EThekwini Transnet Integrated Freight Transport Systems Plan

As per the Memorandum of Understanding entered into between Transnet SOC Ltd and eThekwini Municipality (14-03-2016)

The Design, modelling and route location work stream

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GLOSSARY

CBA	Cost Benefit Analysis
DCT	Durban Container Terminal
DDOP	Durban Dig Out Port
DFR	Dedicated Freight Route
EMME	Equilibre Multimodal Multimodal Equilibrium
ETA	eThekwini Transport Authority
ETIFTSP	eThekwini Transnet Integrated Freight Transport Systems Plan
GPS	Global Positioning System
IFLS	Integrated Freight and Logistics Strategic Framework and Action Plan
KZN	KwaZulu-Natal
KZN DoT	Kwazulu-Natal Department of Transport
LOS	Level of Service
MOU	Memorandum of Understanding
MSC	Mediterranean Shipping Company
NMPP	New Multi Product Pipeline
PCU	Passenger Car Units
PoD	Port of Durban
PRASA	Passenger Rail Agency of South Africa
RCAM	Roads Classification and Access Manual
RHDHV	Royal Haskoning DHV
SACD	South African Container Depot
SADC	South African Development Community
SANDF	South African National Defence Force
SANRAL	South African National Roads Agency Limited
SAPS	South African Police Service
SARS	South African Revenue Service
SDIB	South Durban Industrial Basin
SIDRA	Signalised & Unsignalised Intersection Design and Research Aid
TEU	Twenty Foot Equivalent Unit
TFR	Transnet Freight Rail
TNPA	Transnet National Ports Authority
TRL	Traffic Road Layout
UTG	Urban Transport Guidelines

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1. Introduction

1.1. Terms of reference

The eThekwini Transnet Integrated Freight Transport Systems Plan' (ETIFTSP) aims for Transnet SOC Ltd. and the eThekwini Municipality to jointly develop a conceptual integrated, sustainable transport system plan in the South Durban Basin (inclusive of all port areas) that supports the port developments, city growth and enhances the region for businesses as well as residents.

The project falls under the auspices of the Memorandum of Understanding (MOU)[1] between eThekwini Municipality and Transnet SOC Ltd. and project oversight has been conducted by the quarterly Transnet City Forum meetings jointly chaired by eThekwini Municipality's Chief Strategy Officer and Transnet SOC Ltd. Port Manager for Durban. The plan has been developed utilising internal staffing resources from Transnet SOC Ltd (namely Transnet National Port Authority) and eThekwini Municipality.

The 'Integrated Freight and Logistics Strategic Framework and Action Plan for eThekwini'[2] was adopted as a point of departure for the study; with the strategic recommendations forming the foundation for investigations into the freight infrastructure, operations, land use proposals and regulatory requirements.

The project is geographically bound to the Port of Durban (specifically the Southern port precincts) and the surrounding suburbs, as well as their interactions with the broader transport network (and national corridors). Therefore, deliverables will be based in the South Durban Basin and areas directly affected by the port, geographically. The most Northern boundary of the study area includes Maydon Wharf and Glenwood (namely Che Guevara Road), the most Southern boundary includes Southgate / Umbogintwini (namely Moss Kolnick Drive), the Western Boundary is the N2 and the Eastern Boundary is the Indian Ocean. Where further solutions are required outside this defined area (e.g. Cato Ridge, Tongaat or Illovo) the workgroup will make recommendations, but planning and ultimate solutions will need to be conducted elsewhere (or in future workgroups formed under the Transnet eThekwini MOU).

Project requirements to be included from the outset included the following:

- The primary mandate is to develop a medium to long term framework for an integrated port-city freight transport solution between eThekwini and Transnet, while taking cognisance of short term congestion problems as a secondary objective.
- Key environmental and social issues in the South Durban Basin and surrounding suburbs should be factored in as essential from the outset of the project and must form part of the ultimate solution recommended.

[1] The MOU was originally entered into on 15 September 2006, but has subsequently been updated with a first addendum signed by both parties on 14 March 2016. The MOU is a requirement of the National Ports Act 12 of 2005, with the objective of establishing institutional structures which will aid effective engagement between Transnet and eThekwini on issues of mutual significance pertaining to the Port of Durban, inland logistics corridors, Back of Port logistics area, port/city interface areas and the broader utility of the Durban Bay within which the port is located.

[2] The Integrated Freight and Logistics Strategic Framework and Action Plan for eThekwini was developed by eThekwini Municipality (by the eThekwini Transport Authority) in conjunction with all key freight related stakeholders, inclusive of all Transnet Operating Divisions, South African National Roads Association Limited (SANRAL) , Kwazulu-Natal Department of Transport (KZN DoT) and Dube Tradeport. The plan was adopted by eThekwini Municipality Council on 30 September 2015 and the plan has been adopted in its entirety by the Strategic Infrastructure Project (SIP2) committee.

- The freight transportation system recommended must ensure that there is efficiency and ease in connecting with the national corridor and national transport initiatives.
- The recommended system must be developed to cope with system failure and have the necessary mitigating solutions for a worst case freight transport scenario for sea, road, rail and pipeline.
- Where truck stops and buffer zones are suggested, road and rail connections are to be explored.
- The interrogation and outputs of existing policy documents such as freight demand forecasts, spatial development frameworks, back of port plans and local area plans.

The following report has developed an infrastructure and operational conceptual joint future plan for the study area, with road, rail and supporting logistics facilities recommendations. These have been developed under various scenarios and ultimately supported Transnet's intended port expansions in the Municipal Area. Road options formulated in this report have been tested using traffic modelling, multi-criteria analysis (MCA), as well as being tested for performance, cost and demand.

Policy and legislation recommendations, along with a detailed incident management plan relating to freight and heavy vehicles will be developed outside this project in subsequent studies. A very high level eThekwini land use and Transnet Land Rental (in relation to supporting logistics facilities to the road proposals) have been suggested in this report, but these will need to be further interrogated and detailed beyond this project due to resourcing limitations.

2. Container Freight System Overview

The Port of Durban is the most important general cargo port in Southern Africa, handling containers, break-bulk and bulk cargo for the local and inland areas of South Africa, as well as the Southern African Development Community (SADC) in general. It generates extensive freight transport movements in the region. In addition to the port, significant local industries and economic activities (including cement, solid waste disposal, petroleum and chemicals distribution) also provide demand for freight. 60% - 62% of eThekwini economy is heavily reliant on freight transportation, while the other 38% - 40% of economy still require freight to deliver computers, desks chairs and stationery utilised in an office environment. Roughly 415 000 jobs in eThekwini (+/- 50% of the work force) are dependent on freight & trucking providing a regular service.

Continual growth of import-export cargoes and local industries, as well as the consequent expansion of freight transport have resulted in the present situation in which the demands for port, road and rail services are greater than the capacity of the available infrastructure and facilities. This has been observed around the port and in the critical South Durban Industrial Basin (SDIB). This has been discussed extensively in the previous section.

The low modal share of freight traffic by rail and the rapid growth of road freight, together with the uncoordinated expansion of transport and logistics services, has resulted in unplanned freight and logistics land uses throughout the Municipal Area. This is observed in the local spatial allocation of major logistics facilities such as the car terminal, container depots, back-of-port space for containers, distribution centres, warehousing, bulk storage, handling facilities, parking, staging and handling space for road freight vehicles.

The challenges have been exacerbated by the fragmented responsibility for planning of the freight logistics infrastructure and facilities between national agencies, the local municipality, Transnet and the private sector.

The Integrated Freight and Logistics Strategic Framework and Action Plan (IFLS) study was initiated by the eThekwini Transport Authority (ETA) and completed in 2015 (adopted by the eThekwini Executive

Council on the 30 September 2015). The IFLS was developed in conjunction with Transnet, with the aim of developing a set of interventions that will essentially address freight and logistics infrastructure and operations within the municipal area, minimise logistics costs in South Africa, and enhance the city's industrial opportunities and competitiveness by having the largest port in both Africa and Southern Africa on its doorstep.

The IFLS recommended the need for the enhancement of the current freight corridors between the Durban Container Terminal and the Provincial and National routes. The IFLS noted the requirement for the development of a second access to the Durban Container Terminal to support the anticipated port expansions and higher volumes of container cargo moving through the port area. Also recommended was the development of supporting truck staging (a-check) areas outside the port area to call in trucks with an intelligent freight management system.

The aim of the following section is to introduce and explain the current container freight transport system that functions within and supports the Port of Durban; with the purpose of determining an improved and efficient future container freight transport system and building on the work and recommendations from the IFLS study. This will be achieved by firstly introducing and examining the status quo of the container freight systems that utilises the Port of Durban from port facilities to back of port private sector operations. Secondly, future freight and cargo scenarios will be explained, and the impact of these on the road freight system. This will be done utilising the Transnet Demand Forecast Model, along with the eThekwini Transport Authority's traffic modelling forecasts. Key interventions will be detailed along with the supporting systems and infrastructure required. Finally, a notional desired container terminal freight system will be proposed based on the current freight transport systems short comings identified, the future risks and problems listed. The outcomes of this work will be notional and provide the necessary brief for the following sections of this report.

2.1. Status Quo Overview

The current container freight system is overwhelmingly dominated by heavy goods vehicles (with rail only achieving a 15-20% annual modal share over the last three decades). Figure 1, from the Status Quo Report of the IFLS study shows the actual TEU container movements between origins and destinations for 2014. Importantly this figure demonstrates the overwhelming volume of TEU's transported by road (with rail transportation shown by the green arrows).

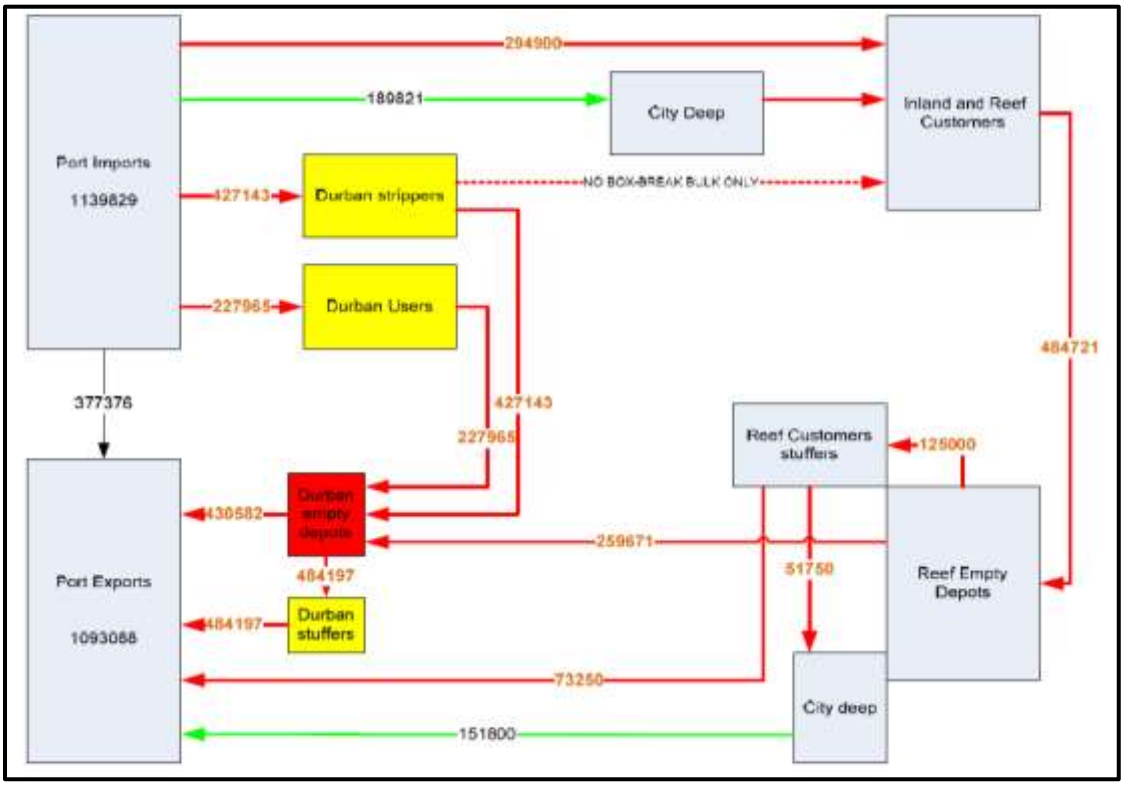


Figure 1 Current Situation with Haulage of Containers to and from Inland Destinations

Figure 2 on the overleaf (also from the IFLS study) simplifies the information shown in Figure 1 above, but demonstrates the proportion of TEU containers destined for a location within eThekwini region (shown notionally by the red dashed box). Approximately 80% of exported TEU's originate from an eThekwini location, while approximately 62% of imported TEU's are destined for an eThekwini location. Again this demonstrates the overwhelming importance of road (with no container being transported by rail within the municipal area) and significance of warehousing and distribution facilities located in the eThekwini Municipal Region.

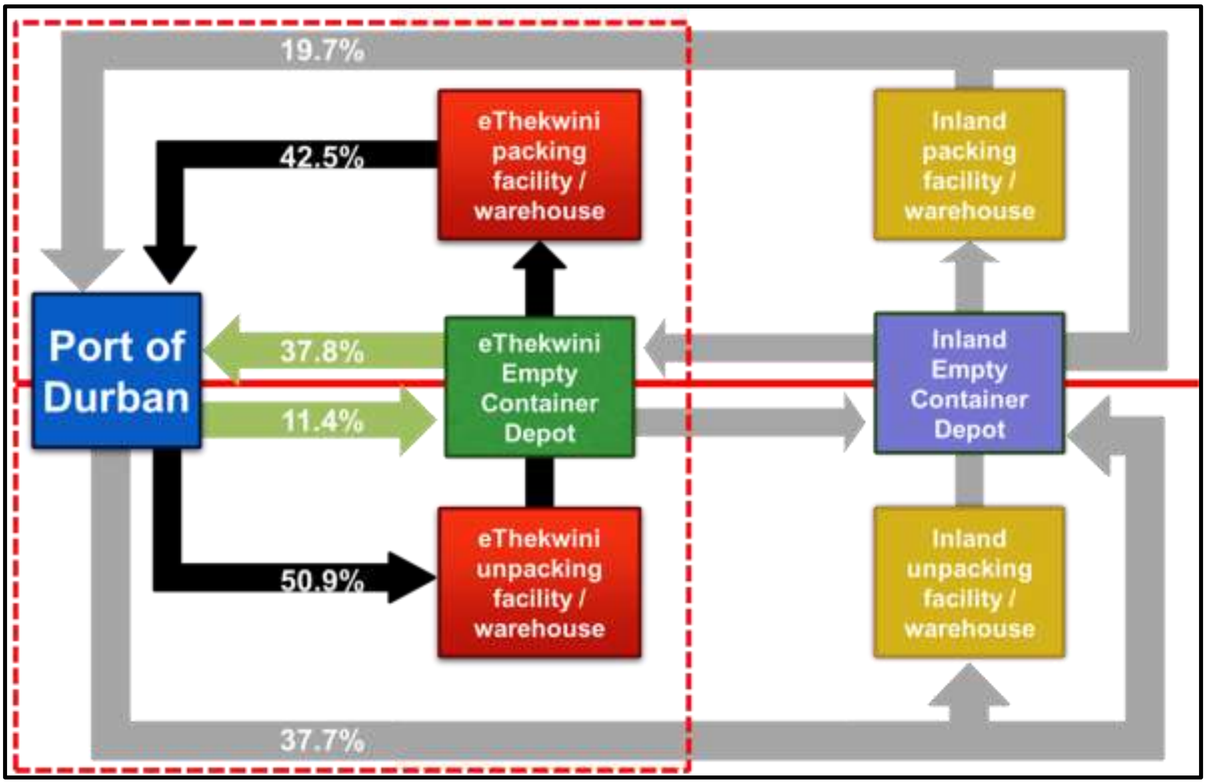


Figure 2 Container movement from and to Port of Durban

Future projected modal share between road and rail remains unclear, with the IFLS anticipating the container rail modal share could realistically achieve roughly 30% in the long term, provided significant rail infrastructure, rolling stock and rail operations receive significant attention and investment. At the time of compiling this report Transnet Freight Rail was still in the process of conducting studies relating to rail infrastructure, rolling stock and rail operations for the South Durban Basin and Bayhead Area. Thus, this section will focus on the road component of the logistics chain.

It must be noted that while the above findings show how containers predominantly remain in the eThekwini Municipal Area, the contents of containers have both a National and Regional footprint.

Figure 3 below shows a broad schematic of the Port of Durban. The schematic very simply demonstrates the various components that will be discussed in this section and provides a physical reference to the various aspects detailed. The orange hatch shows the residential areas, the green hatch the environmentally sensitive areas, the black and orange lines the road system, the dashed black lines the rail system, and the blue the wetlands and water surface. The Container Terminals, A-Check, Bayhead Road Weighbridge, SARS Container Scanner/Warehouse and TNPA gate are also shown as a solid orange block.

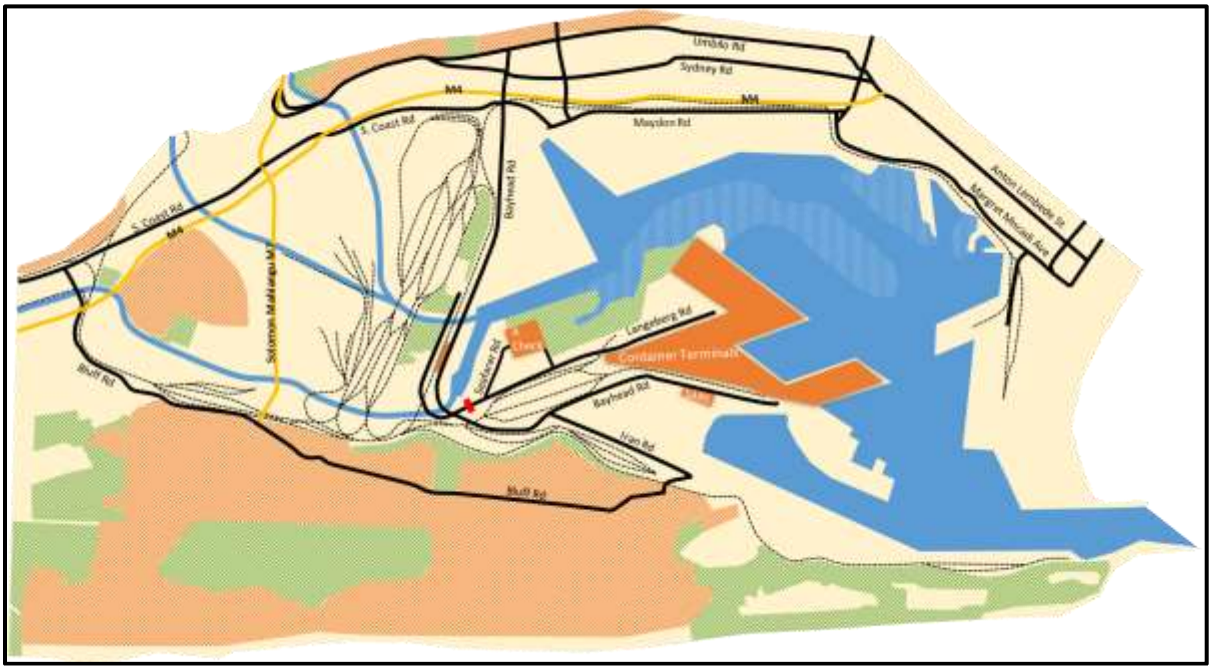


Figure 3 Port of Durban and surrounding areas

2.1.1. Port of Durban Container Terminal Freight System

The container terminal freight system, in the Port of Durban, comprises of all port and terminal functions taking place between the quayside and the Transnet National Port Authority Gate (at the intersection of Bayhead and Langeberg Road). These include the terminals, gantry crane operations, container stacks, straddles, A-Check, P-Check to Gate Out, and TNPA security operations. These various areas can be found within the red area highlighted graphically in Figure 4 below.

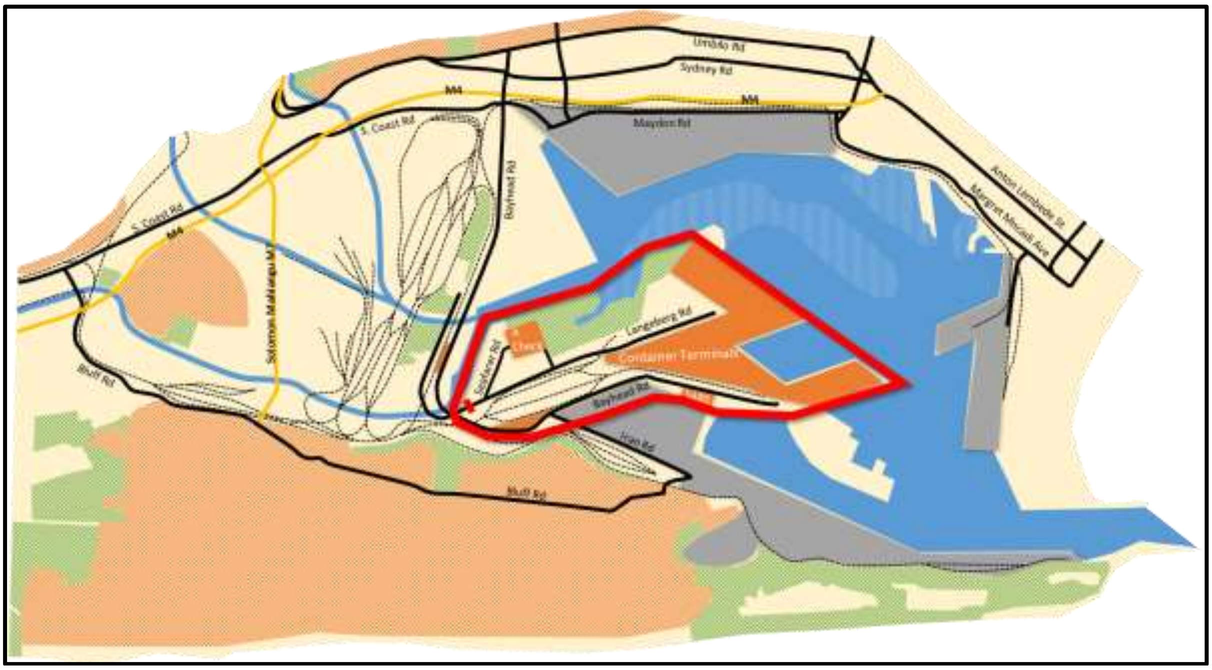


Figure 4 Port of Durban, Container Terminal Freight System

2.1.2. TNPA Gate security

The Transnet National port Authority Security gate is located in close proximity to the Bayhead Langeberg Road Intersection, as shown in Figure 5 below. It is 170 metres from the intersection and 100 metres from the Langeberg - Seafarers Road intersection, which is where all heavy vehicles accessing the Durban Container Terminal need to turn left to access the A-Check facility. This doesn't give much opportunity for heavy vehicle stacking, as this can only be limited to five or six trucks from the gate to Seafarers Road and 14 to 16 trucks from the gate to Bayhead Road. Any security intervention or enforcement from this gate essentially results in heavy vehicle backup onto Bayhead Road, thus limiting these interventions and crucial port oversight into heavy vehicles accessing the port area and terminals.

Figure 5 TNPA Security Gate

2.1.3. Durban Container Terminal A-Check

The Durban Container Terminal (DCT/Pier 2) A-Check is a heavy vehicle holding area located at the Northern end of Seafarers Road, as shown in the red block below in Figure 6. This area pre-stages and attempts to sort heavy vehicles entering the DCT area. Seafarers Road is only access road to this facility and is a three lane road, with two lanes running towards the A-Check and one travelling the opposite direction away. A number of fishing, canoe, boat and other water related recreation clubs gain their access off Seafarers Road, which is not ideal for the clubs or heavy vehicles using this road to get to the A-Check. Therefore, while there are two lanes accessing the A-Check, one lane is mostly left empty to cater for the clubs to access their facilities. The access roads from Bayhead Road to the A-Check are not ideal for a container terminal the size of DCT or suitable for the quantum of heavy vehicle traffic using them, they have limited stacking opportunities as the distance between key intersections (Bayhead/Langeberg and Langeberg/Seafarers) is minimal with only a single lane.

Figure 6 Durban Container Terminal A-Check

The layout of the A-Check is comprised of nine entrance lanes and gates in the lower South East corner of the site, each lane can stack an estimated four to five heavy vehicles. The main area of the A-Check site is broken into 35 heavy vehicle stacking lanes that can accommodate roughly a maximum of 300 heavy vehicles. Furthermore, these 35 lanes are broken into the three towers, to assist with managing the release of heavy vehicles. These towers relate to the container stacks inside the terminal and each tower opens and closes when they are able to service the heavy vehicles. Only a third to two thirds of these 35 stacking lanes are used at one time, as it is rare for more than two stacks to be open or functioning simultaneously.

The heavy vehicle parking configuration of the 35 lanes in the A-Check is stacked in long lines. While this parking configuration maximises the number of heavy vehicles that can be held at this facility, it isn't the most efficient nor convenient parking configuration for a complex container terminal operation. This parking configuration ultimately forces the terminal to sort (and resort) container stacks according to the heavy vehicle queues and how they arrive, this could therefore result in multiple container stack shuffles in the terminal. Provided the containers being collected by heavy vehicles at the start of the A-Check queue are at the top of a stack (and easily accessible) there isn't a problem. However, if a heavy vehicle at the front of the queue needs a container that is three or four deep in a stack, then that stack needs to be reshuffled to retrieve the required container. This adds to the truck turnaround time within the terminal and ultimately if recurring multiple times can lead to heavy vehicle congestion build up.

A fish bone parking configuration with access lanes running between the bays would be far more preferable. This configuration allows heavy vehicles to be called in a manner that containers that are easily accessible can be moved out quickly, thus potentially reducing heavy vehicle staging times and freeing up additional heavy vehicle staging space. This however would significantly reduce the capacity of the A-Check. This facility should also ideally have multiple access points, more appropriate access roads (not Seafarers Road), with suitable lengths away from key intersections to allow for occasional stacking and an appropriate number of dedicated lanes. The pavement design of the roads accessing this facility also should be suitably specified and designed to handle the volume of heavy vehicles utilising the road.

It is recommended that the parking configuration of the A-Check should be reconsidered and therefore a larger piece of land will need to be sort after. Ideally this should not be more than 2-3km from the current location and this facility should have the necessary smart technology to support an operation of this nature. This needs to be interrogated in alignment and concurrently with eThekwini

Transport Authorities strategy and plans to create truck staging facilities throughout the eThekwini Municipal Area.

Transnet Port Terminals captures and releases daily statistics related to the various operational functions within the Port of Durban. The truck turnaround times in the A-Check for the Durban Container Terminal are included in these statistics, Figure 7 below displays the DCT A-Check average daily heavy vehicle staging times between 1 January 2012 and 23 October 2017. The figure shows the average daily staging times (in light blue dots), the average 3 month staging time (in the solid blue line), as well as the six order polynomial trend line over the same period (in dark green). The data shown in the figure demonstrates that average heavy vehicle staging times in the A-Check have steadily been increasing from an average of roughly 75 minutes (in early 2012) to almost 150 minutes (August 2016) per heavy vehicle, as well as varying.

The trend shown in Figure 7 has improved in recent times with an average of closer to 100 minutes per heavy vehicle. The most notable concern from the statistics displayed is the variance in the average A-Check staging times since 2012 and the large number of days where the average heavy vehicle staging times exceed 200 minutes (more than three hours). This could be attributed to increased heavy vehicle traffic resulting in more container stack shuffles in terminal, but will also certainly be attributed to increased vessel sizes and vessels loads utilising the port in recent times. Increased vessel sizes have resulted in peak truck times increasing significantly over shorter periods of time. In essence as this trend is only going to increase with bigger and bigger vessels calling at the Port of Durban, it would require additional truck staging space, and staging facilities with far more sophistication in both sorting as well as the calling of trucks into the port.

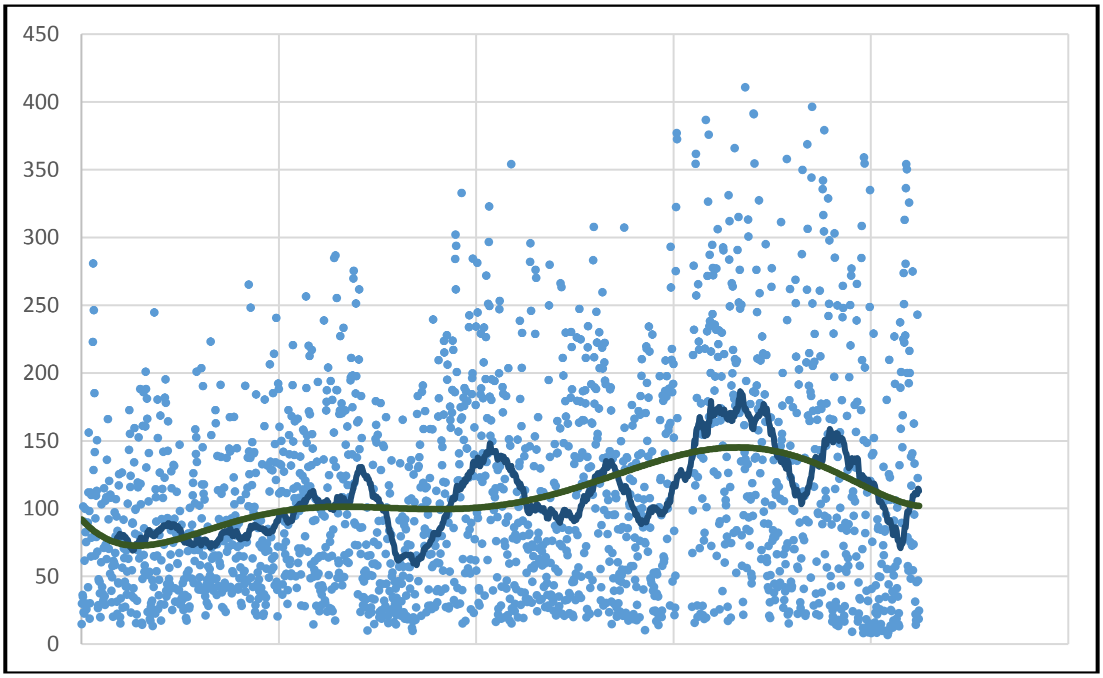


Figure 7 Durban Container Terminal A-Check Average Daily Staging Times, 1 January 2012 – 23 October 2017
Source: Transnet Port Terminals Daily Statistics

2.1.4. Durban Container Terminal P-Check to Gate Out

Heavy vehicles are called into the terminal from the A-Check to collect or drop off their requisite container(s), these heavy vehicles exit the A-Check facility and turn left onto Langeberg Road and travel in a Northerly direction for 670 metres to reach the terminal entrance (as shown in Figure 8 below, by the first red block in lower end of the satellite picture.) The simplest explanation of the heavy vehicles activity in the terminal can be broken into three stages: firstly, entering the terminal at the most Southerly red block in the satellite image in Figure 8; secondly, the heavy vehicles moving to the one of the two large red rectangular blocks shown in the satellite image in Figure 8, to deliver or receive their container from the terminal; and thirdly, to exit the terminal again at the Southerly red block in the satellite image. Transnet measures the time this entire process takes and is referred to as the 'P-Check to Gate out'.

Figure 8 Durban Container Terminal P-Check to Gate Out

The average daily heavy vehicle turnaround time for the P-Check to Gate Out statistics is recorded in minutes and is shown in Figure 9 below. The blue dots represent the daily average minutes heavy vehicles have taken to turnaround for the days between 1 January 2012 and 23 October 2017, the dark blue line represents the 3 month moving average for average truck turnaround times P-Check to Gate Out, and the green line represents the six order polynomial trendline for average truck turnaround times over the period.

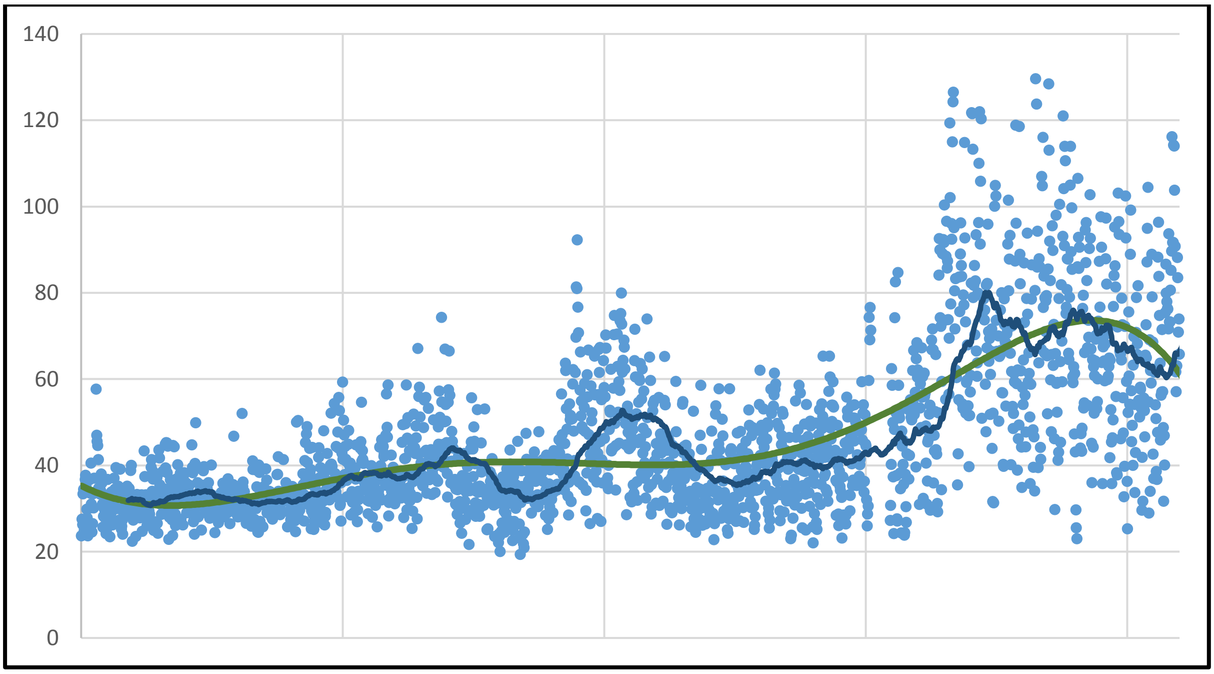


Figure 9 Average heavy vehicle P-Check to Gate Out turnaround time per day

When analysing the three month average line and trendline in Figure 9 it's clear to see that the average heavy vehicle turnaround over the period displayed has increased significantly from an average around 30 minutes per heavy vehicle (in early 2012) to an average of close to 70 minutes per heavy vehicles (in mid-2017). More concerning is that there are a number of days (as shown by the daily statistics) where heavy vehicle turnarounds from P-Check to Gate Out exceeded 100 and even 120 minutes in 2017. This increase is particularly concerning as the increase in time for heavy vehicles staging in P-Check to Gate Out definitely negatively impacts heavy vehicle staging times in the A-check.

The variance demonstrated in the latter years in Figure 9 for turnaround times will be attributed to larger ship calls at the terminal, leading to larger volumes of heavy vehicles calling at the port in shorter time periods, thereby resulting in more terminal container stack shuffles to retrieve containers for vehicles entering terminal. This higher volume of heavy vehicle container moves over a much short space of time, easily explains the extreme variance. However, terminal equipment reliability challenges and terminal staffing challenges could also be cited as possible reasons for the variance in turnaround times from P-Check to Gate Out. Once again the need for better heavy vehicle oversight and management is crucial

Recent literature available indicates that port-hinterland freight distribution relationships are becoming of more significance than initially anticipated (Notteboom et al, 2008). Globally in recent times the greatest improvements in shipping activities have actually been derived from better integrated land side transport and inland transport systems developments, as opposed to seaside infrastructure and operations (Notteboom et al, 2008).

The reason for this is that foreland traffic (or maritime transport) demonstrates the logical process of economies of scale. As volumes increase for maritime transport, larger loads are handled at ports of call, these larger loads result in an overall reduction in the cost of maritime transport (TEU-KM) and ultimately port fees per container (as number of vessel calls decreases). There is also an improvement in port efficiencies with larger vessels resulting in a better utilisation of quayside equipment and better terminal utilisation. However, hinterland traffic (landside transportation) is required to be broken into smaller loads, due to the fragmented nature of consumption, production and supply chain management, which can result in congestion (rail and road) challenges in level of service. This may also place upward pressure on values of land parcels around the port as limited land is available for higher volumes of freight and this may generate diseconomies of scale at higher volumes.

The relationship described above is best shown in Figure 10, where landside transport and efficiencies (hinterland traffic) initially experience economies of scale at higher volumes. These economies of scale for landside transport ultimately results in dis-economies of scale at very high volumes, due to limited or neglected landside infrastructure, the fragmented (unitised) nature of road/rail transport, and poorly scoped logistics systems. Figure 10 as described by Rodrigue, J. and Notteboom, T. 2010 notes this as a universal trend across all maritime logistics systems. Thus the need for intelligent heavy vehicle management at the port-city interface becomes crucial to ensure logistics costs and efficiencies remain tolerable for the broader economy and long term sustainability.

Added to this is that land around the Port of Durban needs to be rationalised and repurposed. Far too many land uses around the port (both in Transnet and City land) no longer serve to benefit the port system and only add to the port/cities challenges leading to further dis-economies in scale. The road and rail logistics system that serve the container terminals are also ill suited to the modern logistics systems and operations, these need to be redesigned in conjunction with the repurposed (or rationalised) land around the port. This will be discussed later in the report in more detail.

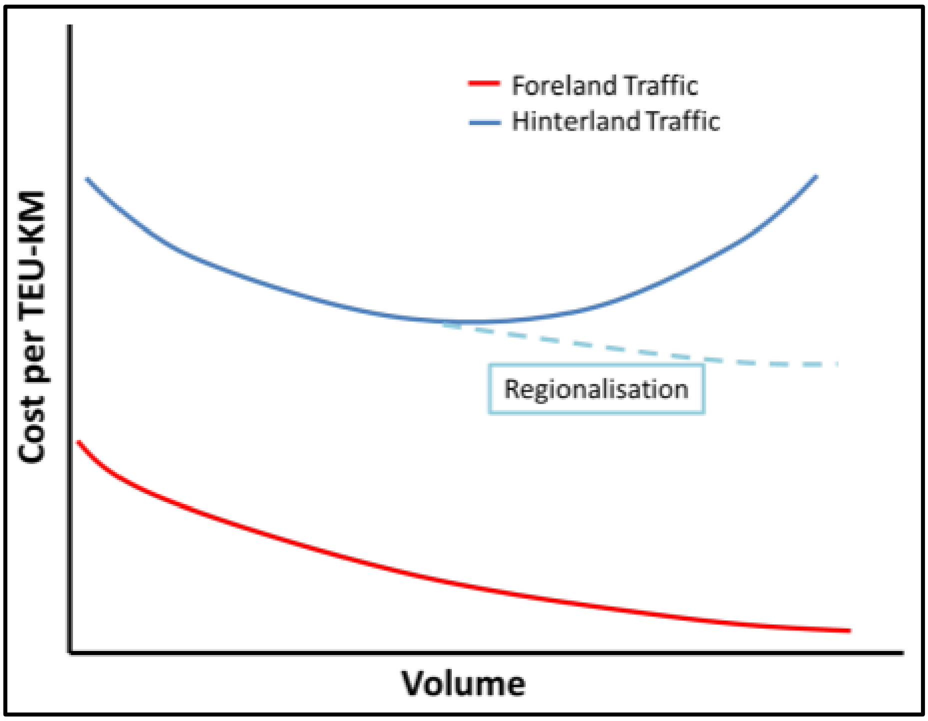


Figure 10 Cost per TEU-km for hinterland and foreland traffic
Source: Rodrigue, J. and Notteboom, T. 2010

2.1.5. EThekwini Road Freight Corridors Supporting the Container Terminal

Figure 3 shows the primary road corridors supporting the Durban Container Terminals; the key freight corridors are Langeberg Road, Seafarer Road, Bayhead Road, South Coast Road, Umbilo Road, Sydney Road and Solomon Mahlangu Drive (M7). Table 1 below shows the traffic counts by key intersections on these roads, the volume of heavies particularly on South Coast Road - Bayhead Road and Solomon Mahlangu Drive - South Coast Road should be noted in relation to other modes of traffic. Heavy vehicles account for 40% of all vehicles at the South Coast Road - Bayhead Road intersection, 18% Solomon Mahlangu Drive - South Coast Road intersection and 18% at Sydney Road - Glastonbury Place intersection (the Berea side of Khangela Bridge).

Table 1 Traffic Counts by Intersection

INTERSECTION	SURVEY DATE	BUSES	HEAVIES	TAXIES	CARS
South Coast Road - Bayhead Road	2017-Jun-19	131	8077	423	12129
Sydney Road - Glastonbury Place	2017-Sep-11	442	3406	1473	14134
Solomon Mahlangu Drive - South Coast Road	2015-Oct-12	984	9298	2486	39757

Each of key roads is dealt with in more detail later in the report, but has been briefly introduced below:

- Langeberg Road and Seafarer Road are within the Transnet Port Terminal (TPT) and TNPA area. Seafarers Road is particularly constrained and not suited for the level of heavy vehicle volumes accessing the port as discussed previously.
- Bayhead Road is a four lane road with two lanes in each direction (and an emergency lane east bound for any fire emergencies at various Port of Durban Terminals). Bayhead Road is key road not only accessing the Durban Container Terminals, but also the main access point for the Ship Repairs and Dry Dock facilities, Cutler Precinct for all liquid bulk cargo, Ambrose

Park, Rotterdam/Belfast Road operations, as well as the Dry Bulk Terminal at the end of the Bluff. Bayhead Road is regularly congested, with IFLS study reporting that more than 8200 heavy vehicles use this road on a daily basis, and that 22-25% of these heavy vehicles are currently overloaded (KZN DoT Weigh-In-Motion heavy vehicle statistics).

- South Coast Road – provides access to the Port from Solomon Mahlangu Drive and the SDIB suburbs. South Coast Road starts at the intersections of Bayhead Road, the Khangela Bridge and Crabtree Road. South Coast Road continues with four lanes (two in each direction) in a Southerly direction until the entrance of 151 South Coast Road (PX Shed) where it narrows to one lane in each direction under the Southern Freeway. South Coast Road then increases to four lanes (two in each direction) closer to the Solomon Mahlangu Drive (M7) intersection, where it continues South through the suburbs of Rossburgh, Clairwood, Jacobs and Mobeni.
- Umbilo Road/ Sydney Road – Connect to Bayhead Road over the Khangela Bridge and provide access to the port for heavy vehicles coming from the Provincial (M7) and National routes (N2), as well as heavy vehicles originating in the Umbilo, Congella and Glenwood suburbs. Both roads are significant in capacity and size with sections increasing to four or five lanes in a single direction. Both roads are in good condition and only experience heavy vehicle congestion when there are problems on Bayhead Road or port operations are dysfunctional.
- Solomon Mahlangu Drive (M7) – is the essential commuter route connecting the Bluff Residents with the broader Municipal Road network, while also playing a crucial role in connecting the SDIB to the provincial and national road network. The road is regularly congested from Bluff Road to the N2 interchange, the high volumes of heavy vehicles certainly doesn't assist with congestion and travel times (but it is unavoidable as there is no alternative access to the SDIB and port.).

The Durban Container Terminals (Pier 1 and 2), as well as Island View (Cutler Precinct) essentially are served by a single access road. This poses an enormous national, regional and local strategic risk based on the importance of these terminals for each of these economies. If the access to these terminals were to fail or have an extended inactivity, the South African economy would suffer significantly considering the volume of road freight which ensures these terminals function optimally. It should be noted that the Port of Durban is a top 50 container port in the world and one of the only container ports globally with a single road access. A second access to the container terminal is necessary, beyond the congestion and road capacity issues, in order to de-risk any potential road failure and address the matter of national strategic importance.

2.1.6. Legislative, Regulatory and Enforcement Freight System Supporting the Container Terminal

Beyond the port areas and supporting road network there are a number of government departments that are required to carry out legislated functions as the Port of Durban is a port of entry into the country, a key import and export gateway for South Africa and certain areas of the Port are declared national security key points.

The current departments required to perform legislated functions within the port area include:

- South African Revenue Services – Customs and Border Control Unit
- South African Police Serves
- State Security Agency
- Department of Health KZN
- Department of Agriculture, Fisheries and Forestry
    - South Africa's Official Perishable Produce Export Certification Agency
- Department of Trade and Industry
- Department of Home Affairs – Immigration Services

- Department of Transport
    - South African Maritime Safety Authority
- Metro Police

These department operate from a variety of locations and regulate a wide spectrum of products being imported and exported, as is shown in Figure 11. At times this means freight forwarders and heavy vehicles are moved across the City area to allow department to conduct their regulatory functions and this only causes additional heavy vehicle movements and congestion. Some departments currently conduct there regulatory activities and checks on the road side in the Ambrose Park area, as they do not have sufficient space within the port area to conduct there functions.

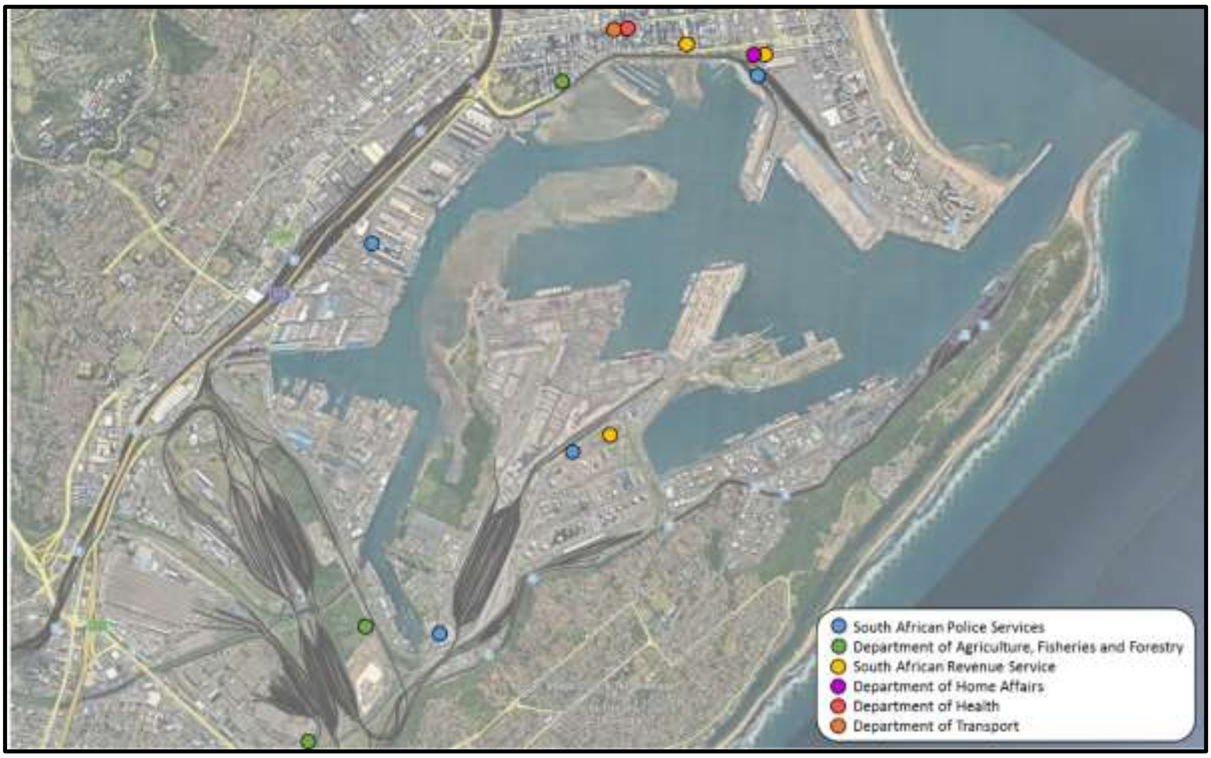


Figure 11 Locations of Legislative, Regulatory and Enforcement Freight System Supporting the Container Terminal

It would be advantageous for a mega enforcement/regulatory area to be created close to the terminal on the road corridor where all checks, regulation and enforcement can be carried out in a coordinated manner for both container terminals, thereby reducing heavy vehicle movements throughout the city and the administrative headache of importers and exporters getting all regulations in order across offices throughout the city.

2.1.7. Freight Related Land Use Surrounding Port of Durban (and Heavy Vehicle Traffic Generators)

The eThekwini Municipality undertook an exercise to identify, profile and map all logistics related land uses in the eThekwini Municipal Area. The challenge of locating all logistics-related land uses is that the eThekwini Municipality covers an extent of 2,297km^2 of land and to cover this entire footprint over the limited duration of the study would be impossible (without considerable financial and human resources). Therefore, for the purposes the industrial, commercial and known logistics nodes (legal and illegal) were targeted for primary data collection. Table 2 shows the suburbs, areas and precincts in eThekwini Municipality that were surveyed for logistics- and freight-related activities. The table shows the approximate area (in square metres and square kilometres) that was surveyed.

Table 2: Areas Surveyed

Area, Suburb, Precinct	m^2	km^2	HA
Avoca	2,649,106	2.65	264.91
Bayhead	10,927,021	10.93	1,092.70
Canelands	731,522	0.73	73.15
Cato Manor/Wiggins	449,206	0.45	44.92
Cato Ridge	3,451,208	3.45	345.12
Clairwood	2,777,998	2.78	277.80
Congella/Umbilo	2,536,901	2.54	253.69
Cornubia	1,445,415	1.45	144.54
Giba Industrial	451,830	0.45	45.18
Hammarsdale	3,675,098	3.68	367.51
Harrison	1,865,469	1.86	186.55
Isipingo Rail	12,097,667	12.1	1,209.77
Jacobs	1,802,798	1.8	180.28
La Mercy Airport	2,676,407	2.68	267.64
Mariannhill	1,548,907	1.55	154.89
Maydon Wharf	1,355,563	1.36	135.56
Mayville	140,629	0.14	14.06
Mobeni	3,663,252	3.66	366.33
Mount Edgecombe	2,121,284	2.12	212.13
North Coast Rd/ Red Hill/Umgeni	1,093,921	1.09	109.39
Phoenix Industrial	3,251,611	3.25	325.16
Pinetown/New Germany	6,962,359	6.96	696.24
Point	246,917	0.25	24.69
Prospecton Industrial	4,509,556	4.51	450.96
Queensmead Industrial	732,636	0.73	73.26
Riverhorse Valley	2,435,990	2.44	243.60
Rossburgh	782,474	0.78	78.25
Sea View	366,038	0.37	36.60
Springfield/Umgeni	4,614,159	4.61	461.42
Tongaat	1,691,916	1.69	169.19
Umbogintwini	3,912,827	3.91	391.28
Verulam	719,006	0.72	71.90
Westmead/Mahogany Ridge	6,553,180	6.55	655.32
TOTAL	94,239,871	94	9,423.99

The areas surveyed are established and permitted industrial and only Clairwood residential (and parts of Rossburgh residential) were surveyed as there are a large number of freight and logistics land uses that illegally use these residential suburbs. Importantly, residential areas like Queensburgh, Chatsworth, Phoenix, Umlazi, Lamontville, Amanzimtoti, Isipingo and Red Hill were not surveyed, even though a number of illegal freight and logistics activities take place in those areas, as these areas are too large and timeframes and resources were limited.

Every freight- and logistics-related land use was documented in the areas listed in Table 2. This was done by means of visual observation from the municipal road network. The surveying commenced in June 2016 and was completed in November 2016. Every road in the various areas was either walked or driven and freight and logistics land uses were documented. The information that was documented was the following: the address of the site; the GPS location of the site; name of the company; contact details of company where available; freight and logistics land use observed on the site; and the extent of land utilised by the company in relation to the eThekwini Municipal ERF land use classification. Furthermore, the driving distance on the road network of every site was measured from Durban Container Terminal (DCT) at the Bayhead and Langeberg Road Intersection.

The freight- and logistics-related land uses observed during the survey included the following:

- Clearing & Forwarding – is a company that provides a service connected with the clearing and forwarding operations of goods as an agent for another person.
- Cold Storage – is a warehouse that is refrigerated and airtight for the purpose of keeping perishable products frozen or cold.
- Concrete Trucking – is a yard that holds specialised concrete trucks that deliver concrete to the construction industry
- Container Depot – is outside the harbour area, and is approved for the purposes of creating additional container capacity as well as for the purposes of unpacking cargo for individual delivery or packaging of goods for export. This should not be confused with empty container depots.
- Courier Services – are facilities that convey small consignments of goods to the general public, such as FedEx, UPS or DHL.
- Edible Oil Storage – is an area of large tankage used to store edible oils and liquids.
- Empty Container Depot – is an open area used for the storage of empty shipping containers; empty container stacks can be 7 containers high.
- Grain Storage – is a facility (warehouse or silos) that stores edible grains.
- Liquid Bulk Manufacturing – is a facility that manufactures liquid chemicals (liquid bulk) for export.
- Liquid Bulk Services – this includes a variety of uses that support the liquid bulk logistics industry (these include liquid bulk truck cleaning facilities)
- Liquid Bulk Storage – this comprises large tanks that hold chemicals and liquid bulks.
- Liquid Bulk Trucking – these are sites that store or hold liquid bulk trucks specifically (not to be confused with general trucking and truck holding facilities.)
- Packaging – these are facilities that provide or sell packaging material for the transportation of goods.
- Pallet Storage – these are sites that manufacture or store pallets used for the transportation of goods
- Ships Chandlers – are retail dealers who specialise in supplies or equipment for ships, known as ship's stores
- Steel Storage – sites that are specifically used for the storage of steel and steel products.
- Truck Cleaning – is a facility that specialises in the cleaning of trucks.
- Truck Holding Area – is an area that is used by trucks (legally or illegally) as a location where they can park or be held (for both short or long periods)
- Truck Manufacturing – is a facility that manufactures or sells trucks.
- Truck Stop – is a facility where trucks can be parked and held over extended periods, and there are facilities for the drivers to use (e.g. sleeping, washing or food sales)
- Truck Worthiness Test Centre – is a facility that conducts truck worthiness inspections specifically.
- Trucking – is a facility that has any other trucking related usage.
- Trucking Repairs – is a facility that specialises in the repairs of trucks.

- Vacant – is land that is currently vacant or empty, but under construction or earmarked as a future freight and logistics related usage (this would most likely be a future warehouse)
- Warehousing & Distribution – is a large storage facility for goods and products. The facility is an area where goods are stored and then distributed when required.
- Manufacturing – needs to be stipulated when a logistics- or freight-related facility also has manufacturing capabilities. For example Toyota manufactures cars, but these are destined for export.

A total of 1178 logistics operators were identified across all the areas surveyed. These logistics operators utilised a total of 1865.39 hectares of land and can be seen shaded in purple in Figure 12. The average logistics operator surveyed has approximately a 1.58 hectare site and is roughly 19.83 km driving distance from the Durban Container Terminal (DCT), once again demonstrating the need for freight corridors in close proximity to the port to provide sufficient capacity and service. The top five areas that have the highest concentration of logistics-related companies are: Clairwood (132); Westmead (129); Springfield/Umgeni (107); Prospecton Industrial (60); Umbogintwini (56); and Queensmead Industrial (49); as shown in Table 3.

Table 3 Total Logistics Operators by Area

Area, Suburb, Precinct	Number of Logistics Companies	% of logistics companies by Area	HA used by logistics companies	Average logistics land size per area	Average driving distance from DCT
Avoca	17	1.4%	33.41	1.97	26.88
Bayhead	40	3.4%	152.62	3.82	4.32
Canelands	7	0.6%	49.59	7.08	44.41
Cato Manor/Wiggins	15	1.3%	15.68	1.05	9.23
Cato Ridge	7	0.6%	19.11	2.73	50.16
Clairwood	132	11.4%	26.01	0.19	7.66
Congella/Umbilo	40	3.4%	43.77	1.09	5.66
Cornubia	4	0.3%	16.00	4.00	38.60
Giba Industrial	2	0.2%	5.55	2.77	30.00
Hammarsdale	18	1.5%	108.51	6.03	47.13
Harrison	18	1.5%	116.01	6.45	49.64
Isipingo Rail	8	0.7%	12.47	1.56	14.60
Jacobs	30	2.5%	62.57	2.09	8.85
La Mercy Airport	8	0.7%	45.68	5.71	49.25
Mahogany Ridge	47	4.0%	47.57	1.01	27.09
Mariann Hill	47	4.0%	102.13	2.17	21.07
Maydon Wharf	29	2.5%	101.87	3.51	4.74
Mayville	8	0.7%	2.11	0.26	10.23
Mobeni	41	3.5%	64.64	1.58	10.97
Mount Edgecombe	35	3.0%	45.31	1.29	33.21
New Germany	34	2.9%	59.19	1.74	22.53
North Coast Rd/Red Hill/Umgeni	39	3.3%	49.22	1.26	23.36
Phoenix Industrial	31	2.6%	39.50	1.27	30.53
Pinetown	23	2.0%	26.21	1.14	23.63
Point	14	1.2%	5.08	0.36	9.74
Prospecton Industrial	60	5.1%	130.85	2.18	17.44
Queensmead Industrial	49	4.2%	31.29	0.64	15.52
Riverhorse Valley	28	2.4%	70.00	2.50	23.97

Rossburgh	8	0.7%	6.66	0.83	5.53
Sea View	28	2.4%	15.76	0.56	7.62
Springfield/Umgeni	107	9.1%	66.24	0.62	20.53
Tongaat	11	0.9%	11.53	1.05	53.65
Umbogintwini	56	4.8%	95.57	1.71	25.11
Verulam	6	0.5%	5.04	0.84	44.05
Westmead	129	11.0%	182.63	1.42	26.03
TOTAL	1178	100%	1865.385	1.58	19.83463

The most prominent logistics activity in the eThekwini Municipal Area is Warehousing and Distribution with 615 surveyed companies offering this service. The second most prominent logistics activity on offer by companies surveyed is Trucking, with 430 sites having some truck-related component. The number of companies with Trucking services in Clairwood is significant at 107; no other area comes remotely close. There are 137 companies that have some Trucking Support facilities. Pallet Storage (108) and Liquid Bulk Storage (104) follow up in number of logistics activities on offer by companies surveyed.

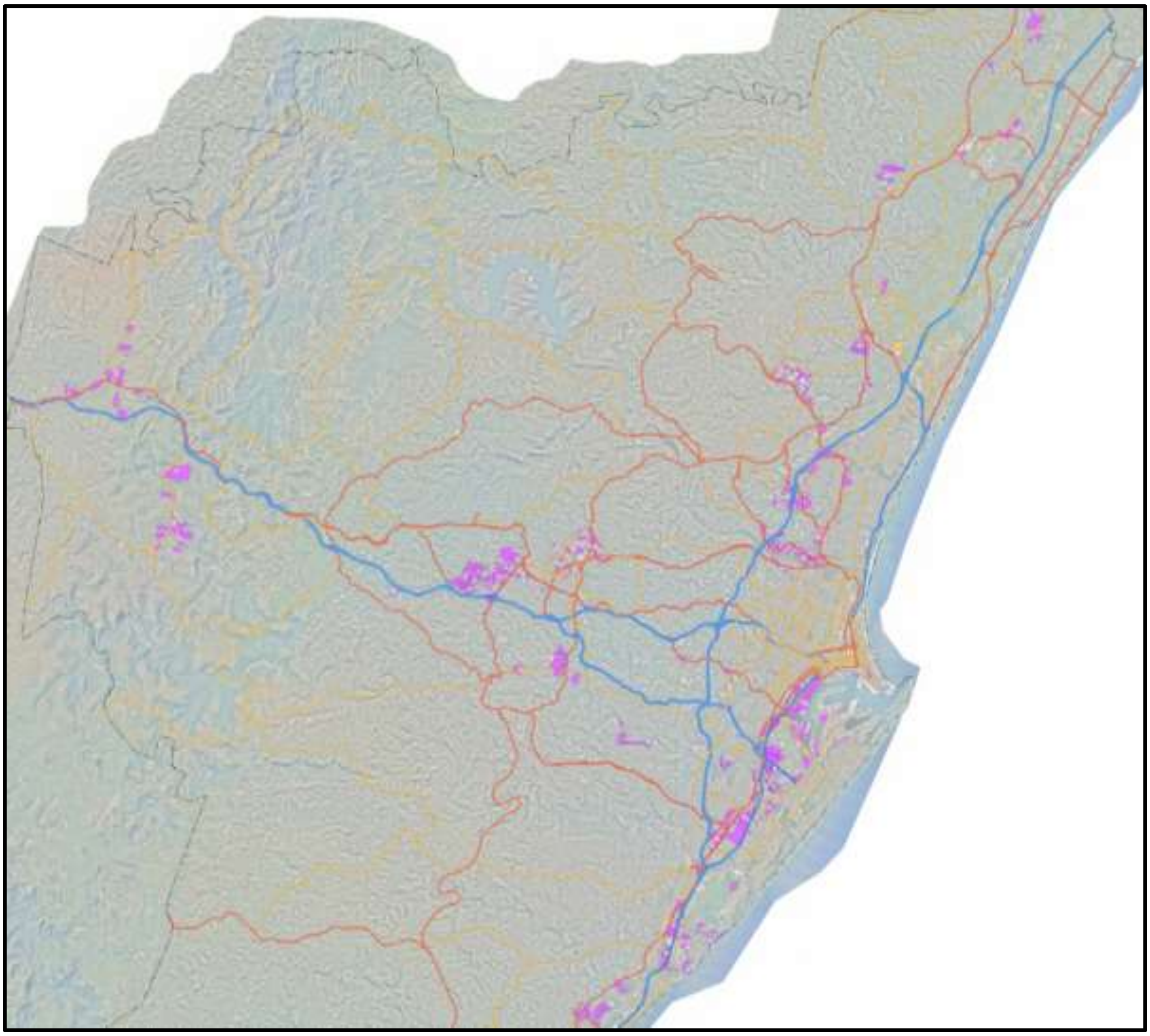


Figure 12 eThekwini Freight and Logistics Land Uses

Figure 13 focuses in on the South Durban Basin freight and logistics land uses. The map demonstrates that there are 610.32 hectares (or 416 companies) of highly intensive logistics operators shown within the SDIB. This the equivalent of 32.72% of total eThekwini logistics land in hectares or 35.31% of total eThekwini logistics companies. The map reveals the significance of port freight and logistics activities in the South Durban Basin. When Westmead, Pinetown, New Germany, Umbogintwini and Southgate are included with the areas shown in Figure 13. They account for 70% of freight and logistics companies' eThekwini and roughly 62.9% of all hectares of freight and logistics related land. Thus, it can be assumed that heavy vehicles movements between these areas and the port are significant; requiring sufficient access, infrastructure and heavy vehicle management to ensure port (and corridor) efficiency and optimisation.

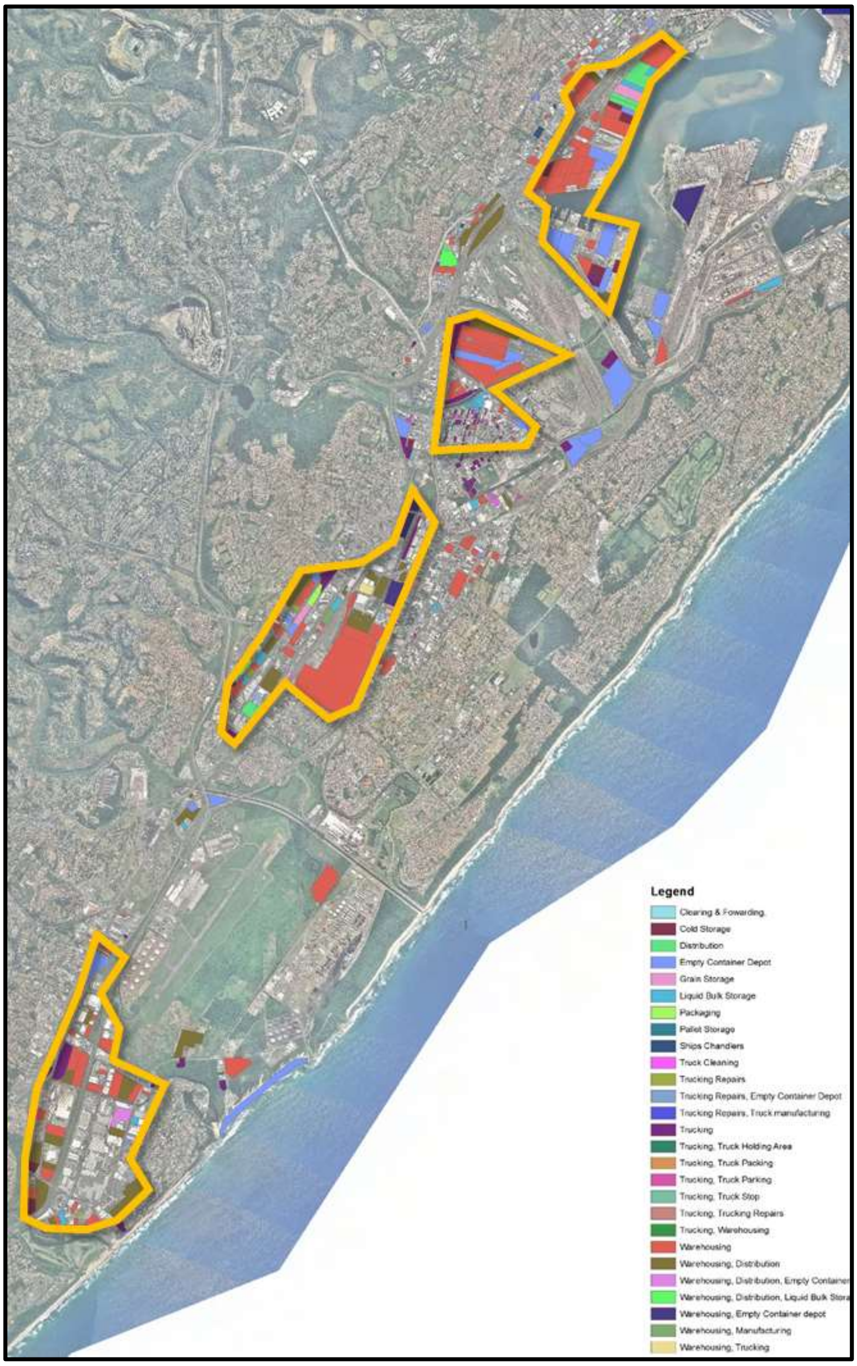


Figure 13 Freight and Logistics Land Uses in the South Durban Basin

2.2. Future Scenarios and Port Expansion Plans

2.2.1. Port Expansion Plans

Figure 14 shows the anticipated Transnet container volume growth as predicted by TNPA (in dashed blue line) and Transnet Long Term Planning Framework (in solid blue line). These are two different growth scenarios for container activity in the Port of Durban. The red solid line represents theoretical container terminal capacity in the Port of Durban, with the step increases in the red line representing additional infrastructural container capacity additions and improvements.

The initial decrease in capacity shows the DCT berth deepening project at Berths 203 to 205 where for duration of construction capacity will be reduced. The first step up in capacity between the years 2021 and 2026 represent Berths 203 to 205 being complete. The second step up in capacity represents the intended Salisbury Infill coming online after 2026. The final two increases in capacity after 2036 represent the Durban Dig Out Port (DDOP) project at the old Durban Airport Site in Reunion.

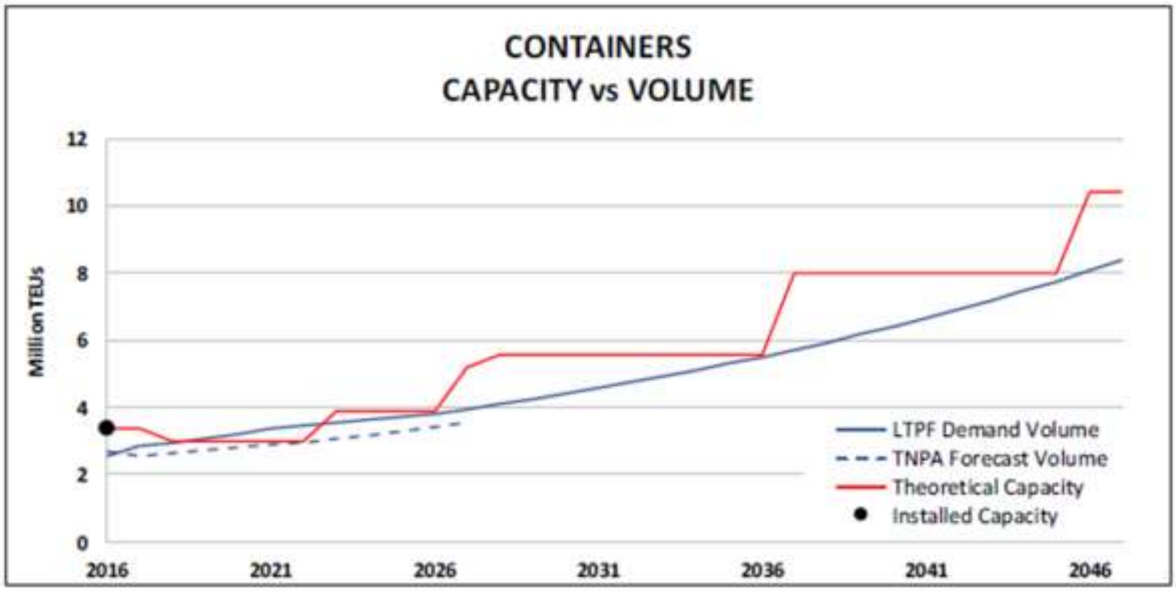


Figure 14 Port of Durban Container Capacity versus Forecasted Container Growth Volumes

2.2.2. Berth 203-205 Deepening and Salisbury Infill Expansion

Figure 15 shows an artist impression of the Salisbury Island Infill and the DCT Berth 203 to 205 Deepening projects, these are the areas shown by the red dashed line. Both these developments intend to increase container terminal capacity at the current port, specifically for the container terminal areas.

Figure 15 Pier 1 Salisbury Island Infill and DCT Berth Deepening

Table 4 shows the anticipated container (TEU) growth for each Port Expansion project with the anticipated year the capacity will become available. The Table further demonstrates the growth container volume capacity in comparison to the current 2018 container capacity at the Port of Durban. The current port should grow by an additional 64.7% in volumes and this is particularly problematic for both the road and rail network and operations, which cannot cope with current volumes. Additional capacity being created at the current port will require additional road capacity, new road handling operational plans, as well as extensive smart port-city infrastructure to manage the massive growth in heavy vehicles. The DDOP is only anticipated in the years 2036 to 2037 and any new infrastructure and operations would need to factor in this potential development further south.

Table 4 Port of Durban Container (TEU) Growth in Capacity

Project	Addition TEU's	Total Port Capacity	Year	Capacity Growth from 2018
2018 TEU Capacity		3,4 million TEU	2018	
DCT Berth Deepening	0,5 million TEU	3,9 million TEU	2023/24	14,7%
Salisbury Island Infill	1,7 million TEU	5,6 million TEU	2027/28	64,7%
DDOP Phase 1	2,4 million TEU	8,0 million TEU	2036/37	135,3%

2.2.3. Heavy Vehicle Growth Scenarios in Port of Durban

Table 5 shows the anticipated cargo growth from 2013 till 2040, as per the Transnet Long Term Demand Model and Transnet Long Term Planning Framework report. The cargo figures displayed are for the Port of Durban alone (regardless of whether they are from the current port or the anticipated Durban Dig Out Port at the old Durban Airport Site). The last column on the right shows the percentage of cargo handled by rail. The 2013 figures are actual figures attained by Transnet Freight Rail, while the future years show Transnet's freight rail anticipated modal share, which now seems very optimistic. With the higher rail modal share of freight incorporated, the model has estimated the anticipated volumes of heavy vehicles accessing the port per day, as can be seen in the table, is expected to more than double from 10376 heavy vehicles per day in 2013. The road network accessing the current Port of Durban does not have the capacity to handle this anticipated growth, as noted by the Integrated Freight and Logistics Strategic Framework and Action Plan for eThekwini. The IFLS therefore recommended the expansion and improvement of the existing freight corridor to and from the port, as well as the requirement for the development of a second access to the Durban Container Terminals at the current port.

Table 5 Future Port Growth and Traffic Growth

Year	Containers (million TEU)	Car Units ('000)	Dry Bulk (Tons '000)	Liquid Bulk (Tons '000)	Break Bulk (Tons '000)	Port Heavy Vehicles (per day)	Rail Modal Share (%)
2013	2.65	497	10 077	30 856	2 017	10 376	Container = 16% Cars = 50% Dry Bulk = 50%
2020	3.54	577	10 834	35 336	2 120	11 865	Container = 30% Cars = 80% Dry Bulk = 60%
2030	5.43	792	12 640	48 367	2 381	15 534	Container = 30% Cars = 80% Dry Bulk = 70%
2040	8.21	1 121	15 160	66 391	2 753	21 691	Container = 30% Cars = 80% Dry Bulk = 70%

Source: Integrated Freight and Logistics Strategic Framework and Action Plan, 2015

2.3. Notional Desired Container Terminal Freight System

The 'Integrated Freight and Logistics Strategic Framework and Action Plan' recommended the following infrastructure intervention for the study area:

- Road:
    - In the short term, an increase in capacity for the current freight road corridor accessing the Container Terminals, namely M7 (Solomon Mahlangu Drive), South Coast Road, Sydney/Umbilo Road, Bayhead Road and Langeberg Road.
    - In the medium term, the development of a second access to the current Durban Container Terminals to support the Container Terminal expansions and improvements. This new road should access the areas in the South Durban Basin with freight and logistics activity, and ultimately connect the Container Terminals to the National and Provincial Road Network.
- Truck staging area:
    - In the short term, develop a truck staging area along the current road system accessing the terminals and relocate the current A-Check facility to this new point. Truck staging area should be provided with sufficient road access and land to handle the current A-Check trucking activity.
    - In the medium term, develop a second truck staging area on the new access road to the container terminals, again replicating the A-Check activities.
    - Both facilities should not be excessively far from the Container Terminal, but need sufficient land, road access and support from both eThekwini and Transnet.
- Freight Management System:
    - In the short term, a smart port-city freight management system should be developed to manage, track and regulate heavy vehicles prior to them arriving at the port entrance. This should be extended to the proposed truck staging areas and along all key freight corridors.
- Land use and port-city interface zones:

- Key land parcels within the Bayhead area under Transnet jurisdiction must be utilised to support road freight operations and all land parcels and leases must be assessed according to impacts on port operations and road congestions. Leases and land usage that aren't essential primary port and terminal operations should be relocated or not renewed.
- Key land parcels within the South Durban Basin controlled by the eThekwini Municipality should be zoned logistics according to the recommendations of the Back of Port study and the land recommendation to support the port activity, logistics and ultimately the freight corridors must be implemented.

This section of the report has further demonstrated:

- The inappropriate location, layout and access for the A-Check area;
- Expansion and improvement of the current road freight corridor accessing the container terminals;
- The National requirement for a second access to the container terminals (Pier 1 and 2), as well as Island View (Cutler Precinct) to de-risk the hazards and pitfalls of only having a single road access to these terminals;
- A second access is again required to support port expansions and the anticipated freight growth through the port, a single access running under current port operations will not be feasible;
- The second road access must give access to freight and logistics operators in the South Durban Basin, where logistics activities are intensive and demand for direct routes are crucial;
- The need for truck staging areas slightly more remote from the current A-Check with sufficient land, correct layout, appropriate access from main freight corridors and smart port-city management systems; and
- Enforcement, regulatory and legislated activities to be consolidated at a single location on the main freight corridor within the port area.

Based on the recommendations above, a notional freight and logistics layout is proposed for design, investigation and development. To carry out this recommended notional preferred layout a current Bayhead and Southern port precinct layout needs to be developed. Figure 16 shows an aerial photograph of the current Bayhead and Southern port precinct grouped by various uses. The red areas represent leased Transnet properties, the blue areas represent the various port terminals, the orange areas represent the truck management areas (A-Check), and the yellow areas represent the enforcement regulation areas currently in operation.

Figure 16 Layout Bayhead and Southern Port Precinct

Figure 17, then represents these areas in a simplified notional system layout. The colours as prescribed in Figure 16 are now represented in boxes (with titles provided), the road network is shown in grey line, the traffic signals are shown by 4 dots around intersections and the green boxes show various key access point or entrance gates to the container terminal. Each of the leased areas is shown in red and titled with the name of the leasee. Ambrose Park is represented by the dead-end road with circle at the end giving access to MSC. Bayhead Road is the vertical grey line curving towards Pier 1 and Cutler Precinct. Langeberg Road is the Horizontal grey line giving access to Pier 2, with Seafarers Road curving off Langeberg to the A-Check area in orange.

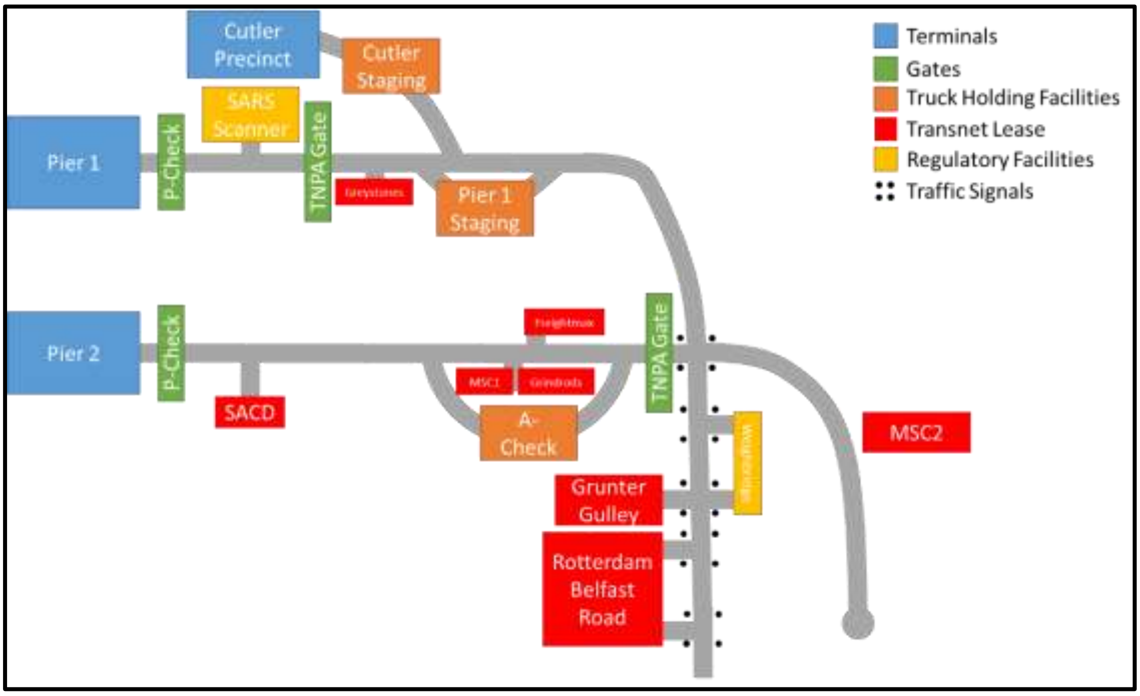


Figure 17 Notional Bayhead and Southern Port Precinct Layout

Based on the recommendation Figure 18 reconfigures the notional system layout shown in Figure 17. Figure 18 shows a preferred Bayhead and Southern Port Precinct Layout. The key differences between Figure 17 (current layout) and Figure 18 (preferred layout) are:

- The relocation of container terminal a-checks and moving them to a remote truck staging areas.
- The cancellation or relocation of various Transnet leasee's (MSC1, Grindrods, Freightmax, Greystones and SACD) that add to road congestion in the Bayhead Area.
- The conversion of the current DCT a-check into a mega enforcement/regulatory facility accommodating all government departments noted earlier in this section.
- The additional roads:
    - Creating a single access to both container terminals (pier 1 and 2), allowing enforcement/regulatory facility to manage both terminals out of a single location;
    - A second access into the South Durban Basin via a truck staging area (a-check); and
    - The enhancement of the current road access via a truck staging area (a-check).

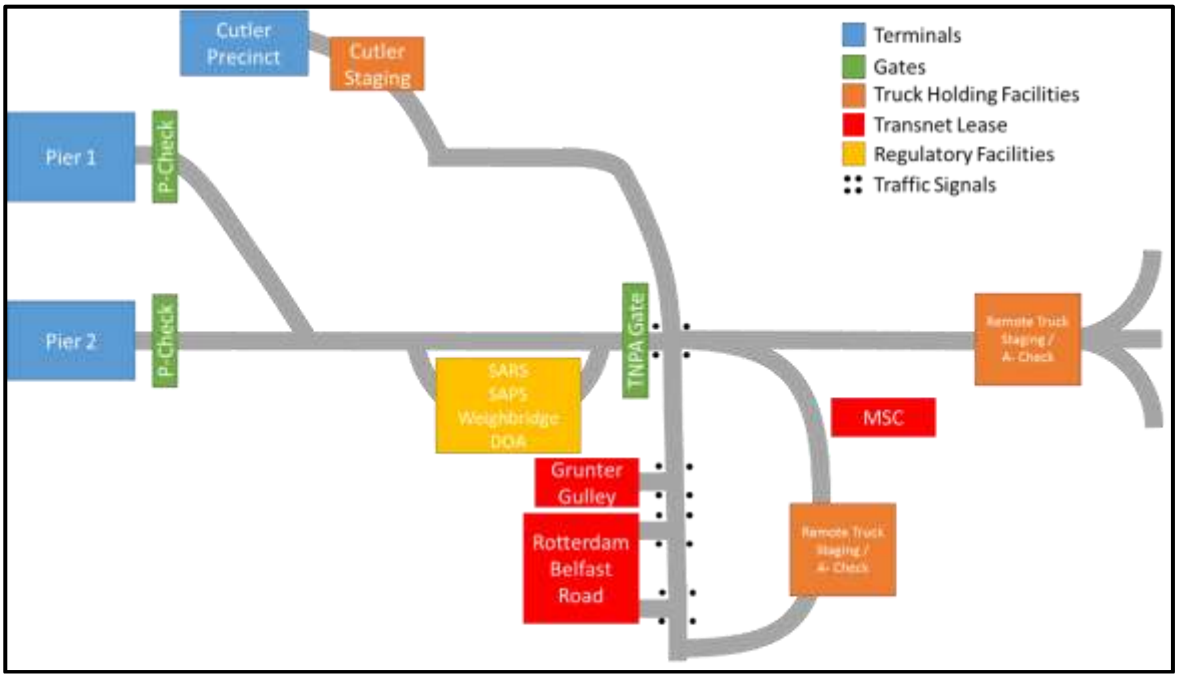


Figure 18 Preferable Bayhead and Southern Port Precinct Layout

The remainder of this report further investigates the viability of what is proposed Figure 18, as well as furthering the recommendations listed previously in section 2.3 Notional Desired Container Terminal Freight System.

3. Background and previous studies done

Traffic modelling of freight vehicles in the mid to late 2000s assumed that freight traffic originating or destined for the Port of Durban was directly linked to Johannesburg / Cato Ridge (Intermodal Hub), as the predominant destination or origin. It was upon this assumption that a dedicated freight route from the Port of Durban to Cato Ridge was developed. However, the Back of Port Study (completed in 2012) as well as the Integrated Freight and Logistics Strategic Framework and Action Plan (IFLS) for eThekwini (completed by Royal HaskoningDHV (RHDHV) in 2015) clearly demonstrated and proved that majority of container related freight traffic and container activity was stuffed and de-stuffed within the eThekwini Municipal Area, predominantly in the SDIB. This is primarily due to supply chain cost reduction strategies by companies, the nature of international container shipping and to a lesser degree Port of Durban operational instability and inefficiency. Previous matrices used in the model, prior to the RHDHV study, did not take these findings into consideration.

3.1. Study A – New Arterial Route

The ETA '*Freight Corridor Study'* (2011) done by Hatch Goba report described the characteristics of the New Arterial Route as follows:

- The Freight Route shall be a dedicated and conditional compulsory route allowing the transport of goods destined for and originating from the Port.
- The full length of this route shall be reserved for freight only and can be a combination of new roads and/or exclusive freight lanes on existing roads.
- High mobility will be ensured through effective geometric design and the incorporation of this design with the underlying topography.
- Entrance and exit points along the route for all freight will be controlled, in order to maintain route exclusivity.
- Supplement heavy traffic on the N3, by capturing all the Durban-based freight destined for the hinterland serviced by the N3, and where practical the freight carriers from surrounding areas along the N2.
- Allow connectivity to various identifiable industrial areas along the route through selective entry and exit points.
- Minimise environmental impact by aligning the route in a practical manner to either avoid or have a minimal intrusion into environmentally sensitive areas.
- Minor economic routes must be serviced as best as possible without losing the exclusivity of the route.

There were several route alignments for the New Arterial that were tested in the ETA Freight Corridor Study (2011). The preferred route alignment that will be constructed in four separate phases are described hereafter:

- Phase 1(a): Bayhead Road to the N2 (shown in Figure 19).
- Phase 1(b): Solomon Mahlangu Drive to the proposed Dig-Out Port.
- Phase 2: M7 to N2 to Mariannhill.
- Phase 3: Mariannhill to Cato Ridge.

The downfall of this study was that it used an algorithm to force freight traffic onto the proposed routes and banned most freight vehicles on other routes in the area. These routes, shown in Figure 19, did not connect to the local SDIB network and industrial zones where high demand for container stuffing and de-stuffing takes place. Thus attracting very little heavy vehicle traffic demand and resulting in a low feasibility. Phase 1 of the dedicated freight route was estimated to cost approximately R9 Billion and this was recommended to be funded by a tolling strategy. A tolling strategy for this route would not work, as the freight traffic would filter through the rest of the network to avoid this penalty. Hence the reason for further studies.

3.2. Study B - eThekwini Freight and Logistics Strategic Framework and Action Plan

As mentioned in Chapter 2, the ETA initiated the '*Integrated Freight and Logistics Strategic Framework and Action Plan*' (IFLS) for the eThekwini Municipal Area in 2013 and the report was compiled by Royal HaskoningDHV. The recommendations and conclusions of the IFLS were adopted by eThekwini Executive Council on the 30 September 2015, as noted in section 1.9.5 of the Council Decision Circular: Meeting Held On 2015-09-30. The aim of the IFLS was to develop a set of freight initiatives, identifying the key decisions and determine how resources should be allocated to pursue and realise the ultimate freight strategy for the eThekwini Municipality.

The IFLS established a host of important findings in arriving at the key recommendations and outcomes, these included:

- The Port of Durban roughly generates 10000 truck movements per day, with rail road modal split for: container at 16%:84%; cars at 50%:50%; and dry bulk at 50%:50%.
- In 2040 (with Port growth forecasts accounted for) if rail were able to increase its modal share for: containers to 30%:70%; cars to 80%:20%; and dry bulk to 70%:30%, then heavy vehicle activity will grow to more than 21000 truck movements per day.
- This growth is significant, when the current municipal, provincial and national road infrastructure is reaching capacity and not coping with the level of heavy vehicle activity.

The IFLS further noted with Pier 1 and 2 being planned for expansion (along with the possibility of a new Dig Out Port) that these developments would extend the theoretical terminal container capacity beyond the current 2.7 million containers to roughly 8-10 million (almost a 4 fold growth in capacity). The IFLS further conducted extensive traffic modelling (using the eThekwini Transport Authorities EMME3 model) with traffic growth scenarios factoring in these proposed port expansions. The EMME3 traffic modelling noted that the strategic road network in the eThekwini Municipal Area would require extensive upgrades and improvements to manage the addition port related freight traffic. It was noted the SDIB would need particularly extensive road upgrades and an additional route the current container terminal to cater for the port expansions and traffic related growth, as shown in Table 6.

Table 6: Integrated Freight and Logistics Strategic Framework and Action Plan - Road Intervention Requirements

Short Term (2015 – 2020)	Medium Term (2020 – 2030)	Long Term (2030-2035)
• **Second Access to container terminal** • **MR577** • **M7 (Bluff Road – Bellville Road)** • **N2 (M7 – EB Cloete Interchange)** • **N3 (EB Cloete Interchange – Marian Hill)**	• M7 (Bellville Road – N3) • Second Access to terminal connecting to DDOP • N2 (M7 – South) • N3 (Marian Hill – Cato Ridge) • MR579 • R603	• N2 (EB Cloete – North) • N3 • R603 • MR579

An essential short term recommendation of the IFLS was the improvement and expansion of the road network around the Port of Durban (particularly the roads accessing the Durban Container Terminal and the South Durban Basin) and the corridors to both the Provincial and National Road network. It was noted in the IFLS that the expansion and improvement of this road network is required to support the Port expansion, manage congestion and support the growth of eThekwini's industrial ambitions. The IFLS noted that these road expansions and improvements be developed in conjunction with

Transnet (as they own and oversee the crucial land parcels and roads surrounding the Durban Container Terminal.)

Beyond the road interventions required the IFLS also noted that the road interventions be implemented in an integrated manner with the other implementation themes. Table 7 shows the key truck stops and truck staging areas required to be implemented in conjunction with the road network, according to the IFLS.

Table 7: Integrated Freight and Logistics Strategic Framework and Action – Truck Staging and Truck Stop Intervention Requirements

Short Term (2015 – 2020)	Medium Term (2020 – 2025)	Long Term (2025-2035)
• **Cato Ridge Truck Stop** • **SDIB Truck Stop** • **Umbilo/Bayhead Truck Staging Area** • **Umgeni Truck Staging Area** • **Springfield Truck Staging Area** • **Riverhorse Valley Truck Staging Area** • **Pinetown Truck Staging Area**	• Rossburgh Truck Stop • Prospecton Truck Stop • Westmead Truck Stop • Tongaat Truck Stop • Umbogintwini Truck Staging Area • Prospecton Truck Staging Area • Mobeni Truck Staging Area • Phoenix Industrial Truck Staging Area	• Pinetown Truck Stop • Maydon Wharf Truck Staging Area • Tongaat Truck Staging Area

3.3. Study C – New Arterial Route, Phase 1A – Bayhead Road to N2

The ETA commissioned a study for '*The New Arterial Route, Phase 1A – Bayhead Road to N2'* (2014) done by Aurecon considered the work done previously by Hatch Goba, investigating the three route options considered from the N2 to the port, as shown in Figure 19. This study utilised the IFLS heavy vehicle traffic modelling matrices and IFLS findings to test the infrastructure recommendations of Hatch Goba study. Option 3, shown in black in Figure 19, was deemed the most viable option from the three routes and underwent a further microscopic traffic simulation exercise and a Traffic Road Layout (TRL). Ultimately the routes recommended by Hatch Goba had no connections to South Durban Basin resulting in low heavy vehicle demand, as IFLS freight traffic matrices models the high attraction between the SDIB and the port. This resulted in the routes showing a low heavy vehicle traffic demand and with cost estimate of R 11.34 billion for Option 3, the route was deemed infeasible.

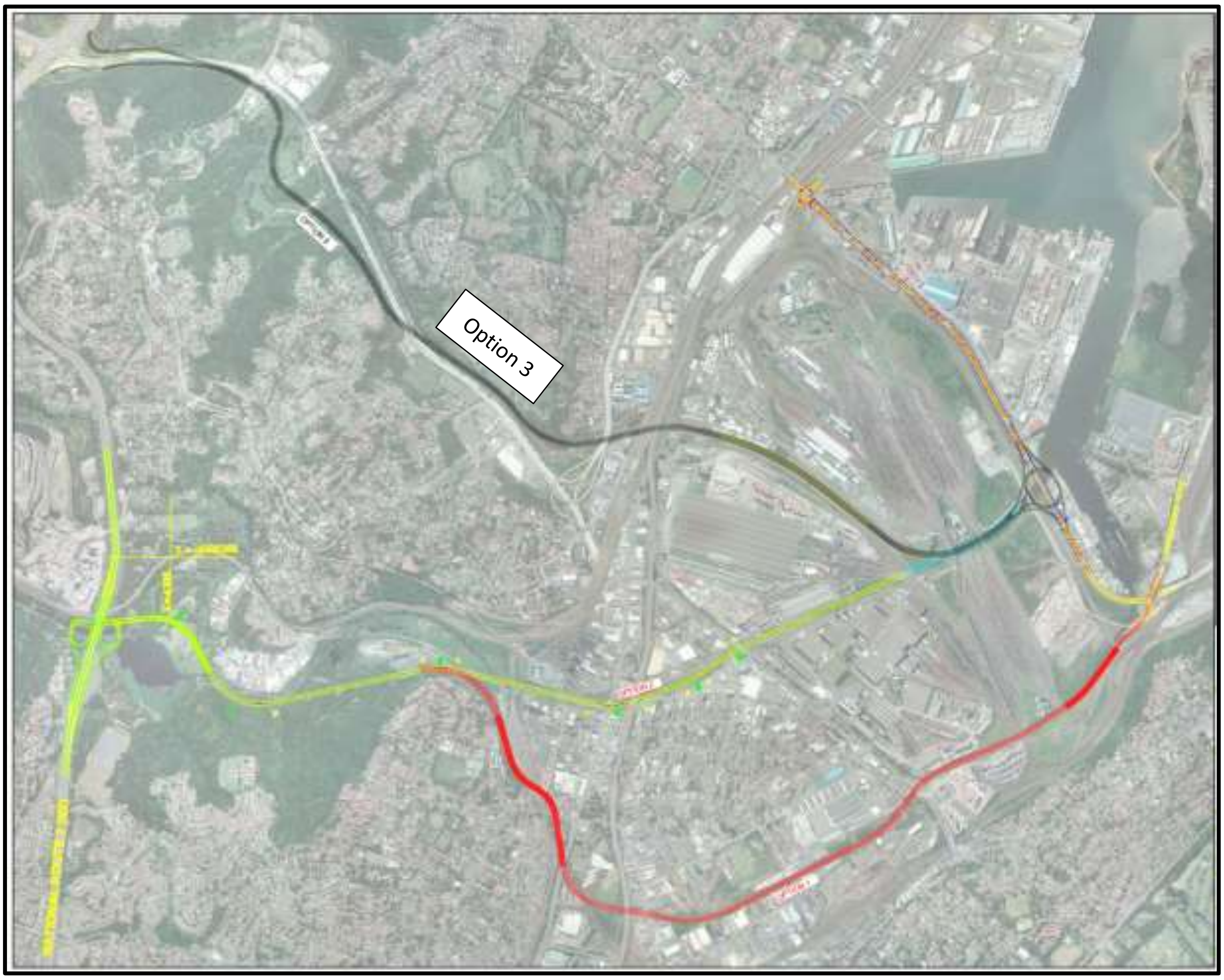


Figure 19: Map of the dedicated freight routes tested in 2014. Source: eThekwini New Arterial Route, Phase 1A – Bayhead Road to N2 (2014)

The study's findings showed that a dedicated freight route was not viable as conceptualised by Hatch Goba, but that a new route would require connections with the SDIB and the route be a mixed traffic route (with freight still being given options to use existing routes). They also found that that various interim intersections and road links needed to be upgraded as these were operating at low Level of Service (LOS) currently and to mitigate congestion in the near future.

These major upgrades are proposed at the following intersections:

- M7 and South Road Intersection
- M7 and Recreation Road Intersection
- M7, Bellair Road and Wakesleigh Road Intersection
- M7 and N2 Interchange – Western Ramp Intersection
- M7 and Titren Road Intersection
- M4 and Blamey Road Interchange - Western Ramp Intersection
- M4 and Blamey Road Interchange - Eastern Ramp Intersection
- Blamey Road and South Coast Road Intersection
- South Coast Road and Bluff Road Intersection
- South Coast Road, M4 Off-ramp and Pinedene Road Intersection
- South Coast and Bluff Road Intersection
- The signal phasing of all key intersections within the study area needs to be assessed and optimised.

Capacity Upgrades are recommended on the following roads:

- M7
- M4 between South Coast Road and Bluff Road
- South Coast Road
- Bayhead Road
- Maydon Wharf Road

The report also states that these are not the only roads in this area that need to be upgraded, noting that: "*there may be more upgrades required over and above the ones mentioned above. As such, it is highly recommended that a detailed analysis of the upgrades required to be undertaken in the near future to ensure that all possible upgrades required are properly identified. The recommended upgrades need to be properly investigated before any design work is undertaken.*" (Aurecon, 2014)

3.4. Study D - South Ports Combined Roads: Short Term Interventions study

Transnet National Ports Authority (TNPA) commissioned the '*South Ports Combined Roads: Short Term Interventions study'* in 2015, this study was conducted by Aurecon. The study builds on the work that Aurecon previously undertook for the eThekwini Transport Authority (ETA) for the establishment of a New Arterial Route into the Port of Durban (2014). The objective of this exercise to identify bottlenecks on the current road network and propose short term road upgrades in mitigation of these bottlenecks. The study included:

- Undertaking traffic surveys where required.
- Commission traffic counts to fill in gaps in the existing available data.
- Developing an AIMSUN Traffic Simulation Model for the base year (2014) and 2020 horizon traffic conditions.
- Identification of bottlenecks on the current road network using the simulation model in conjunction with onsite observations.
- Propose short term road upgrades to mitigate of the congestion identified in the modelling process.

The study concluded that the AIMSUN traffic model demonstrated high levels of congestion in the South Ports area and critical areas of the supporting road network. The study further recommended that several short term interventions/improvements are required to mitigate the problems/ inefficiencies encountered on the road network.

The infrastructure upgrades required on the road network to mitigate the congestion problems identified in the traffic modelling include:

- The upgrade of Bayhead Road and South Coast Road Intersection
- The upgrade of the Bayhead Road and Langeberg Road Intersection with dedicated left turn slip lanes into Langeberg Road
- The construction of a new on-ramp onto the M4 in the southbound direction and a new off-ramp from the M4 in the northbound direction.
- Upgrade the TNPA Ocean Terminal Traffic Control Centre
- Connect the N3TC, SANRAL and ETA Traffic Management Centres to the TNPA Ocean Terminal Control Room
- Develop a Cloud Based Database
- Develop an Integrated and Automated Communications System
- Develop an Internal Truck Staging Area in Ambrose Park
- Install a Traffic Management System for Bayhead Road
- ANPR (Automated Number plate recognition) cameras at the start of Bayhead Road

- New CCTV cameras at the intersection of Umbilo Road and Bayhead Road and at Sydney Road and Bayhead Road
- Variable Message Signs in South Coast Road, Maydon Road, Sydney Road, Solomon Mahlangu Drive and Umbilo Road
- Variable Message Signs along Bayhead Road, Langeberg Road in Ambrose Park, at the internal truck staging area in Ambrose Park
- Variable Message Signs and CCTV camera system at the Pier 1 staging area outside Cutler Complex
- Link or Integrate Existing Systems to the New Traffic Management System
- Bayhead Park Access Control and Internal Circulation

3.5. Study E - South Ports Combined Roads: Medium Term Interventions

A TNPA study for '*The TNPA South Ports Combined Roads: Medium Term* Interventions' (2015) study further builds on the work that Aurecon previously undertook for the eThekwini Transport Authority for the establishment of a New Arterial Route into the Port of Durban (2014). It also proposed medium to long term road upgrades to mitigate the congestion identified from future projections. This study was based on information taken from the "New Arterial Route into the Port of Durban" and "Integrated Freight and Logistics Strategic Framework and Action Plan" studies.

The conclusion and recommendations of the South Ports Combined Roads: Medium Term Interventions were:

- A New Arterial Link to be constructed in order to accommodate increased traffic volumes. This New Arterial Link will begin at a new interchange at Bayhead Road and end at a new interchange at the M4, providing links to the South Durban Basin. The AIMSUN model showed this link will provide the much needed relief to the congested areas and will allow the road network to operate efficiently.
- The model showed intersections that will face high congestion levels in 2035 and recommendations for road improvements were made for the following cordons of the road network:
    - South Coast Road / Recreation Road / Solomon Mahlangu Drive
    - Umbilo Road / Sydney Road / Bayhead Road Cordon of the Road Network
    - South Coast Road, M4 Freeway and Blamey Road Interchange

The AIMSUN Model revealed that the recommended upgrades for the 2035 horizon will improve traffic operations in 2035 and will substantially reduce the foreseeable congestion on the road network.

3.6. Summary

Previous traffic studies, which investigated second accesses to the Port of Durban, proved to be inconclusive, showed low traffic demand and were extremely costly. The routes investigated focused on east-westerly movements, connecting the port to the N2. The latest research has illustrated that majority of freight vehicles stuff and de-stuff containers in and around the SDIB area, as discussed in detail in Chapter 2. Hence, previous studies, not taking into account the overall freight traffic movements, that neglected the SDIB proved to be inadequate as a means of providing a justifiable second access route to the port. Thus, more investigations are needed to provide a feasible route which will serve as a second access into the port and accommodate connection to the SDIB.

4. Scope of this Report

A second access to the port is required to deal with the increasing growth in container traffic due to the expansions within the current Port of Durban, namely the proposed Salisbury Infill, the current congestion and the anticipated growth in road freight traffic into and out of the Port. This route will potentially alleviate congestion and assist in road safety into and out of the Port. As discussed this will form an alternative access from a national perspective as this is a key point to the country. It has been recognised from previous studies done that additional road infrastructure will be needed in this vicinity in the medium to long term to support both planned and potential Port developments in respect to the growth in Port related traffic.

The new thinking is to develop an integrated systems approach and a mixed traffic route instead of a dedicated freight route. This route will now connect with truck stops and truck staging areas to the Port. The connection between the Port and the truck staging areas will need to be integrated with an intelligent telecommunication call-in system.

The route will need to support logistics in the SIDB and will need to help reduce and remove freight congestion in and around residential areas. The overall intention is to provide a high standard road (expressway/arterial type) to be positioned from Bayhead/Langeberg Rd intersection to a Truck Staging Area (A-check), in the SIDB, from this staging area to the National and Provincial Road Network and in the long term from the Staging Area to the proposed Durban Dig Out Port (DDOP).

This project aims to determine a new freight route to the Port of Durban in 2017. A route feasibility assessment has been undertaken by the team with the outputs discussed in this report. The broad brief of this work stream was to fix an Engineering viable route, taking account of environmentally sensitive areas (particularly river crossings, indigenous forests and wetlands), existing developments and traffic conditions. The potential route will ensure that it is well priced and tested for traffic demand.

4.1. Mapping

The eThekwini Municipality's 2017 digital photography and contour plans (2 metre intervals) were used as the base map for the development of potential roads. A map of the contours is illustrated in Figure 20.

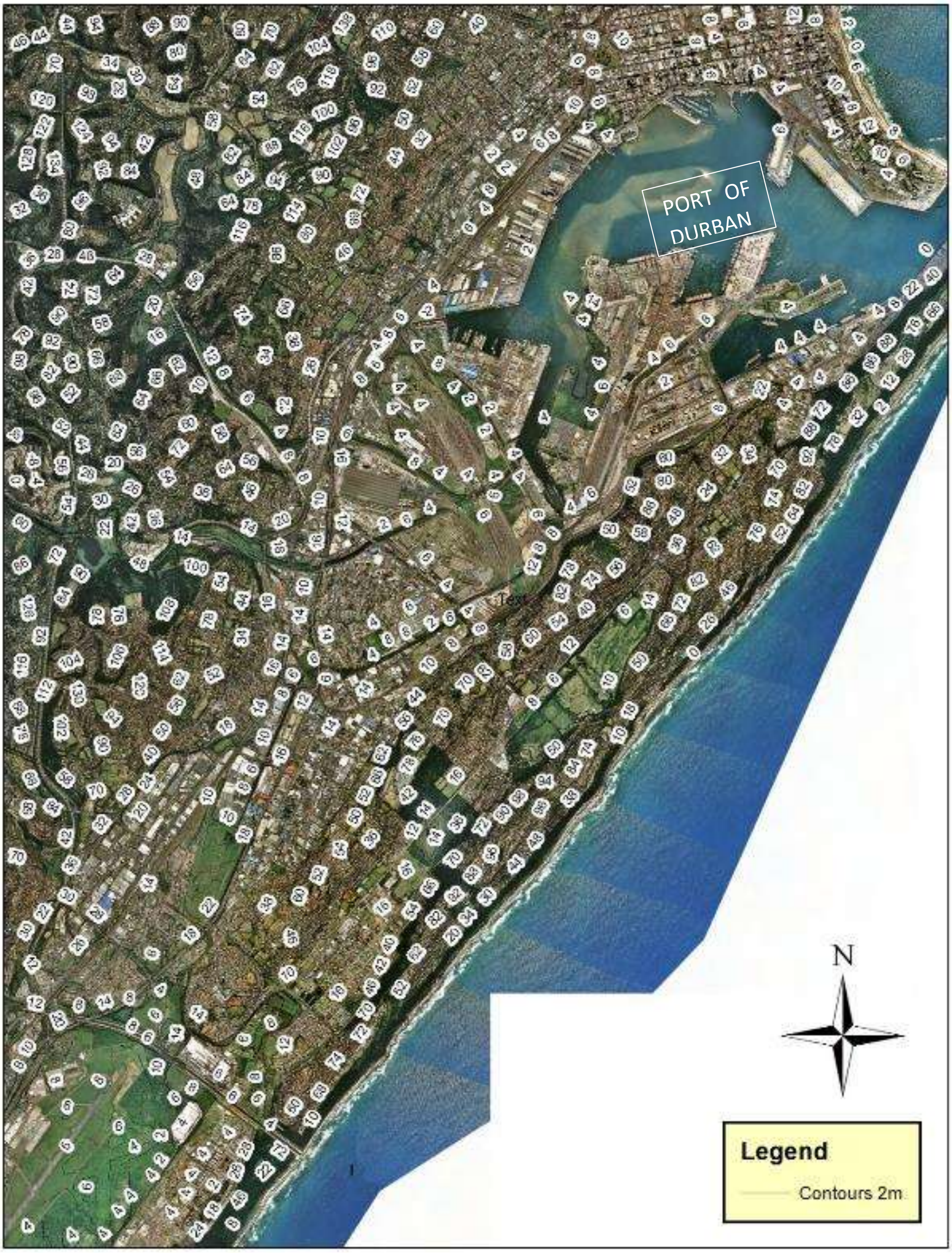


Figure 20: Map of the South Durban Basin 2016 with 2m contours.

5. Environmental Constraints and Wetland Inventory Assessment

As a key point of departure for this study both environmental and social areas have been avoided as far as possible. Rivers will need to be crossed at the narrowest location. A map of the South Durban Basin 2016 with DMOS is shown in Figure 21. DMOS is a layer of potential environmental constraints that will need to be avoided as much as possible when planning new infrastructure.

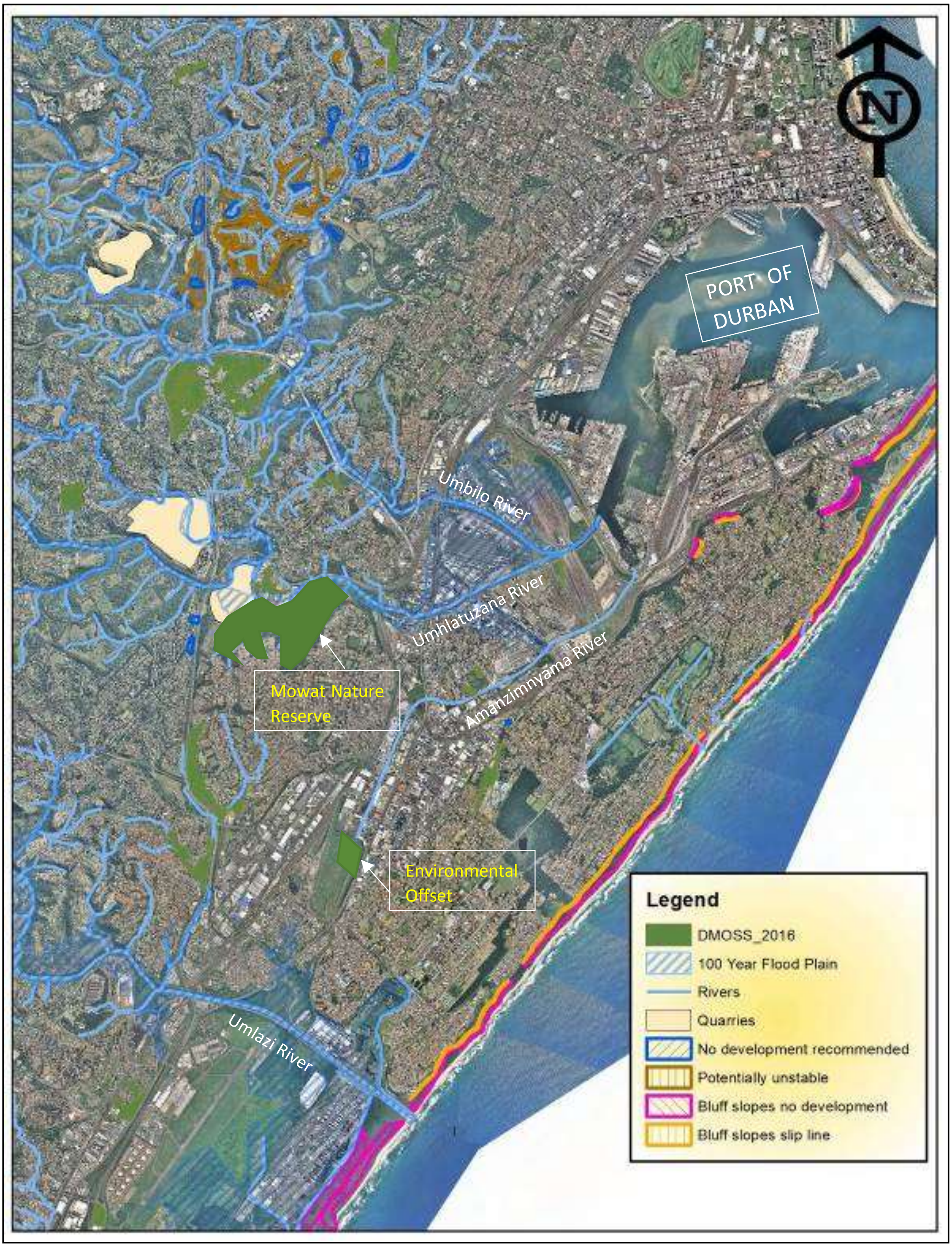


Figure 21: Map of the South Durban Basin 2016 with DMOS, River, 100 year flood line and Quarries.

Figure 21 depicts the study area with various major rivers and canals are located such as the Umhlatuzana River, the Umbilo River, the Umlazi River and Amanzimnyama canal. An environmental offset area has been set aside at the old Clairwood Racecourse so that new proposed development on the remainder of the site can take place, can be shown as well as the Mowat Nature Reserve. Other items such as quarries, 100 year flood line, no development areas and slop slip lines are also indicated on the map as illustrated in Figure 21.

6. Traffic Analysis and Projections

6.1. Introduction

The traffic analysis was first tested at a macroscopic level with the use of ETA's regional EMME model. Understanding the current freight model was paramount to the success of a potential new freight route. Therefore, investigations into the current EMME model began to determine what the existing freight patterns and volumes are, as well as that in future scenarios. From a private car and public transport perspective, the model has been updated and validated to counts for a 2015 base year. From a freight perspective, the EMME model has been updated using the 2014 freight routing and freight matrices that were developed during the IFLS study. This study developed three freight matrices for the base year as well as for each of the projected years. These matrices were used as an input into the EMME model base year and these were founded from the type of freight vehicles surveyed, namely: articulated trucks, container trucks and delivery trucks. The EMME model was considered to be the most suitable modelling tool that could be used in understanding and assessing the traffic and traffic congestion in this study area for all vehicle traffic with a focus on freight vehicle traffic.

6.2. Existing Traffic Demand

A volume to capacity (V/C) ratio diagram has been extracted from the EMME model. Where the V/C ratio is one, or greater than one, the model indicates that the road link is operating at full capacity (or over capacity) and thus has a poor associated Level of Service (LOS) F. This indicates that the road is operating at stand still crawling speed, bumper to bumper traffic. A roadway with LOS D – LOS E is nearing poor conditions, where the volume is approaching the capacity of the road. Roads with a low V/C ratio, meaning that the volume is less than the capacity, will operate between a LOS A-C which is acceptable. LOS A is shown in grey, LOS B – LOS C in green, LOS D in yellow, LOS E – Orange and LOS F is shown in red. A V/C ratio diagram for the morning peak hour for the 2015 base year scenario of the roads in the SDIB area is illustrated in Figure 22.

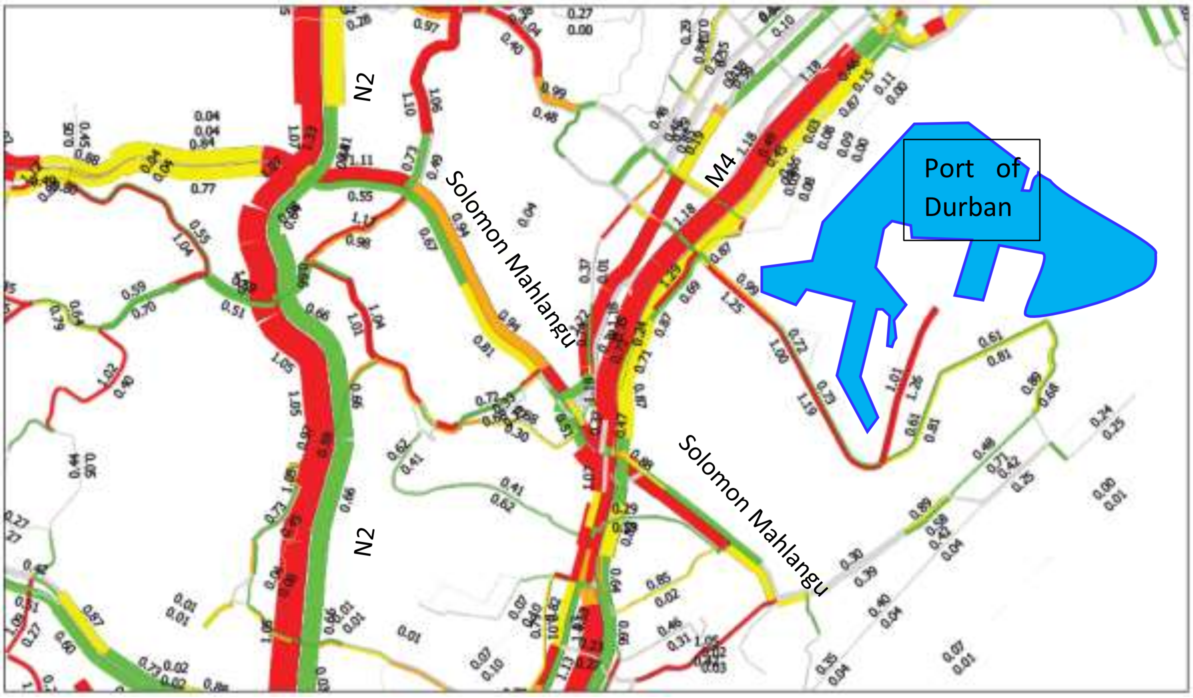


Figure 22: 2015 LOS network assessment (EMME4 output)

This plot shows that the network is congested in the AM peak hour with a lot of roads operating at a LOS F. This also shows that there is very little free capacity surrounding the port in the AM peak hour. Most roads such as the Solomon Mahlangu Road (M7) east bound, the M4 north bound, parts of South coast Road, the N2 and Bayhead Road show high levels of congestion.

Current matrices, which replicate realistic traffic movements, illustrate that freight trips originate from and are destined to various industrial zones. These locations are Pinetown, Phoenix Industrial Park, Cornubia and various other zones in the SIDB described in chapter 2.1.7. The target years for this study were the existing 2015 base year and the ultimate, 2025 and the 2035 horizon years.

6.3. Future Traffic Demand

The general growth in private, public and freight traffic puts massive pressure on the existing road network. With the introduction of potential new developments within the region, resulting in additional traffic, further strain is exerted on the existing road network. Future traffic demand has the potential to be vastly different from the current. The largest single traffic generator will be the Port, with various berth deepening's and infill's which will increase the capacity of the Port and thus directly result in additional freight traffic on the roads.

A V/C ratio plot of all traffic along the roads for the projected 2035 base year is illustrated in Figure 23.

Figure 23: 2035 Level of Service (LOS) network assessment (EMME4 output)

If no additional infrastructure is implemented from the 2015 base year (do-nothing approach), the traffic on the roads in and around the port indicates very high levels of congestion. As illustrated in Figure 23, this 2035 projected year shows high levels of congestion on the Solomon Mahlangu Road (M7), the M4, the N2, South coast Road, Umbilo Road, Sydney road and Bayhead Road as well as other surrounding roads within the vicinity.

These traffic congestion outputs as illustrated in Figure 22 and Figure 23 indicate that this area suffers from high levels of traffic congestion and will be severely worse in the next 10 to 20 years' time. This will have massive implications on the Port resulting in substantial delays for traffic trying to enter or leave the Port utilising the surrounding road network. This report will further investigate infrastructure requirements aimed at improving and maintaining travel time, as well as to reduce traffic congestion going into and out of the Port of Durban.

7. Geometric Standards for the Preliminary Study

7.1. General

The proposed road investigation has been carried out using the guidelines recommended in UTG1 (Urban Transport Guidelines), Guidelines for the Geometric Design of Arterial Roads 1986 (Urban Transport Guidelines, 1986).

7.2. Road Classification and Cross Section

An eThekwini RCAM (Roads Classification and Access Manual) Class 2 road or a KZN Dot Type 1B Urban Provincial Freeway, typical dual carriage cross section as shown in Appendix has been adopted. The elements are summarized below:

- Lane Widths 3,75m and 3.75m inside lanes (two in each direction)
- Inside Shoulder 0.5m
- Outside Shoulder 2,0m
- Median Wide 2.5m

Carriageway is 22.5m with road servitude of 25m.

7.3. Design Standards

Table 8: Summary of Geometric Design variables

Description	Main Road	Access Road
Design Speed	80km/h	60km/h
Maximum super elevation	6%	8%
Cross fall	2%	2%
Minimum radius of curves	300m	280
Maximum grade	6%	9%
Minimum grade	0,5%	0,5%
Minimum length of vertical curves	140m	100m
Minimum K value of vertical curves		
Crest	33	16
Sag	31	16

For bridge decks and span: use a span to depth ratio of 1 in 20. These ideally have column spaces at 20m apart as we will want to minimise the amount of foundations due to the high water table. Hence, if a 20m span then the bridge deck would be 1m and if work to a 15m span the deck would 15/20= 0.75m

8. Geotechnical Considerations

Detailed geotechnical and material analysis has not been done for this project but analysis from previous studies are documented. A centreline test pitting was performed for the characterization of the pavement and subgrade materials at suitable positions at the various intersections as part of the South Ports Combined Roads studies (2015). The main objectives of the centreline investigations were:

- To establish the integrity and layer thicknesses of the materials in the existing road prism
- To establish the quality of the materials along new alignments
- To identify problematic areas, such as low bearing capacity, unstable materials, and the presence of ground water, etc.

The materials investigation was performed by DRENNAN MAUD (PTY) LTD, an accredited laboratory in Durban, during February and May 2015. The field work (test pits) and laboratory testing was performed in accordance with the SANRAL M1 Manual. The laboratory was responsible for the transportation of all samples, as well as all the tests and test reports. Aurecon was responsible for coordinating the work and the completion of all other related items, including the review of the test reports.

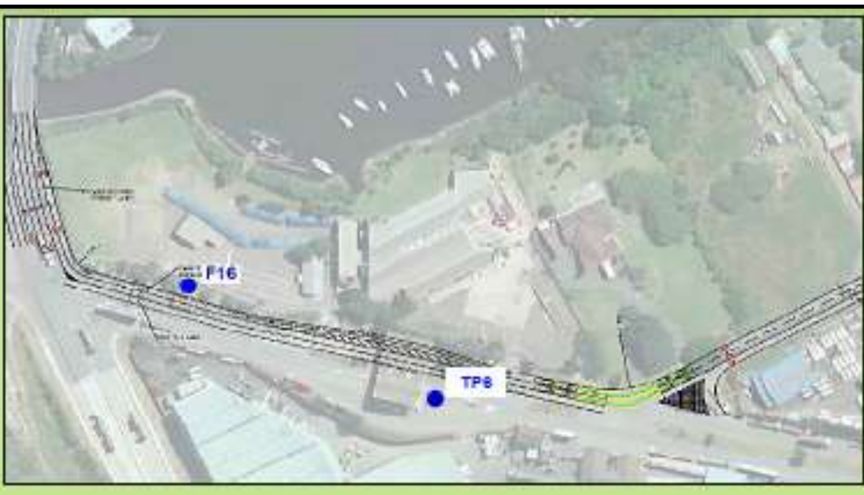
The test pits are defined and categorized as follows:

- 'F'= field in situ test pits
- 'P' = existing pavement test pits
- TP6 = old existing pavement test pit

Cognisance should be given to the geological considerations mentioned in Figure 24 to Figure 28 and Table 9 below, detailing the results of the test pits. These geological considerations are included within this project as to provide additional information on the geotechnical properties of the surrounding study areas.

Langeberg Road:

Test pit location/s:



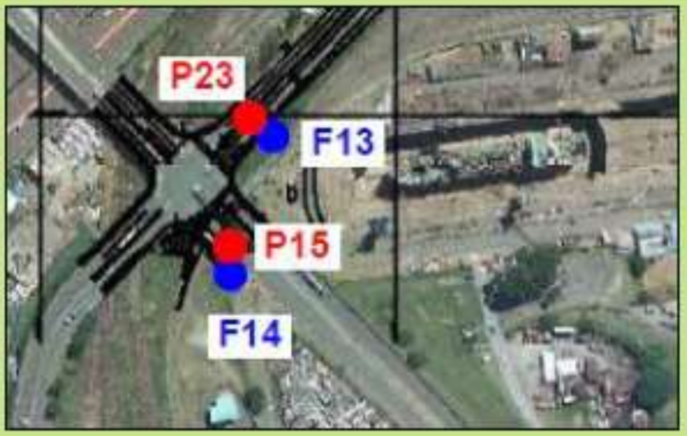
Test pit: TP6	Layer mm	COLTO G-class
AC x 3	130	-
Crusher run	100	'G5'
Crusher run	150	'G5'
Sandy gravel	140	G6
Sandy, slag, and estuarine gravels	250	(G7)
Geological considerations:		-

Test pit: F16	Layer mm	COLTO G-class
Sand + roots	300	(G8)
Sand	250	G7 + (G7)
Coarse sand	250	G7
Sandy gravel	150	<G9
Sandy and estuarine gravels	600	<G9
Geological considerations:		
From 0.8 m depth the materials appear to be unsuitable for roads.		

Figure 24: Langeberg Road Test Pit Locations

Bayhead Road and South Coast Road Intersection:

Test pit location/s:

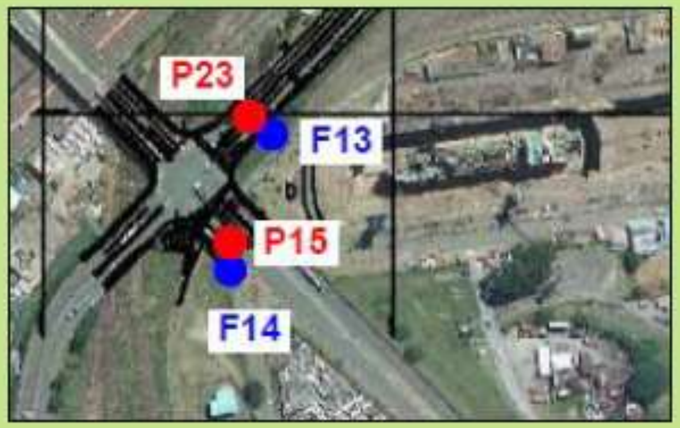


Test pit: P23	Layer mm	COLTO G-class
AC + BC	220	-
Silty gravel	530	G6/G7
Geological considerations:		-

Test pit: P15	Layer mm	COLTO G-class
AC x 3	300	-
Crusher run	130	'G5'
Crusher run	170	G7
Silty gravel	200	G6
Geological considerations:		-

Figure 25: Bayhead/South Coast Road Intersection Test Pit Locations

Test pit location/s:



Test pit: F13	Layer mm	COLTO G-class	Test pit: F14	Layer mm	COLTO G-class
Gravel + roots	200	(G8)	Sand + roots	100	(G8)
Sandy gravel	200	(G8)	Gravel with sand	450	G5
Gravel with sand	700	G7	Gravel with sand	300	G5
Gravel with silty sand	400	G6	Old concrete	50	-
Colluvium	100	(G6)	Old crusher run	400	G9
Geological considerations:			Geological considerations:		-
Notice old services at the bottom of pit.					

Figure 26: Bayhead/South Coast Road Intersection Test Pit Locations (2)

Test pit location/s:

Test pit: P17	Layer mm	COLTO G-class	Test pit: P19	Layer mm	COLTO G-class
AC + BC	250	-	AC + BC	150	-
Coarse gravel	120	G8	Coarse gravel	250	G5
Boulders, refusal	330	-	Gravel and sand	30	G8
			Gravel and sand	100	G8
			Gravel and sand	250	<G9
			Gravelly sand	220	<G9
Geological considerations:		-	Geological considerations:		
			Yellow PVC pipe encountered at 0.65-0.83 m. Unsuitable at 0.53 m.		

Figure 27: M4/South Coast Roads Test Pit Locations (Rossburgh)

Test pit location/s:

Test pit: F18 A	Layer mm	COLTO G-class	Test pit:-	Layer mm	COLTO G-class
Gravel + roots	200	G6			
Sandy gravel	550	G7			
Sand	100	G8			
Geological considerations:		-	Geological considerations:		

Figure 28: M4/South Coast Roads Test Pit Locations (2) (Rossburgh)

Table 9: Summary of Dynamic Cone Penetration (DCP) results on Existing Pavement Structures in Maydon Wharf and Bayhead Road Area

DCP REFERENCE	SURFACING DEPTH (mm)	DSN_{800}	CBR VALUE			APPROXIMATE DEPTH OF TEST (mm)
			10th PERCENTILE (%)	MEDIAN (%)	90th PERCENTILE (%)	
P15	300	-	110	>150	>150	REFUSAL AT 485 mm
P23	220	-	75	>150	>150	REFUSAL AT 170 mm

9. Route Alternatives Investigation

There were various alternative routes that were discussed in the background chapter of this document. As set out in the scope of the report, the team has set out to find the most feasible route option. Of which broad guidelines and specifications were adhered to:

- The proposed route needed to be at grade level as much as possible and minimise the use of structures, hence reducing the cost of the project.
- With respect to access – the route should have minimal access (preferably with a kilometre spacing) and have enough road reserve at potential intersections for future expansions to interchanges.
- The existing rail sidings and unused rail lines in the area needed to be explored for the route alignment.
- Connections to the Solomon Mahlangu Drive (M7) and M4 needed exploration, possibly to improve route feasibility, but not to compromise current mobility on those corridors.
- If the potential route required expropriation /acquisition of land this needed to be noted and possibly avoided as much as possible.
- Social facilities, communities and residential areas are to be avoided.
- Pipelines, electrical, telephone and other utility-service obstructions must be noted and possibly avoided.
- Route options should aim to connect to potential truck staging areas and truck stops, shown in red and green in Figure 29. A more thorough description of the truck staging/stopping areas, marked green in Figure 29, is defined in chapter 11.2.
- Based on information in Chapter 2. The route would need to connect to staging areas and logistic areas as indicated with the yellow arrows in Figure 29.
- Site inspections along routes need to be done to confirm the findings.

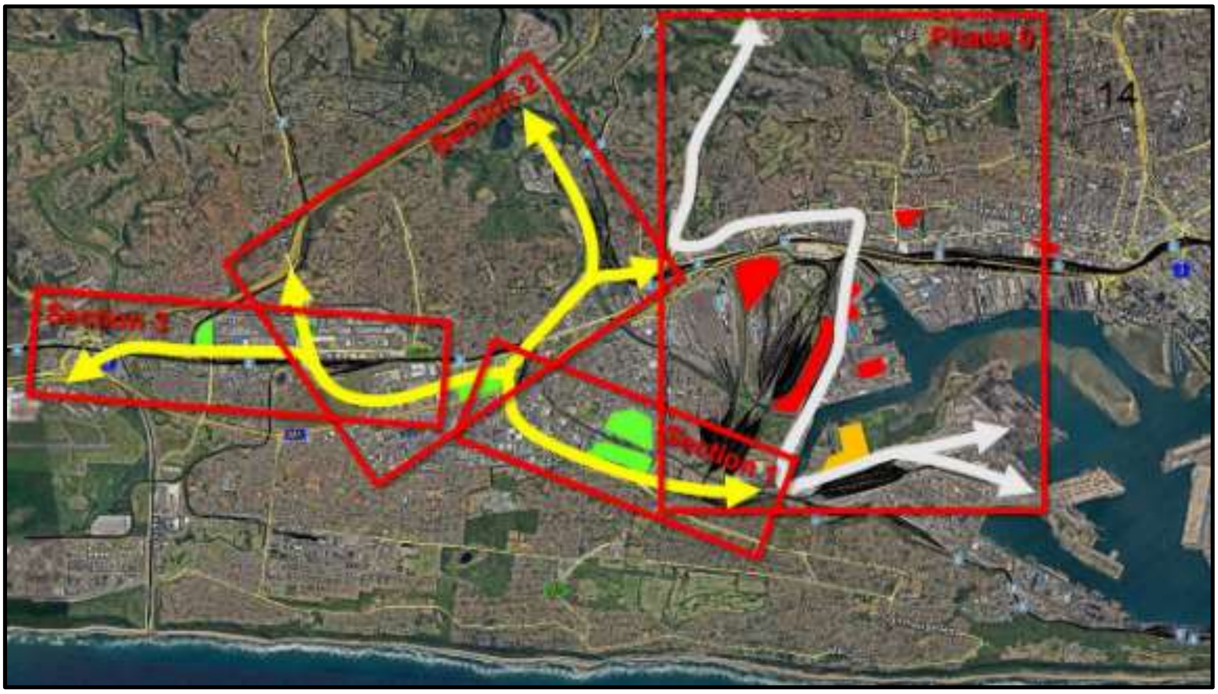


Figure 29: eThekwini Transnet Integrated Freight Transport Systems Plan Study Areas

The road network suitability and investigations were conducted in two phases. Phase 0 being the current base year and investigation into improvements on the current freight corridor network supporting the container terminals. Phase 1 being the future projected scenario years of this study and investigations into a second road access to the Container Terminals to support future port expansions and anticipated container growth. The second access to the Container Terminals route optioneering was conducted in 3 sections, each with various options that were investigated and compared with respect to their associated traffic demand (from traffic models), costing, social impacts as well as environmental impacts. Figure 29 illustrates the phase 0 and various sections for phase 1.

High levels of traffic congestion exist in the am and pm peak hours to and from the Port via Solomon Mahlangu Drive (M7), for the current base year, as illustrated in Figure 22. This has notable traffic congestion and has been addressed in this study as phase zero upgrades. EThekwini is in the process of procuring contractors to commence with the road rehabilitation of Solomon Mahlangu Drive (M7), where construction is planned to begin in August 2018. Further to this, various upgrades are required which are further detailed in Chapter 10 (Phase Zero) of this report.

The options for the various phases and sections are discussed further within this study. The options were investigated based on certain criteria, namely social area/community impact, environmental constraints, a minimisation of cost and the potential for traffic demand as the transport aspect. At the end of Chapter 11 and 12 the most feasible route option for phase one section one and two selected. This is done with the use of a MCA assessment based on the before mentioned criteria.

9.1. Costing Methodology for the Study

9.1.1. Road Costing

For the purpose of this study, high level cost estimates were done on all the investigated routes. This allowed comparisons to be made between the various routes in terms of the cost perspective, via the multi-criteria analyses, done subsequently at the end of each section in order to decide on the most feasible route.

The cost estimates were based on the premise that along each route, the traversing alignment would either be at grade, on structure or tunnelled. The cost per square metre (R/m^2) was attained from the Road Provision Department of the eThekwini Municipality in 2017, which were established from recent construction contracts undertaken by the before mentioned department. These costs are listed below:

- At Grade: R2000 / m^2;
- On Structure: R18 000 / m^2;
- Tunnelled: R50 000 / m^2.

Additionally, the total calculated cost of each alignment was marked up by a 50% contingency, due to the high level assessments made as part of this study, thus taking into account further unforeseen costs. It must be noted that the costs included as part of this study have not accounted for future inflation. The costing breakdown was further utilised as a means to compare the routes like for like, allowing for an equivalent comparison field between the investigated route alignments. This costing methodology was used for all investigated route alignments of this study.

9.1.2. Rail Costing

For the purpose of this study, to take into account the costs associated with the removal and realignment of rail, high level costing was done where required. The costing methodology was based on costs done for a King’s Rest Rail yard project in 2016, undertaken by TNPA. The costs of removing and realigning the rail was also marked up with a 50% contingency, which takes into account unforeseen costs due to the high level assessments done as part of this study. It must be noted that the costing did not take into account inflation.

9.2. Multi-Criteria Analysis (MCA) Methodology

For the purpose of this study, a MCA was done focusing on four criteria in order to form a comparison between the investigated routes, such that the most feasible option/s can be determined. These fields of comparison (criteria) were estimated road costs, social impacts, transport viability and environmental impacts. Each criteria scaled from 0 to 25, with 0 being the worst/most impactful case and 25 being the best case for each criteria. The method in which each individual criteria was assessed is described in detail below.

9.2.1. Cost Criteria

The cost criteria was scaled to be between 12 and 20 out of 25, with 12 being the most expensive and 20 being the cheapest out of the investigated options. This was done in order to limit the effect the cost had on the overall score and thus preventing the cost from being the deciding factor.

The equation used can be seen below:

$$Cost\ Rating = 20 - 8\left(1 - \frac{Cost_{max} - Cost_{current}}{Cost_{range}}\right)$$

Where;

$Cost_{max}$, is the most expensive route cost for a specific section;
$Cost_{current}$, is the cost of the current route to be rated;
$Cost_{range}$, is the difference between the maximum and minimum costs (i.e. $Cost_{max} - Cost_{min}$);

Using this equation and rounding the answer, the cost rating for each route was determined.

9.2.2. Environmental Criteria

The environmental criteria was scaled from 0 to 25, with 0 being extremely impactful on the environment and 25 having no impact, for each route. If the route crossed or traversed near any environmentally sensitive areas, the score given was close to 0. If the route avoided all environmental concerns, it was given a rating closer to 25. However, no route was given 0 nor 25 since the environmental impacts can be unforeseen without the assessment of a qualified environmental specialist.

9.2.3. Transportation Criteria

The transportation criteria was scaled from 0 to 25, with 0 being a route with least transportation demand and 25 having the most potential transportation demand along it. This output was taken during the EMME modelling process. Noting that the route would have higher demand if traversed closer to the potential truck stop / truck staging area. None of the routes were given 0 or 25 as this would skew the overall result and more detailed studies would be required to accurately measure the demand when taking truck stops / staging into account.

9.2.4. Social Criteria

The social criteria was scaled from 0 to 25, with 0 being extremely impactful on social communities and 25 having no impact, for each route. If the route crossed over or traversed near social areas (residential areas, schools, social facilities etc.), the route was scored closer to 0. If the route avoided all social areas it was given a rated closer to 25. Similarly to the environmental rating system, 0 nor 25 was given as a rating. It is impossible to determine whether a route would have no impact (i.e. 25) on social communities, or have a severe impact (i.e. 0), without proper input from public participation forums. Hence, the routes were assessed according to knowledge of the areas and their proximity to social communities.

10. Phase Zero - M7, Sydney & South Coast Roads

10.1. Solomon Mahlangu (M7) Upgrades

The Solomon Mahlangu Road (M7) being the key corridor into and out of the Port and SDIB that connects to the national corridor will remain a very attractive route for freight in the long-term. An analysis has been done to determine if and when this corridor warrants infrastructure upgrades. The site location of the Solomon Mahlangu Road lies between the National Route 2 (N2) and Bluff Road. The area of study is illustrated in Figure 30 this is between the N2 and the Titren Road.

Figure 30: Solomon Mahlangu (M7) Site Location

10.1.1. Capacity Analysis of Existing intersection and flows

A macroscopic transport model called EMME was used to identify problem areas on the road network as well site observations were done during the AM peak traffic hour. This results showed congestion along Solomon Mahlangu Road east bound. This is illustrated in Figure 31 with red depicting a poor LOS with V/C ratio that is greater than 1. The section that showed the most congestion was the section between the N2 and Vusi Mzimela Road intersection. An intersection analysis was done at the M7 Solomon Mahlangu / Vusi Mzimela Road intersection. An intersection analysis computer programme SIDRA (Signalised & Unsignalised Intersection Design and Research Aid) was used to perform a status quo analysis of the Solomon Mahlangu / Vusi Mzimela intersection. The programme takes into consideration the layout and dimensions of the intersection, type of control (signalised intersection in this case), the traffic flows including the percentage heavy vehicles and pedestrian movements and any other considerations that might affect the performance of the intersection. Noting that most roads are most congested and experience the highest delays in terms of travel time during the morning (AM) peak hour and afternoon (PM) peak hour. Therefore, traffic analysis are done during these typical peak traffic times to determine the level of congestion.

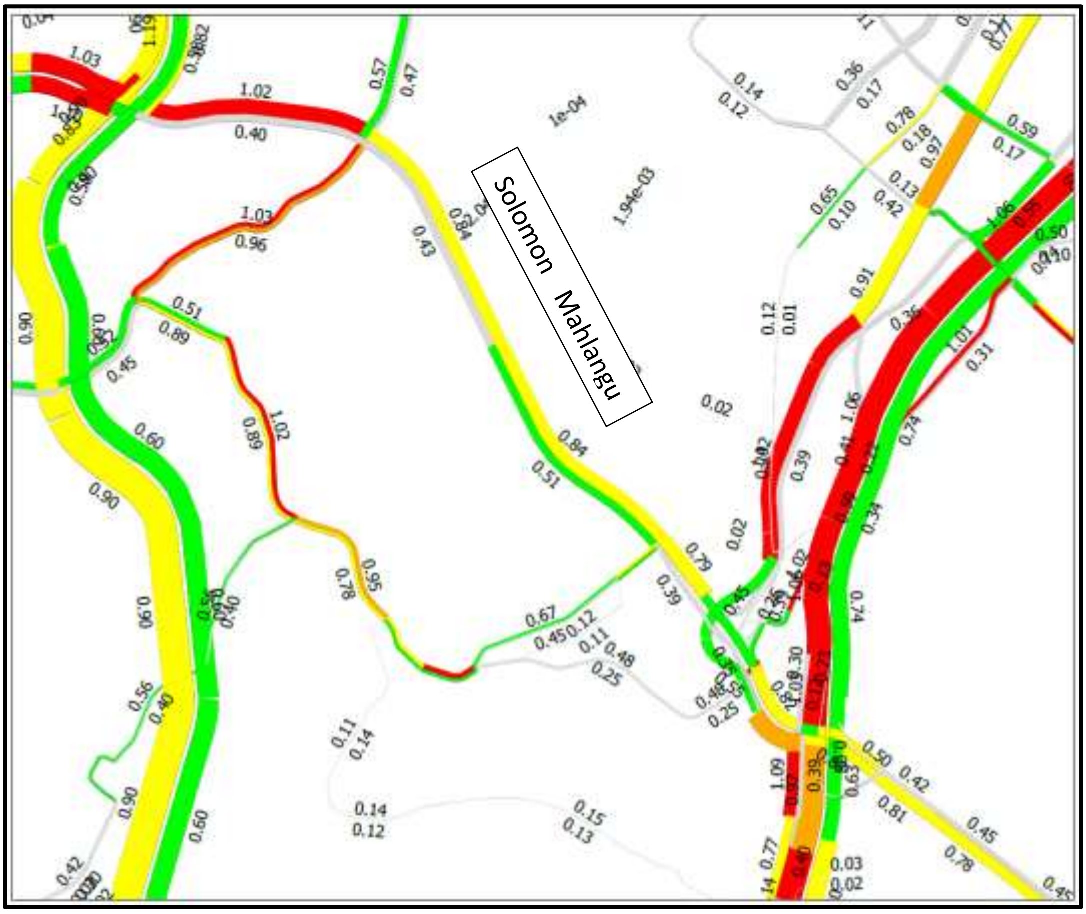


Figure 31: Existing – Volume over Capacity from EMME

The analysis periods were done for the AM peak hour and the PM peak hour on a typical weekday with the detailed output shown in appendix A. The outputs indicate that this road is currently operating at a bad Level of Service (LOS). SIDRA analysis outputs, as is illustrated in Figure 32 and Figure 33 respectively, that the main throughput of traffic in the AM and PM operates at a LOS F. (LOS A = best (free-flow) conditions, to LOS F = worst (severely congested conditions)). This congestion can be seen on site on a most typical weekday trafficked morning and afternoon peak hour periods. This west bound movement on Solomon Mahlangu (M7) gives a LOS F with a queue length distance of 925 metres from the intersection.

Site: Vusi Mzimela / Solomon Mahlango [AM-Existing]

New Site
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.
Sensitivity Analysis (Critical Gap & Follow-up Headway): Results for Parameter Scale = 100.0 %

All Movement Classes

	South	East	North	West	Intersection
LOS	C	F	F	F	F

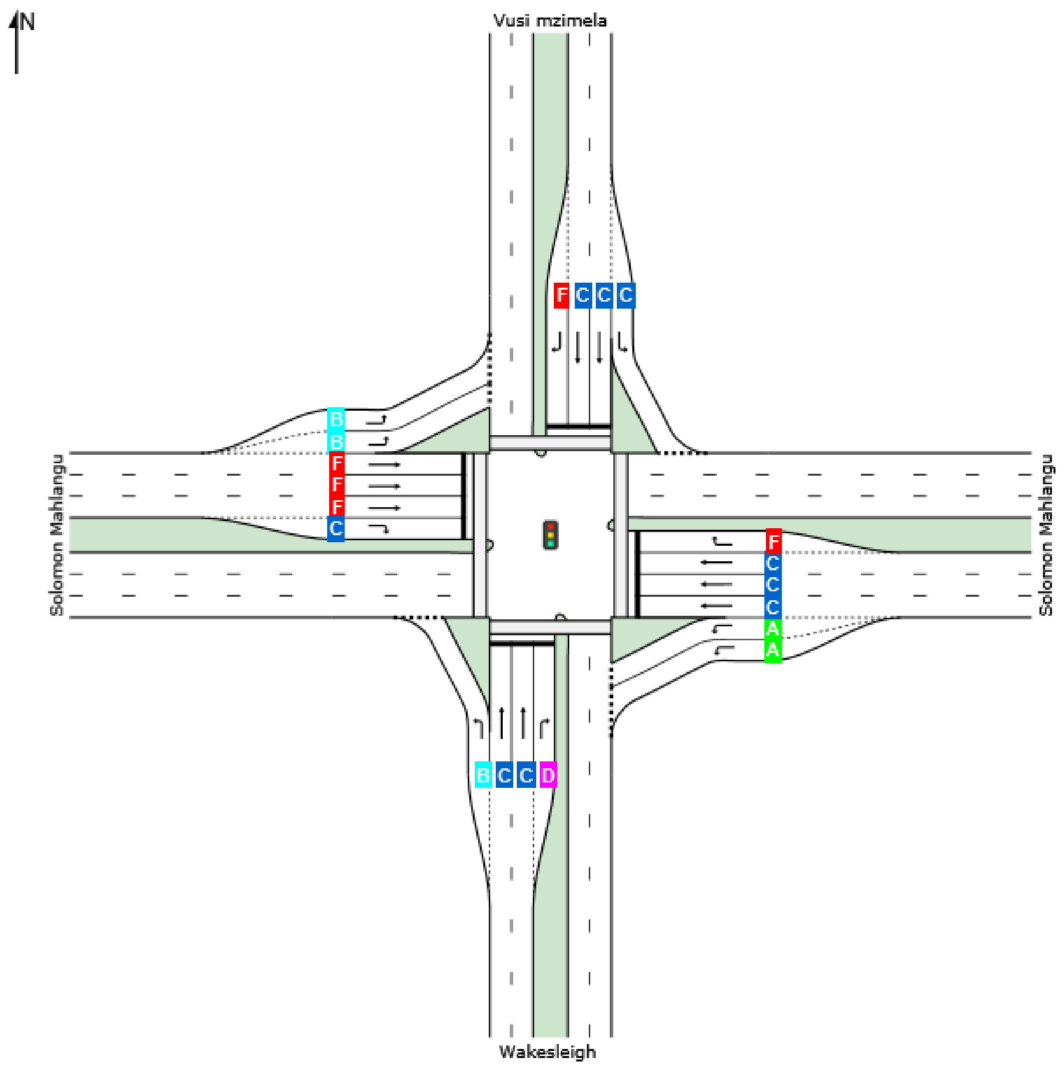


Figure 32: Existing - Vusi Mzimela and Solomon Mahlangu (M7) intersection (AM peak hour)

Site: Vusi Mzimela / Solomon Mahlango [PM-Existing]

New Site
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.
Sensitivity Analysis (Critical Gap & Follow-up Headway): Results for Parameter Scale = 115.0 %

All Movement Classes

	South	East	North	West	Intersection
LOS	C	E	D	C	D

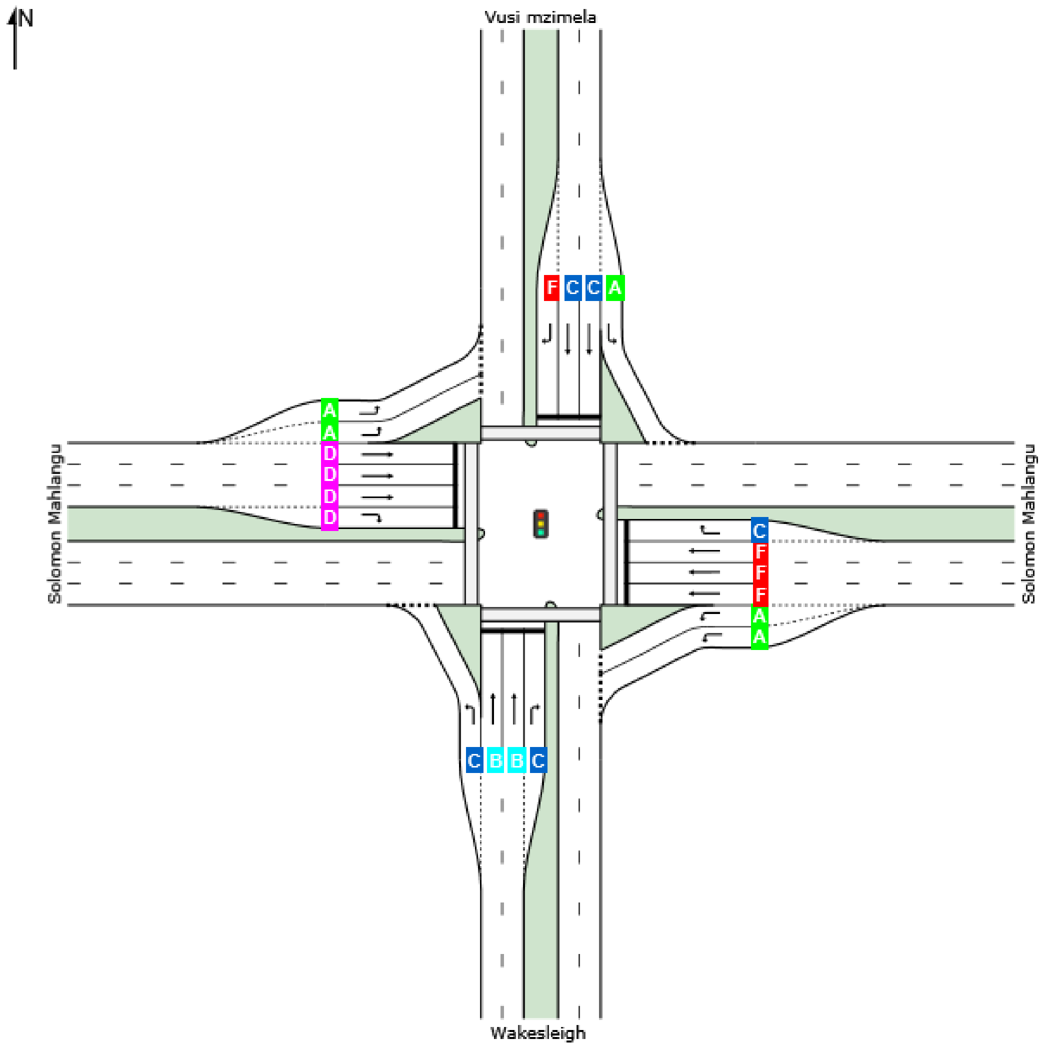


Figure 33: Existing - Vusi Mzimela and Solomon Mahlangu (M7) intersection (PM peak hour)

10.1.2. Proposed upgrades for the intersection and the M7

It is proposed that an additional lane be added in each direction on Solomon Mahlangu (M7) to reduce congestion, travel time and queue lengths. From the analysis above it is clear that sections of this road and at the intersection are currently operating at a poor Level of Service (LOS) due to various reasons such as the poor condition of the road surface, the large volumes of freight vehicles using this corridor and the large volumes of general private and public transport vehicles using this corridor. Noting that the high volume of Freight vehicle using this corridor drastically reduces the throughput of traffic through this corridor and has a significant impact in delays in travel time especially during the morning peak and evening peak traffic hours.

Due to the intersection at Vusi Mzimela and Solomon Mahlangu currently operating at a LOS F during the morning (am) peak hour and the afternoon (pm) peak hour, as well as the Solomon Mahlangu Road link operating at a poor LOS. With the aid of SIDRA intersection analysis an additional lane at the intersection of Vusi Mzimela and Solomon Mahlangu Road has been added and tested. The SIDRA analysis illustrates that the proposed improvements in terms of additional lanes show significant improvement in level of service. An improvement from LOS F to a LOS D and LOS F to a LOS B can be seen in Figure 34 and Figure 35 for the morning and afternoon peak hours respectively.

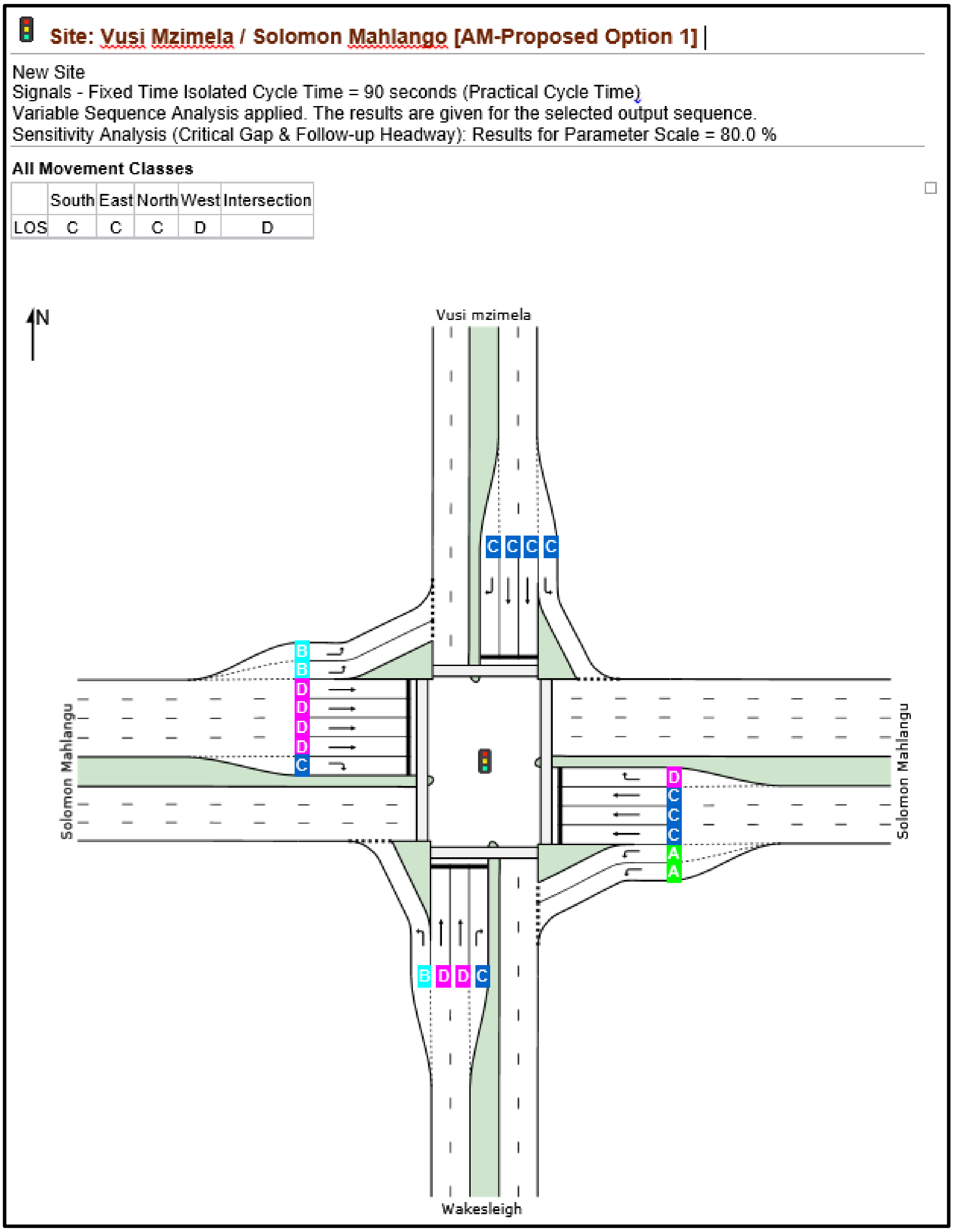


Figure 34: Proposed - Vusi Mzimela and Solomon Mahlangu (M7) intersection (AM peak hour)

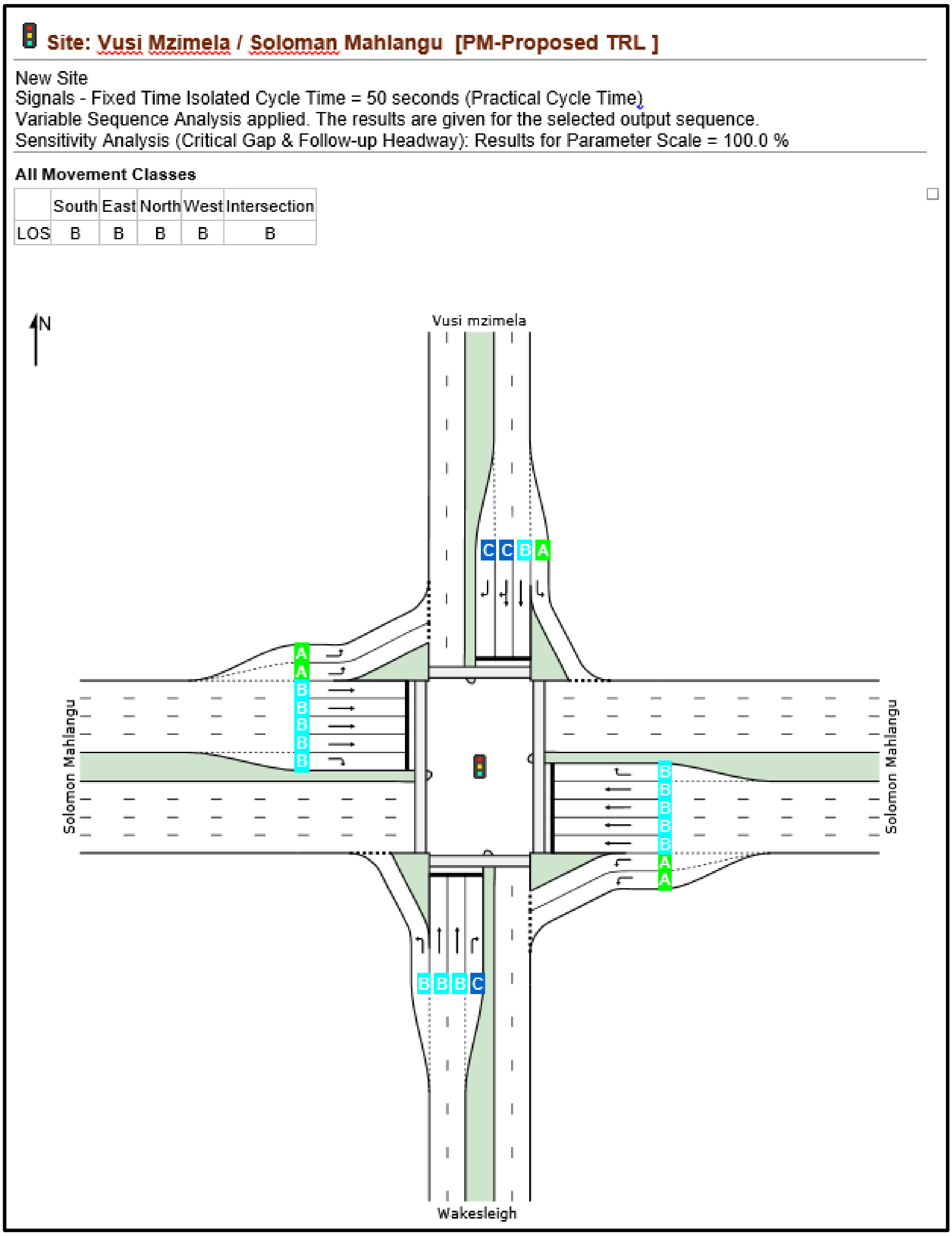


Figure 35: Proposed - Vusi Mzimela and Solomon Mahlangu (M7) intersection (PM peak hour)

This improved LOS will aid commuter traffic to travel more safely alongside freight vehicles within this corridor.

10.1.3. Conclusion

Based on the outputs shown in Figure 31 to Figure 35 from EMME and SIDRA analysis it is proposed that Solomon Mahlangu be upgrade with an additional lane in each direction, from the N2 to Titren road in the short term. Noting that the current base year is operating at a very poor LOS in both weekday peak traffic hours.

10.2. Sydney Road Upgrades

Figure 36 shows the Sydney Road / Bayhead Road (Khangela Bridge) intersection, from onsite observations this intersections experience congestion during Port peak traffic hours or when a container vessel has docked for loading and unloading of containers. Container freight vehicles back up onto Sydney Road from the left slip lane into Bayhead Road (Khangela Bridge). This congestion could be alleviated with the implementation of a remote truck stop / staging area (A-Check) with a call in system to the Port. An additional slip lane with an additional lane on Khangela Bridge and into Bayhead Road going eastbound towards the Port would also assist in preventing vehicles stacking on Sydney Road.

Figure 36: Sydney Road / Bayhead Road Intersection

10.3. South Coast Road Upgrades

There are parts of South Coast Road between Solomon Mahlangu Drive (M7) and Bayhead road that narrows down from two lanes to one lane in each direction. Figure 37 shows a satellite image of the location where South Coast Road narrows to one lane in each direction. Traffic counts conducted (on 19 June 2017) on this sections of South Coast Road illustrate that 894 vehicles approach Eel Road intersection from the South between 6:45am and 7:45am. This is fine for a two lane road but in this case for a single lane class 3 road, it fails from a LOS perspective as can be seen in Figure 38 (HCM, 2000). The maximum amount of vehicles for a single lane class 3 road is 790 for a LOS D and 840 for a LOS E. Hence, this road operates a LOS F at the parts where there is a single lane in each direction in the vicinity of 151 South Coast Road (PX Shed).

This road will need to be upgraded to two lanes in each direction from one lane in each direction for the current base year. And at the 151 South Coast Road (PX Shed) intersections this will need to be widened to 3 lanes in each direction to facilitate the turning movements.

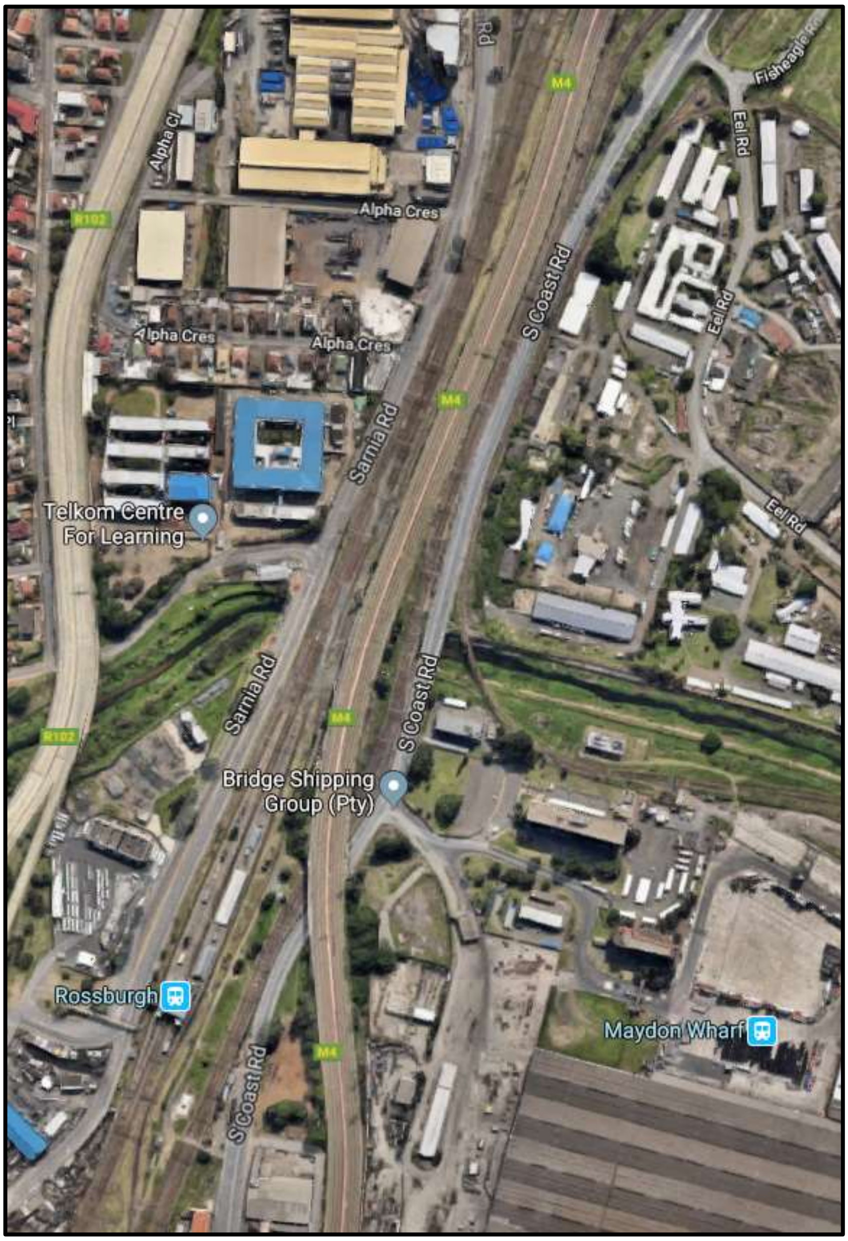


Figure 37: South Coast Road location.

EXHIBIT 10-7. EXAMPLE SERVICE VOLUMES FOR URBAN STREETS
(SEE FOOTNOTES FOR ASSUMED VALUES)

Lanes	Service Volumes (veh/h)				
	A	B	C	D	E
Class I					
1	N/A	740	920	1010	1110
2	N/A	1490	1780	1940	2120
3	N/A	2210	2580	2790	3040
4	N/A	2970	3440	3750	4060
Class II					
1	N/A	N/A	620	820	860
2	N/A	N/A	1290	1590	1650
3	N/A	N/A	1920	2280	2370
4	N/A	N/A	2620	3070	3190
Class III					
1	N/A	N/A	600	790	840
2	N/A	N/A	1250	1530	1610
3	N/A	N/A	1870	2220	2310
4	N/A	N/A	2580	2960	3080
Class IV					
1	N/A	N/A	270	690	790
2	N/A	N/A	650	1440	1520
3	N/A	N/A	1070	2110	2180
4	N/A	N/A	1510	2820	2900

Notes
N/A - not achievable given assumptions below.
This table was derived from the conditions listed in the following table.

	Class			
	I	II	III	IV
Signal density (sig/km)	0.5	2	3	6
Free-flow speed (km/h)	80	65	55	45
Cycle length (s)	110	90	80	70
Effective green ratio	0.45	0.45	0.45	0.45
Adj. sat. flow rate	1850	1800	1750	1700
Arrival type	3	4	4	5
Unit extension (s)	3	3	3	3
Initial queue	0	0	0	0
Other delay	0	0	0	0
Peak-hour factor	0.92	0.92	0.92	0.92
% lefts, % rights	10	10	10	10
Left-turn bay	Yes	Yes	Yes	Yes
Lane utilization factor	According to Exhibit 10-23, Default Lane Utilization Factors			

Figure 38: Highway Capacity Manual extract.

10.4. Upgrade of the Bayhead/South Coast Road Intersection

There are many traffic incidents in the vicinity of the Bayhead/South Coast intersection, for instance; heavy vehicle breakdowns or traffic signal failure, which aggravates the existing traffic congestion resulting in gridlock conditions which prevents access to the South Port precinct and the SDIB. These gridlock conditions, if exacerbated over a period of time, extend to the surrounding city's road network since there are no viable alternative routes to enter or exit the port apart from Bayhead Road. From AIMSUM modelling of the Bayhead/South Coast intersection, done by Aurecon in the External Traffic Study: Short Term Interventions, shows that the intersection requires some form of upgrading in order to provide more capacity for the South Coast Road northbound right-turn movement into Bayhead Road, as this movement causes high levels of congestion along South Coast Road.

The intersection upgrades were adopted from the recommendations issued in the External Traffic Study: Short Term Interventions done by Aurecon in 2015, under the South Port Roads Combined Project. This recommended configuration on Bayhead Road, traversing northbound, consists of two right-turn lanes, two through lanes, and a new left-turn slip lane. As the existing median and lane-drop at Bayhead Road is sufficient to accommodate the proposed lane configuration, the only addition to Bayhead Road is a 3.5 m lane drop consisting of a 1:15 taper, 75 m stacking length, and a slip lane into South Coast Road if traversing northbound along Bayhead Road. The new slip lane will tie-in with the two 3.5 m lanes on South Coast Road in a south-westerly direction. A depiction of the recommended configuration can be seen in Figure 39.

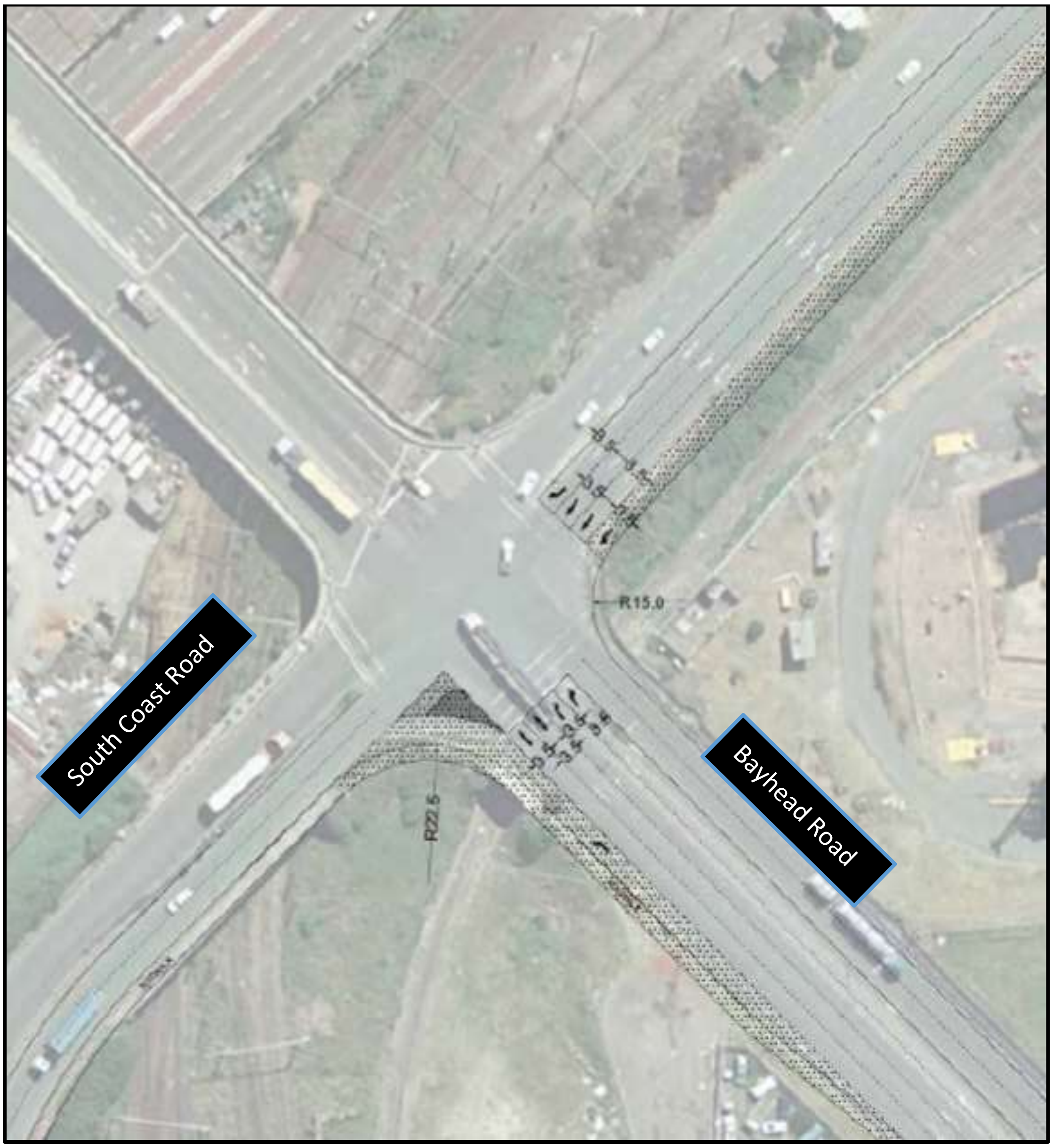


Figure 39 Bayhead / South Coast Road Intersection (Aurecon, 2015)

10.5. Bayhead and Langeberg Roads

According to the External Traffic Study: Medium to Long Term Interventions done by Aurecon in 2015, it is recommended that Bayhead Road must be upgraded to three lanes in each direction. With Bayhead Road already experiencing traffic congestion, this technical report recommends that an additional inbound lane be constructed, thus Bayhead Road being upgraded to three lanes inbound to the Port.

The Bayhead Road and Langeberg Road intersection have been recommended by the 'External Traffic Study: Short Term Interventions' commissioned by TNPA in 2015 to have two dedicated freight lanes for the exclusive use of Durban Container Terminal (DCT) heavy vehicles. These lanes are provided in Bayhead Road as two left-turn free flow lanes into Langeberg Road and are shown in Figure 40. These dedicated freight lanes will then provide stacking space/queuing length apart from the normal traffic lanes in Bayhead Road and Langeberg Road such that if there is a system or operational problem in the DCT queue, back up will not grid lock the Bayhead Road and Langeberg Road intersection, effectively limiting the traffic throughput of the port. Furthermore, if there is a breakdown in the normal traffic lanes where the dedicated freight lanes are provided, then the container traffic is not affected and additionally if there is a breakdown in the dedicated freight lane then the general traffic is not affected.

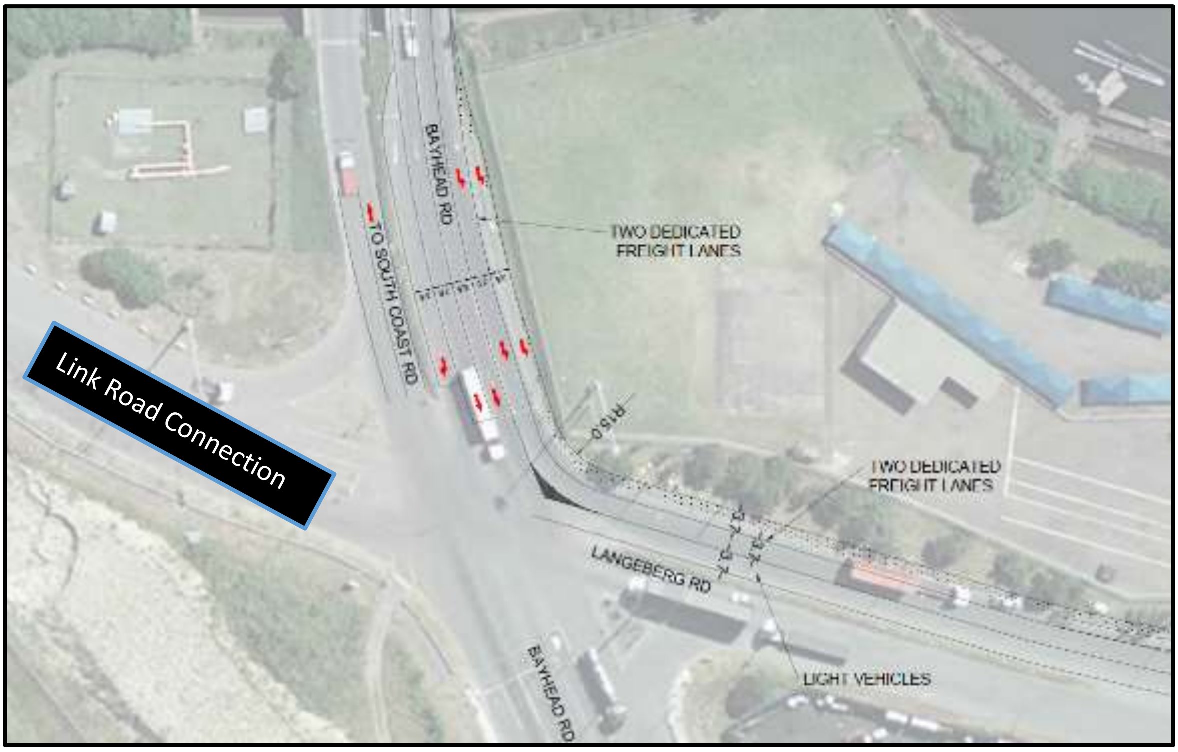


Figure 40 Bayhead & Langeberg Roads Intersection Upgrade (Aurecon, 2015)

10.6. Langeberg and Seafarers Roads

Additionally to the Bayhead Langeberg Road intersection upgrade, the External Traffic Study: Medium to Long Term Interventions also recommends that Seafarers Road (previously mentioned in chapter 2.1.3) be upgraded to a three lane road, with two lanes inbound towards the current A-check and a single dedicated exit lane. This will provide additional potential stacking of freight vehicles that are delayed when entering the port/A-check facility. The associated Langeberg Seafarers Road intersection should also be upgraded in order to accommodate the two lanes entering the A-check. This recommended upgrade in shown in Figure 41, and should be done in conjunction with the upgrades mentioned in chapter 10.5, above.

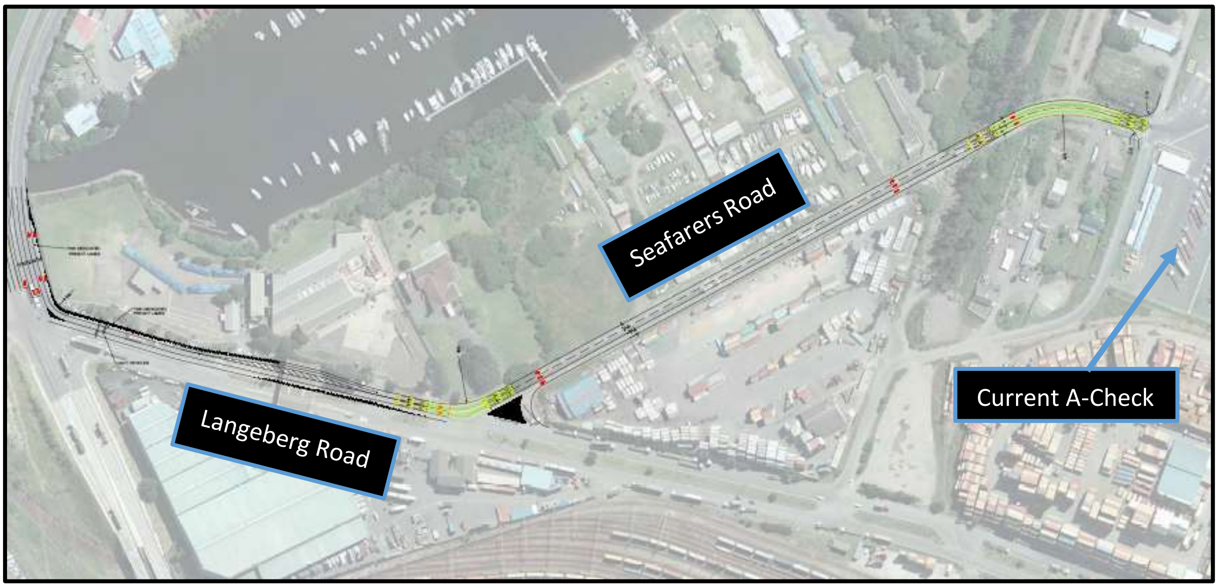


Figure 41: Langeberg Seafarers Road intersection

10.7. Conclusion Phase Zero

There are various road and intersection upgrades that are required in the current base year along major corridors leading into and out of the Port of Durban. These road upgrades entail additional lanes along the Solomon Mahlangu Road (M7) be upgrade with an additional lane in each direction, Sydney road and Bayhead Road intersection upgrade, South Coast and Bayhead Road intersection upgrade, South Coast Road upgrade between the Solomon Mahlangu Road (M7) and Bayhead Road, Bayhead and Langeberg Road intersection upgrades and Bayhead Road upgrades.

If a remote truck staging area (A-Check) were to be created at a location along the current freight corridor, where heavy vehicles could be managed and called in using smart port-city technology, these road upgrades will experience additional decongestion and general traffic benefits. As truck staging areas will prevent heavy vehicles from stacking and parking along Langeberg Road, Bayhead Road, Sydney Road and South Coast Road to access the port.

11. Second Access to the Container Terminal - Section One

Section One (shown in Figure 29) aims at addressing connectivity from the Port of Durban to the SDIB, as well as any associated truck staging/stopping areas. This was done in order to investigate the most feasible route alignment that would serve as a second access route into and out of the Port. Five options were explored and are discussed in this chapter. The study area and associated constraints are also described as a point of departure for the investigated routes. The investigated routes are proceeded by a table describing the negatives, positives, lengths and costs associated with each of the options.

11.1. Study Area and Constraints

The study area for Section One of the routes is the south Clairwood/Bayhead areas that avoid the Clairwood and Bluff Residential areas, and is shown in Figure 42 below. A particular focus for the study was to link the Bayhead/Langeberg Road intersection to the SDIB. This was done by exploring routes that terminated at Chamberlain/Bluff Road intersection or the South African National Defence Force (SANDF) site identified as a possible truck staging area (A-Check). Identified potential truck staging areas within the study area, demarcated 1 and 2, are detailed further in the report in chapter 11.2.

Figure 42: Study Area for Section One

The area under investigation has a number of constraints and obstacles that needed to be accounted for, these include the following:

- Steep slopes towards the Bluff area
- Clairwood community north of the Amanzimyama Canal
- National Multi-Product Pipeline or NMPP (shown in red in Figure 43 below)
- Rail servitudes, owned by Transnet Freight Rail (TFR) and Passenger Rail Agency of South Africa (PRASA)

Figure 43: NMPP (red) and Water Reticulation Network

11.1.1. Critical Constraint

The most critical of all constraints of the study area would be a railway line owned by Transnet Freight Rail shown in red in Figure 44. This line traverses near the Bayhead/Langeberg Road intersection and is used for rail access between the Kings Rest rail yard and the national rail corridors, at the western end of Bayhead Road. For a feasible road solution to intersect with Bayhead Langeberg Road intersection at grade, as per the engineering geometric requirements outlined in chapter 7, it is necessary to remove this rail line in order to form a second access into the Port. Figure 44 shows the proposed route direction in blue and its connection to Bayhead Langeberg Road intersection.

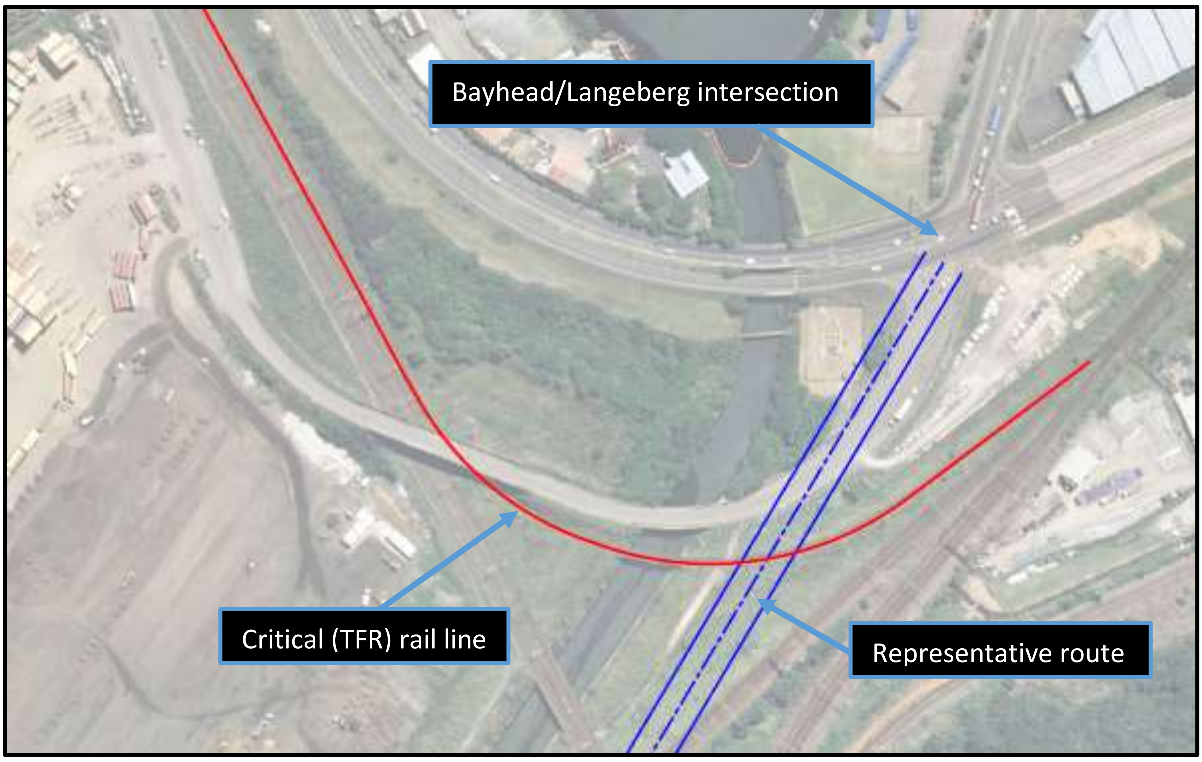


Figure 44: Critical TFR rail line

11.2. Proposed Truck Staging Area for Phase One

Two possible truck stops/ staging areas (A-Check) have been identified as part of this study. Truck staging facilities are required for the heavy road vehicles which cause excessive traffic and vehicle congestion. The identified sites include:

- The old SANDF site:
  - Owned by: eThekwini Municipality
  - Located: Mobeni East
  - Size: 9,1ha
  - Approximately can safely accommodate ±560 trucks
- Wentworth land/ yard:
  - Owned by: Transnet Freight Rail
  - Located: Wentworth (South of Clairwood)
  - Size : 14,9ha
  - Approximately can safely accommodate ±760 trucks

Figure 45 illustrates the locations of the two truck staging/stop sites describe, in relation to the Bayhead Langeberg Road intersection.

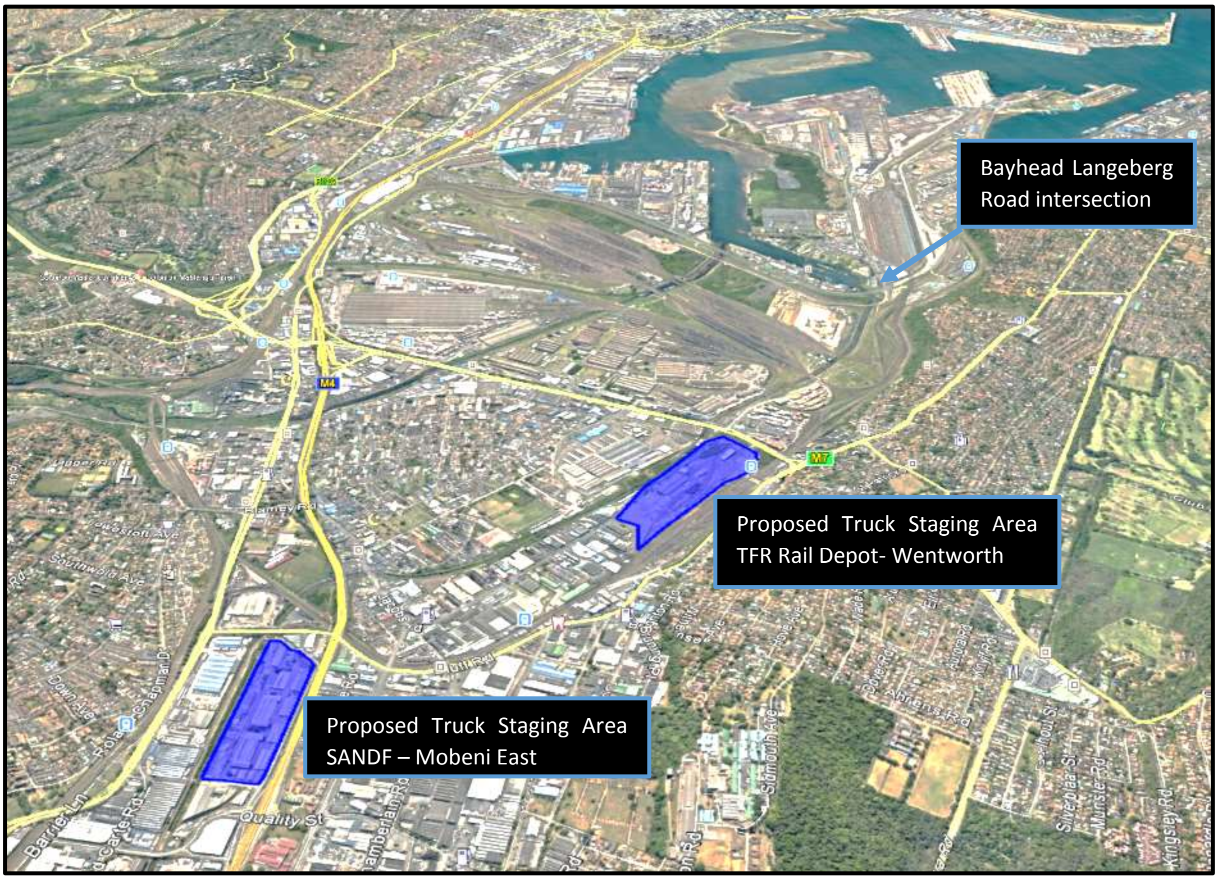


Figure 45: Proposed Truck Staging Sites – SANDF and TRF Rail Depot

11.3. Section One - Option One:

Description: Section One - Option One, illustrated in Figure 46, commences at the Bayhead Road / Langeberg Road intersection within the Bayhead Precinct of the Port. This road traverses towards the SANDF site via south east of Clairwood. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve.

The alignment of Option One runs south of the Amanzimnyama Canal, on structure over Bayhead railway line, for approximately 50% of its length until passing over Solomon Mahlangu Drive (M7). Thereafter, the alignment drops down to traverse at grade on the northern side of the Amanzimnyama Canal. The road traverses over Jacobs Road, as well as the M4 via a heightened structure, to finally drop beneath Bluff Road at grade to end at the SANDF site shown in blue outline.

Proximity: Close to the Amanzimnyama Canal.

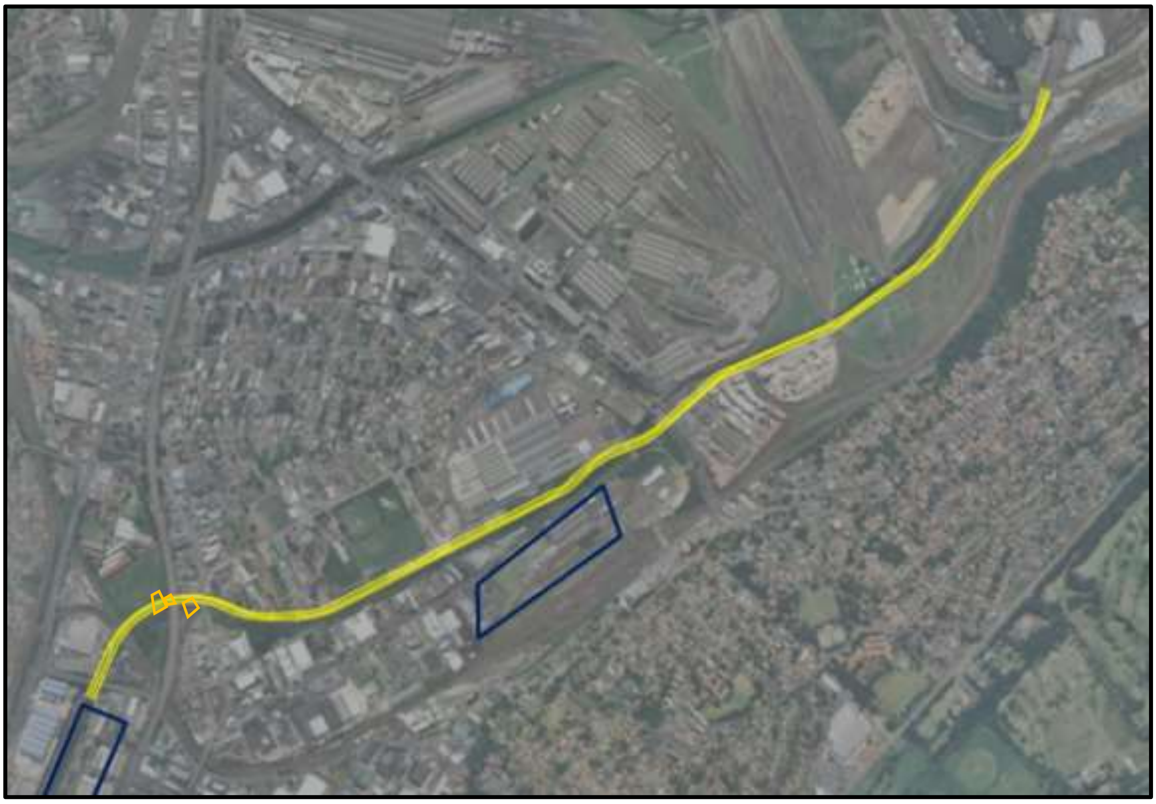


Figure 46: Section One - Option One - Route Alignment

Negatives for this option:	Positives for this option:	General
Structures over rail within the Bayhead area and major structures over the M7 and M4.	Direct route. I.e. shortest distance.	Route Length = 3.9Km
NMPP/National Oil Pipeline conflicts along the Amanzimyama Canal. Poses issues when piling for structures.	Connects well with potential staging areas at either of the two proposed locations.	Cost est. = R 2,01 B
Close proximity to the Clairwood Secondary School grounds.	Good transport / traffic demand along the route.	

Expropriation required within the Clairwood area.		

The route options one to four in section one display a very similar traffic demand when modelled using the EMME macroscopic model. As described in Chapter 6 the IFLS study developed three freight matrices for the base year as well as for each of the projected years. These were used as an input into the EMME model base year and these were based on the type of freight vehicles surveyed, namely: articulated trucks, container trucks and delivery trucks. The output from EMME for this route tested is illustrated in Figure 47. This route was modelled with partial connections to Solomon Mahlangu Drive (M7). Figure 47 illustrates the traffic demand of Freight vehicles for the year 2035. A two lane road was modelled and three bands of freight vehicles were attracted to the corridor. Summing up to 835 and 841 Freight vehicles in Passenger Car Units (PCU). Noting that each Freight vehicle was given a PCU of 2 hence these will need to be divided by 2 to get actual freight vehicles. This equates to 418 and 421 actual container freight vehicles. This was modelled without diverting existing Port traffic to a potential truck staging areas (or remote A-Check). The volume of heavy vehicles will only increase drastically once a staging area (remote A-Check) is situated along this potential freight route. Therefore, this route will need to connect to the truck staging area proposed in this area.

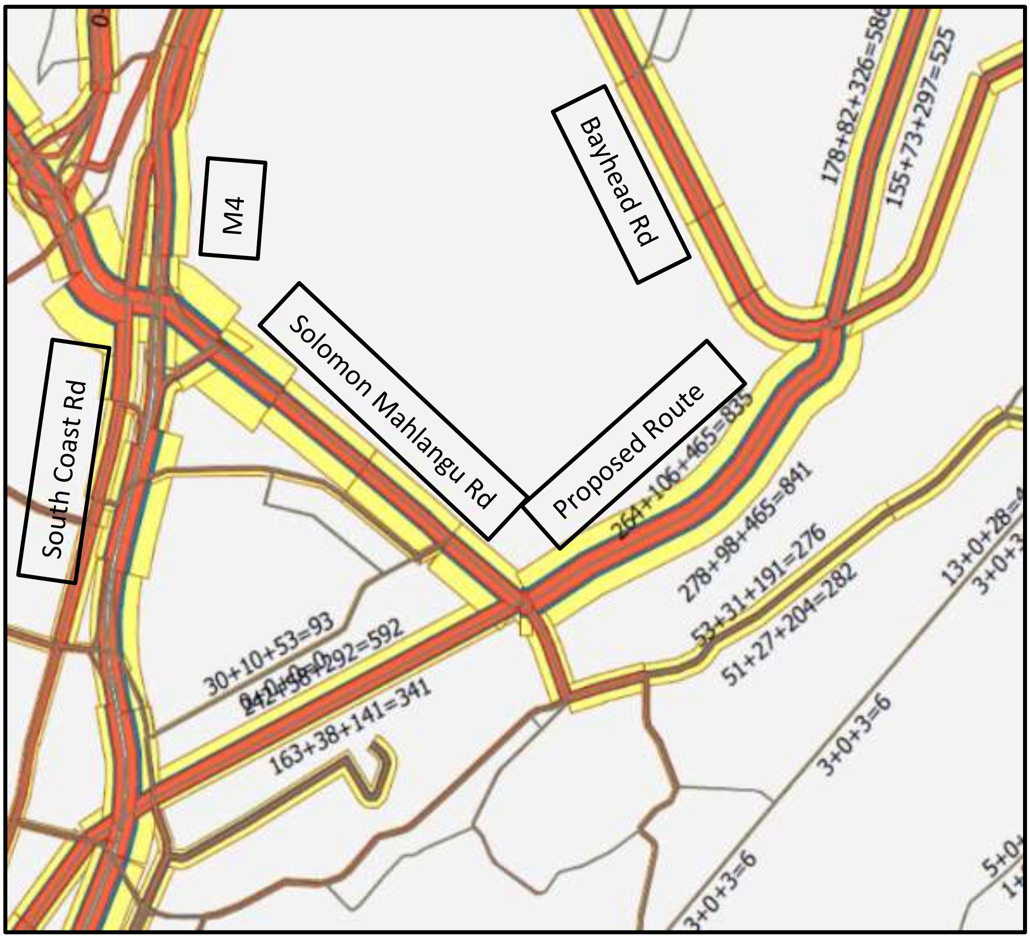


Figure 47: Traffic Demand along routes One to Four.

11.4. Section One - Option Two:

<u>Description:</u> Section One - Option Two, illustrated in Figure 48, commences at the Bayhead Road and Langeberg Road intersection within the Bayhead Precinct of the Port. This road traverses towards the SANDF site via the Bayhead area. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve.

The alignment of Option Two runs south of the Amanzimnyama Canal, at grade, for approximately 50% of its length in the Bayhead Area, until passing under the M7 via a constructed tunnel. Continuing at grade the route circumnavigates the Wentworth rail yard, until traversing over the rail onto the Bluff Road via a heightened structure, and finally lining up at grade with Bluff Road. An exit lane connecting the SANDF site and Bluff Road is incorporated in this option. The exit lane would utilise a current rail siding (owned by eThekwini municipality) that traverses underneath Bluff Road. This road would serve as a direct route onto the second access road, port bound from the potential SANDF staging site.

<u>Proximity:</u> Close to the Amanzimnyama Canal and east where the rail lines at the Southern-Eastern end of Bayhead need to be removed and realigned.

Figure 48: Section One - Option Two - Route Alignment

Negatives for this option:	Positives for this option:	General
Underpass under the M7 via a tunnel.	Less structures.	Route Length = 3,9Km
Structure over rail to Bluff Road between Wentworth and Jacobs stations.	Connects well with potential staging areas.	Rail cost estimation: R 0.7 B
Rail rationalisation required by Transnet (TFR).	Good transport / traffic demand along the route.	Cost estimation: R 1,05 B

Expropriation required (5 sites) for route to tie into Bluff Road. 		Total Cost est.: R 1,75 B

11.5. Section One - Option Three:

Description: Section One - Option Three, illustrated in Figure 49, commences at the Bayhead Road and Langeberg Road intersection within the Bayhead Precinct of the Port. The road traverses towards the Chamberlain/Bluff Road intersection. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve.

The alignment of Option Three runs south of the Amanzimnyama Canal at grade for approximately half of its length in the Bayhead Area, until passing under the M7 Bridge via a constructed tunnel. Continuing at grade, the route circumnavigates part of the Wentworth rail yard, until traversing above the rail via a structure for approximately 280 metres, and finally lining up at grade at Chamberlain/Bluff Road intersection. Similar to Option Two (chapter 11.4), an exit lane connecting the SANDF site and Bluff Road is incorporated in this option. The exit lane would utilise a current rail siding (owned by eThekwini municipality) that traverses underneath Bluff Road. This road would serve as a direct route onto the second access road, port bound from the potential SANDF staging site.

Proximity: Close to the Amanzimnyama Canal and east where the rail lines need to be removed.

Figure 49: Section One - Option Three - Route Alignment

Negatives for this option:	Positives for this option:	General
Underpass under the M7.	Less structures.	Route Length = 4,15Km
Structure over rail to Bluff Road.	Connects well with potential staging areas.	Rail cost estimation: R 0.7 B
Rail rationalisation required.	Very little Expropriation required.	Cost estimation: R 1.27 B
		Total Cost est.: R 1,97 B

11.6. Section One - Option Four:

Description: Section One - Option Four, illustrated in Figure 50, is a combination of Option One and Option Three alignments. The route commences at the Bayhead Road and Langeberg Road intersection, within the Bayhead Precinct of the Port and ends at the SANDF site, within the Mobeni East district. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve.

The alignment of Option Four runs south of the Amanzimnyama Canal, on structure over railway in the Bayhead Area, for approximately 50% of its length until passing the M7 overhead. Thereafter the alignment drops down to grade and travels south towards Jacob's Station through the Transnet Diesel Depot Site, near Wentworth Rail yard, traversing over the rail via a structure, and finally lining up at grade at Chamberlain/Bluff Road intersection. . Similar to Option Two (chapter 11.4), an exit lane connecting the SANDF site and Bluff Road is incorporated in this option. The exit lane would utilise a current rail siding (owned by eThekwini municipality) that traverses underneath Bluff Road. This road would serve as a direct route onto the second access road, port bound from the potential SANDF staging site.

Proximity: Close to the Amanzimnyama Canal then onto the Bluff Road.

Figure 50: Section One - Option Four - Route Alignment

Negatives for this option:	Positives for this option:	General
Structures over rail within the Bayhead area and the M7.	Connects well with potential staging areas.	Route Length = 4,1Km
Structure over rail between Jacobs and Wentworth Stations	Good transport / traffic demand along the route.	Total Cost est.: R 2.06 B
Expropriation required.		

11.7. Section One - Option Five:

Description: Section One - Option Five, illustrated in Figure 51, was investigated as an alignment since it was proposed from previous studies and therefore used for comparisons.

The alignment commences at the Bayhead Road and Langeberg Road intersection, within the Bayhead Precinct of the Port, turns towards and traverses along the Umhlatuzana Canal through the Clairwood residential area and connects to the M4 via a structural overhead interchange. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve. The alignment traverses at grade for the first 15% of the route, thereafter, the route is to be suspended on a mega structure over the railway within the Bayhead area.

Proximity: Close to the Umhlatuzana Canal.

Figure 51: Section One - Option Five - Route Alignment

Negatives for this option:	Positives for this option:	General
Super-structures over rail.	No rail interference within the Bayhead area	Route Length = 2.483Km
Structure over M7.		Cost estimation: R 1,44 B
Does not connect well with potential staging areas.		
Expropriation required adjacent to the canal.		
Infringing Clairwood		
Low traffic demand		

Route option five had a much lower traffic demand when modelled directly to the N2, (close to the NPC site), with some connections along the way. Without connection to the SDIB, the proposed route showed significantly less traffic demand than a route modelled with SDIB connection. Option five modelled without connection to SDIB as a two lane road was modelled and three bands of freight vehicles were attracted to the corridor. Summing up to 345 and 348 freight vehicles in PCU, as illustrated in Figure 52. This equates to 173 and 174 actual container freight vehicles in each direction.

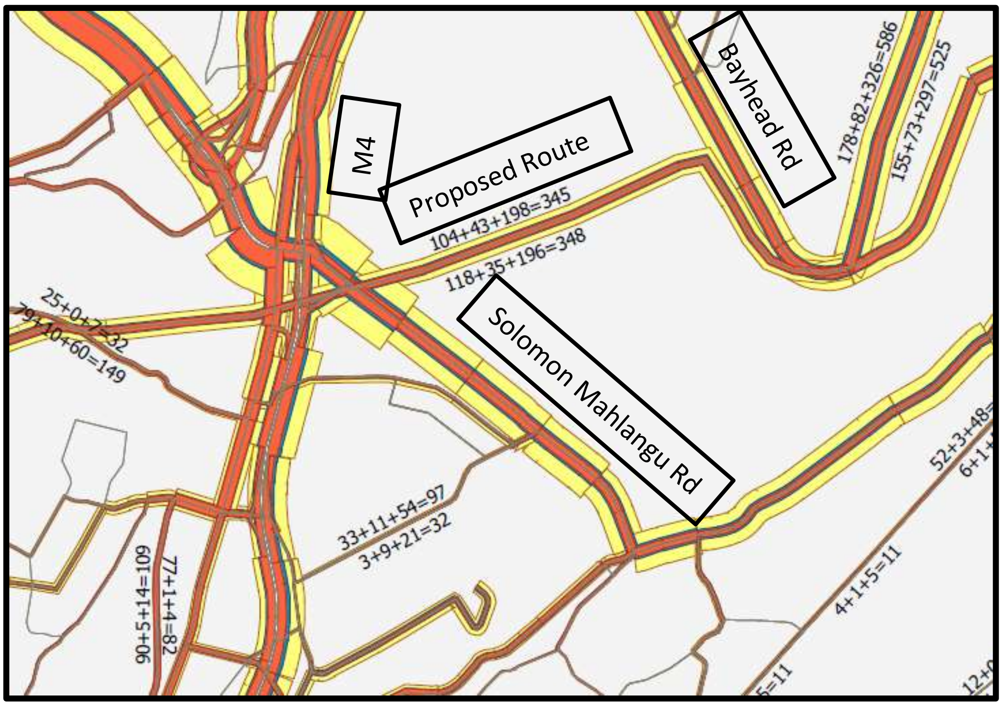


Figure 52: Traffic Demand along route Option Five (without SDIB connection)

Therefore, the option of modelling this route to intersect back to the SDIB area showed much more traffic demand. Figure 53 illustrates the traffic demand of Freight vehicles for the year 2035. A two lane road was modelled and three bands of freight vehicles were attracted to the corridor. Summing up to 634 and 477 freight vehicles in PCU, as illustrated in Figure 53. This equates to 317 and 239 actual container freight vehicles. The traffic demand of this route is much lower than that previously modelled for route in this chapter for options one to four. Additionally it should be noted that this option was modelled without diverting existing Port traffic to a potential truck staging areas.

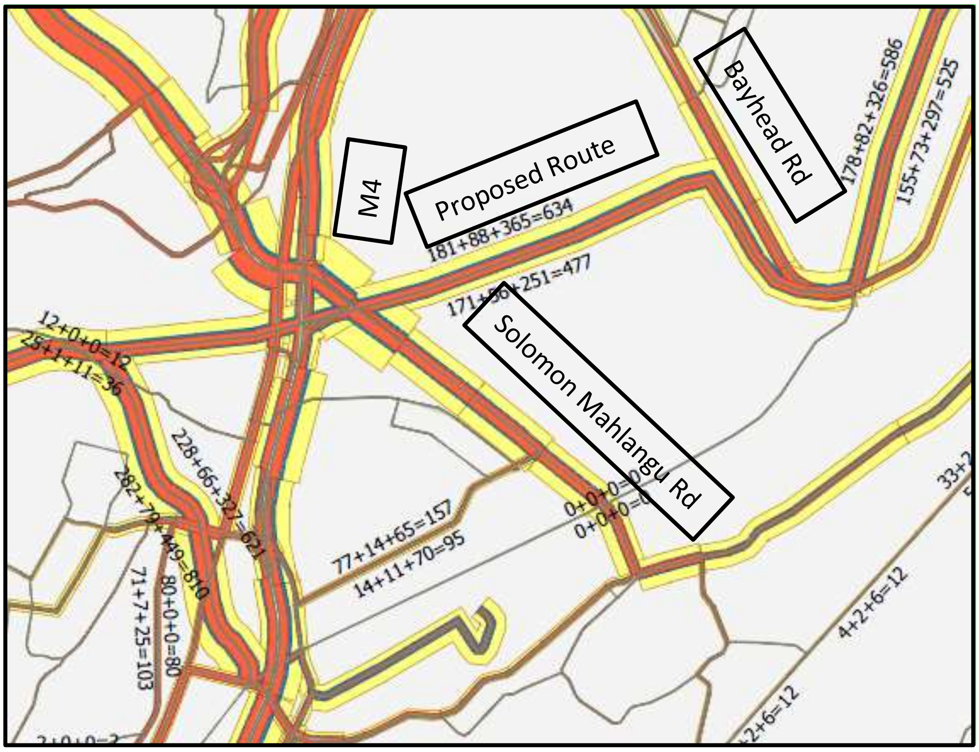


Figure 53: Traffic Demand along route Option Five (with SDIB connection).

11.8. Conclusion of Section One

For Section One of the proposed routes each option was compared using the MCA as described in Chapter 9.2. These fields of comparison were estimated road costs, environmental impacts, transport viability and social impacts. Each of these fields were given equal weighting of 25% each. The routes were individually scored and the results are illustrated in Table 10.

Table 10: Multi-criteria Analysis for Section One

Name	Option One	Option Two	Option Three	Option Four	Option Five
Cost	13	16	13	12	20
Transport	20	20	20	20	10
Environmental	20	20	20	20	10
Social	10	17	20	20	10
Total Score	**63**	**73**	**73**	**72**	**50**

The outcome of this comparison showed that Option 2, 3 and 4 proved the most feasible options. Noting that expropriation costs were not taken into consideration for Option 2 (described in Chapter 11.4).

Neither of options 3 and 4 have expropriation costs (unlike Option 2), they are located on Transnet/Municipal owned land, the environment is not affected as they mainly traverse over areas where there are existing transport services/servitudes, and finally they have virtually no impact on social communities.

Option 3, however, requires the Bayhead rail to be realigned. Particularly the southern rail loops of Bayhead Rail yard will need to be realigned in order for any road to be built at grade within the Bayhead area and this associated cost for the realignment of the rail was estimated to be R700 million, using the rail costing methodology as described in Chapter 9.1.2. This can be seen from a vertical point of view in Figure 70 of the Appendices in Chapter 15.2. The initial section of the vertical alignment, from the left, shows how the road will increase in height from grade (by the Bayhead Langeberg Road intersection) in order to allow a rail underpass for the realigned rail. After this underpass it then falls back down to traverse at grade for the majority of the route. This option may prove beneficial for all stakeholders, with the re-rationalisation of the Bayhead Rail yard and the associated rail network, resulting in a more efficient rail network. This would promote the use of rail, therefore increasing the modal share of rail for Transnet, alleviating freight traffic on the already congested road network.

If the rail isn't realigned, Option 4 will become the only feasible route. From the vertical alignment of Option 4, depicted in Figure 71 of the Appendices in Chapter 15.2, it can be seen that an extensively long structure will be needed, traversing from Bayhead Langeberg Road intersection until over Solomon Mahlangu (M7), in order to navigate over this rail. This can be exacerbating on the costs associated with the design and construction of this route, notably owing to the difficulty in construction that will be experienced due to clashes with constraints such as the NMPP, as mentioned in Chapter 11.1.

However, as previously mentioned in Chapter 11.1.1, the critical constraint of any feasible second access route would require the rail line (depicted in Figure 44) to be removed, such that a second access route can be constructed to line up with the Bayhead Langeberg Road intersection at grade. Failure to remove and realign the before mentioned rail would deem any route, destined to be a second access into the Port, unfeasible.

Additionally, the proposed truck staging areas (A-Check) will need to be confirmed in a future exercise for both the Phase 0 current freight corridor and the future Phase 1 second access to the Durban Container Terminal, as this truck staging area will improve port efficiency and operations, while making the new route more attractive to freight traffic.

Finally, several previous studies have concluded that a second access into the Port is necessary, from both a traffic congestion as well as a national strategic point of view. The outcomes of this study, and proceeding project/s can result in an optimised and efficient Port system. This is not limited to only the traffic aspect, but also port operations. The rationalisation of all Port activities and operations can result in more efficient rail use, resulting in higher rail modal share, port call-in and freight vehicle processing efficiency, therefore resulting in higher through put of the Port increasing port revenues, and finally stakeholder satisfaction which would promote the use of the Port of Durban.

12. Section Two

Section Two, depicted in Figure 29, was aimed at addressing connectivity from the Section One alignments to the N2, as well as any associated proposed truck staging/stopping areas. Eight options were explored and can be seen in this chapter. The study area and associated constraints is also described as a preamble to the investigated routes.

12.1. Study Area and Constraints

The study area for the Section Two routes is the Mobeni East and Mobeni areas of the SDIB, and is shown in Figure 54 below. Particular focus was to ensure that Section One routes, connected to Section Two, forming a complete road network that will alleviate traffic congestion in the surrounding regions, as well as promote traffic demand on the proposed routes. This was done by ensuring that connection to the N3, the industrial district of Mobeni and the potential truck staging area/Chamberlain Road were achieved, thus forming a complete route from the N3 to the Port.

Eight routes were explored in this section and is discussed. The investigated routes are proceeded by a table describing the negatives, positives, lengths and costs associated with each of the options.

Figure 54: Study Area for Section Two

The area under investigation has a number of constraints and obstacles that needed to be accounted for, these include the following:

- Limited land area for the construction of new roads (compact businesses and warehouses)
- Existing traffic congestion on South Coast Road and Quality Street

- Rail servitudes separating Mobeni East and Mobeni
- Significant environmentally sensitive area on the old Race Course (Shown red in Figure 54 above)
- M4 traverses through the study area

12.2. Section Two - Option One:

Description: Section Two Option One, illustrated in Figure 55, commences from Lerwick Road, at the north corner of the old Clairwood Racecourse within Mobeni, and terminates at the South Coast Road and Grimsby Road intersection. The route connects to Section One options using existing road infrastructure, namely Lerwick Road and Chamberlain Road. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve. The routes traverses at grade for the first 60% of its length from Lerwick Road across the old Clairwood Racecourse. It then increases in height onto a structure, traversing over the rail sidings with a clearance of 6.5 metres, to line up at grade with the South Coast/Grimsby Roads intersection. An additional connection to the potential truck staging site, along the Amanzimyama Canal, can be achieved as part of this route alignment. It must be noted that this option traverses over the environmental offset within the old Clairwood Racecourse, as described in chapter 12.1 and depicted on Figure 54.

Proximity: Mobeni east crossing over the old Clairwood Racecourse. At grade intersection at Grimsby / South Coast Road.

Figure 55: Section Two - Option One - Route Alignment

Negatives for this option:	Positives for this option:	General
Structures over rail.	Shortest Route	Route Length = 3.06 Km (6,5 Km)
Section of route in close proximity to environmentally sensitive area.	Low cost	Cost estimation: R 415 M

Removal of rail sidings	Connects well with staging areas	Cost estimation (incl. canal): R 527 M
NMPP clash over the Amanzimyama canal.	Little expropriation. (rail sidings and building near Lerwick Road))	Total Route Cost: R 2.5 B

As previously modelled for section one in Chapter 11, a similar modelling process was done to model freight traffic using EMME. A route to connect the SDIB and the National corrdor via Grimbsy / Higgonson Road interchange was tested with a two lane carriegweay capacity roadway. With truck stops and truck staging areas situated in the SDIB, these protential routes become more feasible from a traffic demand perspective.

Section two route options one to four are very similar in alignment and therefore demonstrate very similar traffic demand when modelled using the EMME macroscopic model. Figure 56 shows this heavy vehicle traffic demand, with 835 and 841 Freight vehicles in PCU along this corridor. This equates to 418 and 421 actual container freight vehicles going into and out of the port in the morning peak hour.

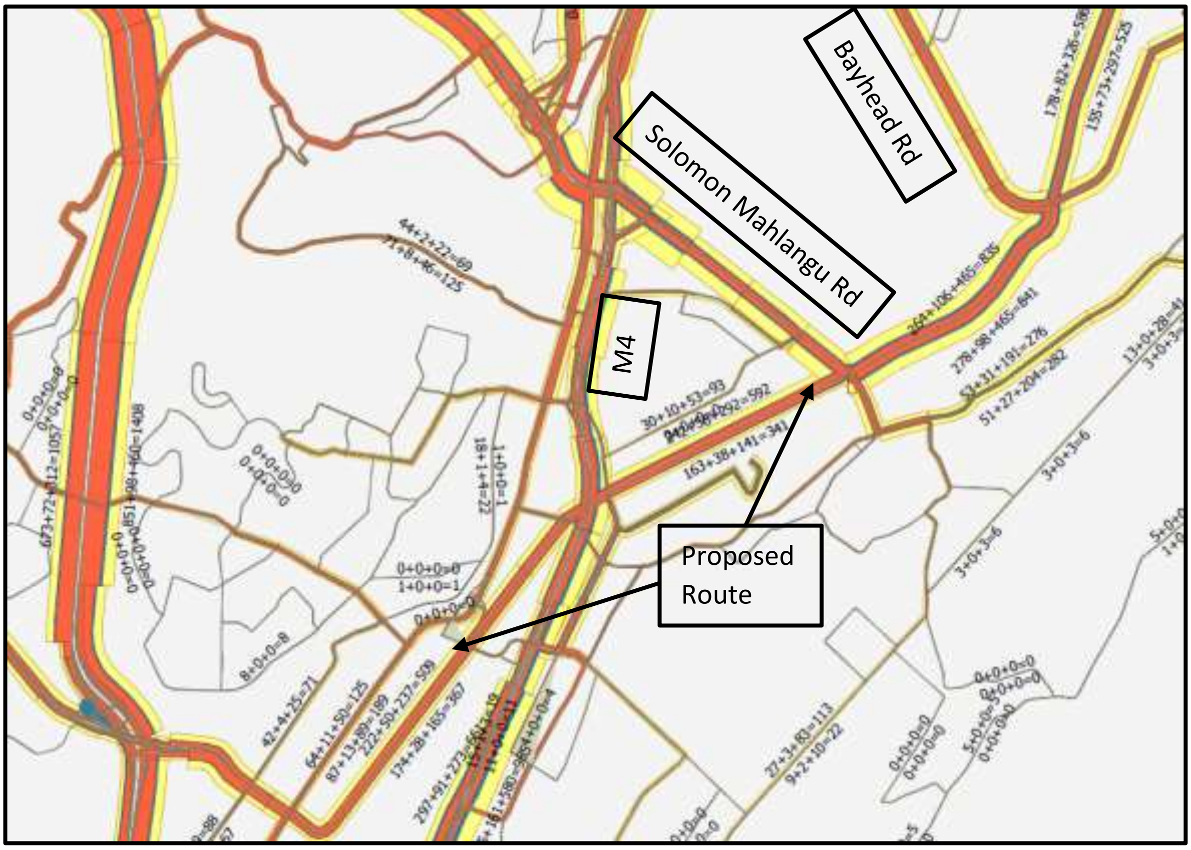


Figure 56: Traffic Demand along routes One to Four.

12.3. Section Two - Option Two:

Description: Section Two Option Two, illustrated in Figure 57, commences from Lerwick Road, at the north corner of the old Clairwood Racecourse within Mobeni, and terminates along Grimsby Road. The route connects to Section One options using existing road infrastructure, namely Lerwick Road and Chamberlain Road. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve. The route traverses at grade for the first 65% of its length, commencing from Lerwick Road and traversing across the old Clairwood Racecourse in a westerly direction. It then increases in height onto a structure, traversing over the rail sidings with a 6.5 metre clearance (with no rail removal necessary), and connecting at grade to Grimsby Road. This route utilises a large H-bridge structure forming an elevated intersection above South Coast Road, which connects South Coast and Grimsby Roads. Similar to Section Two Option One, an additional connection to the potential truck staging site, along the Amanzimyama Canal, can be achieved as part of this route alignment. It must be noted that this option traverses over the environmental offset within the old Clairwood Racecourse, as described in chapter 12.1 and depicted on Figure 54.

Proximity: Mobeni east crossing over the old Clairwood Racecourse. Structure over South Coast Road and adjacent rail lines.

Figure 57: Section Two - Option Two - Route Alignment

Negatives for this option:	Positives for this option:	General
Structures over rail.	One of the shorter Routes	Route Length = 3.08 Km (6,52 Km)
Section of route in close proximity to environmentally sensitive area.	Connects well with staging areas	Cost estimation: R 676 M
3-Phase signalised single point intersection – confusing at first.	Little expropriation. (single building near Lerwick Road)	Cost estimation (Incl. canal): R 790 M
NMPP clash over the canal.	No rail interference.	Total Route Cost: R 2,76 B

12.4. Section Two - Option Three:

<u>Description:</u> Section Two Option Three, illustrated in Figure 58, commences from the potential truck staging (SANDF) site, in the northern Mobeni district, and terminates along Grimsby Road. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve. The route traverses along the Amanzimyama Canal, underneath Quality Street Bridge, for the first 30% of its length. It then increases in height slightly to line up with Richard Carte Road at grade, forming an intersection. Continuing at grade the route links up to Barrier Lane where it continues at grade until a structure over the railway (similar H-bridge structure previously mentioned) connecting to Grimsby Road. The large H-bridge structure forms an elevated intersection above South Coast Road, which connects South Coast and Grimsby Roads.
<u>Proximity:</u> Mobeni east traversing onto Barrier Ln. Structure over South Coast Road.

Figure 58: Section Two - Option Three - Route Alignment

Negatives for this option:	Positives for this option:	General
Structures over rail.	One of the shorter Routes	Route Length = 3.07 Km (6,51 Km)
3-Phase signalised single point intersection – confusing at first.	Connects well with staging areas	Cost estimation: R 1,353M
NMPP clash over the canal.	Little expropriation.	Total Route Cost: R 3.03 B
	No rail interference.	
	No environmental conflict.	

12.5. Section Two - Option Four:

Description: Section Two Option Four, illustrated in Figure 59, commences from the truck staging SANDF site, in the northern Mobeni district, and terminates along Grimsby Road. A two lane carriage (with a 12.5 metre road reserve) exits the staging site, traversing along the Amanzimyama Canal, intersecting at Richard Carte Road (similar to Option 3), and then continuing at grade to line up at Barrier Lane. A two lane carriage (with a 12.5 metre road reserve) traverses north towards the staging site, utilising Barrier Lane and Quality Street. A slip lane devoted for freight vehicles destined for the staging site, is located at the Quality Street and Richard Carte Road intersection. The south portion of the alignment traverses similar to previous options, utilising a structure (H-bridge) to line up with Grimsby Road at grade, with a suspended intersection allowing access onto South Coast Road. Proximity: Mobeni east traversing onto Barrier Ln. Structure over South Coast Road.

Figure 59: Section Two - Option Four - Route Alignment

Negatives for this option:	Positives for this option:	General
Structures over rail.	Connects well with staging areas	Route Length = 3.48 Km (7.63 Km)
3-Phase signalled single point intersection – confusing at first.	Little expropriation.	Cost estimation: R 662 M
Potential NMPP clash over the canal.	No rail interference.	Total Route Cost: R 2,63 B
	No environmental conflict.	

12.6. Section Two - Option Five:

Description: Section Two Option Five, illustrated in Figure 60, commences from the Lerwick/Chamberlain Road intersection (connecting to Section One via Chamberlain Road), traversing along Lerwick Road and south of the old Clairwood Racecourse, finally ending at grade along Grimsby Road. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve. The route traverses at grade for about 80% of its length from Lerwick Road in a southerly direction around the old Clairwood Racecourse. Thereafter, (similar to previous routes) increasing in height to form an elevated structure over rail and South Coast Road with a suspended intersection allowing access onto South Coast Road (H-bridge), and finally lining up with Grimsby Road at grade. Noting that this option connects to Section One via Chamberlain Road, where minor upgrades are required, through to the Bluff/Chamberlain Road intersection. It must be noted that this option traverses over the environmental offset within the old Clairwood Racecourse, as described in chapter 12.1 and depicted on Figure 54.

Proximity: Mobeni east traversing onto Barrier Ln. Structure over South Coast Road.

Figure 60: Section Two - Option Five - Route Alignment

Negatives for this option:	Positives for this option:	General
Structures over rail.	Connects well with staging areas and Chamberlain Rd.	Route Length = 2.69 Km (6,84 Km)
3-Phase signalled single point intersection – confusing at first.	Potential M4 connection.	Cost estimation: R 564 M
Environmental area proximity	Little expropriation.	Total Route Cost: R 2.53 B

Potential industrial development clashes	No rail interference.	

12.7. Section Two - Option Six:

Description: Section Two Option Six, illustrated in Figure 61, commences at the truck staging SANDF site and ends at an interchange by the N2, west of Mobeni. The route connects to Section One options using existing road infrastructure, namely Lerwick Road and Chamberlain Road. The road traverses at grade for the majority of its length and is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve along the old Clairwood Racecourse. From the truck staging site, the road traverses along the Amanzimyama Canal and connects to Lerwick Road via a two lane, dual carriage with a 12.5 metre road reserve. From Lerwick Road it traverses along the eastern side of the old Clairwood Racecourse (25 metre road reserve) until connecting to Basil February Road. Using existing road network, the road traverses to Himalayas Road and Further connects to a newly constructed Msizi Dube Road / N2 interchange. It must be noted that this option traverses over the environmental offset within the old Clairwood Racecourse, as described in chapter 12.1 and depicted on Figure 54.

Proximity: New Interchange at Msizi Dube Rd / N2. Possible linkages to Higginson Highway Interchange.

Figure 61: Section Two - Option Six - Route Alignment

Negatives for this option:	Positives for this option:	General
Infringes on residential zones.	Majority existing road network.	Route Length = 3,75 Km (7,19 Km)
Section of route close proximity of environmental area.	Connects well with staging areas.	Cost estimation: R 586 M
Close to Higginson Hwy Interchange (weaving).	Little expropriation.	Cost estimation (Incl. canal): R 712 M
NMPP clash over the canal.	No rail interference.	Total Route Cost: R 1.98 B
Infringes on residential zones.		

EMME modelling was done for this route Section Two – option Six as shown in Figure 62. This figure shows traffic demand of 736 Freight vehicles in PCU along the most trafficked section of the corridor in each direction. This equates to 368 actual container freight vehicles potentially going into and out of the Port in the am peak hour period. This is lower than that tested for the Mobeni routes in this chapter 12 from option one to four. Observing that this route has a higher route length.

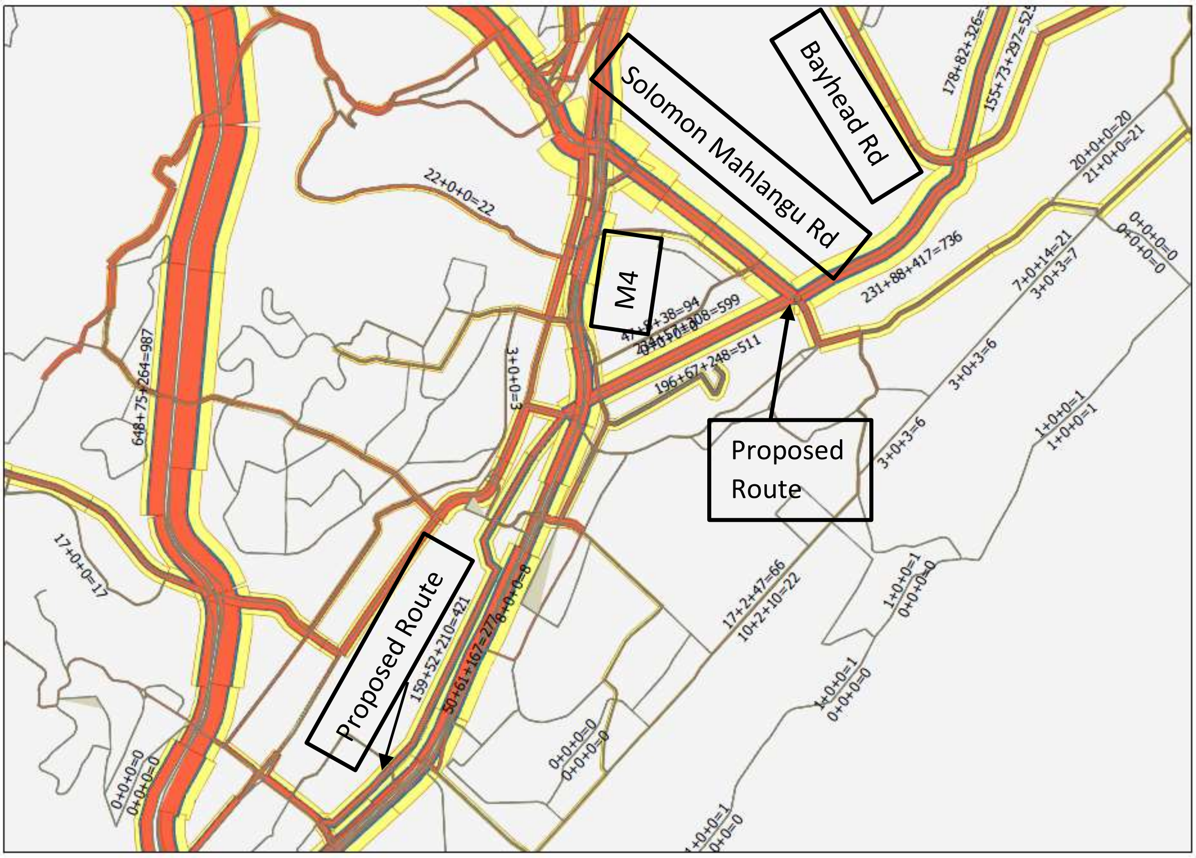


Figure 62: Traffic Demand along routes for Option Six.

12.8. Section Two - Option Seven Umhlatuzana

Description: Section Two Option Seven, illustrated in Figure 63, is an extension of Section One Option Five (chapter 11.7) and commences from the Umhlatuzana Canal over the M4 via Seaward Road, and ends at a newly constructed interchange onto the N2. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve. This option has connection to South Coast Road within the Clairwood area. The road commences along Seaward Road, traversing at grade until the Seaward Road/ Harden Avenue intersection. The road then navigates along Umhlatuzana Road until traversing parallel to the railway on a built up bank. The road follows the rail way until branching off to form an interchange onto the N2. This option utilises Section One Option Five, forming a complete route from the Port to the N2. It must be noted that this route infringes on the Mowat Nature Reserve which is described in Chapter 5 and shown on Figure 21.
Proximity: Traversing along the Umhlatuzana canal then via Seaward Road to the N2 close to NPC. Structure over South Coast Road and M4.

Figure 63: Section Two - Option Seven - Route Alignment

Negatives for this option:	Positives for this option:	General
Infringes on informal settlement	No rail interference.	Route Length = 3.9 Km (6,38 Km)
Environmentally sensitive area, namely the Mowat Nature Reserve	Uses part of existing road network.	Cost estimation: R 1.79 B
Extensively high structures (+50m) for the N2 interchange		Total Route Cost: R 3,23 B
Connection on South Coast Road near Clairwood Secondary School		

EMME modelling was done for this Umhlatazana route as illustrated in Figure 64. This shows traffic demand of 634 and 477 freight vehicles in PCU along this corridor in each direction. This equates to 317 and 239 actual container freight vehicles potentially going into and out of the Port in the am peak hour period. This is much lower than that tested for the Mobeni routes in this chapter 12 from option one to four. And noting that this route attracts additional demand as it is now connected to the SDIB.

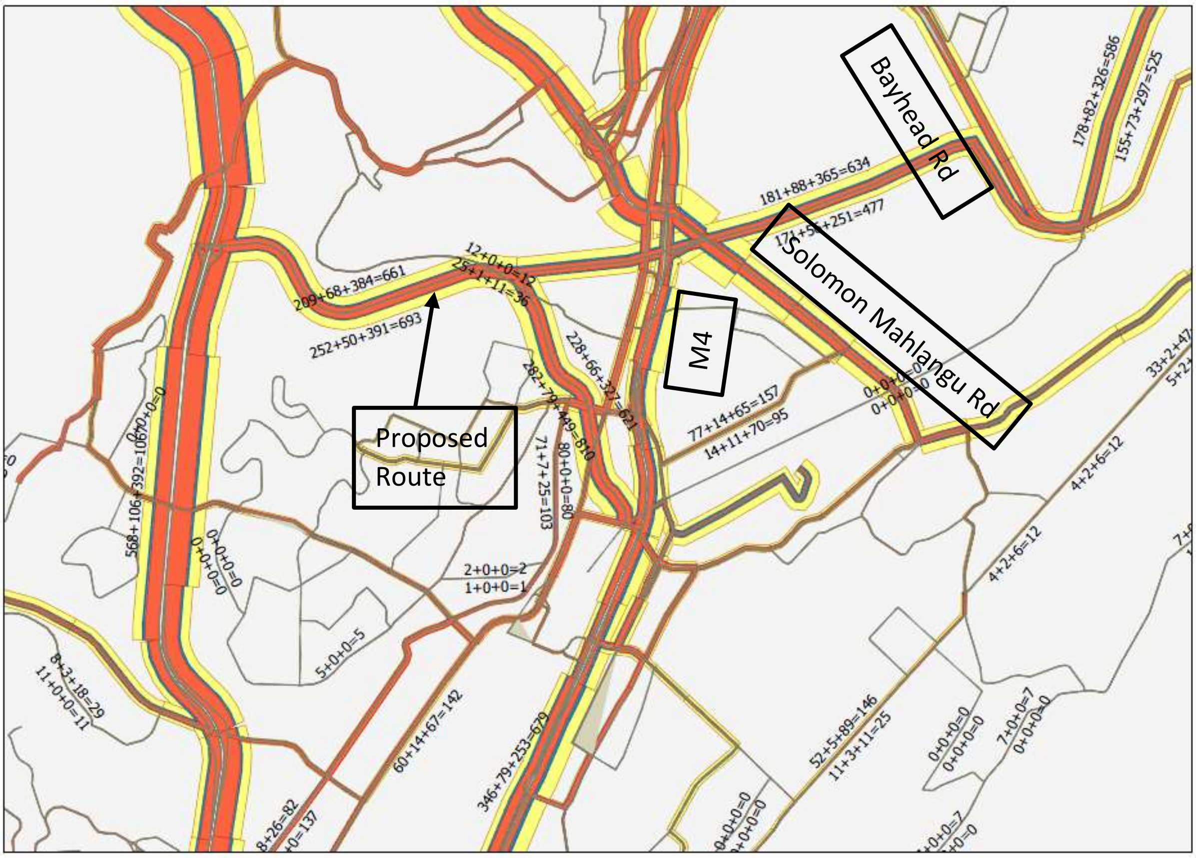


Figure 64: Traffic Demand along routes for Option Seven and Eight.

12.9. Section Two - Option Eight Umhlatuzana

Description: Section Two Option Eight, illustrated in Figure 65, commences from the Umhlatuzana Canal over the M4 via Seaward Road and ends at a newly constructed interchange onto the N2. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve. Similar to Section Two Option Seven, this road has connection to South Coast Road near the Clairwood area. The road commences along Seaward Road, branching off and traversing along a newly constructed road within the Mowat (nature reserve) area, north of Montclair, for the majority of its length. Finally, the road ends at a newly constructed interchange onto the N2. This option utilises Section One Option Five, forming a complete route from the Port to the N2. It must be noted that this route severely infringes on the Mowat Nature Reserve which is described in Chapter 5 shown on Figure 21.

Proximity: Traversing along the Umhlatuzana canal close to the Umhlatazana River to the N2.Structure over South Coast Road and M4.

Figure 65: Section Two - Option Eight - Route Alignment

Negatives for this option:	Positives for this option:	General
Infringes on informal settlement	No rail interference.	Route Length = 3.25 Km (5,73 Km)
Environmentally sensitive area, namely the Mowat Nature Reserve		Cost estimation: R 1.54 B
Extensively high structures (+50m) for the N2 interchange		Total Route Cost: R 2.98 B
Connection on South Coast Road near Clairwood Secondary School		

12.10. Conclusion of Section Two

For Section Two of the proposed routes each option was compared using the MCA as described in Chapter 9.2. These fields of comparison were estimated road costs, environmental impacts, transport viability and social impacts. Each of these fields were given equal weighting of 25% each. The routes were individually scored and the results are illustrated in Table 11.

Table 11: Multi-criteria Analysis of Section Two

Name	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
Cost	17	15	13	16	16	20	12	14
Transport	22	22	19	20	15	9	14	14
Environmental	7	7	20	20	14	12	6	7
Social	20	20	17	18	10	8	10	11
Total Score	**66**	**64**	**69**	**74**	**55**	**49**	**42**	**46**

These options for Section Two were combined with the most suitable option in Section One to give the result of a full route, which was modelled in EMME for the transport viability determination as part of the MCA.

The results from the multi criteria analysis showed that Option 3 and 4 for Section Two proved the most feasible options. Noting that expropriation costs were not taken into consideration for each of the options. These options connect well with the potential truck staging areas and have minimal impact on the residential areas, social facilities and take environmental sensitive areas into consideration. These options have substantial transportation demand and when connected to the potential truck staging areas will have easy direct access to and from the Port from the SDIB.

It must be noted, however, that without the potential truck staging site located at the SANDF or the Wentworth rail yard, described in Chapter 11.2, Options 3 and 4 for Section Two will not be as feasible as assumed under the premise of having connection to a future A-check / truck staging facility. The most feasible routes for Section Two, therefore, must be designed in conjunction with a connecting truck staging facility.

13. Section Three

For Section Three, a high level long term assessment was incorporated as part of this study addressing connectivity to the potential DDOP. Three options were explored and can be seen in this chapter.

13.1. Section Three - Option One:

Description: Section Three Option One, illustrated in Figure 66, commences from the old Racecourse and ends at the old Durban Airport, earmarked to become the future DDoP. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve. This road begins on the south western area of the Racecourse, traversing south following the nearby rail. Continuing under the M4 (and associated roads) via a tunnel, the road traverses parallel to the rail until passing it overhead via a structure. The road then connects to Travencore Drive, until traversing along the Umlazi River canal. A bridge structure then completes the road, allowing connection into the old Durban International Airport. This option utilises Section Two option's One to Five. It must be noted that this option traverses in between social communities, namely China Town and Merewent (Merebank East) communities, and thus will have some degree of social impact.

Proximity: The old Clairwood Racecourse, Merebank East area and old Durban International Airport.

Figure 66: Section Three - Option One - Route Alignment

Negatives for this option:	Positives for this option:	General
Close proximity of social areas and communities.	Shortest Route.	Route Length = 2,76 Km

Expropriation required.	*Low cost	Cost estimation: R 602,1 M
Complex construction (potential tunnelling under M4 and associated roads)		
Chrome-6 contaminated soils within the old Racecourse		

13.2. Section Three - Option Two:

Description: Section Three Option Two, illustrated in Figure 67, commences at the Himalayas / South Coast Road intersection and ends at the old Durban Airport, earmarked to become the future DDoP. This route is a four lane dual carriageway road, with two lanes in each direction and a 25 metre road reserve, with Himalayas Road being upgraded to have three lanes in each direction. This road commences at the Himalayas/South Coast intersection, with a dedicated slip road from South Coast Road onto Himalayas Road, and traverses south easterly along Himalayas Road. The road traverses along Travencore Drive, until lining up parallel to the Umlazi River canal. A bridge structure then completes the road, allowing connection into the old Durban Airport.

Proximity: The old Clairwood Racecourse, Merebank East area and old Durban International Airport.

Figure 67: Section Three - Option Two - Route Alignment

Negatives for this option:	Positives for this option:	General
Community access road infringement along Himalayas Road	Direct Route to the DDOP from South Coast Road and M4	Route Length =1,21Km
	Possible dedicated Engen/SAPREF freight connection, marked orange	Cost estimation: R 244 M
	Majority existing road network.	
	No rail interference	

13.3. Section Three - Option Three:

Description: Section Three Option Three alignment, illustrated in Figure 68, utilises existing road networks allowing access from South Coast Road to the old Durban Airport, and enhancing the exit routes from the old Durban Airport to South Coast Road and Umlazi. The route entails constructing a dedicated off-ramp from South Coast Road (South) to run parallel with the N2 and traversing further till along the dedicated old Airport turn off into the old Durban Airport. This will serve as a dedicated entrance into the old Durban Airport. The exit route entails upgrading of the existing road network, namely an additional lane traversing from the R102 towards the M30 and an additional traversing from the R102 towards South Coast Road.

<u>Proximity:</u> R102, Service Road, South Coast Road, N2 and the old Durban International Airport.

Figure 68: Section Three - Option Three - Route Alignment

Negatives for this option:	Positives for this option:	General
The route is slightly further from the study area. Hence, increased travel time.	Using existing network.	Route Length = 3,66 Km
	No rail interference.	Cost estimation: R 370 M
	Improves access into Umlazi.	

13.4. Conclusion of Section Three

A high level assessment has been conducted for Section Three taking the three investigated options into account. This was to ensure that a connection to the DDOP, SDIB and the Port of Durban has been considered. The routes described in this section show a combination of Option 2 and Option 3 may be warranted in the future once the DDOP is developed. As these options show more positives than negatives. Further investigations will be necessary when more certainty exists about the DDOP and its' associated timelines.

14. Conclusion

This study investigated previous studies done and came up with various options for a second access to the Port of Durban. Macroscopic transport modelling was completed for each of the routes in this report to assess the traffic demand on the potential routes. Environmental considerations were taken into account when exploring each of the routes' alignments. Social impacts on the surrounding areas that each of the routes traversed along were mitigated. The cost of each route was estimated taking structures and topography into account. These criteria were inputted into a multi criteria assessment for each of the routes and the most feasible routes were outlined in this document.

It was determined that a proposed truck staging areas (A-Check) will need to be confirmed in a future exercise for both the Phase 0 current freight corridor and the future Phase 1 second access to the Durban Container Terminal, as this truck staging area will improve port efficiency and operations, while making the new route more attractive to freight traffic.

Several previous studies have concluded that a second access into the Port is necessary, from both a traffic congestion as well as a national strategic point of view. The outcomes of this study, and proceeding project/s can result in an optimised and efficient Port system. This is not limited to only the traffic aspect, but also port operations. The rationalisation of all Port activities and operations can result in more efficient rail use, resulting in higher rail modal share, port call-in and freight vehicle processing efficiency, therefore resulting in higher through put of the Port increasing port revenues, and finally stakeholder satisfaction which would promote the use of the Port of Durban.

For Section One, the outcome of this MCA comparison showed that Option 2, 3 and 4 proved the most feasible options. Noting that expropriation costs were not taken into consideration for Option 2. For Section Two, the results from the MCA showed that Option 3 and 4 proved the most feasible options. These options connect well with the potential truck staging areas and have minimal impact on the residential areas, social facilities and take environmental sensitive areas into consideration. These options have substantial transportation demand and when connected to the potential truck staging areas will have easy direct access to and from the Port from the SDIB. It must be noted, however, that without the potential truck staging site located at the SANDF or the Wentworth rail yard, described in Chapter 11.2, Options 3 and 4 for Section Two will not be as feasible as assumed under the premise of having connection to a future A-check / truck staging facility. The most feasible routes for Section Two, therefore, must be designed in conjunction with a connecting truck staging facility.

For Section Three, a high level assessment has been conducted taking the three investigated options into account. This was to ensure that a connection to the DDOP, SDIB and the Port of Durban has been considered. The routes described in this section show a combination of Option 2 and Option 3 may be warranted in the future once the DDOP is developed. As these options show more positives than negatives. Further investigations will be necessary when more certainty exists about the DDOP and its' associated timelines.

14.1. Selected Overall Option/s

Various routes have been investigated in this report with each Section concluding with a MCA, apart from Section Three. Recommendations were made for the appropriate options that need to be considered and taken to further investigate as part of feasibility. A map of the selected options with potential truck staging areas, are illustrated in Figure 69.

The outcome of the comparison in Section One showed that Option 2, 3 and 4 proved the most feasible options. Figure 69 only included Options 3 and 4 from Section One, due to Options 2 and 3 being similar with expropriation being the variance.

For Section Two, options were combined with the most suitable option in Section One to give the result of a full route. The results from the multi criteria analysis showed that Option 3 and 4 in Section Two proved the most feasible options. Noting that expropriation costs were not taken into consideration for each of the options.

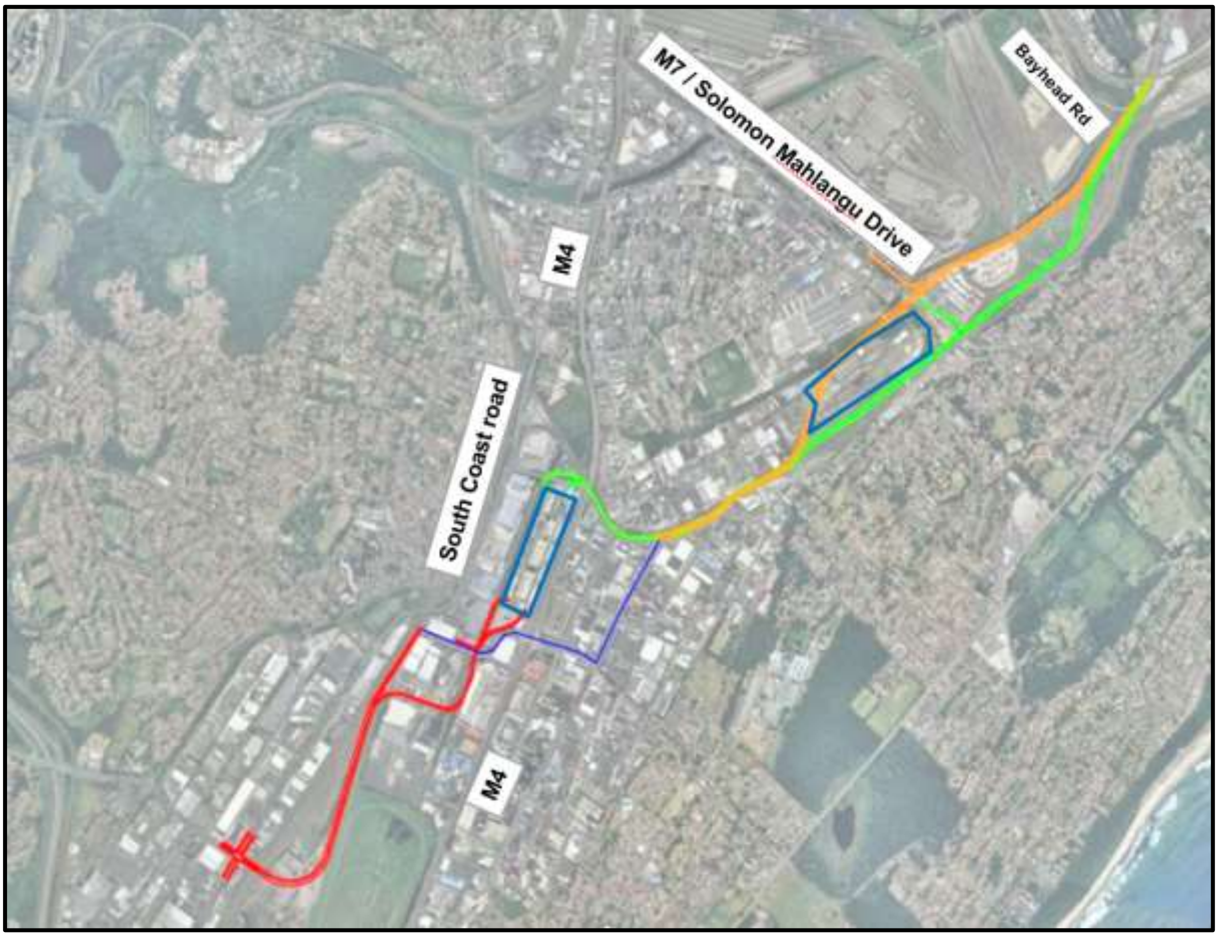


Figure 69: Selected Overall Options

For the next phase of this project a full feasibility assessment would need to be done taking into consideration interchanges, intersections, pavement design options, affected properties by the proposed improvements, earthworks, drainage, structures, utility services, traffic accommodation during construction, and detailed cost estimates.

15. Appendices

15.1. Traffic Analysis

The following chapter contains the SIDRA data as part of the status quo assessment described in Chapter 10.1.

Site: 101 [AM-Existing]

New Site
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.
Sensitivity Analysis (Critical Gap & Follow-up Headway): Results for Parameter Scale = 100.0 %

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Wakesleigh											
1	L2	352	0.0	0.557	19.8	LOS B	8.6	60.0	0.83	0.82	44.9
2	T1	744	0.0	0.491	25.4	LOS C	17.3	121.2	0.75	0.65	42.5
3	R2	349	0.0	0.710	36.6	LOS D	16.7	117.1	0.86	0.84	37.5
Approach		1445	0.0	0.710	26.8	LOS C	17.3	121.2	0.80	0.74	41.7
East: Solomon Mahlangu											
4	L2	36	0.0	0.014	6.6	LOS A	0.1	0.7	0.18	0.58	53.5
5	T1	1079	0.0	0.503	31.6	LOS C	16.2	113.7	0.83	0.72	39.6
6	R2	259	0.0	1.630	1182.7	LOS F	92.1	645.0	1.00	2.91	3.0
Approach		1374	0.0	1.630	247.9	LOS F	92.1	645.0	0.84	1.13	11.9
North: Vusi mzimela											
7	L2	356	0.0	0.696	34.7	LOS C	13.5	94.3	0.90	0.90	38.0
8	T1	159	0.0	0.094	21.2	LOS C	2.7	18.9	0.62	0.49	44.7
9	R2	254	0.0	1.145	357.2	LOS F	47.3	331.4	1.00	2.08	8.8
Approach		769	0.0	1.145	138.4	LOS F	47.3	331.4	0.88	1.20	18.4
West: Solomon Mahlangu											
10	L2	901	0.0	0.414	12.4	LOS B	10.4	72.7	0.52	0.73	49.3
11	T1	2229	0.0	1.119	292.2	LOS F	132.2	925.1	1.00	2.44	10.4
12	R2	92	0.0	0.391	30.0	LOS C	3.3	23.0	0.84	0.75	39.9
Approach		3222	0.0	1.119	206.5	LOS F	132.2	925.1	0.86	1.91	13.7
All Vehicles		6810	0.0	1.630	169.0	LOS F	132.2	925.1	0.85	1.43	16.0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akcelik M3D).

Site: 101 [AM-Proposed Option 2]

New Site
Signals - Fixed Time Isolated Cycle Time = 90 seconds (Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.
Sensitivity Analysis (Critical Gap & Follow-up Headway): Results for Parameter Scale = 80.0 %

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Wakesleigh											
1	L2	352	0.0	0.320	11.4	LOS B	6.0	42.0	0.50	0.71	50.0
2	T1	744	0.0	0.850	43.8	LOS D	18.0	125.7	1.00	1.01	35.2
3	R2	349	0.0	0.582	26.9	LOS C	11.4	79.9	0.86	0.80	41.6
Approach		1445	0.0	0.850	31.8	LOS C	18.0	125.7	0.84	0.89	39.5
East: Solomon Mahlangu											
4	L2	36	0.0	0.012	6.4	LOS A	0.1	0.6	0.19	0.58	53.6
5	T1	1079	0.0	0.587	28.4	LOS C	13.4	94.0	0.90	0.77	41.0
6	R2	259	0.0	0.940	50.2	LOS D	11.0	76.7	1.00	1.11	32.9
Approach		1374	0.0	0.940	31.9	LOS C	13.4	94.0	0.90	0.83	39.4
North: Vusi mzimela											
7	L2	356	0.0	0.432	20.1	LOS C	9.5	66.8	0.70	0.78	44.8
8	T1	159	0.0	0.182	30.9	LOS C	2.9	20.0	0.85	0.66	40.1
9	R2	254	0.0	0.707	29.7	LOS C	8.0	56.3	0.99	0.85	40.6
Approach		769	0.0	0.707	25.5	LOS C	9.5	66.8	0.83	0.78	42.3
West: Solomon Mahlangu											
10	L2	901	0.0	0.395	13.4	LOS B	8.9	62.6	0.57	0.72	48.7
11	T1	2229	0.0	0.925	52.3	LOS D	32.2	225.2	1.00	1.19	32.4
12	R2	92	0.0	0.255	23.2	LOS C	2.4	16.7	0.82	0.74	43.2
Approach		3222	0.0	0.925	40.6	LOS D	32.2	225.2	0.88	1.05	36.0
All Vehicles		6810	0.0	0.940	35.3	LOS D	32.2	225.2	0.87	0.94	38.0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Site: 101 [PM-Existing]

New Site
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.
Sensitivity Analysis (Critical Gap & Follow-up Headway): Results for Parameter Scale = 115.0 %

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Wakesleigh											
1	L2	116	0.0	0.247	22.2	LOS C	2.8	19.3	0.76	0.73	43.6
2	T1	185	0.0	0.103	19.5	LOS B	3.0	21.1	0.60	0.48	45.7
3	R2	27	0.0	0.102	33.0	LOS C	1.1	7.4	0.69	0.70	38.9
Approach		328	0.0	0.247	21.6	LOS C	3.0	21.1	0.66	0.59	44.3
East: Solomon Mahlangu											
4	L2	276	0.0	0.135	9.7	LOS A	2.1	14.5	0.36	0.65	51.2
5	T1	1513	0.0	0.976	92.8	LOS F	46.7	327.2	1.00	1.35	23.9
6	R2	220	0.0	0.615	31.4	LOS C	8.5	59.7	0.87	0.80	39.4
Approach		2009	0.0	0.976	74.6	LOS E	46.7	327.2	0.90	1.20	27.0
North: Vusi mzimela											
7	L2	150	0.0	0.145	7.5	LOS A	1.6	10.9	0.26	0.62	52.8
8	T1	591	0.0	0.331	22.0	LOS C	10.9	76.2	0.68	0.59	44.3
9	R2	390	0.0	0.948	87.3	LOS F	32.6	228.5	0.95	1.16	24.8
Approach		1131	0.0	0.948	42.6	LOS D	32.6	228.5	0.72	0.79	35.4
West: Solomon Mahlangu											
10	L2	224	0.0	0.107	7.9	LOS A	1.1	7.4	0.29	0.63	52.5
11	T1	675	0.0	0.407	37.5	LOS D	10.7	74.6	0.86	0.72	37.3
12	R2	229	0.0	0.857	48.1	LOS D	10.8	75.8	1.00	0.95	33.4
Approach		1128	0.0	0.857	33.7	LOS C	10.8	75.8	0.77	0.75	38.6
All Vehicles		4596	0.0	0.976	52.9	LOS D	46.7	327.2	0.81	0.94	32.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akcelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [PM-Proposed TRL]

New Site
Signals - Fixed Time Isolated Cycle Time = 50 seconds (Practical Cycle Time)
Variable Sequence Analysis applied. The results are given for the selected output sequence.
Sensitivity Analysis (Critical Gap & Follow-up Headway): Results for Parameter Scale = 100.0 %

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Wakesleigh											
1	L2	116	0.0	0.156	10.1	LOS B	0.9	6.2	0.61	0.70	50.9
2	T1	185	0.0	0.158	14.2	LOS B	1.7	11.9	0.77	0.60	48.9
3	R2	27	0.0	0.132	27.5	LOS C	0.6	4.4	0.91	0.71	41.5
Approach		328	0.0	0.158	13.8	LOS B	1.7	11.9	0.72	0.64	48.9
East: Solomon Mahlangu											
4	L2	276	0.0	0.148	9.7	LOS A	1.3	9.1	0.55	0.69	51.1
5	T1	1513	0.0	0.693	19.0	LOS B	8.9	62.5	0.95	0.85	45.8
6	R2	220	0.0	0.451	14.9	LOS B	3.3	23.4	0.80	0.76	47.9
Approach		2009	0.0	0.693	17.3	LOS B	8.9	62.5	0.88	0.82	46.7
North: Vusi mzimela											
7	L2	150	0.0	0.125	6.7	LOS A	0.7	4.9	0.30	0.63	53.2
8	T1	591	0.0	0.674	18.0	LOS B	9.0	63.2	0.93	0.83	46.1
9	R2	390	0.0	0.674	24.7	LOS C	7.5	52.2	0.94	0.87	43.4
Approach		1131	0.0	0.674	18.8	LOS B	9.0	63.2	0.85	0.82	45.9
West: Solomon Mahlangu											
10	L2	224	0.0	0.098	7.2	LOS A	0.6	4.2	0.36	0.64	52.9
11	T1	675	0.0	0.309	15.8	LOS B	3.4	23.5	0.83	0.67	47.7
12	R2	229	0.0	0.584	16.6	LOS B	3.5	24.8	0.93	0.80	46.9
Approach		1128	0.0	0.584	14.3	LOS B	3.5	24.8	0.76	0.69	48.5
All Vehicles		4596	0.0	0.693	16.7	LOS B	9.0	63.2	0.83	0.77	47.1

P.C.U.'s counted on 2017-Jun-19																		**Weather: GOOD**					
Comments: . .																							
	SOUTH COAST ROAD						SOUTH COAST ROAD						EEL ROAD										
	From North						From South						From East					From West					Interse
End Time	**NL**	**NS**	**NR**	**App**	**Dep**		**SL**	**SS**	**SR**	**App**		**Dep**	**EL**	**ES**	**ER**	**App**	**Dep**	**WL**	**WS**	**WR**	**App**	**Dep**	**Total**
06:15	13	83	0	96	91		0	85	43	128		90	7	0	6	13	56	0	0	0	0	0	237
06:30	8	88	0	96	139		0	130	57	187		97	9	0	9	18	65	0	0	0	0	0	301
06:45	25	46	0	71	146		0	141	69	210		56	10	0	5	15	94	0	0	0	0	0	296
07:00	50	70	0	120	128	504	0	121	124	245	770	90	20	0	7	27	174	0	0	0	0	0	392
07:15	44	90	0	134	157	570	0	152	91	243	885	103	13	0	5	18	135	0	0	0	0	0	395
07:30	35	82	0	117	163	594	0	151	45	196	894	95	13	0	12	25	80	0	0	0	0	0	338
07:45	11	99	0	110	154	602	0	143	15	158	842	107	8	0	11	19	26	0	0	0	0	0	287
08:00	11	78	0	89	165	639	0	157	24	181	778	87	9	0	8	17	35	0	0	0	0	0	287
08:15	11	102	0	113	179	661	0	165	13	178	713	119	17	0	14	31	24	0	0	0	0	0	322
08:30	10	96	0	106	138	636	0	127	16	143	660	125	29	0	11	40	26	0	0	0	0	0	289
08:45	8	89	0	97	197	679	0	184	20	204	706	116	27	0	13	40	28	0	0	0	0	0	341
09:00	3	90	0	93	143		0	137	15	152		106	16	0	6	22	18	0	0	0	0	0	267
09:15	10	150	0	160	172		0	163	13	176		165	15	0	9	24	23	0	0	0	0	0	360
09:30	6	95	0	101	125		0	112	12	124		118	23	0	13	36	18	0	0	0	0	0	261
09:45	6	96	0	102	160		0	148	6	154		116	20	0	12	32	12	0	0	0	0	0	288
10:00	6	117	0	123	170		0	162	8	170		135	18	0	8	26	14	0	0	0	0	0	319
10:15	17	158	0	175	214		0	203	14	217		171	13	0	11	24	31	0	0	0	0	0	416
10:30	5	85	0	90	102		0	98	7	105		98	13	0	4	17	12	0	0	0	0	0	212
10:45	1	226	0	227	167		0	155	7	162		249	23	0	12	35	8	0	0	0	0	0	424
11:00	3	64	0	67	77		0	72	10	82		71	7	0	5	12	13	0	0	0	0	0	161
11:15	9	145	0	154	83		0	78	6	84		162	17	0	5	22	15	0	0	0	0	0	260
11:30	9	130	0	139	163		0	156	10	166		146	16	0	7	23	19	0	0	0	0	0	328
11:45	8	115	0	123	152		0	147	12	159		138	23	0	5	28	20	0	0	0	0	0	310
12:00	13	111	0	124	190		0	185	7	192		123	12	0	5	17	20	0	0	0	0	0	333
12:15	11	112	0	123	218		0	209	16	225		136	24	0	9	33	27	0	0	0	0	0	381
12:30	5	123	0	128	153		0	148	3	151		137	14	0	5	19	8	0	0	0	0	0	298
12:45	7	116	0	123	160		0	149	8	157		127	11	0	11	22	15	0	0	0	0	0	302
13:00	12	136	0	148	147		0	140	13	153		157	21	0	7	28	25	0	0	0	0	0	329
13:15	8	146	0	154	162		0	154	10	164		157	11	0	8	19	18	0	0	0	0	0	337
13:30	5	127	0	132	158		0	150	11	161		140	13	0	8	21	16	0	0	0	0	0	314
13:45	7	123	0	130	155		0	149	13	162		135	12	0	6	18	20	0	0	0	0	0	310
14:00	9	115	0	124	164		0	157	19	176		125	10	0	7	17	28	0	0	0	0	0	317
14:15	10	144	0	154	149		0	141	13	154		164	20	0	8	28	23	0	0	0	0	0	336
14:30	3	142	0	145	97		0	94	7	101		151	9	0	3	12	10	0	0	0	0	0	258
14:45	13	106	0	119	147		0	137	17	154		130	24	0	10	34	30	0	0	0	0	0	307
15:00	3	96	0	99	126		0	115	18	133		108	12	0	11	23	21	0	0	0	0	0	255
15:15	12	139	0	151	121		0	111	31	142		150	11	0	10	21	43	0	0	0	0	0	314
15:30	21	190	0	211	283		0	234	14	248		270	80	0	49	129	35	0	0	0	0	0	588
15:45	2	123	0	125	182		0	147	9	156		184	61	0	35	96	11	0	0	0	0	0	377
16:00	14	165	0	179	173		0	138	11	149		202	37	0	35	72	25	0	0	0	0	0	400
16:15	7	130	0	137	149		0	131	2	133		188	58	0	18	76	9	0	0	0	0	0	346
16:30	5	180	0	185	132		0	122	2	124		226	46	0	10	56	7	0	0	0	0	0	365
16:45	2	159	0	161	134		0	116	8	124		180	21	0	18	39	10	0	0	0	0	0	324
17:00	2	193	0	195	165		0	161	4	165		215	22	0	4	26	6	0	0	0	0	0	386
17:15	4	169	0	173	126		0	119	6	125		193	24	0	7	31	10	0	0	0	0	0	329
17:30	2	183	0	185	162		0	151	13	164		203	20	0	11	31	15	0	0	0	0	0	380
17:45	11	151	0	162	127		0	122	13	135		160	9	0	5	14	24	0	0	0	0	0	311
18:00	8	114	0	122	162		0	158	18	176		125	11	0	4	15	26	0	0	0	0	0	313
Total	**505**	**5887**	**0**	**6392**	**7327**		**0**	**6825**	**923**	**7748**		**6846**	**959**	**0**	**502**	**1461**	**1428**	**0**	**0**	**0**	**0**	**0**	**15601**

15.2. Preliminary Vertical Alignments

The vertical alignment for Section One Option Three is depicted below in Figure 70

Figure 70: Section One - Option Three - vertical alignment

The vertical alignment for Section One Option Four is depicted below in Figure 71.

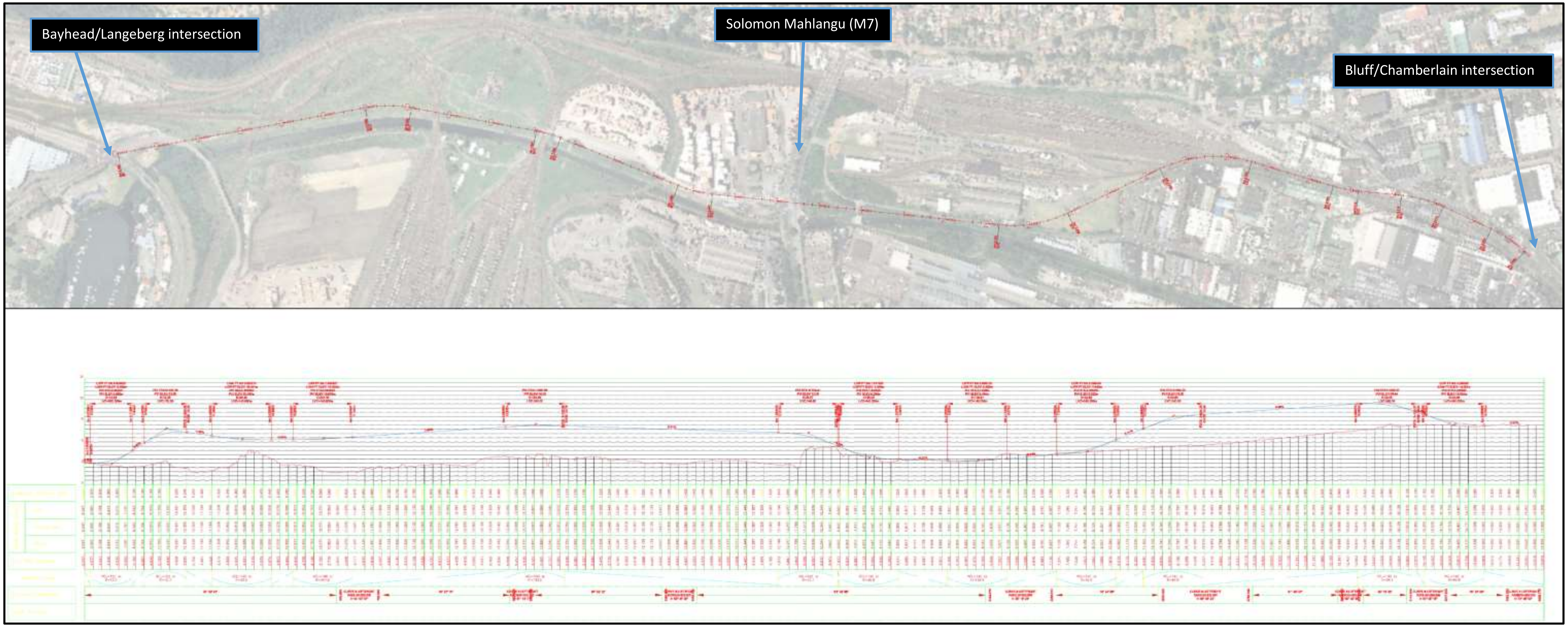


Figure 71: Section One - Option Four - vertical alignment

The vertical alignment for Section Two Option Four is depicted below in Figure 72.

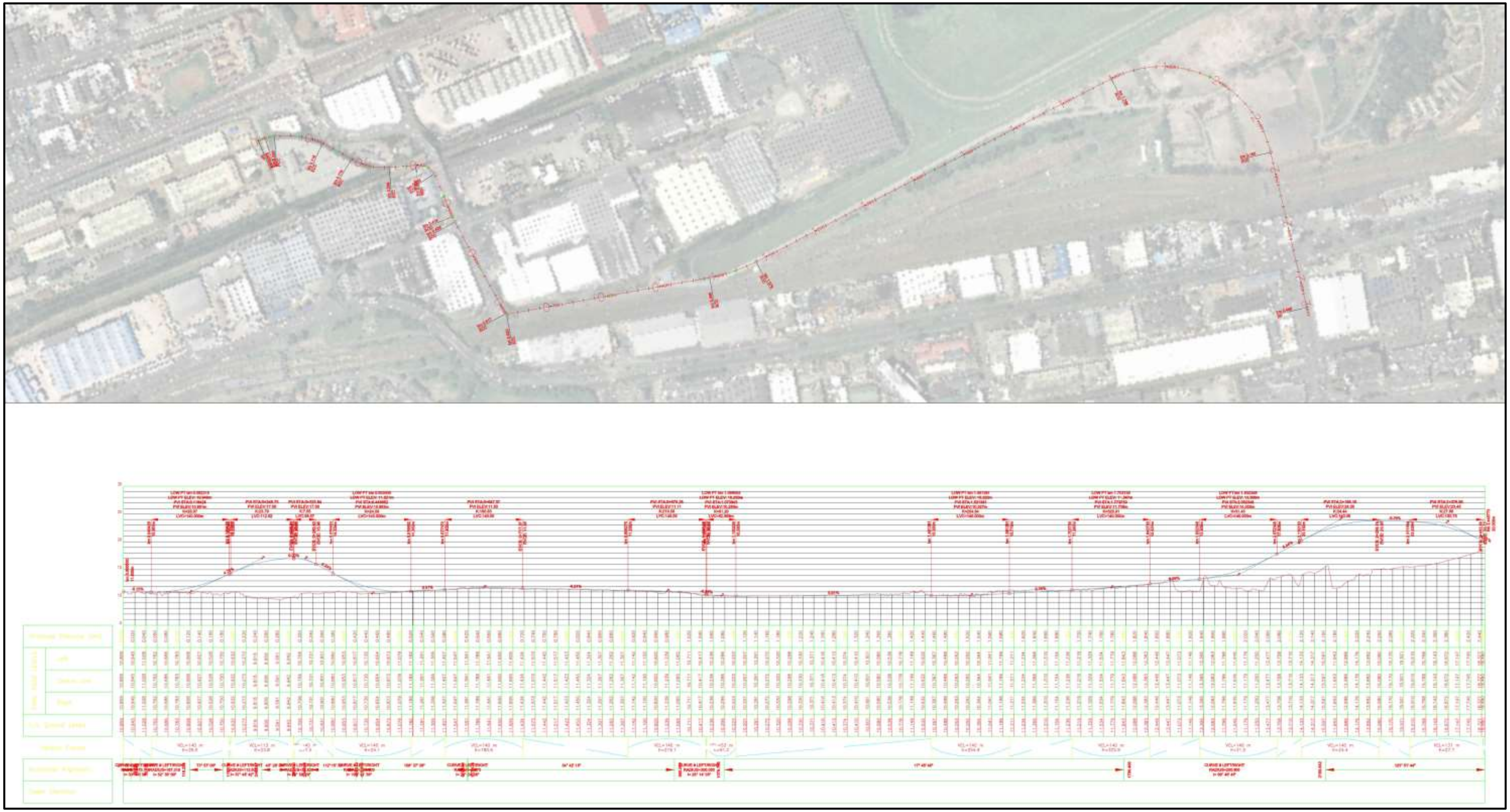


Figure 72: Section Two - Option Four - vertical alignment

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