ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ('NUCLEAR 1') AND ASSOCIATED INFRASTRUCTURE

Transport Specialist Study
Impact Assessment Phase

Volume 4
Annexures D - G




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Annexure D

Eskom Nuclear-1 Project at Thyspunt Site

Road Investigations for EIA Process Addendum

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Synopsis

This report provides information and recommendations on the feasibility of existing and new roads to accommodate the expected construction traffic and abnormal traffic during the construction of the Thyspunt Nuclear-1 Plant through the Humansdorp area from the N2 and Hankey roads onto the both the Humansdorp St Francis and Oyster Bay roads, and also to provide a direct link from the St Francis to Oyster Bay.

1. INTRODUCTION

ESKOM has expressed a need for further power generation within South Africa using nuclear technology and Thyspunt in the East Cape Province was identified as the preferred location for such a facility.

The Thyspunt site is a green field's site along the coastal belt between St Francis and Oyster Bay, and south of the inland town of Humansdorp. This power station is vital to power distribution in the provinces of the East and West Cape as most of the power supply is presently provided via overhead lines from the coal fired power stations in mainly situated in Mpumalanga. The anticipated commencement of the construction of this power plant is 2013 when the Environmental Authorisation is to be issued.

2. BACKGROUND

2.1 General

Aurecon was requested directly by ESKOM to investigate road alternatives for access to the proposed new nuclear power station plant at Thyspunt. The additional information is required for the Environmental Impact Assessment process which is currently in progress. Various public participation meetings were conducted with the road access to the power plant and existing road usage for construction traffic and abnormal loads lodged as major concerns.

Aurecon was previously appointed for various feasibility and concept investigations for access roads on site, a direct coastal link road from Jeffrey's Bay to St Francis and the abnormal load haul route from the harbours in Port Elizabeth.

To provide more clarity on the road network in and around Humansdorp for passenger, construction and abnormal load traffic, this further investigation was carried out to provide more detail as to other possible transport routes, in order to satisfy the concerns of the general public.

2.2 Traffic Usage

It is important to note that when evaluating the various routes, there are three distinct types of road usage that are to be considered.

Firstly there is the route that will be used to transport **abnormal loads**. These loads are extremely large items mounted on multi-wheeled trailers pulled by a number of power units or "horses", and impose severe restrictions on the road geometrics, bridge loading, road widths, obstacles, street furniture, traffic control etc. These vehicles will travel at very low speeds, usually less than 10 km per hour. **However, there are relatively few of these loads (in the order of 60 loads above 100 tons in total,) and these will be spaced over a period of approximately three years**. Generally these vehicles will travel at night between 21h00 and 05h00 when traffic is at its least, and consequently, the disruption to both rural traffic and normal business when moving through towns, will be occasional and limited to short periods. (For example, the trip through Humansdorp would take approximately two hours, say, and occur approximately twice a month.)

Based on these restrictions, as well as the assumption that the loads will be landed at one of the Port Elizabeth Harbours, the most suitable route to Thyspunt has been evaluated by Aurecon in a report entitled "Abnormal Load Haul Route Investigation – 23 March 2011" (There are a number of possibilities for the landing of the imported items of plant but for the purposes of this report it is assumed that the Port Elizabeth Harbours will be used.) This route travels via Humansdorp and St Francis Bay to Thyspunt along the proposed Eastern Access site road.

The second type of road usage is the actual **construction traffic**. This will consist of normal construction haul vehicles carrying a variety of building materials and will be continuous daily traffic during the 7 year construction period. Naturally there is considerable concern amongst residents of Humansdorp and St Francis Bay about this type of traffic. **It is therefore important to note that it is intended to use the road between Humansdorp and Oyster Bay (DR1763) as the main construction traffic haul route, and construction traffic will not be routed past St Francis Bay on MR389(R330.)** Also included in this category are busses which will transport general workers who will be living in the Humansdorp area and surrounding towns and who will work on the Thyspunt site.

The third type of traffic which can be expected is **domestic traffic**, i.e. normal cars transporting staff members working at the Thyspunt site who will live in towns close to the site and who travels to the site every day. These vehicles will travel either on the Oyster Bay road (DR1763) or along the Western access on site, or the St Francis Bay road (MR389) past St Francis Bay and along the Eastern access road on site.

This purpose of this report, therefore, is

1. to examine possible routes for the first two types of traffic to bypass Humansdorp, as this is the town that will be most affected, especially by the construction traffic, and
2. to evaluate the upgrading of the MR389(R330) to allow for the increase in traffic using the eastern access on site.

A Key plan showing all the routes investigated for this report is attached as Annexure A.

3. ROAD INVESTIGATIONS

3.1 ROAD ID A - HUMANSDORP EASTERN BYPASS (FOR ABNORMAL VEHICLES)

3.1.1 General

The route for abnormal load vehicles landed at Port Elizabeth enters Humansdorp in the east along the Voortrekker Road. Using existing road infrastructure, the most suitable route through the town is directly down Main Street. This is the widest street through the town and will not require any upgrading except for the main intersections with Voortrekker and Park Streets which will need some widening to cater for the large radius turning circle of the haul train.

Traffic can easily be diverted via the other streets for the short period the haul train will disrupt Main Street traffic.

These intersections are shown in the Google images below.

Concerns have nevertheless been raised about the use of Main Street for this purpose and we have therefore investigated various other possible routes to bypass the town.

During our initial investigation into the abnormal haul routes, we examined the other streets running parallel to Main Street and concluded that none of them were viable options.

We note that there has been mention of using Saffery Street, but this was not considered an option for a number of reasons, one of which is the vertical alignment and sharp sag at the intersection of Du Plessis Street, which is too severe for the abnormal haul vehicle.

The street is narrow and there is insufficient room at the intersections with Voortrekker and Park Streets to be able to accommodate the large turning radius of the haul train. Similar constraints apply to the other streets.

Three new routes were investigated in the March reports for the abnormal load bypass and these are shown on the Google image overleaf.


Voortrekker Road
Eastern Bypass (Alternative B)
Eastern Bypass A (Alternative A)
MR381 (R330) F
Boskloof
Kwanomzamo
Humansdorp
Park St
R330
Protea St
Dahlia St
Witels Rd
Geelhout Ave
Nico Malan St
Saffery St
Kemp St
Bureau St
Main St
Heugh St
Du Plessis St
Beda St
Gxotiwe St
Ketse St
Zakhe St
Mjekula St
Honyane St
Vumazonke St
Mtsila St
© 2011 AfriGIS (Pty) Ltd.
Image © 2011 DigitalGlobe
©2010 Google
Eye alt 3.25 km
34°02'14.96" S 24°47'18.33" E elev 104 m
Imagery Date: 3/6/2006
2003
719 m

The first route (Alternative A) is a direct link between Voortrekker Road (MR389) and the St Francis Bay road MR381(R330) intersecting just north of Kwanomzamo. This is the shortest route for an eastern bypass, approximately 850m long, and is the most practical for construction. The topography at the start of the route traverses the Boskloof valley which will be crossed by a fairly large fill over a large box culvert to cater for the stream. Thereafter the ground is flat and ideal for such a road. Except for the initial portion which runs diagonally down the Boskloof valley, the ground is open and belongs to the Municipality.

The second route investigated (Alternative B) runs to the east of the suburb of Boskloof and traverses privately owned farmland. This route is approximately 1.3Km long. The topography is reasonable for road construction except for the final portion where it intersects with MR381. There is a deep valley just before this intersection (the Boskloof Stream) and this will require a relatively high bridge to span the stream and connect with the MR381 at an acceptable grade. This route is not considered practical and would be extremely costly to build. It is not considered further in this report.

The third route, (Alternative C) runs through farmland approximately 0.7Km east of Boskloof and joins MR381 approximately 1.5Km south of Kwanomzamo. The route follows existing cadastral boundaries where possible and is approximately 2.7Km long. For the most part, the topography is reasonable but there are two valleys which have to be crossed. The second, the Boskloof valley, is again deep and close to MR381 with the result that either a high fill or a bridge would be required to ensure that the bypass arrives at the MR381 intersection at a reasonable grade. This route would therefore also be extremely costly to construct and is not considered a viable option.

It is concluded from the above discussions that Alternative A is the most beneficial option for the following reasons:

- It is the shortest route available to effectively bypass the town.
- It is the most economical route to construct.
- It crosses vacant available Municipal land and has good alignment suitable for the abnormal load vehicles.
- It will also have significant benefits for Humansdorp as a bypass route for St Francis Bay traffic which currently uses roads such as Saffery Street as “rat runs” to bypass the congested main street. These roads were not built to take the traffic and are consequently seriously deteriorating.

We also note that in the future it is likely that, once this bypass is constructed, normal traffic travelling from Jefferys Bay to Oyster Bay and other coastal resorts to the west of Humansdorp will use the new road to bypass Main Street and travel along Park Street to the Oyster Bay road. Park Street is in a poor condition and consideration should be given to upgrading this street as well.

3.1.2 Road Classification

Bypass roads for both the abnormal and construction traffic would designed to a Class 3 Provincial road standard with a surfaced width of 8,6m. A typical cross section of such a road is given in Annexure B.

3.1.3 Expected Traffic Usage

Apart from the occasional abnormal load, this bypass will be used in the future by residents of St Francis Bay and Oyster Bay travelling to Jefferys Bay and vice-versa. This will relieve Main Street of this traffic which will improve congestion in the town. It will also relieve Saffery Street which is used as a “rat run” by many travellers to St Francis Bay to avoid the congestion of Main Street. Saffery St has been severely damaged by this traffic in recent years as it was not designed for these traffic loads.

3.1.4 Geometric Design Standards

3.1.4.1 Typical Cross-Section

This bypass, would consist of a surfaced width of 8,6m consisting of two lanes of 3.4m and 0.9m surfaced shoulders.

3.1.4.2 Horizontal and Vertical Alignment

Horizontal and vertical alignment will be designed to UTG1 standards suitable for a Class 3 Provincial road. Special attention would be given to this bypass in terms of minimum standard curves which must be able to accommodate the large turning radii required by the abnormal haul train. The intersections with Voortrekker Road and the St Francis Road (MR381) will be wider than normal to accommodate this.

3.1.5 Drainage

As stated above, the Boskloof Stream will be catered for by means of a large box culvert under the road. A hydrological analysis will be done at detail design stage to ensure that this culvert will be capable of handling at least a 1 in 100 year flood. Usually such a culvert would be designed for a 1 in 50 year event but in this case there is no alternative route for flood water and it would be prudent to use a larger design storm. The culvert would be similar to the existing one under Voortrekker Road.

3.1.6 Environmental Constraints

Environmental approval will be required for this bypass because of the crossing of the Boskloof stream. This is standard practice and should not cause any problem. It is anticipated that this approval could take a year to obtain.

3.1.7 Existing Services

There is a bulk water main running along part of the route which would cross under the road just to the south east of the hospital boundary. This pipeline delivers water from the NMBM Churchill pipeline to the Humansdorp Treatment Works.

There are other township services serving Kwanomzamo at the St Francis Bay road intersection which will have to be accommodated.

3.1.8 Affected Properties & Land Owners

The land for this bypass is owned by the Municipality and is not earmarked for development at this time.

3.1.9 Road Authority Approval

The bypass would become a provincial road and approval from the District Roads Engineer would be sought. Aurecon has liaised with the District Engineer who has lodged no objection in principle with this proposed route. Aurecon also liased with the Town Engineer of Humansdorp who has stated that their offices have no objection in principal to the bypass and that it will, in fact, be an asset to the town as it will relieve the traffic being imposed on Main Street and Saffery Street as discussed above.

3.1.10 Road Pavement Structure

A full geotechnical investigation will be carried out on the in-situ ground at detail design stage but it is probable that the pavement structure will consist of a 150 mm thick G9 and 150 mm thick G7 selected subgrade layers, 150mm thick stabilised C3 subbase, 150mm thick G1 crushed stone base course and a 40mm thick premix surfacing. Costing has been based on this design. This pavement design is also based on the assumption that an E4 traffic classification will apply (in excess of 12 million 80kN axles during the construction of the power plant)

3.1.11 Cost Estimate

It is estimated that the cost of this bypass (Alternative A) will be approximately R6.8 million. The costs have been based on recent contract rates where possible and include allowances for Contractor overheads, contingencies, and escalation. Details of the cost estimate are given below.

3.1.12 Execution Plan

It is estimated that the design and construction of this bypass would take approximately 6 months to complete.

3.1.13 Long Lead Items

Environmental approval will be required for this bypass and this is a long lead item which could take anything from 7 months to 24 months depending on the public participation process.

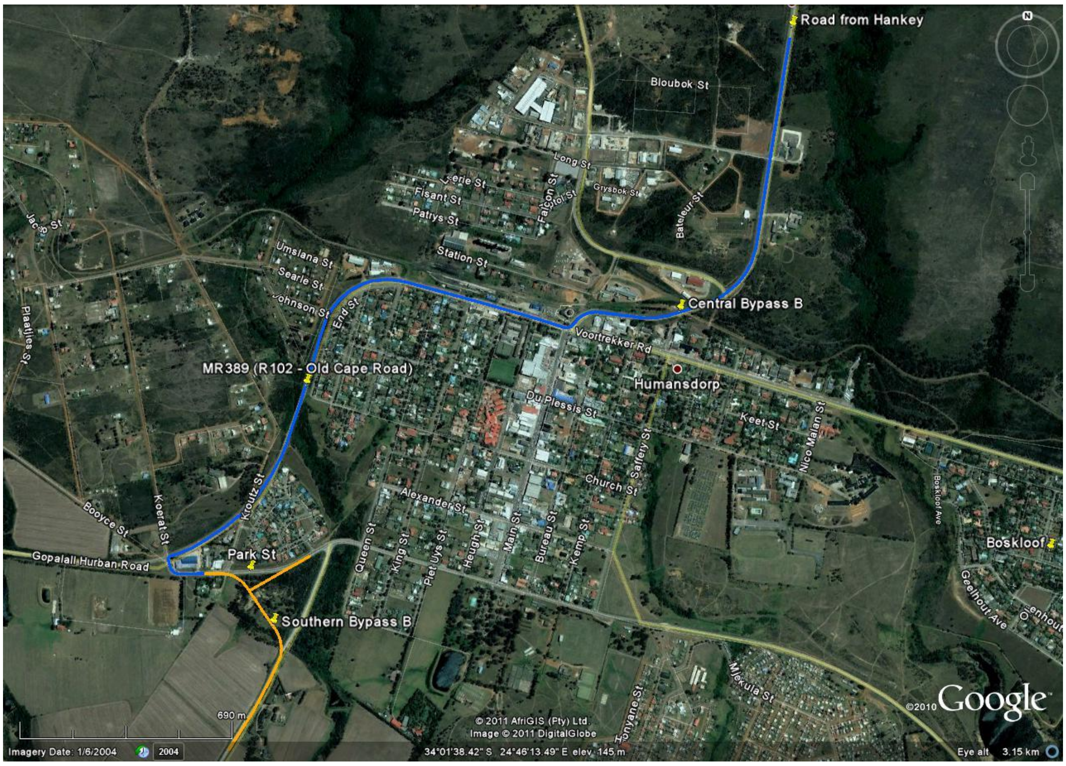
3.2 ROAD ID B - HUMANSDORP CENTRAL BYPASS ALONG OLD CAPE ROAD (MR389) AND SOUTHERN BYPASS (FOR CONSTRUCTION TRAFFIC)

3.2.1 General

It is generally expected that the majority of the construction traffic travelling through Humansdorp to Thyspunt will come from the N2 (from Port Elizabeth) or the Hankey Road. Either way, it would enter the area via the Humansdorp Interchange on the N2 north of Humansdorp and would arrive at the existing main intersection on Voortrekker Road. The current route through Humansdorp would be to cross this intersection and travel directly down Main Street to the Tee junction with Park Street. However this is not desirable as it will cause serious congestion in the town.

This construction traffic needs to get from the Voortrekker Road intersection to the Oyster Bay intersection on Park Street, just east of Queen Street. The best route for these vehicles to follow is to turn right into Voortrekker Street and continue along this road, around the western edge of Humansdorp. This road (MR389) is the old road to Cape Town and is a major Provincial road.

It is therefore constructed to a high standard and already carries considerable traffic. The first portion of the route travels between the Railway station and businesses and thereafter between Kruisfontein and Humansdorp. For the most part, it is well separated from the nearest residential dwellings and therefore forms an effective bypass route. This route is shown in blue on the Google image below.



The route continues along the Old Cape Road until it reaches the intersection with Park Street, which is also one entrance into Kruisfontein, at which point it turns left. After approximately 600m, it meets the Oyster Bay road. The right hand turn onto the Oyster Bay road is very sharp and an acute angle of more than 90 degrees which is not suitable for construction vehicles.

It is proposed that the alignment of Park Street is improved to provide a smooth entrance onto the Oyster Bay Road as shown in the figure below as the Southern Bypass. This road would become the main through road and a new Tee junction would be constructed for Park Street as shown.

3.2.2 Road Classification

The major portion of this route is already constructed to a major Provincial road and the Southern Bypass (and the Oyster Bay road) will be constructed to a Class 3 Provincial road standard.

3.2.3 Topography

The topography of this route poses no problems to the required road construction. The proposed alignment of the Southern Bypass onto the Oyster Bay road is an improvement on the present alignment and eliminates the current stream crossing just south of Park Street.

3.2.4 Geometric Design Standards

3.2.4.1 Typical Cross-Section

This bypass, would consist of a surfaced width of 8,6m consisting of two lanes of 3.4m and 0.9m surfaced shoulders.

3.2.4.2 Horizontal and Vertical Alignment

The horizontal alignment of the proposed route onto the Oyster Bay road is an improvement to the existing alignment. The Vertical alignment is well within design criteria for this class of road.

3.2.4 Drainage

Drainage structures are well established on this route and are adequate. The Southern Bypass portion poses no drainage problems.

3.2.5 Intersections

This route will require significant changes to some intersections as follows.

3.2.5.1 Voortrekker Road/Main Street Intersection

This is the main entrance into Humansdorp and is already a very busy intersection. With the additional construction traffic, it would be necessary to upgrade it to a major intersection. The geometry of the roadways is skew and not ideal for such an intersection. However there is little scope for changing the road alignments.

Should this bypass route be chosen, it is proposed that the intersection be upgraded to a fully signalised intersection. An option to construct a traffic circle was also investigated, but with the current and expected traffic volumes, such a circle would need to be a major one and there is not enough space available.

The proposed intersection is shown in the image overleaf. It shows that all the incoming roads would be upgraded to three lanes, namely straight, dedicated right turn lanes with vehicle stacking and a dedicated left turn or slipways. The existing incoming left turn slipway would remain.

Traffic signals would control vehicle movements with right turn arrows to improve flow, especially for arriving haul vehicles.

Some alterations would also be recommended to the layout of the existing petrol station to improve vehicle movement into and out of the forecourt on to Main Street and Voortrekker Road. These are also shown on the image below.

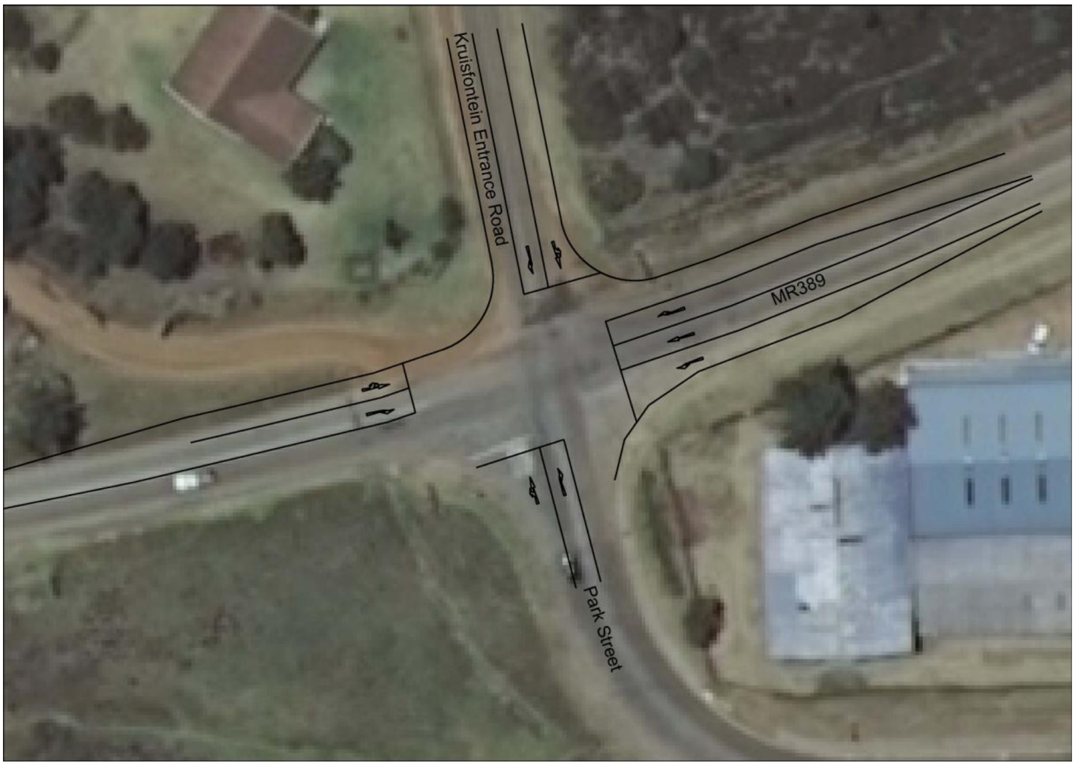
Aurecon must note here that, even if this route is not chosen as the construction haul route, it is likely that, with the construction of Thyspunt, normal traffic entering and passing through Humansdorp will increase significantly in the future. It might be prudent, therefore, to consider upgrading this intersection in any event. The intersection is in poor condition at present and deteriorating rapidly.

The intersection configuration is also not very good and should be improved. Current traffic volumes are high and may already warrant a signalised intersection. Traffic counts which will be carried out shortly will confirm this.

3.2.5.2 Cape Road/Park Street intersection

This intersection will need to be upgraded. The existing intersection is cross road junction with the second of two entrances into Kruisfontein. Kruisfontein is a large suburb of Humansdorp and significant traffic uses this intersection. The intersection will therefore need to be upgraded to a major one with dedicated right turn lanes, especially from the Park Street side, to cater for the construction vehicles returning from Oyster Bay turning into Cape Road.

This is shown on the image overleaf. Site distance for traffic from Oyster Bay entering Old Cape Road at the junction is good. A Traffic Impact Assessment will be needed for both intersections described here.



3.2.5.3 Westgate Road/Park Street Intersection

At the intersection of Westgate Road and Park Street, The Park Street – Oyster Bay road will become the major through route and Westgate and Park Street East the minor ones. It is proposed therefore that Park Street be re-aligned to form a new Tee junction controlled by a Stop Condition. Similarly, Westgate Road would remain a "Stop" controlled T-junction onto Park Street. Finally, the existing intersection to Oyster Bay on Park Street will be abandoned. This is shown on the image in 3.2.1 above.

3.2.6 Environmental Constraints

There should not be any environmental restraints on this bypass route.

3.2.7 Existing Services

There will be existing services at the Voortrekker intersection but these will be identified and incorporated into the construction of the upgraded intersection.

There may be some existing services in Park Street but these will be incorporated in the revised alignment.

3.2.8 Affected Properties & Land Owners

The southern bypass will cross a corner of private land which is currently unused and covered with alien vegetation. This land will have to be acquired and registered as road reserve and this process should start immediately to avoid any delays.

3.2.9 Road Authority Approval

The Old Cape Road as well as the Oyster Bay roads are both Provincial roads and approval for the proposed route will have to be obtained from the District Road Engineer. Aurecon has discussed the proposals with them and no objection was lodged in principle on the said routes. Aurecon has also discussed the alignment with the Town Engineer who does not have any objections in principal.

3.2.10 Road Pavement Structure

A full geotechnical investigation will be carried out on the Southern Bypass at detail design stage but it is probable that the pavement structure will consist of a 150 mm thick G9 and 150 mm thick G7 selected subgrade layers, 150mm thick stabilised C3 subbase, 150mm thick G1 crushed stone base course and a 40mm thick premix surfacing. Costing has been based on this design. This pavement design is also based on the assumption that an E4 traffic classification will apply (in excess of 12 million 80kN axles during the construction of the power plant directly as a result of construction traffic)

3.2.11 Cost Estimate

It is estimated that the cost of this bypass will be approximately R14.4 million. The costs have been based on recent contract rates where possible and include allowances for Contractor overheads, contingencies, and escalation. Details of the estimate are given below.

3.2.12 Execution Plan

It is estimated that the design and construction of this bypass would take approximately 7 months to complete.

3.2.13 Long Lead Items

The land acquisition for the Southern Bypass could take anything between 7 and 24 months and would be the longest lead item. An EIA would also be required which could also take up to two years. A Traffic Impact Assessment will also be required which should take into account Christmas peak traffic flows so further investigations should commence as soon as possible to avoid any delays.

3.3 ROAD ID C - HUMANSDORP INDUSTRIAL BYPASS TO MR389 AND SOUTHERN BYPASS (FOR CONSTRUCTION TRAFFIC)

3.3.1 General

The possibility of bypassing the main Voortrekker Road/Main Street intersection was investigated. The only way to achieve this would be to turn east off the incoming Hankey Road from the N2 before crossing the railway line, and cutting through, or north of, the industrial area which lies north of the railway station.

The logical position to do this would be at the intersection of Bosbok Street and the Traffic Department entrance, for the route to follow Bosbok and Long streets until the western end of the industrial area is reached. The route would then swing south down Loerie Street to intersect with Cape Road opposite the present Buitekant Street intersection.

There are, however a number of disadvantages to this bypass as follows:

- The construction traffic would have to cross the traffic exiting Humansdorp bound for the N2 and Hankey when they turned into Bosbok Street. This would mean upgrading this intersection to a full intersection with right turn lane with stacking. (On its own, this would not be a bad thing as it currently handles industrial traffic heading north or returning from the N2 but is a plain one-way Stop controlled Tee junction.)
- The traffic through the industrial area would increase significantly and all intersections along Bosbok and Long Streets would need major upgrading.
- Bosbok and Long Streets would have to be completely re-constructed as they are not of a high enough standard to withstand the construction vehicles.
- The railway lines at the west end of the Railway Station would be crossed. This is a marshalling yard and there would be continuous conflict between the rail and road traffic. The railway lines are close to the Cape Road and a grade separated road-over-rail bridge would not be feasible.
- Finally the intersection with the Old Cape Road would have to be upgraded to a major signalised intersection to avoid conflict between haul vehicles and normal traffic along this major road. Furthermore, it is on a bend in the road which is undesirable for a major intersection.

An alternative route considered is to construct a new intersection on the incoming Hankey Road north of the industrial area. The route would then travel westwards just south of the solid waste tip site to the end of the industrial area, at which point it would swing south to meet with the Old Cape Road. The route would travel southwards but, instead of traveling down Loerie Street, it would be aligned with Cape Road as shown on the image below. The Railway line would be crossed again but this position is further away from the marshalling yard and a single line level crossing would be constructed. The rail traffic here is very light with only occasional trains travelling to the west. The crossing would require traffic signals or booms which would be operated by oncoming trains. Consequently the construction traffic would be unimpeded unless a train was approaching.

It is proposed that the main entrance into Kruisfontein be moved to Searle Street. Cape Road would be re-aligned to meet with the Industrial Bypass at a crossroad intersection at the end of Searle Street and this would become a major intersection. This would improve the entrance into Kruisfontein which is currently into Johnson Street and is uncontrolled and dangerous for vehicles crossing the Cape Road traffic when entering Kruisfontein from Humansdorp.

Aurecon conclude from the above investigations that the second alternative for the Industrial Bypass would be the most beneficial to Humansdorp as it will enable the construction vehicles to bypass the main intersection on Voortrekker Road and the majority of the town, as well as improving the access into Kruisfontein as an added benefit.

3.3.2 Road Classification

The Industrial area bypass would be constructed as a Class 3 Provincial road.

3.3.3 Expected Traffic Usage

The main usage of the bypass would be construction traffic. **Construction traffic will be specifically instructed to use this bypass and not travel into Humansdorp.** Once the construction at Thyspunt is finished, the traffic will lessen considerably but the bypass will probably still be used by some vehicles wishing to bypass Humansdorp to Oyster Bay. It is most likely, however, that normal private light vehicles will continue to proceed into Humansdorp, either to break long journeys to Cape Town or Port Elizabeth as at present, or to travel to the south coastal resorts.

3.3.4 Geometric Design Standards

3.3.4.1 Typical Cross-Section

This bypass, would consist of a surfaced width of 8,6m consisting of two lanes of 3.4m and 0.9m surfaced shoulders.

3.3.4.2 Horizontal and Vertical Alignment

The horizontal alignment of the Industrial area bypass is straightforward and well within the minimum standards for a road of this class. The vertical grades are fairly steep as the topography slopes from north to south along the route. However the grades are within the minimum required standards and no geometrical design constraints are a concern.

3.3.5 Drainage

There are no major drainage paths crossing the route and drainage will not present any problems.

3.3.6 Environmental Constraints

An EIA will be required as for any new road constructions but no major problems are currently foreseen which may delay the process or adversely affect this route as an option.

3.3.7 Existing Services

There are some existing services to be crossed in the industrial area and at the intersection with Cape Road but these are not surmountable and will be addressed during detail designs.

3.3.8 Affected Properties & Land Owners

The land on the route is all municipal land so no private properties are affected and require expropriation.

3.3.9 Road Authority Approval

The Hankey and Old Cape Roads are Provincial roads and approval for the proposed route will have to be obtained from the District Roads Engineer. Aurecon has obtained verbally principle approvals for this route with no serious objections made. Principle approval was also obtained from Town Engineer for this alignment and proposal.

3.3.10 Road Pavement Structure

A full geotechnical investigation will be carried out on the Southern Bypass at detail design stage but it is probable that the pavement structure will consist of a 150 mm thick G9 and 150 mm thick G7 selected subgrade layers, 150mm thick stabilised C3 subbase, 150mm thick G1 crushed stone base course and a 40mm thick premix surfacing. Costing has been based on this design. This pavement design is also based on the assumption that an E4 traffic classification will apply (in excess of 12 million 80kN axles as mainly this route will be used by construction traffic)

3.3.11 Cost Estimate

It is estimated that the cost of this bypass will be approximately R32.8 million. The costs have been based on recent contract rates where possible and include allowances for Contractor overheads, contingencies, and escalation. Details of the estimate are given below.

3.3.12 Execution Plan

It is estimated that the design and construction of this bypass would take approximately 11 months to complete.

3.3.13 Long Lead Items

The EIA is a long lead item which could take anything from 7 to 18 months. A Traffic Impact Assessment will also be required which should take into account Christmas peak traffic flows so this impact assessment should be undertaken as soon as possible to avoid any delays.

3.3.14 Conclusions

There are both advantages and disadvantages to both these two above described routes through Humansdorp and these are summarised below:

- The main advantage of the Central route (B described in 3.2 above,) is that it makes use of the existing major Provincial road i.e.MR389. This road is capable of handling the construction traffic in its present form with the exception of the main intersection with Voortrekker Road and Main Street. However this intersection can easily be upgraded to cope with the increased traffic. This is, in fact, the route preferred by the Provincial Roads Authority. The disadvantage of the route is that the additional construction will, in spite of the upgraded intersection, add to the congestion in the town as part of MR389 has become one of the town's streets and is lined with various businesses. Consequently, the Humansdorp residents will be in favour of the alternative Industrial Route.
- The Industrial bypass has the advantage that it will take the construction around the business portion of MR389 as described above and will avoid the Main Street intersection. It will also improve the entrance to Kruisfontein by means of a signalised intersection at the Searle Street junction. The disadvantage of this route, however, is that it is a new road and will consequently be considerably more costly to construct. This option will also be advantageous if cement and other materials are carted in by rail with the rail siding in close proximity to this road network for off- loading, loading and direct haul to the Thyspunt site.

The conclusion for these two options is that is probable that the benefit to the town of the Industrial bypass option will outweigh the additional cost, and it is therefore recommended that the Industrial Bypass be constructed.

3.4 ROAD ID D - HUMANSDORP WESTERN BYPASS FROM N2 TO OYSTER BAY ROAD (DR1763) VIA DR1786 - MR389 - DR1779 - MINOR ROAD 2H (FOR CONSTRUCTION TRAFFIC)

3.4.1 General

The possibility of a construction vehicle route bypassing Humansdorp altogether was also investigated. This would mean that all construction vehicles would continue westwards along the N2 (or turn on to the N2 from the Hankey road) until a crossroad was reached whereby they could turn south to eventually connect with the Oyster Bay road south of Humansdorp.

The first such road crossing the N2 after the Humansdorp interchange is the DR1786. This road crosses the N2 on an overpass bridge approximately 10 km west of the Humansdorp interchange. An “Off” ramp and an “On” ramp would have to be constructed to provide access for the haul vehicles on to the N2. DR1786, which is a gravel road, then continues southwards for approximately 1.6km at which point it connects with MR389 or the Old Cape Road.

The route then travels back in an easterly direction along the Cape Road for 3.7 km where it turns right onto DR1779. After approximately 1 km the route turns left onto Minor Road 2H, which travels south east for a further 5 km until it intersects with the Oyster Bay road from Humansdorp.

DR1786, DR1779 and Minor Road 2H are minor gravel roads which would have to be re-constructed completely. The alignment of DR1786 is good but the alignment, both vertically and horizontally, of the other two is severe in places, especially where they cross streams on low level drifts, and significant re-alignment would be required to bring the geometric alignment to an acceptable standard. This would, in turn, require some land acquisition as well as fairly extensive earthworks. Furthermore, the width of the road reserve on Minor Road 2H is only between 10 and 15m, and a wider reserve would have to be acquired from the land owners for the full length.

MR389 would also need at least a premix overlay to cater for the increased volume of construction traffic.

3.4.2 Topography

Generally the topography along these roads is reasonable although as stated above there are sections where it is more severe.

3.4.3 Expected Traffic Usage

The upgrading of this route will attract some additional traffic but it is anticipated that most of the traffic will be made up of construction vehicles. Once the power station is finished, it is expected that the traffic will be light. In fact at this point it may be required by SANRAL that the new ramps onto DR1786 are blocked off. This option will not have any long term benefit for the community after the construction of the power station is complete.

It must be noted that this route will add approximately 25 km to travelling distance per round-trip for all construction haul vehicles. Apart from the high capital expenditure to upgrade these roads, the additional time and costs incurred on every haul trip will amount to significant additional haulage costs.

The longer trip distance may also impact on downstream construction operations which could have significant adverse effects on construction progress.

3.4.4 Drainage

There are a number of streams which cross this route and they would need to be catered for by means of pipe or box culverts. There are no major river crossings. These streams are prone to flash flooding in times of high rainfall and in order to prevent delays to construction traffic, it may be necessary to construct low bridges at these points. Alternatively the roadway could be raised on fills over the culverts to attenuate flood waters upstream of the fills and prevent overtopping. This would be finalised at detail design stage if this proposed route is to be further considered.

3.4.5 Environmental Constraints

The upgrading of these minor roads would require an environmental impact assessment. Although the route follows existing roads, the new road will be significantly wider and of a higher standard than the present minor roads and will impact on the present landowners.

3.4.6 Existing Services

It is unlikely that there are any existing services along this route except at the intersections with MR389.

3.4.7 Affected Properties & Land Owners

The portions of this route which need re-construction passes through privately owned farmland.

3.4.8 Road Authority Approval

The minor roads as well as MR389 are provincial roads and approval will be required from the District Roads Engineer. The exit ramps onto and off the N2 will require the approval of SANRAL. At this stage principal approvals were not obtained from either these road authorities as this route is considered not feasible for reasons given earlier.

3.4.9 Road Pavement Structure

A full geotechnical investigation will be carried out on the in-situ ground at detail design stage but it is probable that the pavement structure will consist of a 150 mm thick G9 and 150 mm thick G7 selected subgrade layers, 150mm thick stabilised C3 subbase, 150mm thick G1 crushed stone base course and a 40mm thick premix surfacing. Costing has been based on this design. This pavement design is also based on the assumption that a E4 traffic classification will apply (in excess of 12 million E80's during the construction of the power plant as mainly this route will be used by construction traffic).

The gravel on the existing roads would be stockpiled and re-used in the subgrade layers.

3.4.10 Cost Estimate

It is estimated that the cost of this bypass will be approximately R70.4 million The cost was based on recent contract rates where possible and include allowances for Contractor overheads, contingencies, and escalation. Details of the cost estimate are given below. The cost shown is for the portion from the N2 to the junction with the Oyster Bay road.

3.4.11 Execution Plan

It is estimated that the design and construction of this bypass would take approximately 16 months to complete.

3.4.12 Long Lead Items

The land acquisition for the Western Bypass could take up to two years and would be the longest lead item. The EIA is also a long lead item which could also take 18 months to 24 months.

3.4.13 Conclusions

The advantage of using this route as a bypass to Humansdorp is that most of the construction traffic will bypass Humansdorp completely. However, there are a number of major disadvantages as follows:

- The route is approximately 12.5 km longer than any of the other routes through Humansdorp. This translates to a major additional haulage cost for all materials coming from the PE or Hankey direction by adding a total of some 25 km to every round haul trip;
- The cost of construction is approximately R38 million more than the most costly route through Humansdorp;
- Additional haul trip distance and longer travel time with subsequent higher haulage costs;
- The minor roads which would be upgraded for this route would be little used once construction was complete and the additional cost would be abortive;
- The additional time required to design and construct this road would have serious implications on the overall construction program;
- This option will not have any long term benefit for the community after the construction of the power station is complete.

It is concluded that the disadvantages far outweigh the advantage of this route and the route is therefore not considered as a viable option.

3.5 ROAD ID E – UPGRADING HUMANSDORP – OYSTER BAY ROAD (FOR CONSTRUCTION TRAFFIC)

3.5.1 General

The existing road from Humansdorp to Oyster Bay is a Provincial Road used by traffic travelling to Oyster Bay, farmlands and other resorts along the coast. It is a gravel road in reasonable condition and is well maintained. It is the intention of Eskom to use this road as the main construction haul road for the Thyspunt Power Station. However it is not suitable in its present form for the high volumes of construction traffic it will have to cater for and it will need to be upgraded to at least a Provincial Class 3 standard. This will basically entail complete re-construction of the entire road.

The road is programmed to be upgraded by the Provincial Authority but a lack of available funding has delayed this construction indefinitely at this time.

3.5.2 Road Classification

The road will be upgraded to Class 3 Provincial standard. The present design is to a class still below the typical Class 3 standard with 3.4 m wide lanes up to chainage 16,000 and from this chainage to Oyster Bay the lane width is reduced to 3.2. Note that the 0.9 m outer shoulders are gravel built.

3.5.3 Topography

The topography along this road is undulating farmland for most of its length. However there are a number of streams and one major river (the Kromme River) crossing it and these sections of the road are typically relatively steep and winding and not ideal for large construction haul vehicles.

3.5.4 Expected Traffic Usage

During the 7 year construction period, this road will be heavily trafficked by large haul vehicles in addition to the farming and holiday vehicles. All labour housed in Humansdorp will also be transported to site in busses along this road.

3.5.5 Geometric Design Standards

3.5.5.1 Typical Cross-Section

This road, would consist of a surfaced width of 8,6m consisting of two lanes of 3.4m and 0.9m surfaced shoulders. This is typical a Class 3 Provincial cross section standard.

Aurecon noted that the current Provincial design does not include surfaced shoulders and it is recommend that for the expected construction traffic which will be using this road it is imperative that the shoulders be surfaced.

The present design provides the required road prism and therefore only the base course and sub base layers would need to be constructed for supporting the surfacing for the 0.9 m wide surfaced shoulders. The latest cost estimate makes allowance for upgrading the gravel shoulders to surfaced using a Cape Seal and to ensure the entire road is constructed to a 8.6 m wide road up to Oyster Bay.

3.5.5.2 Horizontal and Vertical Alignment

The horizontal and vertical alignment of the existing road is generally good and will need little change. However as stated above there are some sections leading down valleys to river crossings which are very steep and winding, and these sections will require significant improvement to cater for the construction haul vehicles. This will in turn require some land acquisition where sharp curves are smoothed out and steep grades eased. A number of properties are listed in the Design Report of the Upgrading of the Road DR01763 and DR01761 from Humansdorp to Oyster Bay dates March 2011 where negotiation with land owners is required to accommodate the wider road cross section. It must be emphasized that this process should be commenced urgently to acquire the require land.

Aurecon has noted that the current geometric design shows some vertical and horizontal curves in these river valleys that are below normal curvature standards. These will suffice for normal traffic but it is not acceptable for the construction haul vehicles. The current design will therefore have to be re-evaluated and additional geometric improvements made to the alignment. This will have a significant cost implication which was added to the cost estimate for the original upgrade as contained in the aforementioned report.

3.5.6 Drainage

The streams and rivers are currently crossed by means of low level drifts over box or pipe culverts and these sections are not passable during times of heavy rain. Consequently, a number of high level bridges will be required, as well as pipe and box culverts for smaller streams. These structures (two cell structures and two bridges) were subsequently fully designed as part of the initial design with the cost estimated at approximately R 21 million. These costs were used in the latest cost estimate referred to in item 3.5.12.

3.5.7 Environmental Constraints

As with any major road construction, an EIA is required for this road and it is not clear if this process has started. Aurecon is presently investigating the status hereof as to determine if this road upgrading works could commence immediately after the final designs. If environmental authorisation was issued, it would be imperative to commence with construction as soon as possible before the approval lapses.

3.5.8 Existing Services

There are a number of Telkom and ESKOM services which cross this road but generally these are overhead cables which will not affect the construction. The services relocation works have been addressed in the initial designs.

3.5.9 Affected Properties & Land Owners

The Oyster Bay road passes through privately owned farmland. The existing road reserve is approximately 25m wide which is sufficient for a road of this standard. However, as stated above, there are some areas where the alignment will need straightening and some land will have to be acquired in these places.

The initial Design Report provides detail of all the affected land properties and should be consulted for further engagement. Refer to item 3.5.5.2 where the importance of this process is highlighted as to avoid delays to the start of construction works.

3.5.10 Road Authority Approval

This is a Provincial road but the upgrading is already planned by them. Consequently additional approval will not be required. The final design will, however, be carried out with their approval.

3.5.11 Road Pavement Structure

A full geotechnical investigation has been carried out on the in-situ ground and the pavement structure will consist of a 150 mm thick G9 and a 150 mm thick G7 selected subgrade layersl, two 125 mm thick stabilised C4 subbase layers, 125 mm thick Waterbound Macadam and a Cape Seal comprising a chip and spray surfacing. Initial costing has been based on this design.

The above original pavement design should be reconsidered with the geometrical design improvements as an alternative pavement design may yield a more cost effective solution based on conventional road building techniques which may also save some significant construction time.

The gravel on the existing roads would be stockpiled and re-used in the subgrade layers.

3.5.12 Cost Estimate

It is estimated that the cost of this road upgrading will be approximately R283 million. The costs have been based on recent contract rates where possible and include allowances for Contractor overheads, contingencies, and escalation. Details of the cost estimate are given below. The estimate as mentioned earlier, allows for additional earth works to improve the geometrical design where substandard horizontal and vertical sections were identified, providing surfaced shoulders and ensuring a 8.6 m road width from chainage 16 to the Oyster Bay construction limit.

3.5.13 Execution Plan

It is estimated that the design and construction of this road would take approximately 36 months to complete. The main reason for this long construction period is the four major storm water structures and construction of the road in half width. This construction technique should perhaps be reconsidered if other alternative roads could be identified for use during the construction which could reduce the construction duration.

3.5.14 Long Lead Items

The land acquisition for the re-aligned sections could take up to two years and would be the longest lead item. The EIA is also a long lead item which could also take 18 months to 24 months if this process has not been started as noted in item 3.5.7.

3.6 ROAD ID F – REHABILITATION OF HUMANSDORP TO ST FRANCIS (MR381) (INCLUDING SECTION FROM KROMME TO SEA VISTA)

3.6.1 General

This existing road linking Humansdorp and St Francis is still in a fair condition, although the road pavement is reaching the end of its life span and requires some pavement rehabilitation. This rehabilitation is not as a direct result of this route being designated for the abnormal load haul route, but merely to ensure this road condition remains in a good standard for local road users commuting between these two towns. The traffic volume will increase as soon as construction works on the Thyspunt power plant starts and it is therefore imperative to carry out the required pavement rehabilitation works.

3.6.2 Expected Traffic Usage

The road forms part of the abnormal haul route and limited construction traffic from Humansdorp could be expected to use this road while the eastern site access road is constructed. Primarily this road is for light traffic such as personnel working at the Thuspunt site who reside in Humansdorp and Jeffrey's Bay (while the Jeffrey's Bay Coastal road is not constructed).

3.6.3 Geometric Design Standards

The existing road was designed for a design speed of 100 km per hour which still conforms to the latest geometrical standards, with no substandard sections identified for major improvement while rehabilitation work is to be carried out. The only section of road requiring attention is a 300 metre section just south of the St Francis Bay main entrance that washed away during heavy flooding in 2007, with temporary works carried out up to selected subgrade level only, and with the vertical alignment therefore still to be corrected.

Provision has been made in the cost estimate for this rehabilitation.

3.6.4 Drainage

Overall the drainage network and structures are fully functional with no improvements required. The only section where the road drainage needs to be improved is at the wash away road section as mentioned above, where a complete pipe system and portal culvert would have to be installed under the roadway to accommodate the major storm water discharge. The cost estimate provides for the upgrading of the storm water system in this immediate area.

3.6.5 Environmental Constraints

As this is primarily an existing road the rehabilitation should not trigger any EIA listed activities and therefore a full EIA approval process may not be necessary. In such a case this work could commence once the design is completed.

3.6.6 Existing services

Existing services adjacent or crossing this road should not be affected with the pavement rehabilitation works.

3.6.7 Affected Properties & Land Owners

No adjacent land owners will be affected as the construction work is limited tom pavement rehabilitation only with minor storm water upgrading works on a short section of the road as explained in item 3.6.4.

3.6.8 Road Authority Approval

The final rehabilitation designs will be subject to approval by the Provincial road authority this will be obtained on completion of the designs.

3.6.9 Road Pavement Structure

Preliminary visual assessments have been conducted which indicate that the road is reaching the end of its design life and that the base course and sub-base layer will require replacement or rehabilitation. The latter is presently a conservative approach for cost estimating and during detail design stage a full field investigation will be conducted.

The prescribed pavement rehabilitation will entail the replacement of the sub base and base course layers with a cemented C4 150 mm thick and a G1 crushed stone base of 150 mm thick followed by 40 mm asphalt surfacing. Note that the existing base course material will be reused in the rehabilitation process. In-situ recycling could also be an option which will be investigated during the detail design stage.

The rehabilitation works will be carried out in half width construction which will result in one way directional traffic deviation controlled by traffic lights. This technique will have a serious disruption to the general road users as well as to construction traffic.

3.6.10 Cost Estimate

It is estimated that the cost of this road rehabilitation will be approximately R 73million. The costs have been based on recent contract rates where possible and include allowances for Contractor overheads, contingencies, and escalation. This cost estimate allows for the storm water improvements and re-grade of a road section where the road was damaged as a result of flooding. Details of the cost estimate are given below.

3.6.11 Execution Plan

It is estimated that the design and construction of this road would take approximately 16 months to complete.

3.6.12 Long Lead Items

There are no major long lead items for this rehabilitation work.

3.7 ROAD ID G - UPGRADING OF ST FRANCIS BAY TO OYSTER BAY LINK ROAD (FOR LOCAL TRAFFIC)

3.7.1 General

There is an existing link road running from St Francis Bay, just south of the Kromme River Bridge on the R330, to the Oyster Bay Road. This is a gravel road known as DR1762 and it is desirable to upgrade it as a second link to Thyspunt. The road is shown on the Google image below.

3.7.2 Road Classification

This road is a minor Provincial road and it would be upgraded to a surfaced road with gravel shoulders. It would be designed for an 80 km per hour design speed whereas all the other roads would be designed for a 100 km per hour design speed.

3.7.3 Topography

The topography on this road is undulating farmland and is relatively smooth.

3.7.4 Expected Traffic Usage

It is expected that this road will be used by some Thyspunt staff members living in St Francis Bay, Humansdorp or Jefferys bay and also residents of these towns holidaying in one of the other towns.

The main reason for the road is, however, to provide a surfaced secondary access to Thyspunt as well as to provide a high standard link road for traffic from Oyster Bay and the western coastal resorts travelling to St Francis Bay without having to traverse the power station property. It will also provide an optional route from Oyster Bay to Humansdorp during construction, should the construction traffic be too heavy on the main Oyster Bay – Humansdorp road.

3.7.5 Geometric Design Standards

3.7.5.1 Typical Cross-Section

This link road would consist of a surfaced width of 8,6m consisting of two lanes of 3.4 m and 0.9 m gravel shoulders. This would typically conform to a Class 3 Provincial standard with the exception that the 0.9 m shoulders would not be surfaced. Due to the expected traffic volume on this road once upgraded, the surfaced shoulders are not warranted at this stage.

3.7.5.2 Horizontal and Vertical Alignment

The alignment of the existing road is fairly winding in places and these curves will have to be smoothed. There are also some places where the vertical alignment is steep which will also need to be improved.

3.7.6 Drainage

Generally the drainage on this road will be simply taken care of by means of pipe culverts across the road. There are no major river crossings.

3.7.7 Environmental Constraints

The upgrading of this minor road would require an environmental impact assessment. Although the route follows an existing road, the new road will be significantly wider and of a higher standard than the present one and will impact on the present landowners.

3.7.8 Existing Services

There is a water supply pipeline running along the first portion of this road.

3.7.9 Affected Properties & Land Owners

The road runs in an existing servitude which is, for the most part, sufficiently wide for the proposed upgrading. Sections which need re-aligning will, however, require additional land to be acquired.

3.7.10 Road Authority Approval

The road is a Provincial road and approval from the District Roads Engineer will be required. Aurecon has however engaged the matter with them with no objection in principal raised on the proposed upgrading of this road.

3.7.11 Road Pavement Structure

A full geotechnical investigation will be carried out on the in-situ ground at detail design stage but it is probable that the pavement structure will consist of a 150 mm thick G9 and 150 mm thick G7 selected subgrade layers, 150mm thick natural G4 subbase, 150mm thick G1 crushed stone base course and a 40mm thick premix surfacing. Costing has been based on this design.

This pavement design is also based on the assumption that a E2 traffic classification will apply (below 3 million E80's after the peak construction of the power plant as mainly this route will be used by light traffic).

The gravel on the existing roads would be stockpiled and re-used in the subgrade layers.

3.7.12 Cost Estimate

It is estimated that the cost of this road upgrading will be approximately R60 million. The costs have been based on recent contract rates where possible and include allowances for Contractor overheads, contingencies, and escalation. Details of the cost estimate are given below.

3.7.13 Execution Plan

It is estimated that the design and construction of this bypass would take approximately 13 months to complete.

3.7.14 Long Lead Items

The land acquisition for the re-aligned sections could take up to two years and would be the longest lead item. The EIA is also a long lead item which could also take 18 months to 24 months.

4. COMBINED COST ESTIMATES

The combined cost summary of the preferred road options investigated and recommended in this report is tabled below.

Combined Cost Estimate Summary

Road ID	Road Description	Estimated Cost (Excl VAT)	Construction Duration (Months)	Preferred Option/Route	Comments	Total Costs of Preferred Routes
A	Humansdorp Eastern Bypass (Bypass A as recommened in TO1 Report)	R 6,809,547.36	6	*Yes*	Abnormal haul route and use by local residents	R 6,809,547.36
B	Humansdorp Central Bypass along MR389 and Southern Bypass to Oyster Bay Road (MR389 to DR1763)	R 14,420,313.60	7	*No*	For construction traffic around Humansdorp	R -
C	Humansdorp Industrial Bypass (From MR389 to N2/Hankey Road) & Southern Bypass to Oyster Bay Road (MR389 to DR 1763)	R 32,816,857.92	11	*Yes*	For construction traffic around Humansdorp	R 32,816,857.92
D	Humansdorp Western Bypass including ramps at interchange on N2 (DR 1786 to DR 1779 to Minor Road 2H)	R 70,430,162.88	16	*No*	For construction traffic around Humansdorp	R -
E	Humansdorp to Oyster Bay (DR 1763)	R 283,271,738.20	36	*Yes*	For use by construction traffic, buses etc	R 283,271,738.20
F	Humansdorp to St Francis (R330/MR381), including Kromme River to Sea Vista	R 72,932,798.40	16	*Yes*	Abnormal haul route and use by local residents	R 72,932,798.40
G	Road DR1762 - Link Road between St Francis (R330) and Humansdorp (DR 1763)	R 60,262,171.20	13	*Yes*	For use by local residents and workers to the plant	R 60,262,171.20

Total Costs	**R 456,093,113.08**

Notes:
1 *No VAT included*
2 *No professional fees and other costs included*

Note that Road ID’s B and D are excluded as these options are no further considered. The reasons for this are explained in sections 3.3.14 and 3.4.13 above. The estimated construction periods for every listed road are also provided as indicative time lines. The time frames are further discussed in more detail the next section as to priority not to affect the other major road construction projects. Note that VAT was not applied at this stage to these cost estimates. No professional fees and additional fees for site monitoring and disbursements were also calculated and indicated at this stage.

5. PRELIMINARY CONSTRUCTION PROGRAMMES

A preliminary construction programme has been compiled for the various preferred road upgrading and new road bypasses as recommended in the aforementioned section. Note that the programme is assuming that construction can start as early as January 2012 on high priority roads which are the upgrading of the Humansdorp – Oyster Bay Road followed by the Humansdorp Eastern bypass. This assumption is based that all EIA approvals are obtained before this planned commencement date and applying the shortest possible time frames as to mitigate risks.

This sequencing will ensure that on completion of these roads, construction traffic for material haulage could start using these completed routes therefore avoiding the Humansdorp CBD. Again the programme is illustrating that both the upgrading of the Humansdorp to Oyster Bay and St Francis roads must be completed before construction commences on the two site access roads to the nuclear power plant.

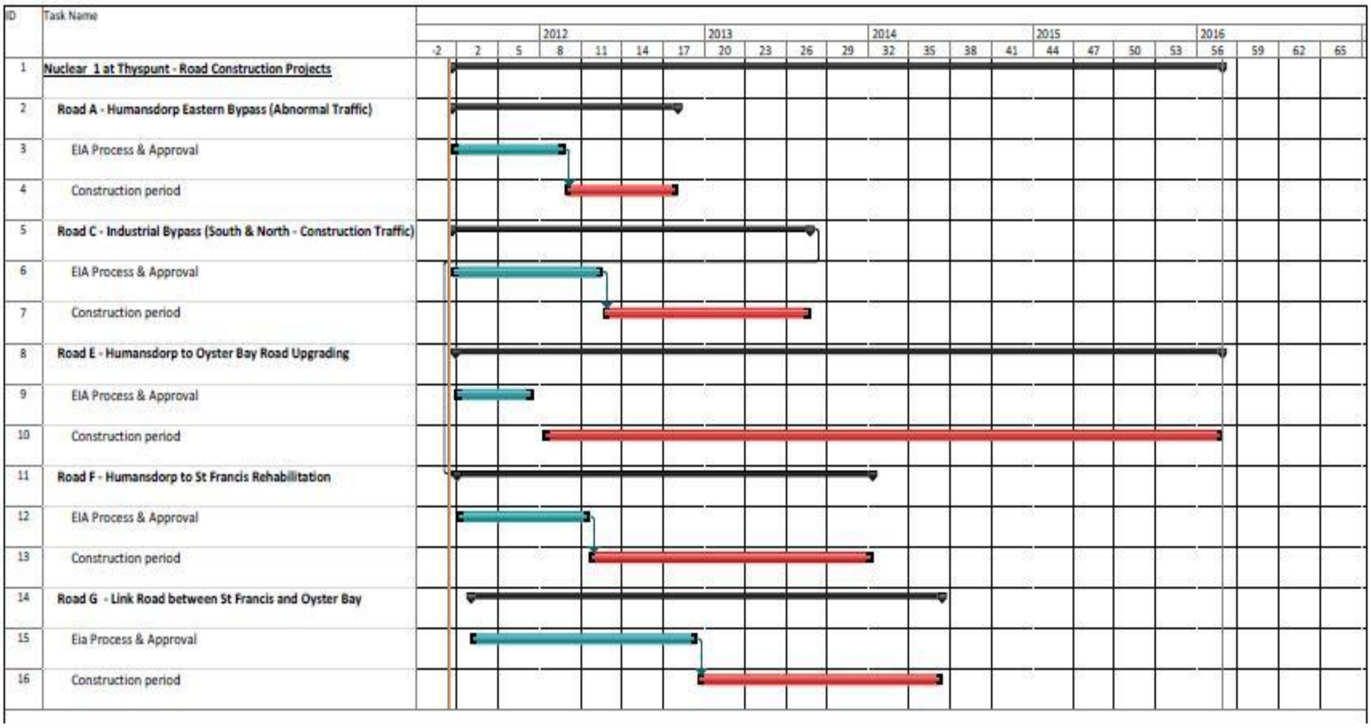
The link road between the two towns of St Francis Bay and Oyster Bay is not seen as a high priority at any given stage, although this road could, when completed early, be used as an alternative route during the construction of either the Humansdorp to St Francis road or Humansdorp to Oyster Bay Road.

The construction of the Humansdorp to St Franscis will have to be carried out in half width construction which may have a significant time implications to the road users. The same construction methodology is described for the construction of the Humansdorp to Oyster Bay road with similar adverse effects. The latter could therefore adversely affect any construction supplies to any of the power plant projects as construction traffic will be caught up in these single lane control traffic deviations.

The Humansdorp to Oyster Bay road has also a number of large storm water drainage structures and bridges which will impact on the construction timing.

It specifically illustrates the most realistic construction duration based on conventional road building methodologies.

Below the envisaged construction programme for the recommended roads:



It is evident from the programme that construction of the Humansdorp to Oyster Bay road will require a 36 month contract and therefore only be completed by middle 2016 if to start 14 months from date of this report. Note that this road is critical for accommodating construction traffic during the construction of the Nuclear-1 plant. Note that the Humansdorp to St Francis road may also require some time for rehabilitation and as this route is earmarked for the haul of abnormal loads it is just as vital for an early start of construction of the works.

The above construction time table must therefore be considered closely with the overall construction programme of Nuclear-1 as to the expected start date of major construction operations. It is strongly advised that the Humansdorp to Oyster Bay and St Francis roads should preferably be completed before any construction starts on the two site access roads to the nuclear power plant, so as to avoid delays with the haul of materials, equipment and personnel.

6. FINAL RECOMMENDATION AND CONCLUSION

In conclusion the report recommends the following road networks in support of the Environmental Impact Assessment process currently underway. The concept investigations revealed that these recommended road routes are feasible and executable in all respects. Principle approvals have been obtained from both the local Municipality and Provincial Road authority on these recommended routes. From an EIA perspective no other fatal flaws are foreseen except the impact to the local communities during construction.

The final recommendation is therefore as follows:

- Road A – Humansdorp Eastern Bypass (Bypass A as contained in the Task order No 1 Report dated 23 March 2011, Report No 5318, Revision No 3, Abnormal Load Haul Route Investigation – New road construction;
- Road C – Humansdorp Industrial Bypass (Extension of Old Cape road (MR389) to N2/Hankey Road around northern industrial area of Humansdorp, and Southern Bypass linkage from Old Cape road (MR389) directly to Oyster Bay Road (DR1763) –- New road construction;
- Road E – Upgrading of the Humansdorp to Oyster Bay Road (DR1763) – From gravel to surfaced;
- Road F – Rehabilitation of the Humansdorp to St Francis Road (R330/MR381) - Asphalt overlay;
- Road G – Upgrading of Link Road between St Francis and Oyster Bay (DR1762) – From gravel to surfaced.

7. REPORT APPROVALS

The author of the report hereby certifies that the report content is correct with respect to the findings, conclusions and final recommendations.

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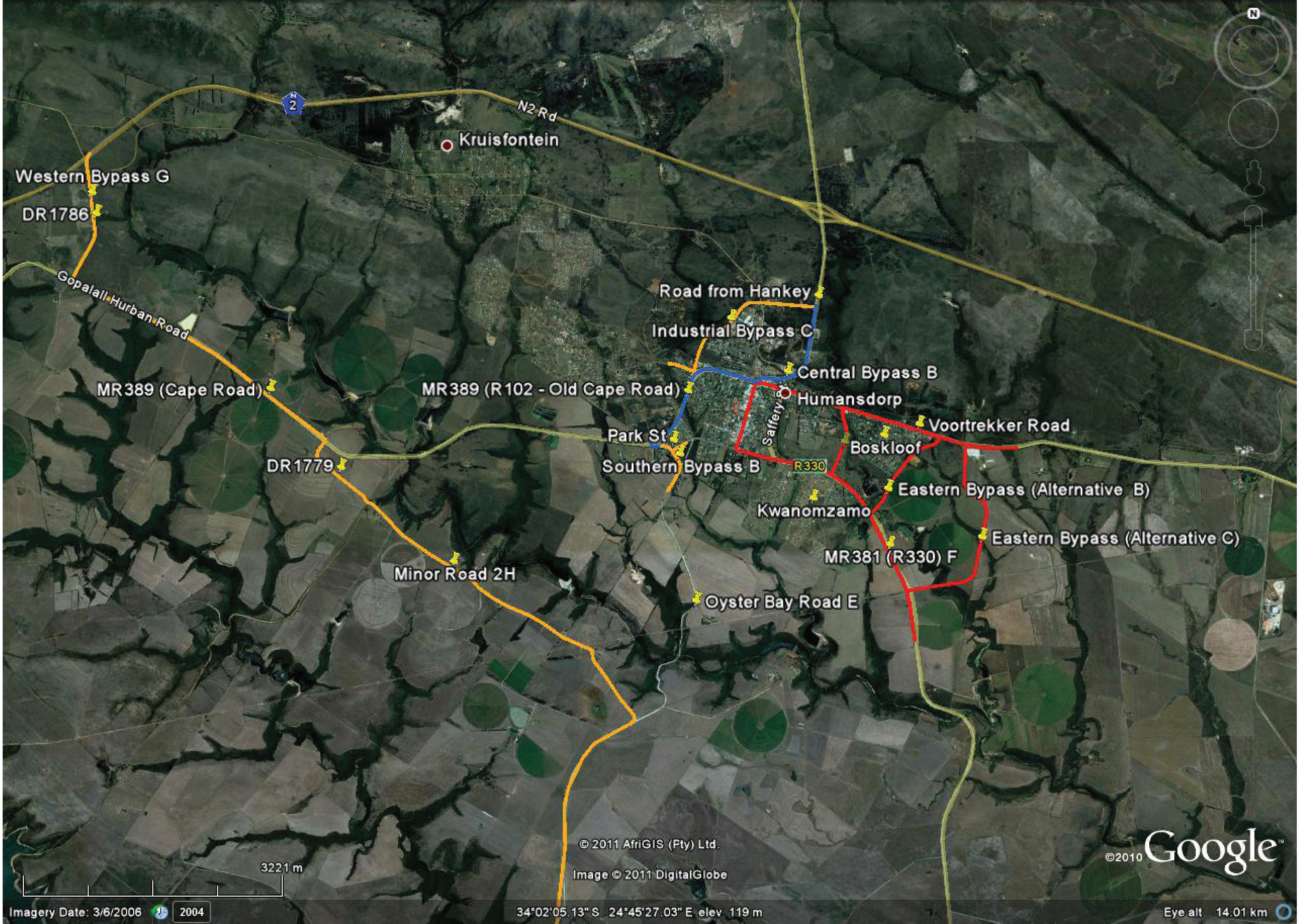
Chris Roberts Pr Eng

On behalf of Aurecon South Africa

ANNEXURE A

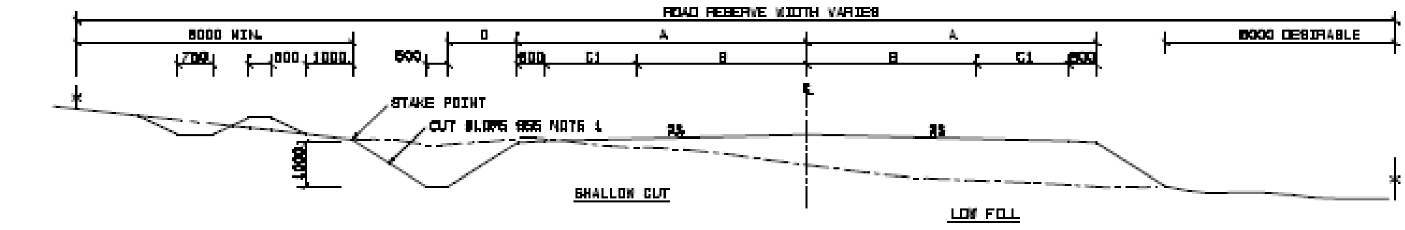
KEYPLAN LAYOUT OF ROAD OPTIONS INVESTIGATED



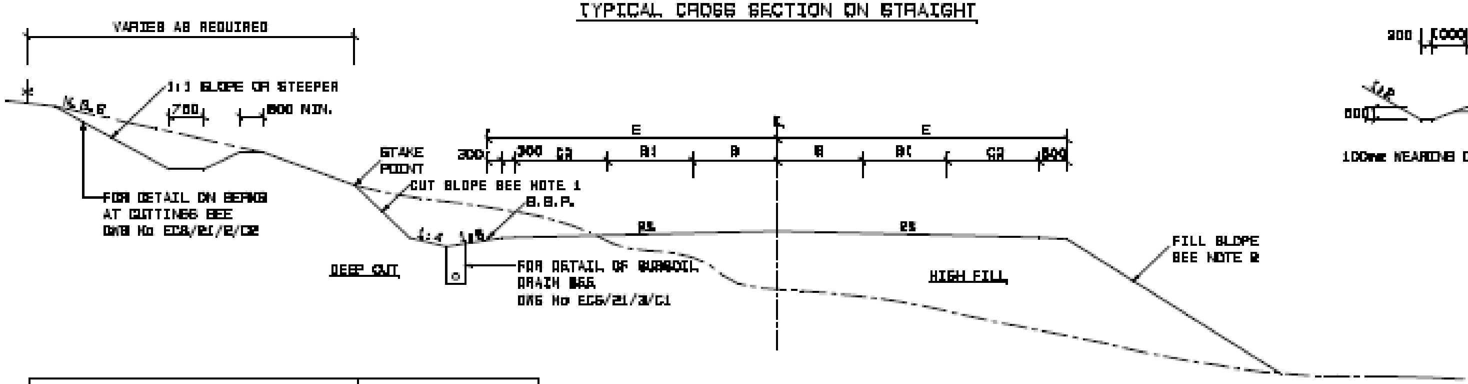
N2 Rd
Kruisfontein
Western Bypass G
DR1786
Gopalall Hurban Road
Road from Hankey
Industrial Bypass C
Central Bypass B
MR389 (Cape Road)
MR389 (R102 - Old Cape Road)
Humansdorp
Voortrekker Road
Park St
Saffery
Boskloof
Southern Bypass B
DR1779
R330
Eastern Bypass (Alternative B)
Kwanomzamo
Eastern Bypass (Alternative C)
MR381 (R330) F
Minor Road 2H
Oyster Bay Road E
© 2011 AfriGIS (Pty) Ltd.
Image © 2011 DigitalGlobe
©2010 Google
3221 m
Imagery Date: 3/6/2006
2004
34°02'05.13" S 24°45'27.03" E elev 119 m
Eye alt 14.01 km

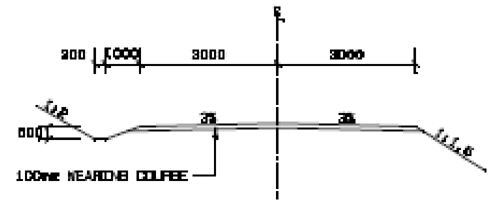
ANNEXURE B

TYPICAL CROSS SECTION FOR CLASS 1 PROVINCIAL ROAD



TYPICAL CROSS SECTION ON STRAIGHT

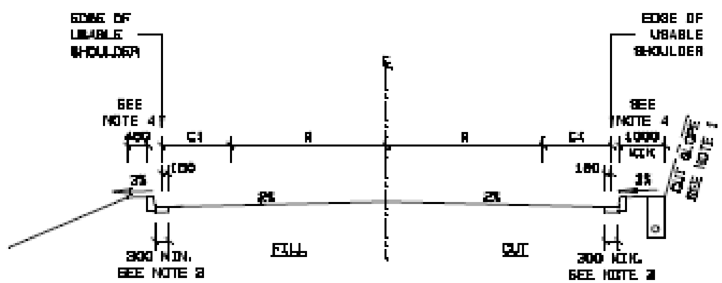




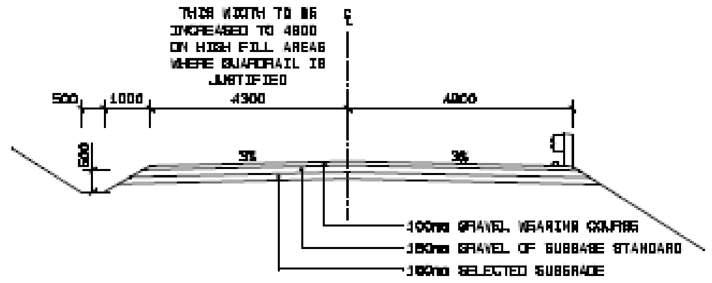
ACCESS ROAD

					WITH CLIMBING LANE		
CLASS	A	B	C1	D	C2	E	B1
CLASS 1	6300	3700	2000	1200	1600	9200	3400
CLASS 2	6000	3400	1600	1200	1600	8900	3400
CLASS 3	4900	3400	900	1200			

TYPICAL CROSS SECTION ON STRAIGHT WITH CLIMBING LANE



ROAD WITH KERB AND CHANNEL



CLASS 4

NOTES :

1. CUT SLOPE :
   1:0,25 IN ROCK.
   1:1 IN SOFT ROCK.
   1:1,50 IN SOFT MATERIAL OR AS DIRECTED
   WHERE CUTS ARE DEEPER THAN 4m, BENCHES MAY BE REQUIRED AS DIRECTED BY FOR CUTS DEEPER THAN 6m IN CLAY, REFER TO MATERIALS ENGINEER.

2. FILL SLOPES :
   1:2 FILL LESS THAN 4,0m IN HEIGHT.
   1:1,5 FILL GREATER THAN 4,0m IN HEIGHT OR AS DIRECTED BY D.I.C.
   FILLS GREATER THAN 8m IN CLAY SHALL BE REFERRED TO MATERIALS ENGINEER.
   BENCHES IN FILL TO BE CONSTRUCTED AT EACH 6m MULTIPLE BELOW G.B.P.

3. WIDTH VARIES TO SUIT STORMWATER REQUIREMENT.

4. WIDTH TO SUIT PEDESTRIAN OR SIGHT DISTANCE REQUIREMENTS.

Department of Roads and Public Works, Province of the Eastern Cape	SCALE : N.T.S.	CROSS SECTION	INDEX NO. ECS/11/1/D1
DRAWN BY / CHECKED BY / FILE No.	A3 ORIGINAL	TYPICAL CROSS SECTION DETAILS	PLAN NO. SHEET 1 OF 1

Annexure E

aurecon

Eskom Nuclear 1 Project: Thyspunt Site

Abnormal Load Haul Route Investigation

Aurecon Report: 5318
23 March 2011
Revision 3

PREPARED BY:

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1. INTRODUCTION

1.1 GENERAL

In 2008, the then Ninham Shand were appointed by Messrs Roshcon Civils Infrastructure to investigate the issue of access by special vehicles for large size and mass components which would be imported by sea for the construction of a Nuclear Power Station at Thyspunt, near Oyster Bay.

The physical size and mass of some of these components exceed the normal design limits for obstacles such as bridges, overhead cables, township street widths etc, and such elements need to be assessed to determine if they present insurmountable obstacles and whether or not alternative arrangements can be made.

1.2 SCOPE OF THE PROJECT

This report covers the following aspects:

- Choice of harbour
- Possible alternative routes from harbour to Thyspunt
- Load bearing capacity of existing roads
- Suitability of road widths to accommodate the loads
- Load bearing capacity of bridges and culverts
- Strengthening / propping of bridges if required
- Bypass routes for over / underpasses at intersections
- Necessity and feasibility of constructing new roads if necessary
- Upgrading existing roads if necessary
- Detailed description of preferred route and identification of all obstacles
- Proposals for overcoming obstacles
- Discussions with road authorities and identification of requirements for permits
- Recommendations on way forward.

1.3 METHODOLOGY

The following methods and standards have been used in this study:

- Aerial survey data and contours obtained from the Nelson Mandela Bay Municipality (NMBM).
- Aerial photographs obtained from the NMBM.
- All possible routes have been driven and visually assessed.
- Preferred route has been driven and photographed approximately every 500m minimum.

- As built road drawings of the N2 freeway have been obtained from the SA National Road Agency Limited (SANRAL).
- Physical survey of harbour exit, alternative routes for over pass bridges, “Fountain circle” in Jeffrey’s Bay, route through Humansdorp and Centreline of complete route.
- Geometric design standards based upon the UTGI - Guidelines for Geometric Design of Urban Arterial roads have been used to check alignment of the routes.
- Minimum horizontal and vertical alignment limits required by the transport train as provided by local companies that provide a heavy haul service.

2. TRANSPORTATION – LOADING AND GEOMETRIC CONSTRAINTS

2.1 LOADING CONSTRAINTS

Typically, most major components for a nuclear power plant are manufactured overseas and imported by sea, and many of these components are abnormally large in comparison to normal road freight. A table of typical components with dimensions is given in the table below:

Table 1: Typical Loads

COMPONENT	NUMBER OFF	WEIGHT TONS	WIDTH H	EIGHT	WIDTH LOADED	HEIGHT LOADED
Steam Generator	2	628.3	5.97	6.20	7.0	7.40
Generator Stator	1	420.0	4.7	6.50	7.0	7.70
Reactor Vessel	1	295.3	6.22	6.61	7.0	7.81
Condenser Lower shell Module (A)	2	287.4	4.50	10.99	7.0	12.19
Condenser Lower shell Module (B)	2	287.4	4.50	10.99	7.0	12.19
Condenser Lower shell Module (C)	2	287.4	4.50	10.99	7.0	12.19
Generator Rotor	1	190.0	1.83	1.83	7.0	3.03
Rotor LP	3	184.2	3.72	4.33	7.0	5.53
Pressurizer	1	183.3	2.77	00.00	7.0	1.20
Closure Head	1	169.9	4.78	3.94	7.0	5.14
Condenser Upper shell module A/B/A	3	130.7	9.93	5.50	9.4	6.70
Core makeup tank	2	114.3	4.76	0.00	7.0	1.20
Rotor HP	1	98.9	2.80	3.32	4.0	4.52
Lower Internals	1	94.3	0.00	0.00	4.0	1.20
PRHR Heat Exchanger	1	90.7	2.69	6.08	4.0	7.28
HP Casing Upper shell	1	90.3	4.11	2.93	4.1	4.13
HP casing lower shell	1	88.9	4.11	2.32	4.1	3.52
LP outer casing Lower shell mid-section	3	84.4	3.32	4.33	4.0	5.53
LP outer casing Lower shell end-section	6	75.3	3.63	4.33	4.0	5.53
Integrated Head Package	1	68.0	0.00	0.00	4.0	1.20
Upper Internals	1	51.2	0.00	0.00	4.0	1.20
LP inner casing Lower shell mid-section	3	44.9	3.11	4.02	4.0	5.22
Condenser Feed water heater #1 A/B/C	3	39.9	1.20	2.40	4.0	3.60
LP inner casing Upper shell mid-section	3	39.0	3.11	3.32	4.0	4.52

COMPONENT	NUMBER OFF	WEIGHT TONS	WIDTH H	EIGHT	WIDTH LOADED	HEIGHT LOADED
Accumulator Tank	2	38.6	4.81	0.00	4.08	1.20
LP outer casing Upper shell mid-section	3	35.4	3.32	4.02	4.0	5.22
LP outer casing Upper shell end-section	6	34.9	3.32	4.02	4.0	5.22
Condenser Feed water heater #2 A/B/C	3	28.9	1.70	2.40	4.0	3.60
LP inner casing Lower shell end-section	6	19.5	1.83	4.02	4.0	5.22
Condenser Equalizing shell A-B/B-C	2	16.3	2.20	2.00	4.0	3.20
LP inner casing Upper shell end-section	6	15.9	1.40	3.02	4.0	4.22
Condenser Flush Box	2	13.3	8.99	1.00	9.0	2.20
Nozzle diaphragm 16^{th} stage (Max size)	12	12.7	2.71	0.70	4.0	1.90

From this table it is evident that loads of up to approximately 650 tonnes in weight, approximately 13m in height and 10m in width need to be catered for.

These components will be transported by means of multi-wheeled trailers, either self-propelled or pulled by anything up to five power units. Such "haul trains" distribute the heavy loads evenly onto the roads but have limited turning and climbing capacity. Consequently the road geometrics as well as structural capacity of bridges, culverts etc. need to be checked.

2.1.1 Load bearing capacity of roads

Generally, the bearing capacity of municipal and provincial roads should not present any major problems. The structural designs of the road layer-works forming the road prism are usually designed by Consulting Engineers in accordance with the principles determined by soil mechanics and traffic impact studies.

These can only be verified by detailed soils and laboratory tests and analyses. This is especially so for the older roads such as Greenbushes' Road on the edge of Port Elizabeth. However, the original designs should have been prepared to conform to prevailing frameworks of axle loads and road lifecycle designs.

2.1.2 Road transport permits

There are two courses of action available for the exercise of moving equipment to the site:

a) either conform strictly to the load limits as applied to the original design of the road, in which case there would be no risk of damage to the road,

Or, alternatively

b) Prepare a permit application which would allow for exceeding the load limits by an acceptable margin but for which the permits could be obtained. The transportation of abnormal loads on public roads is covered by the CSIR publication TRH 11 “Conveyance of Abnormal Loads”.

Abnormal loads are defined as loads, which do not comply with the provisions of the Road Traffic Ordinance. These vehicles may only use public roads after obtaining a permit. Permits can be a single trip permit (for a single load only) or, as in this case, period permits for the transportation of a number of loads over a relatively short term using the same or similar vehicle and the same route. The issuing of a permit is subject to the payment of fees to cover the expected damage to the road pavement which is calculated from a fairly complex formula based on tyre pressures, axle loading, total mass, escort requirements etc.

The maximum wheel loads may exceed normal maximum permissible axle loadings (for normal heavy vehicles) as it may be impractical to add innumerable wheels and axles to the trailer being drawn. There is however a maximum load allowance in terms of the ESWM (Equivalent single wheel mass load), which is calculated in terms of a specific formula.

Information supplied by heavy haulage companies has indicated that trailer and axle configurations are available which will allow the imposed loadings to not exceed the normal allowable axle loading.

Any temporary roadworks required on the route will be designed to surfaced standard and suitable layerworks to be able to support the full design loading.

2.1.3 Load Capacity of Bridges

There are several river bridges, which will need to be crossed most notably:

- Van Stadens (Gorge) (N2)
- Gamtoos (N2)
- Kabeljous
- Swart
- Seekoei
- Kromme

There are also overpasses (bridges over other roads) on the N2 at Witteklip and near Gamtoos. These can be propped if necessary off the existing underpass roads. The structures which will be encountered on the proposed route are discussed in more detail in Section 5 of this report. A schedule of all the bridges and culverts along the various routes is given in Annexure A.

2.2 GEOMETRIC CONSTRAINTS

There are numerous configurations for haul trains depending on the haulage company used and available trailers. It could consist of two or three pulling power units, two multi-axle trailers each with centre pivot load supports and possibly one or two rear power units. Alternatively, a single trailer could be used. One haul company has indicated that a 28 axle single trailer would suffice for the heaviest load. Examples of these are shown overleaf.

The worst case geometric constraints imposed by these configurations will be approximately as follows:

Table 2: Haul Vehicle Constraints

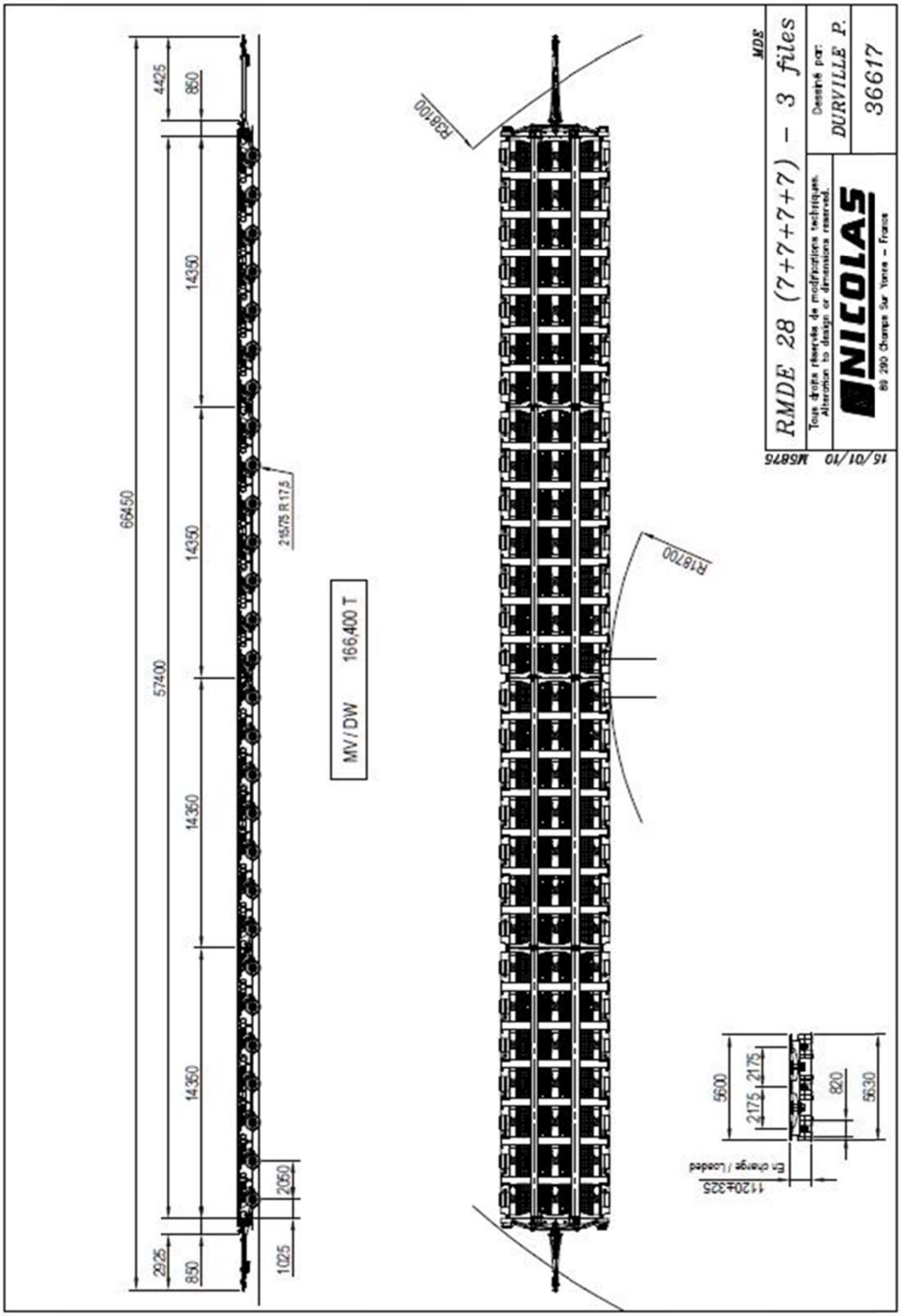
Total length of train up to approximately	100m	
Minimum outside turning radius	50m	(Double Trailer)
Minimum inside turning radius	18m	(Trailer)
Minimum swept inside turning radius	5m	(Load on Double Trailer)
Minimum vertical curve radius (say).	253m	
Equivalent vertical design "K" Value	24	
Minimum vertical curve length	231m	
Maximum road gradient	7%	
Maximum super elevation	7%	
Minimum height clearance (11 + 2,5)	13.5m	
Minimum width (widest load)	9.4m	
Maximum grade change over length of trailer	3%	28 axle trailer 70m long

The normal height allowance on bridge structures over the N2 is 5.2 - 5.4m. Where this height is exceeded, alternative routes around the overhead bridges must be used, such as on and off ramps at interchanges. If these do not exist, temporary ramps will have to be constructed. These situations are discussed in detail under section 6 in this report. Width clearance should not be a problem as the maximum load width is 9.4m. However some roads will have to be closed to oncoming traffic during transport. The trailer (wheel) width will be approximately 6m and all surfaced roads used for the haul route must be at least this wide. The narrowest surfaces on the haul route are freeway on and off ramps, which are 7m wide. However the throat or entrance to some ramps narrows to 4m and these will require temporary widening over a short length of some 10 m. A list of longitudinal gradients on the proposed route is given in *Annexure B.*

2.3 OTHER SERVICES

Other existing services that will be affected by the haul route will consist of stormwater culverts, overhead cables (Telkom and electrical) and street furniture in narrow roadways including trees. Generally culverts will not be affected provided normal maximum design axle loads are not exceeded as they are relatively short compared to the length of the haul train.

There are numerous overhead cables which will be affected and which will require either lifting (temporarily or permanently) or dismantling during passage of each load. The method of dealing with these will be decided by the service owner during detailed design stage. Overhead cables which will be encountered on the proposed route are listed and detailed in *Annexure C*.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Dessiné par: DURVILLE P.
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NICOLAS
89 290 Champs Sur Yonne – France
Tous droits réservés de modifications techniques. Alteration to design or dimensions reserved.
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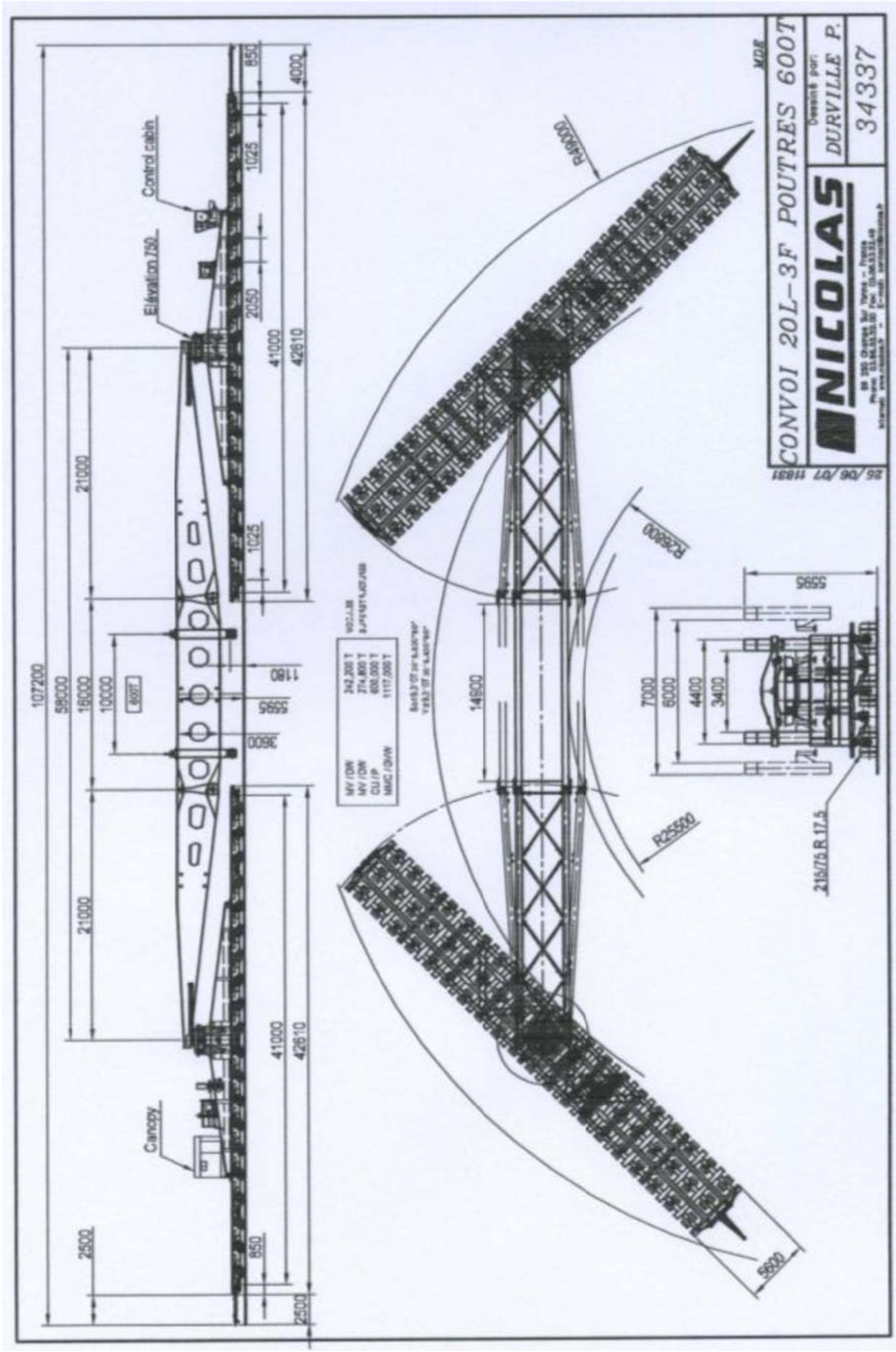
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3. AVAILABLE PORTS

There are three available ports for the offloading of large loads. These are Port Elizabeth, Port of Nqura (Coega) and Port St Francis. Port St Francis is primarily a small yacht harbour but also caters for commercial chokka boats. It is unlikely that it will be able to cater for the type of loading required for Thyspunt, but a separate investigation is being carried out in this regard. A report on the access routes from Port St Francis to the Thyspunt Site will be included in that report.

This report is based on the assumption that either Port Elizabeth or Nqura will be used.

3.1 PORT ASSESSMENTS

A comprehensive Port Handling Feasibility Assessment has been compiled and is attached as *Annexure G*. The conclusions reached in this report are as follows:

"*Based on the vessels identified during the assessment it is suggested that a vessel which has self-contained heavy haul equipment, namely heavy duty cranes, should be used for the transportation of the components. The benefit of using vessels which have their own off-loading machinery will allow for the efficient change over from maritime to land-based transportation. The proposal of containerized transportation of equipment may be neglected based on the fact that only the 'condenser equalizing shell A-B/B-C' units could possibly be transported in containers.*

Both port options offer suitable locations for the off-loading of these abnormally large components. Although the difference in distance from port to nuclear plant site between the two ports is negligible, separate study reports discuss the possible access routes and required temporary measurements in more detail. The existing land-based infrastructure provided within both ports is sufficiently adequate to cope with the expected high loading demands generated once placed on land-based transport vehicles. The shallower depth along berth 8 does however mean that a certain number of vessels capable of transporting the equipment will not be able to utilize PE, as mentioned in section 3.2.3. The relatively quiet traffic flow through the port of Ngqura and the availability of open space, along South Quay, suggests that the movement and off-loading of equipment would be more efficient compared to the port at Port Elizabeth."

3.2 HARBOUR EXIT ROUTES

3.2.1 Port Elizabeth Harbour exit

An aerial view of the Port Elizabeth Harbour is shown below in *Image 1*. As proposed in the Port Handling Feasibility Assessment discussed in 3.1 above, Quay 8 is the most suitable quay for the offloading of the large equipment. The aerial *Image* shows the proposed exit route from Quay 8 to the NMBM road network. The route will cross numerous railway tracks and will run on top of rail tracks between the cold storage warehouse and the adjacent freeway. The ground will have to be built up to the level of the rails with asphalt pavement to form a permanent vehicle roadway for the haul vehicles.

Some security palisade fencing will have to be moved and/or re-constructed with removable panels to allow for the passage of the haul trains. Overhead electric power lines will also need to be moved or temporarily raised when the haul vehicles leave the harbour. Photographs of these are shown in *Images 2 to 6.*

Image 1: Google Image of Port Elizabeth Harbour exit route

Image 2: PE Harbour Quay 8

Image 3: PE Harbour exit past cold storage

Image 4: PE Harbour overhead power lines

Image 5: PE Harbour typical rail crossings

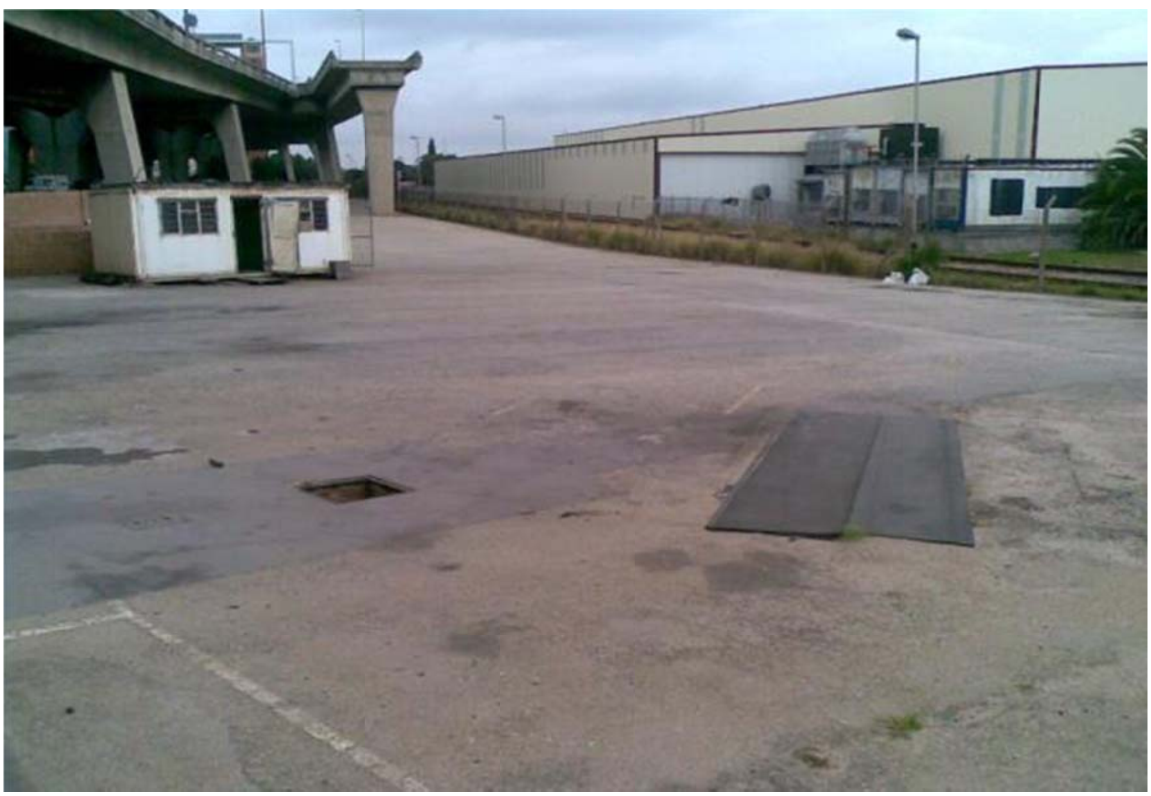


Image 6: PE Harbour exit to road

A ramp will have to be constructed where the route enters the road system. This will be approximately 40m long and 2m high (gradient 5% maximum). The ramp will connect to the roadway just north of the Baakens River bridge crossing.

We have discussed all these matters with the harbour officials and they have indicated that suitable arrangements can be made.

3.2.2 Port of Nqura Harbour exit

The exit from the Port of Nqura is relatively straight forward and there is an obstacle-free route for this. The haul route travels westward along Neptune Road as it exits the harbour. However this road travels under the N2 National road at the main Coega interchange, so the haul vehicle would have to travel along the “on ramp” from the harbour, across the N2 and down the “off ramp” back on to Neptune Road. Some earthworks to level the median will be required at this point.

This section of the route includes two recently constructed bridges, one in the Port and a road-over-rail bridge on the N2 off-ramp to Neptune Road.

This road-over-rail bridge has concrete balustrades which are approximately 1.2 m high. The distance between the balustrades is approximately 8 m which could possibly interfere with a 10 m wide load, depending on the shape and height of the widest part of the load (see image 7 below)

Image 7: Coega Rail Bridge

A Google *Image* of this harbour exit is shown in *Image 8.*

Image 8: Google Image: Nqura Harbour exit

3.2.3 Summary

Either of the two ports, Port Elizabeth or Nqura could be used for off-loading the large equipment. Both ports have suitable exit routes, although some additional work will be required in Port Elizabeth to make the current exit usable.

4. ALTERNATIVE ROUTES TO THYSPUNT

Several different routes have been identified and investigated from both Port Elizabeth and Nqura harbours to Thyspunt. These routes were the ones that presented the least number of overhead obstacles and the least number of bridges that would require additional support, as well as fitting the geometric restrictions with the minimum of additional work. From a strength point of view, it is assumed that the haul train configuration will be such that wheel bearing pressures will be within reasonable limits and axle loadings will be within normal design standards, **(i.e. not greater than 88KN/axle OR 30 KN/m²)**. This has been confirmed with specialist haulage companies such as Rotran.

The different routes investigated are shown on the keyplan drawings 402763 PE 104 and 105 included at the end of this section. They have been colour coded and are discussed as follows:

4.1 PORT OF NQURA TO N2 WOODRIDGE INTERCHANGE

All routes out of Port Elizabeth meet at a common point at the Woodridge Interchange on the N2 national road as shown in Image 9 overleaf indicating the green and blue route from Nqura and the orange and red route from Port Elizabeth.

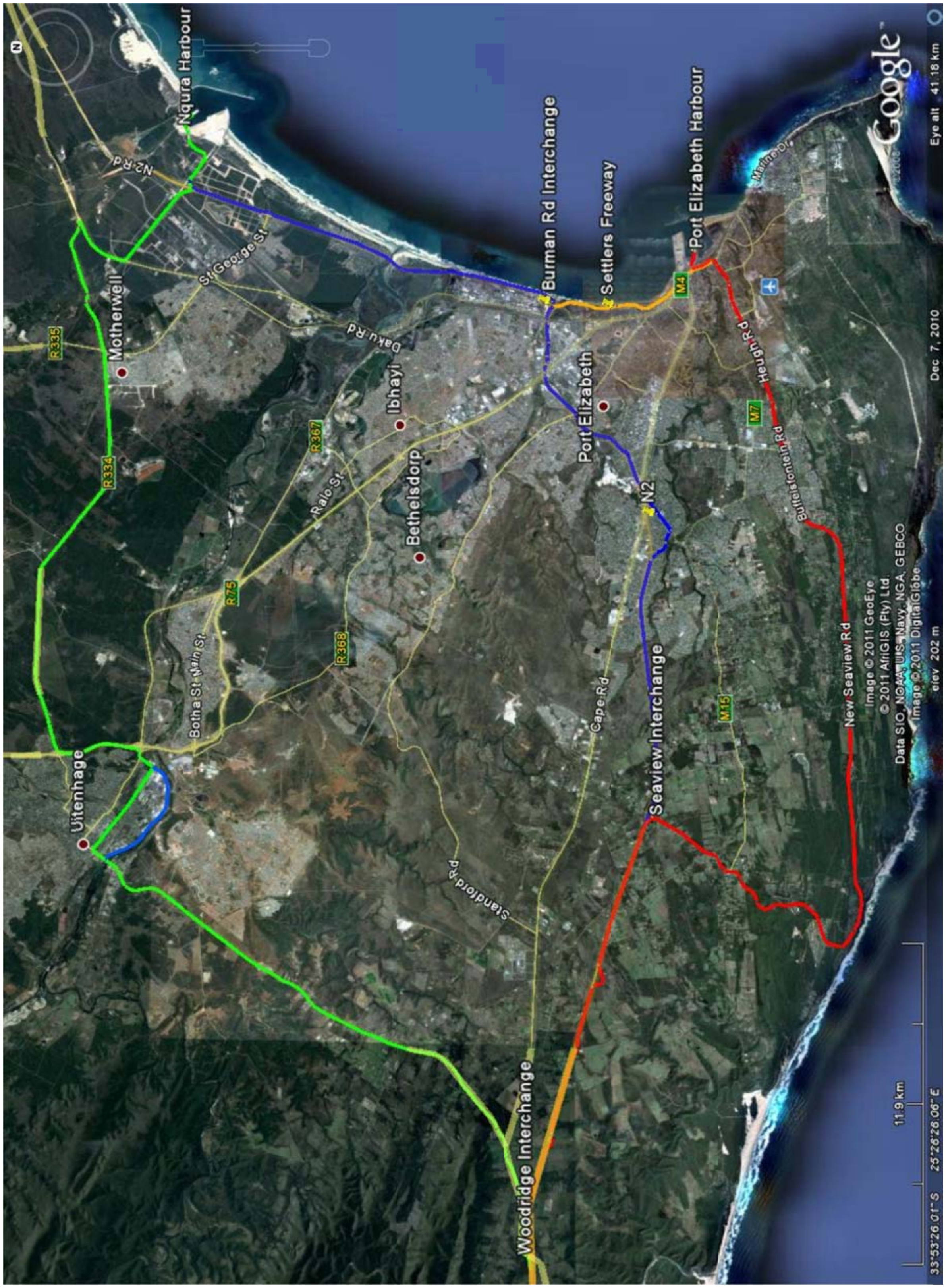


Image 9: Google Image: Harbours to Woodridge alternative routes

There are two routes available to travel from Nqura to Woodridge, namely south and west along the N2 or via Uitenhage.

4.1.1 N2 Route

The first route runs south and west along the N2 through the city and is shown in blue in image 10.

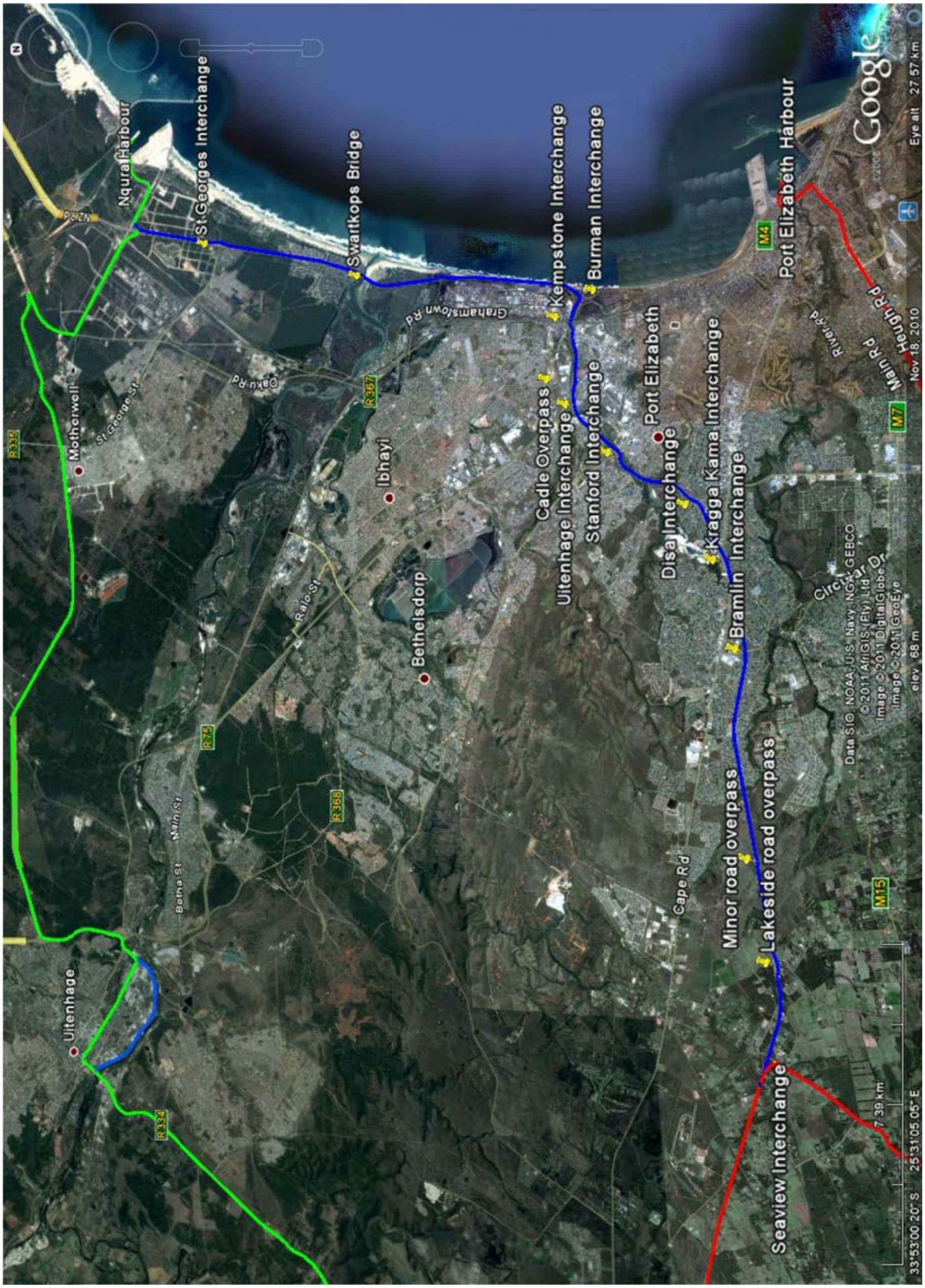


Image 10: N2 route through the city

There are a number of intersections, bridges and underpasses along the route described as follows:

The first interchange on the route is the St Georges interchange which contains an overpass bridge. This can be bypassed using the existing off and on ramps of the interchange.

The route continues south until it crosses the Swartkops river bridge. The Swartkops River is tidal at this point and this multi span bridge cannot be propped. It is similar to the bridges over the Gamtoos and Kromme River bridges which were analysed in the bridge investigation in section 5 of this report. It is unlikely to require strengthening to increase bending capacity, but may require torsion and sheer strengthening.

The next two interchanges, are the Burman Road and the Kempston Road Interchanges. These both have complex clover leaf type geometry and overpass bridges which cannot simply be bypassed using existing ramps. In addition, there is a large stormwater cannel running through both. This is clearly visible on image 11 below, which also shows the only possible bypass route which would entail the construction of ramps which would be very difficult to construct due to limited space. In between these two interchanges, the N2 crosses over Grahamstown Road and a series of railway lines and these two bridges would need strengthening or propping.

Image 11: Google Image Burman and Kempston Interchanges

The next obstacle is the Cadle Road overpass. This bridge will also require construction of bypass ramps as shown in Image 12. Immediately thereafter is the Uitenhage Road interchange which can be bypassed by means of the existing on and off ramps. This is followed by the Keeton Road underpass bridge, but this small bridge would not require propping.

Image 12: Google Image Cadle Road, Uitenhage interchange

The next interchange, Stanford Road, would be bypassed using existing ramps, but immediately following is an overhead pedestrian bridge which would require the construction of bypass ramps. Shortly thereafter the route crosses the Haworthia Road underpass, which bridge may require strengthening. These are shown in Image 13.

Image 13: Google Image Stanford interchange

The next interchange is the Disa Road interchange which can be bypassed using existing ramps.

Approximately 1.2km after Disa Road is the Kragga Kama interchange. This is shown in Image 14 below and it can be seen that there are three overpass bridges and a pedestrian bridge that obstruct the route along the N2. While it would be possible to bypass the first two bridges on the south side of the interchange, the developed erven are too close to the third and pedestrian bridge to enable bypass ramps to be built.

Image 14: Google Image Kragga Kama interchange

The only available alternative option is shown on Image 15 below. This route consists of a bypass road around the first interchange bridge, which will take the haul vehicle on to the old Cape Road, and then south along Kragga Kama Road as far as the intersection with Samantha Way. Road widening would be required here to enable the right turn into Samantha Way.

The route then continues to the Bramlin Road interchange at which point the haul vehicle can re-join the N2 via the existing on ramp.

Between the Bramlin and Seaview interchanges there are two further overpass bridges which would require the construction of bypass ramps.

The route then joins the red route from PE Harbour which is described elsewhere.

Image 15: Google Image Samantha Way

It is clear from this discussion that the route along the N2 includes a number of bridges, including the Swartkops River Bridge, and underpasses in the city of Port Elizabeth which would be extremely difficult and costly to bypass.

These are considered as fatal flaws for this route and it is not considered further in this report.

4.1.2 Uitenhage Route

The second available route from Nqura is via the town of Uitenhage and is shown in green in *Image* 16. Once out of the Port, the route crosses over the N2 (requiring temporary earthworks), a road-over-rail bridge and continues along Neptune Road. The route then travels north along the R102 and then west along the R334 (also known as MR460) up to the intersection with St Georges Street (the Addo Road - R335). This portion of the R334 is in very poor condition with large potholes and would require significant upgrading of the surfacing over a length of approximately 5,5km. Although it is still registered as a Provisional Main Road, it is seldom used at present. We have discussed the road with the Provisional Roads Department who advise that there are no plans to rehabilitate it in the near future. It is therefore unlikely that any Provincial funds would be made available should it be decided to upgrade this road for a haul road and the costs of upgrading will most likely be for Eskom's account.

The route continues along the R334 to the intersection with the dual carriageway R75 which bypasses Uitenhage on the way to Graaff Reinet.

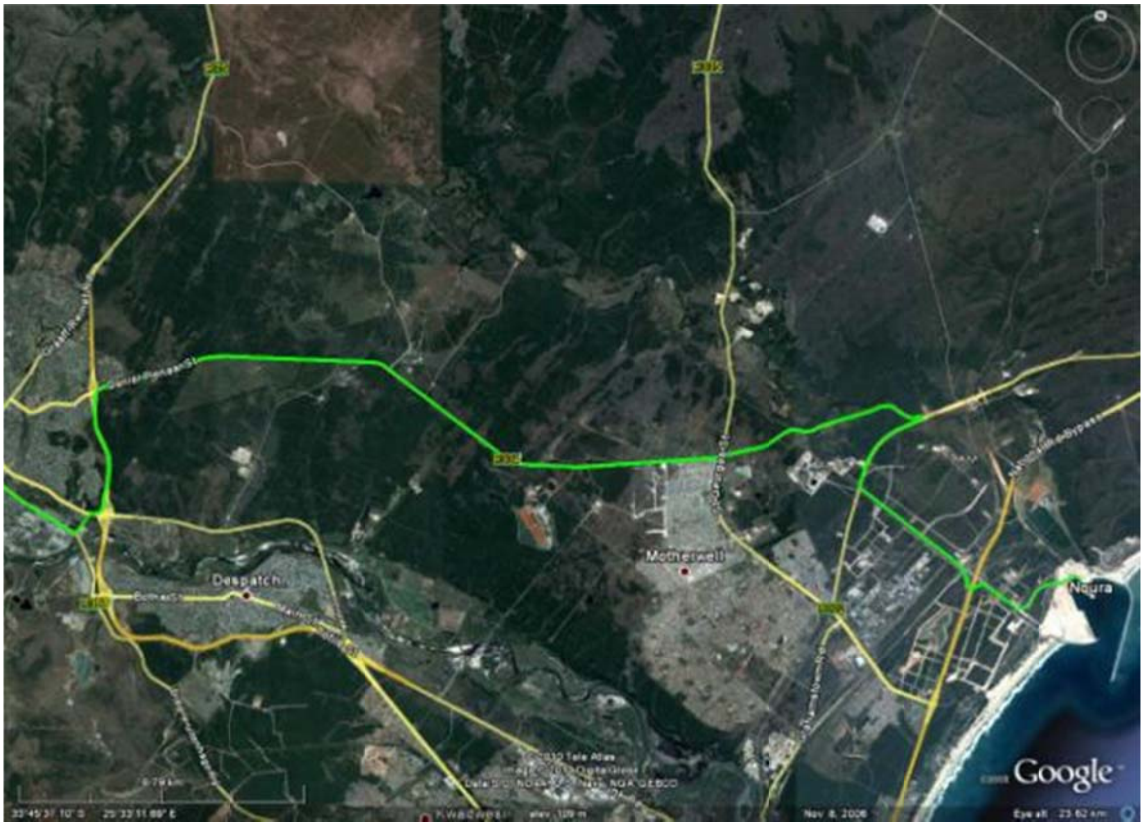


Image 16: Google *Image* Nqura to Uitenhage

In order to bypass the centre of Uitenhage which would present a number of difficult turns and intersections, the best route will be to turn south along the southbound carriageway of the R75 until the next interchange. At this point the haul vehicle would need to cross the median and exit the R75 on to the intersecting Union Avenue (also a dual carriageway) along the "on ramp". The route would then cross the median of Union Avenue and exit on to Marconi Avenue.

At the next intersection it could turn west onto Algoa Road through the heavy industrial area of Uitenhage. Algoa road has a number of speed bumps which would have to be removed and later replaced. It is an extremely busy road and it may be necessary to travel on a Sunday. The route would continue along Algoa Road which becomes Durban Street until it turns left into Cuyler Street. This left turn is very restricted by existing buildings and it may not be possible to turn the haul train here. It is seen as a fatal flaw to the Algoa Road route. This is all shown in green in *Image 17* below.

An alternative route to Algoa Road would be to continue along Marconi Street straight across Algoa Road around the south of the Volkswagen factory to meet with Mel Brookes Avenue (shown as the blue alternative in *Image 17* below). At the present end of Mel Brookes Avenue, an additional stretch of road, approximately 600m long, would have to be constructed to extend Mel Brookes to Cuyler Street. The route would then turn left and continue along Cuyler Street to Woodridge.

This extension to Mel Brookes has been on the Municipality's long terms road layout for many years and the cost of constructing it could possibly be shared with them.

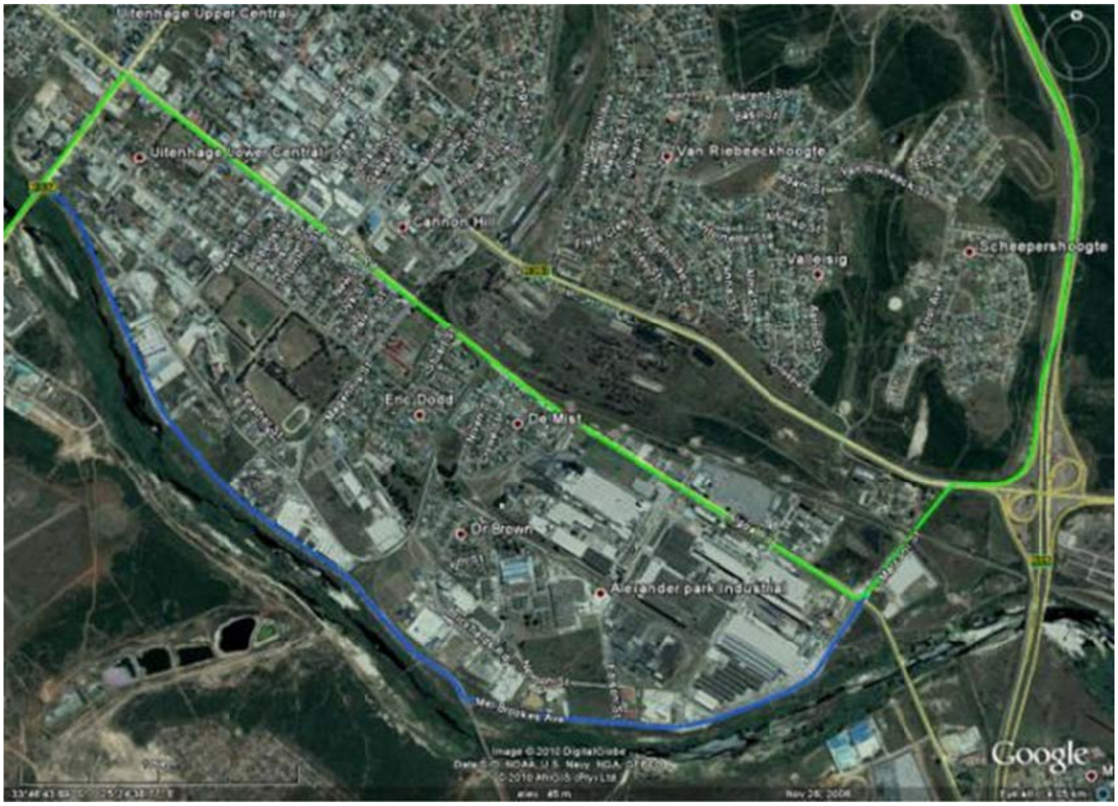


Image 17: Google *Image* Uitenhage

Cuyler Street is the continuation of the R334 and the route follows this south and west until it intersects with the R102 (Cape Road) and the N2 at Woodridge. The route crosses the Swartkops River as it leaves Uitenhage and this bridge can be propped if necessary. This portion of the route is shown in *Image 18* below.

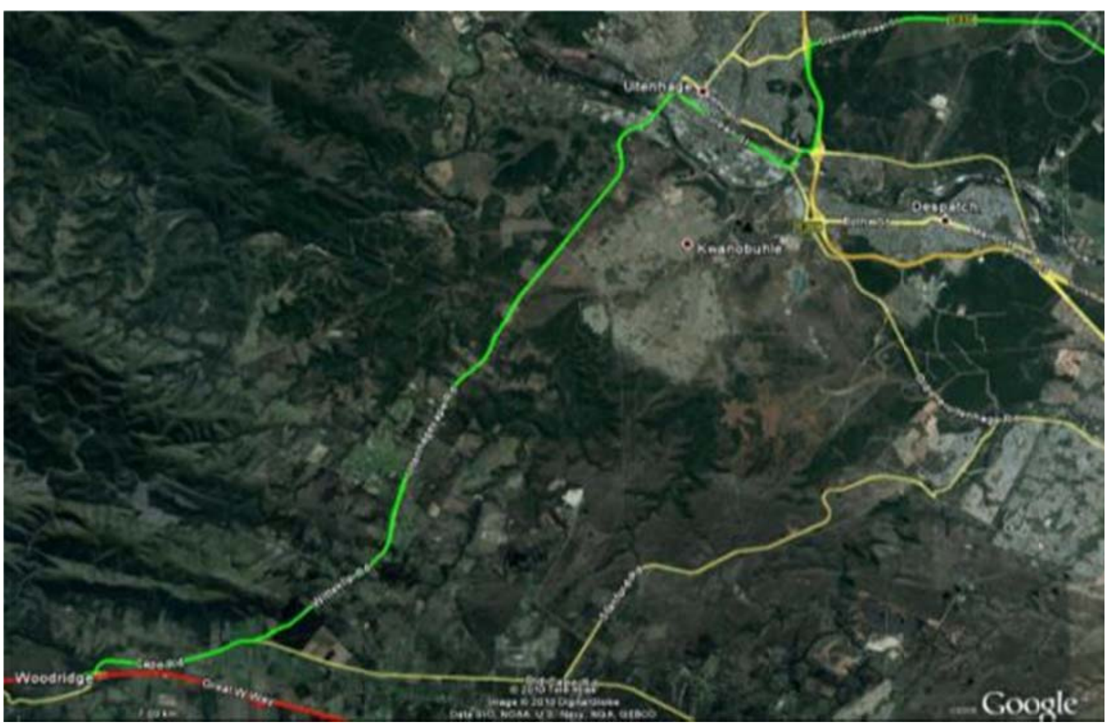


Image 18: Google *Image* Uitenhage to Woodridge

At the Woodridge interchange, the N2 travels over the R102 and the haul vehicle would need to enter the N2 against the normal traffic direction via the east bound off-ramp and then cross the median onto the west bound carriageway. This is shown below in *Image 19.*

Image19: Google Image Woodridge Interchange

4.2 PORT ELIZABETH HARBOUR TO N2 WOODRIDGE INTERCHANGE

4.2.1 Settlers Freeway system route

There are two main routes from the harbour out of Port Elizabeth, namely the foreshore Settlers Freeway system onto the N2, and the Heugh Road / Seaview route as shown in image 20. The Settlers Freeway route is however not considered suitable for the following reasons: (See image 21 and photos below.)

- Access onto the elevated Settlers freeway would not be possible from existing harbour exits
- Approximately 2 km of the freeway is an elevated bridge structure and would require structural checking and possible stiffening.
- Numerous road-over-road bridges exist on the Settlers freeway which cannot be bypassed using existing on and off ramps due to their complex alignment. Bypass ramps cannot be built due to lack of space and adjacent infrastructure. These are the Russell Road, Albany Road, Mount Road, North End and Burman Road Interchange.
- A large number of overhead freeway direction signs would have to be removed, some on concrete arch supports.
- Similarly numerous bridges and overhead signs would cause obstacles on the N2 portion of the route as discussed in section 4.1.1.

This route is considered fatally flawed and is not considered further.

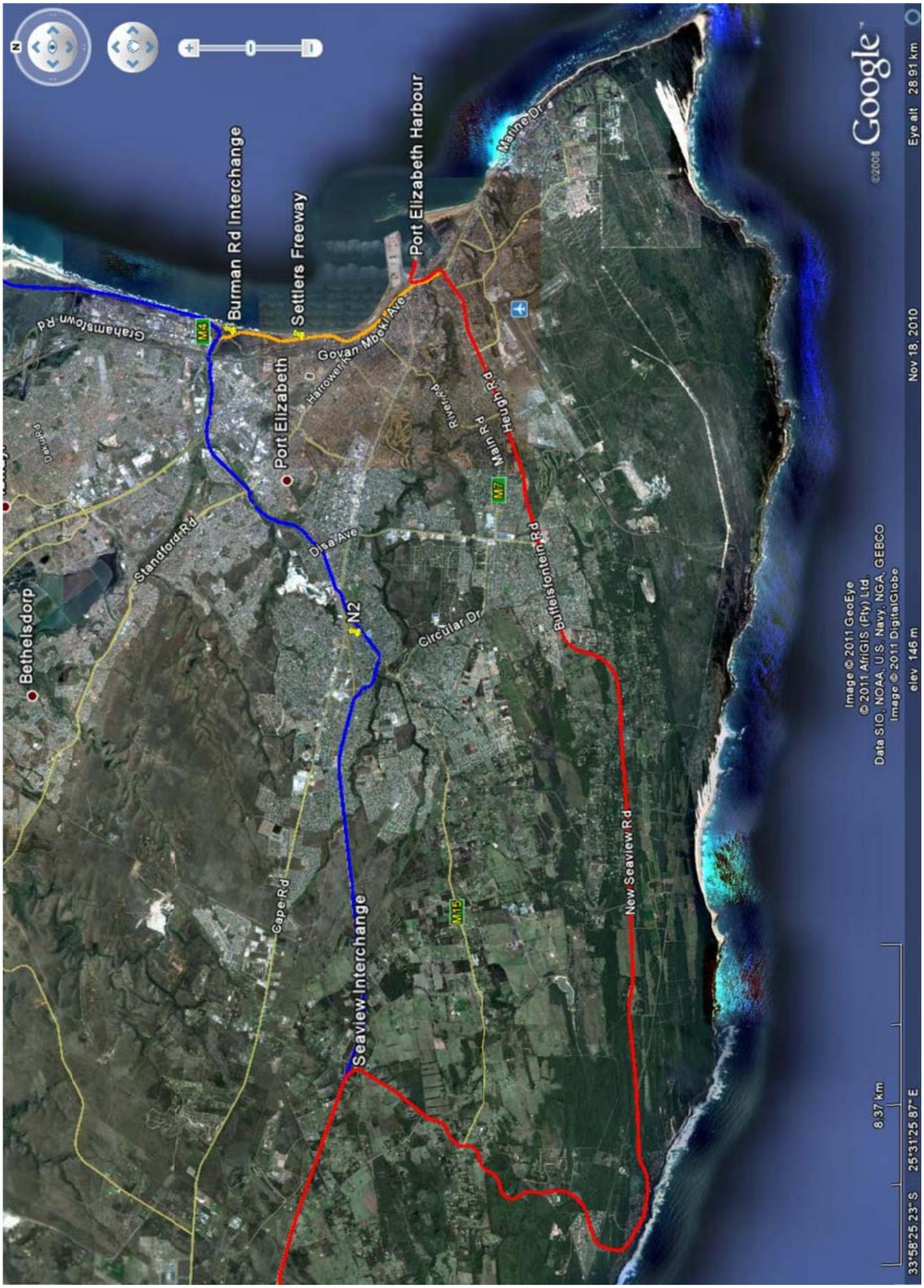


Image 20: Google image PE Harbour to Seaview

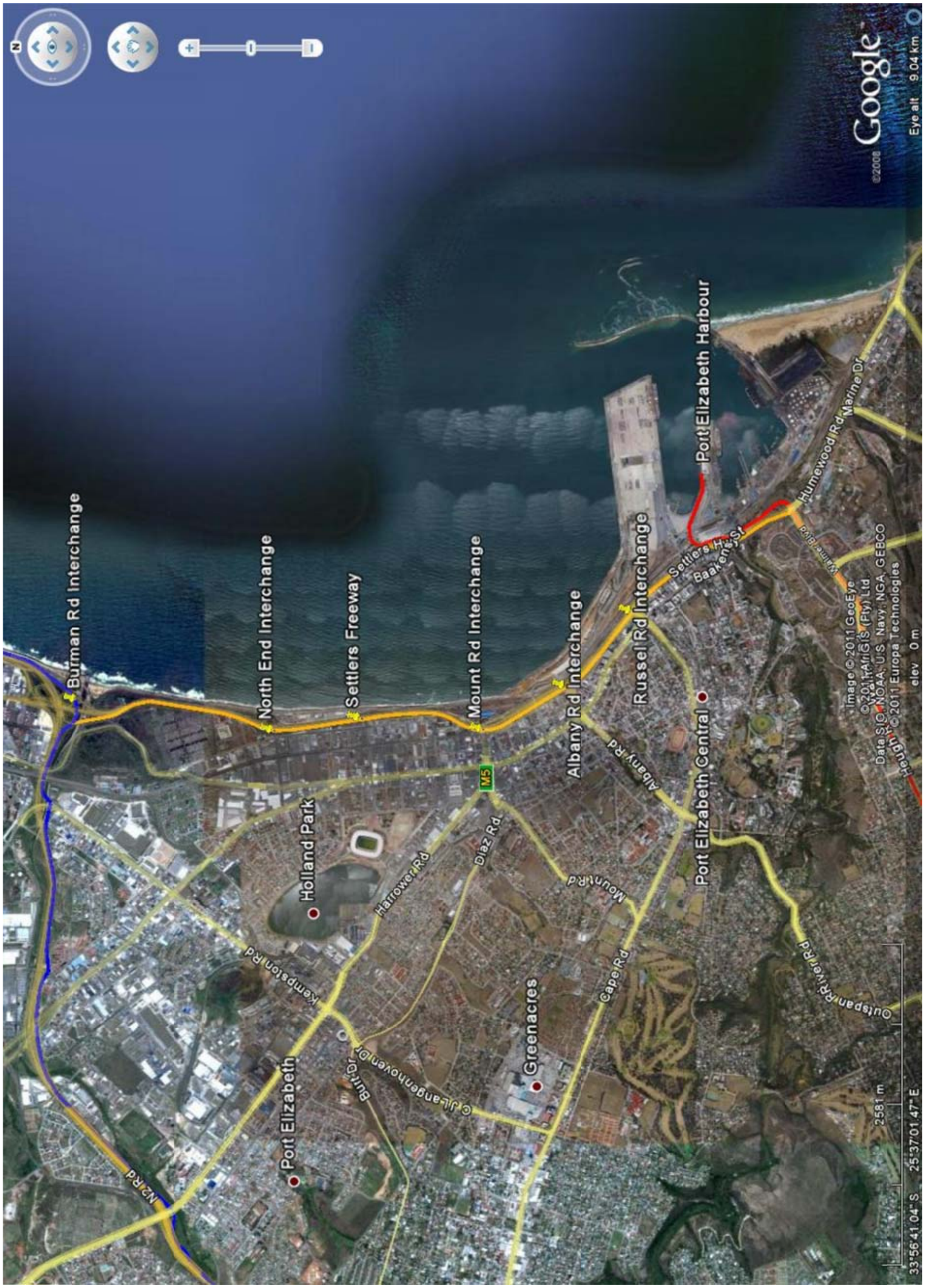
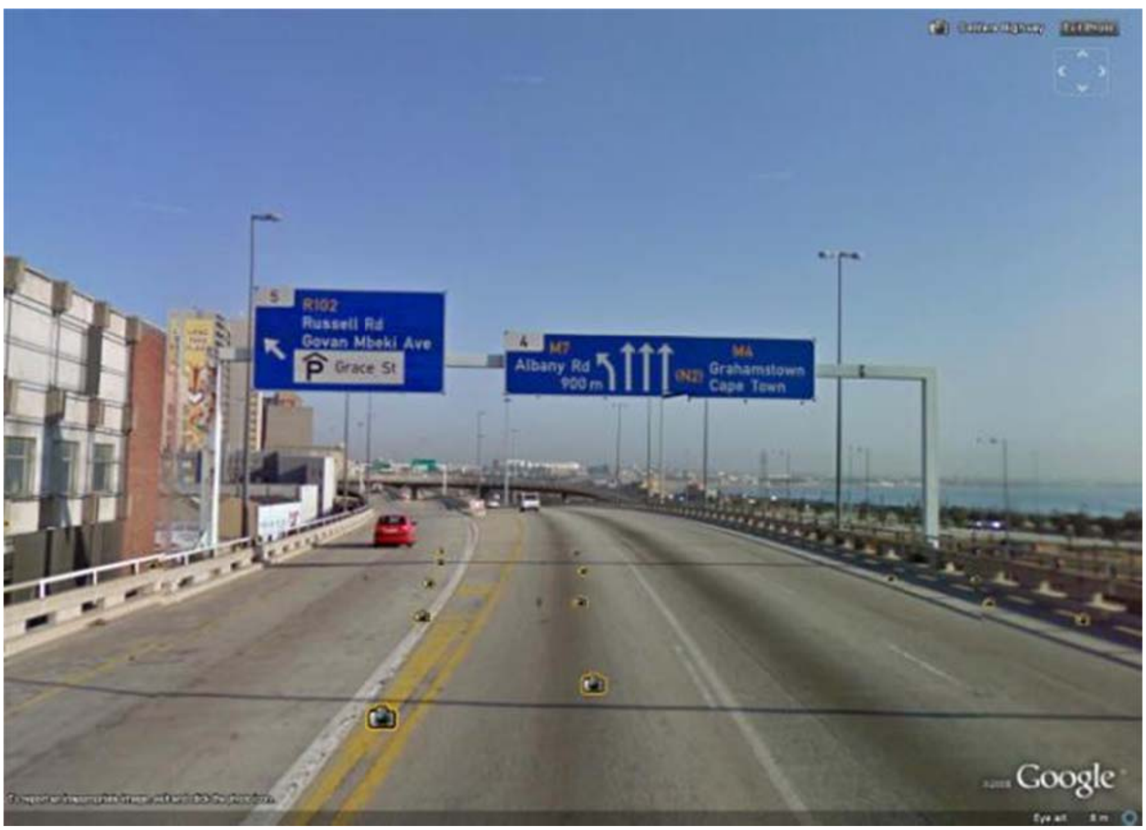


Image 21: Google Image Settlers Freeway

Proposed Harbour exit adjacent to elevated Settlers Freeway

Baakens Bridge and elevated Settlers Freeway

Elevated Settlers Freeway and typical interchange



Typical overhead sign

South Harbour exit and elevated Settlers Freeway

Campanile Harbour exit and elevated Settlers Freeway

4.2.2 Route via Seaview

The second available route from the PE harbour is via Seaview. Immediately after crossing the Baakens River outside the harbour, the route sweeps to the west onto Walmer Boulevard as shown in *Image 22* below.

This is a major road which travels straight westward through the city changing in name to Heugh Road, Buffelsfontein Road and eventually the Seaview Road in the suburb of Mount Pleasant.

The first 2.4 km up to 3rd Avenue Walmer have recently been upgraded and overhead power and telephone lines re-routed underground. The road is a dual carriageway to this point. After 3rd Avenue the road narrows to a two lane road but is in good condition and suitable for the heavy loads. From here onwards till it exits the City, there are numerous overhead electricity and telephone lines which would have to be raised, either temporarily for each load, or permanently if the cost warrants.

Image22: *Google Image PE to Mount Pleasant*

Up to the exit from the City, approximately 11 km from the harbour, this road is heavily trafficked. However, there are numerous alternative routes for the normal vehicles and management of re-routing the traffic around the moving haul vehicle should be relatively simple. Once out of the City, traffic is light up to the junction with the N2. There are no bridges or other major obstacles to this route with the exception of a large permanent advertising signboard in which will have to be removed. The route joins with the N2 at the Seaview Interchange. At this point, some minor roadworks will be required to widen the entrance onto the freeway on-ramp. This portion of the route is shown in *Image 23* below.

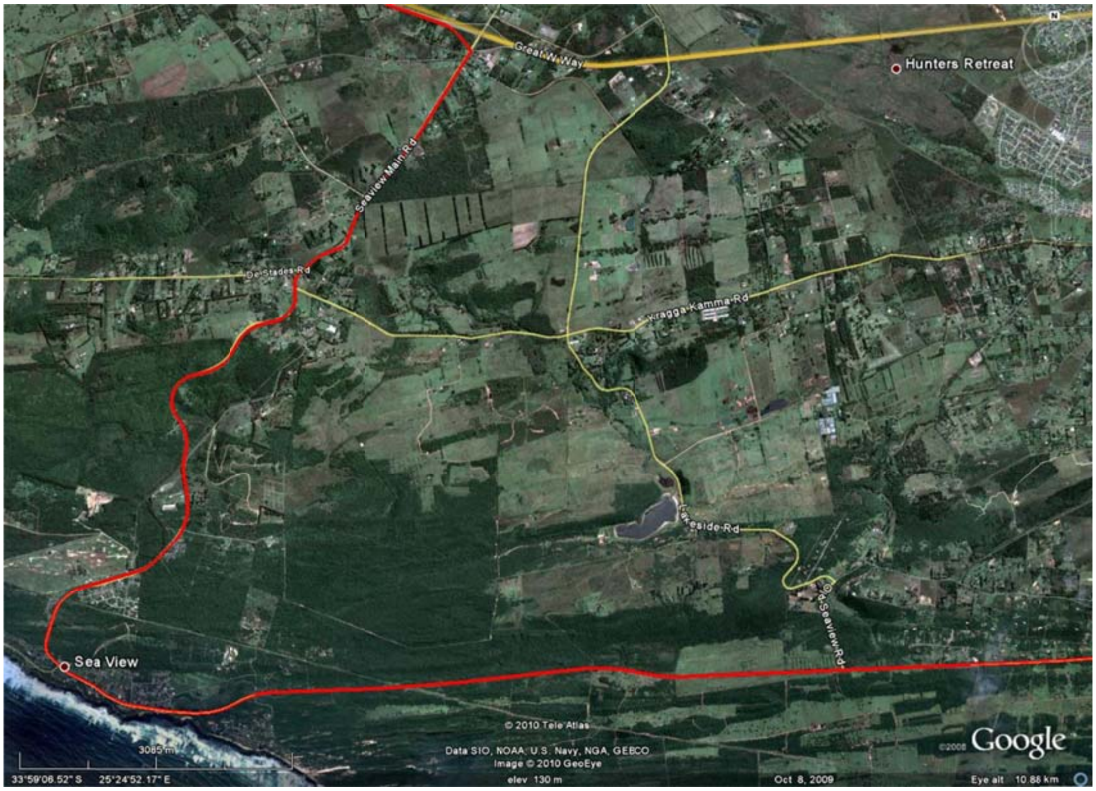


Image23: *Google Image Mt Pleasant to Seaview Interchange*

From the Seaview Interchange to the Woodridge Interchange the route is relatively straight forward along the N2. This portion of the route crosses the St Albans road at an interchange which can be bypassed using the existing off and on ramps. There are also two overpass bridges which will require bypass ramps to be constructed. These are discussed in detail in section 6.

We conclude from the discussions above that the red route from Port Elizabeth Harbour to the Woodridge Interchange on the N2 is the preferred route for the following reasons:

- **It is approximately 7 km shorter than the Nqura route**
- **Approximately 5.5 km of the Nqura route is in a very poor condition and will require extensive re-construction**
- **Approximately 0.6 km of new roadway will have to be constructed in Uitenhage**
- **The Nqura route passes through the busy Uitenhage industrial area**
- **The Nqura route crosses the Swartkops River Bridge which may need propping.**
- **The road from Uitenhage to Woodridge is narrow and very uneven. As it is the main route from the N2 to Uitenhage, it is also fairly heavily trafficked.**

4.3 WOODRIDGE TO THYSPUNT

The red route shown on the keyplan at the end of this section (drawing No's 402763-01-RDS-104 and 105) is one continuous route from the Port Elizabeth Harbour to Thyspunt. There are numerous alternative routes for sections of this route and these are discussed below.

4.3.1 Red Route (Woodridge - Kromme River – Sea Vista, St Francis Bay)

The route between Woodridge and the Jeffery's Bay East Interchange is common to all alternative routes. From the Woodridge Interchange, the red route travels along the N2 until it crosses the Gamtoos River. Shortly thereafter it leaves the N2 at the Jeffery's Bay East interchange and travels along MR389 to Humansdorp. This route has the major advantage of taking the haul vehicle off the N2 as soon as possible after crossing the Gamtoos River.

From a traffic management point of view, this route can be closed to normal traffic during the haul periods section by section, and the traffic can be diverted to and from Jeffrey's Bay via the East and West Interchanges while N2 through traffic will be unaffected. The number of bridges to be crossed is also less along this route than continuing along the N2 to Humansdorp. The Red route to Humansdorp includes three major bridge structures, namely the Kabeljous River Bridge, a road-over-rail bridge and the Swart River Bridge.

There is also a major traffic circle at the intersection with the R102, the main entrance to Jeffery's Bay, which contains a significant water feature in the centre island. Some road widening will be required at this point to allow the haul train to circumnavigate the circle.

In Humansdorp, there are a number of alternative streets that could be used to travel southwards through town, and on to the next leg of the journey to St Francis Bay.

The entrance to Humansdorp along Voortrekker Road is relatively wide and will enable the haul train to negotiate the 90° left turn into any of these streets. The area swept by the suspended load could, however, cut across the corners of the corner erven, which are not splayed, and some work will be required to clear the swept area. The first street encountered is Saffery Street (which was previously proposed), but our investigation has shown that there is a vertical dip at the intersection with Du Plessis Street which is too sharp for the haul train. The next street is Kemp Street which is marginally suitable. However it is in a poor condition and would require major upgrading. A number of trees would need severe trimming and some overhead telephone lines disconnected. The third street Birreau Street is too narrow. Finally this route could continue along Voortrekker Road to the intersection with High Street, which is the main street in the town. This is a wide street in good condition with few overhead cables. The turn into High Street is geometrically feasible but some traffic islands will need to be demolished and re-built later.

Image24: Google Image Humansdorp

The 90° left turn onto the St Francis Bay Road at the south end of High Street is possible with appropriate road widening and temporary encroachment onto the caravan park ground to the south. The entrance and boundary wall will be affected which will need to be partly demolished and re-built later. During haul periods through the town, traffic can be re-directed around the haul train via the existing street network and disruption to the traffic would be relatively minor.

In view of these discussions, in terms of existing streets, High Street is the recommended route through Humansdorp.

We note, however, that because of the probability of large numbers of transport vehicles that may move through Humansdorp to Thyspunt during the construction process, which would span a number of years, it is likely that a bypass road will need to be constructed to re-direct this traffic around the town. This is discussed in more detail in Section 6.

Between Humansdorp and St Francis Bay, there are 2 bridges on the MR381, the Seekoëi Bridge and the Kromme River Bridge. Both of these bridges may require strengthening as neither of them can be propped. Some additional work will be required on the Seekoei Bridge which has a crossfall of 10%.

Once past the Kromme River, the route continues southwards along MR381 past St Francis Bay to a point just south of Sea Vista Township, which is the start of the Eastern Access route to Thyspunt. The only obstacles along this portion of the route are the Sand River Bridge and the traffic circle at the entrance to St Francis Bay. The Sand River bridge consists of large standard box culverts, which can be propped if required. These props would be of a temporary nature and would be removed once the haul vehicle has passed. They would not therefore affect the river flow.

This portion of the road is the main access into, and past the town of St Francis Bay. Because it will probably be used as one of the main access routes to Thyspunt for construction and managerial staff living in Jeffery's Bay and St Francis Bay, it will be necessary to upgrade the road from the Kromme River to the Eastern Access road. At present the road is a two lane 8.6m wide Class 3 surfaced roadway and it should be upgraded to a Class 2 road standard, with turning and climbing lanes. In addition, a section of the road, approximately 500m long and on a steep rise as it passes St Francis Bay, was extensively damaged during flooding in 2007 and a temporary repair carried out at that time is still in use. However this section of the road is very vulnerable to any flooding that might re-occur and the road will have to be reconstructed, together with the installation of major storm water culverts to prevent a similar occurrence in the future.

4.3.2 Green Route – N2 Gamtoos to Humansdorp

With reference to the keyplan drawing 402763-01-RDS-105, the green route represents the N2 freeway. The haul route could follow this route right up to Humansdorp, but there would be four additional bridge structures to take into account than the Red route. The main disadvantage is, however, that the N2 is a high speed national route and it is desirable that the haul vehicles use this road as little as possible. The red route to Humansdorp is therefore considered more desirable.

4.3.3 Route 4 (Brown Route)

With reference to the keyplan drawing 402763-01-RDS-105, the brown route connects the MR389 (Red Route) to the MR381 to St Francis Bay using DR1767 and DR1768 past the farm Lombardini The main advantage of this route is that it bypasses Humansdorp. There are very few services that cross this route and it avoids the Seekoei River Bridge on the MR381, which may require strengthening. The Seekoei River is crossed on this route by means of a drift, which would have to be upgraded. The main disadvantage, however, is that the route is a gravel road which will have to be upgraded to a surfaced one which will be very costly.

4.3.4 Light Blue Route - Humansdorp to Thyspunt

With reference to the keyplan drawing 402763-01-RDS-105, the light blue route is an existing gravel road connecting Humansdorp to Oyster Bay. The existing tight horizontal and vertical alignment would need extensive upgrading to be able to accommodate the geometric constraints of the haul train, and the whole road, including a number of drifts, would need upgrading to 9m wide surfaced standard. This is a Provincial road and the upgrading of it is being investigated by the Provincial Roads Department at present. It is due to be upgraded within the next three years. However, the costs of improving the curvilinear alignment to abnormal haul vehicle standards would be prohibitive and this will not be done.

The main advantage of upgrading this route is that it avoids the crossing of the existing Seekoei and Kromme River bridges and it would also improve access to Oyster Bay. The Seekoei River is crossed by means of a drift at present, which would also be upgraded, probably to large culverts. The Kromme River is crossed by a low level bridge at present and a new bridge will be constructed during the upgrading.

This route will become the main construction haul and access route to Thyspunt but it will not be suitable for the abnormal haul route. For various reasons the last part of this route known as the Northern Access will not be built and the Western Access road, shown in purple, will be used instead.

4.3.5 Dark Blue Route – Humansdorp to Thyspunt.

In order to avoid travelling through the town of Humansdorp, a route (shown in dark blue on drawing 402763-01-RDS-105) was investigated which follows the Old Cape Road (MR389) westwards from Humansdorp, crosses the Kromme River at the tail of the Impofu Dam, then runs south east along the DR1762 to meet the light blue DR1763 from Humansdorp. The first 23 km of this route on MR389 is surfaced and is in good condition. The alignment is reasonable although some grades are fairly steep in places.

There are three bridges crossing the Seekoëi, Leeubos and Kromme rivers which would need propping. The Kromme Bridge is a long bridge and some spans are over deep water and may need strengthening. The next 18 km of the route is a gravel road which would need re-constructing to surfaced standard. Finally, the last portion of this route follows either the Northern or Western access road to Thyspunt.

This route would add approximately 29 km to the overall haul route. For this reason, coupled with the significant cost of reconstructing the additional 18 km of DR1762, this route has not been considered further.

4.3.6 Yellow Route (DR1762)

With reference to the Keyplan 402763-01-RDS-105, from MR381 just south of the Kromme River Bridge, the Yellow Route travels westwards on an existing gravel road up to the intersection with the Humansdorp - Oyster Bay Road (the Light Blue Route – DR1763).

The existing road is approximately 5m wide with a poor gravel surface. This road will require complete upgrading to a 9 m wide surfaced road standard. The existing alignment is generally acceptable and there are no bridges to cross.

The remaining route to Thyspunt is a continuation of the existing Oyster Bay road and the final approach to Thyspunt along the northern or western access forms part of a separate study together with other access roads to Thyspunt.

4.3.7 Red Route - St Francis Bay to Thyspunt

With reference to the Keyplan 402763-01-RDS-105, this route is the proposed eastern access road to Thyspunt. Details of the route will be addressed in a separate report dealing with access to Thyspunt but it is proposed as the main abnormal load haul route. The main advantage of this route over either the Light blue or Yellow routes is that it is the shortest length of road requiring construction. It is approximately 15 km long compared with the Yellow- Light Blue-Purple route which is 22 km long.

While the Blue and Yellow routes only require upgrading from gravel to tar roads and the Red route requires completely new construction, the latter will still be the most economical.

4.4 COSTS

4.4.1 General

In addition to the physical constraints imposed by the various alternative routes, it is also necessary to examine the comparative costs of the routes in order to arrive at the most economical as well as physically feasible route.

We have therefore carried out an approximate costing exercise on the various alternative routes. For the purposes of this report and the alternative comparison exercise, we have assumed that no propping of the large culverts will be necessary only the small bridges. This is because the span of even the largest culvert is relatively short compared to the length of the transport vehicle and consequently, the loading on the culvert will be relatively low. We have also assumed that the Gamtoos and Kromme River bridges will be externally strengthened.

At this stage, the Van Stadens River arch bridge is not included for two reasons. Firstly a check on its potential strength will be a costly exercise, as it essentially requires a complete re-design. Secondly it is a common bridge to all the alternative routes and will therefore not affect the comparison of the alternatives. (The preliminary structural investigation in Section 5 of this report indicates that although some strengthening of the columns may be necessary, the structure will be adequate)

Although the costs given in this comparison are relatively rough estimates, the results of the comparison exercise are clear and in terms of choice of the preferred route, more accurate costing is unlikely to change the resultant choice. The preferred route is costed in more detail later.

4.4.2 Cost Comparison

The cost comparison of the alternative routes is based on the following basic cost assumptions.

Table 3: Cost comparison assumptions

Minimum surfaced road width – 6m	
Construction of new roads, e.g. St Francis Bay to Thyspunt (Eastern Access) would consist of four - 3,75m wide lanes and 0,6m gravel shoulders i.e. surfaced road width of 15,0m.	R11,5million per km
Construction of completely new two lane road	R8 million per km
Upgrading of existing gravel road to temporary surfaced standard for haul only	R4 million per km
Construction of new on and off ramps at overhead bridges on N2	R6 million per set
Alterations to traffic circle	R200 000
Lifting of minor electrical and Telkom overhead lines	R10 000 each
Dealing with major Eskom overhead lines	R100 000 per crossing
Propping of bridges	R100 000 each
Design check on bridges	R100 000 each

Details of these cost comparisons are included as Annexure D and the results are shown in the table below:

Table 4: Results of cost comparisons

Route	Description	Comparative Cost
Green and Red	Nqura to Woodridge - to Jeffreys Bay East Interchange	R 51 350 000
Red	PE to Woodridge to Jeffreys Bay East interchange	R 49 240 000
Comparison of Routes from Jeffrey's Bay East Interchange to Thyspunt		
Red	To Kromme - Red to Sea Vista and Red to Thyspunt	R158 660 000
Green – Red	Along N2 to Humansdorp - Red to Sea Vista - Red to Thyspunt	R168 060 000
Green – Mauve	To J Bay West - Mauve to Fountains - Red to Kromme - Red to Sea Vista - Red to Thyspunt	R168 810 000
Red – Brown	J Bay East - Brown Lombardini - Red to Sea Vista - Red to Thyspunt	R180 730 000
Red – Light Blue	J Bay East to Humansdorp, Light Blue to Thyspunt	R188 830 000
Red – Dark Blue	J Bay East to Humansdorp, Dark Blue to DR1763, Light Blue to Thyspunt	R237 480 000
Red – Yellow	To Kromme - Yellow and Light Blue to Thyspunt	R193 570 000

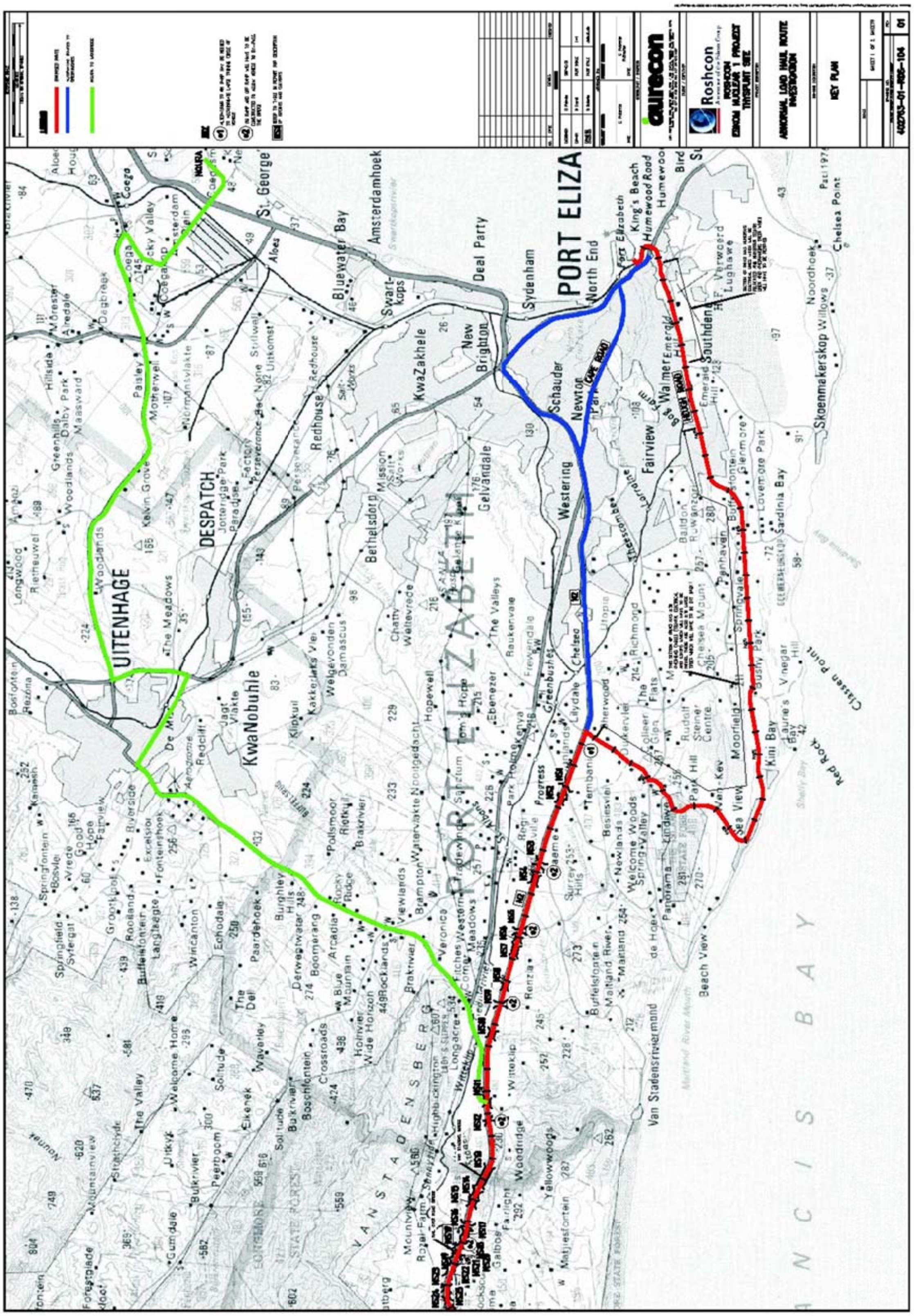
4.4.3 Conclusion from cost comparison

From the above discussions we conclude that the preferred route for loading and transporting the heavy equipment destined for the Thyspunt site is as follows:

- **While both Nqura and Port Elizabeth harbours are suitable for loading and offloading the equipment, and that, in fact, Nqura is the better of the two, Port Elizabeth is the preferred harbour because of the exit routes through the city to the N2 at Woodridge.**
- **The preferred route through the City is along Walmer Boulevard, Heugh Road, Buffelsfontein Road, Seaview onto the N2 at the Seaview interchange.**
- **From Seaview interchange along the N2, across the Gamtoos river to the Jeffreys Bay East interchange.**
- **From Jeffreys Bay East to Humansdorp along MR389.**
- **Construct a new bypass between Voortreker Road and Park Street in Humansdorp.**
- **From Humansdorp to St Francis Bay along MR381.**
- **From St Francis Bay to Thyspunt along the Eastern Access.**

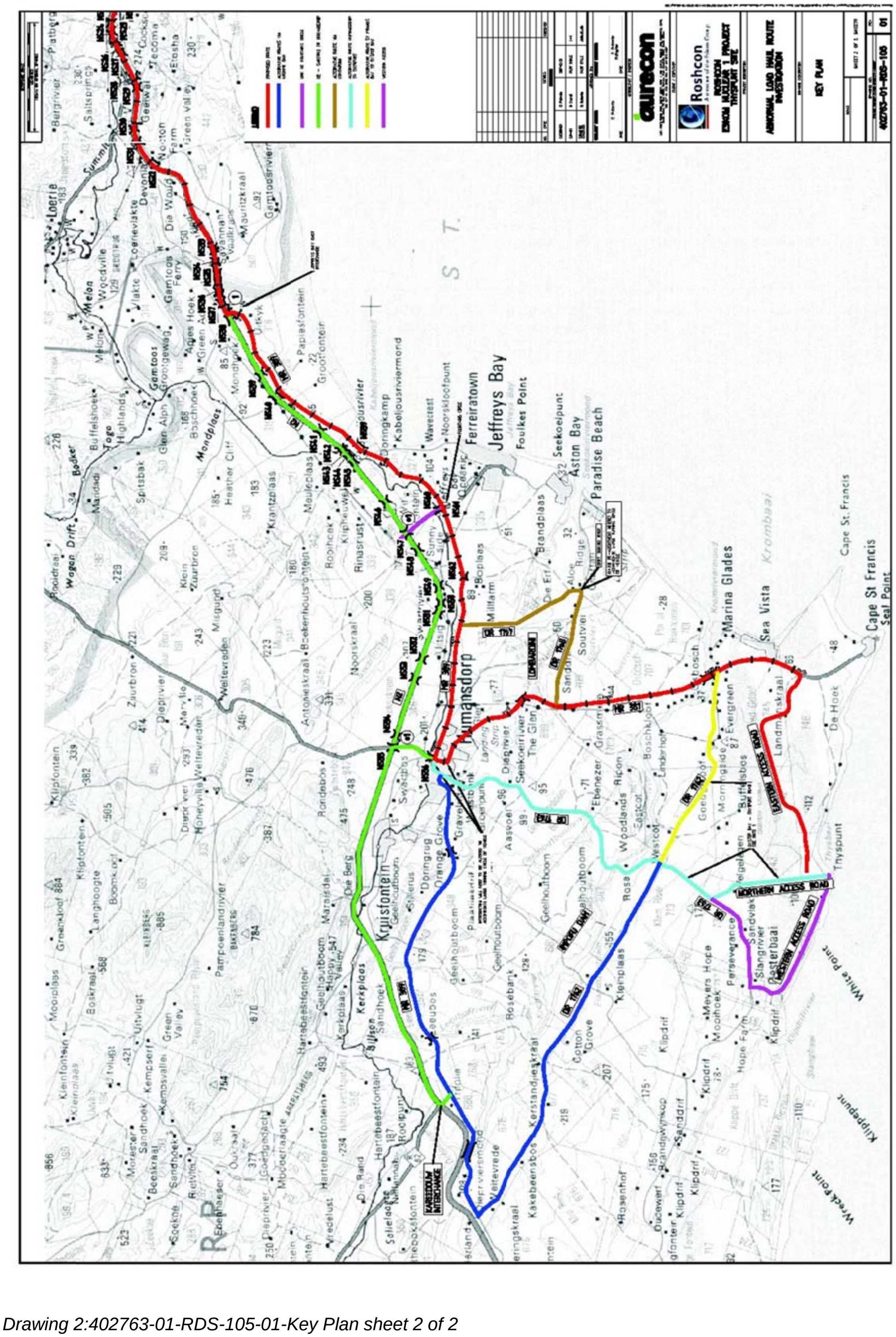
This route has been chosen as it is the most economical, will disrupt traffic the least and requires the least road improvements and bridge strengthening.

A detailed description of the route follows in section 6.



Drawing 1: 402763-01-RDS-104-01-Key Plan sheet 1 of 2

Note that this drawing is provided as a PDF and is best viewed as an A3 size.



Drawing 2:402763-01-RDS-105-01-Key Plan sheet 2 of 2

Note that this drawing is provided as a PDF and is best viewed as an A3 size.

5. BRIDGES INVESTIGATION

5.1 STRUCTURAL CAPACITY INVESTIGATION

The structures on the proposed heavy haul route were checked for fatal flaws only. Structures that could therefore be propped were not considered in this investigation as they would not constitute a fatal flaw. Structures on both the proposed red and green alternative routes were investigated.

5.1.1 Loads to be transported

A list of typical components required for the nuclear power facility was provided for the purpose of this investigation. The heaviest load is the steam generator at 628.3 t and this load (rounded to 650 t) was used in this investigation.

5.1.2 Transportation Vehicle

The present loading for road structures include an abnormal vehicle load (NC loading) of 40 m long, 5 m wide with a uniformly distributed load of 30 kN/m^2. The loading code used at the time when most of the structures on this route was constructed (late 1960's to early 1970's on the National Route 2) did not include a load equivalent to the NC loading. It was therefore assumed that the possibility that these structures could withstand a uniformly distributed load of more than 30 kN/m^2 would be remote and vehicle configurations with higher loads were therefore not considered.

There are numerous configurations of the transport vehicle that could be used and it is important to note that whatever vehicle is chosen it should distribute the load evenly, and such that the resultant loading on the road does not exceed 30 kN/m^2. We also note that here that the 30 kN/m^2 should not be seen as the absolute maximum that the structure can withstand, as there are a number of safety factors that are inherent in the design process over and above the applied vehicle load. These factors allow for uncertainly of the sizes of actual future loads, as well as for uncertainties in the actual strength of materials used to construct the structure. In the case of the NC load, for example, an additional 20% is added to the design load for analysis purposes. Consequently, the overall level of safety is in excess of 20%, even with the full 30 kN/m^2 vehicle load.

For the purpose of this investigation a 5.6 m wide 27 axle trailer was considered with axles spaced at 2.05 m. The weight of the trailer is 155.25 t and an additional allowance of 50 t was made for spreader beams in order to distribute the load. A total weight of 650 + 155.25 + 50 = 855.25 t was therefore used. This load is distributed over 5.6 m wide by 53.3 m long giving a uniformly distributed load of 28.65 kN/m^2.

Any vehicle providing a uniformly distributed load less than the assumed vehicle would have a lesser effect on all the structures except maybe the Van Stadens River Bridge.

5.1.3 Methodology

Only a limited number of design or as-built drawings could be obtained for the relevant bridges and some were not of a very good quality. It was therefore decided to compare the propose load with the original design load. The original design load was obtained from the then road authority; the Cape

Provincial Administration Department of Roads' "Code of Procedure for the Design of Provincial Bridges and Culverts" dated January 1971.

This code was a metric version of the same code that was in use since 1958. This code contained two loading configurations for bridges:

- Normal Bridge Live Loads – This loading consists of a uniformly distributed load depending on the loaded length, acting together with a knife edge load of 40 kN per meter acting perpendicular to the traffic direction.
- Abnormal Bridge Live Loads – This loading consists of a design vehicle with four axles spaced 2 m, 6 m and 2 m apart. Each axle consists of four wheels spaced 1 m apart. The load of each wheel is 90 kN.

It was assumed that the bridges were designed to at least resist the loading in this code with some reserve strength. The relevant bridges were modelled and loaded with both the loads from the design code and the proposed abnormal load.

The calculated moments, shear forces and torsion was then compared between the two loads and conclusions drawn.

Using the load comparison method for evaluating the existing structures is inherently conservative since no allowance is made for spare capacity of the structures. For the purpose of this report, and based on previous experience, it was assumed that the structures have spare capacity of 20% as far as bending and shear is concerned. If it was found that the overstress (proposed new load versus original design load) in the tables below is less than 20%, we conclude that strengthening would more than likely not be required. The torsion results were generally low and even high overstress percentages were not seen to be critical in most cases.

We believe this approach to be reasonable for the fatal flaw study in order to determine the preferred route. Once the route has been finalised, we will attempt to obtain additional information on the affected structures by means of either additional design drawings or field measurements.

5.2 RED ROUTE

The bridges that cannot be propped on this route are discussed in more detail below:

5.2.1 Van Stadens River Bridge

The Van Staden's river bridge is approximately 350m long, with its central section supported on a concrete arch spanning 198m. The deck consists of 21 spans of approximately 16,7m, made up of precast beams, interconnected with transverse diaphragms and deck slab, and made continuous over the supporting columns. These are supported either on the arch, or on the valley slopes on either side.

The deck is 26m wide, and carries 2 carriageways, separated by a 900mm wide median. The abnormal vehicle will therefore be unable to travel along the centreline of the bridge

Drawings of this bridge could not be provided by the relevant road authority (South African National Road Agency), but some drawings could be sourced from the original design engineers. The drawings were sufficient to accurately show the structural system and the concrete dimensions, but did not have any reinforcing details. The effects of the proposed load were therefore compared to the original design load.

Due to the large and complex computational effort required for this bridge, only a check on the arch, which is the most critical element of this bridge, has been completed. Other elements, such as the deck and columns can be relatively easily strengthened, if required, and they do not therefore constitute a fatal flaw.

Table 5: Van Staden's River Bridge Results on arch.

Position on Arch	Design Load	Axial Force	Maximum Moment	Maximum Shear	Maximum Torsion
Springing Point	27 Axle Trailer	28378	34000	2663	2439
	Original Design Load	28588	30000	2248	1816
	% Overstress	-	13,3%	18,5%	34,3%
Span	27 Axle Trailer	20990	19966	2503	2325
	Original Design Load	20470	20166	2130	1608
	% Overstress	2,5%	-	17,5%	44,6%

Based on the above, it is very unlikely that the arch will need to be strengthened to increase axial load capacity, bending, shear or torsion resistance.

5.2.2 Gamtoos River Bridge

The Gamtoos River Bridge consists of 14 simply supported spans of each 31.9 m long. The deck consists of eight precast, prestressed beams spaced approximately 1.7 m apart. The deck is supported on solid wall type piers and closed abutments.

Since the decks are simply supported, only one span needs to be analysed. The drawings that were obtained from the road authority are not very clear and most of the details and dimensions were illegible. The dimensions of the deck were scaled from the drawing and together with dimensions taken on site, were used to model this bridge. The results are summarized in Table 6 below:

Table 6: Gamtoos River Bridge results.

Design Load	Maximum Moment	Maximum Shear	Maximum Torsion
27 Axle Trailer	7049	944.1	116.1
Original Design Load	6616	823.2	106.6
% Overstress	6.5%	14.7%	8.9%

Based on the above findings it is unlikely that the bridge would have to be strengthened to increase moment or torsion capacity. The shear capacity can be increased by adding vertical steel bands near the supports.

5.2.3 Kabeljous River Bridge on MR 389

This bridge is a four span simply supported bridge with an in situ beam and slab deck. The deck with four beams is supported on solid wall type piers and closed abutments. Only one span needs to be evaluated.

No as-built drawings could be obtained for this bridge and measurements on site were used to model the structure. The results are summarized in Table 7 below:

Table 7: Kabeljous River Bridge on MR 389 results.

Design Load	Maximum Moment M	aximum Shear	Maximum Torsion
27 Axle Trailer	2613	582.1	27.4
Original Design Load	2174	457.9	3.9
% Overstress	20.2%	27.1%	602.6%

Based on the above findings this bridge would have to be strengthened to increase the moment, shear and torsion capacity. This can be done by providing steel plates on the soffit on the beams and vertical steel bands near the supports.

5.2.4 Swart River Bridge on MR 389

This bridge consists of three simply supported spans consisting of concrete arches. It appears as if the bridge was widened at a later stage. A concrete arch is a very effective structural system where the loads are resisted more with axial forces in the arch instead of bending and shear.

No as-built drawings could be obtained for this bridge and the structure was modelled by means of measurements taken on site. The results of the analyses can be seen in Table 8 below:

Table 8: Swart River Bridge on MR 389 results.

Effect of 27 axle trailer	Maximum Moment (kNm)	Associated Axial force (kN)	Concrete Stress (MPa)	
			Top	Bottom
Sagging Moment	84.42	476.1	1.767	0.915
Hogging Moment	44.63	557.0	1.647	2.395

From the above results it can be seen that the arch never goes into tension under the proposed load. It is therefore not required to evaluate the original design load. No strengthening is required for this bridge.

5.2.5 Seekoei River Bridge

This bridge consists of three simply supported spans of 26.5 m each. The deck consists of 5 precast beams with an in situ deck slab. The deck is supported on wall type piers and closed abutments. Only one span was evaluated.

No as-built drawings could be obtained for this bridge and it was modelled by means of dimensions measured on site. The results can be seen in Table 9 below:

Table 9: Seekoei River Bridge results.

Design Load	**Maximum Moment M**	**aximum Shear**	**Maximum Torsion**
27 Axle Trailer	7508	1186	135.6
Original Design Load	7060	1049	99.41
% Overstress	6.3%	13.1%	36.4%

Based on the above findings it is unlikely that the bridge would have to be strengthened to increase moment capacity.

The shear and torsion capacity can be increased by adding vertical steel bands near the supports.

5.2.6 Kromme River Bridge

This bridge consists of 11 simply supported spans of 26 m each. The deck consists of 6 precast beams with an in situ deck slab. The deck is supported on wall type piers and closed abutments. Only one span was evaluated.

No as-built drawings could be obtained for this bridge and it was modelled by means of dimensions measured on site.

The results can be seen in Table 10 below:

Table 10: Kromme River Bridge results.

Design Load	**Maximum Moment M**	**aximum Shear**	**Maximum Torsion**
27 Axle Trailer	6552	1075	108.2
Original Design Load	6044	925.3	67.1
% Overstress	8.4%	16.2%	61.3%

Based on the above findings it is unlikely that the bridge would have to be strengthened to increase moment capacity. The shear and torsion capacity can be increased by adding vertical steel bands near the supports.

5.3 GREEN ROUTE

The green route includes the Van Stadens and Gamtoos River Bridges, but crosses alternative bridges over the Kabeljous and Swart Rivers on the N2. These bridges are discussed in more detail below:

5.3.1 Kabeljous River Bridge on N2

This bridge is a one span bridge with a deck consisting of 8 precast, pre-stressed beams and an in situ slab. The deck is supported on closed abutments.

As-built drawings were obtained for this bridge. The effects of the proposed load was compared with the original design loads and the ultimate moment capacity was checked in order to determine the reserve capacity.

The results are summarized in Table 11 below:

Table 11: Kabeljous River Bridge on N2 results.

Design Load	**Maximum Moment M**	**aximum Shear**	**Maximum Torsion**
27 Axle Trailer	17679	1616	107.7
Original Design Load	15619	1392	66.98
% Overstress	13.2%	16.1%	60.1%

The ultimate moment capacity was calculated as 27 500 kNm and is well in excess of the moment due to the proposed load. This can be expected with prestressed beams which were most likely designed to have no tension stresses under live loading.

Based on this comparison this bridge would not have to be strengthened.

5.3.2 Swart River Bridge on N2

This bridge is a four span simply supported bridge with a deck consisting of 8 precast beams and an in situ slab. The deck is supported on closed abutments.

No as-built drawings could be obtained for this bridge. From measurements taken on site, the beams are similar to those used at the Kabeljous River Bridge. The dimensions of that bridge were therefore used, together with measurements taken on site, to model this bridge deck.

The results are summarized in Table 12 below:

Table 12: Swart River Bridge on N2 results.

Design Load	**Maximum Moment M**	**aximum Shear**	**Maximum Torsion**
27 Axle Trailer	11966	1351	82.76
Original Design Load	11135	1203	59.64
% Overstress	7.5%	12.3%	38.8%

Based on the above findings and the findings for the Kabeljous River Bridge, this bridge is unlikely to require any strengthening.

5.4 SUMMARY

Based on the above investigation, no fatal flaws could be identified.

Both routes would be possible, with only the Kabeljous River Bridge on MR 304 requiring substantial strengthening on the Red route.

When the detailed analysis is performed, more effort will be made to obtain as-built drawings of the relevant bridges. The final design of any strengthening can then be performed based on the actual strength of the bridges. If no further information can be obtained, the strengthening of the bridges will be designed for the difference in effect between the proposed load and the original design load.

A more detailed discussion on bridge loading criteria is included as Annexure I.

6. DETAILED DESCRIPTION OF PREFERRED ROUTE

6.1 PORT ELIZABETH HARBOUR AND EXIT

As discussed in the report on the Port handling feasibility assessment, the heavy equipment will best be imported on specialist ships with their own heavy cranes.

The road haul train will be positioned alongside the quay and the ships own lifting gear will place the equipment directly onto the road trailer.

The preferred quay for this operation is quay 8. This quay is largely unused but is clear and has a direct access onto the exit route.

Image 25 below shows the proposed exit route. This route is not completely clear and the following work will be required to allow free movement of the haul vehicle.

- Replacement of Palisade fencing with removable sections
- Levelling of roadways over the railway tracks
- Temporary removal of overhead electric locomotive power lines
- Construction of a ramp to access the City road system

Image25: Preferred Harbour Exit Route

6.2 HARBOUR TO MOUNT PLEASANT

Once out of the port the route immediately crosses the Baakens River bridge. This bridge might have to be propped but this will be a relatively simple exercise in this case as there is still concrete bedding on the rock left over from the original construction. The road then sweeps to the right in a wide curve and enters Walmer Boulevard as depicted in *Image 26* below.

Image26: Google Image Walmer Boulevard Intersection

The route then runs straight through the suburb of Walmer along Walmer Boulevard, Heugh Road, Buffelsfontein Road which is a major arterial route through the city. The first 2,4 km of this route have recently been upgraded to a 4-lane carriageway but for the next 4 km it is a 2-lane 8m wide carriageway.

Note that a short section (130m) of Walmer Boulevard has a gradient of 7.8%

There are numerous overhead electricity and Telkom cables which will have to be raised or temporarily removed and these are listed in *Annexure C.* From Km 7 to Km 8 the road has again been recently upgraded to 4-lane carriageway after which it continues as an 8m wide 2-lane road.

Advertising Board

At approximately Km 7 there is a new overload advertising board which will have to be partially dismantled when a load >6m high is being transported.

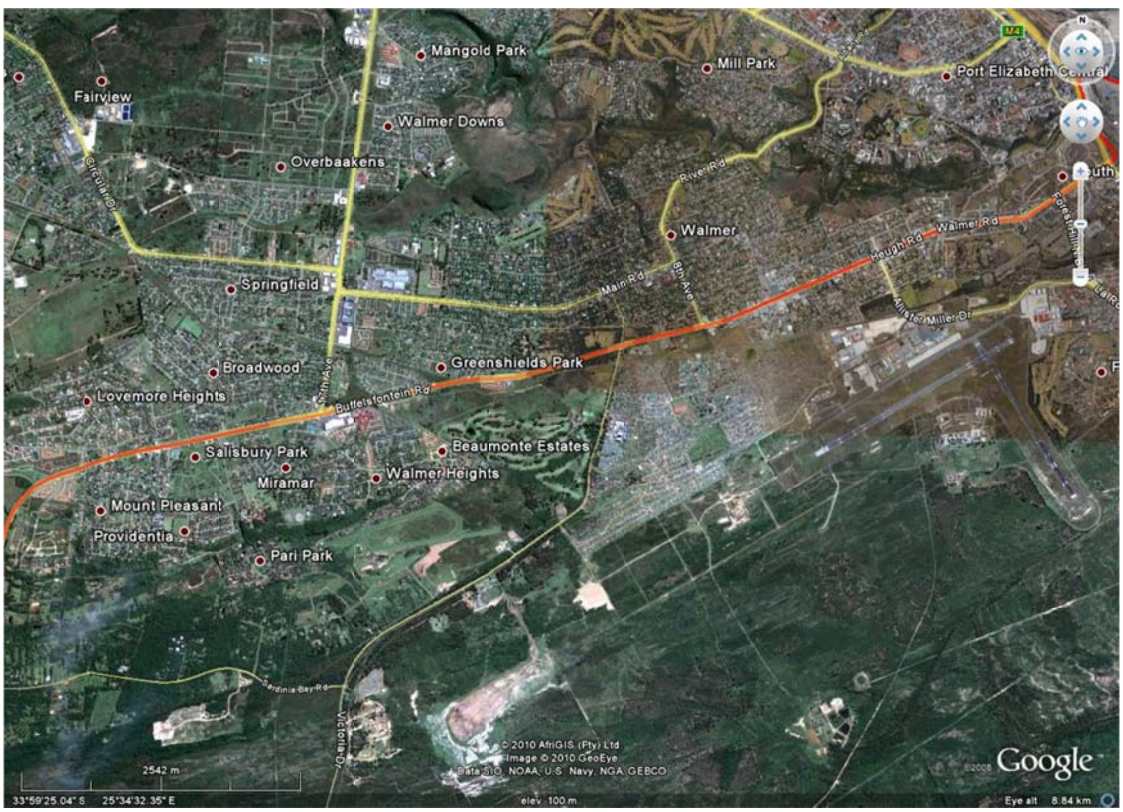


Image27: Google Image Walmer to Mount Pleasant

This road exits the city at Km 10 and is for the most part flat and straightforward. Diversion of traffic within the city will be relatively simple as there are numerous side roads and alternative routes for the traffic.

6.3 MOUNT PLEASANT TO SEAVIEW INTERCHANGE

From Km 10 for the next 20 km the road travels along the coast and through the suburb of Seaview after which it turns inland and eventually meets the N2 national route to Cape Town at the Seaview interchange.

Here the route enters the N2 via the existing on-ramp. Some minor road widening of the entrance to this ramp will be required to accommodate the large turning radius of the haul train.

Image28: Google Image Seaview Interchange

6.4 SEAVIEW TO WOODRIDGE

Approximately 6 km after the Seaview interchange, the N2 crosses over the St Albans/ van Stadens Mouth road at the St Albans interchange. The bridge can be by-passed by using the exiting off and on interchange ramps.

Image29: Google Image St Albans Interchange

Approximately 2.9 km after the St Albans interchange the N2 is crossed by an overhead road bridge (the Draaifontein Road). This is not an interchange, and bypass ramps will have to be constructed to accommodate loads higher than 5.5m.

A Google *Image* of these ramps is shown below and a preliminary design drawing showing the longitudinal section along the bypasses is shown on drawing no. 402763-01-RDS-112 in *Annexure E.*

Image30: Google Image Draaifontein bypass

We note that these ramps and others along the N2 will not be required by the National Roads Agency for future interchanges and will therefore be a temporary installation. In order to prevent use of these ramps by the public as they will not be to full National Road Agency design standard we propose that guardrails be installed across the mouths of the ramps on the crossing road and that when the haul train arrives sections of these guardrails can be unbolted until the haul train has passed and then replaced.

Approximately 3.4 km after the Draaifontein bridge a Local Service Road crosses over the N2 (Km 49.7.) Again, temporary ramps will have to be constructed to bypass this bridge as shown below and a preliminary design and longitudinal section of this bypass is shown on drawing no. 402763-01-RDS-113 in *Annexure E.*

Image31: Google Image Km 49.7 bypass

Approximately 4.5 km further the route reaches the intersection with the old Cape Road at the Woodridge interchange. The N2 crosses over Cape Road on a bridge but to avoid any propping or strengthening the haul train can use the on and off ramps of the interchange so no work is required here.

Image32: Google Image Woodridge Interchange

6.5 WOODRIDGE TO GAMTOOS RIVER

Approximately 1 km after the Woodridge interchange at Km 55.2 the N2 passes under a local overpass bridge leading from Woodridge to the Van Stadens Protea Flower Reserve.

Two bypass ramps will be required to bypass this bridge as shown below and detailed on drawing no. 402763-01-RDS-114 in *Annexure E*.

Image33: Google Image Protea Reserve bypass

Approximately 2 km further on at Km 57.2 the N2 crosses over the Van Stadens River on the Van Stadens gorge arch bridge. From preliminary analysis as stated previously in Section 5 the columns supporting the bridge deck may need strengthening and bracing.

Image34: Van Stadens River Bridge

Approximately 2.7 km after the Van Stadens gorge bridge at Km 60, the N2 passes under the R102 to Thornhill at the Thornhill interchange. Again no work is required here as the haul train can use the off and on ramps of the existing interchange.

Image35: Google Image Thornhill interchange

Approximately 1.3 km after the Thornhill interchange the N2 passes under the Apple Express railway line. This crossing will require the construction of a bypass ramp as shown below and detailed on drawing no. 402736-01-RDS-115 in *Annexure E.*

Image36: Google Image Apple Express rail bypass

Shortly after this rail crossing the N2 dual carriageway ends and becomes a single carriageway road. Approximately 3.5 km after the rail crossing at Km 64.8 the N2 crosses the R331 to Loerie at an interchange, no additional work is envisaged at this interchange as the haul train can use the existing off and on ramps.

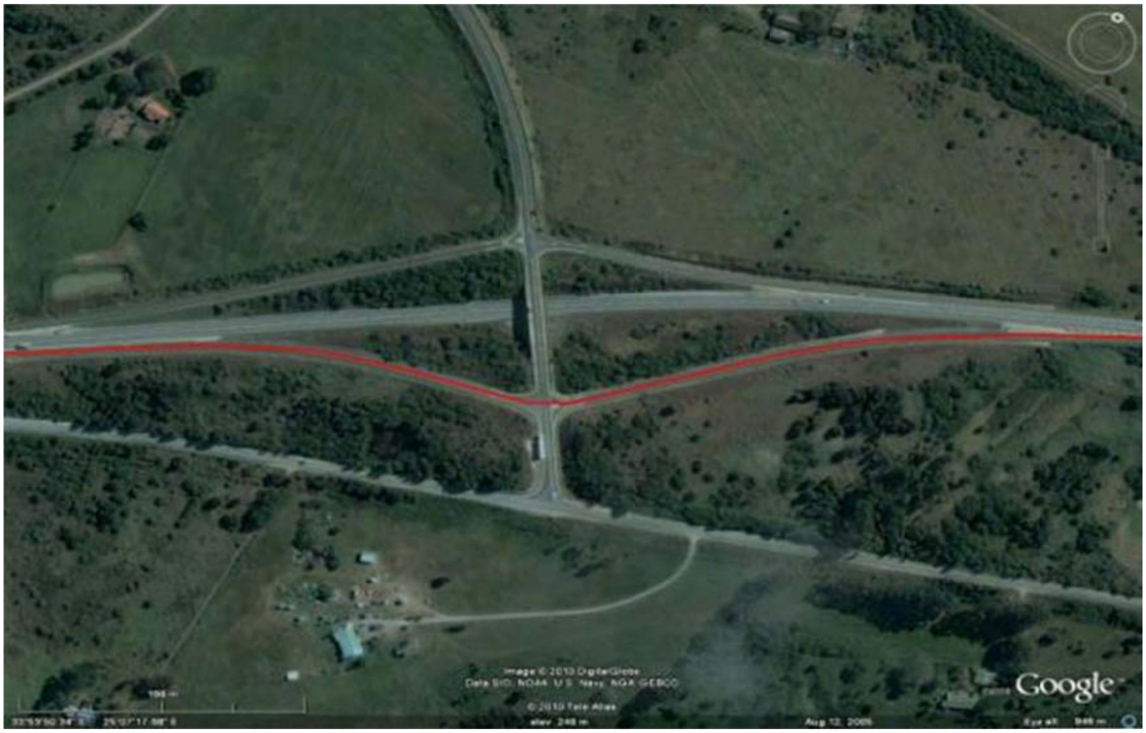


Image37: Google Image Loerie Interchange

For the next 11 km the N2 travels down the Gamtoos River Pass to where it crosses the Gamtoos River at 75.8 Km. There are two structures just before the Gamtoos River bridge namely a large culvert over the Churchill water supply pipelines which carry Port Elizabeth's Main Water Supply and a small bridge crossing the Van Stadens River mouth access road. Both these bridges can easily be propped if necessary.

The Gamtoos River bridge is discussed in more detail in the report on bridges contained in Section 5.

Image38: Google Image Churchill & Gamtoos Mouth Rd overpasses

6.6 GAMTOOS TO HUMANSDORP

Approximately 0.6 km after the Gamtoos River crossing the N2 again crosses the Churchill pipeline in a large culvert and 200m further on the N2 crosses over the R102 (or the old Cape Road). This bridge can also be strengthened or propped if necessary.

We note here that the bridge over the R102 has already been strengthened and it may require additional propping. In addition, as can be seen in *Image* 40 below, the road widening required for the Haul vehicle at the Jeffery's Bay East Interchange is fairly extreme.

An alternative solution to both these instances would be to construct a ramp at Km 77.4 just before the R102 crossing to meet with the R102 as shown in *Image* 39 below. A final decision on this will be made at detail design stage.

Image39: Google Image Churchill pipeline overpass & R102 alternative access ramp

Approximately 1.2 km after the R102 crossing ie Km 78 the N2 reaches the Jeffrey's Bay East interchange. The proposed route leaves the N2 at this point along the off-ramp and joins the R102 travelling toward Jeffrey's Bay. Some widening of the ramp bellmouth and the following T-junction with the R102 will be required as shown below. The T-junction with the R102 is at Km 78.2.

Image40: Google Image J Bay East interchange

There are no further constraints for the next 9.5 km at which point the Kabeljous River crossing is encountered. This is a fairly old narrow bridge with a surfaced width between kerbs of 6.2m. This bridge will require some strengthening and/or propping.

The next constraint occurs approximately 4.9 km after the Kabeljous bridge and this is the Fountains circle which is part of the main entrance into Jeffrey's Bay. Some relatively minor earthworks and road widening will be required here to enable the haul train to bypass this circle.

The route then continues along the R102 for approximately 3.5 km where it crosses the Swart River. This is an arch bridge which will not require any propping.

6.7 HUMANSDORP

There are no further constraints on this route for approximately 8.8 km at which stage the haul train enters Humansdorp and turns left into the Main Street in Humansdorp as shown below. This intersection will require some road works and demolishing of the centre islands to enable the 90° turn into Main Street. Details of this intersection are shown in drawing no 402763-01-RDS-303 attached in *Annexure F*.

Image41: Google Image Humansdorp main road intersection

The route travels down the centre of Main Street in Humansdorp for approximately 0.9 km. Diversion of traffic in Humansdorp will be straightforward as there are numerous crossing roads within the town along which the traffic can be rerouted while the haul train travels down Main Street.

At the end of the main street the Haul train again turns left and some road widening will be required here. Details of this intersection are shown in *Image 42* below and in drawing number 402763-01-RDS-304 in *Annexure F*.

Image42: Google Image Humansdorp Caravan Park intersection

6.8 HUMANSDORP BYPASS

We note here that, while the route through Humansdorp described in 6.7 above might be acceptable to the town for the abnormal load vehicles, it will not be acceptable to transport large numbers of workers (i.e. busses) or construction haul vehicles through the town. For these vehicles, it will be necessary to construct a bypass to divert traffic around the town from Voortekker road across to Park Street i.e. the St Francis bay Road. It is intended to route these vehicles along Park Street in a westerly direction to the intersection with the existing Oyster Bay road. This road is currently being upgraded by the Provincial Road department and will be used as the main construction haul road. The section of Park Street from the new bypass to the Oyster Bay intersection will also have to be upgraded as it is in poor condition and will not stand up to the construction haul traffic.

A Google *Image* is shown below which shows three (3) possible routes for a bypass. The routes shown follow existing cadastral boundaries where possible in order to minimise disruption to existing farming operations and so that farms are not dissected by the bypass route.

All three bypasses have to cross the Boskloof Valley in which there is a stream. The valley is fairly steep and large culverts will have to be installed under the road.

Bypass A is the preferred option as it is the shortest of the three routes. It also connects on to Park Street at 90 deg. and can then be used by the main construction haul vehicles which will be routed to Thyspunt along the main Oyster Bay road. Although this report is based on existing roads as far as possible, including the Main Street in Humansdorp, it is strongly recommended that this bypass road be constructed. We have included the costs of the bypass in our costs estimates for the haul route.

Image43: Google Image Humansdorp bypasses

6.9 HUMANSDORP TO ST FRANCIS BAY

Approximately 3.4 km outside Humansdorp on the way to St Francis Bay the route crosses the Seekoei River. The valley is deep and consequently the bridge is too high to be able to prop, it could be strengthened if needed. The bridge is on a right hand bend and is super-elevated. We have surveyed the bridge deck and found that the super- elevation or cross fall, is 10% which is outside the constraints of the haul vehicle. The road will have to be raised on the low side to build up the cross fall to the acceptable limit of 7 %.

The route continues towards St Francis Bay for approximately 8.9 km until the Kromme River Bridge is reached. The preliminary design check on this bridge indicates that it may require some strengthening to increase shear and torsion capacity.

Approximately 2.5 km from the Kromme River bridge the route reaches the main entrance into St Francis Bay and to St Francis Links. At this point there is a traffic circle and some road widening will be required to enable the haul train to circumnavigate this circle.

Shortly after the entrance to St Francis Bay the road climbs a short but fairly steep hill. During severe flooding in 2007 his road was severely damaged. Temporary repairs were made to this road at that time and these repairs are still in place. A section of approximately 300m of roadway is only built up to subbase level which was overlaid with a temporary tarred surface. This road will have to be upgraded to its original standard before the heavy haul vehicles can travel over it. In addition the stormwater control along the side of this road requires significant upgrading to avoid future flood damage. Allowance for this upgrading has been made in the cost estimates.

The eastern access is covered under a separate report which will take the abnormal haul vehicles to the Thyspunt site which is approximately 10 km further on.

As stated previously, the section of road south of the Kromme River to Thyspunt will be used by many members of the construction and permanent staff working in Thyspunt, who will be accommodated in Jeffery's bay, Humansdorp and St Frances bay itself.

We are therefore of the opinion that, as it is also the main access road to St Francis and Cape St Francis, this section of the road should be upgraded to a Class 2 road with passing / climbing lanes and surfaced shoulders. The intersection at the entrance to St Francis Bay and the St Francis Links will also need to be upgraded.

It is anticipated that the traffic past St Francis Bay will increase significantly and we believe that it would be prudent to construct a large berm between the road and St Francis Bay, to act as a sound and vehicle headlight barrier for the residents.

St Francis Bay is a quiet holiday resort town and this additional traffic could adversely affect the nature of the town (A similar berm has been constructed by the developers of the St Francis Links along the western side of the road along their property, which is very effective).

7. EXPROPRIATION

Although the majority of the proposed haul route follows existing roads, where bridge bypass ramps are required, these ramps will be constructed on private land. Consequently negotiations will need to be entered into with the land owners and, ultimately the land will need to be expropriated. It is likely that the ramps will remain as a permanent feature for possible abnormal load haul, should any additional or replacement major equipment be required in the future.

8. ENVIRONMENTAL IMPACT ASSESSMENT

8.1 THE BRIEF

Our Environmental section has provided the following advice on the Environmental requirements for the four proposed bypasses for the Heavy Haul Road from Port Elizabeth to Thyspunt.

8.2 ASSUMPTIONS

It is assumed that the planned project will not be considered a new route determination in terms of Section 40 of the National Roads Act (no 7 of 1998) and would thus not trigger Regulation 545: Listing 2 - Activity 18 that requires a Scoping and EIR.

8.3 ASSESSMENT

The National Road (N2) transects a number of Critical Biodiversity Areas (CBAs). Currently only the areas captured in the Nelson Mandela Municipal Open Space Strategy (NMMOSS) are in the process of being promulgated. It is therefore likely that in the future, Regulation 546: Listing 3 - Activity 12-14 will be triggered.

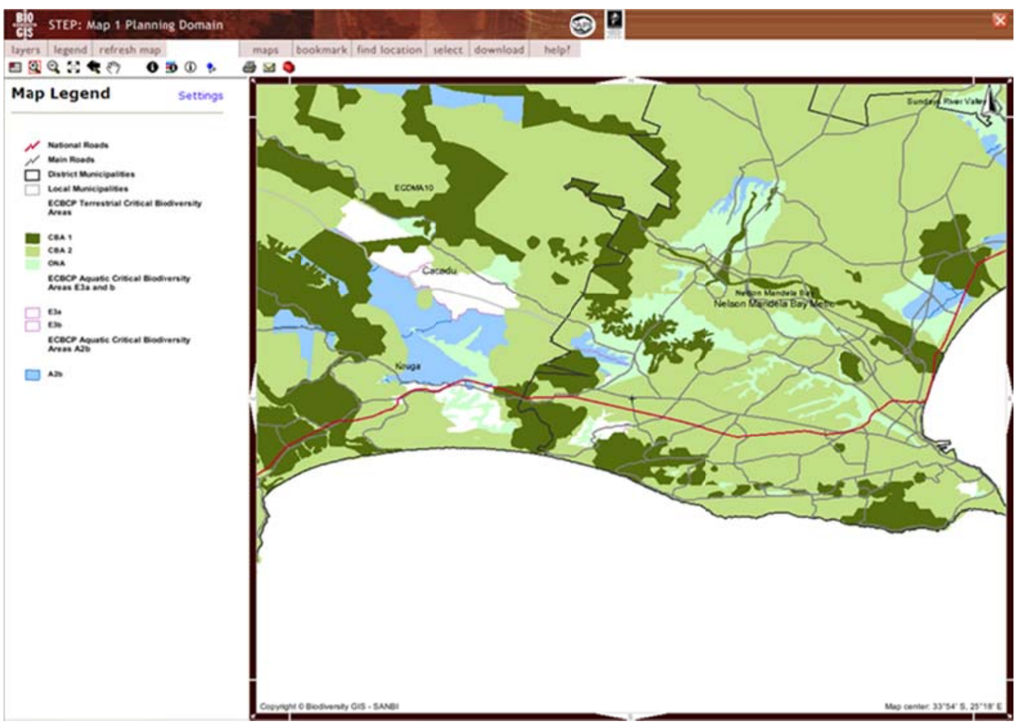


Image 44: Critical Biodiversity Areas

Regulation 546: Listing 3 – Activities 4 & 19: The construction of a road wider than 4 metres with a reserve less than 13,5 m and the extending road by 1 km currently not triggered. However, given the NMMOSS and given that this is a National road, it is highly likely that DEDEA could request a Basic Assessment in terms of Regulation 546: Listing 3 - Activity 26 referring to phased activities in specific geographic areas (NMMOSS) where each phase is below the threshold but where the cumulative phase distance exceeds the minimum threshold.

Image 45: Bypass 1

Bypass 1 does not trigger any activity in terms on the 2010 NEMA regulations, as the extension is less than 1 km and the vegetation is exotic.

Image 46: Bypass 2

Bypass 2 does not trigger any activity in terms on the 2010 NEMA regulations, as the extension is less than 1 km. It is not clear if Regulation 546: Listing 3 - Activities 12-14 will be triggered, as a vegetation assessment needs to be done.

Image 47: Bypass 3

Bypass 3 does not trigger any activity in terms on the 2010 NEMA regulations, as the extension is less than 1 km. It is not clear if Regulation 546: Listing 3 - Activities 12-14 will be triggered, as a vegetation assessment needs to be done.

Image 48: Bypass 4

Bypass 4 does not trigger any activity in terms on the 2010 NEMA regulations, as the extension is less than 1 km. It is not clear if Regulation 546: Listing 3 - Activities 12-14 will be triggered, as a vegetation assessment needs to be done. This proposed bypass is within a CBA.

8.4 SUMMARY

It is recommended that allowance be made for the minimum of a Basic Assessment on this proposed project. Once details of the project are defined, it is recommended that a pre-application meeting be scheduled with DEDEA. This meeting will serve to clarify the requirements, as, at the time of commencement of the project, the CBA might not yet have been promulgated. It is therefore highly likely that an EMP would suffice to address the DEDEA requirements at that stage, rather than an EIA process.

9. COST ESTIMATES OF PROPOSED ROUTE

9.1 PREPARATION OF HAUL ROUTE

A preliminary cost estimate for the preparation of the haul route has been carried out and is tabulated overleaf. It is estimated that the cost of the required upgrading will be in the order of R 97 million, including Contractor’s overheads, contingencies, professional fees and VAT. This cost includes for work inside the Port Elizabeth Harbour, strengthening or propping of road bridges, raising or dismantling of overhead cables, dismantling of overhead signs, construction of overpass bridge bypass ramps, widening of interchange ramp entrances, widening of intersections, accommodation of traffic, rehabilitation of short sections of road which are in poor condition and the upgrading of the road past St Francis Bay. Also included in this cost is the construction of the Humansdorp bypass as recommended in section 6, at an estimated cost of approximately R19 million. Details of this cost are also given overleaf.

Together with the cost of the Eastern Access road which is estimated at approximately R115 million, the total cost of the heavy haul route would be approximately R212 million.

Table 13: Abnormal Load Haul Road Cost Estimate

Item No.	Description	Qty	Unit	Rate	Sub totals	Cost
					DATE:	25 February 2011
1	PE Harbour					
1.1	Level off road at railway tracks	2640	m2	R 350	R 924,000	
1.2	Replace pallisade fencing with removable panels	40	m	R 350	R 14,000	
1.3	Deal with overhead electric locomotive power lines	1	Sum	R 30,000	R 30,000	
1.4	Break down brick wall	20	m	R 600	R 12,000	
1.5	Construct ramp on to roadway	1500	m2	R 450	R 675,000	
	Total for PE Harbour					R 1,655,000
2	Propping/strengthening of bridges					
2.1	Propping of small bridges	9	No	R 100,000	R 900,000	
2.2	Van Stadens Bridge	1	Sum	R 1,618,000	R 1,618,000	
2.3	Gamtoos Bridge	1	Sum	R 1,079,000	R 1,079,000	
2.4	Seekoei Bridge	1	Sum	R 540,000	R 540,000	
2.5	Kromme Bridge	1	Sum	R 1,079,000	R 1,079,000	
	Total for Bridges					R 5,216,000
3	Deal with overhead cables					
3.1	Telkom	35	No	R 10,000	R 350,000	
3.2	LV Cables	60	No	R 10,000	R 600,000	
3.3	Eskom HV power lines	9	No	R 54,000	R 486,000	
3.4	Information Signs	3	Sum	R 54,000	R 162,000	
	Total for overhead obstacles					R 1,598,000
4	Widening of Seaview interchange ramp entrance	1	Sum	R 45,000	R 45,000	R 45,000
5	One Set Overpass Bypass Ramps 1.2km long x 8m					
5.1	Bulk Earthworks (Borrow to Fill)	36000	m3	R 55	R 1,980,000	
5.2	SSG Lower	1875	m3	R 200	R 375,000	
5.3	SSG Upper	1760	m3	R 200	R 352,000	
5.4	Subbase	1650	m3	R 300	R 495,000	
5.5	Basecourse	1550	m3	R 350	R 542,500	
5.6	Premix surfacing	9600	m2	R 150	R 1,440,000	
5.7	Removable Guardrails on crossing road	40	m	R 540	R 21,600	
	Total for one bypass ramp set					R 5,206,100
6	Additional sets of Bypass Ramps	3	Sum	R 5,206,100	R 15,618,300	R 15,618,300
7	Widening J Bay East Interchange off ramp	1	Sum	R 240,000	R 240,000	R 240,000
8	Widening J Bay Fountains Circle bypass	1	Sum	R 190,000	R 190,000	R 190,000
9	Humansdorp Bypass A	1	Sum	R 9,955,000	R 9,955,000	R 9,955,000
10	Lessening Seekoei River Bridge Crossfall	1	Sum	R 190,000	R 190,000	R 190,000
11	Rehabilitating MR381 from Kromme to Sea Vista	5.5	Km	R 700,000	R 3,850,000	R 3,850,000
12	Widening St Francis Bay Entrance Road 2km x 4m					
12.1	Bulk Earthworks	1500	m3	R 55	R 82,500	
12.2	SSG Lower	1920	m3	R 200	R 384,000	
12.3	SSG Upper	1750	m3	R 200	R 350,000	
12.4	Subbase	1600	m3	R 300	R 480,000	
12.5	Basecourse	1400	m3	R 350	R 490,000	
12.6	Premix surfacing	8000	m2	R 150	R 1,200,000	
12.7	Stormwater pipes under MR381 side drain 900dia	430	m	R 3,500	R 1,505,000	
12.8	Stormwater culvert under at St Francis Entrance MR381	150	m	R 5,800	R 870,000	
12.9	Concrete block retaining structure	600	m2			
12.10	Rehabilitate MR381 flood damage	1	Sum	R 850,000	R 850,000	
	Total for entrance road upgrading					R 6,211,500
13	Accomodation of traffic	1	Sum	R 1,000,000		R 1,000,000
14	Rehabilitate sections of uneven roadway	1500	m	R 1,000		R 1,500,000
	Sub - Total					R 52,474,900
	Contractors Preliminary & General Cost	20 %				R 10,494,980
	Sub - Total					R 62,969,880
	Contingencies	10 %				R 6,296,988
	Sub - Total					R 69,266,868
	Escalation	12 %				R 8,312,024
	Sub - Total					R 77,578,892
	Professional Fees	6 %				R 4,654,734
	Other Recoverable Cost	4 %				R 3,103,156
	TOTAL:					R 85,336,781
	Add VAT:	14 %				R 11,947,149
	Gross TOTAL:					**R 97,283,931**
					Estimated cost of Eastern Access Road	**R 115,000,000**
					Estimated gross cost of haul route from PE harbour	**R 212,283,931**

Table 14: Humansdorp Bypass Cost Estimate

Item No.	Description	Qty	Unit	Rate		Cost
				DATE:		25 February 2011
1	**Humansdorp Bypass - 850m long x 12.4m surfacing**					
1.1	Bulk Earthworks	12000	m3	R 55	R 660,000	
1.2	SSG Lower	1650	m3	R 200	R 330,000	
1.3	SSG Upper	1750	m3	R 200	R 350,000	
1.4	Subbase	1800	m3	R 300	R 540,000	
1.5	Basecourse	1650	m3	R 350	R 577,500	
1.6	Premix surfacing	8500	m2	R 150	R 1,275,000	
1.7	Box Culvert - Boskloof stream 3.6x3.6	35	m	R 25,000	R 875,000	
	Total for Bypass					R 4,607,500
2	**Park St Upgrading - 1800m long x 8m surfacing**					
2.1	Remove existing layer works and stockpile	8640	m3	R 55	R 475,200	
2.2	Additional box cut excavation	4300	m3	R 55	R 236,500	
2.3	SSG Lower using stockpiled material	2800	m3	R 120	R 336,000	
2.4	SSG Upper	2600	m3	R 200	R 520,000	
2.5	Subbase	2500	m3	R 300	R 750,000	
2.6	Basecourse	2400	m3	R 350	R 840,000	
2.7	Premix surfacing	14600	m2	R 150	R 2,190,000	
	Total for Park Street upgrading					R 5,347,700
						R 0
						R 0
						R 0
						R 0
						R 0
						R 0
	Sub - Total					R 9,955,200
	Preliminary & General Cost	20 %				R 1,991,040
	Sub - Total					R 11,946,240
	Contingencies	10 %				R 1,194,624
	Sub - Total					R 13,140,864
	Escalation	12 %				R 1,576,904
	Sub - Total					R 14,717,768
	Professional Fees	10 %				R 1,471,777
	Other Recoverable Cost	4 %				R 588,711
	TOTAL:					R 16,778,255
	Add VAT:	14 %				R 2,348,956
	Gross TOTAL:					**R 19,127,211**

10. PROGRAMME

A possible programme for the work involved in the upgrading and preparing the haul route is given overleaf. The program also includes the construction of the Humansdorp Bypass. It is estimated that the time from instruction to proceed to the completion of the necessary road works would be approximately 10 months. As an example, the programme shows that if we were given the instruction to proceed by the end of February 2011, say, the Haul road including the Humansdorp Bypass could be complete by March 2012.

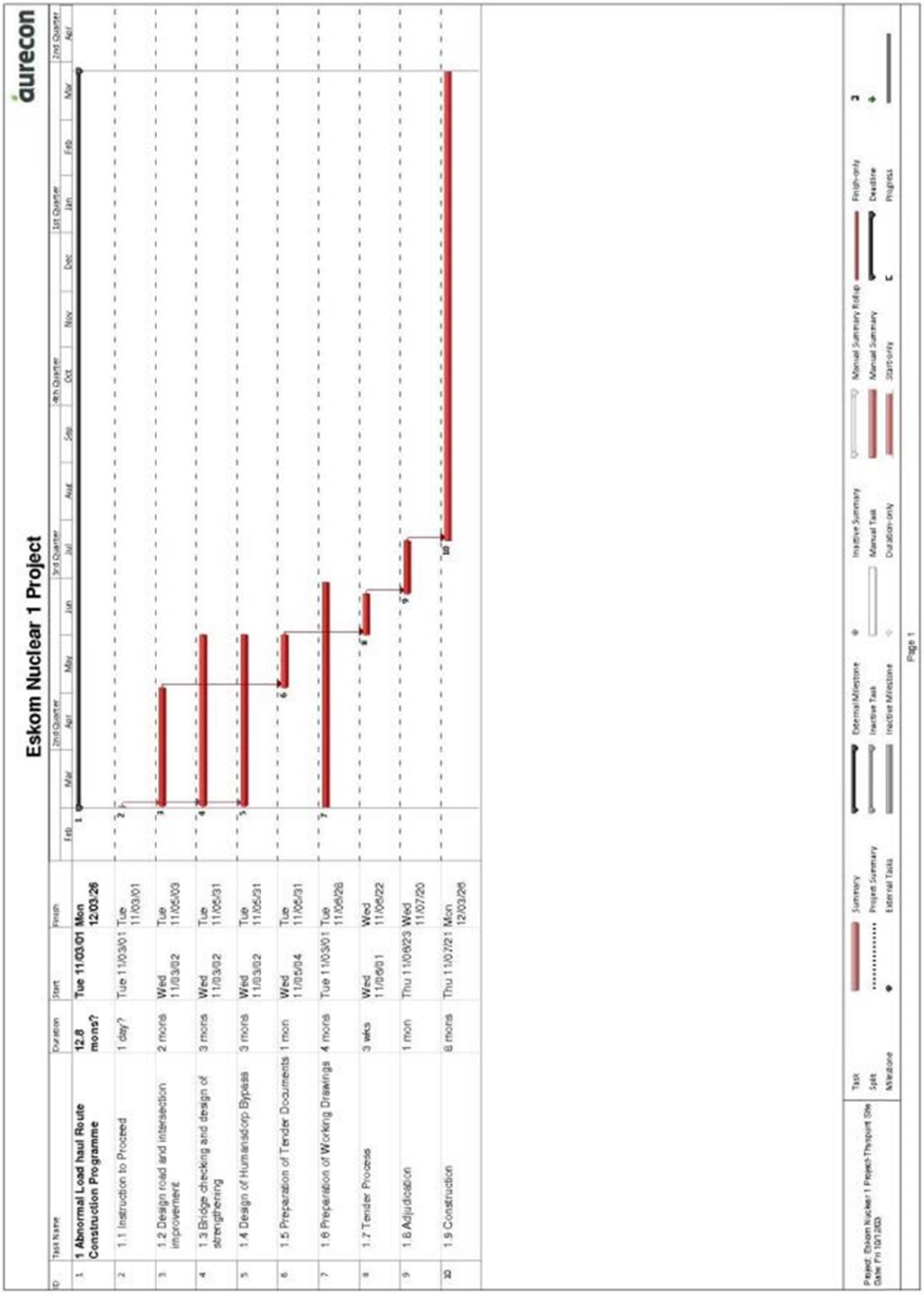


Image49: Construction Programme

11. RECOMMENDATION

It is recommended that:

11.1 This report be used as a guideline to vendors requiring information regarding an available route for the landing and transport of abnormally heavy equipment to Thyspunt. The recommended route makes use of the Port Elizabeth Harbour and existing roads, and details certain upgrading of infrastructure that will be required to cater for large transport vehicle. The upgrading required has been based on worst case scenarios using various vehicles configurations up to a 28 axle single trailer capable of carrying loads up to 650 tones.

11.2 Once the vendor has been chosen and has identified his requirements for loads and vehicles to be used, detailed design and construction of required upgrading of the route be carried out.

11.3 The instruction to proceed with detailed design and tender procurement be given a minimum of one year prior to the anticipated arrival of the first abnormal load in Port Elizabeth.

11.4 The Humansdorp Bypass indicated in section 6.8 be constructed at the same time.

11.5 If it is decided to construct the Jeffery's Bay- St Francis Bay link road (covered in a separate report) this road would become a component of the abnormal load haul route, which would then bypass Humansdorp. Although in this case the bypass discussed in 6.8 would not be used for the abnormal load haul, it will still be necessary to construct the bypass to carry normal construction haul vehicles during the construction period.

For Aurecon

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C Roberts Pr Eng

ANNEXURE A – BRIDGE AND CULVERT SCHEDULE

Proposed Haul Route Distance Km	NS Bridge / Culvert / Structure Number	Actual Bridge Number	Structure Ow	ner	Description of Area/Location	NRA Km Value	On/Off Ramp Required	Comment
Inside Harbour	NS102		Quay 8	Portnet				check Quay strength
	NS101		Quay 101	Portnet				check Quay strength
				Spoornet	Dock area			Open fences or install gates in existing fences to allow large radius turns
				Spoornet	Dock area			Construct road behind cold storage building including existing railway line in centre.
			Fences, Wall,	Spoornet	Strand Street/ Baakens River		YES	Small ramp required to get onto Settlers Way
0	HARBOUR EXIT				HARBOUR EXIT			Zero Km value
0.3	NS103		River Bridge	PE Mun	Strand Street/ Baakens River		NO	May need propping
0.3 TO 37			Small culverts	PE Mun/ Provincial Roads	Harbour to Greenbushes Interchange		-	
40	NS1	B764	Road Over Road	SANRAL	N2 over road to Draaifontein	N2 11 – 10.8w	-	May need propping
40.65	NS2		Large Culvert	SANRAL	Agricultural underpass	N2 11 – 10.2w	-	
43.4	NS3 St Albans Interchange		Road Over Road	SANRAL	Van Stadens / St Albans turnoff, N2 goes under Bridge	N2 11 – 7.2w	NO	Make use of on/off ramps to bypass bridge, Minor alterations needed to accommodate vehicle turning circle
	NS4		Large Culvert	SANRAL		N2 11 – 6w	-	
46.2	NS5	B762	Road Over Road	SANRAL	N2 under Road to Van Stadens river (Upington Bridge)	N2 11 – 4.2w	YES	New On/Off Ramps need to be constructed to bypass bridge
46.7	NS6		Road Over Road	SANRAL	N2 over Service Road	N2 11 – 3.8w	-	May need propping
47	NS7		Culvert	SANRAL		N2 11 – 3w	-	
47.1	NS8		Large Culvert	SANRAL		N2 11 – 1.2w	-	
49.54	NS9		Road Over Road	SANRAL	N2 Under Service Road to Old National Road	N2 11 – 0.8w	YES	New On/Off Ramps need to be constructed to bypass bridge
51	NS10		Large Culvert	SANRAL		N2 10 – 79.2w	-	

Proposed Haul Route Distance Km	NS Bridge / Culvert / Structure Number	Actual Bridge Number	Structure Ow	ner	Description of Area/Location	NRA Km Value	On/Off Ramp Required	Comment
54.3	NS11 Van Stadens Pass Interchange		Road Over Road	SANRAL	N2 over Road to Van Stadens Pass	N2 10 – 76.4w	NO	Make use of on/off ramps to bypass bridge, Minor alterations needed to accommodate vehicle turning circle
55.2	NS12		Road Over Road	SANRAL	N2 Under Woodridge Bridge	N2 10 – 75.6w	YES	New On/Off Ramps need to be constructed to bypass bridge
57.25	NS13	B127	River Bridge	SANRAL	N2 – Van Stadens River Bridge	N2 10 – 73.8w	-	Check Designs for maximum allowable loads, Cannot be propped
58.96	NS14		Culvert	SANRAL	N2 over 3.8x3.8 Agricultural Underpass	N2 10 – 71.7w	-	
59.42	NS15		Culvert	SANRAL	N2 over 2.5x2.5 Agricultural Underpass	N2 10 – 71.3w	-	
60	NS16 Thornhill Interchange		Road Over Road	SANRAL	N2 Under Road to Thornhill / Sunnyside	N2 10 – 70.8w	NO	Make use of on/off ramps to bypass bridge, Minor alterations needed to accommodate vehicle turning circle
60.325	NS17		Culvert	SANRAL	N2 over 2.8x2.5 Agricultural Underpass	N2 10 – 70.4w	-	
60.952	NS18		Culvert	SANRAL	N2 over 3.5x3.5 Agricultural Underpass	N2 10 – 69.8w	-	
61.25	NS19	4198	Rail Over Road	SANRAL / Spoornet	N2 Under PE / Humansdorp Railway Line	N2 10 – 69.4w	YES	New On/Off Ramps need to be constructed to bypass bridge
62.4	NS20		Culvert	SANRAL	N2 over 3.0x3.0 Agricultural Underpass	N2 10 – 69.2w	-	
	NS21		Culvert	SANRAL	N2 over 2.0x2.0 Box Culvert	N2 10 – 68.5w	-	
63.18	NS22		Culvert	SANRAL	N2 over 2.8x5.65 Box Culvert	N2 10 – 68.3w	-	
	NS23		Culvert	SANRAL		N2 10 – 67.6e	-	
64.1	NS24		Underground Pipe Line	SANRAL		N2 10 – 66.7e	-	Check Depth of Pipe Line to see if loads will effect it
64.3	NS25		Rail Under Road	SANRAL / Spoornet	N2 Over PE / Humansdorp Railway line	N2 10 – 66.5e	-	Might need to be propped
64.4	NS26		Culvert	SANRAL	N2 Over 2.45x2.45 Agricultural Underpass	N2 10 – 66.4e	-	
64.8	NS27	B147	Road Over Road	SANRAL	N2 Under Hankey / Gamtoos Mouth Road	N2 10 – 66.0e	NO	Make use of on/off ramps to bypass bridge, Alterations may be needed to accommodate vehicle's turning circle
65.8	NS28		Culvert	SANRAL	N2 Over 2.45x2.4 Box Culvert	N2 10 – 65.0e	-	

Proposed Haul Route Distance Km	NS Bridge / Culvert / Structure Number	Actual Bridge Number	Structure Ow	ner	Description of Area/Location	NRA Km Value	On/Off Ramp Required	Comment
66.5	NS29		Culvert	SANRAL	N2 Over 2.45x2.45 Box Culvert	N2 10 – 64.3e	-	
67.3			Culvert	SANRAL	N2 Over 2x1.8m dia Pipe Culvert		-	
68.1			Culvert	SANRAL	N2 Over 2x1.8m dia Pipe Culvert		-	
68.36	NS30		Culvert	SANRAL	N2 Over 2x1.8m dia Pipe Culvert	N2 10 – 62.4e	-	
69.26	NS31		Culvert	SANRAL	N2 Over 3x1.8m dia Pipe Culvert	N2 10 – 61.5e	-	
70.3	NS32		Road Over Road	SANRAL	N2 over Road to Mondplaas / Witteklip	N2 10 – 60.5e	YES	May need propping
75.625	NS33		Culvert	SANRAL NMBM	Churchill pipeline under N2	N2 10 – 55.1e	-	
75.87	NS34	B151	Road Over Road	SANRAL	N2 Over Gravel Road alongside Gamtoos River	N2 10 – 55.0e	-	May need propping
75.95	NS35	B176	River Bridge	SANRAL	N2 – Gamtoos River Bridge	N2 10 – 54.7e	-	Check Designs for maximum allowable loads, Cannot be propped
76.69	NS36	B153	Road Over Road	SANRAL	N2 Over Gravel Farm Road	N2 10 – 54.2e	-	May need propping
76.89	NS37	B521	Road Over Road	SANRAL	N2 Over Old National PE/ Jeffrey's Bay Road	N2 10-52.8e	-	May need propping
78	NS38 Mondplaas Interchange		Road Over Road		(Jeffrey's Bay East Turnoff) N2 over Road to Jeffrey's Bay East / Mondplaas	N2 10 – 52.8e	NO	Use Off ramp to get onto old Jeffrey's Bay Road (start of Pink Route), Intersections will need widening to accommodate vehicle turning circle
88	NS59		River Bridge	Provincial Roads Dept.	Old Kabeljous River Bridge		-	May need propping
			± 10 Small Culverts on this Route		Along Red Route		-	
92.5	NS61 Fountains Circle		Traffic Circle		MR389 / MR4 intersection		-	Western approaches to circle will need to be widened to accommodate vehicle turning circle.
96	NS62		River Bridge	Provincial Roads Dept.	MR 389 – Swart River Bridge		-	May need propping
			Small Pipe Culverts		Between Traffic Circle and Humansdorp		-	
105			Traffic islands	Kouga Municipality	MR389 / Humansdorp High St Intersection		-	Road widening and alterations to traffic islands needed

Proposed Haul Route Distance Km	NS Bridge / Culvert / Structure Number	Actual Bridge Number	Structure Ow	ner	Description of Area/Location	NRA Km Value	On/Off Ramp Required	Comment
105.7				Kouga Municipality	Tee junction High St / MR381			Temporary removal of Caravan Park entrance walls and road widening needed
110.5	NS57	5230	River Bridge	Provincial Roads Dept.	MR381 – Seekoei River Bridge		-	Cannot be propped, Check Bridge Designs for allowable loads
119.3	NS58	5208	River Bridge	Provincial Roads Dept.	MR381 – Kromme River Bridge		-	Cannot be propped, Check Bridge Designs for allowable loads
121			River Bridge	Provincial Roads Dept.	MR381 - Sand River Bridge			May need propping
122			Traffic Circle	Provincial Roads Dept.	Entrance to St Francis Bay			Widening of road around circle needed
124.3					Intersection with MR381 / Eastern Route to Thyspunt			Design intersection to accommodate heavy haul turning radii

ANNEXURE B – PROPOSED ROUTE LONGITUDINAL GRADES

CHECK ON HAUL ROUTE GRADIENTS > 4%

ROAD GRADE CHECK				Description
Start chain (km)	Length (m)	Grade (%)	Slope	
0				PE Harbour exit
0.590	130	7.8	up	Walmer Boulevard
9.950	350	4.3	up	
11.500	600	5.5	down	
23.850	200	4.1	down	
25.600	300	4.6	down	
27.500	400	5.7	up	
29.050	620	4.9	up	
29.700	480	7.1	up	
30.750	230	7.2	up	
32.300	250	6.6	up	
36.962				Start of on-ramp to N2 at Seaview Interchange
61.060	160	6.2	down	
54.250				Crossing over MR434 - Woodridge
56.000				Crossing over MR434
64.730				MR 400/MR4343 - Loerie Interchange
66.150	200	5.0	down	
70.100				Bridge over MR389
70.350	350	4.8	up	
71.300	2000	4.9	down	Gamtoos Pass
73.350	1400	4.5	down	Gamtoos Pass
73.300	1800	4.2	down	
76.700				Bridge over MR389
77.750				Bridge over DR1799
78.000				Jeffrey's Bay East interchange
86.400	700	4.3	down	Kablejous River
87.350	450	4.0	up	
89.650	950	4.2	up	
91.250	150	5.2	up	
96.800	300	4.3	down	
97.300	200	6.5	up	
105.100	100	5.6	up	
105.650	100	6.9	down	
105.750	130	8.3	down	
106.650	200	4.3	down	
110.450	450	6.7	down	Seekoei River
121.250	100	6.2	up	
123.850	200	6.5	up	St Francis Bay
124.050	150	5.7	up	

NOTE: Grades less than 4% have not been recorded here

VERTICAL CURVE CHECK FOR K VALUES OF < 16

Allowable vertical curvature for 70m long 28 axle trailer = +2.4% to -2.4% = 4.8% grade difference

P.I chain (km)	Front grade %	Back grade %	Difference in grade %	Curve length for K=16 (m)	Actual curve length(m)	Comment
25.500	-1.677	-3.489	1.812	29	50	O.K
34.400	1.348	-4.015	5.363	86	80	O.K
34.500	-4.015	0.101	4.116	66	60	O.K
35.000	-3.031	2.010	5.041	81	100	O.K
35.100	2.010	-3.856	5.866	94	100	O.K
36.100	0.453	-2.782	3.235	52	70	O.K
54.250	-2.496	4.339	6.835	109	100	O.K
59.950	2.319	-2.624	4.943	79	110	O.K
60.200	-2.624	0.833	3.457	55	90	O.K
91.450	5.241	-2.614	7.855	126	150	O.K
95.350	-1.348	-3.817	2.469	40	80	O.K
95.500	-3.817	2.034	5.851	94	140	O.K
95.700	2.034	-3.243	5.277	84	140	O.K
95.900	-3.243	2.556	5.799	93	135	O.K
98.150	-1.590	1.898	3.488	56	100	O.K
105.850						Humansdorp intersection needs full reconstruction
105.900	}					
106.000						
121.250	0.304	6.204	5.900	94	100	O.K
121.350	6.200	0.778	5.422	87	90	O.K
121.900	-1.820	1.756	3.576	57	80	O.K

NOTE: A geometric design "K" value of 16 for a road vertical curve, translates to a grade change of 4.4% (i.e.+2.2% to -2.2%) over a trailer length of 70m

ANNEXURE C – OVER HEAD CABLES ON PROPOSED ROUTE

PE HARBOUR TO THYSPUNT STRUCTURE SURVEY

Distance (Km)	Y - Coord	X - Coord	Min. Vertical Clearance	Structure	Road
0	-58007	3759968	5.513	Harbour Entrance	Harbour Entrance
0.58	-57999	3760026	5.254	Overhead Information	Ramp Street
0.296	-58157	3760211	5.314	Overhead Information	Ramp Street
9.3	-49849	3763127	6.595	Telkom	M9
9.645	-49514	3763189	6.315	Telkom	M9
9.73	-49428	3763215	6.076	Telkom	M9
10.16	-49024	3763328	6.119	Telkom	M9
10.32	-48868	3763386	6.19	Telkom	M9
12.24	-47732	3764765	6.834	Power	M15
13.16	-46812	3764963	7.28	Power	M15
14.13	-45846	3765001	6.99	Power	M15
15.93	-44048	3765139	7.64	Power	M15
18.35	-41631	3765218	6.74	Telkom	M15
18.47	-41509	3765228	8.55	Power	M15
19	-40987	3765239	21.24	Power	M15
20.77	-39212	3765212	7.16	Power	M15
20.87	-39118	3765200	6.69	Telkom	M15
24.91	-35071	3765432	8.78	Power	M15
28.71	-33122	3764193	5.33	Telkom	M15
29.21	-33611	3764048	6.07	Telkom	M15
29.92	-34125	3763595	6.1	Telkom	M15
29.93	-34133	3763583	7.68	Power	M15
30.17	-34201	3763343	13.86	Power	M15
30.25	-34198	3763265	5.26	Telkom	M15
30.73	-34157	3762795	9.28	Power	M15
30.72	-34165	3762750	6.62	Telkom	M15
33.72	-35502	3760660	8.11	Power	M15
34.145	-35859	3760430	6.96	Power	M15
34.39	-36030	3760279	10.81	Flying Stay	M15
34.48	-36067	3760188	6.02	Power	M15
34.68	-36141	3760006	6.04	Power	M15
34.77	-36167	3759921	7.03	Flying Stay	M15
34.83	-36207	3759876	7.05	Flying Stay	M15
34.84	-36220	3759867	10.97	Flying Stay	M15
35.09	-36378	3759669	7.64	Power	M15
35.54	-36665	3759331	5.38	Telkom	M15
35.6	-36693	3759275	6.94	Power	M15
35.75	-36785	3759169	4.85	Telkom	M15
35.92	-36884	3759016	5.58	Telkom	M15
36.12	-36987	3758851	7.6	Power	M15
36.75	-37317	3758314	6.27	Telkom	M15
36.829	-37357	3758251	6.42	Telkom	M15
36.83	-37360	3758250	6.53	Power	M15
40.02	-34692	3756914	10.4	N2-11 10.4W	N2
40.24	-34487	3756845	8.37	Power	N2
43.15	-31628	3755996	5.03	Bridge	N2
44.07	-31048	3755847	6.6	N2-11 6.6W	N2
46.22	-28980	3755258	5.84	Telkom	N2
46.32	-28890	3755208	4.88	Bridge	N2
46.79	-28433	3755098	7.93	Power	N2

Distance (Km)	Y - Coord	X - Coord	Min. Vertical Clearance	Structure	Road
47.79	-28162	3755035	3.6	N2-11 3.6W	N2
47.07	-26044	3754441	1.4	N2-11 1.4W	N2
49.26	-25949	3754407	7.74	Power	N2
49.37	-25588	3754298	5.18	Bridge	N2
49.74	-25079	3754173	0.4	N2-11 0.4W	N2
50.27	-23887	3753835	12.47	Power	N2
51.5	-23867	3753824	9.42	Power	N2
51.53	-23544	3753742	78.8	N2-10 78.8W	N2
51.85	-21733	3753612	8.99	Power	N2
53.69	-21576	3753637	76.8	N2-10 76.8W	N2
53.85	-20594	3753690	9.74	Power	N2
54.84	-20274	3753698	5.14	Bridge	N2
65.16	-19363	3753750	74.6	N2-10 74.6W	N2
56.08	-15775	3752608	5.26	Bridge	N2
59.93	-15743	3752590	10.19	Telkom	N2
60.49	-15239	3752438	70.2	N2-10 70.2W	N2
60.28	-15442	3752507	70.4	N2-10 70.4W	N2
60.37	-15358	3752470	7.63	Power	N2
60.97	-14784	3752279	6.63	Telkom	N2
61.22	-14543	3752200	5.22	Bridge	N2
62.46	-13362	3751805	7.84	Telkom	N2
63.2	-12650	3751696	7.54	Power	N2
63.28	-12577	3751696	9.44	Power	N2
64.73	-11222	3752257	5.13	Bridge	N2
65.08	-10923	3752450	7.69	Power	N2
65.19	-10830	3752501	8.14	Power	N2
69.75	-6641	3753546	12.18	Power	N2
69.78	-6624	3753562	15.23	Power	N2
70.18	-6330	3753844	7.58	Telkom	N2
70.83	-6214	3754480	25.91	Power	N2
72.53	-4832	3755360	6.88	Power	N2
105.45	20487	3766319	8.84	Power	R 330
105.44	20480	3766335	10.42	Power	R 330
105.65	20989	3766572	6.54	Power	R 102
105.65	20761	3766615	6.92	Power	R 102
105.66	20760	3766631	5.6	Power	Saffery Street
105.79	20793	3766762	5.35	Power	Saffery Street
105.91	20828	3766877	5.75	Power	Saffery Street
106.08	20879	3767044	7.03	Flying Stay	Saffery Street
106.31	20941	3767263	5.77	Flying Stay	Saffery Street
106.5	20984	3767451	5.77	Power	Saffery Street
107.76	20075	3767706	5.94	Power	R 330
108.01	19683	3768086	7.01	Power	R 330
108.23	19586	3768280	6.26	Telkom	R 330
	48834	3763403	6.37	Telkom	R 330
110.76	18713	3770561	21.73	Power	R 330
111.1	18411	3770695	22.7	Power	R 330
111.12	18398	3770708	12.16	Telkom	R 330
111.64	18341	3771212	16.61	Power	R 330
113.58	18590	3773064	6.38	Telkom	R 330
117.57	18146	3777029	8.28	Power	R 330

Distance (Km)	Y - Coord	X - Coord	Min. Vertical Clearance	Structure	Road
119.7	17345	3779542	4.87	Power	R 330
119.7	17345	3779542	8.99	Power	R 330
120.62	17310	3779863	6.18	Telkom	St Francis/Oyster Bay
120.68	17356	3779858	4.65	Telkom	St Francis/Oyster Bay
120.92	17535	3779707	5.99	Telkom	St Francis/Oyster Bay
121.23	17798	3779579	11.3	Power	St Francis/Oyster Bay
121.44	17999	3779585	5	Telkom	St Francis/Oyster Bay
121.54	18120	3779585	6.28	Telkom	St Francis/Oyster Bay
121.68	18239	3779596	7.88	Power	St Francis/Oyster Bay
121.71	18274	3779602	5.48	Telkom	St Francis/Oyster Bay
122.06	18611	3779620	5.59	Telkom	St Francis/Oyster Bay
122.12	18657	3779579	8.27	Power	St Francis/Oyster Bay
122.74	19256	3779600	5.57	Power	St Francis/Oyster Bay
122.74	19256	3779600	6.26	Telkom	St Francis/Oyster Bay
123.47	19901	3779429	7.59	Power	St Francis/Oyster Bay
123.49	19912	3779418	6.49	Power	St Francis/Oyster Bay
123.79	20154	3779290	5.88	Telkom	St Francis/Oyster Bay
124.14	20508	3779356	4.84	Power	St Francis/Oyster Bay
124.15	20515	3779356	6.19	Telkom	St Francis/Oyster Bay
124.42	20779	3779288	7.55	Power	St Francis/Oyster Bay
124.51	20860	3779293	7.46	Power	St Francis/Oyster Bay
124.8	21005	3779542	6.9	Power	St Francis/Oyster Bay
125.31	21447	3779722	5.47	Telkom	St Francis/Oyster Bay
130.4	25740	3777084	4.76	Telkom	St Francis/Oyster Bay
133.55	27490	3779590	5.28	Telkom	St Francis/Oyster Bay
135.02	28380	3780756	4.22	Telkom	St Francis/Oyster Bay
135.06	28417	3780776	4.48	Flying Stay	St Francis/Oyster Bay
136.5	29799	3781134	7.36	Power	St Francis/Oyster Bay
137.66	30954	3781242	7.47	Power	St Francis/Oyster Bay
138.11	31405	3781282	490	Telkom	St Francis/Oyster Bay
138.24	31534	3781291	7	Power	St Francis/Oyster Bay
138.25	31549	3781293	11.31	Power	St Francis/Oyster Bay

ANNEXURE D – COMPARATIVE COSTS FOR ALTERNATIVE ROUTES

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COMPARITIVE COSTS FOR ALTERNATIVE HEAVY HAUL ROUTES FROM HARBOUR TO THYSPUNT

REFER TO KEYPLAN DRAWING NO 402763-01-RDS-104 AND 105

LIME GREEN AND RED ROUTE				
NQURA TO WOODRIDGE AND JEFFREYS BAY EAST INTERCHANGE				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks - Rehabilitation (MR460)	Km	5.5	R 5,000,000	R 27,500,000
Extension of Mel Brookes Ave in Uitenhage	Km	0.6	R 8,000,000	R 4,800,000
Construction of overpass bridge bypass ramps ramps	No	1	R 9,650,000	R 9,650,000
O/H Cables to be lifted	No	30	R 10,000	R 300,000
Eskom Power Lines to be lifted	No	5	R 100,000	R 500,000
Propping of Bridges	No	9	R 100,000	R 900,000
Design check of bridges	No	6	R 100,000	R 600,000
Additional roadworks at existing interchange ramps	No	7	R 300,000	R 2,100,000
Strengthing of Van Stadens Bridge	Sum	1	R 3,000,000	R 3,000,000
Strengthing of Gamtoos Bridge	Sum	1	R 2,000,000	R 2,000,000
TOTAL				R 51,350,000

RED ROUTE				
PE HARBOUR TO WOODRIDGE AND JEFFREYS BAY EAST INTERCHANGE				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km		R 8,000,000	
Construction of level crossings & ramp in PE harbour	Sum	1	R 2,000,000	R 2,000,000
Construction of overpass bridge bypass ramps ramps	No	4	R 9,650,000	R 38,600,000
O/H Cables to be lifted	No	34	R 10,000	R 340,000
Eskom Power Lines to be lifted	No	7	R 100,000	R 700,000
Propping of Bridges	No	7	R 100,000	R 700,000
Design check of bridges	No	7	R 100,000	R 700,000
Additional roadworks at existing interchange ramps	No	4	R 300,000	R 1,200,000
Strengthing of Van Stadens Bridge	Sum	1	R 3,000,000	R 3,000,000
Strengthing of Gamtoos Bridge	Sum	1	R 2,000,000	R 2,000,000
TOTAL				R 49,240,000

GREEN ROUTE				
JEFFREYS BAY EAST INTERCHANGE THROUGH HUMANSDORP VIA N2				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km		R 8,000,000	
Construction of overpass bridge bypass ramps ramps	No	1	R 9,650,000	R 9,650,000
O/H Cables to be lifted	No	3	R 10,000	R 30,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges	No	4	R 100,000	R 400,000
Design check of bridges	No	4	R 100,000	R 400,000
Additional roadworks at existing interchange ramps	Sum	2	R 300,000	R 600,000
Humansdorp Bypass A	Sum	1	R 19,000,000	R 19,000,000
TOTAL				R 30,080,000

GREEN ROUTE				
JEFFREYS BAY EAST INTERCHANGE TO WEST INTERCHANGE VIA N2 AND TO FOUNTAINS CIRCLE				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km		R 8,000,000	
Construction of overpass bridge bypass ramps ramps	No	1	R 9,650,000	R 9,650,000
O/H Cables to be lifted	No	3	R 10,000	R 30,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges	No	4	R 100,000	R 400,000
Design check of bridges	No	4	R 100,000	R 400,000
Additional roadworks at existing interchange ramps	Sum	1	R 300,000	R 300,000
TOTAL				R 10,780,000

RED ROUTE				
JEFFREYS BAY EAST INTERCHANGE TO FOUNTAINS CIRCLE VIA MR389				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km		R 8,000,000	
Construction of overpass bridge bypass ramps ramps	No		R 9,650,000	
O/H Cables to be lifted	No	3	R 10,000	R 30,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges (Kabeljous)	No	1	R 200,000	R 200,000
Design check of bridges	No	1	R 100,000	R 100,000
Additional roadworks at existing interchange ramps	No	1	R 300,000	R 300,000
				R 630,000

RED ROUTE				
FOUNTAINS CIRCLE THROUGH HUMANSDORP VIA MR389				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km		R 8,000,000	
Construction of overpass bridge bypass ramps ramps	No		R 9,650,000	
O/H Cables to be lifted	No	15	R 10,000	R 150,000
Eskom Power Lines to be lifted	No	2	R 100,000	R 200,000
Propping of Bridges (Swart)	No		R 100,000	
Design check of bridges	No	2	R 100,000	R 200,000
Humansdorp Bypass A	Sum	1	R 19,000,000	R 19,000,000
Additional roadworks at Fountains Circle	Sum	1	R 500,000	R 500,000
				R 20,050,000

BROWN ROUTE				
FOUNTAINS CIRCLE -MR389 (RED) TO LOMBARDINI TURNOFF TO MR381				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
Surfacing gravel road for haul purposes only	Km	11	R 4,000,000	R 44,000,000
Construction of overpass bridge bypass ramps ramps	No		R 9,650,000	
O/H Cables to be lifted	No	10	R 10,000	R 100,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges	No		R 100,000	
Design check of bridges	No	1	R 100,000	R 100,000
Additional roadworks at Fountains Circle	Sum	1	R 500,000	R 500,000
Drift over Seekoei River	No	2	R 600,000	R 1,200,000
				R 45,900,000

RED ROUTE				
HUMANSDORP TO KROMME RIVER VIA MR381				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km		R 8,000,000	
Construction of overpass bridge bypass ramps ramps	No		R 9,650,000	
O/H Cables to be lifted	No	13	R 10,000	R 130,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges	No	1	R 100,000	R 100,000
Seekoei River Bridge crossfall correction and strengthening	Sum	1	R 1,350,000	R 1,350,000
Kromme River Bridge propping and strengthening	Sum	1	R 2,000,000	R 2,000,000
Design check of bridges	No	2	R 100,000	R 200,000
TOTAL				R 3,780,000

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RED ROUTE				
KROMME RIVER TO SEA VISTA				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km		R 8,000,000	
Construction of overpass bridge bypass ramps ramps	No		R 9,650,000	
O/H Cables to be lifted	No	5	R 10,000	R 50,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges	No		R 100,000	
Upgrading of MR381 Kromme to Eastern Access	Km	5.5	R 1,300,000	R 7,150,000
Widen St Francis Bay entrance and additional stormwater control	Sum	1	R 12,000,000	R 12,000,000
				R 19,200,000

RED ROUTE				
THYSPUNT EASTERN ACCESS ROAD				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km	10	R 11,500,000	R 115,000,000
				R 115,000,000

LIGHT BLUE ROUTE (OYSTER BAY ROAD)				
HUMANSDORP TO DR1762 INTERSECTION ALONG DR1763				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km	11.5	R 8,000,000	R 92,000,000
Construction of overpass bridge bypass ramps ramps	No		R 9,650,000	
O/H Cables to be lifted	No	5	R 10,000	R 50,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges	No		R 100,000	
Design check of bridges	No		R 100,000	
Kromme River low level bridge	No	1	R 4,000,000	R 4,000,000
				R 96,050,000

YELLOW ROUTE				
KROMME RIVER TO DR1763 INTERSECTION ALONG DR1762				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km	12	R 8,000,000	R 96,000,000
Construction of overpass bridge bypass ramps ramps	No		R 9,650,000	
O/H Cables to be lifted	No	15	R 10,000	R 150,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges	No		R 100,000	
Design check of bridges	No		R 100,000	
Drifts	No	2	R 400,000	R 800,000
				R 96,950,000

LIGHT BLUE ROUTE (OYSTER BAY ROAD)				
DR1762 INTERSECTION TO THYSPUNT ALONG DR1763 AND NORTHERN ACCESS				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km	9	R 8,000,000	R 72,000,000
Construction of overpass bridge bypass ramps ramps	No		R 9,650,000	
O/H Cables to be lifted	No	10	R 10,000	R 100,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges	No		R 100,000	
Design check of bridges	No		R 100,000	
				R 72,100,000

PURPLE ROUTE				
THYSPUNT WESTERN ACCESS ROAD				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km	8.5	R 11,500,000	R 97,750,000
				R 97,750,000

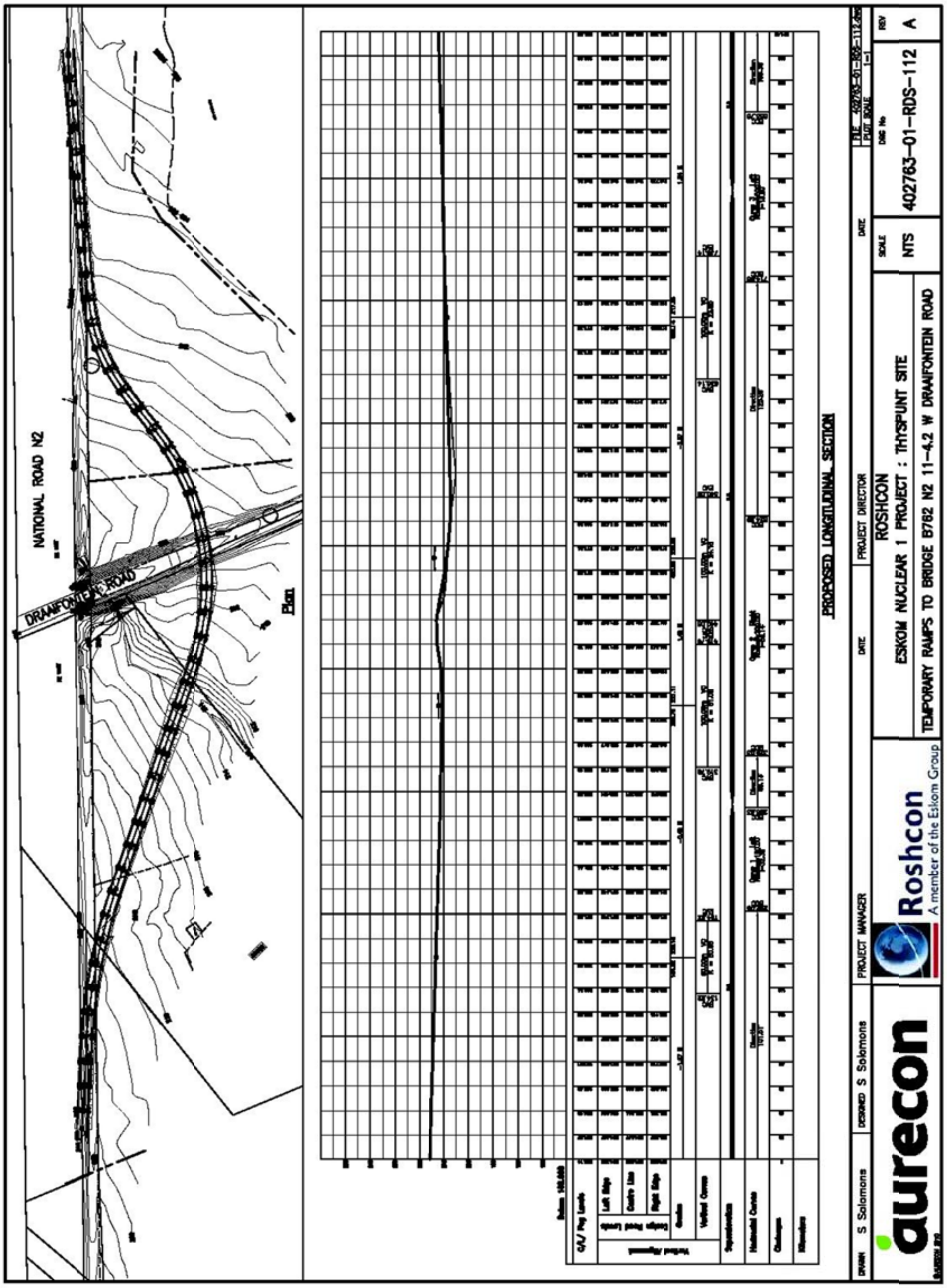
DARK BLUE ROUTE				
IMPOFU ALTERNATIVE HUMANSDORP - DR1763				
Description of work	**Unit**	**Quantity**	**Rate**	**Estimated Amount**
New Roadworks	Km	18	R 8,000,000	R 144,000,000
Construction of overpass bridge bypass ramps ramps	No		R 9,650,000	
O/H Cables to be lifted	No	10	R 10,000	R 100,000
Eskom Power Lines to be lifted	No		R 100,000	
Propping of Bridges	No	3	R 100,000	R 300,000
Design check of bridges	No	3	R 100,000	R 300,000
				R 144,700,000

SUMMARY OF COMPARATIVE COSTS FOR ROUTE COMBINATIONS

DESCRIPTION OF ROUTE	**COMPARITIVE COST**
Green Nuqra to Woodridge and Red to Jeffreys Bay East interchange - common to all routes from Nqura	R 51,350,000
Red from PE to Woodridge and Jeffreys Bay East interchange - common to all routes from PE	R 49,240,000
COMPARISON OF ROUTES FROM JEFFREYS BAY EAST INTERCHANGE TO THYSPUNT	
Red to Kromme-Red to Sea Vista and Red to Thyspunt	R 158,660,000
Green along N2 to Humansdorp-Red to Sea Vista, Red to Thyspunt	R 168,060,000
Green to J Bay West -Mauve to Fountains-Red to Kromme-Red to Sea Vista-Red to Thyspunt	R 168,810,000
Red J Bay East-Brown Lombardini-Red to Sea Vista-Red to Thyspunt	R 180,730,000
Red J Bay East to Humansdorp, Light Blue to Thyspunt	R 188,830,000
Red J Bay East to Humansdorp, Dark Blue to DR1763, Light Blue to Thyspunt	R 237,480,000
Red to Kromme-Yellow and Light Blue to Thyspunt	R 193,510,000

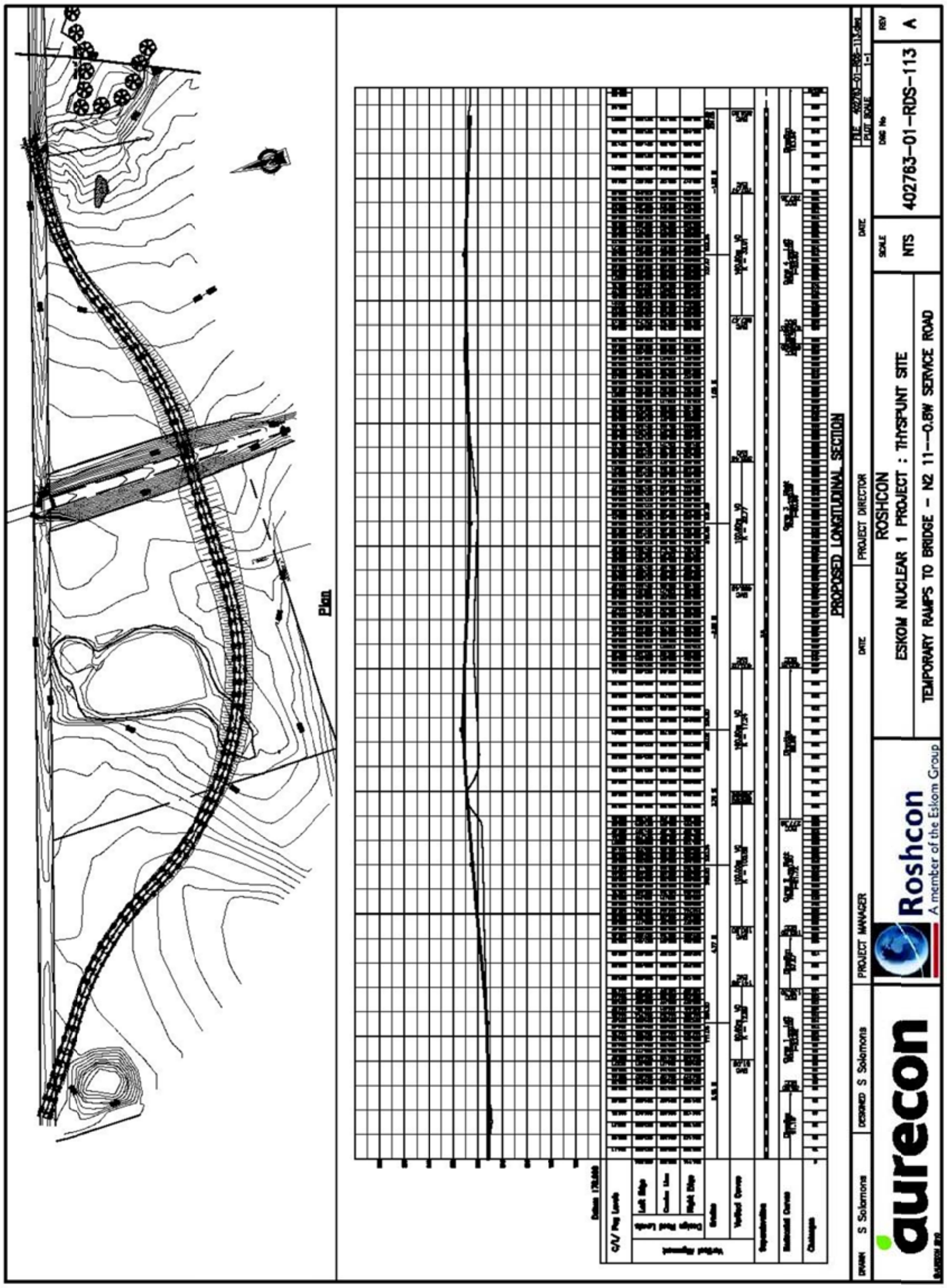
Comparative total cost of most economical (red) route from PE harbour to thyspunt = R 207,900,000

ANNEXURE E – OVERPASS BRIDGES – BYPASS LONGITUDINAL SECTIONS



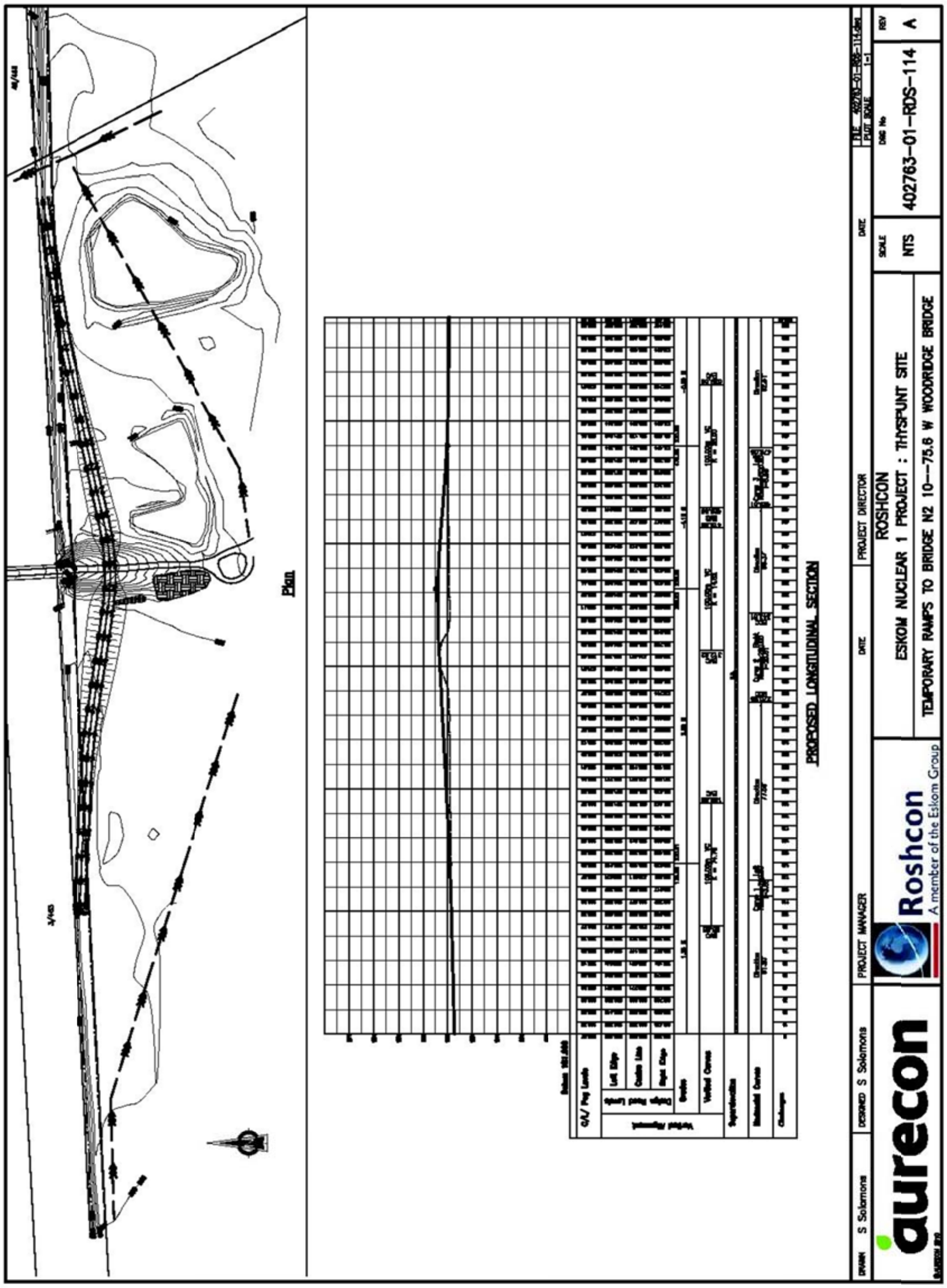
Drawing 3: 402763-01-RDS-112-A-Temporary Ramps to Bridge Draaifontein road

Note that this drawing is provided as a PDF and is best viewed as an A3 size.



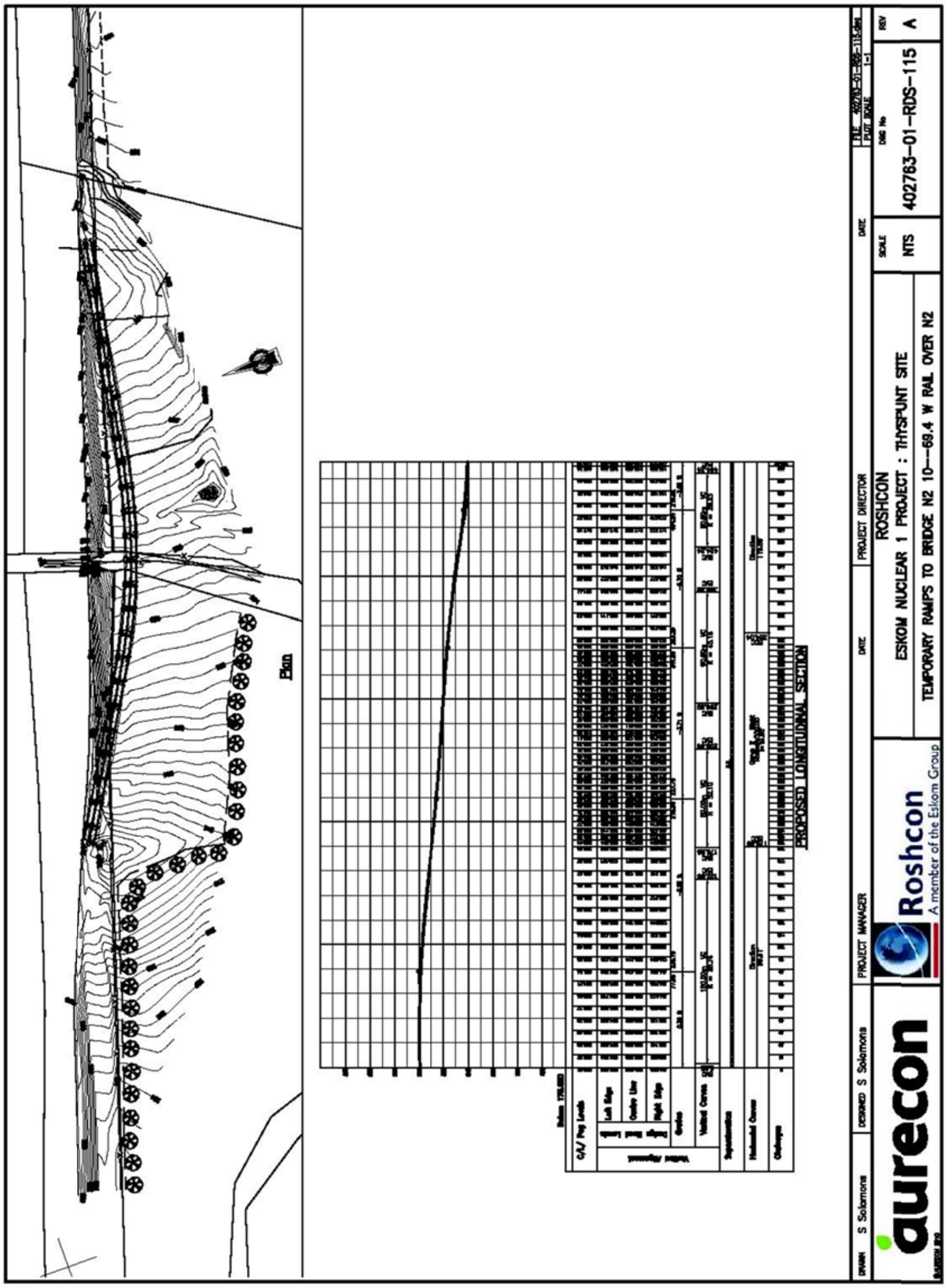
Drawing 4: 402763-01-RDS-113-A-Temporary Ramps to Bridge Service road

Note that this drawing is provided as a PDF and is best viewed as an A3 size.



Drawing 5: 402763-01-RDS-114-A-Temporary Ramps to Bridge Woodride road

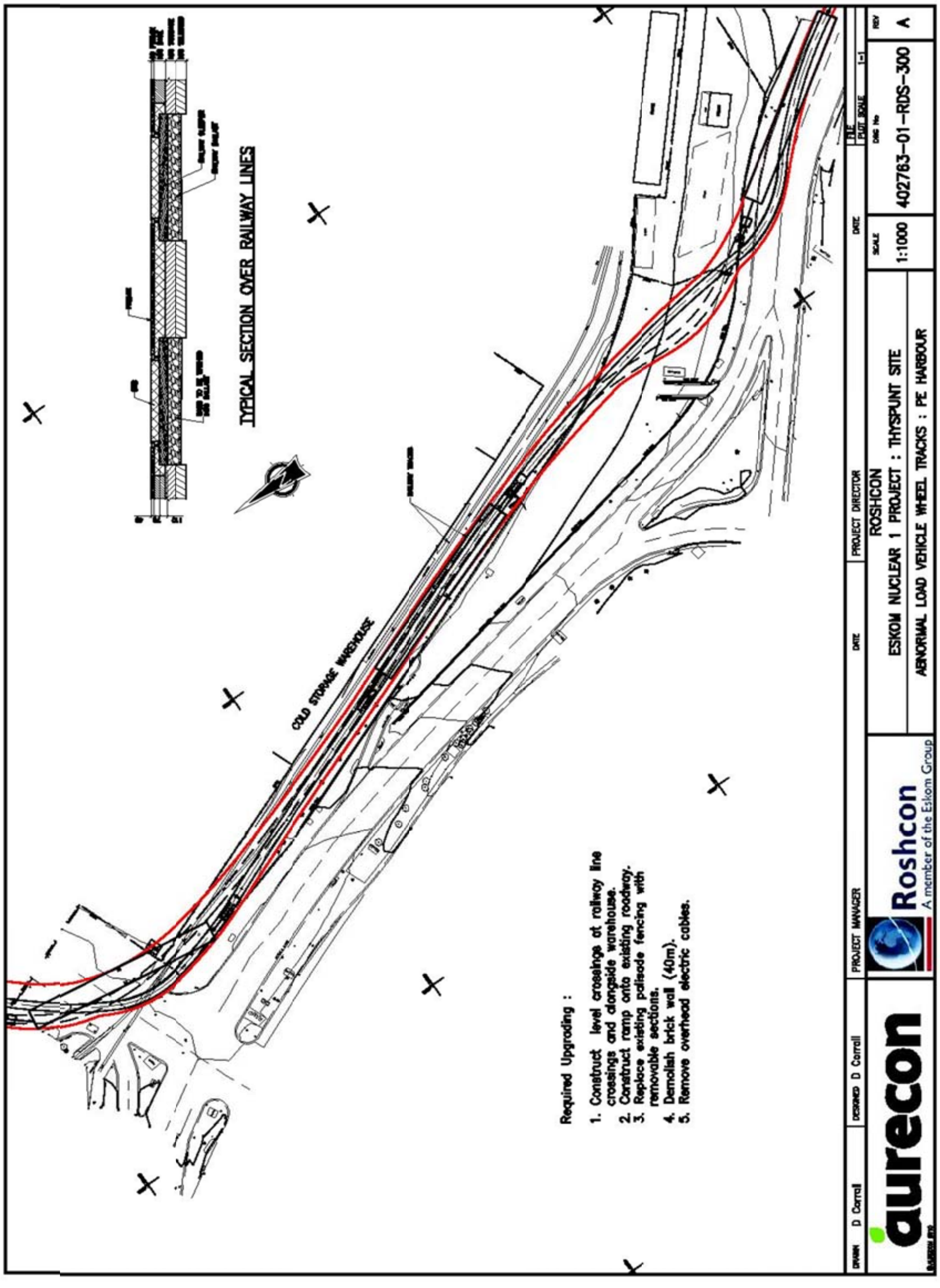
Note that this drawing is provided as a PDF and is best viewed as an A3 size.



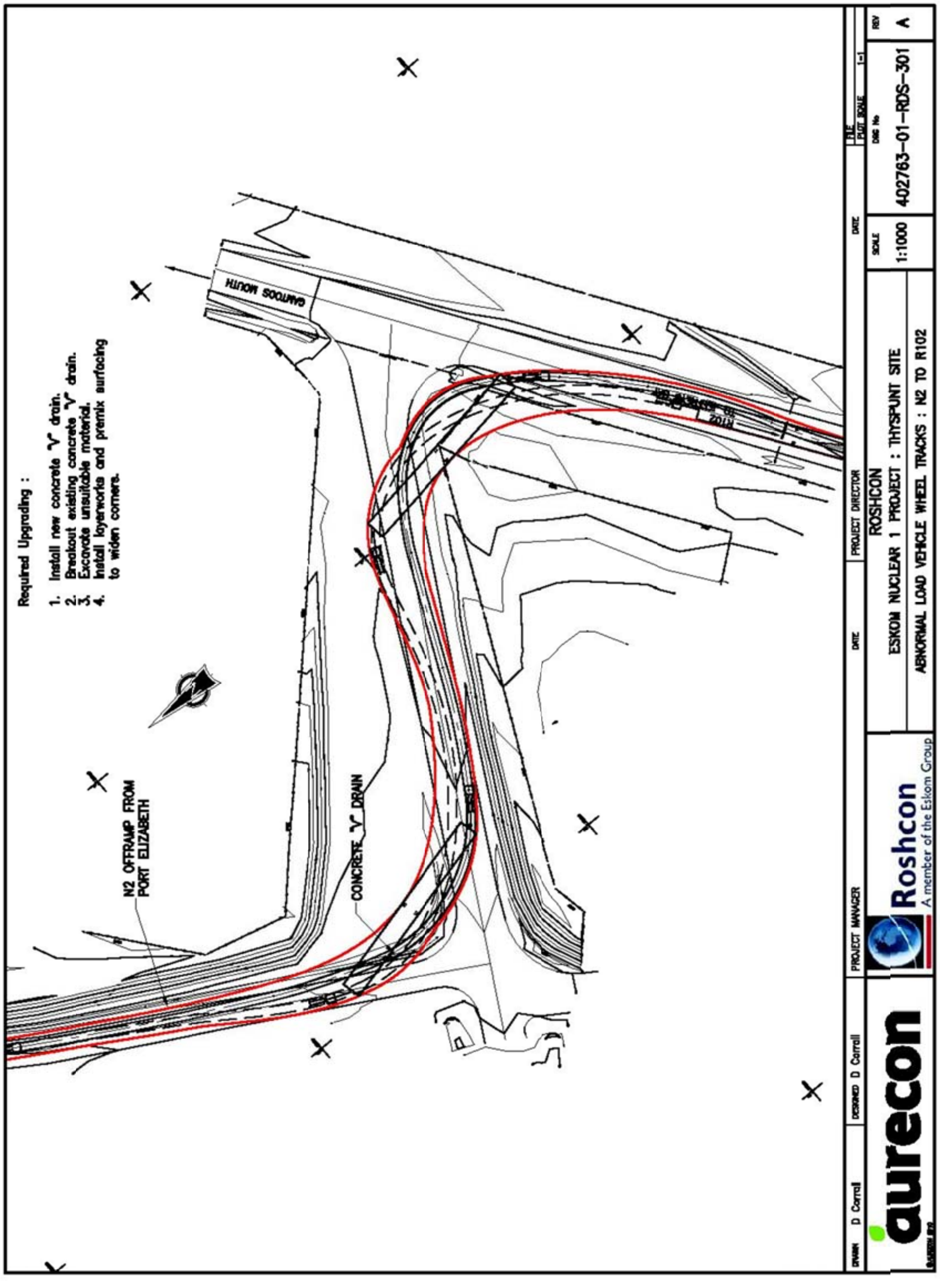
Drawing 6: 402763-01-RDS-115-A-Temporary Ramps to Bridge Rail over N2

Note that this drawing is provided as a PDF and is best viewed as an A3 size.

ANNEXURE F – INTERSECTION WHEEL TRACK PLANS

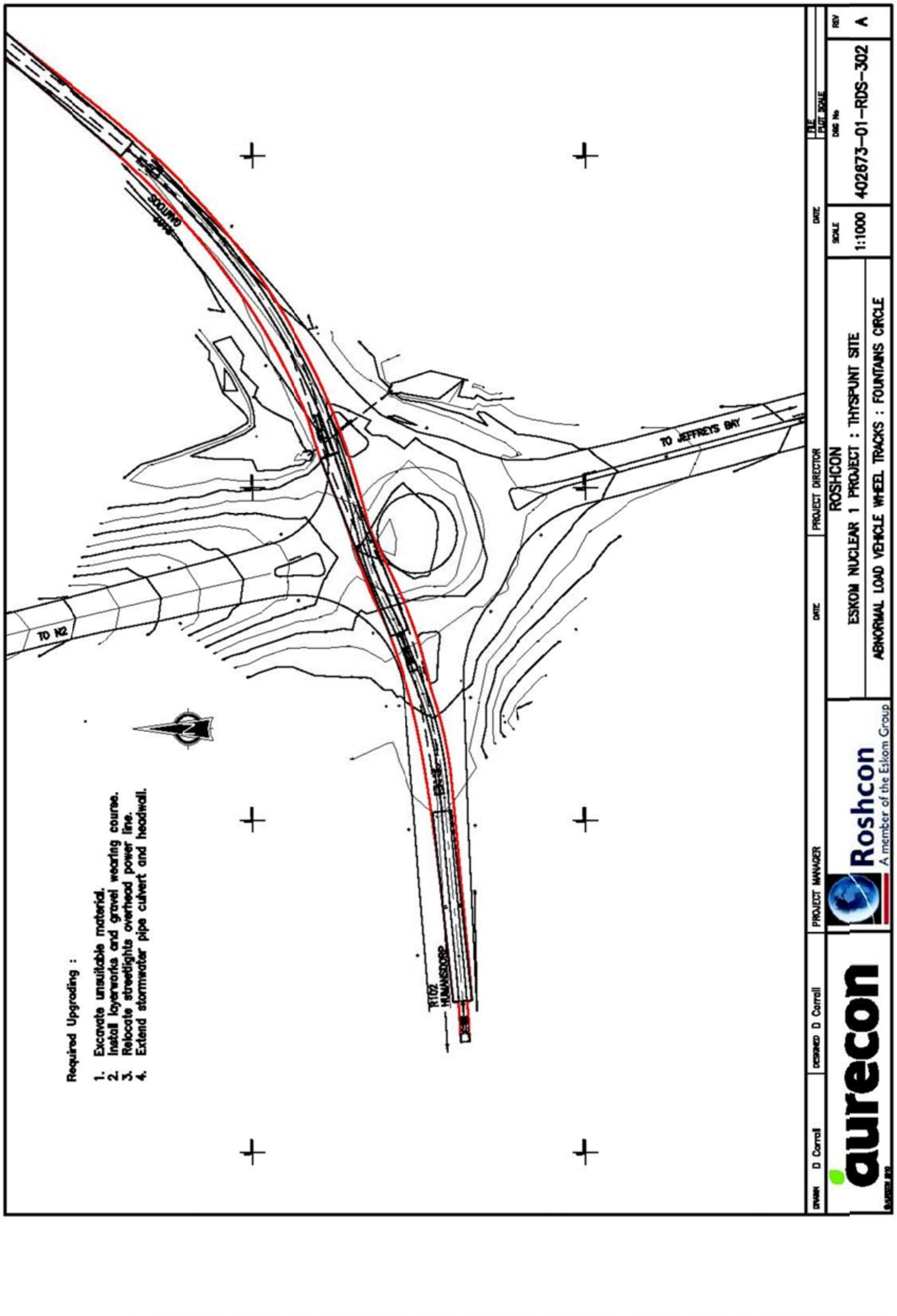


Drawing 7: 402763-01-RDS-300-A-Abnormal Load Wheel tracks: PE Harbour

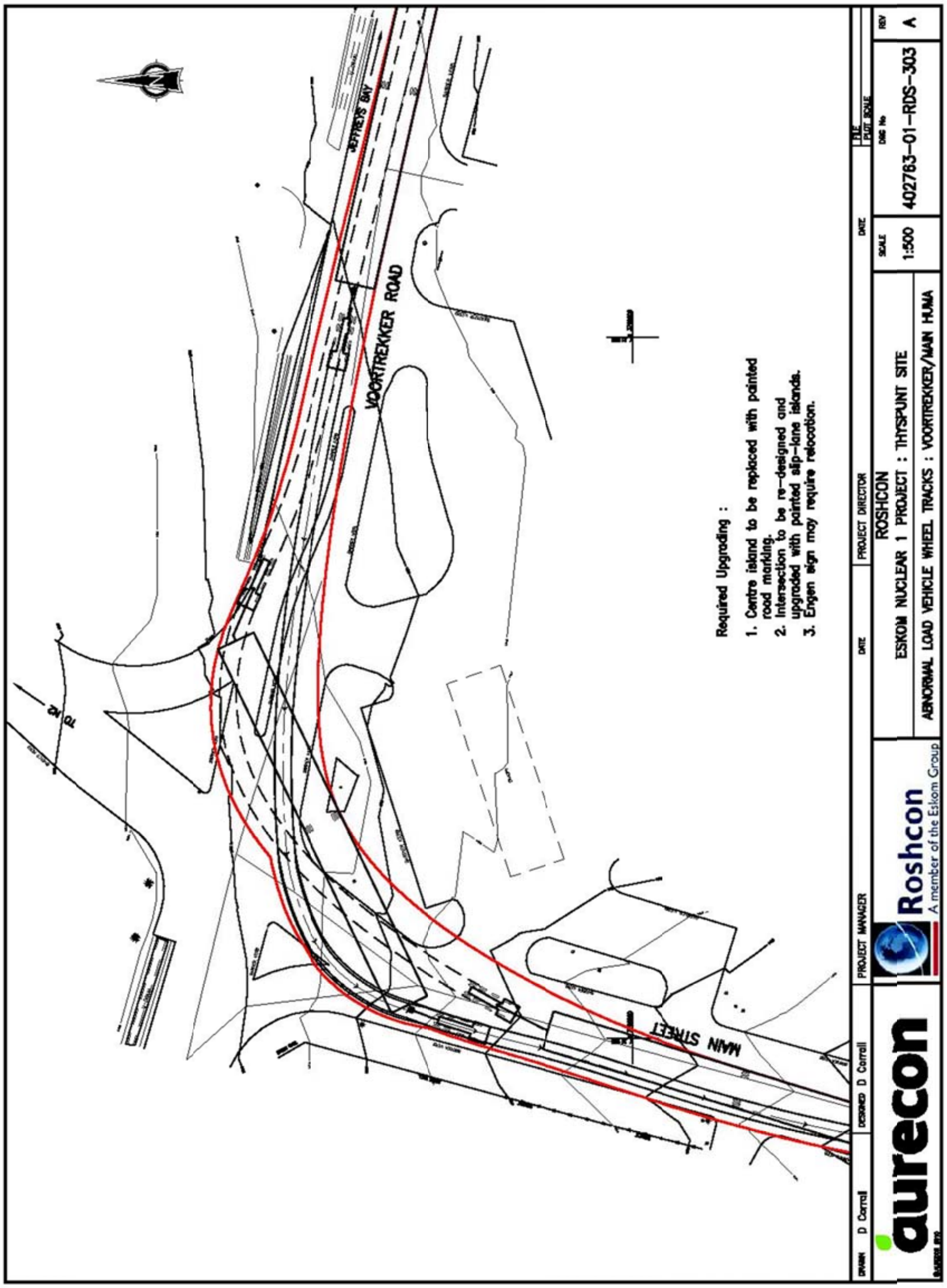


Filename : R:\0L_Current\402763_Thyspunt Powerplant Project\402763_T01 Heavy Haul & General\CAD\Intersection Details.dwg\301-turn off from new n2 to old n2 -- 30/Nov/2010 15:06 by DAVECO

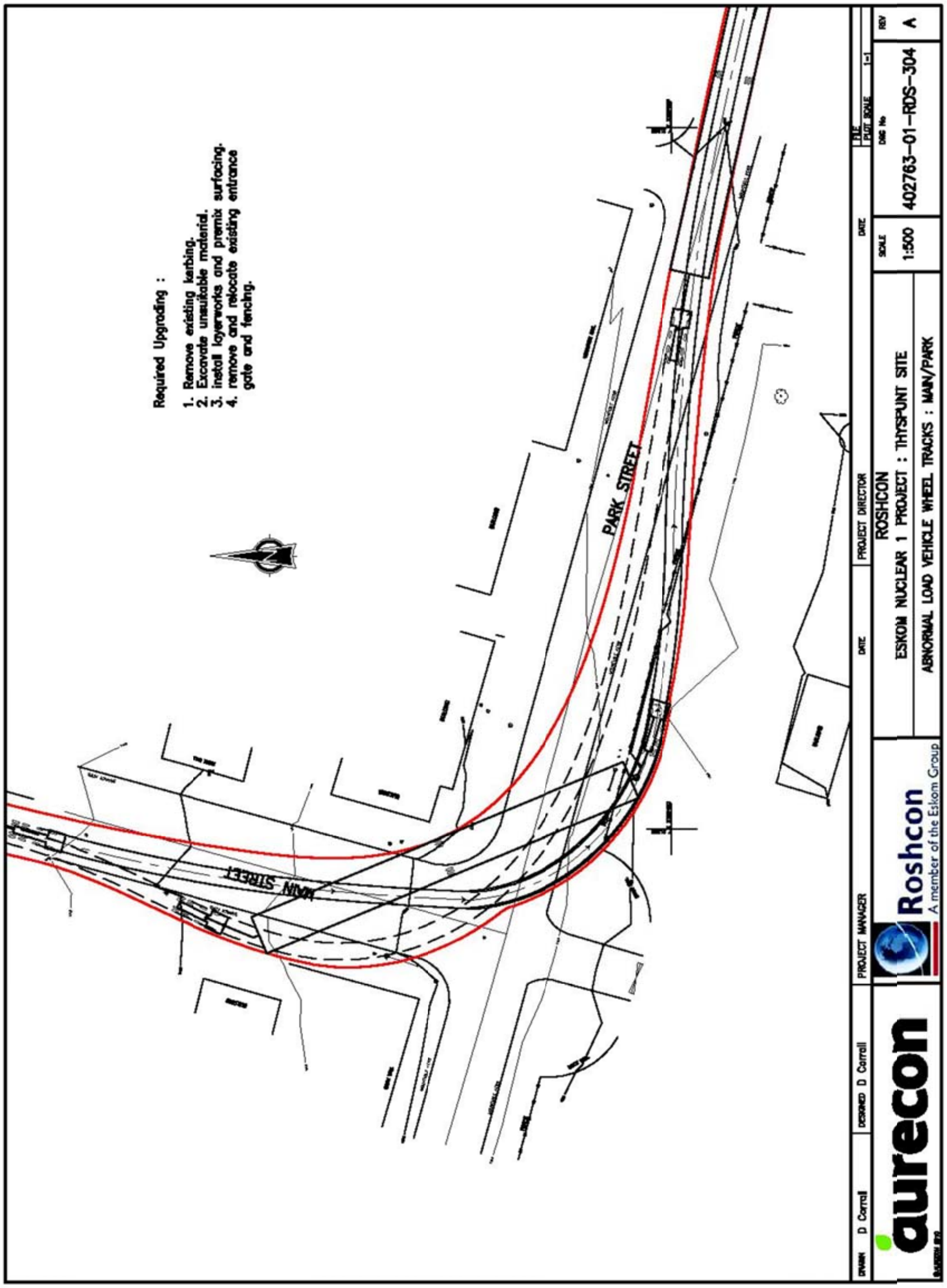
Drawing 8: 402763-01-RDS-301-A-Abnormal Load Wheel tracks: N2 to R102



Drawing 9: 402763-01-RDS-302-A-Abnormal Load Wheel tracks: Fountains Circle



Drawing 10: 402763-01-RDS-303-A-Abnormal Load Wheel tracks: Voortreker Main Huma



Drawing 11: 402763-01-RDS-304-A-Abnormal Load Wheel tracks: Main/Park

ANNEXURE G – PORT HANDLING FEASIBILITY ASSESSMENT

ANNEXURE H – DRAWING 402763-01-RDS-106-PREFERED ROUTE LAYOUT PLAN

(Drawing is best viewed as an A0 size)

ANNEXURE I – DETAILED DISCUSSION ON BRIDGE LOADING CRITERIA

DISCUSSION ON BRIDGE LOADING CRITERIA		
Comment No.	Comment	Author's Reply
11	There are two flaws inherent in this approach: 1. The load factor of 1.2 (generally applied to NB and NC design loads) cannot be seen as providing reserve capacity that can be used for load cases that overload the structure. This load factor, together with various material factors, ensures that the probability of exceeding the various ultimate limit states is limited to a specified value. Once a load factor is reduced, then this probability of exceedence is accordingly increased. The influence on acceptable structural safety that follows from this increased probability of exceeding the ultimate limit states subsequently needs to be evaluated. If the load factor to be applied to the load imposed by the 27 axle trailer is to be reduced, because the uncertainty inherent in this load is deemed to be less than is the case for a general design load, then the reduction must be carried out in accordance with the recommendations of the selected bridge design loading code and associated bridge design code of practice.	This part of the report only refers to the decision as to what vehicle to consider for the fatal flaw study. A comment was received, from Eskom, expressing concern that the chosen vehicle (providing a UDL of 28.65 kN/m^2) did not allow for a sufficiently large factor of safety over the 30 kN/m^2 of the NC load. The author merely tried to explain that the 30 kN/m^2 from the NC loading already have an inherent factor of safety and further factors of safety need not be considered. It was therefore not the intention to suggest that the safety factors can be reduced for this specific load.
	2. Although the checks of the ultimate limit states (strength) are important, I believe that the serviceability limit states checks (e.g. deflection, rotations at the bearings, cracking, etc.) are equally important. For these cases, any exceedence must be justified with extreme circumspection.	The author is of the opinion that a fatal flaw study should only consider the Ultimate Limit State. As far as the Serviceability Limit State is concerned the author would like to comment as follows: Deflection - the South African bridge design code (TMH 7) does not set deflection limits. Cracking - It would not be possible to determine crack widths of the structural members without information on the actual reinforcement used in the members. As stated in another part of the report, as-built or design drawings could not be obtained for most of the bridges. If the Serviceability Limit for crack widths is however exceeded due to the proposed load, this will not impair the structural capacity of the bridge, but may have a negative impact on durability. It would be possible to monitor the actual cracks caused by the load and repair these cracks if required. Rotation of bearings – The rotation capacity of the bearings can only be determined if more information is available of the actual bearings used.
	3. For the purpose of this investigation a 5.6 m wide 27 axle trailer was considered with axles spaced at 2.05 m. The weight of the trailer is 155.25 t and an additional allowance of 50 t was made for spreader beams in order to distribute the load. A total weight of 650 + 155.25 +50 = 855.25 t was therefore used. This load is distributed over 5.6 m wide by 53.3 m long giving a uniformly distributed load of 28.65 kN/m2. Was this data derived from a specific vehicle or vehicles? If so please identify them.	After discussions with heavy load transporters Westinghouse and Rotran, a number of possible vehicles were identified. It was eventually decided to consider a modular vehicle. This vehicle consists of modules of trailers consisting of 3 or 7 axles. The trailers are propelled by means of a number of truck, both in front or behind the trailers. The photograph below shows a similar vehicle with a spreader beam, similar to that considered. Details of a 20 axle trailer are attached.

DISCUSSION ON BRIDGE LOADING CRITERIA		
Comment No.	Comment	Author's Reply
		
12	The 90 kN wheel load represents 36 units of HB loading. Is it possible that 24 units (i.e. 60kN per wheel) could have been used for some of the bridges?	The loading code in use at that time did not have the equivalent of 24 Units of NB loading and it is therefore highly unlikely to have been used for the design of these structures.
13	Comment 1 also applies here. It is re-emphasised that serviceability checks are extremely important, and it is noted that the results for the ultimate limit state load combinations cannot be applied to the service load checks because the load factors for the two different limit states differ.	See reply to the second part of query 11 above.
14	The following comments apply to the checks reported for all the bridges considered in this document: 1. Comment 1 and Comment 4 also apply here.	
	2. Descriptions of the analyses should be provided in greater detail.	The bridges were modelled as grillages and analysed on the Prokon suite of structural analyses programs.
	3. Details of the load combinations must be provided. This includes a description of the component loads (e.g. dead load, live load, etc.) together with the load factors applied.	The following loads were considered: DL – Self weight of the bridge deck, parapets and surfacing NBL – Normal bridge loads according to the 1971 bridge loading code of the Cape Provincial Administration. ABL – Abnormal bridge loads according to the 1971 bridge loading code of the Cape Provincial Administration. NL – Loading due to the heaviest component (steam generator – 628.3 kg) required for the proposed new nuclear power station near Thyspunt together with the transportation vehicle. The following load combinations together with the load factors were considered: Combination / Load Case / ULS / SLS C1 / DL / 1.32 / 1 NL / 1.32 / 1 C2 / DL / 1.32 / 1 NBL / 1.65 / 1 C3 / DL / 1.32 / 1
	4. It is important to note that the comparison of load effects cannot be based on the load effects induced by the live loads only. The comparison must be based on the load effects induced by the relevant load combinations. Please confirm that load combinations were used.	Load combinations were considered as described above.

DISCUSSION ON BRIDGE LOADING CRITERIA		
Comment No.	Comment	Author's Reply
	5. Please confirm that the original design load referred to in the tables correspond to the loads prescribed by the bridge loading code of the Cape Provincial Administration.	No design loads were stated on the as-built drawings that could be obtained and the original design load is therefore not known for certain. After discussions with the bridge engineer of the CPA as well as a retired CPA bridge engineer, who was responsible for the design of the Gamtoos River bridge, we are reasonably confident that the bridge loading, as described in the report, was used in the design of the bridges under consideration.
	6. Please consider checks on the substructure elements as well as bearings. If these are not done, then a proper justification for this omission should be provided.	We are of the opinion that the substructure and bearings will not be critical and they were not considered for this fatal flaw study. It will be extremely difficult to do checks on the substructure and bearings without as built drawings of these elements.
	7. It is suggested in the report that overstress with respect to moment, shear and torsion can be remedied by providing external reinforcement in the form of plates. In such cases, please provide the results of supporting calculations that demonstrate the viability of this solution.	The strengthening measures were not designed in detail, but preliminary calculations were performed to investigate the viability of the strengthening measures. The strengthening was designed by assuming the minimum reinforcement required to withstand the moment due to the original design loads and then adding steel plates to the bottom of the section to increase the moment capacity to that required for the proposed new loading. In the analysis of section calculations it was assumed that both the steel plates and the reinforcing steel is yielding at the ultimate moment state of bending. An example of the calculations for the Kabeljous River bridge on MR 389 is included.
	8. It is not clear what criterion was applied to assess if strengthening work is required. This is particularly true for torsion, in which case a 44.6% and 60.1% exceedence are found to be acceptable in the case of the Van Staden's River Bridge and the Kabeljous River Bridge, respectively. Yet the report suggests that strengthening is required for torsion in the case of the Seekoei River Bridge, where the torsion moment induced by the 27 axle trailer exceeds that induced by the original design loads by 36.4%.	The load comparison method is inherently conservative as it does not allow for any reserve capacity in the bridges. Normally during the design process the structural members are designed for bending moment and shear forces and the torsional capacity is checked. The reserve capacity with regards to bending moment and shear was estimated to be approximately 20% based on previous experience. For the detailed design stage it will be attempted to obtain additional information to verify this assumption. The torsion moments were generally very low compared to the torsional capacity of the structural members and even high overstress was not considered to require remedial measures. Strengthening for shear also increases the torsional capacity and that is why the report mentions strengthening for shear and torsion for some bridges where shear strengthening is required and no strengthening where only the torsion moments are exceeded.
15	This conclusion is valid only if the load combinations prescribed by the code have been applied in the analysis. It is therefore important to describe the load combinations considered in the analysis in order to enable the reader to assess the validity of this conclusion.	See reply to comment 14 above.
16	This conclusion only applies to the ultimate limit state for flexure. I believe that it is important to check the	It was decided not to use the original allowable stress approach in the comparison between the original loads

DISCUSSION ON BRIDGE LOADING CRITERIA		
Comment No.	Comment	Author's Reply
	serviceability limit states in this case, particularly because the original design would have been based on an allowable stress design approach.	and the proposed new load since using the current limit state approach would lead to more conservative results. The previously used allowable stress approach did not allow for different load factors and therefore only limited the allowable stress under service conditions to a conservatively low value. For this investigation load factors were applied to the original design loads in line with what would be allowed for similar load in the modern loading codes (1.65 for normal loading and 1.32 for abnormal loading).
22	"…..Costs for Van Stadens River crossing…" This is an important cost and we need to have some indication of the cost to do comparisons with Task Order 8 Port St. Francis Harbour Investigation.	For the Van Stadens River crossing only the arch was considered for this fatal flaw study as the columns could be temporarily braced to increase their axial capacity. For the cost comparison study it is proposed to assume the worst case scenario where the columns need bracing. We estimated the steel required for this bracing to be in the region of 60t of structural steel at R25000/t. This provides a cost for the temporary bracing of R1.5m.
23	A lack of backup calculations. Particularly, with these bridges the calculations determine the feasibility or not of the routes.	The author trusts that the answers to the above queries show that sufficient calculations were performed in order to prove that there are no fatal flaws in the ability of the bridges to carry the proposed load.

Annexure F

Eskom Nuclear 1 Project: Thyspunt Site Evacuation Routes

Aurecon Report: 5319
16 March 2011
Revision 2

PREPARED BY:

Jeanne Rossouw
Aurecon Port Elizabeth

SUBMITTED TO:

Mr J Kotze
Roshcon

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1. INTRODUCTION

In order to assess the suitability of the existing road infrastructure to serve as evacuation routes for the local communities around the Thyspunt site, Aurecon were tasked to draft a report, highlighting potential bottlenecks and obvious shortcomings of the existing road infrastructure.

The findings of this report are to be used in engaging with authorities to facilitate the upgrading of the proposed evacuation routes as part of their upgrading programs if necessary.

1.1 Terms of Reference

The initial instructions, as per Task Order no.1 were to:

- Identify all routes away from the site and surrounding communities within a 20km radius of the proposed power station and evaluate for use as evacuation routes.
- Drive and assess the condition of the roads, identifying bottlenecks, taking photos and measuring distances to junctions with surfaced roads.
- Develop proposals and mitigation solutions.

These terms were revised at a later progress meeting to consider a smaller evacuation radius of 16km as well as focus on an 800m buffer around the proposed site. Intermediate evacuation radii of 3 and 5km were also to be investigated.

2. INVESTIGATIONS

The 20km radius, as specified in Task Order 1, around the Thyspunt site contains 4 primary population nodes.

These nodes, listed in order of proximity are:

a) Oyster Bay

b) St Francis bay and Cape St Francis

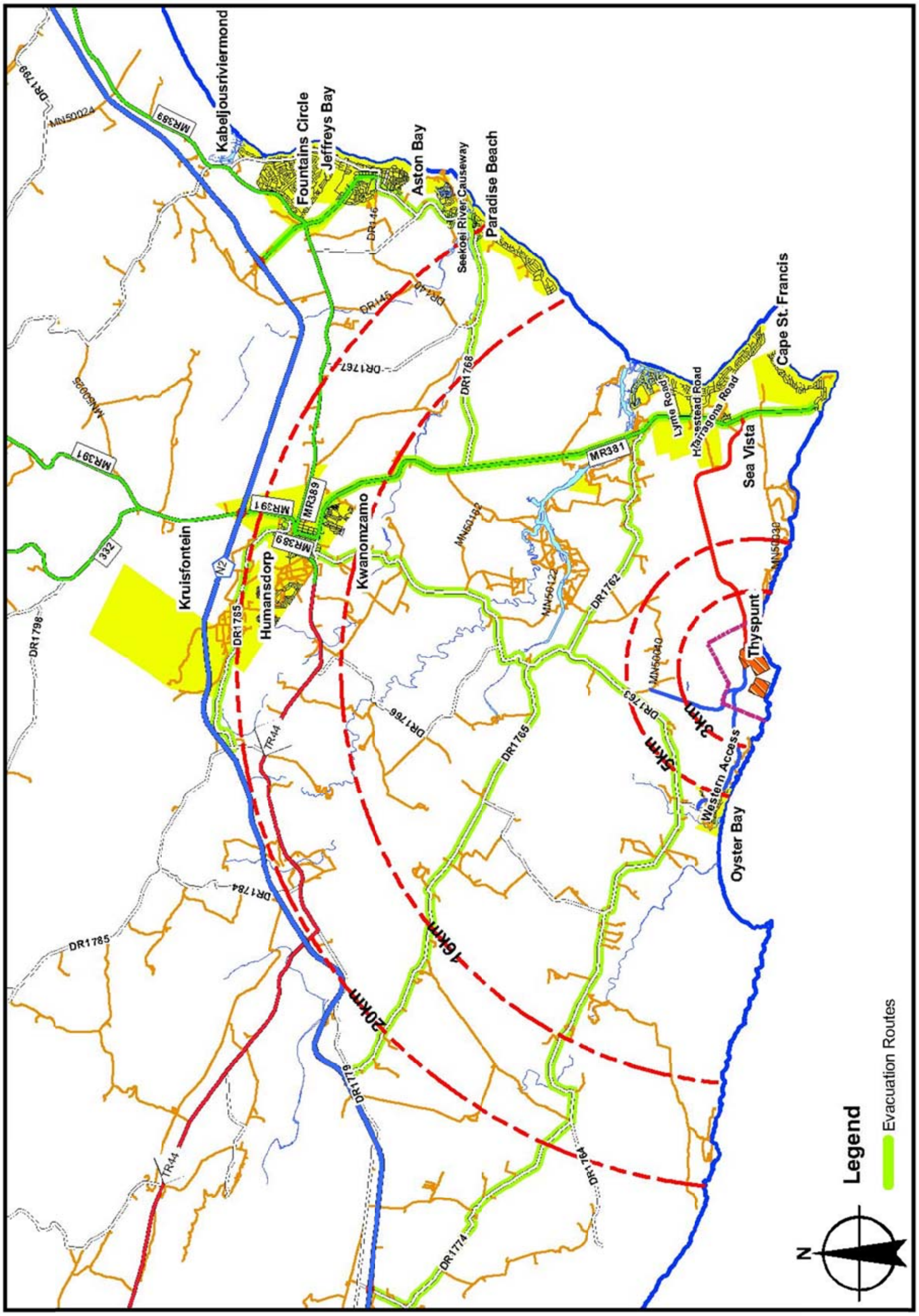
c) Humansdorp (including Kruisfontein and Kwanomzamo)

d) Paradise Beach

The balance of the area comprises of low density farming areas with isolated farmsteads occurring throughout the 20km radius.

From aerial images and topographical maps, several routes as depicted on Image.1 were identified as possible evacuation routes from the Thyspunt site and the above mentioned nodes.

Image. 1: Potential Evacuation Routes



In order to qualify as an evacuation route the roads should meet the following minimum requirements

- Be capable of handling two way traffic
- Be suitable for use in all weather
- Service a local community
- Connect to higher order roads
- Lead away from the Thyspunt site
- Fall within the allocated minimum radius
- Facilitate evacuation within a prescribed time

All roads falling within a 20km radius of the site which qualified as evacuation routes as per the abovementioned criteria were assessed during a visual inspection held on 17 September 2010.

The routes were assessed in terms of drivability, road condition, road width and potential for bottlenecks. Cognisance was given to the future upgrading of the various roads as well as the construction of new roads within the area to service the existing communities.

The construction of access roads as part of the Thyspunt development was also evaluated in terms of their impact on the evacuation of the area.

2.1 Findings

The findings of the investigation are as follows:

2.1.1 Evacuation of Oyster Bay

Oyster Bay has two primary evacuation routes as shown on Image.2, The northern route (DR1763) is in the process of being upgraded to a surfaced road and will serve as the main evacuation route for residents of Oyster Bay.

The western route is a gravel road (DR1763/1774/1776) which intersects with the N2 approximately 25km west of Thyspunt.

No obstructions are present on the northern route along DR1763, but it is anticipated that bottlenecks would occur at all the main intersections in and around Humansdorp as a result of general congestion in the town and the additional vehicular traffic as a result of the evacuation process.

Congestion at the turn off to Oyster Bay as shown on Image.3 from DR1763 to DR1761 would warrant an improved intersection and alignment depending on the orientation of the planned Western Access road to the Thyspunt site.

Image. 2: Oyster Bay Evacuation Routes

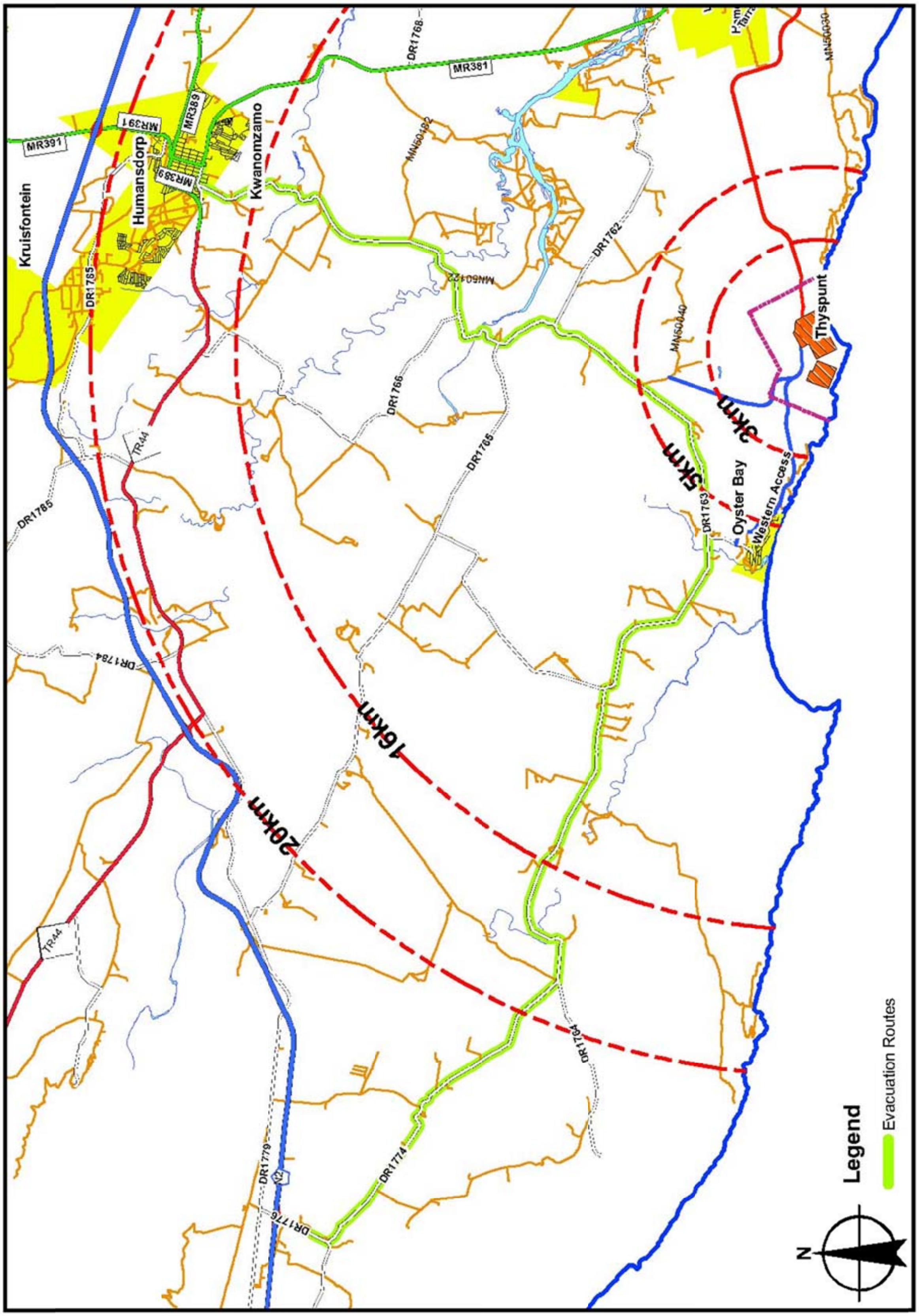
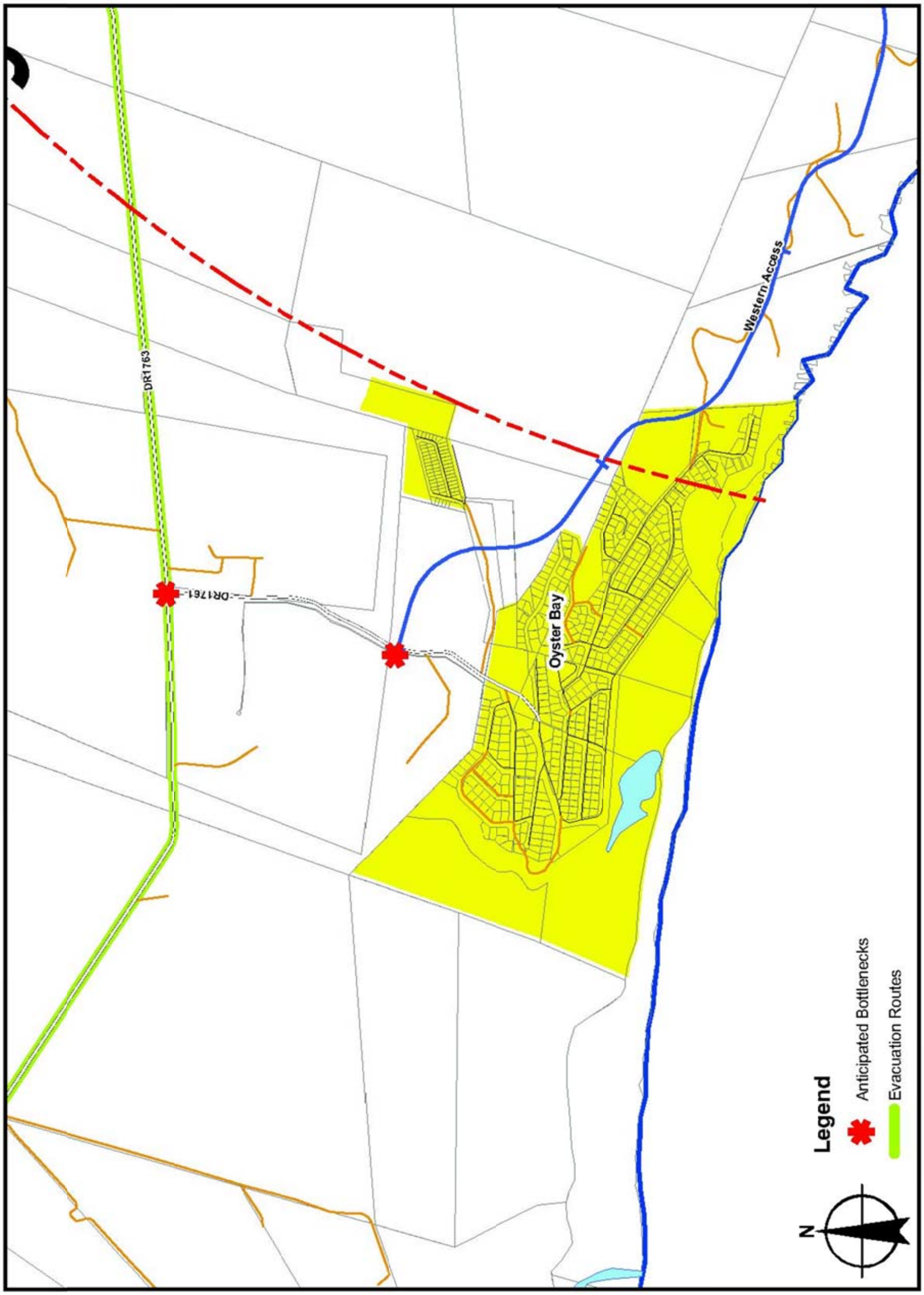


Image. 3: Oyster Bay Bottlenecks



The current roads are in a good condition and suitable for use as evacuation routes. Regular maintenance will be required to maintain the status of the roads as evacuation routes. As these are provincial roads, maintenance is carried out by the Provincial Roads Department. The conditions of all the district roads identified in the report should however be continuously monitored by the Thyspunt safety staff to ensure that the present status of the routes is maintained.

2.1.2 Evacuation of St Francis Bay and Cape St Francis

The Evacuation routes from St Francis Bay and Cape St Francis are shown on Image. 4 overleaf.

Main Road (MR381), between Humansdorp and St Francis Bay would serve as the main evacuation route for St Francis and Cape St Francis. The road is surfaced, is currently in reasonable condition and is suitable for use as an evacuation route.

As an alternative to joining the N2 at Humansdorp, some residents may elect to head east along DR1768 to Paradise Beach. This district road is a gravel road in good condition but does require regular maintenance as well as continuous monitoring.

A new surfaced road between Jeffrey’s Bay and St Francis Bay, shown as a dotted line is being planned. This road would obviate the need to use DR1768 and aid in reducing the congestion in Humansdorp as many residents can be directed towards the N2 via Jeffery’s Bay.

Bottlenecks are to be expected within St Francis Bay and at the Lyme Road, Tarragona and Homestead Road intersections with MR381 as well as at the existing Oyster Bay turn off, south of the Kromme River. These are shown on Image. 5.

Image. 4: St Francis Bay Evacuation Routes

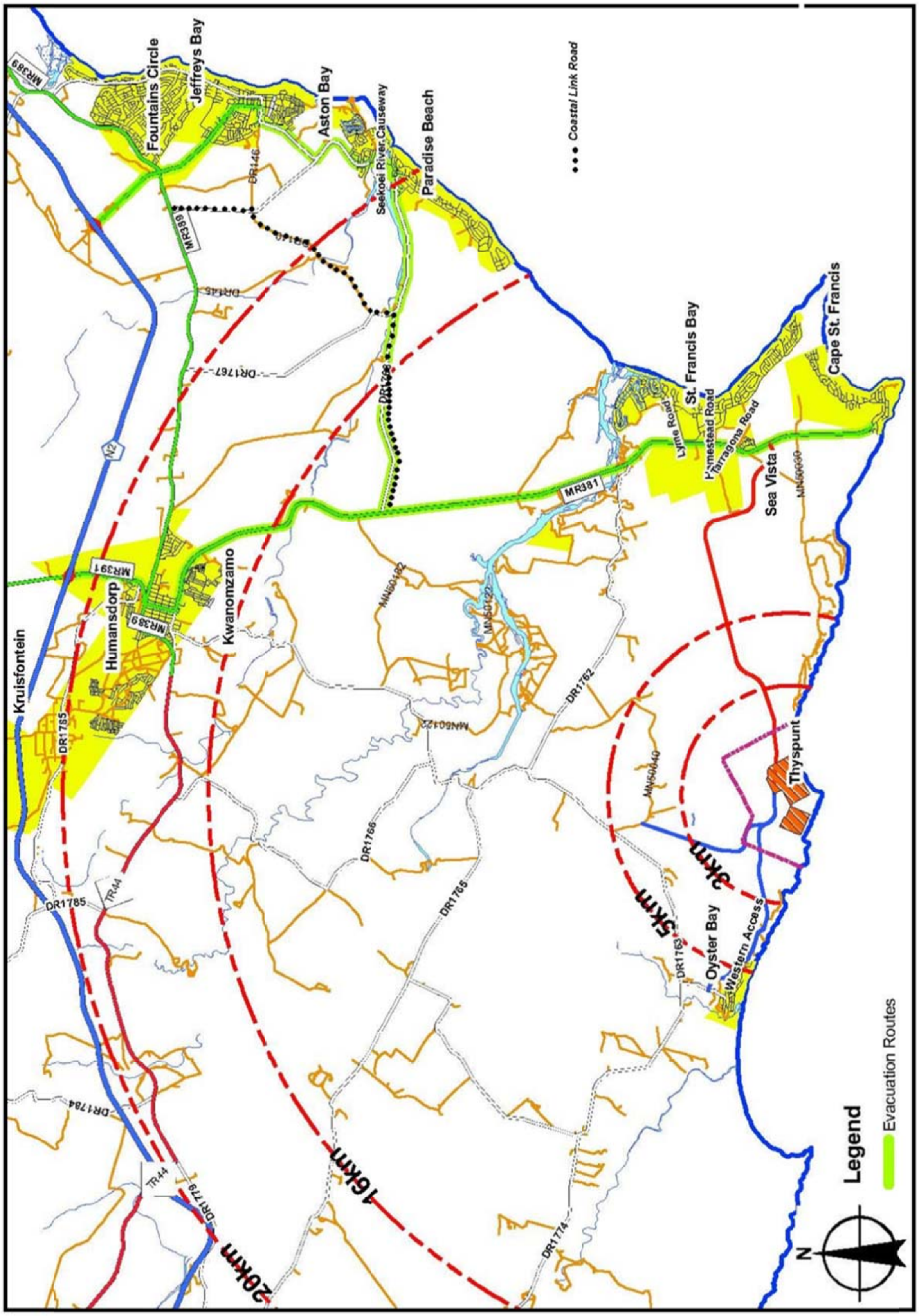
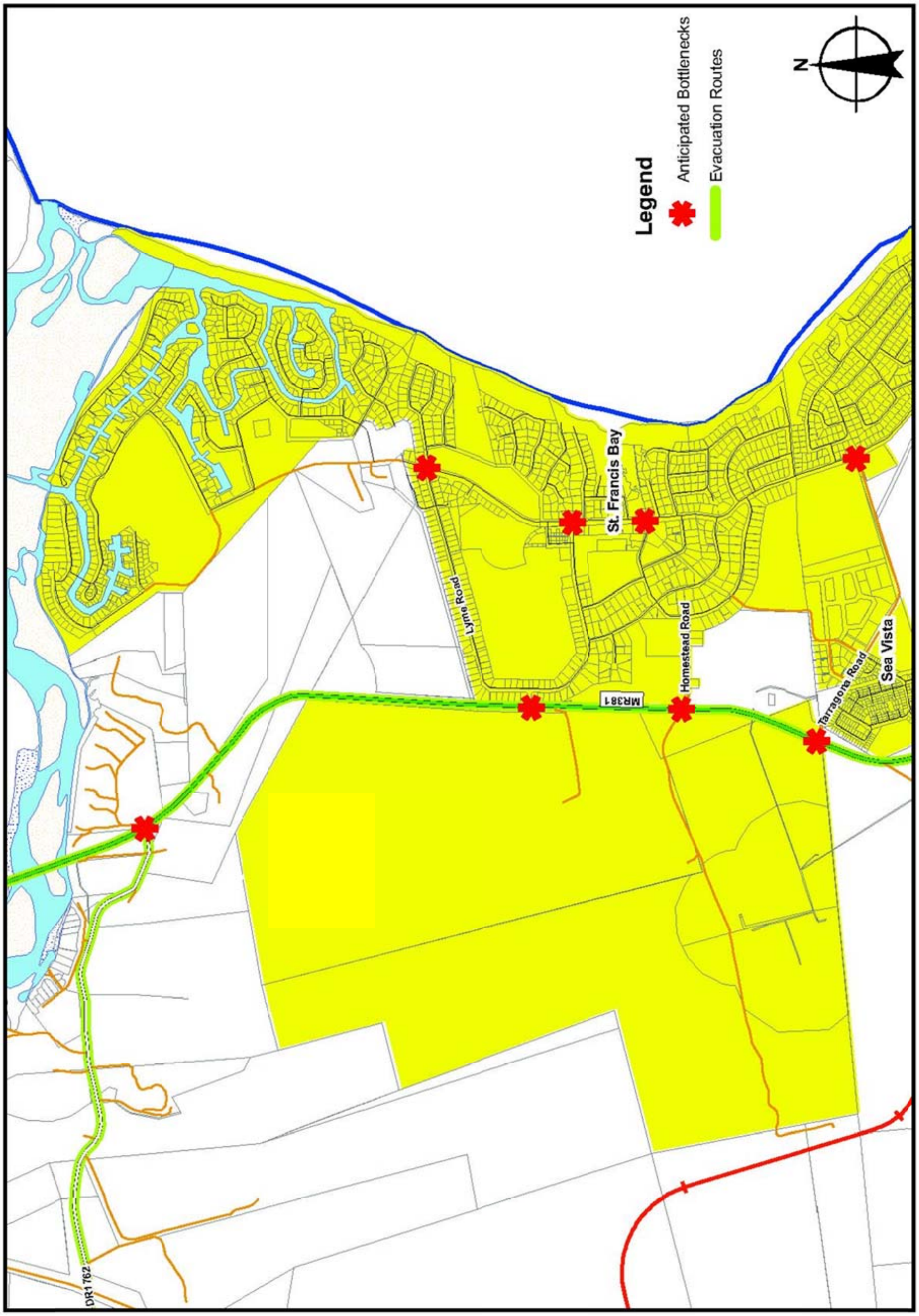


Image. 5: St Francis Bay Bottleneck



The nodes indicated on Image. 5 show the position of the anticipated bottlenecks resulting from an un-coordinated evacuation of St Francis Bay. It is important to note that although a formal evacuation of St Francis and Cape St Francis is not likely as it is outside of the 3km temporary evacuation radius, a “panic” reaction from the residents following a report of an incident at the plant could occur. Furthermore, a sudden influx of vehicles leaving the Thyspunt site and arriving in St Francis Bay via MR381 would have a significant impact on congestion in the town along MR381. The intersections along MR381 need to be upgraded to assist with limiting congestion.

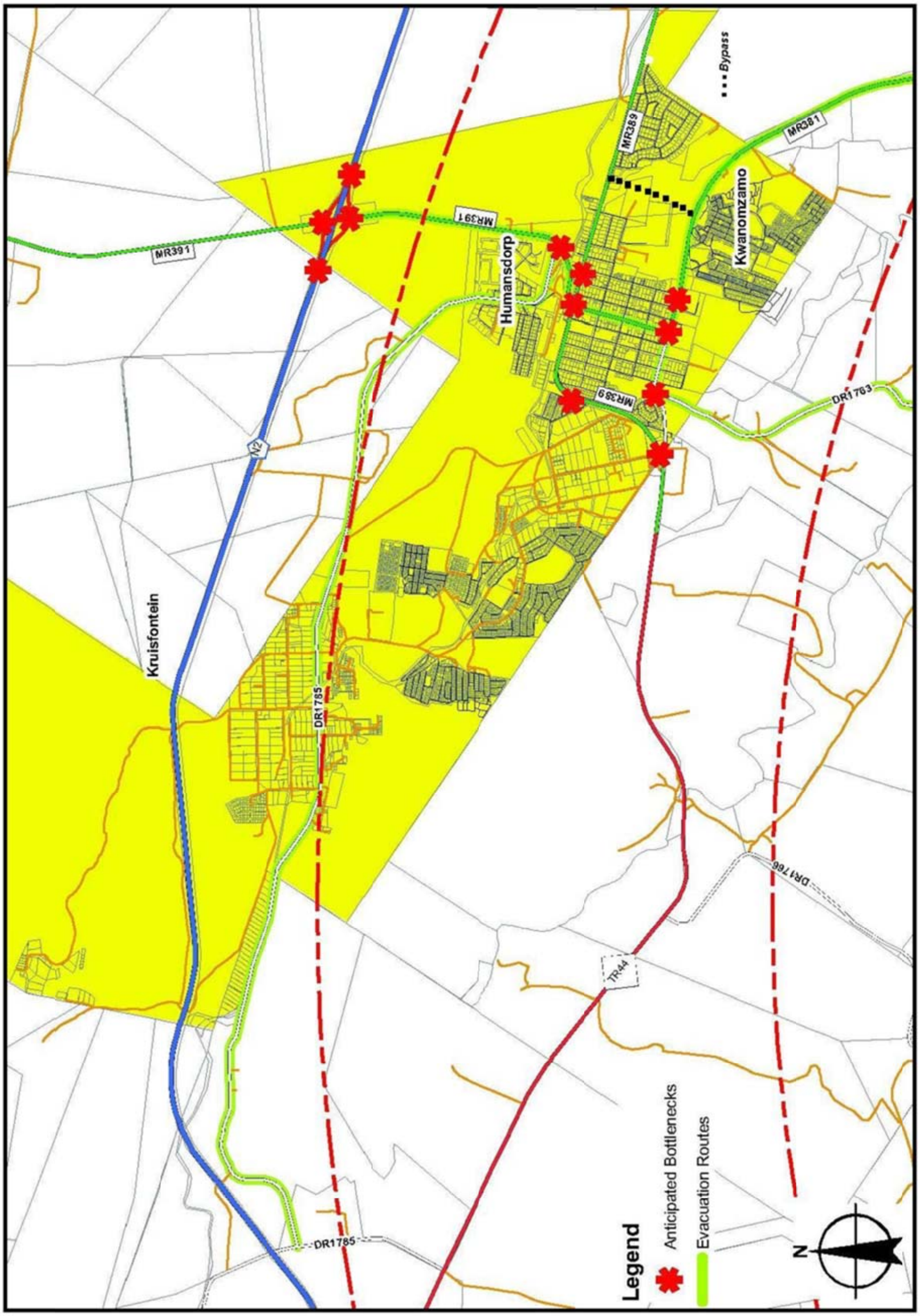
2.1.3 Evacuation of Humansdorp, Kruisfontein and Kwanomzamo

Humansdorp is the commercial hub of the area under consideration and serves as a gateway to both the St Francis and Oyster Bay nodes. The town is characterised by a congested main road and narrow side streets.

There are two densely populated townships to the north-west (Kruisfontein) and south-east (Kwanomzamo) of the Humansdorp CBD.

The closest evacuation route for both Kwanomzamo and Kruisfontein is through Humansdorp and onto the N2, north of Humansdorp as shown on Image. 6 overleaf.

Image. 6: Humansdorp Evacuation Routes



Kruisfontein to the west of Humansdorp is serviced by a number of internal surfaced roads. Residents of Kruisfontein are able to exit the area through Humansdorp and onto the N2. Alternatively residents may evacuate by gravel road (DR1785) on the northern side of Humansdorp, or to the west of Humansdorp along DR785, joining onto MR389.

Kwanomzamo to the south-east of Humansdorp has two main exit points and the residents can be evacuated either directly through Humansdorp onto the N2 or east along MR389 towards Jeffrey's Bay. Both of these routes require residents to negotiate the narrow and congested streets of Humansdorp.

It is anticipated that bottlenecks would occur at all the major intersections in and on the immediate outskirts of Humansdorp. Plans to construct a bypass on the eastern outskirts of Humansdorp as part of the abnormal load route to the site have been proposed and this would serve to alleviate the pressure from the evacuation of Kwanomzamo as well as the evacuation of St Francis Bay.

Although the Humansdorp node falls outside of the 16km evacuation radius, it is pivotal to the evacuation process as it is the conduit thorough which the bulk of the evacuation traffic will pass.

2.1.4 Evacuation of Paradise Beach

Being the furthest point from the Thyspunt site, Paradise beach is on the edge of the originally prescribed 20km radius. Residents from Paradise Beach can evacuate directly to Jeffreys Bay via the causeway over the Seekoei River as depicted on Image. 7 overleaf.

Alternatively residents may elect to travel west along the DR1767/1768 towards MR381 and MR389 respectively although this is unlikely as it will be perceived as traveling toward the danger area. If the proposed link between MR389 and MR381 is constructed many will choose to go out along DR1767 and then north along the link to MR389.

It is expected that a bottleneck would occur at the Seekoei River causeway as shown on Image. 8. Congestion is anticipated in Paradise Beach as well as Jeffery's Bay as a result of evacuation traffic.

2.1.5 Local Authorities

We have had brief discussions with the local authorities about budgets for upgrading roads and intersection. The Kouga Municipality has indicated that they have very tight budgetary constraints and would not be able to assist with any upgrades and this is unlikely to change in the foreseeable future.

The Department of Roads and Public Works have indicated that will upgrade the Humansdorp Oyster Bay road to a surfaced road but it is dependent on finance from Bhisho.

Image 7: Paradise Beach Evacuation Routes

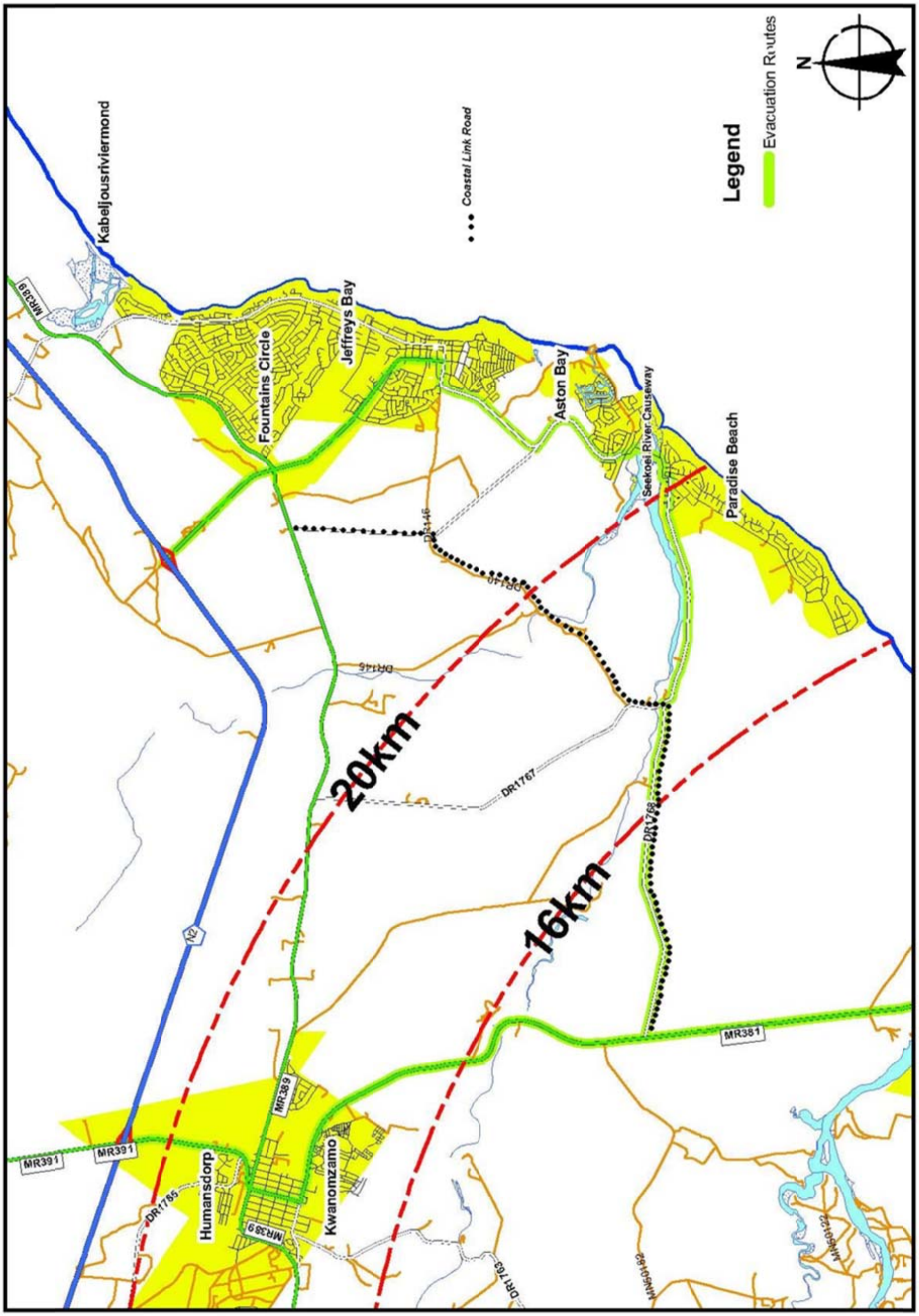
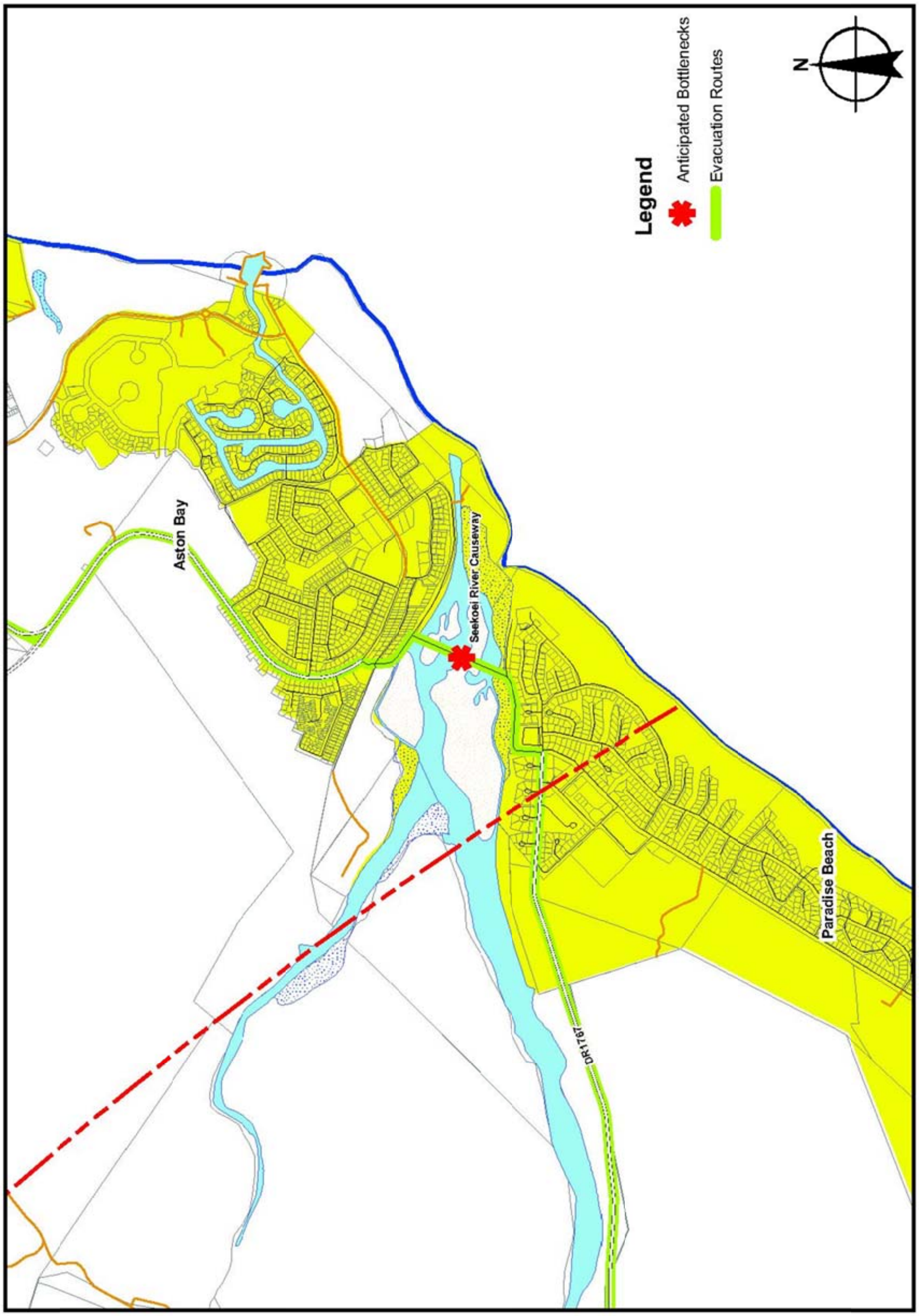


Image 8: Paradise Beach Bottleneck



3. TIME FOR EVACUATION

From Table1 of The Nuclear Division/Nuclear Build/Nuclear Sites Position Paper, Emergency Planning Zones for New Nuclear Installations, 15 March 2010, Rev 0, the following proposed emergency planning zone sizes (expressed in radii) for evacuation are given:

Exclusion Zone:	0 - 0.8km
Long Term Protective Zone (temporary relocation):	0.8 – 3km

The table requires that implementation times of 4 hours and one week are adhered to respectively and apply from the time that a site emergency is declared.

The various evacuation routes were assessed in term of vehicular capacity.

We have used the AASHTO Highway Capacity Manual 2000 as a reference point. As there are no formal guidelines for what the capacity of rural roads are under extreme conditions such as an evacuation.

The manual states that a single lane on a Highway can cope with 2400 vehicles per hour travelling at 120km/h. Based on our inspections of road geometry and condition we have made the assumption that surfaced roads in the area would be able to handle 1200 vehicles for per hour, at an average speed of 80km/h.

We have made further assumptions that gravel roads would have about a ⅓ of the capacity of a surfaced road which equals to 400 vehicles per hour and we have assumed that the average speed on the gravel would be 40km/h. We have also assumed that due to the fact that there are numerous intersections and with future intersection upgrades to allow for better flow of traffic, the capacity of the roads will therefore be the limiting factor in the evacuation times.

Information provided by the Kouga Local Municipality summarizes the population figures for the respective population nodes within the 16km radius as follows. Although the current population figures are small there is a significant increase during holiday periods and a large number of the erven remain undeveloped.

To compensate for the future development and population variability, the total number of erven has been used as the basis for the anticipated number of vehicles.

For the calculation of the number of vehicular units, each erf has been assigned 6 people and 4 people have been assigned per vehicle.

Node	Population (number of people)	Number of formalised erven	Estimated number of vehicles
St Francis Bay/Cape St Francis	2321	4321	6482
Oyster Bay	842	583	874
Thyspunt	4500*		747*

Table 1: Estimated Number of Vehicles

*from Table2 Construction values with daily and annual vehicle numbers (year 8) , Nuclear Build Department Position Paper, Nuclear-1 Traffic Estimates During Construction And Operation to the Thyspunt Site 17 June 2010 Rev 1

Based on the above assumptions, the vehicular capacity for the various roads and critical evacuation radii were calculated.

The results are summarised below.

Node	Vehicles/ hour 16km*	Vehicles/ hour 5km*	Total expected traffic (passenger)**	Time to evacuate 16km***	Time to evacuate 5km***
Oyster Bay (west) 40%	400	-	349	1h15	-
Oyster Bay (north) 60%	400	411	525	1h45	1h00
St Francis Bay	1200	-	6482	6h00	0h56
Thyspunt (east) 50%	1200	374	374		
			6856		
Thyspunt (west) 50%	400	406	899	2h15	1h00

Table 2: Estimated Evacuation Capacity

*represents the continuous number of vehicles in convoy passing a point on the specified radius, in an hour, from the time that the first vehicle departs from the respective node
**the value is calculated from the allocation of people per erf and vehicle capacity as well as a proportioning of traffic along the various routes.
***The time to evacuate is a theoretical time based on the number of cars passing a specific distance in an hour and does not account for the mobilization of residents or combined traffic volumes from various nodes unless otherwise stated.

All the population nodes identified in the investigation are outside of the 3km evacuation radius. As such, only the Thyspunt staff and contractors would need to be evacuated in times of a site emergency. Cognisance must be given to the likelihood of a “panic” reaction from the Oyster Bay residents in times of an emergency. As such, the traffic from Oyster Bay has been included as part of the Thyspunt traffic heading north along DR1763

The following traffic splits have been used to proportion the traffic along the various routes

Oyster Bay: 60% north, 40% west

Thyspunt: 50% east, 50% north

The evacuation distances have been measured along the existing gravel roads identified from the field investigation and the road surfaces have been assessed in their current condition.

4. SUMMARY OF INVESTIGATIONS

Based on the above mentioned findings it is evident that sufficient infrastructure exists to cater for the evacuation of nodes as identified in Section 2 of the report. Routine maintenance of the existing gravel roads as well of the upgrading of the existing Oyster Bay Road will ensure that the residents of Oyster Bay and the St Francis nodes will be able to evacuate the area on separate routes, minimising congestion.

Although sufficient infrastructure exists, the management of traffic at the population nodes poses a challenge. Of great concern is the anticipated bottlenecking at Humansdorp once traffic from Oyster Bay, St Francis Bay area as well as Humansdorp merges to get access to the N2, north of Humansdorp. The narrow side roads and congested main road are not conducive to free flow conditions and will place a severe restriction on any evacuation process.

5. COST ESTIMATES TO UPGRADE INTERSECTION

At present there are six intersections that fall within the 16km Evacuation Zone. Two of the intersections, on the Western side of the site will be upgraded with the construction of the Western Access and the reconstruction of the DR1763 respectively.

On the Eastern side of the site there are four intersections connecting to the MR381 that will require upgrading to improve the flow of traffic during an evacuation.

The Cost per intersection is calculated to be R500 000-00. For all four intersection mentioned above it is a total of R 2 million. This cost is inclusive of fees, site supervision but excluding VAT.

6. RECOMMENDATIONS

It is recommended that the Kouga Local Municipality and the Provincial Roads Department be approached to improve the key intersections and streets within the population nodes identified in the report. The upgrading of the Voortrekker Road and Main Street Intersection warrants the most attention.

Should the municipality not consider this intersection a priority, the improvements to this intersection should be included as part of the proposed Bypass to the east of Humansdorp (see image 6)

Arrangements should be made with the Provincial Roads Department to prioritise the maintenance of the evacuation routes

The construction of the Humansdorp bypass will aid in the evacuation of both Kwanomzamo and St Francis Bay. In addition to the proposed Bypass, the construction of the proposed Coastal Link Road as depicted on Image 7 will further aid in reducing congestion in Humansdorp by diverting traffic away from Humansdorp towards Jeffrey's Bay

For this reason it is recommended that the bypass be constructed and included in the evacuation strategy and that the construction of the Coastal Link Road be implemented.

Annexure G

Eskom Nuclear 1 Project: Thyspunt Site

Proposed Site Access Roads

Aurecon Report: 5356
16 March 2011
Revision 2

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1. INTRODUCTION

Eskom propose to build a Nuclear Power Station at Thyspunt, a site on the South Eastern Cape Coast, between Oyster Bay and St Francis Bay. This report provides the background to the investigation of road access on to the site and the reasons for the choice of the recommended routes contained in the report. Preliminary design criteria , plans, details and cost estimates are also provided.

Eskom has a need to develop further power generation capacity within the borders of South Africa. The decision has been made to explore the possible building of additional nuclear power generation facilities.

One of the candidate sites for such a plant is at Thyspunt, an as-yet undeveloped site on the coast between St. Francis Bay and Oyster Bay, and south of Humansdorp.

The position on site of the proposed plant has been defined in the Environmental Impact Assessment (EIA) process already commissioned by Eskom, although the footprint has not yet been finalised. The position of the proposed power station is close to the coastline at Thyspunt.

Existing main access roads in the area include the MR 381 which links St Francis with Humansdorp, a gravel road DR 1762 linking Oyster Bay to the MR 381 and another gravel road, DR 1763, which links Oyster Bay to Humansdorp.

The only roads existing within the site are narrow un-surfaced roads or tracks which are completely unsuitable for use by Eskom in the construction or operation of the proposed power plant. Accordingly, the requirement is to investigate the possible routes across site that will serve the power plant, taking into account the topography, ecology and geometry of the site, and the needs of Eskom. These roads must also connect to the outside public road network.

2. BACKGROUND

The Thyspunt site is situated on some 1800Ha of undeveloped land of approximate dimensions 6km x 3km. The site of the Power Station itself is close to the shore line, mid-way along the site.

The site is bounded by a significant dune field system to the North and the coastline to the South as well as the developed areas of Oyster Bay and St Francis Bay to the West and East respectively.

The topography is dominated by a series of vegetated sand ridges running approximately East West. Other significant constraints with respect to the use of the site are areas of coastal forest, fynbos and wetland areas. A small number of people presently reside in permanent dwellings on the overall site.

Access across the site is by means of existing informal gravel roads and tracks in various degrees of repair. These roads and tracks are used by the permanent residents and occasional visitors, but are not of a sufficient standard to serve the needs of Eskom either during construction of the power plant, or for operational purposes, after completion of the works.

3. SCOPE OF THE WORK / TERMS OF REFERENCE

The aim of this report is to investigate and report on the access from Oyster Bay and/or St Francis Bay to the construction site. Suitable routes for permanent roads are to be identified, evaluated and investigated up to the point of route location and preliminary design stage. This is to be done in conjunction with various environmental consultants and Eskom, and is to assist the EIA process being undertaken for the actual power station site.

Routes from the west, north and east are to be considered. This excludes the provision of civil service infrastructure such as sewerage and potable water reticulation, which are considered under separate task orders, but includes provision for stormwater management.

The report is to identify, evaluate and investigate up to the stage of route location and preliminary design in order to assist with the EIA process which is currently underway, as well as provide information and cost estimates for the overall planning process for the construction of a new Nuclear power Station.

Budget estimates and feasibilities are to be reported upon for each of three broad options for an access road from the West, the North and the East of the overall site and linking into the position of the power station.

4. TRAFFIC DEMANDS

4.1 Heavy Haulage of Abnormal and Oversized Loads

Delivery to the site by Abnormal Load vehicles of exceptionally large or heavy loads will be required for the power plant. The overall approach options available to deliver these loads to the site boundaries from the harbour at Port Elizabeth are dealt with in a separate report. However, a road system within the site is required for access and movement across site.

The final road layout must allow movement of heavy haul plant without hindering other construction traffic in any way. The number of separate heavy haul loads brought to site is expected to be of the order of eighty eight for the Construction Nuclear 1.

The expected traffic classification and traffic demand is covered in Section 8 under the Design Standards.

4.2 Construction

The construction programme for the first phase of the project, which entails the construction of the civil and electrical infrastructure for the power generation plant, and the construction of the power plant itself, will extend over a period of several years. Traffic volumes will build up in accordance with the main construction programme for the access roads, bulk earthworks and then the main structures. The access roads must accommodate all the construction traffic over this period, together with the heavy haul loads.

4.3 Operational Traffic

The operation and maintenance of the plant will generate a comparatively small number of vehicle trips compared to the construction phase, but if any further phases of construction proceed, then there should be no hindrance of this traffic by construction traffic.

5. MOTIVATION FOR MULTIPLE ROUTES

5.1 Construction Phasing

In the event of a road accident, closure or blockage on one access road on the site, there must always be an alternative route available for traffic to use in order not to cause any delays to construction

Further, having two access roads available for both the construction and operational staff traffic will have the additional effect of reducing the traffic volumes that would prevail on a single route and would potentially halve the disturbance to communities close to the site arising from traffic noise and movement that would otherwise be caused by a single entrance.

5.2 Safety, Emergency Evacuation

In the event that an emergency situation arises, all personnel must be able to quickly and easily leave the immediate area of the site. Construction of more than one road access to site will reduce the demand on just a single evacuation road.

5.3 Simultaneous Construction, Heavy Haul and Operations

The nature of the operational requirements of the commissioned plant requires that there is always a clear access road for the movement of traffic. The movement onto site of abnormal loads would potentially create a blockage on the roads used unless provision is made for a wider-than-normal road cross section to allow construction and/or operational vehicle traffic to flow freely.

Accordingly, the primary route onto site for the movement of abnormal loads will be designed and constructed with a wider carriageway to allow for a dedicated lane for abnormal loads to ensure that there is no interruption caused to other traffic by the movement of abnormal loads. In the event of any future extensions or alterations to the plant, duplication of the traffic patterns from the first phase may be replicated in the course of construction of such extensions, which would interfere with the traffic movements of the operational staff working on the commissioned works. To resolve this, a second access route is required to separate as much as possible the two diverse traffic streams.

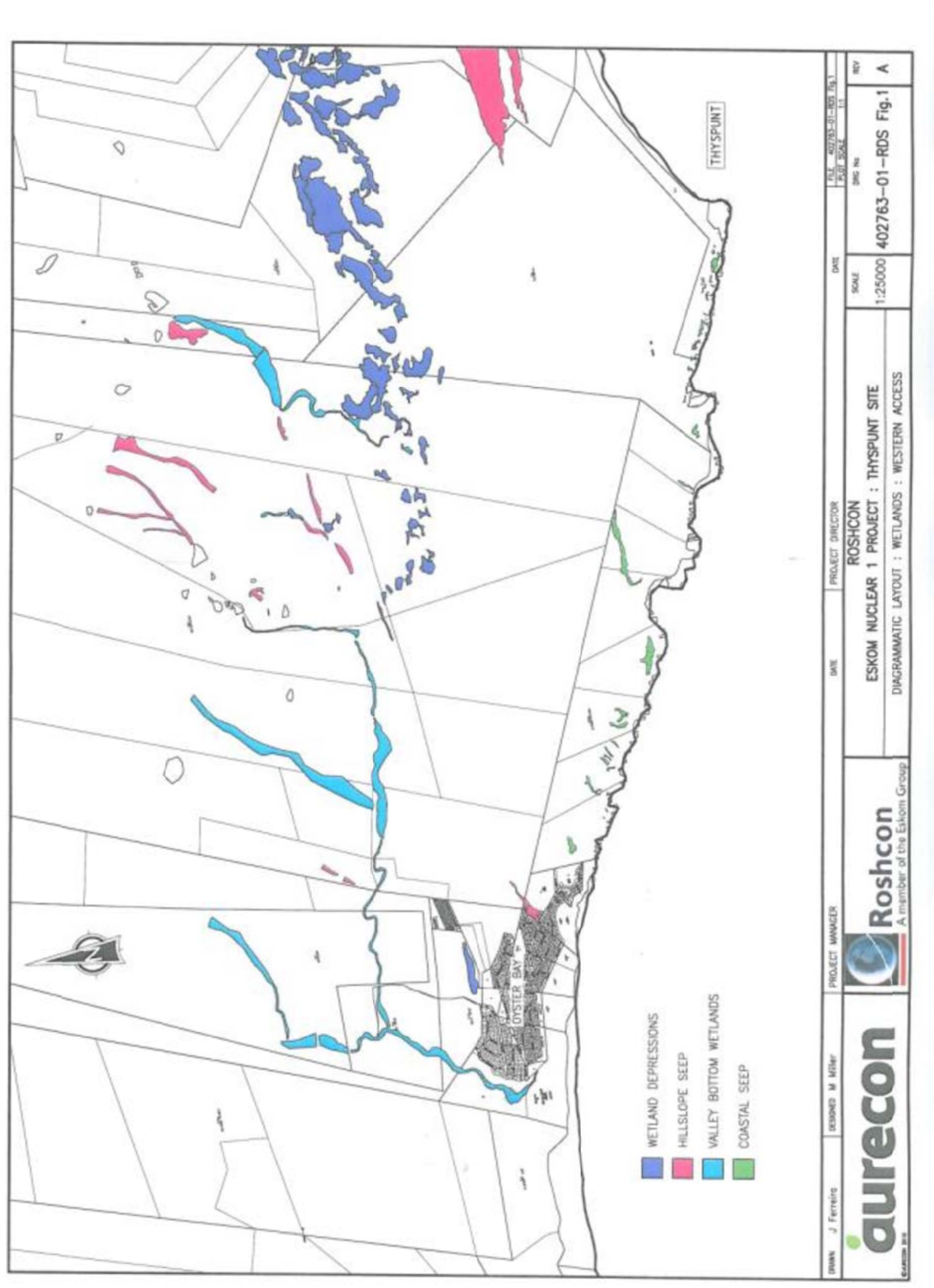


Figure 1: Diagrammatic Layout: Wetlands: Western Access

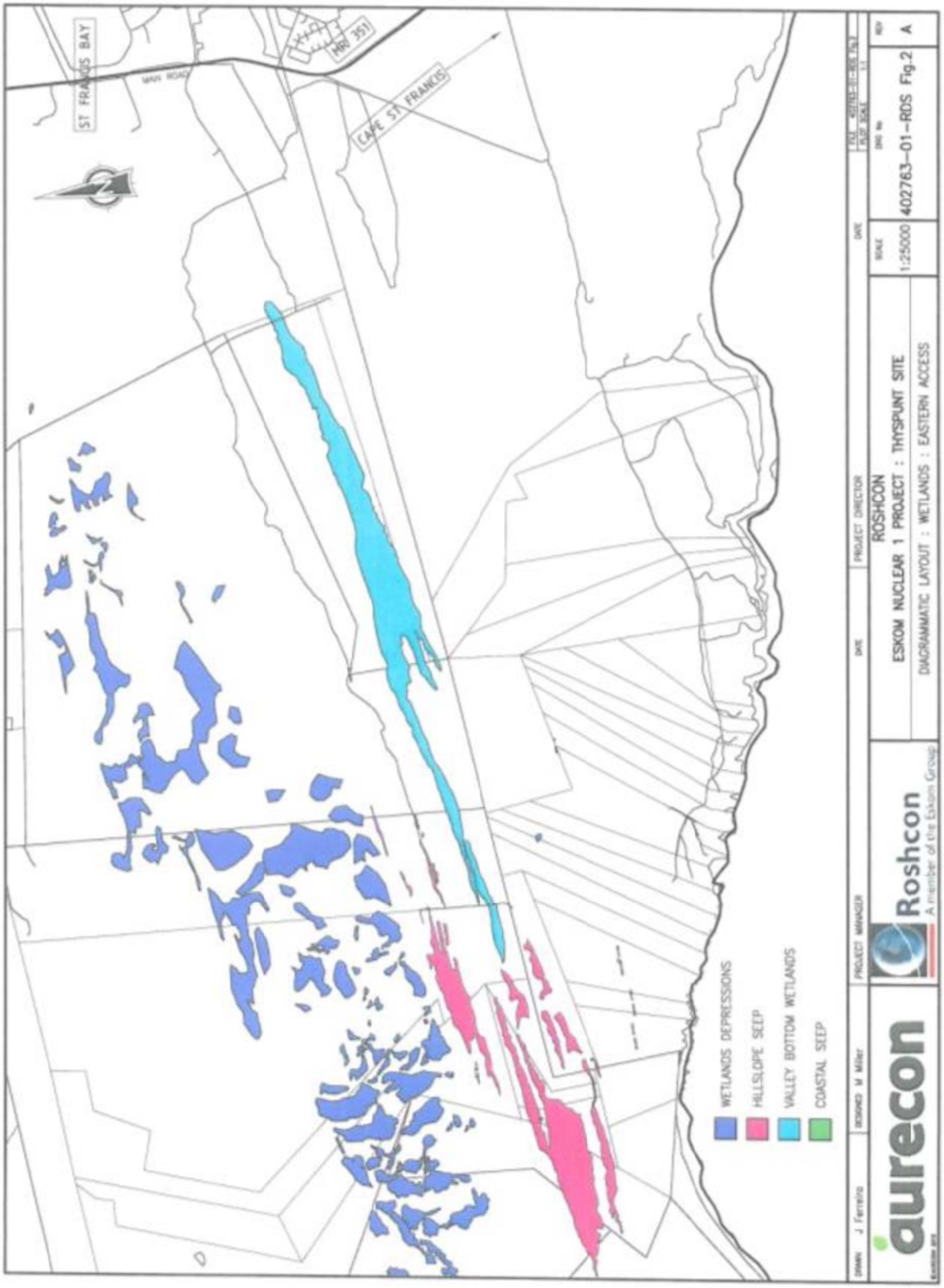


Figure 2: Diagrammatic Layout: Wetlands: Eastern Access

6. DESIGN CONSTRAINTS

Road lengths and geometrics are dictated by a combination of engineering factors, environmental issues and social constraints. Selection of, and motivation for, any preferred route involves resolution of all component concerns into a single recommendation. Given the environmentally sensitive nature of the site, the construction of any required road across site cannot entail straight and direct road lines to the main facility. The apparently round-about approaches are more costly than simple direct routes but will satisfy the overall requirements.

The following specific aspects have been taken into account when planning the routes.

6.1 Geotechnical

The material which is expected to be encountered in the road foundation is predominantly dune sand although some of the deeper cuttings may expose some of the Table Mountain sandstone which outcrops along the coast and to the north-west of Oyster Bay.

No detailed geotechnical survey has to date been undertaken for road design purposes, but a basic assumption has been made that the in-situ material on which the road layerworks will lie will be dune sand which would need to be compacted to 100% MAMDD, (Modified AASHTO Maximum Dry Density) and that this will be a suitable foundation material for the road layerworks. However, being a wind-blown deposit, the density of the in-situ sand will need to be checked and deep compaction with heavy rollers possibly specified in the construction process.

Due to the highly erodible nature of the dune sand, the treatment of cut and fill slopes and protection against wind erosion during construction will need to be carefully considered and specified in the construction contract. This will be particularly relevant with any deep cuttings required in the forming of the road.

After approval of the EIR and when the final positions of the access road routes are approved in conformance with the findings of the EIR and ROD, the route will be pegged on site by a land surveyor. This will thus allow a detailed and extensive geotechnical survey to be undertaken along the route of the roads to enable a finalised formal design of the layerworks.

6.2 Environmental

6.2.1 Dune fields

The topography is dominated by dune systems that align east / west across the whole Thyspunt / Cape St Francis cape area. The system closer to the coast is heavily vegetated and more stable than those dunes aligned further to the north, which are largely un-vegetated. Generally, there appears to be a surface water run-off watershed at approximately the east-west midpoint of the site.

Any routes selected to provide access to the power station may be forced to cross these dune systems at some point, although ideally the dunes should be skirted wherever possible rather than traversed.

6.2.2 Wetlands & Coastal Seeps

Inter-dune valley-bottom wetlands exist within the dune system as well as hill slope seeps. These will need to be dealt with using suitable design and construction methods in order to preserve the status quo of the surface and subsurface water flow. A comprehensive report on these has been submitted by The Freshwater Consulting Group.

The positions and extent of the wetland areas have been mapped by the wetland specialist assisting the EIA process. These are shown on Figures 1 and 2. ("DIAGRAMMATIC LAYOUT : WETLANDS : WESTERN ACCESS, 402763-01-RDS Fig 1" AND " DIAGRAMMATIC LAYOUT : WETLANDS : EASTERN ACCESS, 402763-01-RDS Fig 2") Apart from these areas indicated on the figures, there are also isolated minor coastal seeps on site.

The alignment of the routes takes both the wetland areas and costal seeps into account and the positions of the roads across site, well set back from the coastline, are such that these are unlikely to disturb the coastal seeps during construction of the roads

The presence of wetland areas is being addressed by setting parameters for the closest approach of a road or other structures to the wetlands. Thus a buffer area width of 100 metres has been specified between any development and identified wetlands. Although this requirement is generally possible, there are specific instances where a closer approach is unavoidable, specifically where a crossing of the line of the wetlands is necessary.

At preliminary design stage, there is one instance identified for the eastern access road where the road that will run behind the actual nuclear facility will be within 60 metres of a small wetland. (Refer "DIAGRAMMATIC LAYOUT: WETLANDS: EASTERN ACCESS, 402763-01-RDS Fig 2) This is dictated by the fact that the position and footprint size of the nuclear facility building structure is required to be set back from the coastline such that it forces the road alignment fairly close to this particular wetland strip.

6.2.3 Vegetation

The vegetative cover across the site varies between coastal forest, *fynbos* and invasive species. There is no ecological value to any of the invasive species such as *rooikrans* and these can be removed with impunity. However, the coastal forests are protected and their positions and extent will have to be considered in the final design process to reduce damage to the species.

As previously, stated for the wetlands above, pegging of the proposed preferred route after completion of the EIA process, will allow for final checking that the routes do not impact too heavily on the areas of sensitive vegetation.

For the given road reserve width required, reducing overall the length of roadway to be built will reduce the quantity of vegetation to be cleared, regardless of type.

6.2.4 Heritage Sites

There may be instances where archaeological finds on site will be encountered. During the pegging process, once again, the road alignment may need to be altered marginally where possible to avoid such sites . If this is not possible the sites/finds will be excavated prior to actual road construction.

6.2.5 Carbon Footprint

Given that the position of the power station itself is fixed, the locations and alignments of the access roads will have significant long-term effects on the over-all carbon footprint of the traffic to and from the station. Vehicle exhaust emissions will increase with greater travel and commuting distances from beyond the site to the point of work. As such, the design should incorporate some consideration for minimising travel distances for the staff on site, both construction and operating. This will have a concomitant effect on the extent of vegetation cleared for roadways.

6.2.6 Noise and Social Impact

All vehicle traffic approaching site will have some degree of social impact on the St Francis and/or the Oyster Bay communities. The noise component can be reduced by sensitive positioning of the roads within the site, particularly near Oyster Bay. Of the route options available for the access roads onto site, considerable effort was put into refining the horizontal alignments to supply the most acceptable final layout.

6.3 Approach Roads External to Site

The network of existing roads external to the site will have some effect on the start/end junction positions, as candidate positions are evaluated. Unacceptably short sight distances and the proximity of any existing intersections or junctions will largely eliminate unsuitable positions for junctions. Remaining available positions have been identified, considered and selected as part of the main design process.

6.4 Land Ownership and Cadastral

A significant portion of the land required for construction of the access roads has already been purchased by Eskom, or is under negotiation for purchase.

Minor design adjustments to the alignment have been considered to exclude the possibility of minor encroachment on any neighbouring property boundaries. One such realignment was required to accommodate the demands of a landowner on property Langfontein 736 (Portion 9) who reached an agreement with Eskom to allow a road across his property as long as the remainder available for his use on the coastal side of the road exceeded 10 Ha. The road alignment was adjusted away from the coast line in order to achieve this.

6.5 Health and Safety

The major considerations for the access routes from the perspective of Health and Safety are the Emergency Evacuation route, which is being covered in a separate report. The road design will need to balance the design speed from a safety point of view and consideration of the terrain in places..

6.6 Cost Implications

6.6.1 Heavy Haul Route Termination

The point at which the heavy haul/abnormal load route brings large components onto site will have a bearing both on the intersection layout of the internal road start point , the length of, and structural engineering associated with, the road itself. The decision to use existing surfaced roads as far as is possible, has minimised the need to upgrade or rebuild any significant sections of public road. However, this has in itself forced the delivery point to site of heavy haul components to be at the eastern end of the site.

This has led to the eastern access road being designed with a wider-than-normal carriageway width to accommodate heavy haul traffic concurrently with normal construction traffic.

7. ROUTE OPTIONS

The site as a whole is undeveloped, and any project within the overall site would necessitate the construction of new access roads across the site to serve the power plant. With no infrastructure presently existing within the site, there are no limitations from an engineering perspective on the possible layouts of roads.

However, significant environmental restraints largely dictate what can be achieved.

The only possible access routes to the position of the power station are, from the east, the north and the west, several options and alternatives were considered and in each case the preferred route identified.

7.1 Eastern Access Route

From the start of the investigation process, it has been recognised that the main access point for the movement of the heavy haul/abnormal load traffic onto site would in all likelihood be from the east, past St Francis Bay.

The most suitable overall route to site for the movement of heavy equipment from Port Elizabeth is detailed in a separate report, but the recommendation given that report indicate that the route will connect to Thyspunt itself, from the Eastern side of the Thyspunt area .

Access from this eastern end of site would also be advantageous from the point of view of both construction and operational staff that may choose to live in, and commute from, Jeffrey's Bay or St Francis Bay.

Four different access points were considered as the entry point for the road onto site

7.1.1 Options E1, E2 and E3

The broad layout of the various routes considered is included as Figure 3 in this report.

a) Route Option E1

Route option **E1**, shown in pale blue starts at the Provincial road MR381 in the vicinity of Cape St Francis, and generally follows the alignment of an existing gravel road in a westerly direction close to the coast, crosses a number of dunes and arrives at the eastern edge of the power station site.

Although this route is one of the shorter of the Eastern Access options (9km), it was felt by the specialists to be too close to the coastline from a visual impact; it affected several coastal properties and also intersected several natural water springs.

The crossing of the active dunes at km 8 was also considered problematic. For these reasons it was not further considered.

b) Route Option E2

The second candidate route, **E2**, would essentially follow the existing service road access to St Francis Links Estate and then continue in an Easterly direction across the "Dunes" development, through a dune corridor and link up to the Power station site.

At 8,9 km, this is the second shortest route from the East; however it would impact severely on the St Francis Links development and on significant areas of coastal forest which was considered unacceptable by the environmental team.

c) Route Option E3

Although it is the longest of the Easterly route options at 11.2 km, Route option **E3** ,shown in dark blue, was considered as the route with the least environmental and social impact on the Thyspunt and St Francis area.

This route would start approximately 2 km beyond St Francis Bay on the MR 381 and cross low sensitivity degraded land in a westerly direction, turn north through a corridor between the St Francis Links and the "Dunes" developments and thereafter turn again west and generally follow the route of existing gravel roads and tracks. It would ultimately turn south-west and terminate at the power station site.

Some finer amendments to the Route E3 alignment were made in consultation with the Environmental specialists to further avoid sensitive areas of vegetation. Further small adjustments in alignment were made to E3 to shift the road closer to property boundaries. The ultimate adjusted route is the one presented in Figure 3.

d) Route Option E4

A link between MR 381 and route E3, North of the St Francis Links development was also considered as **E4**, shown in pale green on Figure 3, but based on the environmental decisions relating to the development of the Links development in this area, it was considered unrealistic to opt for a route so close to the Sand River dune system, especially seeing that, the developers of the Links golf course estate were previously not allowed to extend any further north than is shown on Figure 3. Thus the green line representing route option **E4** on Figure 3 would have in all likelihood, not been permitted.

All of the above options involve the construction of new roadway on Eskom property. For comparison purposes, the different lengths of the different options are compared below:

Route	*Eskom Private Road*
E1	*9 km*
E2	*8,9 km*
E3	*11.2 km*
E3/E4	*10.4 km*

Table 1: Lengths of route options

Figure 3: Route Options E1, E2 and E3

7.1.2 Recommended Eastern Access Route

Following the evaluation of the routes outlined above, and in conjunction with the site EIA process, Route E3 was identified as the preferred route. This route is shown in the figure below.

SKETCH 14 : ROUTE E3

a) Description of Route E3

The route starts at a point along the Provincial road MR 381 leading to Cape St Francis. The new surfaced road will lead off westwards onto site then curve right and left to avoid the eastern end of the existing dune field. It will then follow the property boundary between "The Dunes" and the St Francis Links development. It will hug the boundary as much as is reasonably possible to avoid the creation of a dead space between the road and boundary fence, before turning westwards to run parallel with the primary, Sand River dune field.

After approximately 8 km the route turns south to cross the inter-dune valley and the wetlands at approximately at a right angle. The line of the road then turns south-west and leads directly towards the site of the power plant.

b) Vegetation encountered

Areas of indigenous *fynbos* and coastal forest occur across the site, as do areas of alien vegetation. The preferred route has been aligned such that the impact on the indigenous plant life is minimised.

There is not yet a sufficiently detailed formal map identifying the areas of coastal forest to allow desktop preliminary planning of the route alignment.

However, it is proposed that now that once the preliminary design alignment has been accepted, this route will be pegged on site by a surveyor, walked over by the full Professional team and final adjustments made where possible. Final comment will then allow final fixing of the route.

c) Natural or man-made obstacles.

The wetlands areas, including the hill-slope seeps, valley bottom seeps and the coastal seeps, all constitute a natural obstacle that can be negotiated with careful design.

The general layout of these wetlands across site have been shown in the Figures 1 and 2 “DIAGRAMMATIC LAYOUT: WETLANDS: WESTERN ACCESS, 402763-01-RDS Fig 1” and “DIAGRAMMATIC LAYOUT: WETLANDS : EASTERN ACCESS, 402763-01-RDS Fig 2”

The dune topography that dominates the site sets up restraints on road alignments, forcing road alignments to be either very steep or winding, or necessitating deep cuts and high fills. However, the environmental restraint is even greater. The environmental concern for the dunes precludes any direct and arbitrary crossing of the dunes to suit the engineering parameters only.

The simplest option would be to avoid the dunes altogether, but this is unrealistic and impractical on this particular site, given the positioning of the power plant itself. Where there is an inevitable interface between the road alignment and the dunes, the alignments have been restricted to the vegetated dune areas, so as not to interfere with overland sand migration from East to West.

d) Constraints

The intersection with the existing MR 381 required some consideration from the aspect of providing sufficient stopping sight distance for vehicles using MR 381. The acceptable position of the main entrance to the site is part way along a long gentle downslope, which slightly increases the total length of access road required.

This however is not a major issue. As the recommended route is independent of other public and private roads, apart from the single intersection, no traffic access problems are anticipated. This intersection will need to be analysed and designed properly to avoid creating traffic flow problems or safety hazards, and will need to be approved by the Road Authorities.

e) Advantages

The route E3 option links up with what is recognised as the logical preferred heavy haul/abnormal load route that reaches the site boundary close to St Francis Bay, and conveys traffic across site with minimal disruption to the indigenous vegetation caused by construction.

The preferred route also minimises the impact on both the wetland areas and on the dune system as a whole.

f) Disadvantages

In using the preferred route from the eastern edge of site, the increased staff vehicle traffic from Jeffrey’s Bay, Aston Bay and other points to the north-west of the site will create additional noise and traffic safety issues for the residents of St Francis Bay and, to a lesser extent, those living in Cape St Francis.

g) Services

Conventionally, buried services lie close to the road, and within the road reserve. In the particular circumstances applicable at Thyspunt, water supply and sewage treatment will be dealt with on site and it is not envisaged that extensive pipelines will be required for these services within the road reserve. However, a slurry pipeline is under consideration for the removal of sand from the nuclear island. Should this system be implemented, then it is likely that the slurry pipeline will be laid along the route of the eastern access road, within the area of the road reserve

Street lighting, electrical and communication ducts will also be accommodated in the road reserve.

h) Stormwater Management

Where the access road crosses the water course discharging from "The Dunes" development, appropriate design measures will be necessary in order to prevent any impact on the wetland area which has developed at the Dunes since removal of alien vegetation. Design must also provide for the major flows which have more recently been observed emanating from this water course during very heavy rainfall events. This could incorporate flood control measures and prevent a recurrence of the damage previously caused downstream during recent floods. Generally, the site will not be altered in terms of the stormwater run-off regime, but particular attention will be paid to the placement and design of culverts or channels to allow the continued free flow of water after the construction of the road is complete. No water will be conveyed underground in buried pipelines. Where a section of road goes through cutting, concrete channels will be used to convey water away from the road to re-join whatever natural runoff regime existed before construction of the road. In sections where the road structure must cross a wetland, multiple low culverts will be laid down under the road prism for the full width of the wetland.

7.2 Western Access Route

7.2.1 Options available

A normal requirement for the establishment of the power plant is that there should be at least two entrance/exit roads serving the site. This is from both the safety point of view in providing a second emergency evacuation route and from the point of view of reducing potential traffic congestion on a single route only. The eastern route, discussed previously, will serve as the primary access route. As alternatives, consideration was given to possible approaches to the site from the direction of Oyster Bay to the west. Multiple alternatives were considered. The benefits of having such a second access route include:

- Safety considerations, should there ever be a need to quickly move people off site. Concomitantly, should there be a blockage on one of the access roads, traffic can still move freely onto and off site using the the alternate route. A single exit point, regardless of the standard to which it was constructed, would create an unsatisfactory bottleneck in the traffic flow.
- Access to housing opportunities for hourly paid construction workers. Eskom are considering housing such a workforce near Humansdorp, and bussing the workers to and from the site

daily. A western route will alleviate the traffic load that would be exerted on the eastern route, and also shorten the required commuting distance for those travelling between site and either Oyster Bay or other points towards Humansdorp.

- The Eastern Cape Department of Roads is considering upgrading the gravel road between Humansdorp and Oyster Bay (DR1762). At this stage the programme is unknown, but it is understood that tenders may be called in mid-2011 The successful completion of this upgrade would ease the movement of the transport of personnel, but would not be used as part of the heavy haul/abnormal load route. Discussion has been initiated with the Roads Department to consider a contribution from Eskom to upgrade the road to a level better than the current design standard to a higher standard more suitable to cater for the proposed traffic volumes imposed on the road by the Thyspunt Power Station construction process. However, no resolution has been reached at this stage and these discussions will continue once the project is given the go-ahead..
- In the longer term, when construction is complete for the first phase and the power plant is commissioned, it is likely that construction of Phase 2 will proceed immediately. When this occurs the western access route will be available for use by the construction vehicles for phase 2, leaving the eastern access route clear for the exclusive use by the operating staff and vehicles for phase 1. (Refer also to Paragraph 7.1.2 h above).

a) Option W1

This route starts at the existing Oyster Bay access road and passes between Oyster Bay and Umzamawethu Township running to the North of the proclaimed, but as yet undeveloped erven on the north side of the town. The route then passes south of the high vegetated dunes and merges with the existing gravel track east of Oyster Bay before following an east / west alignment approximating the line of the existing tracks through the area.

This route has the advantage that it does not impact on the active dune field North of Oyster Bay.

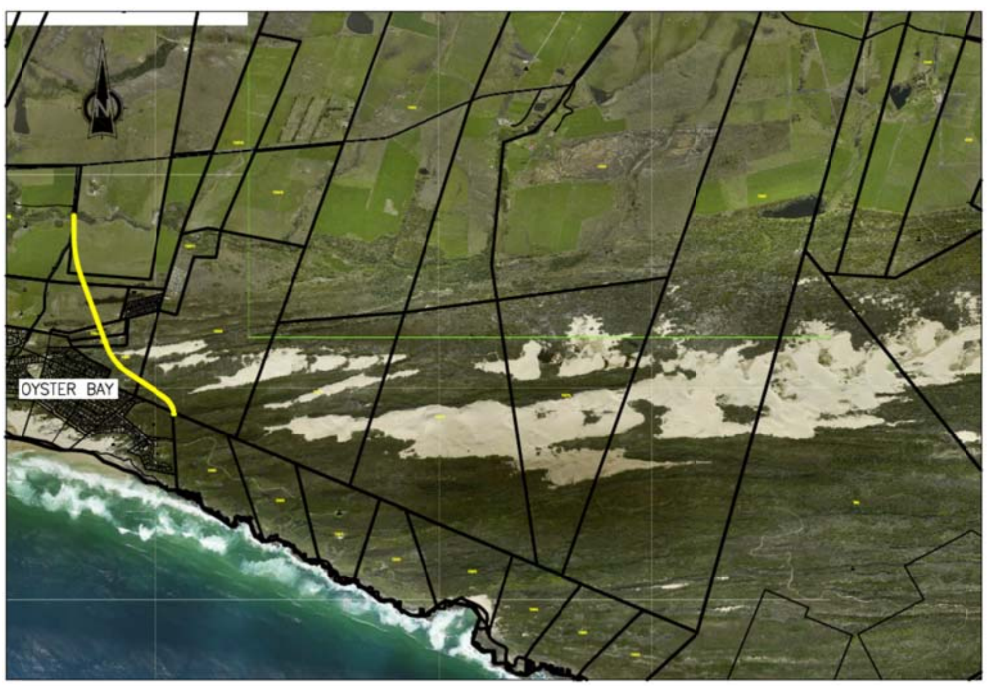
However, a disadvantage is the proximity of the route to the existing Oyster Bay properties. However, this could be alleviated through the use of suitably vegetated berms screening the road from the town. Another disadvantage is that the route passes between Umzamawethu and Oyster Bay and could be perceived by the residents of Umzamawethu as a barrier between their community and Oyster bay village and constitute a safety hazard to pedestrians. This could be dealt with by use of an overpass, pedestrian bridge or other design method for the Umzamawethu access road.

The route is also the shortest route in terms of cost and crosses the minimum number of private erven.

SKETCH 1 : ROUTE W1

b) Option W2

This route is a slight variation on Route W1 above by virtue of the junction point with the existing Oyster Bay access road being positioned approximately 400 m further away from the village of Oyster Bay.

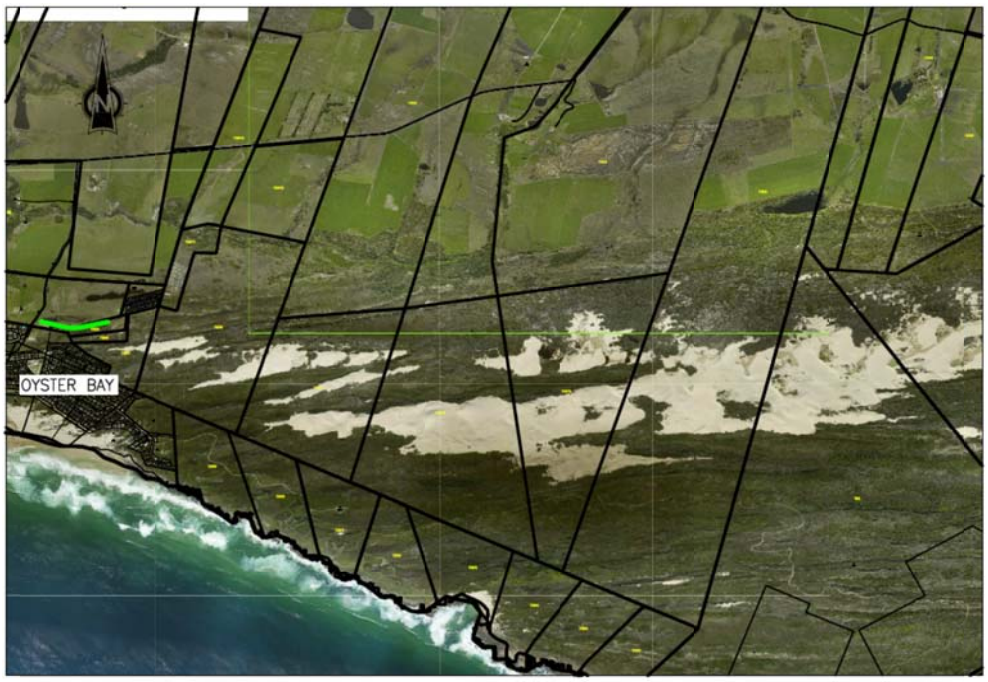


SKETCH 2 : ROUTE W2

An advantage of this route over W1 is that the new road becomes the priority road with Oyster Bay residents having to "turn-off" from this road, which may give the perception of reduced impact on Oyster Bay. A disadvantage is that it crosses an additional two private erven. The new construction is also 200m longer than that required for W1, although the overall length from DR 1762 remains the same. All other advantages and disadvantages are as per W1 above.

c) Option W3

This route is also a very minor variation on the Option W1, with the first 450 metres of the road following the base of the ridge below the road joining the village of Oyster Bay with Umzamawethu. Thereafter it becomes identical with Option W1.



SKETCH 3 : ROUTE W3

For all three options, W1, W2 and W3, residents of Oyster Bay would enjoy varying lengths of surfaced road resulting from the upgrade of the initial portion of their existing gravel road. The final section of gravel road before entry into the village could however be upgraded as part of a social benefit to the Oyster Bay community.

d) Option W4

Route W4 commences from the local district road DR 1762, runs south-east passing some 400m East of Umzamawethu and intersects the dune system approximately 0.5km beyond the eastern end of Oyster Bay. The route then turns south-west, following a valley between two open dune fields before intersecting with the alignment of the two routes described above, just north of the present access road from Oyster Bay to Thyspunt.

The advantages of this route are as follows:

- Minimal impact on Oyster Bay

- Does not separate Oyster Bay and Umzamawethu
- Travel distance from Humansdorp to site is approximately 1.5 km shorter than that offered by Routes W1 to W3.

SKETCH 4 : ROUTE W4

The disadvantages of the route are as follows:

- Length of new construction from DR 1762 is 300m longer
- Does not provide Oyster Bay with a surfaced access road benefit
- Greater impact on the dune field even though it passes through vegetated or static dune areas.
- Longer route from Oyster Bay to site for any Oyster Bay residents involved in construction or operation of the Power Station.

e) Option W5

From the common junction point of Options W1,W2, W3 and W4 outlined above, a proposed common route then generally follows an existing track for approximately 1.5km before splitting, giving rise to options W6 and W7. This route option offers the advantage of the start of the most direct route to site from the eastern end of Oyster Bay. A significant disadvantage is that the route is relatively close to the coastline (generally within 300 metres), and truncates existing privately owned the coastal properties. If these properties were purchased by Eskom, the issue would not arise, but some property owners wish to retain ownership of their land.

SKETCH 5 : ROUTE W5

The route also approaches closely to several coastal seeps and does not find favour with the environmentalists. Currently, the requirement from the environmental process is that no structure may be built within 200 m of the high water mark. Generally this is not a problem, but, as for the case of the coastal seeps, the road does approach closely at some point.

f) Option W6

The route option W6 continues from W5 and veers east and inland, following a line between dune ridges. It then veers south-east in order to avoid the vegetated dune field and terminates at a point north of the approximate footprint of the main power station. In a very general manner it follows the route of an existing gravel service track.

This was an initial choice of route, attempting to minimise disruption to the indigenous vegetation by mimicking the route of the old road.

The advantages of this route are that:

- It generally follows the old road, simplifying alignments.
- It follows the topography of the land, reducing large cuts or fills until immediately before the site, at which point it has to cross a ridge.
- The route moves away from the coast line, which is desirable from a visual impact perspective and also avoids coastal seeps.

SKETCH 6 : ROUTE W6

The possible disadvantage of the route is that portions cross vegetated areas and a final on-site inspection with the experts will be necessary to ensure that coastal forest growth is not threatened or damaged unnecessarily.

g) Option W7

An early consideration in the access road planning was a route that largely followed an existing track along the coastline thus avoiding the vegetated dune areas, but the new route would essentially be a new road over a large proportion of its length. The visual impact is greater, as it is visible from the sea. It also crosses a number of watercourses which daylight as springs at the rocky coastline edge.

This alternative also follows a route close to the south of any future possible extensions to the power station and consideration would need to be given to the vertical alignment in order to conform with future planning and construction of this..

The advantages of this route are that:

- It completely avoids the vegetated dune areas
- It is shorter than option W6 to achieve access to the power station. This may however generate a disadvantage in that vehicle access to the plant itself may well be from the north side, and thus additional roads presently not on the layout will require to be constructed along the west side of the plant to carry traffic to the north side of the plant building.

SKETCH 7 : ROUTE W7

Other disadvantages are:

- Great visual impact as the road would be visible from the sea.
- Potential adverse effect on these coastal properties' values.
- The road would cross a number of watercourses which daylight as springs or seeps at the coastal edge. This stipulation that any new road does affect coastal seeps is a requirement noted in the separate report on the wetlands system by The Freshwater Consulting Group.

h) Option W8

Subsequent consideration of the routes, both desktop and on site, has led to the possibility of further routes being proposed. W8/W9 has been mooted as connecting onto DR 1762 approximately 200 m further to the east of the point at which W4 joins, running in a direction parallel to present property boundaries and then curving south-west to pass between a vegetated gap between sand dunes and then turning eastwards to pass beyond the edge of the un-vegetated dunes. After 2.5 km it crosses W6, then turns back and becomes co-incident with W6 (refer earlier) for the balance of the route up to the footprint of the power station.

The advantages of this route are:

- The route avoids Oyster Bay in a similar manner to W4, but after turning past the eastern end of Oyster Bay, it curves further inland, and further away from the coast than W5 or W7.
- The route was selected specifically to circumvent all coastal forest and the route lies completely within areas of alien vegetation apart from a short section where only a few individual trees are threatened..
- Being further from the coastline, it would not be visible from the sea or coastline.

- It does not threaten any wetlands or seeps.

- It moves the road alignment further out of the smaller coastal properties.

SKETCH 8 : ROUTE W8

The disadvantages are:

- As for W4 above, it does not offer Oyster Bay a surfaced access road.

- People living in Oyster Bay will have a greater distance to travel if they wish to access the power station site.

- The first section of roadway would cut through an extensive length of wetland depression.

i) Option W9

Some consideration was given to the tightening of the loop of road in Route option W4/W8 that was envisaged approaching the eastern end of Oyster Bay. The proposal, noted as W9, follows W8 until it approaches W4 then curves away directly into and across the dune field. After crossing the dune field it re-joins W8/W9 and continues until it reaches the power station.

The advantages of this route are:

- The route cuts out the loop of road close to Oster Bay, which shortens the length of road to be constructed.

- The route is a further 500m away from the eastern edge of Oyster Bay, than the other options..

- The route is close to the property boundaries, and thus does not create any ‘dead’ or unusable areas of land.

SKETCH 9 : ROUTE W9

The disadvantages are:

- The route would now cut directly across the western end of the dune field, with associated deep cuts and fills.
- The first section of roadway would cut through a length of wetland depression in the vicinity of the Slang River.
- The first section of road of 1.5km cuts off a strip of land that would be difficult to exploit.

j) Option W10

- The last disadvantage listed for Options W8 and the last two for W9 were addressed by relocating the start point of the route even further along DR 1762, into the adjacent property.
- The advantage of this route is that the route thus proposed lies just within the property line, and no area of land is isolated.
- The route is further away from the wetland depression.
- The disadvantage is that the route still needs to cross two sections of wetland depression. However, this can be addressed by appropriate design of road drainage structures at the points of crossing.

SKETCH 10 : ROUTE W10

7.3 RECOMMENDED ROUTE

Two main routes have been identified for further consideration as suitable for the proposed western access. The first, which has been identified by the environmental specialists as the preferred route, is depicted in component sections on the various sketches and generally tries to follow the existing gravel roads on site.

The second route identified is an alignment chosen to reduce the social impact on Oyster Bay by positioning the route completely away from the village.

These two options are indicated as Option 1 (W2-W5-W6) and Options 2 (W10-W8) on Sketch 11

Option 2 is however the recommendation of this report.

7.3.1 Description of Recommended Route (Option 2)

This route begins at road DR 1762 approximately 1.7 km further to the east from the present Oyster Bay access Road. The route then runs in a generally southerly direction parallel to existing property boundaries and then curving south-west to pass between a vegetated gap between sand dunes and then turning eastwards to pass beyond the edge of the un-vegetated dunes. The alignment then continues in a westerly direction not less than 500 m from the coastline, before turning south to connect with the power Station site itself. The total length of road required is **6.7** km. This compares with a required length of road for Option 1 of **6.2** km

7.3.2 Vegetation encountered

The vegetation encountered is largely invasive alien species as described in general terms above. Final comment from the environmental experts with regards to any coastal forest areas will be taken into account in the detail design, after the route have been pegged by a surveyor and a detailed onsite inspection is undertaken. Thereafter all final details will be finalised.

SKETCH 11 : PREFERRED ROUTES

7.3.3 Natural or man-made obstacles

The route does not impact on any existing developments , being kept away from Umzamawethu and Oyster Bay. The dune ridges and valleys are significant geographical features that need to be negotiated carefully.

7.3.4 Constraints (start, end points, etc.)

The requirement to avoid, as far as possible, interfering with the un-vegetated dune areas, forces the early parts of the road for both preferred routes to swing through the gap between Oyster Bay and the end of the dune field. Generally, the major concern for all options is to avoid the dune field.

7.3.5 Advantages of Option 2 route

The advantages of route – Option 2 are as follows :

- Avoids the problem of isolating Umzamawethu from Oyster Bay and presents a shorter travel distance from Humansdorp.
- Does not attempt to follow any existing tracks, Thyspunt access is therefore not disrupted during construction of the new road.
- Will be routed primarily through alien vegetation, which can be removed with impunity

- Avoids any coastal seeps.
- Lies further away from the coastline and is much less likely to be seen from the sea or coastline
- Affects fewer coastal properties.

7.3.6 Disadvantages of Option 2

- Passes through the end of the un-vegetated dune field system.

7.3.7 Services

In a similar way to the Eastern access, minimal services will be required in the road reserve and this aspect should not influence the design in any meaningful way. The minimum road reserves are wide enough to accommodate future services such as street lighting, electrical cabling and communication ducts.

The typical road reserve cross section below indicates the proposed positioning of these future services. The proposed services will be positioned alongside the road reserve boundaries to allow for the future widening of these roads if required. This service buffer or servitude will also be restricted for construction of any other infrastructure along these roads as to reserve for future services only. The service road as shown will be covered in the next item as this will merely for temporary access during construction of the road.

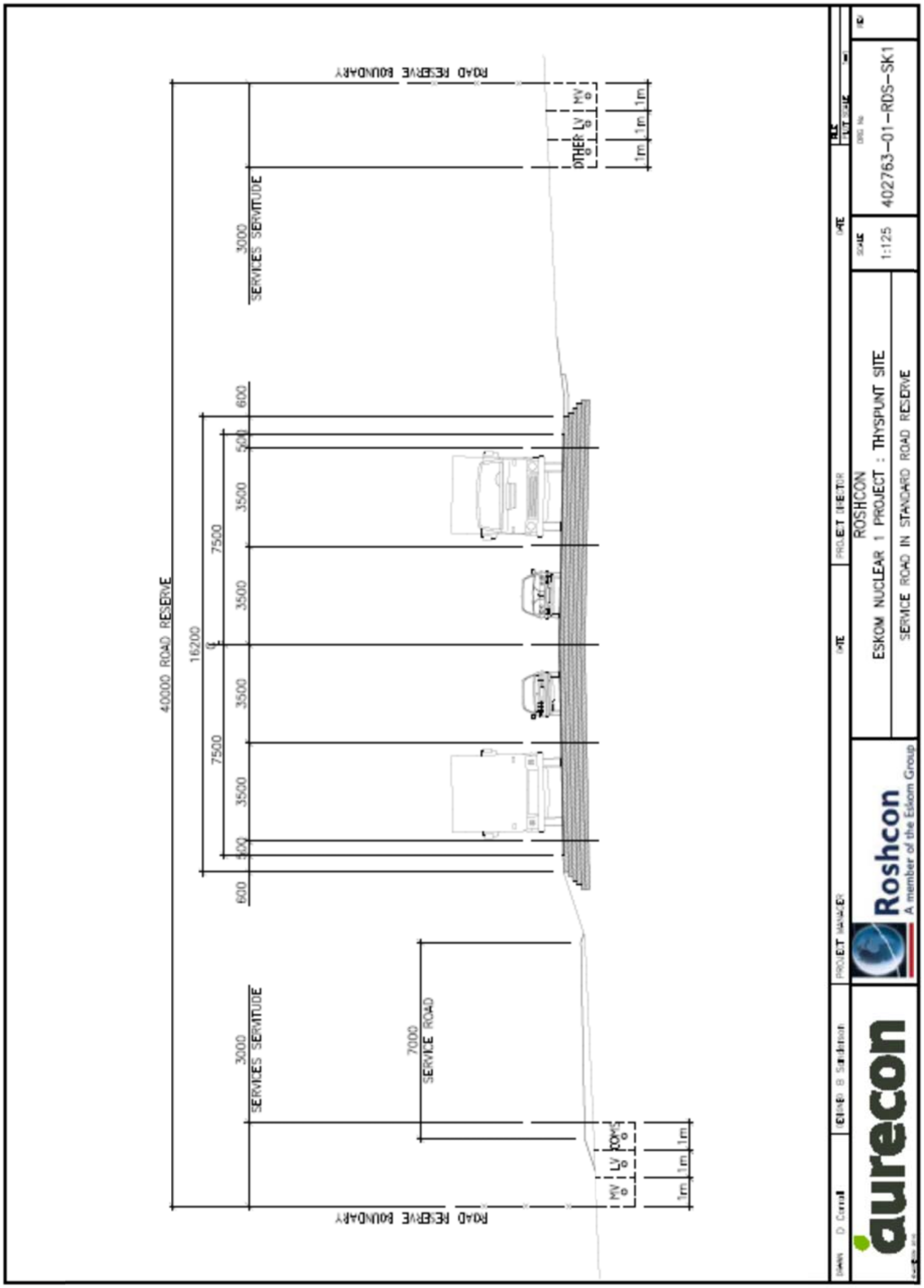


Figure 4: Proposed services servitudes

7.3.8 Temporary Access Roads

The main purpose of the temporary road is to allow the Power Plant Vendors, access to this site while the access roads are being constructed. During the construction of the proposed site access roads all traffic, construction and other will be accommodated by a temporary access road.

It will be positioned within the normal road reserve and as far as possible adjacent to the new road profile. The road building contractor will have also have to provide access to the site of works for the movement of his personnel and plant and therefore such a temporary service access road is essential. This temporary access road will have to be shared with other road users such as personnel involved with building the power plant and to also accommodate any other construction and delivery vehicles.

The proposed road width of 7 m (two by 3,5 m lanes) and comprising gravel wearing course layer, with the vertical alignment complying for a design speed of 40 km/h for site safety reasons and to minimize reduce dust generation.

Where sections of the permanent roads are in deep cutting or high fills, these sections should be constructed immediately, after the contract commencement, so that they form part of the temporary access road. It is recommended that these sections be built with all required pavement layer works with a temporary single seal surfacing. The latter is imperative as to avoid wide fills and cuts for accommodating a temporary access road which will also not be cost effective.

The recommended access road for a temporary access road alongside the permanent road would be the 6,7 km western access route. This route is much shorter than the eastern access route and also contains fewer constraints.

The western access route has been analysed to provide a temporary access road and the following have been established requiring a cost effective solution:

- 87 % of the temporary access road can be accommodated within the minimum road reserve adjacent to the new road profile (length 5,15 km) – Refer to typical cross section shown under item 7.3.7 Services showing the temporary service road;
- 15 % of the temporary access road will have to be constructed outside the road reserve boundary where the new road profile will be in fill and using the entire road reserve width (length = 1 km) - Cross section below indicate service road outside road reserve boundary

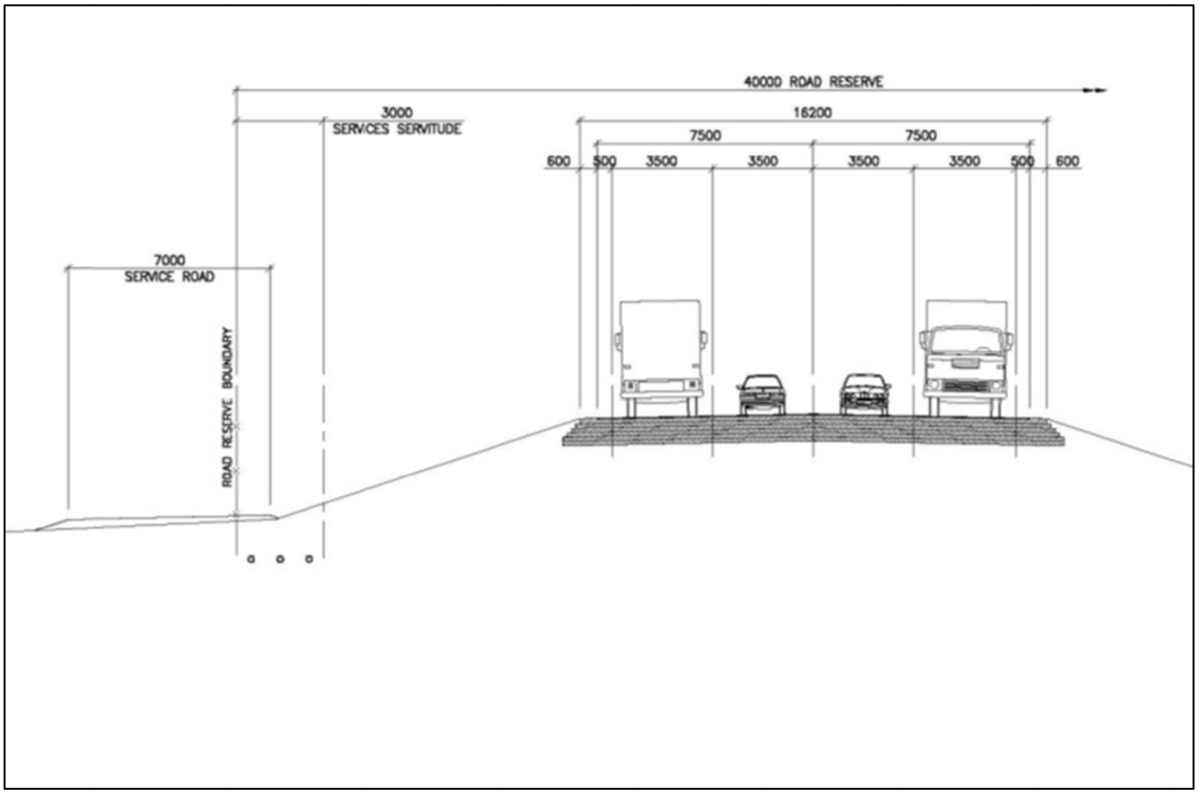


Figure 5: Service Road Outside Road reserve

- 8 % of the temporary access road will have to be diverted as mentioned earlier back onto the new road profile at deep cuttings with these permanent road sections to be prioritized for construction (length = 550 m). This would avoid that wider cuttings be created to accommodate the temporary road adjacent to the new road prism.

The temporary access road will have of nominal drainage structures where required, consisting of precast pipe culverts. In order to reduce cost, no headwall or wing wall structures will be constructed for the temporary culverts. The road building contractor will be expected to maintain this temporary road for the duration of lifespan.

Where the temporary road is constructed over the service buffer or servitude the service should only be installed after removal or rehabilitation of this temporary road.

Note that the cost estimates in this report do not make allowance for the construction of any temporary access roads as describe in this section.

A preliminary cost estimate to construct a temporary access road along the western route is table below:

Layer	Estimated Quantity	Rate	Amount
Gravel Wearing Coarse Surfacing (WC)	6,458 m^3	R 200-00	R 1,291,600-00
Selected Subgrade (G7)	8,610 m^3	R 100-00	R 861,000-00
Roadbed Preparation – In-situ (RBP)	6,458 m^3	R 45-00	R 290,610-00
Drainage – pipe culverts	Sum	R 750,000-00	R 750,000-00
Maintenance – during construction	Sum	R 350,000-00	R 350,000-00
		Total Cost Estimate	**R 3,543,210-00**

Note that this temporary road will be rehabilitated on completion of the permanent access road with cost for this activity allowed under the cost estimates for the permanent road.

7.3.9 Stormwater Management

Stormwater control and management will be handled in a similar fashion to that of the Eastern Access, in that wetland areas, coastal seeps and erosion control will need to be carefully managed.

7.4 Northern Access Route

Apart from the two general options considered already for access from the east and from the west of the site, another possibility exists for the provision of an alternate route into the site. The property on which the power station is sited extends north until it is bounded by the road DR1762. This road offers a direct access route for traffic to or from the site.

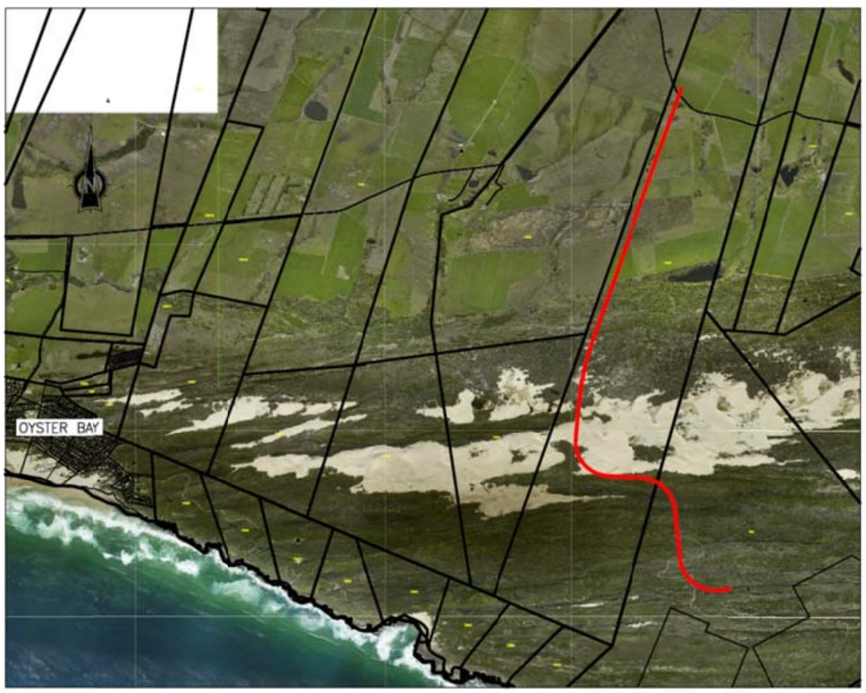
Access from the north would be the shortest route on to the power station site from an adjacent road, with the smallest construction foot print, as this new road would be about 3,5km in length across undeveloped land.

This route would also provide the shortest route from the power station to the sources of construction materials, housing for hourly paid workers and general connectivity to the surrounding road infrastructure, with attendant savings in both fuel use, CO2 emissions and travelling time.

The route would also avoid the developed areas of Oyster Bay and St Francis Bay. However this route crosses the dune field and the environmental impacts of such a road would potentially be highly significant. Access directly across the dune field did initially raise concerns but independent expert opinion, provided by Dr. W. Illenberger who is a recognized authority on dunes and dune fields, proposed that this northern access corridor does in fact present viable alternatives for routes. Accordingly, two possible options from this direction were considered and described as follows :

7.4.1 Route N1

This route starts at the existing provincial road, DR 1762, and follows the western boundary of the panhandle to the Eskom property before crossing the dune field and then onto the main site. This route, at a total length of 5200 metres, is longer than the alternative Route N2 (described below) but is nonetheless shorter than both the Eastern & Western options for access from Oyster Bay and St Francis Bay respectively. This length of 5200 m is derived from a total of 4100 m of road down the panhandle and part way across the site, and 1100 m of road common to this option and the option from the western (Oyster bay) side of the site. The advantage of this route is that the new road remains totally within Eskom property, and also avoids interfering with the road network in and immediately around Oyster Bay.



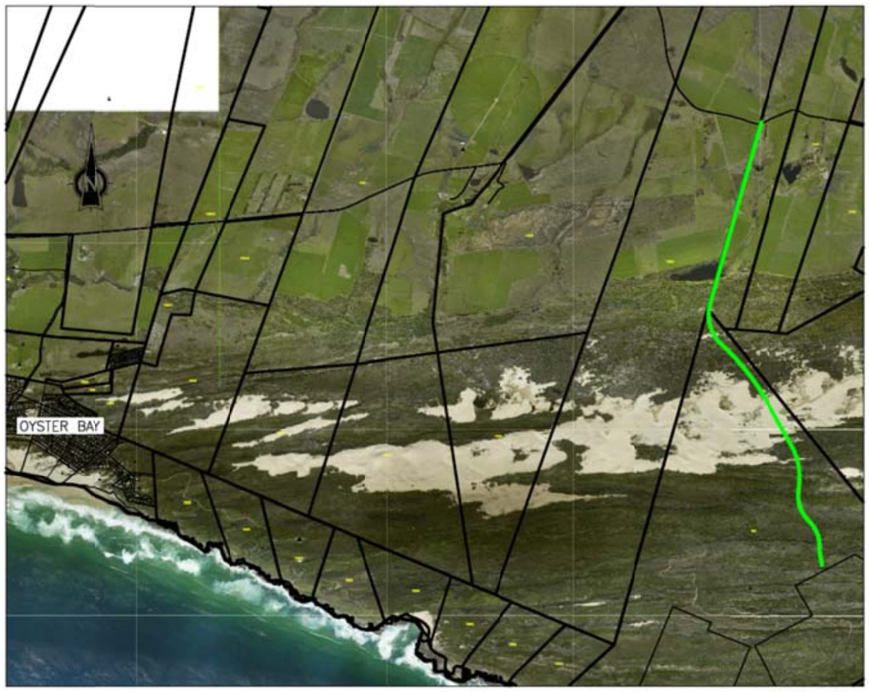
SKETCH 12 : ROUTE N1

However, in crossing the dune field a significantly deep cutting would need to be excavated for the road. Adjustment of the horizontal and vertical alignments can however reduce the effective depth of the cutting without compromising the traffic considerations. This option also has the possible disadvantage of needing to cross the route of the pylons supporting the proposed overhead power lines lying along the panhandle, although this may be beneficial to construction or maintenance teams responsible for the power lines.

7.4.2 Route N2

This route starts at the existing provincial road, DR 1762, and follows the eastern boundary of the panhandle of the ESKOM property before crossing the dune field and then onto the main site.

The length of travel from Humansdorp / St Francis to the Power Station site is 1.3km shorter than for Option N1. General advantages of either route leading into the site from the North include ready access to the proposed electrical substation, the overhead power lines and the possible quarry site. This would apply both in the short term for construction and in the long term for maintenance purposes. However, if the long term impact on the dune system was felt to be too severe, this road could be downgraded or removed after the completion of construction of the power station.



SKETCH 13 : ROUTE N2

7.4.3 Recommended Route

Although both the routes described above are viable and will adequately service the desired purpose, a final choice needs to be made based on both the positive and negative impacts noted in this report, as well as the recommendations of the dune movement specialist (Dr W. Illenburger) and the various specialists and Environmental consultant for this project.

From a purely technical engineering viewpoint the shorter route (Option N2) is the option that presents the simpler solution in isolation. However, should the western access <u>also</u> be required, then option N1, which becomes a common route with option W6 close to the power station site, becomes equally as viable, with no great difference in construction cost.

However, for a single route excluding any eastern or western access road, then the recommended route will be Option N2.

a) Natural or man-made obstacles

The dune system and any associated indigenous vegetation is the major obstacle to the route of the road from the north. The implications of crossing the dune field directly have been covered elsewhere, and this remains a major consideration in further planning.

b) Constraints

A major consideration is that the road must, of necessity, lie close to the side boundary in order to bypass the proposed HV switchyard. Also consideration must be given to the possibility of wind-blown sand as a hazard for traffic. Following the investigation of a possible Northern Route, it became evident in the Environmental Impact assessment process that a Northern Route was highly unlikely to be approved. This route has therefore not proceeded to preliminary design stage.

c) Advantages

An advantage of this route is that it is the shortest possible route onto site from any existing road infrastructure and would not require crossing any private erven, and similarly to route N1, also avoids the need to approach Oyster Bay itself in order to gain access to site

d) Disadvantages

A disadvantage is that it crosses the dune field, for a distance of approximately 350 metres, which could raise objections from the environmental lobby. However, Dr. Illenberger has noted that there can be no serious and valid environmental objection to crossing the dunes provided certain guidelines are followed in the design and construction processes.

e) Geometrical considerations

The same considerations as covered in the options described above for the western route will apply.

f) Structural design and road cross-section

If a Northern access road is built, it will likewise carry significant numbers of heavy vehicle and a high standard road pavement will be required. However, should the decision be made to remove the road and reinstate the ground after the completion of the construction phase, then the parameters affecting the road design may be adjusted to suit the shorter life span and thus reduce costs.

g) Services

It is not anticipated that there will be a need to accommodate any services alongside the road or within the road reserve.

h) Stormwater Management

All water will be directed away from the road, as per normal design practice, but will need to be carefully dealt with in order not to cause erosion or a change to the dune field eco-system.

8. DESIGN STANDARDS

8.1 Geometrical Standards

All routes are to be designed for a design speed of 80 km/h although Eskom have noted that within their property, a speed limit of 50 km/h will be enforced. The justification for the design speed of 80 km/h is to improve safety and also to facilitate the geometric requirements of the heavy haul vehicles which are more in line with an 80 km/h design speed.

Where possible however a higher standard should be aimed at in order to improve safety.

With the western access route being earmarked as the primary route for construction and bus traffic, long steep grades should be avoided which could slow vehicle speeds to an unacceptable level.

The numbers of bus and heavy vehicle traffic will be fairly significant on the Western Access. This will require the inclusion of climbing lanes on steeper gradients and on the sharper horizontal bends.

Consideration must therefore be given to the Western Access having a cross section similar to that of the Eastern Access. However this should possibly be reduced in the more sensitive areas of the dunefield in order to minimise impact on the dune system.

With the Eastern Access route being the primary route for supply of heavy haul/abnormal loads to site, additional limitations to the design apply because of the limitations of the heavy haul vehicles. In this case, the maximum vertical gradient applicable to the road may not exceed 7 %, and the maximum camber or cross fall may not exceed 4 %. This in turn will influence the minimum allowable horizontal curve radius. The high k-values used for the Eastern access road design are a result of the need to accommodate the heavy haul vehicles

The geometric design has been done in accordance with the Class 1 Rural Road Standards for Eastern Cape Provincial Road Design Guidelines as tabled below:

Table 2: Eastern Cape Provincial Road Design Guidelines

Design Parameters	Eastern Access Road	Western Access Road
Horizontal alignment		
Design speed	80 km/h	60 km/h
Minimum Radius (2% superelevation)	320 m	170 m
Design speed for superelevation	80 km/h	60 km/h
Maximum super elevation	4 %	4 %
Maximum road reserve width	40 m	40 m

Design Parameters	Eastern Access Road	Western Access Road
Minimum intersection spacing	500	500
Vertical alignment		
Design speed	80 km/h	60 km/h
Maximum gradient	7 %	7 %
Minimum gradient	0.5 %	0.5 %
Minimum vertical curve length	60	60
Minimum K value (sag)	26	16
Minimum K value (crest)	33	16

The typical road reserve cross section is 40 m wide except where high fills and deep cut will dictate a wider road reserve. The road reserve is shown on the layout drawings and will be finalized during the detail design with co-ordinates. It is determined that the road reserve is for most of the road lengths falling with the standard 40 m wide configuration. All though these roads may in time become more of an urban arterial than a rural main road, it is envisaged that this will possibly only happen in the far future, It is therefore proposed to design and build the road as a Class 1 provincial main road. Although no traffic study or traffic volumes predictions are done to date, it is assumed that the road would adequately serve the traffic requirements of the proposed power station.

The geometrical standards for any Urban Arterial road are in all cases (other than width and lane numbers) lower than those given in the above table, which would therefore cause no necessary re-alignments in the future.

8.2 Typical Cross-Section

The typical road cross section has been designed to be wide enough to accommodate the simultaneous movement of heavy haul vehicles and normal light construction vehicles, without interfering with each other.

It is also proposed that, as shown in Figure 6 below, the carriageway width is set at 15 m wide. This is to accommodate simultaneously two lanes of normal traffic and two lanes of heavy traffic. The same parameters will apply to the Western Access route design.

At a later stage, when possible further developments proceeds, the operating staff for the first phase power plant will not be hindered in any way by further heavy haul or construction vehicle movement,

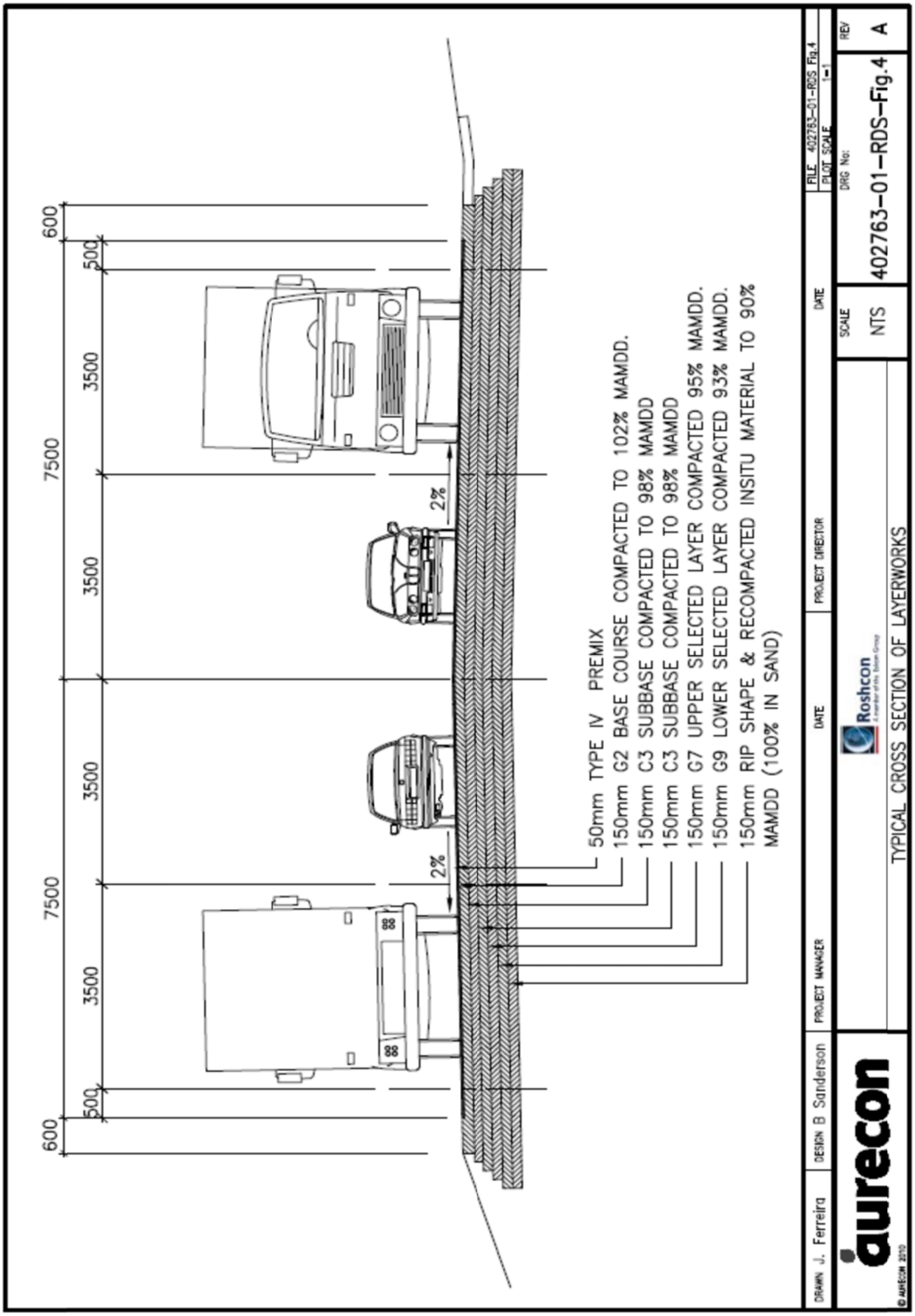


Figure 6: Typical Cross Section

The typical cross section comprises of four 3,5 m wide lanes with a surfaced outside shoulder lane of 0,5 m wide. The shoulder break point is 0,6 m off set to the edge of tar which provides for an unsurfaced outer shoulder.

8.3 Pavement Design

The Western Access route will be expected to accommodate the major portion of the construction traffic and all the buses carrying construction workers to and from work. For the purposes of the report, it is assumed that all hourly-paid workers will be based in or around the Humansdorp area during the construction phase.

The layout of roads will give good access and will ensure safe and efficient transport movement

Although much needed information, such as anticipated traffic, in situ soil conditions and availability of construction material, is still outstanding, this report will endeavour to present the preliminary pavement designs for both the Access roads, with the pro visa that detail may change after the outstanding information becomes available.

As a general, the Draft UTG 3, 1993: Structural Design of Urban Roads published by the Committee of Urban Transport Authorities, was used as guide in the design strategy.

Category	Reserve	No of lanes	Road width
Primary distributor UA/UB	60 m / 40 m	4	4x3,7m

The primary distributor will consist of a Category UA from the point of entrance up to a point where traffic intensity only requires a category UB road and the structural design will change accordingly.

Table 3: A general definition of the road categories

Road Category			
General Description	**UA**	**UB**	**UC**
	Primary & distributor roads		Local access roads
Importance & Service Level	Very Important, high level of service	Important, moderate level of service	Less important, low level of service
Total Traffic over design Life	Up to 50 mill E80's	Up to 12 mill E80's	Up to 3,0 mill E80's
Recommended Design Life	20 years	20 years	20 years

At present insufficient information is available to provide the anticipated traffic figures for both the Eastern and Western Access roads to a reasonable degree of accuracy. To determine the most probable traffic scenario for the anticipated road network, a prediction was made with the aid of the following available information:

- Anticipated construction vehicles after the construction of the roads
- Anticipated busses and normal traffic after construction
- Assumed traffic growth over the design life time

The calculated anticipated traffic is assumed to be 5,000 which was further analysed. The following predicted traffic indicators were used to obtain the anticipated E80 traffic for the different roads:

- % heavies 45%
- E80 per heavy 3
- Average Growth rates 0,5%

At this point in the investigation and design process it was not possible to adequately calculate the traffic flow figures on these two roads, however once the overall planning of the Nuclear-1 power plant development is known, a traffic impact assessment will be required especially for the design of the major intersections where these roads join existing provincial main roads.

The Traffic Analysis based on the certain assumptions as mentioned above is depicted on the next page.

Project Name:	**Nuclear-1 Thyspunt Project**
Project No.	**402763**
Road Name:	**Eastern & Western Access Routes**

Traffic Analysis

Traffic Detail:			
1	AADT/direction	5000	Assumed
2	% heavies	45	Assumed
3	E80/heavy	3	
4	No. of lanes (2, 4 or 6)	4	
5	Growth rates (%)	0.5	
		1	
		1.5	
		2	
		2.5	
		3	
		3.5	
6	Base Year to Construction (years)	1	
7	Construction Period (years)	1.5	
8	Growth during construction (%)	0.5	
9	Design Life (years) - max 25	20	

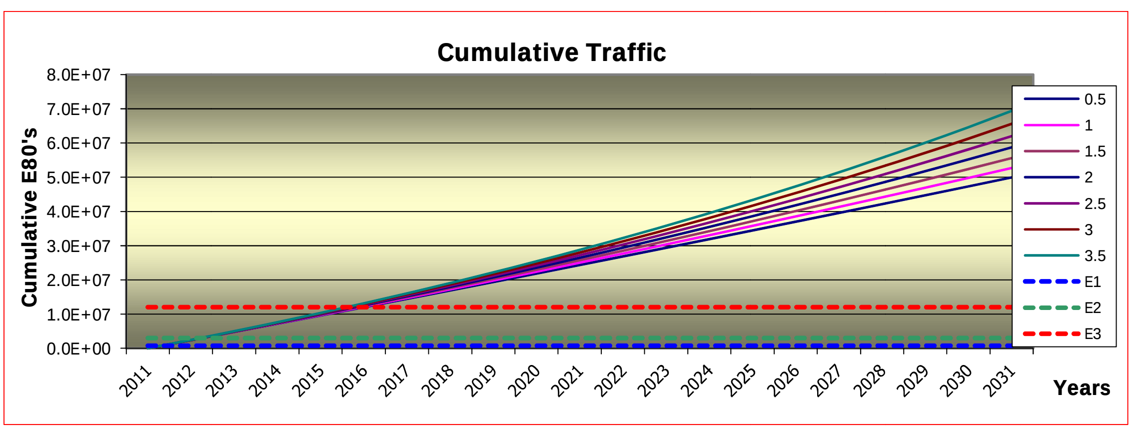
Calculation: E80's per Day	
E80/direction (1*2*3)	6750
E80/direction in slow lane	6413
E80 after construction	6493

Time Frames	
Base Year	2011
Start of Construction	2012
End of Construction	2013.5
End of Design Life	2033.5

Traffic Classification:

E1	0,2 - 0,8 million E80's
E2	0,8 - 3,0 million E80's
E3	3,0 - 12,0 million E80's
E4	12,0 - 50,0 million E80's

End of Year	E80/day	Cumulative E80's over Design Life at growth of:						
		0.5	1	1.5	2	2.5	3	3.5
2011	6493	0	0	0	0	0	0	0
2012		2 381 779	2 393 629	2 405 478	2 417 328	2 429 178	2 441 027	2 452 877
2013		4 775 467	4 811 194	4 847 039	4 883 002	4 919 085	4 955 285	4 991 604
2014		7 181 123	7 252 934	7 325 223	7 397 990	7 471 239	7 544 971	7 619 187
2015		9 598 808	9 719 092	9 840 579	9 963 278	10 087 198	10 212 347	10 338 736
2016		12 028 581	12 209 912	12 393 666	12 579 872	12 768 555	12 959 745	13 153 468
2017		14 470 503	14 725 639	14 985 049	15 248 797	15 516 947	15 789 565	16 066 717
2018		16 924 634	17 266 524	17 615 303	17 971 101	18 334 048	18 704 279	19 081 929
2019		19 391 036	19 832 818	20 285 011	20 747 851	21 221 577	21 706 434	22 202 673
2020		21 869 771	22 424 775	22 994 765	23 580 136	24 181 294	24 798 655	25 432 643
2021		24 360 898	25 042 651	25 745 164	26 469 066	27 215 004	27 983 641	28 775 663
2022		26 864 482	27 686 707	28 536 820	29 415 776	30 324 556	31 264 178	32 235 688
2023		29 380 583	30 357 202	31 370 351	32 421 419	33 511 848	34 643 130	35 816 814
2024		31 909 265	33 054 403	34 246 384	35 487 175	36 778 822	38 123 452	39 523 279
2025		34 450 590	35 778 576	37 165 558	38 614 247	40 127 470	41 708 182	43 359 471
2026		37 004 622	38 529 990	40 128 520	41 803 860	43 559 834	45 400 455	47 329 929
2027		39 571 424	41 308 919	43 135 926	45 057 265	47 078 007	49 203 496	51 439 354
2028		42 151 061	44 115 636	46 188 443	48 375 738	50 684 135	53 120 628	55 692 608
2029		44 743 595	46 950 421	49 286 748	51 760 581	54 380 416	57 155 274	60 094 726
2030		47 349 092	49 813 554	52 431 528	55 213 120	58 169 104	61 310 959	64 650 918
2031		49 967 616	52 705 318	55 623 479	58 734 710	62 052 509	65 591 315	69 366 577
		Predicted Traffic Classification:			E4			



In general the anticipated traffic can be summarised that the access roads to the Nuclear Plant will be a E4 traffic classification (up to 50 million E80's by 2025 and beyond thereafter)

As no geotechnical/materials investigation was undertaken to date to determine the in situ conditions prevailing along the access roads it is at present very difficult to ascertain the uniformity of the site.

The term "material depth" is used to denote the depth below the finished road level to which soil characteristics have a significant effect on pavement behaviour. Below this depth, the strength and density of the soils are assumed to have a negligible effect on the pavement. This depth approximates the cover for a soil of 1 – 2% CBR.

The general Material Depths utilised for urban roads is as follows:

Road Category	Material Depth (mm)
UA	1 000

In accordance with UTG 3 (1993), the roads will generally consist of the following layers. These preliminary specifications may change during the detailed design and final analysis of available resources:

Description	Reserve	Lane Width	Category	Maximum Traffic E80's	Structural Layers (see full description below)
Primary Distributor	60 m / 40 m	4*3,7	UA	50 mill	50 mm AC 150 mm G1 150 mm C3 150 mm C3 Subgrade *

Description of material to be utilised (in accordance with TRH 14, 1985)

- AC - Continuously graded asphalt surfacing
- G1- Dense-graded unweathered crushed stone; Max size 37,5 mm; Plasticity Index less than 4; compacted to 88% of apparent density
- C3- Cemented natural gravel: maximum aggregate size 63 mm: maximum Plasticity Index after stabilisation = 6; Unconfined Compressive Strength of 1,5 to 3,5 MPa at 100% modified AASHTO density; Minimum Indirect Tensile Strength of 250 kPa at 95 to 97% of modified

AASHTO density ; compacted to 97% of modified AASHTO density as top subbase, and 95% of modified AASHTO density as bottom subbase layer

- G7 - Gravel/soil; Min CBR (California Bearing Ratio) of 15 at 93% of modified AASHTO density; Plasticity Index not more than 12; Maximum swell of 1,5% at 100% of modified AASHTO density; compacted to 93% of modified AASHTO density.
- G9 - Gravel/soil; Min CBR (California Bearing Ratio) of 7 at 93% of modified AASHTO density; Plasticity Index not more than 12; Maximum swell of 1,5% at 100% of modified AASHTO density; compacted to 93% of modified AASHTO density.
- G10 - Gravel/soil; Min CBR (California Bearing Ratio) of 3 at 93% of modified AASHTO density; compacted to 90% of modified AASHTO density.

Any road will deteriorate with time, traffic and environmental conditions. Each category described above, will reveal different terminal distress conditions towards the end of its design life.

The table below is an abstract from UTG 3, which clearly indicates the expected terminal condition of each category:

Possible condition at end of structural design period	**Road Category**		
	UA	**UB**	**UC**
Rut Depth (mm) Length of road exceeding stated rut depth (%)	20 10	20 15	2 25
Type of Cracking: Granular Base	Crocodile Cracking, surface loss, pumping of fines		
Length of road on which stated cracking might occur (%)	10	15	25

For all categories, general maintenance will be required during the life of the pavement. To optimise pavement and material performance, rehabilitation will be required after approximately 12 to 15 years, but is very dependent on environmental conditions and the actual traffic making use of the road infrastructure. For a life cycle costing, it can be recommended that the rehabilitation will consist of between 5 and 10% base patching as well as a provision of a 35 to 40 mm asphalt overlay.

If concrete blocks must be provided, 30 mm rut depth over approximately 30% of the area will be anticipated after approximately 12-14 years. This can be rectified by unzipping the pavers, then providing a levelling layer (or patching the sub base layers) and a sand bedding layer and again zipping the existing block pavers into position. Alternative pavement designs, or alternative pavement materials, will still to be compared report on an economic basis during the detail design and also be based on the availability of materials in the regions as per the findings of the Task Order No 5.

The following pavement designs are therefore recommended:

Primary Distributors Category UA:

- 50 mm Continuously graded asphalt surfacing (AC)
- 150 mm dense-graded crushed stone compacted to 88% of apparent density (G1)
- 150 mm cemented natural gravel subbase, compacted to 97% of modified AASHTO density (C3)
- 150 mm cemented natural gravel subbase, compacted to 95% of modified AASHTO density (C3)
- 150 mm natural gravel top selected subgrade, compacted to at least 93% of modified AASHTO density (G7)
- in situ preparation still to be verified

8.4 Storm Water Management Design

The storm water design of both the Western Access and Eastern Access roads has been carried out according to the recommendation of the South African National Roads Agency Limited Drainage Manual, 5th Edition.

The surface drainage component of the design has been divided into two sections, namely

- Bridging of rivers, streams and minor watercourses
- Rain falling on the road

8.4.1 Design of Minor Cross Drainage Structures

Minor Cross Drainage Structures are defined as structures which convey water through or under the road prism. The design procedure is as follows

- Identification of drainage paths (length, slope)
- Identification of contributing catchment area (area)
- Assessment of catchment characteristics (slope, shape, roughness, hydrology, permeability, vegetation)
- Calculation of peak discharge (Return interval, time of concentration)
- Selection of drainage structure (hydraulics, headwater depth)

The storm water analysis for the Minor Cross Drainage Structures will be carried out using the following design parameters

Flood Estimation Method	**Alternative Rational Method**
Return Period	1:50 year
Permissible headwater depth	1.2D (max)
Minimum freeboard to road surface	0.5m
Mannings n-value for concrete	0.012
Mannings n-value for asphalt	0.016
Minimum slope of culverts	1:150

8.4.2 Design of Road Prism Drainage

Road Prism Drainage comprises the methods and structures involved in disposing of storm water which may fall within the limits of the road works prism.

The following elements will be considered:

- Catch water banks
- Cutting chutes
- Cutting side drains
- Cutting drop inlets
- Mitre drains at the end of cuttings
- Fill side drains
- Fill drop inlets
- Fill chutes
- Subsurface drains

8.4.3 Road Surface Drainage

In order to prevent hydroplaning the following design standards will be implemented

Maximum flow depth during 1:5 year event	**6mm**
Minimum gradient of flow path	2%

8.4.4 Wetlands, Vlei's and Marshes

In the design process consideration must be given to the various wetlands occurring in the proximity of both the Western and Eastern Access roads. Given the erratic nature of these wetlands and the variability in the depth of the water table in the study area, we propose to span the full width of the wetland flow paths with storm water conduits where they intersect the proposed road alignment.

8.4.5 Erosion Protection

As these roads will passes through a dune area comprising of non-cohesive, poorly graded sand. The control of erosion as a result of scouring is imperative to prevent the undermining of the road and associated structures as well as prevent damage to the environmentally sensitive surrounding area.

To facilitate the prevention of erosion various methods of energy dissipation and velocity control will be implemented in the design process.

These may include

- Gabion baskets
- Reno mattresses
- Armorflex channels
- Stone pitching

8.5 Areas of Concern

The following areas have been identified as being problematic to the drainage of the Western Access road (W10).

a) The crossing of the Slang River:

The Slang River tributaries cross W10 in two places, SV700-840 and SV160-220. The catchment area for the tributaries is in excess of 400ha and generates a significantly large run-off in the 50 year storm. Box culverts have been provided as a solution for the crossing at this stage of the design process but pending the outcomes of the detail design, a bridge may need to be constructed.

b) SV 1900 to SV1940:

The catchment area of this drainage point is large and requires further investigation. Box culverts have been proposed at this stage but may be omitted in favour of pipe culverts if it is demonstrated that the flow is insufficient to warrant the box culvert.

c) SV 6360 to SV 6480:

The road transects a natural depression in the dunes. This depression drains towards the east once it has filled to a significant level. To prevent any possibility of the road being flooded, consideration must be given to constructing a drainage channel to draw water away from the road and towards the natural flow path (eastwards).

8.6 Road Signs and Markings

Provision has been made in the cost estimate for road signage and markings although not in detail addressed in the preliminary design stage.

8.7 Design Verification

As part of the quality assurance of the design process, the preliminary design has been scrutinised and adjusted by a professional engineer to allow for internal value management and design refinement. Below find a quality control sheet used in the process:

Aspects which were identified during refinement and which should be followed up include:

- Update pavement design once geotechnical investigations results are available during the detail design.
- Roads signs and markings part of detail design.

The completed design verification sheet below is summarizing the preliminary design approval.

NUCLEAR-1 PROJECT AT THYSPUNT

PRELIMINARY DESIGN

DESIGN VERIFICATION
OF
ROADS

CONSULTING ENGINEER: **Aurecon South Africa (PTY) LTD**

DRAWINGS CHECKED: **Christo Beukes**

EXAMINER: **Chris Roberts**

DESIGN ELEMENTS CHECKED	IN ORDER		COMMENTS
	YES	NO	
1. LAYOUT			
1.1 Correct erf layout used for design			Not applicable
1.2 Erf layout approved by town planner and developer			Not applicable
1.3 Existing roads/street indicated	X		
1.4 Exisiting road/street tie-in points indicated	X		
1.5 A layout plan must be provided, indicating the road category (UA, UB, UC or UD) and the traffic classification (ER, E0, E1, E3, E2 or E4) of all roads	X		
2. TYPICAL ROAD RESERVE CROSS-SECTIONS			
2.1 Typical road reserve cross sections accepted by all parties for design purposes	X		
2.2 Every erf must have access at a maximum gradient of 1:4.			Not applicable
2.3 The maximum gradient from the street to the erf boundary, excluding the erf access, is 1:3.			Not applicable
2.4 Correct kerb type must be indicated for different road-widths on cross-sections and road layout plan.			Not applicable
2.5 The minimum cross-fall of roads in order	X		
2.6 Single cross-fall for street widths less than 6m.			Not applicable
2.7 Single cross-fall must be against the natural slope.			Not applicable
2. ROADS			
2.1 GEOMETRICAL DESIGN			
2.1.1 Name of design model used?	X		
2.1.2 A layout plan must be provided, showing the road classification as well as all other relevant information such as street names, erf numbers, cadastral information,	X		
2.1.3 Street widths (Indicate on layout plan and cross-sections):	X		
2.1.4 Reserve widths (on layout plan and cross-sections):	X		
2.1.5 Position of streets in road reserves (on layout plan and cross-sections).	X		
2.1.6 Evaluate proposed geometrical layout in terms of adjacent layouts.	X		
2.1.7 Radii of bell mouths according to Design Standards Report	X		
2.2 VERTICAL ALIGNMENT			
2.2.1 The minimum gradient of roads complying with standards	X		
2.2.2 Maximum gradients checked for compliancy	X		
2.2.3 Vertical alignment must be adapted to existing streets, and provision must be made for future street extension where applicable.	X		
2.2.4 Check sight distances (horizontal and vertical) especially for intersections where there is no stop street or traffic light in the higher order road.	X		
2.3. PAVEMENT DESIGN			
2.3.1 Pavement designed in accordance with Design Standards Report criteria	X		
2.3.2 Insitu soil conditions investigated for optimum use of suitable insitu material	X		
2.3.3 Alternative surfacing investigated for spillage of fuels and oils at intersections	X		
2.3.4 Layerworks for side walks and cycle paths designed			Not applicable
2.3.5 Vertical gradient not steeper than 1:8 (12,5%) consider other surfacing			Not applicable
2.3.6 Consider other materials for pavement layers	X		
2.3.7 Investigate modification of materials		X	Refer to Task Order No 5 Materials Report
2.3.8 Investigate hard excavation material for cost estimate purposes		X	Detail design stage
2.3.9 Investigate ground water and need for sub soil systems			Provision made in cost estimate but further investigations at Detail Design Stage
3 DESIGN QUANTITIES			
3.1 Quantities of design measured and checked	X		
3.2 Construction rates relevant for cost estimate	X		
3.3 Cost estimate checked and accepted	X		
4. PRELIMINARY REPORT			
5.1 Verify the most cost effective engineering solutions	X		
5.2 Contents for the Preliminary Design Report checked and accepted	X		

Aspects which were identified during refinement and which should be followed up include:

- Geotechnical information is required to add intelligence to a number of the designs, particularly relating to sub soil conditions along road cuttings to confirm dune seepage and other.
- There is still good opportunity for additional value engineering, especially as regards input from local authorities and finalising the design of the vertical road alignment.
- Environmental investigations to sensitive areas are required before detail design can be undertaken especially where the roads are crossing wetlands and dune fields.

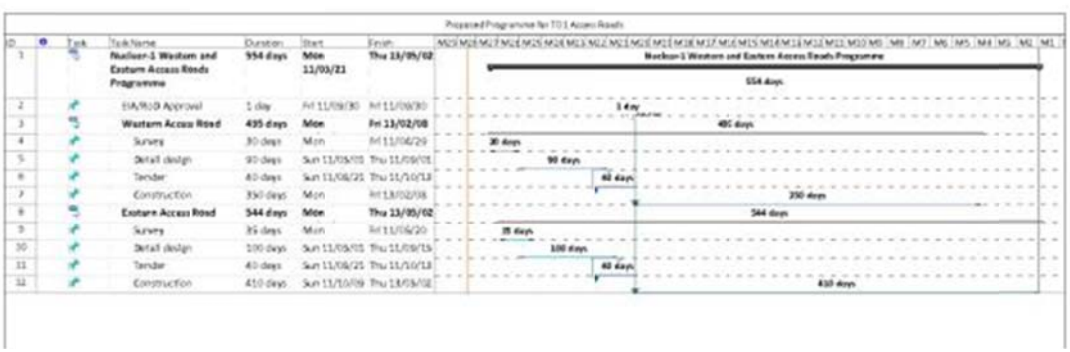
9. PROGRAMME AND TIMING

The proposed programme is based on the assumption that the EIA/Record of Decision approval will be obtained towards the end of the third quarter of 2011. The programme indicated early start dates of detail designs which will include detailed surveys and geotechnical investigations to ensure timeous completion of the design and construction work drawings. It was further assumed that both the access roads will be constructed simultaneously in order to complete at the earliest date for vendor activities.

9.1 Proposed Execution Plan

It is evident from this programme that the construction of both the access roads will commence at the same time with the Western Access road having an envisaged contract period of 15 months and the Eastern Access road an contract period of 18 months. The construction periods were calculated on a realistic cost turn over which can be achieved in the construction industry by a large road building contractor. Further shortening of the programme may be possible, but probably only with significantly increased costs to accommodate additional resources

The detail design periods are subject that the survey data information is obtained within a reasonable period after commencement of this particular activity. The Tender item is based on the assumption that the construction works will be carried out by Roshcon and that the normal tender procurement and approval process will not be applicable.



9.2 Long Lead Items for Action

The following long lead activities are summarized which may result in time constraints on the execution of the proposed programme:

- All EIA/Record of Decision (RoD) approvals for the access roads and other such as water sourcing for construction;
- Approvals of the road designs by all local and provincial authorities;
- Start of detailed surveys on preferred road routes to enable detail designs;
- Start with geotechnical and soil investigation on the preferred routs to finalize pavement designs and material availability. Crushing of aggregates for concrete products and road base

course material (G1) and asphalt surfacing to commence at construction start to ensure timeous supplies for construction activities;

- Acquisition of all private land which may be affected by the preferred road routes before construction to commence;
- Final negotiations with private land owners on sourcing of road building materials as per the recommendation of the Task Order No 5 Report.
- Provision of water for road construction activities and dust control during construction to comply with the Environmental Regulations and RoD

9.3 Shorter Implementation Plan

Construction work will not be allowed to commence until the EIA Record of Decision has been issued by the Environmental Authorities, therefore no advance construction work may proceed such a bush clearing, topsoil removal etc. In order to reduce the construction period the following could be considered:

- Package the work in separate contracts for more than one vendor to perform (increased resources);
- Negotiate with vendors a shorter construction period (subject to available resources)

The detail surveying of the proposed road alignments can be undertaken immediately to enable detail designs to commence. This would timeously provide clarified on any environmental implications on the proposed routes as to effect minor adjustments on the alignment where required. However, these works are pre-construction and would yield a shorter construction period.

10. COST ESTIMATES AND CASH FLOW

The cost estimates are based on the assumption that all selected sub grade layers for this road can be sourced from nearby private landowner borrow pits as per the investigations contained in the Task Order No 5 Report. It was furthermore assumed that all cut material will be suitable to use for fill, with only a marginal quantity allowed for cut to spoil and borrow to fill to supplement the shortage. A provisional sum was allowed for a subsoil system and provision was also made for the removable of unsuitable road bed material and replacement with rock dump as a pioneer layer. The later may be required where the roads are crossing the wet land areas.

These cost estimates are therefore subject to adjustment once the geotechnical investigation has been completed as to confirm the initial assumptions made in this report.

All amounts in this reports are exclusive of Value Added Tax (VAT).

10.1 Eastern Access Road (Recommended Route)

COST ESTIMATE							
RECOMMENDED EASTERN ACCESS ROAD TO NUCLEAR-1 AT THYSPUNT (E3)							
CONSTRUCTION COSTS							
	ITEM NO	**ITEM DESCRIPTION**	**MATERIAL**	**UNIT**	**ESTIMATED QUANTITY**	**RATE**	**TOTAL**
ROAD WORKS	1	Surfacing	50 mm thick asphalt	m^2	149 250	R 140.00	R 20 895 000.00
	2	Surfacing	Prime	m^2	149 250	R 10.00	R 1 492 500.00
	3	Base course	150mm G1	m^3	22 835	R 350.00	R 7 992 337.50
	4	Upper sub base	150mm C3	m^3	24 626	R 300.00	R 7 387 875.00
	5	Lower sub base	150mm C3	m^3	25 074	R 300.00	R 7 522 200.00
	6	Upper selected subgrade	150mm G7	m^3	25 522	R 250.00	R 6 380 437.50
	7	Lower selected subgrade	150mm G9	m^3	25 970	R 200.00	R 5 193 900.00
	8	Road bed preparation	150mm rip & compact	m^3	25 970	R 65.00	R 1 688 017.50
	9	Cut to fill	G10	m^3	78 000	R 35.00	R 2 730 000.00
	10	Cut to spoil		m^3	19 000	R 55.00	R 1 045 000.00
	11	Borrow to fill	G7 - G10	m^3	2 000	R 60.00	R 120 000.00
	12	Rockfill/Undercutting/Fill	Rockdump/G9/G10	m^3	12 500	R 150.00	R 1 875 000.00
						SUBTOTAL FOR ROAD WORKS	**R 64 322 267.50**
DRAINAGE WORKS	1	Lined drains	Concrete	m	1400	R 750.00	R 1 050 000.00
	2	Subsoils	Various	sum	1	R 500 000.00	R 500 000.00
	3	Pipe culverts	Assumed 600 dia Class 100D	m	1300	R 2 250.00	R 2 925 000.00
	4	Box culverts	Assumed 1,5 by 3,6 portals with base	m	115	R 15 000.00	R 1 725 000.00
						SUBTOTAL FOR DRAINAGE WORKS	**R 6 200 000.00**
ANCILLARY WORKS	1	Gabions & stone pitching	Standard	m^3	400	R 1 350.00	R 540 000.00
	2	Topsoiling	From site	m^3	4 000	R 25.00	R 100 000.00
	3	Hydroseeding/grassing	Standard mix	m^2	40 000	R 5.50	R 220 000.00
	4	Fencing	Stock proof	km	9.95	R 175 000.00	R 1 741 250.00
	5	Road marking & road studs	Standard	km	9.95	R 2 750.00	R 27 362.50
	6	Road signs	Standard	m^2	80	R 750.00	R 60 000.00
	7	Guardrails	Standard	m	3000	R 500.00	R 1 500 000.00
						SUBTOTAL FOR ANCILLARY WORKS	**R 4 188 612.50**
						SUBTOTAL	R 74 710 880.00
PRELIMINARY & GENERAL CHARGES (20 %)							R 14 942 176.00
						SUBTOTAL	R 89 653 056.00
CONTINGENCY (10 %)							R 8 965 305.60
						SUBTOTAL	R 98 618 361.60
CONTRACT PRICE ADJUSTMENT PROVISION (12 %)							R 11 834 203.39
						TOTAL	**R 110 452 564.99**

CONSULTANCY COSTS	
Normal Services - Detail Design (less prelim design stage fees), Tender Documentation, Contract Administration	R 5 371 699.56
Additional Services - Site Supervion, H & S and Environmental Compliace, Surveys, Geotechnical, EIA	R 4 596 000.00
TOTAL	**R 9 967 699.56**

TOTAL ESTIMATED PROJECT COST	**R 120 420 264.55**

The unit cost per kilometre of road using the above detailed cost yield an amount of R 12,1 million per kilometre, exclusive of VAT. This amount compares favourably with the average road building costs in the region.

10.2 Western Access Road (Recommended Route)

COST ESTIMATE							
RECOMMENDED WESTERN ACCESS ROAD TO NUCLEAR-1 AT THYSPUNT (W10 - W8 - W6)							
CONSTRUCTION COSTS							
	ITEM NO	**ITEM DESCRIPTION**	**MATERIAL**	**UNIT**	**ESTIMATED QUANTITY**	**RATE**	**TOTAL**
ROAD WORKS	1	Surfacing	50 mm thick asphalt	m^2	101 250	R 140.00	R 14 175 000.00
	2	Surfacing	Prime	m^2	101 250	R 10.00	R 1 012 500.00
	3	Base course	150mm G1	m^3	15 491	R 350.00	R 5 421 937.50
	4	Upper sub base	150mm C3	m^3	16 706	R 300.00	R 5 011 875.00
	5	Lower sub base	150mm C3	m^3	17 010	R 300.00	R 5 103 000.00
	6	Upper selected subgrade	150mm G7	m^3	17 314	R 250.00	R 4 328 437.50
	7	Lower selected subgrade	150mm G9	m^3	17 618	R 200.00	R 3 523 500.00
	8	Road bed preparation	150mm rip & compact	m^3	17 618	R 65.00	R 1 145 137.50
	9	Cut to fill	G10	m^3	155 000	R 35.00	R 5 425 000.00
	10	Cut to spoil	Assumed 15 %	m^3	23 250	R 55.00	R 1 278 750.00
	11	Borrow to fill	G7 - G10	m^3	38 250	R 60.00	R 2 295 000.00
	12	Rockfill/Undercutting/Fill	Rockdump/G9/G10	m^3	6 250	R 150.00	R 937 500.00
						SUBTOTAL FOR ROAD WORKS	**R 49 657 637.50**
DRAINAGE WORKS	1	Lined drains	Concrete	m	2000	R 750.00	R 1 500 000.00
	2	Subsoils	Various	sum	1	R 500 000.00	R 500 000.00
	3	Pipe culverts	Assumed 600 dia Class 100D	m	575	R 2 250.00	R 1 293 750.00
	4	Box culverts	Assumed 1,5 by 3,6 portals with base	m	325	R 15 000.00	R 4 875 000.00
						SUBTOTAL FOR DRAINAGE WORKS	**R 8 168 750.00**
ANCILLARY WORKS	1	Gabions & stone pitching	Standard	m^3	200	R 1 350.00	R 270 000.00
	2	Topsoiling	From site	m^3	9000.0	R 25.00	R 225 000.00
	3	Hydroseeding/grassing	Standard mix	m^2	90000.0	R 5.50	R 495 000.00
	4	Fencing	Stock proof	km	6.75	R 175 000.00	R 1 181 250.00
	5	Road marking & road studs	Standard	km	6.75	R 2 750.00	R 18 562.50
	6	Road signs	Standard	m^2	100	R 750.00	R 75 000.00
	7	Guardrails	Standard	m	1000	R 500.00	R 500 000.00
						SUBTOTAL FOR ANCILLARY WORKS	**R 2 764 812.50**
						SUBTOTAL	R 60 591 200.00
PRELIMINARY & GENERAL CHARGES (20 %)							R 12 118 240.00
						SUBTOTAL	R 72 709 440.00
CONTINGENCY (10 %)							R 7 270 944.00
						SUBTOTAL	R 79 980 384.00
CONTRACT PRICE ADJUSTMENT PROVISION (12 %)							R 9 597 646.08
						TOTAL	**R 89 578 030.08**

CONSULTANCY COSTS	
Normal Services - Detail Design (less Prelim design stage fees), Tender Documentation, Contract Administration	R 4 510 624.99
Additional Services - Site Supervion, H & S and Environmental Compliace, Surveys, Geotechnical, EIA	R 3 830 000.00
TOTAL	**R 8 340 624.99**

TOTAL ESTIMATED PROJECT COST	**R 97 918 655.07**

The unit cost per kilometre of road using the above detailed cost yield an amount of R 14,5 million per kilometre, exclusive of VAT. This amount compares favourably with the average road building costs in the region. It must be noted that the cost for Western Access road is higher due to the wetland crossings and other major water course.

10.3 Possible Cost Savings

The cost estimates are based on the assumption that all materials for the road pavement layers will be imported from commercial sources in the region. The materials investigation conducted under a separate Task Order No 5 is covered later in this report under Item 11. It is quite evident that suitable road building material could be obtained from local sources in close proximity to these proposed access roads. If the possibility of securing material from these identified sources could be negotiated, the material for constructing all the selected subgrade and stabilized sub base layers could result in huge savings from the amounts depicted in Items 10.1 and 10.2.

If it is assumed that the material is available for at a nominal royalty rate of R 10/m^3 and a further R 90/m^3 for loading, haulage and processing therefore amounting R 100/m^3 then the saving would be approximately R 100/m^3 compared to that of commercial rates used in the cost estimates. The issue of royalties to private borrow pit owners is merely an assumption at this stage and it is proposed that this securing of material sources be further engaged by ESKOM or their vendors.

The savings would be as follows:

- Eastern Access Road - R 14,960,000 on road works
- Western Access Road - R 10,148,000 on road works

The total saving using materials from identified sources as contained in the Task Order No 5 report would thus be R 25,440,000-00.

The suitability of other sources on the construction footprint of the proposed power station plant may also result in further savings and this should be investigated during the detail design stage when available geotechnical reports are made available for the road pavement designs. The same cost saving could be expected if material is obtained from on-site sources as this operation will entail loading, hauling and processing of the layer to the required compaction.

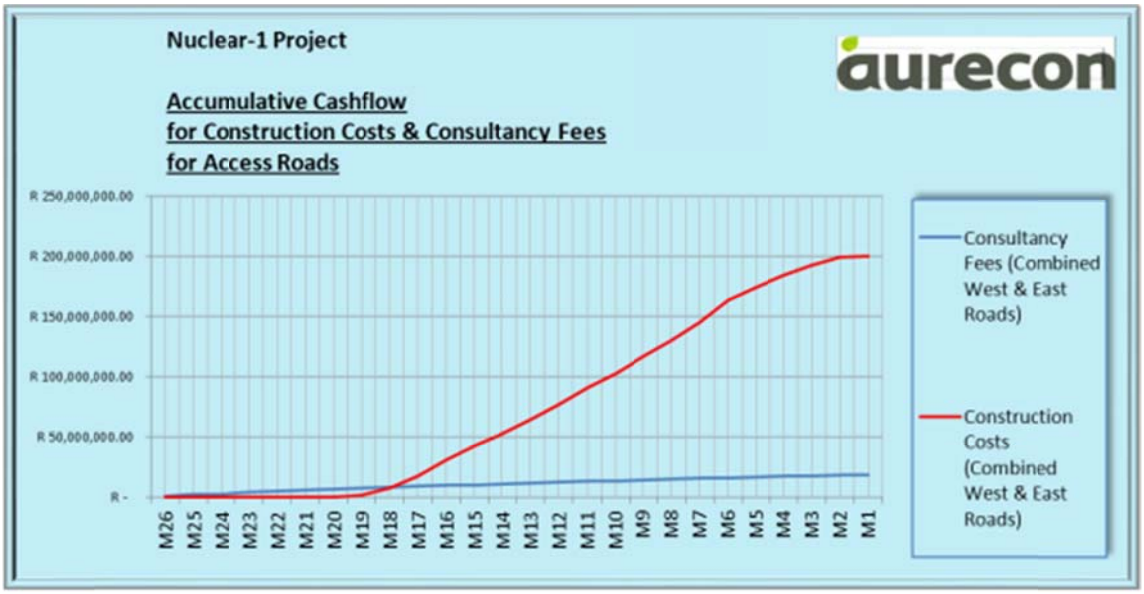
10.4 Northern Access Road

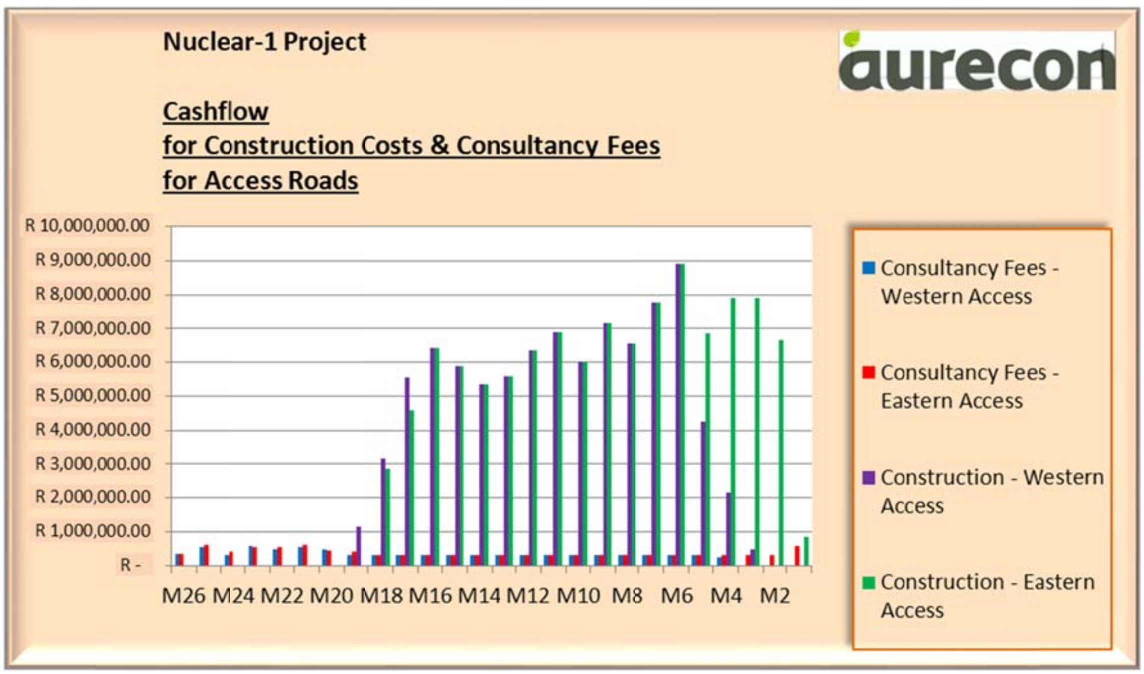
This route although covered in this report was not separately cost. The primary reason is that this route is not feasible and economical as the eastern and western access routes will provide transport linkages with important residential areas which will accommodate workers and staff. A single access road even much shorter in length will also contribute to congestion on normal and construction traffic and will also adversely affect traffic flow in the event of an emergency. This route can be cost on but instruction if required, but the report will recommend the two preferred routes being the Western and Eastern Access routes.

10.5 Cash Flow Projection

The cash flow projection was based on the proposed programme mentioned in Section 10 of this report and the cost estimates covered in the aforementioned section.

The graph below depicts the accumulative costs for construction costs and consultancy fees for the western and eastern access roads combined.





The graph above indicates the estimated cost for construction and consultancy fees for respectively the Western and Eastern Access roads. The cash flow during period from March 2011 to August 2011 clearly depicts the detail design stage where after the cash flow sharply increases as the construction work commences.

11. ROAD CONSTRUCTION MATERIALS

The estimated pavement layer works for the two preferred routes as determined for the cost estimates are summarized as follows:

Pavement Layer/Material	Eastern Access Road	Western Access Road	Total Material Volume m^3
	Volume m^3	Volume m^3	
G1 Base Course	22,835	15,491	38,325
C3 Upper sub base (G5 natural)	24,626	16,706	41,332
C3 Lower sub base (G5 natural)	25,074	17,101	42,175
G7 Selected Subgrade	25,522	17,314	42,836
G9 Selected Subgrade	25,970	17,618	43,588
G10 Borrow to fill	2,000	38,250	40,250
Rockdump/Pioneer layer	12,500	6,250	18,750

The availability of road building materials was investigated under Task Order No 5 and this section should therefore be read in conjunction with the Task Order No 5 report. In general it seems that all the required layer works material can be sourced in the immediate area from private borrow pits. The sourcing of the G1 crushed stone base course and dump rock for rock fill materials are presumed to be obtained from a commercial quarry.

It must be noted here however, that should the choice be made to use material available from local sources on site, then Eskom should immediately enter into discussions with the local land-owners to secure the use of the material now. This would ensure that the material is available, and at rates which would be cheaper than those applicable from local quarries. Failing this, it is possible that a third party may approach the owners of local sources, buy aggregate and sell on to the vendor at commercial rates, thereby negating any savings achievable by early action.

12. CONCLUSION AND RECOMMENDATION

The preliminary designs conclude that the most feasible access routes have been determined from any engineering, cost and environmental perspective. These access routes also in compass the expected socio-economic aspects of the region and the final routes recommended routes were also done in collaboration with the other Task Order investigations. The fact that Oyster Bay, Humansdorp and Cape St Francis towns are in proximity to the proposed new power plant development, necessitates that the road network to this plant provides convenient, safe and direct access for workers and staff that will reside in these towns.

This report therefore recommends the approval of the two preferred access roads to the new Nuclear-1 power plant at Thyspunt and that based on the proposed programme, that the detail design phase commence as soon as the final approval is obtained for the project roll-out by Eskom. It is also recommends that the two preferred routes be submitted to the both the local and provincial road authorities for principal approval while the final project approval is being awaited.

13. ABBREVIATIONS

1	AASHTO	American Association of State Highway and Transportation Officials
2	AC	Asphalt Coarse
3	C3	TRH Stabilization Layer Classification
4	CBR	California Bearing Ratio,
5	CO2	Carbon Dioxide
6	DR	District Road
7	E1	Eastern Access 1
8	EIA	Environmental Impact Assessment
9	EIR	Environmental Impact Report
10	G1	TRA Material Classification
11	G7	TRA Material Classification
12	G9	TRA Material Classification
13	Ha	Hectares
14	HV	High Voltage
15	MAMDD	Modified AASHTO Maximum Dry Density
16	MPa	Mega Pascal
17	MR	Main Road
18	N1	National Road 1
19	N2	National Road 2
20	RoD	Record Of Decision
21	TRH	Technical Recommendation for Highways
22	UTG	Urban Transportation Guide
23	VAT	Value Added Tax
24	W1	Western Access 1

ANNEXURE A - LAYOUT DRAWINGS AND LONGITUDINAL SECTIONS

(EASTERN AND WESTERN ACCESS ROADS)

ANNEXURE B - GENERAL LAYOUT OF ROUTE OPTIONS

(EASTERN AND WESTERN ACCESS ROADS)

ANNEXURE C - CROSS-SECTIONS OF RECOMMENDED ROUTES

(EASTERN AND WESTERN ACCESS ROADS)