

Access roads connecting the proposed beach landing locations to the first major road were surveyed and evaluated.

6.1.1 Seta Beach Landing Access

This access section starts at the Dolphin Monument shown in Figure 14 and ends at the Sea View shown in Figure 16. The road reserve, shown in Figure 15**,** is approximately 18m wide and can easily accommodate the abnormal vehicles. Should a reverse movement be required for the trailers on return from the delivery then this could be easily achieved within the current road reserve due to the T-Junction configuration.

Direct access to the R241 is quite easy from this beach landing location as shown in Figure 17.

Figure 14: Seta Access Road – Monument

Figure 15: Seta Access Road – Road Reserve

Figure 16: Seta Access Road – Sea View

Figure 17: Seta Access Road – R241

6.1.2 Maritima Beach Landing Access & Road Section J

This access point is located 350 m from the Seta Lodge and the R241 along the road shown in Figure 18.

Adequate road reserve is available to accommodate abnormal vehicles along Road Section J. However, there are various businesses located along Road Section J, for instance a business named Handling distributes retail products from a warehouse and retail outlet. Heavy vehicles were seen collecting and delivering goods throughout the day.

Abnormal vehicles would have to make a left turn from the local road into the access road on their return trip and a right turn from the access road going towards the R241 as shown in Figure 19.

Low hanging power cables will also need to be extended to accommodate abnormal load vehicles.

Fishermen are very active along the coastline between the Seta and Maritima Beach Landing locations as seen in Figure 21.

Figure 18: Maritima Connecting Road to R241

Figure 19: Maritima Access Road to the left past the tree

Figure 20: Heavy Vehicles Delivering Goods along Road Section J

Figure 21: View towards Maritima Beach Landing

6.1.3 Brisa Mar Beach Landing Access & Road Section C

The Brisa Mar Beach Landing point is located 350m from Brisa Mar and 4.3 km from the R241, Seta access.

Figure 22 shows the 4th four-way intersection leading to Brisa Mar 1.49km south of the R241. At this point the road is no longer tarred and becomes a track that is twisting left and right Figure 23 towards Brisa Mar. The Beach landing point is approximately 350m further south from the Brisa Mar turn-off shown in Figure 24**.** The beach landing site, shown in Figure 25, does not have a steep slope toward the sea and is similar to Maritima in this respect.

Low hanging power cables will have to be extended to accommodate abnormal load vehicles.

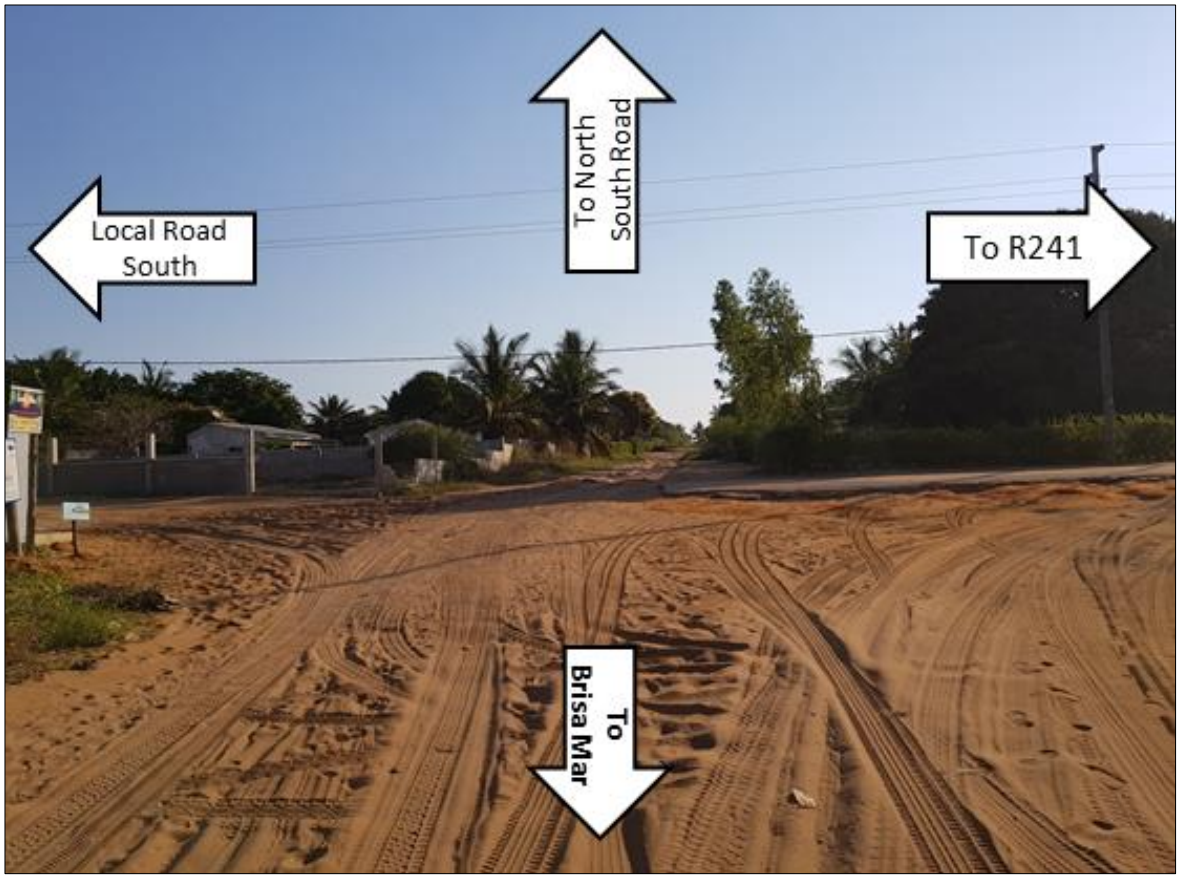

Figure 22: Intersection X before Road to Brisa Mar

Figure 23: Twisting Track to Brisa Mar along Road Section C

Figure 24: Turnoff to Brisa Mar along Road Section C

Figure 25: View towards Brisa Mar Beach Landing Point

6.2 Inhassoro Local Roads

Over and above Road Sections C & J that was mentioned in the previous sections the following four local road sections were also evaluated, as shown in Figure 26:

- Section E: From Intersection X to North South Road (2.3km);
- Section G: From Brisa Mar Access to North South Road (4.15km);
- Section I: Maritima to North South Road (1.77km); and
- Section J: Inhassoro Monument (R241) to Intersection X (1.49km).

Figure 26: Local Road Sections (Intersection X marked)

6.2.1 Section C: Brisa Mar - From Intersection X to Brisa Mar Beach Landing (3.21km)

Section C is 3.21km long and consists of a sandy track that starts at the intersection shown in Figure 24 and ends at the Brisa Mar Beach landing access point, 350 m from the Brisa Mar turnoff. The track winds through the area that is sparsely populated. Low hanging power cables will have to be extended.

6.2.2 Section E: Local Road – From local road in Inhassoro to North South Road

Section E is 2.3km long and consists mainly of a sandy track that starts at the intersection shown in and ends at the North South Road to the east. The area surrounding the road is residential and the main mode of transport was seen to be walking along this road. Safety for pedestrians would be a major concern as the road reserve is in some areas less than 10m wide.

6.2.3 Section G: From Brisa Mar Access to North South Road

Section G is mainly bush with some sections a sandy track that goes through a tribal type of residential area as at nears the North South Road as shown in Figure 27.

Pedestrian safety would also be a concern in the residential area should abnormal loads be transported through this rural area.

Figure 27: Section G to North South Road

6.2.4 Section I: Maritima Beach Landing to North South Road

Section I is an existing sand road that runs parallel to the R241 and connects the Maritima Beach Landing site with the North South Road. It travels through a residential area where the road reserve varies from 15m to 20m and direct property access is allowed to the sandy road.

Pedestrian safety would also be a concern in the residential area should abnormal loads be transported through this area.

6.2.5 Section J: Inhassoro Monument (R241) to Intersection X

Section J is the main collector road linking the lodges facing the sea. Various businesses are located along this road. It consists of a black top road without any kerbs. Low hanging power cables, pedestrians and delivery vehicles will be points of conflict with abnormal loads along this road.

6.3 Major Linking Sections

Major linking sections are defined as the R241, EN1, North South Road, the Shortcut Road between En1 & the North South Road as well as the link to the CTT site.

6.3.1 Section A: R241 – Inhassoro area

At the time of the previous report in 2014 the R241 narrowed in some sections to 3.4m. Since 2014 this road was upgraded and now consists mostly of a 6m wide black top road as shown in Figure 28**.**

Figure 28: R241 - 580m from Inhassoro Monument

Damage to the edge of tar (edge cracking) can be seen in various areas (Figure 29), however the road is without any major potholes. Maintenance will be required in the near future. Low hanging power cables will have to be extended to accommodate abnormal loads on the road.

Figure 29: R241 – Edge cracking and erosion

6.3.2 Section A: R241 – Govuro River Bridge

According to the AECOM report a bypass structure will be required at the existing Govuro Bridge on the R241. Further analysis of this was not done in this report. Updated pictures of the bridge are shown in Figure 30 and Figure 31.

Figure 30: R241 – Govuro River Bridge – (Inhassoro towards EN1)

Figure 31: R241 – Govuro River Bridge – Side View

6.3.3 Section A: R241 & EN 1 Intersection

The approach from Inhassoro to the EN1 intersection is shown in Figure 32 and Figure 33**.** The turning radius is gradual and the long trailers will be able to traverse this movement easily.

Figure 32:R241 / EN1 Intersection: Eastern Approach

However, the turning movement (yellow turning arrow) from the EN1 onto the R241 would require some improvement to accommodate the abnormal vehicles.

Figure 33:R241 / EN1 Intersection (Source Google Earth)

6.3.4 Section B: EN1 - From R241 Intersection to CTT Turnoff

This section is 17.6km long and starts at the EN1/R241 intersection ending at the turnoff to the Sasol CTT plant access road.

The EN1 is in good condition for approximately 1.6km from the EN1/R241 intersection in the southern direction. However, after this point the quality of the road does deteriorate, and potholes are seen from time to time as shown in Figure 34**.** Evidence of edge cracking can also be found along this road.

Figure 34:EN1 1.6km from Intersection

Severe deterioration of the black top can be found 2.8km from the EN1/R241 intersection as shown in Figure 35**.** Fortunately, road maintenance is done on this road and evidence can be found where the washed out shoulder material is replaced with sand and potholes are filled and compacted, see Figure 36 to Figure 37 of maintenance activity 10.9km from the EN/R241 intersection.

The turnoff to CTT from the EN1 does have a short right turn lane and bypass lanes for through traffic on the northern approach as shown in Figure 38. Traffic on the southern is accommodated by means of a left turn lane into the CPP access road and one through lane as shown in Figure 39. This is a busy intersection in terms of pedestrian traffic as many businesses have developed over time at this intersection. Both the wester approach (Figure 40) and the northern approach have low hanging cables that will need to be extended.

Figure 35:EN1 2.8km from Intersection

Figure 36:EN1 10.9km from EN1/R241 Intersection near Jofane (Fill material)

Figure 37:EN1 10.9km from EN1/R241 Intersection near Jofane (Patch Work)

Figure 38:EN1/CTT Intersection – Northern Approach

Figure 39:EN1/CTT Intersection – Southern Approach

Figure 40:EN1/CTT Intersection – Western Approach

6.3.5 CTT Access Road

As shown in Figure 41 the road surface to CTT is well maintained, without potholes, and is 7m wide. The speed is 50km/h along the road and NMT (Non-Motorised Transportation), pedestrian and bicycle, activity was observed.

Figure 41: CTT Access Road

The distance measured from the Intersection of the EN1/Access Road to this road is 4.7km and ends at the CTT security gate as shown in Figure 42.

Figure 42: CTT security gate

Fuel Tanker trucks were observed queuing outside the facility waiting to be hailed to the Gantry, refer to Figure 43. Special care must be taken so as to minimise the conflict between abnormal vehicles queuing / holding outside the facility and abnormal vehicles delivering heavy equipment.

Figure 43: Fuel Tanker Trucks

6.3.6 EN1 / North South Road Shortcut

The start of the access road is located 2.89km north of the CTT access from on the EN1 as shown in Figure 44. It is a dirt track and only one vehicle wide. It crosses the Govuro River over a pipe bridge as shown in Figure 45**.** This track passes through a tribal area with scattered villages along the way and joins the North South Road. Overhead power cables can be found along the route that will have to be accommodated should a more formal road be constructed through this area.

Figure 44: Shortcut road starting point on EN1

Figure 45: Shortcut road pipe bridge

Figure 46: Shortcut road power cables

6.3.7 North South Road

The North South Road starts in Inhassoro and continues south until it reaches Vilanculos. It is a well pad road and in most places between 6.5m and 6.7m wide as shown Figure 47**.**

As it the road nears the town of Inhassoro the road changes from a well pad road to a black top road as shown in Figure 48. The black top road is 2km long and 5m wide.

Figure 47: North South Road 970m from shortcut road

Figure 48: North South Road near Inhassoro

6.4 Route Evaluation

The surveys in the previous sections gave insight into which of the possible routes would be viable for the abnormal load transport from Inhassoro to the CTT site. This is further explored in this section.

6.4.1 Route Evaluation: Options Considered

As per the previous report the following options were evaluated as part of the main roads (R241 & EN1):

- Option 1A – From Seta Beach Landing Access to CTT via R241 & EN1;
- Option 2A – From Brisa Mar Beach Landing Access to CTT via R241 & EN1; and
- Option 3A – From Maritima Beach Landing Access to CTT via R241 & EN1.

The back-route options evaluated were:

- Option 1B – From Seta Beach Landing Access to CTT via Back Roads;
- Option 2B-1 – From Brisa Mar Beach Landing Access to via Back Roads (Dirt Roads);
- Option 2B-2 – From Brisa Mar Beach Landing Access to via Back Roads (Sand Tracks); and
- Option 3B – From Maritima Beach Landing Access to CTT via Back Roads.

Figure 49 shows the sections that were used to determine the possible routes.

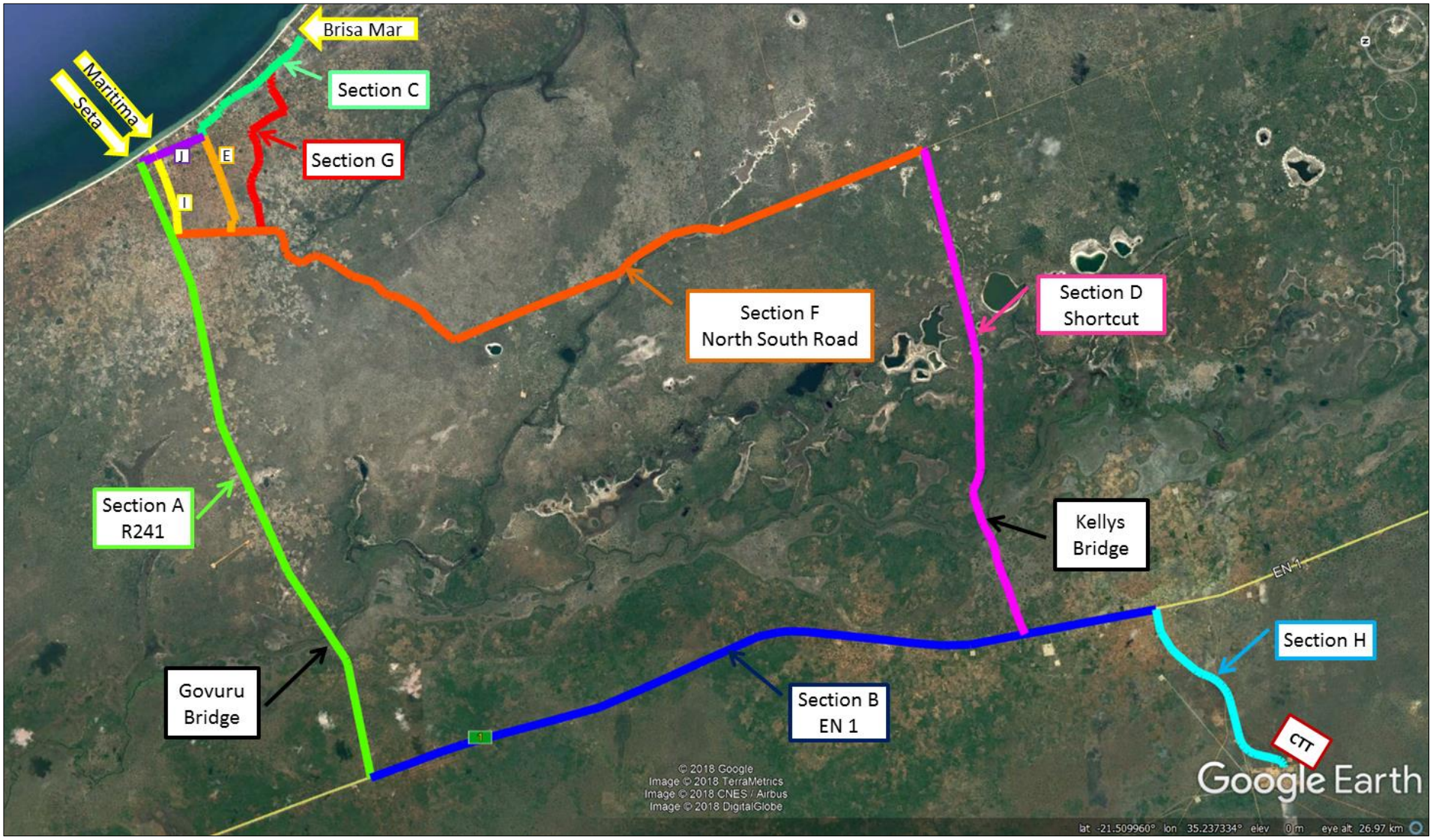

Figure 49: Sections for Route Evaluation

6.4.2 Route Evaluation: CTT via Main Roads

Each option is detailed in the tables below showing the total distance.

Table 10: Option 1A – Seta Beach Landing to CTT via R241 & EN1

Section	Description	From	To	Road Type	Dist. (km)	Comments
	Access	Seta Beach Landing Point	Inhassoro Monument	Existing Track	0.15	Adequate road reserve
A	R241	Inhassoro Monument	R241 / EN1 Intersection	6m wide black top	14.38	Recently upgraded to 6m wide for the full length of the road
	Govuro Bridge 11.3km from Inhassoro Monument					Bypass or alternative structure required as per AECOM Beach Landing Report
B	EN1	R241 / EN1 Intersection	CTT Turnoff	5.8. to 5.9m black top	17.59	Some edge cracking and potholes found along the road
H	CTT Access Road	CTT Turnoff	CTT security gate	7m wide black top	4.75	Well maintained road
TOTAL TRAVEL DISTANCE					36.87	

The Beach Landing Report estimated an upgrade and improvements cost of R 3.96 million US$ associated with this option.

Table 11: Option 2A - From Brisa Mar Beach Landing Access to CTT via R241 & EN1

Section	Description	From	To	Road Type	Dist. (km)	Comments
	Access	Brisa Mar Beach Landing Point	Section C	Bush	0.38	Bush path across open stand
C	Section C	Section C / Turnoff to Brisa Mar	Intersection X (Lodges)	Existing sand track	3.21	Winding sand track
J	Local Collector	Intersection X	Inhassoro Monument (R241)	5.8. to 5.9m black top	1.49	Various businesses located along this road
A	R241	Inhassoro Monument	R241 / EN1 Intersection	6m wide black top	14.38	Recently upgraded to 6m wide for the full length of the road

Section	Description	From	To	Road Type	Dist. (km)	Comments
	Govuro Bridge 11.3km from Inhassoro Monument					Bypass or alternative structure required as per AECOM Beach Landing Report
B	EN1	R241 / EN1 Intersection	CTT Turnoff	5.8. to 5.9m black top	17.59	Some edge cracking and potholes found along the road
H	CTT Access Road	CTT Turnoff	CTT security gate	7m wide black top	4.75	Well maintained road
TOTAL TRAVEL DISTANCE					41.79	

The Beach Landing Report estimated an upgrade and improvements cost of R 4.96 million US$ associated with this option.

Table 12: Option 3A - From Maritima Beach Landing Access to CTT via R241 & EN1

Section	Description	From	To	Road Type	Dist. (km)	Comments
	Access	Maritima Beach Landing Point	Section J	Sand Road	0.22	Adequate road reserve available
J	Local Collector	Maritima turnoff from Section J	Inhassoro Monument (R241)	5.8. to 5.9m black top	0.37	Various businesses located along this road
A	R241	Inhassoro Monument	R241 / EN1 Intersection	6m wide black top	14.38	Recently upgraded to 6m wide for the full length of the road
	Govuro Bridge 11.3km from Inhassoro Monument					Bypass or alternative structure required as per AECOM Beach Landing Report
B	EN1	R241 / EN1 Intersection	CTT Turnoff	5.8. to 5.9m black top	17.59	Some edge cracking and potholes found along the road
H	CTT Access Road	CTT Turnoff	CTT security gate	7m wide black top	4.75	Well maintained road
TOTAL TRAVEL DISTANCE					37.31	

The Beach Landing Report estimated an upgrade and improvements cost of R 4.14 million US$ associated with this option.

6.4.3 Route Evaluation: CTT via Back Roads

Each option is detailed in the tables below showing the total distance.

Table 13: Option 1B – From Seta Beach Landing Access to CTT via Back Roads

Section	Description	From	To	Road Type	Dist. (km)	Comments
	Access	Seta Beach Landing Point	Inhassoro Monument	Existing Track	0.15	Adequate road reserve
	R241	Inhassoro Monument	North South Road	6m wide black top	1.68	Recently upgraded to 6m wide for the full length of the road
F	North South Road	Intersection R241/North South Road	Shortcut Road to EN1	6.5m Well Pad Road	18.3	Well maintained road
D	Shortcut Road	North South Road	EN1	Sand Track & Bush	11.1	Sand Track through villages, some sections are a Bush Track
	Govuro (Kellys) Pipe Bridge 8.5km from EN1					New bridge required
B	EN1	Shortcut Road / EN1 Intersection	CTT Turnoff	5.8. to 5.9m black top	2.89	Well maintained section
H	CTT Access Road	CTT Turnoff	CTT security gate	7m wide black top	4.75	Well maintained road
TOTAL TRAVEL DISTANCE					38.87	

The Beach Landing Report estimated an upgrade and improvements cost of R 9.33 million US$ associated with this option.

Table 14: Option 2B-1 – From Brisa Mar Beach Landing Access to CTT via Back Roads (Dirt Roads)

Section	Description	From	To	Road Type	Dist. (km)	Comments
	Access	Brisa Mar Beach Landing Point	Section C	Bush	0.38	Bush path across open stand
C	Section C	Section C / Turnoff to Brisa Mar	Intersection X (Lodges)	Existing sand track	3.21	Winding sand track
E	Local Collector	Intersection X	North South Road	Existing sand track	2.3	Various businesses located along this road

Section	Description	From	To	Road Type	Dist. (km)	Comments
F	North South Road	Intersection Section E / North South Road	Shortcut Road to EN1	6.5m Well Pad Road	16.98	Well maintained road
D	Shortcut Road	North South Road	EN1	Sand Track & Bush	11.1	Sand Track through villages, some sections are a Bush Track
	Govuro (Kellys) Pipe Bridge 8.5km from EN1					Bypass or alternative structure required as per AECOM Beach Landing Report
B	EN1	Shortcut Road / EN1 Intersection	CTT Turnoff	5.8. to 5.9m black top	2.89	Well maintained section
H	CTT Access Road	CTT Turnoff	CTT security gate	7m wide black top	4.75	Well maintained road
TOTAL TRAVEL DISTANCE					41.61	

The Beach Landing Report estimated an upgrade and improvements cost of R 11.27 million US$ associated with this option.

Table 15: Option 2B-2 – From Brisa Mar Beach Landing Access to CTT via Back Roads (Sand Tracks)

Section	Description	From	To	Road Type	Dist. (km)	Comments
	Access	Brisa Mar Beach Landing Point	Section C	Bush	0.38	Bush path across open stand
C	Section C	Section C / Turnoff to Brisa Mar	Section G Track	Existing sand track	1.02	Short section of C
G	Section G	Near Section G / Turnoff to Brisa Mar	North South Road	Sand Track	4.15	Not a well-defined track
F	North South Road	Intersection Section E / North South Road	Shortcut Road to EN1	6.5m Well Pad Road	16.3	Well maintained road
D	Shortcut Road	North South Road	EN1	Sand Tack & Bush	11.1	Sand Track through villages, some sections are a Bush Track

Section	Description	From	To	Road Type	Dist. (km)	Comments
	Govuro (Kellys) Pipe Bridge 8.5km from EN1					Bypass or alternative structure required as per AECOM Beach Landing Report
B	EN1	Shortcut Road / EN1 Intersection	CTT Turnoff	5.8. to 5.9m black top	2.89	Well maintained section
H	CTT Access Road	CTT Turnoff	CTT security gate	7m wide black top	4.75	Well maintained road
TOTAL TRAVEL DISTANCE					40.59	

The Beach Landing Report estimated an upgrade and improvements cost of R 11.23 million US$ associated with this option.

Table 16: Option 3B – From Maritima Beach Landing Access to CTT via Back Roads

Section	Description	From	To	Road Type	Dist. (km)	Comments
	Access	Maritima Beach Landing Point	Section J	Sand Road	0.22	Adequate road reserve available
I	Local Road	Maritima Beach Landing Point	North South Road	Existing sand road	1.77	Road reserve varies from 15m to 20m.Throug a residential area.
F	North South Road	Intersection Section E / North South Road	Shortcut Road to EN1	6.5m Well Pad Road	18.1	Well maintained road
D	Shortcut Road	North South Road	EN1	Sand Track & Bush	11.1	Sand Track through villages, some sections are a Bush Track
	Govuro (Kellys) Pipe Bridge 8.5km from EN1					Bypass or alternative structure required as per AECOM Beach Landing Report
B	EN1	Shortcut Road / EN1 Intersection	CTT Turnoff	5.8. to 5.9m black top	2.89	Well maintained section
H	CTT Access Road	CTT Turnoff	CTT security gate	7m wide black top	4.75	Well maintained road
TOTAL TRAVEL DISTANCE					38.83	

The Beach Landing Report estimated an upgrade and improvements cost of R 9.73 million US$ associated with this option.

6.5 Route Selection Impact and Traffic Management Plan

6.5.1 Impact on Existing Traffic in terms of Delay

The various route options are compared below in terms of the high-level impact of the construction, operational and abnormal load trips on the existing traffic in terms of delays experienced.

Table 17: Delay due to Development Traffic

Route Type	Route Option	Impact of Construction Vehicles Trips on Existing Traffic (Delays)	Impact of Abnormal Loads on Existing Traffic (Delays)	Impact of Operational Vehicle Trips on Existing Traffic (Delays)
Main Roads	Option 1A – From Seta	Low	Moderate	Negligible
	Option 2A – From Brisa Mar	Low	Moderate	Negligible
	Option 3A – From Maritima	Low	Moderate	Negligible
Back Routes	Option 1B – From Seta	Low	Low	Negligible
	Option 2B-1 – From Brisa Mar (Dirt Roads)	Low	Low	Negligible
	Option 2B-2 – From Brisa Mar (Sand Tracks)	Low	Low	Negligible
	Option 3B – From Maritima	Low	Low	Negligible

6.5.2 Construction Vehicle Traffic Impact

If is estimated that the frequency of construction vehicle deliveries to the site will peak between month 15 to 19 but will start slowly and will decrease toward the end of the construction period. The impact of the construction vehicles will be more visible toward the access from the EN1 to the CTT access road and is discussed below and evaluated in Table 18**.**

Adequate turning lane lengths are required to ensure enough queuing space for turning vehicles in order to prevent conflict with fast moving through traffic.

Generation of dust will be higher on routes that do not have a protective blacktop layer or that are not protected with a dust prevention layer or dust prevention treatment. For construction vehicles generation of dust will also be form the sand / materials that are transported.

Risk of vehicle collision will be higher on roads with more background traffic and less on dirt road and tracks. However, the probability of a collision will be higher where fast travelling vehicles needs to pass slow moving construction vehicles.

Risk of pedestrian accidents is lower in areas of less traffic movement. However, the risk increases significantly in areas that allow heavy vehicle traffic through residential areas, which should normally be shielded from frequent heavy vehicle traffic.

Degradation of roads increases significantly with an increase in vehicle load and is dependent on the type of pavement structure.

Table 18: Construction Vehicle Traffic Impact

Route Option	Turning Lane Lengths	Generation of dust	Risk of vehicle collision	Risk of pedestrian accidents	Degradation of Public Roads
Construction Vehicles on EN1 & CTT Access Road	Low, only inadequate in certain identified areas	Moderate	Moderate	Moderate	Moderate

6.5.3 Abnormal Vehicle Traffic Impacts

The route chosen comes with other traffic related impacts due to the infrequent transport of abnormal loads these are discussed below and evaluated in Table 19**.**

Generation of dust will be higher on routes that do not have a protective blacktop layer or that are not protected with a dust prevention layer or dust prevention treatment.

Risk of vehicle collision will be higher on roads with more background traffic and less on dirt road and tracks. However, the probability of a collision will be higher where fast travelling vehicles needs to pass abnormally long and slow moving abnormal vehicles.

Risk of pedestrian accidents is lower in areas of less traffic movement. However, the risk increases significantly in areas that allow heavy vehicle traffic through residential areas, which should normally be shielded from frequent heavy vehicle traffic.

Degradation of roads increases significantly with an increase in vehicle load and is dependent on the type of pavement structure.

Table 19: Abnormal Load Impacts

Route Type	Route Option	Generation of dust	Risk of vehicle collision	Risk of pedestrian accidents	Degradation of Public Roads	Costs of Additional Roads / Improvements	Cost of Road Improvements (Million US$)
Main Roads	Option 1A – From Seta	Low	Low	Low	Moderate	Moderate	3.957
	Option 2A – From Brisa Mar	Moderate	Moderate	Moderate	Moderate	Moderate	4.966
	Option 3A – From Maritima	Moderate	Moderate	Moderate	Moderate	Moderate	4.137
Back Routes	Option 1B – From Seta	High	Low	Moderate	High	High	9.331
	Option 2B-1 – From Brisa Mar (Dirt Roads)	High	Low	High	High	High	11.270
	Option 2B-2 – From Brisa Mar (Sand Tracks)	High	Low	High	High	High	11.229
	Option 3B – From Maritima	High	Low	Moderate	High	High	9.727

6.5.4 Traffic Management Plan / Traffic Impact Mitigating Measures

It is important to minimise the impact of the development generated traffic during the construction and operational phases, as such the following mitigating measures are proposed as outlined in Table 20 and constitutes a high-level Traffic Management Plan. A detailed traffic Management Plan should be developed by each contractor that incorporates the guidelines as set out in this section of the ESIA report.

Table 20: Traffic Management Plan / Mitigating Measures

Vehicle Type	Impact	Mitigating Measure
Construction Vehicles during construction period Local impact	Traffic Delay	Indicate areas where heavy vehicles will be expected with adequate signage
	Adequate turning lane lengths / safety	EN1 / CTT Access northern approach: add minimum 30m right turning lane with a 45m taper to allow for safe queuing. EN1 / CTT Access northern approach: add minimum 30m left turning lane with 45m taper
	Generation of Dust	Cover materials with tarpaulins where possible alternatively wet sand and/or provide other means of protection. Treatment of dirt / sand roads near communities would be advisable. The contractors should also engage communities and plan activities around market times, public gatherings, school schedules and other community activities in order to limit any potential impacts.
	Risk of vehicle collision	Indicate areas where heavy vehicles will be expected with adequate signage
	Risk of pedestrian accidents	Clearly indicate pedestrian crossings Educate drivers on potential areas of high pedestrian and cyclist activity. Educate community on dangers of construction vehicles new to their area.
	Degradation of Public Roads	Upgrade roads and bridge crossing where necessary. The deterioration over time must be monitored and a maintenance plan must be negotiated with the ANE (National Road Administration) with specific mention of the Monitoring and Planning departments that should be consulted.
Abnormal Loads periodic during construction period Local impact	Traffic Delay	Ensure that at least two vehicles accompany every abnormal load; one vehicle in the front and one at the back.
	Generation of Dust	Slow moving abnormal loads should generate low dust level, but this should be monitored during the first trip.
	Risk of vehicle collision	Ensure that at least two vehicles accompany every abnormal load; one vehicle in the front and one at the back. Position flag men at critical crossings of all major routes these include but are not limited to the Beach Landing

Vehicle Type	Impact	Mitigating Measure
		/ R241, EN1/R241 and the EN1 / CTT access intersections.
	Risk of pedestrian accidents	Communicate dates and times of vehicle movements to the communities, schools and businesses along the routes. Educate drivers on potential areas of high pedestrian and cyclist activity. Educate community on dangers of construction vehicles new to their area. The contractors should also engage communities and plan activities around market times, public gatherings, school schedules and other community activities in order to limit any potential impacts.
	Degradation of Public Roads	Upgrade roads and bridge crossing where necessary. The deterioration over time must be monitored and a maintenance plan must be negotiated with the ANE (National Road Administration) with specific mention of the Monitoring and Planning departments that should be consulted.
Operational Vehicles	Traffic Delay	None required
	Generation of Dust	None required
	Risk of vehicle collision	None required other than that prescribed by the local authority for this class of road already prescribed and implemented.
	Risk of pedestrian accidents	None required other than that prescribed by the local authority for this class of road already prescribed and implemented.

Other than the specific measures identified above the following should be ensured:

- Project specific access roads must be maintained throughout the project phases. This requires road condition monitoring to enable speedy maintenance thus ensuring minimal delays to the transportation of abnormal loads and safe operating conditions for all other vehicles. Any temporary roads which will only be used for a limited period and which will serve no further use to either CTT or the public, will be decommissioned and rehabilitated;
- Enforcement of appropriate speed limits, together with adequate signage specifically at intersections, schools, housing areas, places of activity and business nodes. As stated above, transportation activities should be schedules around community activity times (markets, school times, public gatherings etc);
- Advertise the dates and times of the abnormal load movements, taking specific care to inform communities that do not have access to newspapers and other forms of media;
- provide signage and a warning indication to motorists at major pedestrian crossings;
- Restriction of heavy vehicle traffic to daylight hours as street lighting is inadequate;
- Develop driver training programmes to educate drivers on project specific road, vehicle and pedestrian safety;

- Education & awareness programmes for the project-affected population;
- Inclusion of specific measures in an Emergency Preparedness Response Plan for this project on accidents that involve personal injury; and
- Liaison with the traffic authorities about the movement of abnormal loads.

7.0 CONCLUSION

The traffic impact of the additional vehicles during the construction and operational phases of the CTT on the existing road network is low in terms of traffic delay. The additional trips will not contribute towards any significant delays that might require infrastructure upgrades.

However, the impact of the construction and abnormal loads in terms of vehicular and pedestrian safety is significant and road upgrades and improvements are required as detailed in the Beach Landing Report.

Based on the higher risk of pedestrian safety and extensive road upgrades that will be required for the Brisa Mar and Maritima Beach landing sites, the SETA beach landing site has lower associated impacts.

Taking into consideration the two main transportation route options, R241-EN1-CTT and the back roads to the CTT via the North South Road and Shortcut Road, it is concluded that both are technically feasible to cater for the abnormal vehicle loads, although the route via the back roads (dirt roads) will require extensive upgrades and will therefore be more costly (with higher impacts from a biophysical and social perspective as described in those studies).

In addition to this, there is currently higher pedestrian traffic along the main Inhassoro (R241) and EN1 roads, than the back roads. On these roads, pedestrians have a greater familiarity with large vehicles and have a higher degree of traffic safety knowledge and general awareness than the pedestrians within the more rural back roads. It is also true that with the formalisation of the shortcut route between EN1 and the North South Road, it would be expected to attract more pedestrians and other vehicles in the near future.

With the implementation of the mitigation measures recommended in Table 20, the risk to pedestrian safety along the main Inhassoro and EN1 roads (Option 1A) is lower than that of the alternative route (North South and Shortcut Road). It is further recommended that a detailed Traffic Management Plan should be developed by each contractor based on the guidelines provided in Section 6.0 of this report. Once final options are chosen, these should be communicated to affected communities well in advance, along with traffic education programmes aimed at awareness creation of traffic related hazards and safety practices.

Signature Page

Golder Associados Moçambique Limitada

Willie Bouwer
GIBB (Pty) Ltd

Aiden Stoop
ESIA Lead

GIBB/AS/up

Reg. No. 2002/007104/07
Directors: RGM Heath, MQ Mokulubete, SC Naidoo, GYW Ngoma

c:\golder\projects\sasol\sasol mgtp\for submission\english\18103533-321147-19_rep_ctt_traffic_impact_study_final.docx

golder.com