WESTERN CAPE FREIGHT DEMAND MODEL

Western Cape Government
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Mobility

2023 Model | Report | December 2024

South Africa is facing a freight logistics crisis that undermines the foundation of its economy. Inefficiencies across all transport modes – ports, rail, road, and shipping – have escalated into systemic failures, costing the country billions in lost revenue and eroding its global competitiveness. Resolving this crisis demands immediate and decisive action to implement reforms, attract investment, and restore the transport system to its critical role as a driver of economic growth.

The financial cost of South Africa's logistics failures is staggering. By 2023, inefficiencies in freight transport were estimated to cost the economy R1 billion per day. This includes R50 million in daily tax losses, the loss of 500 jobs every 24 hours, and mounting inefficiencies that ripple across industries[1]. Transnet's financial woes compound the crisis, with R30 million in daily interest charges adding to its unsustainable debt burden. The consequences are especially severe in export-driven sectors like mining, manufacturing, and agriculture, which are vital to the nation's economic stability – particularly in regions like the Western Cape, where these industries are a cornerstone of local economies.

Successful national and regional macrologistics interventions rely heavily on a data-driven approach. Evidence-based macrologistics planning for infrastructure investment and policy direction requires an activity-based data and costing framework, similar to the precision needed in business logistics. Just as businesses analyse trade-offs between strategic alternatives and investment options through detailed evaluation of logistics activities, the same principle applies to national and regional logistics planning.

In South Africa's logistics crisis – marked by inefficiencies in Transnet and the rail sector's inability to meet industry demands – a demand-based freight flow model has emerged as an essential tool for identifying and assessing potential solutions.

Understanding the movement of goods on both national and provincial scales is crucial, and this need is effectively addressed by a demand-driven model.

The Freight Demand Model™ (FDM™) for South Africa captures freight flows across 372 districts for 83 commodities, encompassing export, import, and domestic freight movements over a 30-year forecast horizon. This model provides invaluable insights to guide decision-making and long-term planning, offering a foundation for tackling the country's logistics challenges.

The freight flow model offers valuable insights into the current freight volumes across various transport modes in a region while also assigning costs to these flows. This current demand is closely tied to the region's GDP, often referred to as "GDP in motion." By incorporating forecasts, the model can project future demand for each flow, providing a wealth of analytical opportunities for decision-makers. This enables the evaluation of policy interventions and industrialization strategies, including their impacts on infrastructure, cost-benefit analyses of different transport modes, and assessments of congestion management and law enforcement measures.

National and provincial governments must develop comprehensive strategies to mitigate the effects of the logistics crisis and establish a foundation for a more resilient and efficient sector. In this regard, the Western Cape Provincial Government has emerged as a leader in tackling the crisis directly. The eighth iteration of the Western Cape Freight Demand Model™ (WC FDM™) plays a crucial role in shedding light on the complexities of freight movement within the region. By analysing 2023 data, the WC FDM™ report provides invaluable insights into data sources, the rigorous methodology used, and the outcomes achieved. These insights lay the groundwork for informed, strategic decision-making, ensuring that policies and interventions are targeted for maximum effectiveness.

The Western Cape's commitment to transparency and data-driven approaches highlights the provincial government's determination to address the logistics crisis and drive sustainable growth in the region's transport and logistics sector.

[1] Aritua, B., Havenga, J., Simpson, Z,. Swarts, S., Neethling, H., De Bod, A. 2024. Pathway to Integrated Surface Transport and Logistics Regulation in South Africa. *Presentation delivered at the 3rd Florence Rail Regulation Conference, Co-organised by Transport Area of the Florence School of Regulation and Paris Dauphine-PSL University (CR2D)*. 8 July, Florence.

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Executive summary

Amidst the ongoing logistics crisis in South Africa, successful national and regional macrologistics interventions have proven to be critically dependent on a data-driven approach. National and Provincial government need to develop comprehensive strategies that can mitigate the effects of the crisis and lay the foundation for a more resilient and efficient logistics sector. In this context, the Western Cape Provincial Government has emerged as a pioneer in addressing the crisis head-on. The eighth iteration of the WC FDM™ plays a pivotal role in shedding light on the complexities of freight movement within the Western Cape. By analysing data from 2023, this Western Cape Freight Demand Model (WC FDM™) report offers invaluable insights into the data sources, the rigorous methodology used, and the outcomes achieved. These insights lay the groundwork for informed, strategic decision-making, ensuring that policies and interventions are targeted for maximum effectiveness. The Western Cape's commitment to transparency and data-driven approaches highlights the provincial government's determination to address the logistics crisis and drive sustainable growth in the region's transport and logistics sector.

The WC FDM™ supports strategic decision-making in the implementation of the Western Cape Freight Strategy. This report outlines the methodology and data sources of the model, and summarises key characteristics associated with freight flows to, from, and within the Western Cape, as well as a potential scenario for modal shift and terminal networks in the province.

Methodology

The national and provincial freight demand models are comprised of econometric and flow modelling. Econometric modelling identifies and analyses causes and effects, and correlates relationships between total freight transport demand and its drivers. Flow modelling uses the supply and demand values of the econometric model to represent freight movement between supply and demand areas for all commodities and modes.

The models are based on Logistics Service Provider cost and tariff data (interview-based), Transnet Freight Rail data, Transnet National Ports Authority data, Western Cape-specific data (agriculture, crops, and mining), Western Cape-specific waste data, international air freight data for Cape Town International Airport, and publicly available industry and business data.

Western Cape Trade – Modal split

The total road and rail freight with an origin or destination in the Western Cape in 2023 amounted to 143.6 million tonnes, showing a slight increase from the previous year. Modal share in the Western Cape (excluding air freight and pipelines) remained unchanged for total freight (61% for road and 39% for rail) in 2023. As for GFB[1] freight, the 99% for road and 1% for rail marked a 1% shift toward road from 2022. When considering total freight, the mining sector is dominant due to 51.1 million tonnes of export iron ore freight. Pipeline freight amounted to 3.98 million tonnes, whereof everything was crude oil being moved between the City of Cape Town and the Port of Vredenburg.

Fruit on rail presents a major opportunity that has not been realised due to the lack of consolidation facilities and service levels. The mining sector is dominant in GFB rail freight volumes, which is primarily driven by Namakwa Sands activity. Agriculture freight by rail decreased by 43%, while mining and manufacturing contracted by 10% and 31%, respectively. Rail lost 25% of its market share of GFB volumes in 2023 compared to 2022. Opportunities exist for rail transport of long-distance GFB freight in the Western Cape.

Provincial trade

A total of 148.0 million tonnes of freight touched the Western Cape in 2023 and is made up of 87.2 million mining tonnes (59%), 41.8 million manufacturing tonnes (28%), 16.6 million agricultural tonnes (11%), and 2.5 million (2%) waste tonnes. The Western Cape GFB freight (65.4 million tonnes) is split between intra-Western Cape freight (21.2 million tonnes), freight transported to other provinces (24.8 million tonnes) and freight received from other provinces (18.9 million tonnes). Waste is an intra-provincial flow only and amounts to 2.5 million tonnes (10% of intra-provincial freight).

Almost half (44%) of intra-Western Cape freight and 78% of freight to other provinces are manufacturing commodities, which together amount to 30.2 million tonnes. Manufacturing freight represents 57% of the Western Cape's freight from other provinces. The largest commodity group in the Western Cape's manufacturing sector is processed foods (29%), followed by beverages and diesel (both 11%). KwaZulu-Natal is the Western Cape's main GFB trading partner, followed closely by Gauteng. If it was not for port-related trade, Gauteng would have been the Western Cape's biggest trading partner, because 23.8% of trade with KZN is related to the Port of Durban.

Corridors

For total freight touching the Western Cape, the N7 is the only corridor with significant rail volumes. However, this is primarily due to the dedicated iron ore corridor (i.e. iron ore and manganese exports). Corridor GFB freight is dominated by road, with a 99.5% market share on the N1 corridor; 99.8% market share on the N2 corridor and 86.1% market share on the N7 corridor. The average travel distance of road freight on the N1, N2, N7, Metropolitan and Core Western Cape corridor is 1 391 km, 659 km, 409 km, 27 km and 83 km, respectively. Due to the low rail market share, modal shift opportunities exist for long-distance road freight in the Western Cape (more detail in Scenario 1: Modal shift).

Flow segmentation

Manufactured goods, transported over long distances on road, constitute a large volume of the Western Cape's GFB freight. This presents two opportunities for rail, namely (1) siding-to-siding freight, that is, long-distance freight that is usually moved from large manufacturing plants to other plants for further beneficiation; and (2) FMCG freight, which can be palletised, containerised, and transported through domestic intermodal solutions.

The inability of the railway to develop these solutions collaboratively with road to capture the long-distance FMCG freight impacts transport costs, and hence hampers the competitiveness of industries in the Western Cape. South Africa's logistics challenges and rail reform initiatives create opportunities for the public and private sector to establish terminal and consolidation centres, promoting the shift of palletised and containerised freight to alternative transportation modes (see section on Scenario 4: Rail freight potential in the Western Cape).

Economic forecast

Iron ore and manganese exports constitute the majority of the Western Cape's mining sector freight intensity[2]. Manufacturing and agricultural commodities from the Western Cape are transported over significantly longer distances than the mining commodities. The manufacturing sector is forecast to generate the largest logistics demand in the absence of the ring-fenced export lines. The economic forecast suggests the development of infrastructure that will support the growing manufacturing and agriculture sectors.

Freight transport costs

In 2023, road freight accounted for 87% of the total transportation cost. The main road freight transport cost drivers were fuel (R32.6 billion; 40.7% of total cost), maintenance and repairs (R11.5 billion; 14.4% of total cost) and truck driver wages (R7.9 billion; 9.9% of total cost). Fuel cost increased by 62.3% against 2021 (driven by higher fuel prices), but decreased 2.2% against 2022 (driven by lower fuel prices). With its current low market share, the South African freight railway's challenge is that it needs a substantial modal shift from road to realise density benefit and further emphasises the significance of resolving the rail crisis in South Africa.

[1] GFB is defined as the competitive market space and consists of the total freight tonnes less iron ore exports, manganese exports, pipelines and, for the analysis that follows, stone and aggregate. The latter has been removed from the subsequent GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport.

[2] Freight transport intensity is the ratio of freight transport demand (measured in tonne kilometres) and the economic output measured by Gross Domestic Product (GDP). Freight intensity is the quantum of freight transport required to achieve the same output. Freight transport intensity, for instance, for income received from gold mining versus income received from coal mining is very low. Meaning much less freight activity is required to achieve the same income. In a general sense high freight intensity means low returns for many tonne-kilometres. It can be reduced by higher value economies (services and high value products where the freight to product value ratio is low) or more efficient logistics (less kilometres for the same task, achieved through (inter alia) lower empty haul, better routing, better load factors).

Externality costs

The total externality cost for road freight transport in the province amounts to R14.12 billion, which is 20.4% of current direct road freight transport costs. Road freight transport contributes 94% of the total freight transport externality cost of R15.02 billion. The four largest road freight transport externality cost drivers, namely emissions, accidents & crashes, noise, and congestion, contribute more than 80% to total freight transport externality costs in the province, impacting the general population while not being carried by the users of the service. The internalisation of externality costs can be induced through policy interventions. Policy interventions could induce a systemic change to shift rail-targetable freight to rail.

Waste data gathering and analysis process

Waste does not contribute to the GDP directly, but it has an indirect impact since its transportation and disposal requires resources that could have been used for activities that contribute to the GDP.

The WC FDM™ waste forecast investigates a plausible relationship between waste being landfilled (i.e. waste landfilled) and commodity demand. Waste Management and the logistics behind it are complex and waste landfilled is inherent not only to the consumption of goods but also to extraction and manufacturing processes. Therefore, a portion of transportable GDP will end up in landfills.

Municipal waste reduction initiatives have seemingly been reducing the waste landfilled cumulatively by 34 000 tonnes per year since 2010 up until 2023, given that the demand for processed foods and beverages in the CoCT explains the waste landfilled. Municipal waste forecasts for the CoCT, based on demand for processed foods and beverages, in the absence of additional waste reduction measures such as recycling and reuse, are expected to increase to 2.76 million tonnes per year by the year 2054. Garden waste landfilled is expected to increase by 34% by 2054 based on the forecast of fertilizer demand in the CoCT. Construction and demolition waste is expected to grow the fastest of the three waste streams, based on the forecast of bricks and cement demand in the CoCT.

Air freight data

In 2023, 60 023 freight tonnes were transported via Cape Town International Airport (CTIA), whereof 36 597 tonnes (61%) were exported and 23 426 tonnes (39%) were imported. This shows a growth in total trade of 14.6% (7 634 tonnes) from the 2022 volumes of 52 389 tonnes; and 45% (18 624 tonnes) from the 2021 volumes of 41 399 tonnes. However, air trade volumes are still lower than the 63 015 tonnes transported in 2019. CTIA predominantly imports and exports food in its role as a facilitator of international trade.

Apart from food-related commodities, the most air trade volumes in 2023 are perishable non-foods (4 465 tonnes); clothing and accessories (3 012 tonnes); machinery for general industrial uses (1 894 tonnes); other chemicals & products (1 083 tonnes) and pharmaceuticals (930 tonnes). While 2023's export and import volumes are much higher than in 2022, they are still lower than those traded in 2019.

While sufficient and reliable data is available for international air freight values and volumes, sparse data is available for domestic air freight volumes, specifically data disaggregated by origin-destination and commodity. Government and industry stakeholders need to collaborate to improve the availability, reliability and level of detail of domestic air freight data, as this area in the market is key to economic job creation and competitiveness in the province. The presence of such a database would also allow for a more integrated and detailed air transport view in the WC FDM™, similar to current capabilities for other freight transport modes. Since competitive advantage and intellectual property are of considerable concern to many of the parties, both government and industry will need to ensure that data-sharing is beneficial to all stakeholders concerned.

Scenario 1: Modal shift

The modal shift scenario is for commodities that have been identified as rail friendly, based on the density attributed to the origin and/or destination, packaging type and distance. As rail traffic density increases, it becomes more efficient. An estimated 9.81% of the Western Cape's total freight transportation cost could have been saved in 2023 through modal shift. At current rail volumes, road is more competitive within the Core Western Cape area. The largest modal shift opportunity is for the N1 corridor freight. This could potentially reduce total transport costs by 9.37%. Modal shift potential is discussed further in Scenario 4, within the context of rail freight potential in the Western Cape.

Scenario 2: Performance Based Standards (PBS)

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. Pressing policy issues were identified, such as the provincial government's position on Performance Based Standards (PBS) vehicles and a high-level scenario was developed to estimate the potential annual impact on freight transport costs in the Western Cape. The current results are indicative, with the purpose of encouraging discussions to increase the accuracy of the scenario development outputs.

Transporting liquid bulk with PBS vehicles has the potential to reduce transport costs by up to 28%. Cost savings of 9% and 39% could be realised when transporting PBS friendly commodities with a 50% and 75% load factor, respectively. A 5% transport cost increase would be realised when transporting the remaining palletised freight (over and above what is classified as PBS friendly commodities) with a 50% load factor. However, at a 75% load factor, a 30% cost saving could be realised when transporting the remaining palletised freight.

PBS vehicles have the potential to reduce the number of laden trips by 25% for liquid bulk, 39% for PBS friendly commodities and 35% for the remaining palletised freight.

The use of PBS vehicles could result in a 16% and 7% reduction of diesel consumption for the transportation of liquid bulk and PBS friendly commodities, but an 8% increase for the remaining palletised freight if a 50% load factor is achieved. If the load factor of PBS vehicles could increase to 75%, the fuel saving for PBS friendly commodities and remaining palletised freight would be 38% and 28%, respectively. This fuel saving will also result in the same direct reduction of emissions externality cost.

This scenario identifies that sixteen roads, including the N1, N2 and N7, are required for transporting approximately 80% of freight using PBS vehicles.

Scenario 3: Cape Town International Airport's jet fuel supply

The demand for jet fuel at CTIA ranges from 1.4 million to 2.0 million litres per day, depending on the season, currently translating into 40 to 52 vehicles delivering jet fuel at the airport daily. CTIA usually has a three-to-four-month supply of fuel in storage. Fuel deliveries at CTIA have peaked at 60 vehicles within a 24-hour period from the Astron Energy Refinery, following a supply chain disruption at the PoCT that caused a temporary fuel supply shortage.

Assuming a linear construction cost per kilometre, a pipeline to CTIA needs to transport at least 1.37 million tonnes (1.71 million litres) of jet fuel per year to be competitive with current road transport cost.

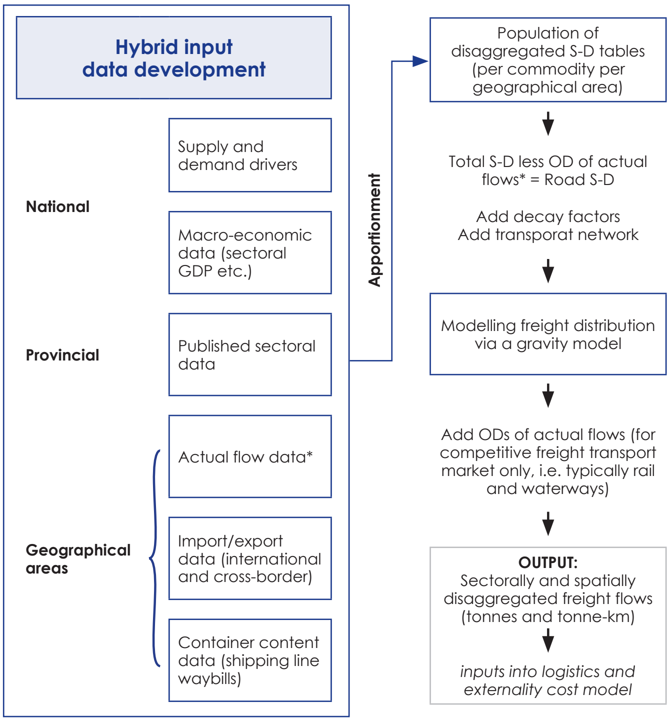
At the current volumes, a pipeline from the Astron Energy Refinery to CTIA would need to be constructed at a cost 3.36 times lower than the benchmark NMPP construction cost per kilometre. At the current volumes, a pipeline from the PoCT to CTIA would need to be constructed at a cost 15.49 times lower than the benchmark NMPP construction cost per kilometre.

Scenario 4: Western Cape rail freight potential

The scenario results show immediate potential for modal shift from road to rail on nearly all the branch lines in the province, covering rail-friendly commodities such as fruit exports, palletised freight, dry bulk, waste, cement and barley from road to rail.

This scenario indicated that rail potential in the Western Cape could shift 2.7m tonnes from road to rail, leading to significant reductions in truck trips (over 100 000), transport cost (R1.4 billion) and externality cost (R0.6 billion) at a lower uptake. At full uptake, 8.3 million tonnes could shift from road to rail in the Western Cape, which would save nearly 300 000 truck trips, R4.9 billion transport cost and R2.2 billion externality cost overall.

The process and key data sources that are used to develop the Western Cape Freight Demand Model[1] are indicated in Figure 1. The model produces supply and demand data which, in turn, defines freight flows in terms of origin, destination, commodity, volume and transport mode. The primary steps include: gathering and development of actual and modelled commodity-level data, disaggregation of this data to supply and demand per geographical district and modelling of the freight flows between origins (supply) and destinations (demand). Supply-and-demand tables are developed based on a hybrid approach that utilises the available datasets for each geography.



S-D = Supply and demand
OD = Origin-destination
** Rail, waterways, pipelines, conveyor belts (where applicable)*

Figure 1: Adapted from key data sources and process detail of the FDM (Havenga and Simpson, 2018)

The National Freight Demand Model (FDM™) was first developed and used in 1998. The model was improved in 2006 to become a completely repeatable model that captures freight flows between 372 districts for 83 commodities for all modes of transport on land within South Africa, for export, import and domestic freight, over a 30-year forecast horizon. The WC FDM™ was developed for the first time in 2017/18, based on the national FDM™ with the objective of providing the province with richer and more refined known data to enable the development of more refined strategies.

The methodology for developing the FDMs (both national and provincial) consists of two steps: (1) econometric modelling and (2) flow modelling.

Econometric modelling

This modelling approach is required to develop multi-commodity, multi-regional national freight demand models (Havenga and Simpson, 2018). Econometric models identify and analyse cause-and-effect and correlative relationships between the total freight demand and its drivers. Figure 2 shows the econometric modelling steps.

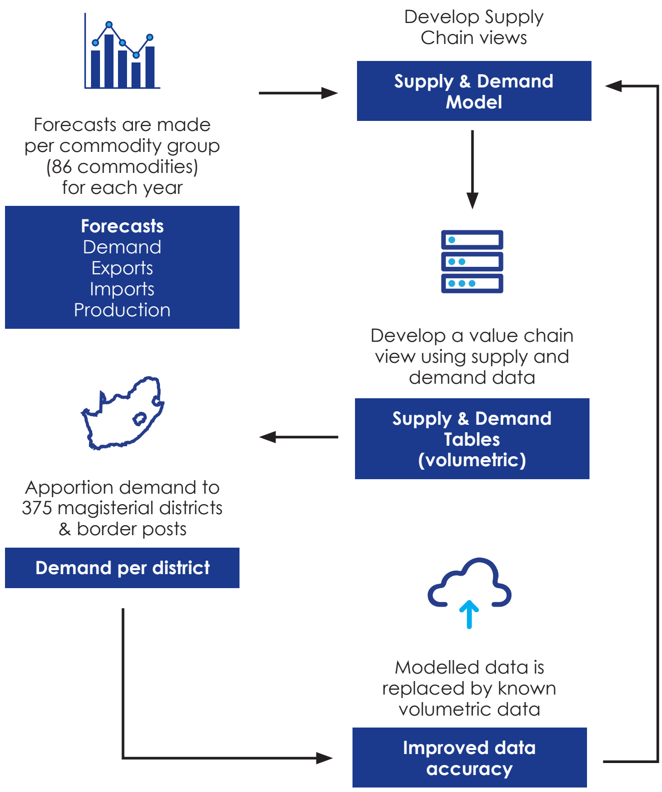


Figure 2: Econometric model

Supply and demand are forecasted 30 years into the future. This provides likely high and low growth scenarios. These forecasts are based on assumptions regarding the international economic outlook, Gross Domestic Product (GDP) growth, inflation, national capital spending, population growth, and various other forecasting factors.

Flow modelling

Flow modelling uses the supply and demand values of the econometric model to model the movement of freight between supply areas (origins) and demand areas (destinations) throughout the country, for all commodities and modes.

The input data is created by subtracting the volume of known flows per geographical district (rail, pipeline, conveyor) from the total supply and demand volumes.

[1] Western Cape Freight Demand Model utilises in part the "FDM" (a registered trademark of GAIN Group (Pty) Ltd)

The balance of supply and demand is then modelled as road flows, using gravity modelling.

Gravity modelling is based on the premise that freight flows between geographical districts are determined by supply and demand volumes for each commodity, and by a measure of transport resistance[2] per commodity.

Distance and travel time are the most common measures of transport resistance as an objective, readily-available variable. Road cost components, such as diesel consumption and truck wear-and-tear, also typically have a linear relationship with distance and time. A distance-decay function describes the attraction value between origins (supply) and destinations (demand). The decay factor determines the slope of the decay function and its relative change over distance and time.

Low value, bulk commodities that generate a transport demand disproportionate to their value tend to have a sharp rate of decay (i.e., they tend not to be transported over long distances). The impact of distance is smaller for higher-value commodities, thus suggesting low decay parameters (mostly used for manufactured and end-use agriculture commodities, that is, heterogeneous agglomerations with use that is more dispersed over a number of geographical districts).

Figure 3 shows the Flow Model.

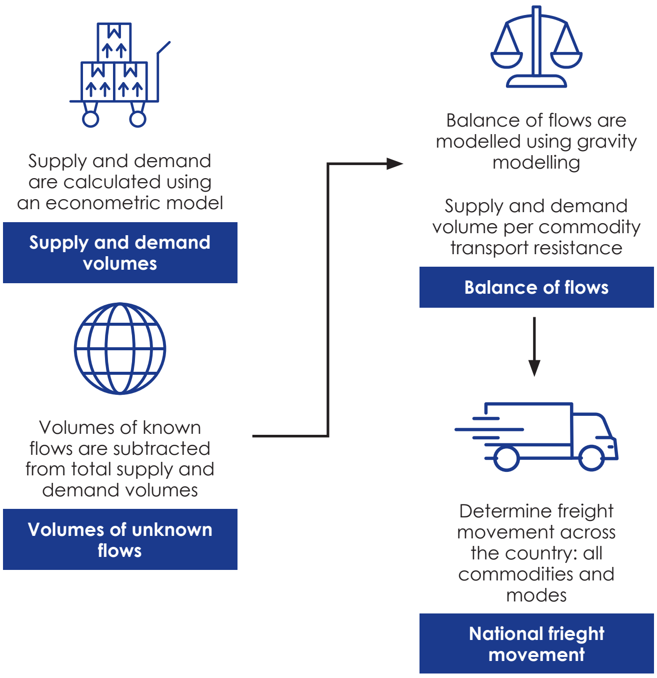


Figure 3: Flow Model

The Western Cape Freight Demand Model (WC FDM™)

The WC FDM™ is confined to the Western Cape geographical districts from the national FDM™ (42 magisterial districts, 3 ports) for which freight either originates, is destined for, or moves within the district. The model is a complete set of origin and destination freight movements, per commodity (currently 86 commodities) and per transport mode (road, rail, pipeline and international air freight). A geographic representation of the WC FDM™ districts is presented in Figure 4.

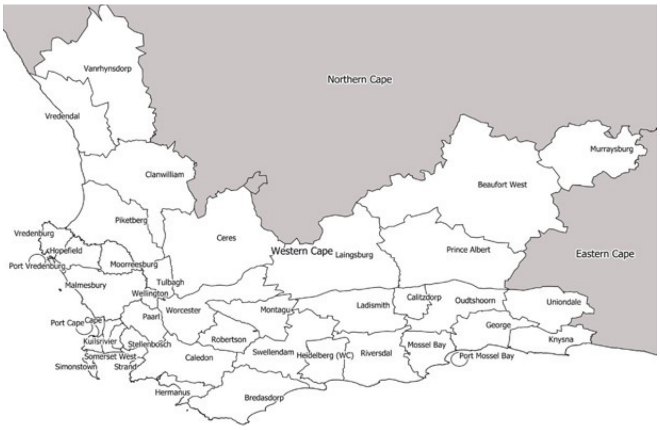


Figure 4: Geographical districts within the Western Cape

Data sources

During the development of the WC FDM™, the following data sources were used:

- Inputs from participating Logistics Service Providers (LSPs);
- Transnet Freight Rail (TFR) data;
- Transnet National Ports Authority (TNPA) data – bulk and containers;
- Western Cape specific data: agriculture crops, waste and mining data;
- Publicly available data for industry and businesses.
- Western Cape specific air freight data.

Figure 5 and the text box below provide a summary and explanation of the datasets used and updated:

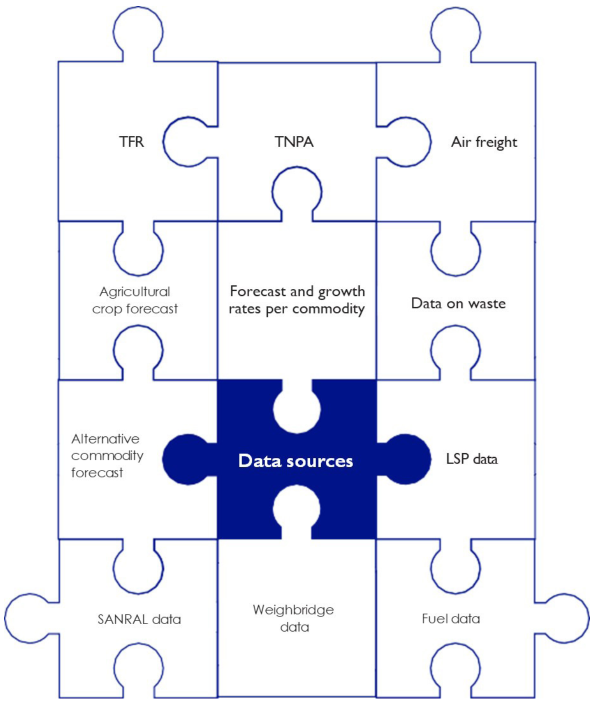


Figure 5: Data Sources

[2] Transport resistance is a commodity's propensity to be transported over a specific distance, with that propensity being determined by the utility and desirability, which is traded-off with transport cost as a percentage of delivered cost. Propensity is, therefore, estimated through a decay function for each commodity in question. In cases where the transport cost percentage is very low, the commodity will move even if the utility and desirability is low.

1. Forecasts and growth rates: Revised in line with the national FDM™ for imports, exports, production, intermediate demand and final demand/consumption in WC FDM™.
2. Waste: Data collected and included in the model.
3. Participating Logistics Service Providers (LSPs): Company origin-destination freight movements were further interrogated and verified with more detailed cost and tariffs.
4. Liquid fuels and the imports and exports of refined petroleum products: Additional research was conducted and comparisons made between data from industry, the South African Petroleum Industry Association (SAPIA) and the Department of Energy.
5. Weighbridge data: Used to validate WC FDM™ flows. It largely confirmed the modelled WC FDM™ road flows.
6. South African National Roads Agency Limited (SANRAL) data: New SANRAL data for analysis and comparison with modelled data on the N1, N2 and N7.
7. Agricultural data: Latest data, including estimated current crops and future plantings and yields, were incorporated.
8. Air freight data: International air freight handled by Cape Town International Airport included but not yet integrated with other modes of transport in the FDM™, as the origin destination (OD) detail is not available.

Refer to Chapter 6 of Havenga et al (2020), Havenga (2013) and Chapter 8 of Havenga (2007) for a more technical description of the FDM model:

Havenga, J.H. (2007), 'The development and application of a freight transport flow model for South Africa', dissertation presented for the degree of Doctor of Philosophy (Logistics Management), Stellenbosch: University of Stellenbosch.

Havenga, J.H. (2013), 'The importance of disaggregated freight flow forecasts to inform transport infrastructure investments', Journal of Transport and Supply Chain Management, Vol. 7 No. 1, pp. 1-7.

Havenga, J.H., Witthoft, I.E., De Bod, A. and Simpson, Z. 2020. *From Logistics Strategy to Macrologistics: Imperatives for a developing World. London. Kogan Page Publishers.*

Havenga, J.H. and Simpson, Z.P. (2018), 'National freight demand modelling: a tool for macrologistics management', International Journal of Logistics Management, Vol. 29 No. 4, pp.1171-1195, https://doi.org/10.1108/IJLM-11-2017-

In this chapter, Western Cape freight is discussed from two perspectives, namely, total freight and general freight business (GFB). GFB is defined as the competitive market space and consists of the total freight tonnes less coal-, iron ore-, and manganese exports, pipelines and (for the subsequent analysis) stone and aggregate. The latter has been removed from the GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport. Previously iron ore on the export line, which was used for Saldanha Steel, was included in GFB. This iron ore, however, uses the same dedicated line and station infrastructure as the export iron ore and was revised to be non-GFB freight, as it was not mode competitive.

Modal split

Total road and rail freight with an origin or destination in the Western Cape in 2023 is shown in Figure 1 and amounted to 143.6m tonnes, representing a slight increase from the 142.3m tonnes in 2022.

The total tonnes per sector for road and rail are given in Figure 2. The waste data[1], consists of municipal waste, organic waste, and construction and demolition waste. The largest concentration of waste generation and transportation occurs within the CoCT, which has a substantial impact on local flows.

GFB volumes are shown in Figure 3, with the dominance of manufacturing being evident. The 2023 data shows a decrease for road tonnes from 2022 for the agriculture (-2%) and mining (-13%) sectors, but an increase for the manufacturing (3%) sector. Agriculture freight by rail decreased by 43%, while mining and manufacturing contracted by 10% and 31%, respectively. Rail lost 25% of its market share of GFB volumes in 2023 compared to 2022.

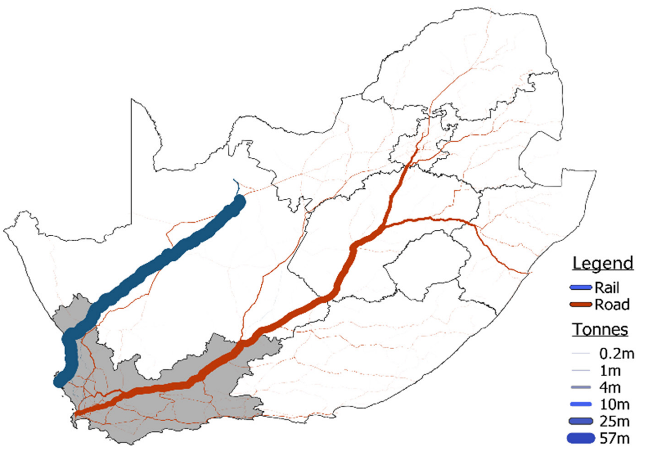


Figure 1: Total freight with an origin or destination in the Western Cape scaled to iron ore export line (2023)

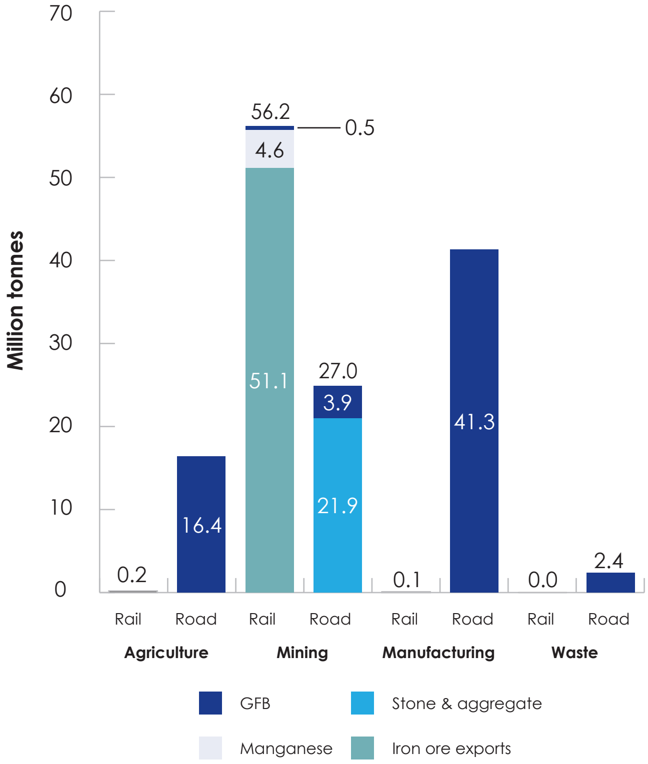


Figure 2: Total road and rail tonnes per sector in the Western Cape (2023)

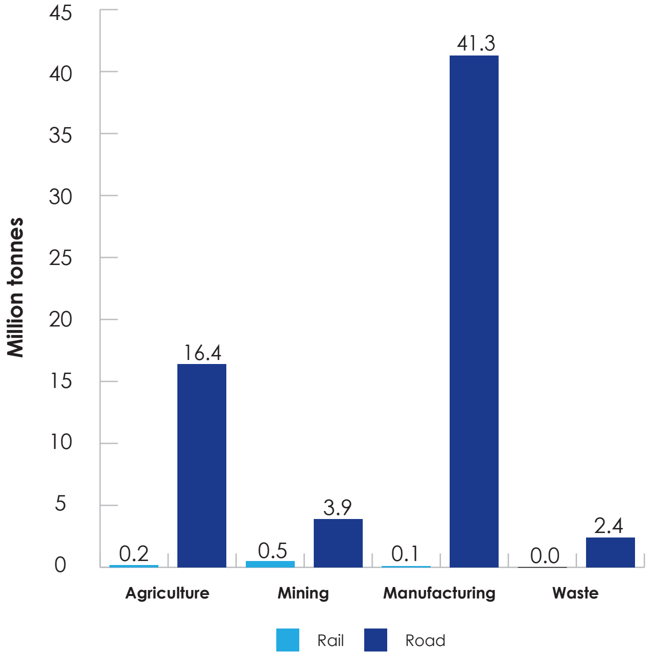


Figure 3: GFB road and rail tonnes per sector (2023)

[1] Available waste data has been integrated, despite not fully visible in terms of all routing and movements, as well as limited detail on other waste categories such as hazardous waste.

Figure 4 (to its own scale) shows GFB rail freight movements that touch the Western Cape.

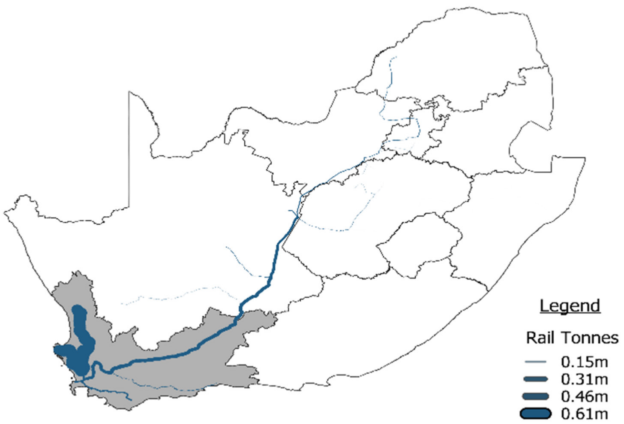


Figure 4: GFB rail freight that touches the Western Cape (2023)

While agricultural dry bulk freight is still transported on rail to a limited extent, year-on-year volumes have nearly halved. Barley and maize were 66 361 (i.e. 34%) and 91 844 (i.e. 46%) tonnes less, respectively. All wheat (17 673 tonnes) and grain sorghum (6 896 tonnes) transported by rail were lost between 2022 and 2023.

Rail, therefore, lost 1.4% and 16% of the market share for wheat and grain sorghum freight, respectively.

Fruit presents a major opportunity that has not been realised due to the lack of consolidation facilities, rail service levels and capacity. Apart from coal and iron ore needed for the plant, rail is basically only used at Namakwa Sands (Tronox), at a stable rate of half a million tonne per annum. Rail has still not been able to recover the limestone, granite and other manufacturing loss from 2021. All iron & steel freight (11 196 tonnes, i.e. 0.8% market share) transported by rail were lost between 2022 and 2023. Figure 4's contrast with Figure 1 highlights the limited role of rail, once the bulk coal and iron ore exports have been removed.

Apart from road and rail freight, there is one movement of crude oil in pipelines between the City of Cape Town and the Port of Vredenburg amounting to 3.98m tonnes. In comparison, 1.35m tonnes of crude oil were transported by pipelines in 2022. This represents a substantial 195% (2.63m tonnes) increase despite no crude oil being imported via Mossel Bay (0.9m tonnes less than 2022) or gas being moved from offshore production wells to the Mossgas production platform (0.15m tonnes less than 2022).

Commodity splits per mode

Freight volumes per commodity per mode for Western Cape-related GFB freight can be seen in Figure 5.

The commodity "Other Agriculture" mostly consists of unmanufactured agricultural animal feed (namely lucerne and hay).

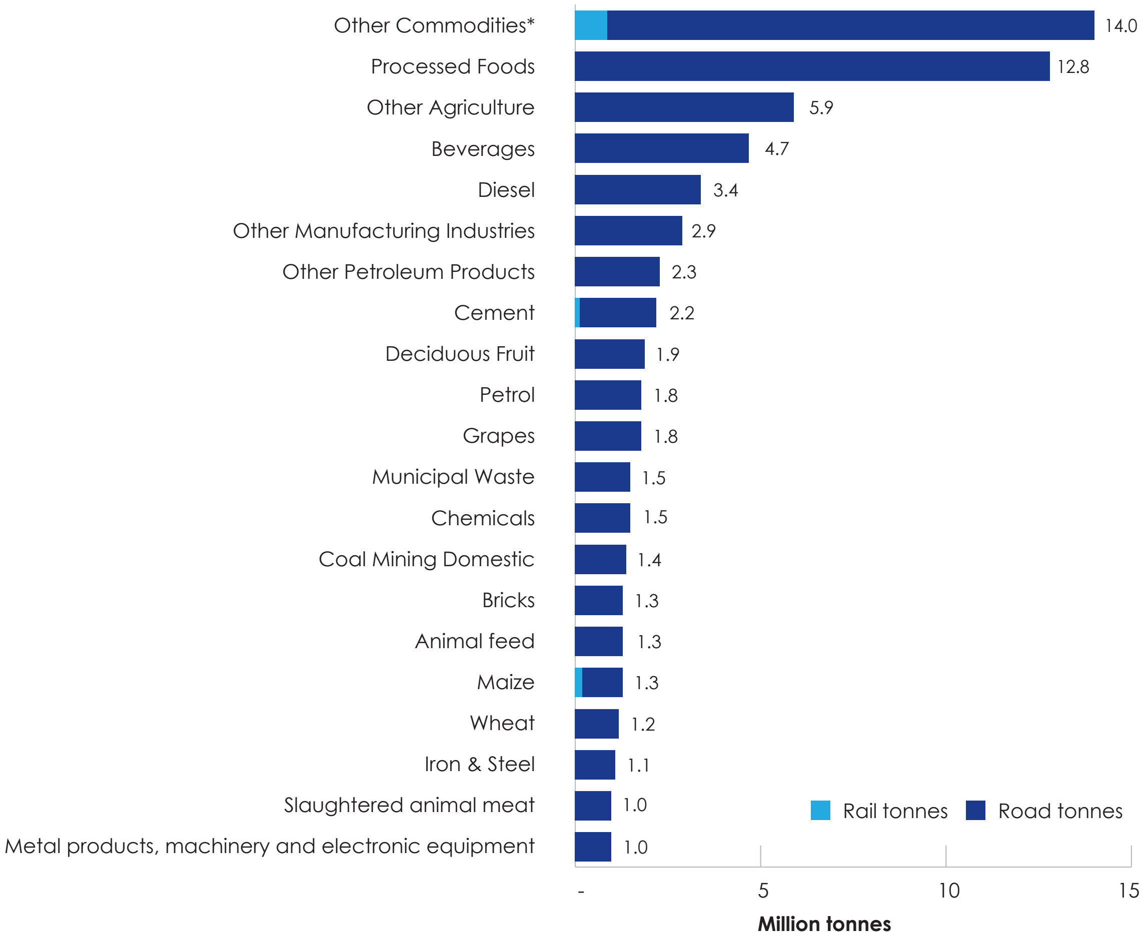


Figure 5: Western Cape related GFB freight volumes per commodity per mode (2023)

* See section 15-1, for detail on "other manufacturing industries" and the grouping "other commodities"

Table 1 provides the Western Cape rail volumes and market share for commodities that have rail market share.

Table 1: Rail volumes and market share (2023 and 2022)

Commodity on rail	Rail volumes (thousand tonnes)		Rail Market Share	
	2023	2022	2023	2022
Ilmenite (Titanium ore)	403.3	428.3	100%	50%
Barley	129.6	195.9	33%	62%
Maize	107.9	199.7	9%	15%
Zircon	88.9	107.9	77%	70%
Cement	57.9	69.8	3%	3%
Rutile	28.0	31.4	94%	18%
Beverages	19.8	36.8	0.4%	1%
Coal Mining Domestic	19.5	29.9	1%	2%
Gypsum	8.0	14.4	6%	12%
Fertilizer	7.8	8.5	2%	2%
Chemicals	4.2	4.0	0.3%	0.3%
Metal products, machinery and electronic equipment	0.1	-	0.01%	0%
Titanium slag	-	-	0%	1%
Wheat	-	17.7	0%	16%
Grain Sorghum	-	6.9	0%	1%
Iron & Steel	-	11.2	0%	0%
Diesel	-	-	0%	0%
Other Manufacturing Industries	-	-	0%	0%
Granite	-	-	0%	0%
Limestone	-	-	0%	0%

Globally, the largest rail market share has historically been in low-value, bulk commodities with large parcel sizes (i.e., consignments). The traditional belief was that these freight categories serve rail economics better; the bulk mining and agricultural commodity market share was usually the highest. However, intermodal traffic, and especially domestic intermodal, has grown faster in most developed countries' railways over the last decade.

Rail has a captive market in bulk mining exports; the current success of their business, therefore, depends largely on exogenous factors, such as global economic growth, strong commodity prices, and proximity to transport facilities. Globally, rail service providers have realised that the most stable growth opportunity is fast-moving consumer goods (FMCG), which can be palletised, containerised, and moved through a domestic intermodal solution. This should also be the case for South Africa, especially for the Natal and Cape corridors. Rail transportation becomes more efficient than road over long distances, given a sufficient level of density. Therefore, based on the long average distance freight travels on the Cape Corridor, it presents the biggest opportunity.

Despite rail tonnes in the Western Cape growing faster than national rail tonnes since 2010, it was not resilient to the drop in rail freight in 2020, however, it did recover some freight in 2023 (like it did during 2021) after declining again in 2022 (see Figure 6).

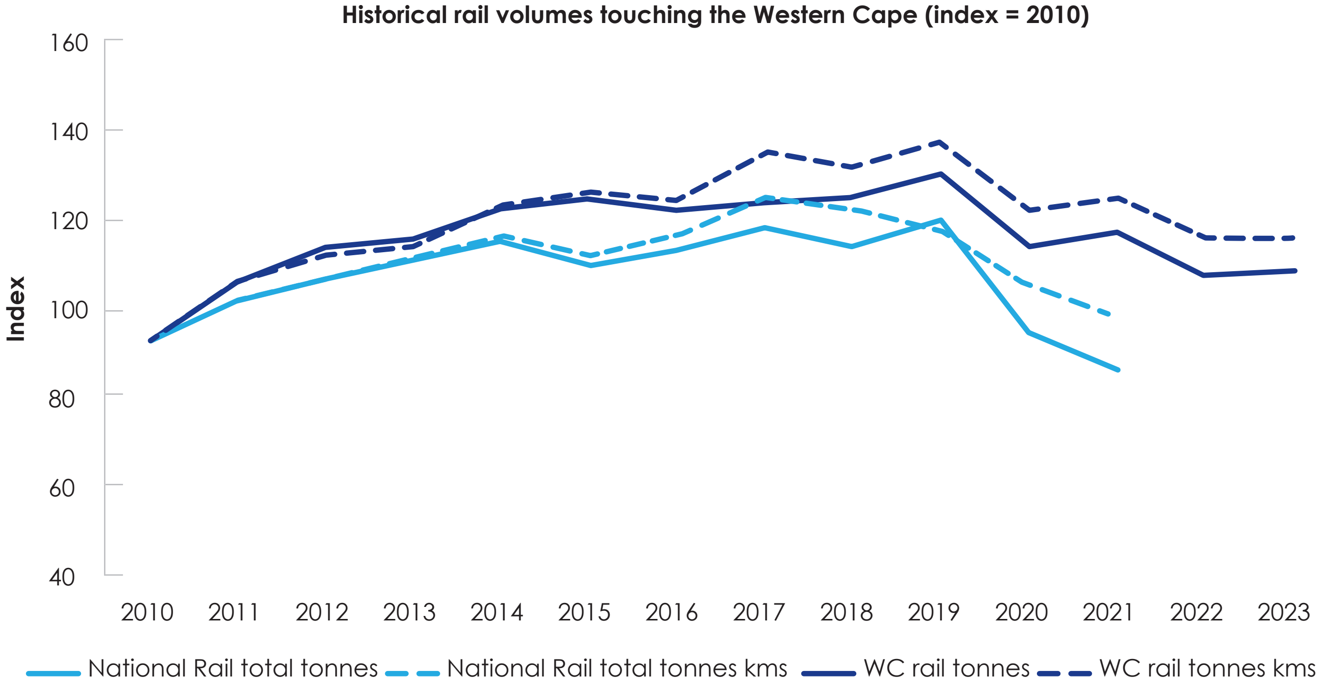


Figure 6: Time series of indexed rail tonnes and tonne-kms from 2010 to 2023 (index = 2010)[2]

[2] National Rail volumes unavailable for 2022 and 2023

Highlights

- Total road and rail freight (2023) with an origin or destination in the Western Cape amounted to 143.6m tonnes, showing a slight increase from the 142.3m tonnes in 2022.
- Modal share in the Western Cape (excluding air freight and pipelines) remained unchanged for total freight (61% for road and 39% for rail) in 2023. As for GFB freight, the 99% for road and 1% for rail marked a 1% shift toward road from 2022.
- When considering total freight, the mining sector is dominant due to 51.1m tonnes of export iron ore freight.
- Pipeline freight amounted to 3.98m tonnes, whereof everything was crude oil being moved between the City of Cape Town and the Port of Vredenburg.
- Air freight via Cape Town International Airport amounted to 60 023 tonnes, whereof most (85%) movements were related to exports. Overall, food was the most prevalent air freight commodity (44%).
- Fruit on rail presents a major opportunity that has not been realised due to the lack of consolidation facilities and service levels.
- The mining sector is dominant in GFB rail freight volumes, which is primarily driven by Namakwa Sands activity.
- GFB freight rail volumes decreased across all three sectors in 2023.
- Opportunities exist for rail transport of long-distance GFB freight in the Western Cape.

The total 148.0m tonnes of freight touching the Western Cape is made up of 87.2m mining tonnes (59%), 41.8m manufacturing tonnes (28%), 16.6m agricultural tonnes (11%), and 2.5m waste tonnes (2%) (refer to Figure 1).

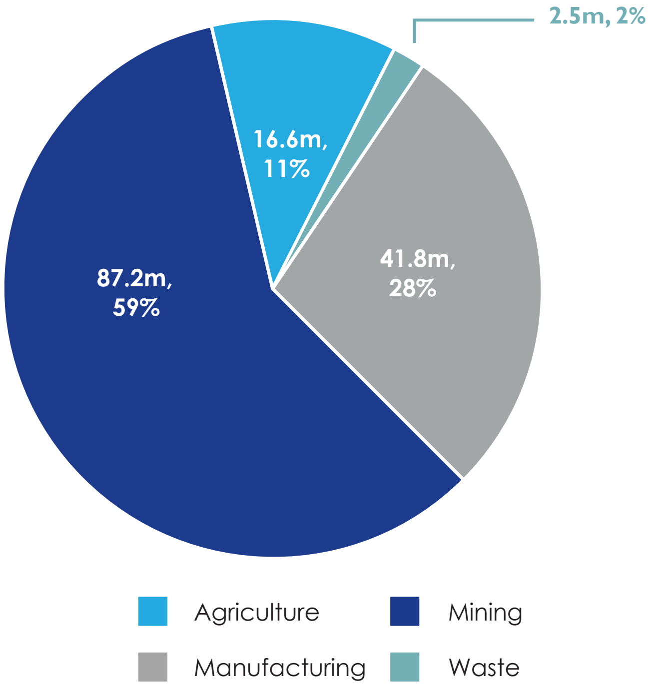


Figure 1: Total freight-flows per sector (tonnes 2023)

The Western Cape General Freight Business (GFB)[1] of 65.4m tonnes consists of 21.2m tonnes intra-Western Cape freight, 24.8m tonnes transported to other provinces and 18.9m tonnes received from other provinces.

Intra-Western Cape freight shows a decrease of 1.1m tonnes for 2023 compared to 22.3m tonnes in 2022. The tonnes transported to other provinces increased by 0.5m tonnes (24.3m tonnes in 2022) and freight received from other provinces decreased by 0.9m (19.8m tonnes in 2022). These flows are shown per sector in Figure 2. Waste was modelled as a separate sector to determine its impact on the Western Cape's freight flow economy. Waste is not moved to or from other provinces, therefore, it is only an intra-provincial flow. While the 2.5m tonnes of waste transported in 2022 represented 11% of intra-Western Cape freight, the 2.5m tonnes of waste transported during 2023 represented 10% of intra-Western Cape freight.

In 2023, the Western Cape received 0.03m less tonnes of mining commodities from other provinces than in 2022. Similarly, 0.3m less tonnes of mining commodities were sent to other provinces. The manufacturing freight sent to other provinces in 2023 saw an increase of 1.0m tonnes compared to 2022, with manufacturing freight received from other provinces decreasing by 0.5m tonnes. The volumes of agriculture commodities sent and received both decreased by 0.3m tonnes.

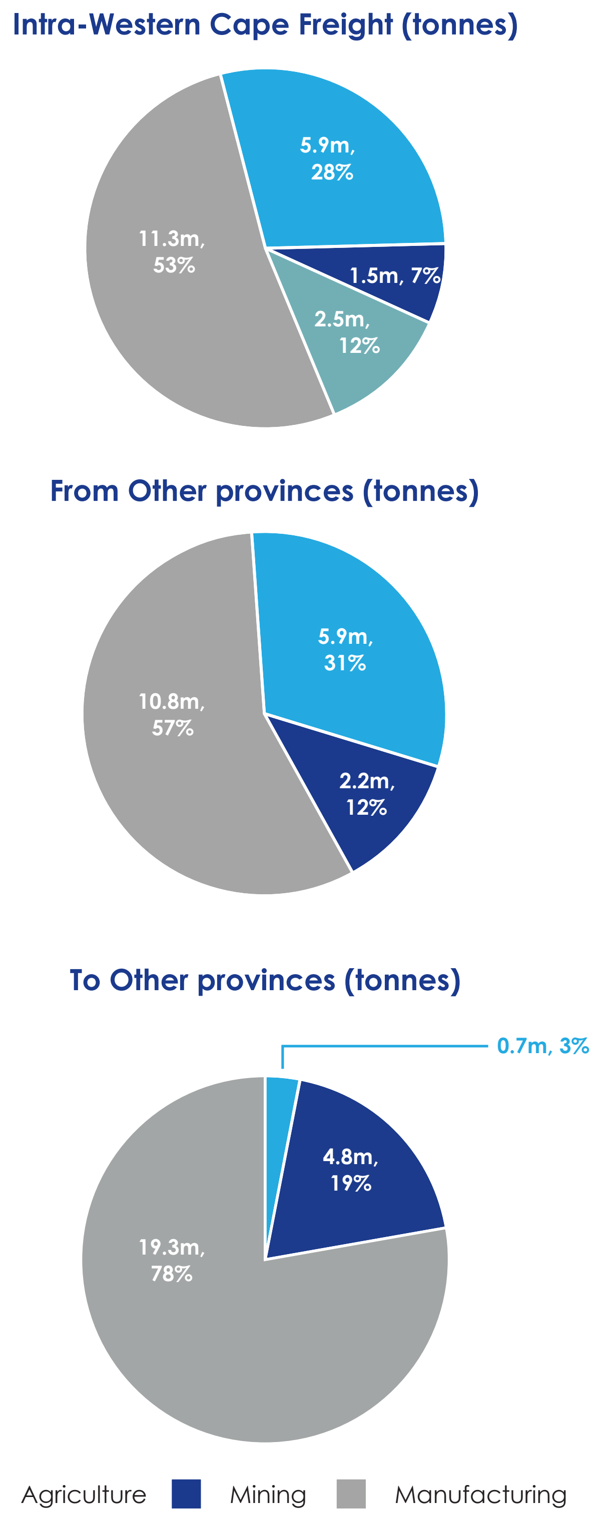


Figure 2: Provincial GFB freight-flows per sector (tonnes 2023)

[1] GFB is defined as the competitive market consists of the total freight tonnes less iron ore exports, manganese exports, pipelines and, for the analysis that follows, stone and aggregate. The latter has been removed from the subsequent GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport.

An industry breakdown of the Western Cape manufacturing sector is shown in Figure 3. It shows the intra-Western Cape manufacturing tonnes, as well as the manufacturing tonnes flowing to other provinces, to depict the manufacturing base of the province. Of the total 30.6m tonnes of manufacturing commodities that originate from the Western Cape, only 11.3m tonnes are distributed inside the province while 19.3m tonnes are sent to the rest of the country. The largest commodity group is processed foods which contributes 29% (an increase of 215 607 tonnes from 2022), followed by beverages and diesel, each contributing 11%. Provided that there is no structural change to the South African economy, processed foods should continue to be the mainstay of the Western Cape's manufacturing sector.

KwaZulu-Natal again dominates as the Western Cape's main GFB trading partner, followed by Gauteng as shown in Figure 4. The Western Cape receives 5.2m tonnes (34.5%) of its GFB freight from KwaZulu-Natal and 3.0m tonnes (26.4%) from Gauteng. Of all the GFB freight originating from the Western Cape, 5.2m tonnes (20.9%) are destined for Gauteng and 4.6m tonnes (18.6%) for KwaZulu- Natal. If it was not for the Port-related trade with KZN, Gauteng would have been the Western Cape's biggest trading partner, because 23.8% of trade with KZN is related to the Port of Durban.

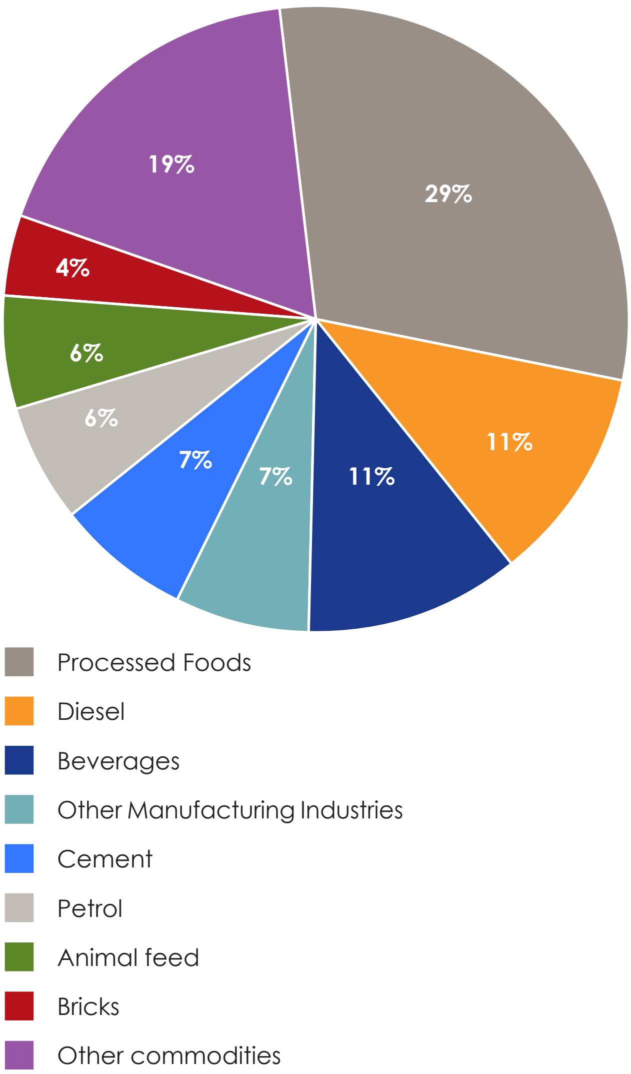


Figure 3: Manufacturing commodities with origin Western Cape (intra-provincial and outgoing, 2023)

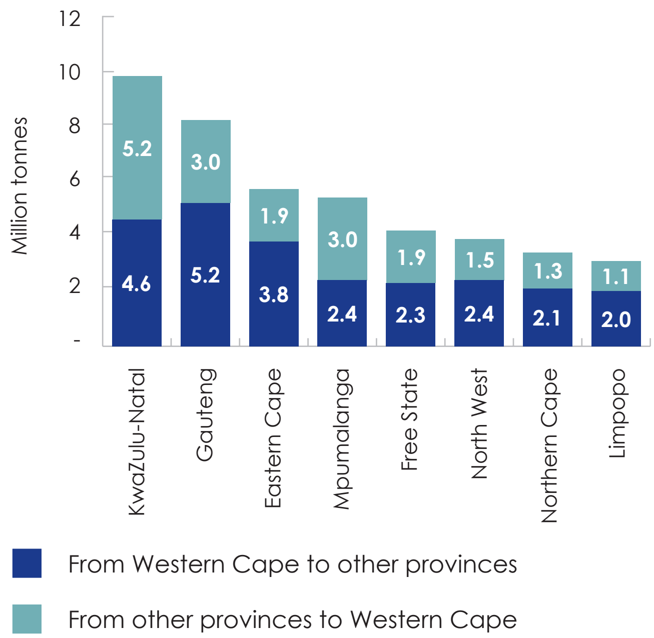


Figure 4: Western Cape inter-provincial GFB freight (2023)

Highlights

- A total of 148.0m tonnes of freight touches the Western Cape 2023 and is made up of 87.2m mining tonnes (59%), 41.8m manufacturing tonnes (28%), 16.6m agricultural tonnes (11%), and 2.5m (2%) waste tonnes.
- The Western Cape GFB freight (65.4m tonnes) is split between intra-Western Cape freight (21.2m tonnes), freight transported to other provinces (24.8m tonnes) and freight received from other provinces (18.9m tonnes).
- Waste is an intra-provincial flow only and amounts to 2.5m tonnes (10% of intra-Western Cape freight).
- Almost half (44%) of intra-Western Cape freight and 78% of freight to other provinces are manufacturing commodities, which together amount to 30.2m tonnes. Manufacturing freight represents 57% of the Western Cape's freight from other provinces.
- The largest commodity group in the Western Cape's manufacturing sector is processed foods (29%), followed by beverages and diesel (both 11%).
- KwaZulu-Natal is the Western Cape's main GFB trading partner, followed closely by Gauteng. If it was not for the Port related trade, Gauteng would have been the Western Cape's biggest trading partner, because 23.8% of trade with KZN is related to the Port of Durban.

To determine corridor freight for the N1, N2 and N7, the districts of South Africa are divided into five (5) zones, of which the first four are illustrated in Figure 1:

1. N1 Corridor;
2. N2 Corridor;
3. N7 Corridor;
4. Core Western Cape (districts within which freight movements are not considered to be on any of the national corridors);
5. Metropolitan (a combination of the Cape Town Metropolitan area and its peripheral areas); and
6. Non-corridor (any freight movement not clustered according to the cluster rules)

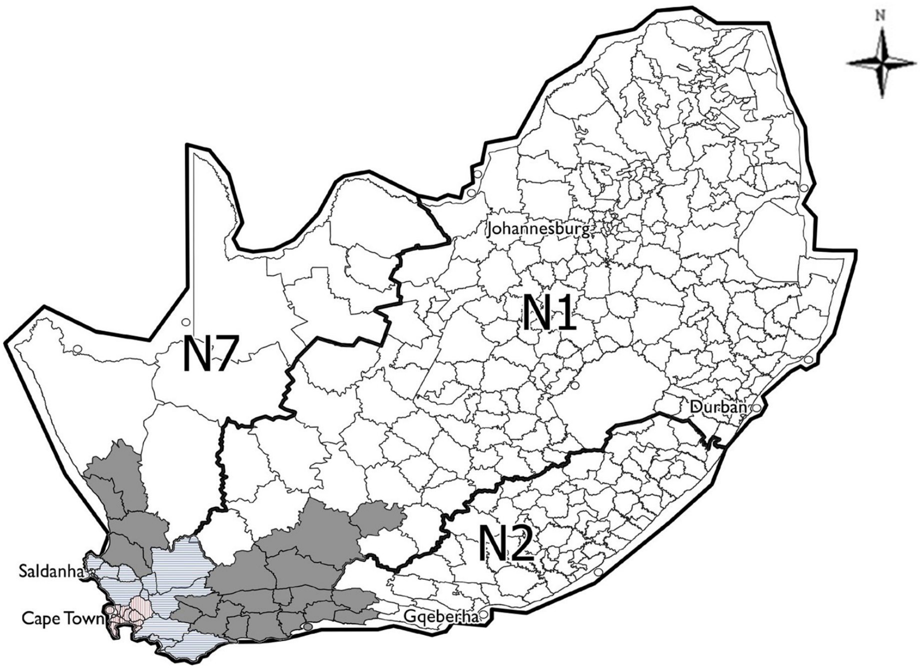


Figure 1: Corridor definitions for Western Cape freight

As shown in Figure 2, freight in the Core Western Cape zone is further sub-divided into Cape Town Metropolitan freight.

The Cape Town Metropolitan (Zone 5) freight is defined as freight that has its origin and destination inside the metropolitan areas.

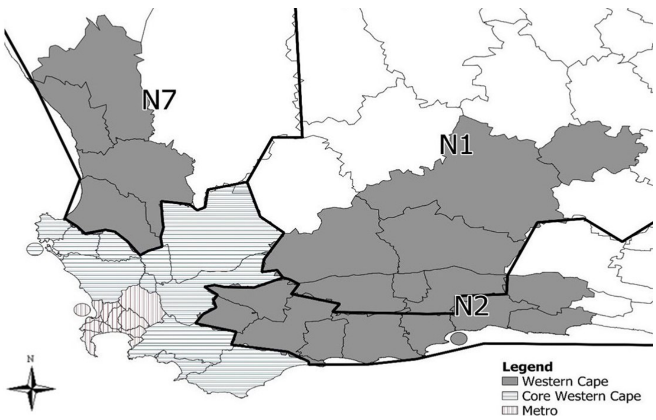


Figure 2: OD pairs for Cape Town Metropolitan freight

The Origin-Destination (OD) pairs are clustered into corridors by applying the following rules:

Cluster rules

- If the origin and destination are both within either the N1, N2 or N7 zones, the OD pair is assigned to that corridor.
- If the origin and destination are within different corridor zones, the OD pair is not assigned to a corridor.
- If the origin and destination are both within the core Western Cape zone, the OD pair is not assigned to a corridor.
- If either the origin or destination is within the core Western Cape zone, the OD pair is assigned to the corridor zone in which the non-core Western Cape origin or destination is.

Table 1 provides total road and rail freight in tonnes and tonne-kms, with the percentage split for each, per zonal grouping.

Table 1: Total road and rail freight in tonnes and tonne-kms per zone (2023)

	Total tonnes			Total Tonne-kms		
Zonal Grouping	**Road tonnes (million) (% of zone freight)**	**Rail tonnes (million) (% of zone freight)**	**Total (million)**	**Road tonne-kms (billion) (% of zone freight)**	**Rail tonne-kms (billion) (% of zone freight)**	**Total (billion)**
N1 Corridor traffic	30.3 (99.5%)	0.1 (0.5%)	30.4	41.9 (99.6%)	0.1 (0.4%)	42.1
N2 Corridor traffic	8.9 (99.8%)	0.01 (0.2%)	8.9	5.3 (99.9%)	0.01 (0.1%)	5.3
N7 Corridor traffic	4.5 (7.4%)	56.2 (92.6%)	60.7	2.5 (4.5%)	51.7 (95.5%)	54.2
Metropolitan traffic	26.1 (100.0%)	0.0 (0.0%)	26.1	0.5 (100.0%)	0.0 (0.0%)	0.5
Core Western Cape	8.6 (98.1%)	0.2 (1.9%)	8.8	0.6 (97.4%)	0.02 (2.6%)	0.6
Non-corridor traffic	9.1 (99.6%)	0.04 (0.4%)	9.1	10.2 (99.5%)	0.1 (0.5%)	10.3
Total	**87.5 (60.7%)**	**56.6 (39.3%)**	**144.1**	**61.1 (54.0%)**	**51.9 (46.0%)**	**113.1**

Table 2 provides total GFB[1] road and rail freight in tonnes and tonne-kms, with the percentage split for each, per zonal grouping.

Table 2: GFB road and rail freight in tonnes and tonne-kms per zone (2023)

	GFB Tonnes			GFB Tonne-kms		
Zonal Grouping	**Road tonnes (million) (% of zone freight)**	**Rail tonnes (million) (% of zone freight)**	**Total (million)**	**Road tonne-kms (billion) (% of zone freight)**	**Rail tonne-kms (billion) (% of zone freight)**	**Total (billion)**
N1 Corridor traffic	30.1 (99.5%)	0.1 (0.5%)	30.2	41.9 (99.6%)	0.1 (0.4%)	42.1
N2 Corridor traffic	8.0 (99.8%)	0.01 (0.2%)	8.0	5.3 (99.9%)	0.0 (0.1%)	5.3
N7 Corridor traffic	3.3 (86.4%)	0.5 (13.6%)	3.8	1.3 (84.7%)	0.2 (15.3%)	1.6
Metropolitan traffic	8.1 (100.0%)	0.0 (0.0%)	8.1	0.2 (100.0%)	0.0 (0.0%)	0.2
Core Western Cape	6.3 (97.4%)	0.2 (2.6%)	6.5	0.5 (96.8%)	0.0 (3.2%)	0.5
Non-corridor traffic	8.7 (99.6%)	0.04 (0.4%)	8.7	10.2 (99.5%)	0.1 (0.5%)	10.3
Total	**64.5 (98.7%)**	**0.9 (1.3%)**	**65.4**	**59.5 (99.2%)**	**0.5 (0.8%)**	**59.9**

Table 3 displays the GFB freight, excluding domestic iron ore and coal.

Table 3: GFB (also excluding domestic iron ore and coal) road and rail freight in tonnes and tonne-kms per zone (2023)

	GFB (also excluding domestic iron ore and coal) Tonnes			GFB (also excluding domestic iron ore and coal) Tonne-kms		
Zonal Grouping	**Road tonnes (million) (% of zone freight)**	**Rail tonnes (million) (% of zone freight)**	**Total (million)**	**Road tonne-kms (billion) (% of zone freight)**	**Rail tonne-kms (billion) (% of zone freight)**	**Total (billion)**
N1 Corridor traffic	29.1 (99.5%)	0.1 (0.5%)	29.3	40.5 (99.6%)	0.1 (0.4%)	40.7
N2 Corridor traffic	8.0 (99.8%)	0.01 (0.2%)	8.0	5.3 (99.9%)	0.0 (0.1%)	5.3
N7 Corridor traffic	3.2 (86.1%)	0.5 (13.9%)	3.7	1.3 (84.6%)	0.2 (15.4%)	1.6
Metropolitan traffic	8.1 (100.0%)	0.0 (0.0%)	8.1	0.2 (100.0%)	0.0 (0.0%)	0.2
Core Western Cape	5.7 (97.2%)	0.2 (2.8%)	5.8	0.5 (96.7%)	0.0 (3.3%)	0.5
Non-corridor traffic	7.8 (99.8%)	0.02 (0.2%)	7.8	9.0 (99.9%)	0.0 (0.1%)	9.0
Total	**61.9 (98.6%)**	**0.9 (1.4%)**	**62.8**	**56.9 (99.3%)**	**0.4 (0.7%)**	**57.3**

[1] GFB is defined as the competitive market consists of the total freight tonnes less iron ore exports, manganese exports, pipelines and, for the analysis that follows, stone and aggregate. The latter has been removed from the subsequent GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport.

When compared to volumes of previous years, the rail tonnages on the N1 and N7 corridors show a negligible increase in the volumes of chemicals and metal products for machinery and electronic equipment within the N1 zonal grouping. GFB freight on the Core and N1 corridors grew by 1.5% and 1.3% respectively, while metropolitan corridors saw an increase of 12.5% compared to 2022 figures. In contrast, the N2 and N7 corridors decreased by 2.4% and 9.5%, respectively. The tonne-km view confirms a smaller rail market share, indicating that longer distance freight is increasingly being transported by road. This indicates that a long-distance market exists that could potentially benefit from rail's economies of scale, provided that rail operators can offer a competitive service.

Table 4 shows the breakdown of GFB (excluding road domestic iron ore and coal) road freight per zone. Note that 47.1% of this freight travels on the N1 road corridor, with an average distance travelled of 1 391 km.

Table 4: GFB (excluding road domestic iron ore and coal) road freight per zone (2023)

Zonal Grouping	Road tonnes (million)	Percentage of road traffic	Average Travel Distance (km)
N1 Corridor traffic	29.1	47.1%	1 391
N2 Corridor traffic	8.0	13.0%	659
N7 Corridor traffic	3.2	5.2%	409
Metropolitan traffic	8.1	13.0%	27
Core Western Cape	5.7	9.2%	83
Non-corridor traffic	7.8	12.6%	1 159
Total	**61.9**	**100.0%**	

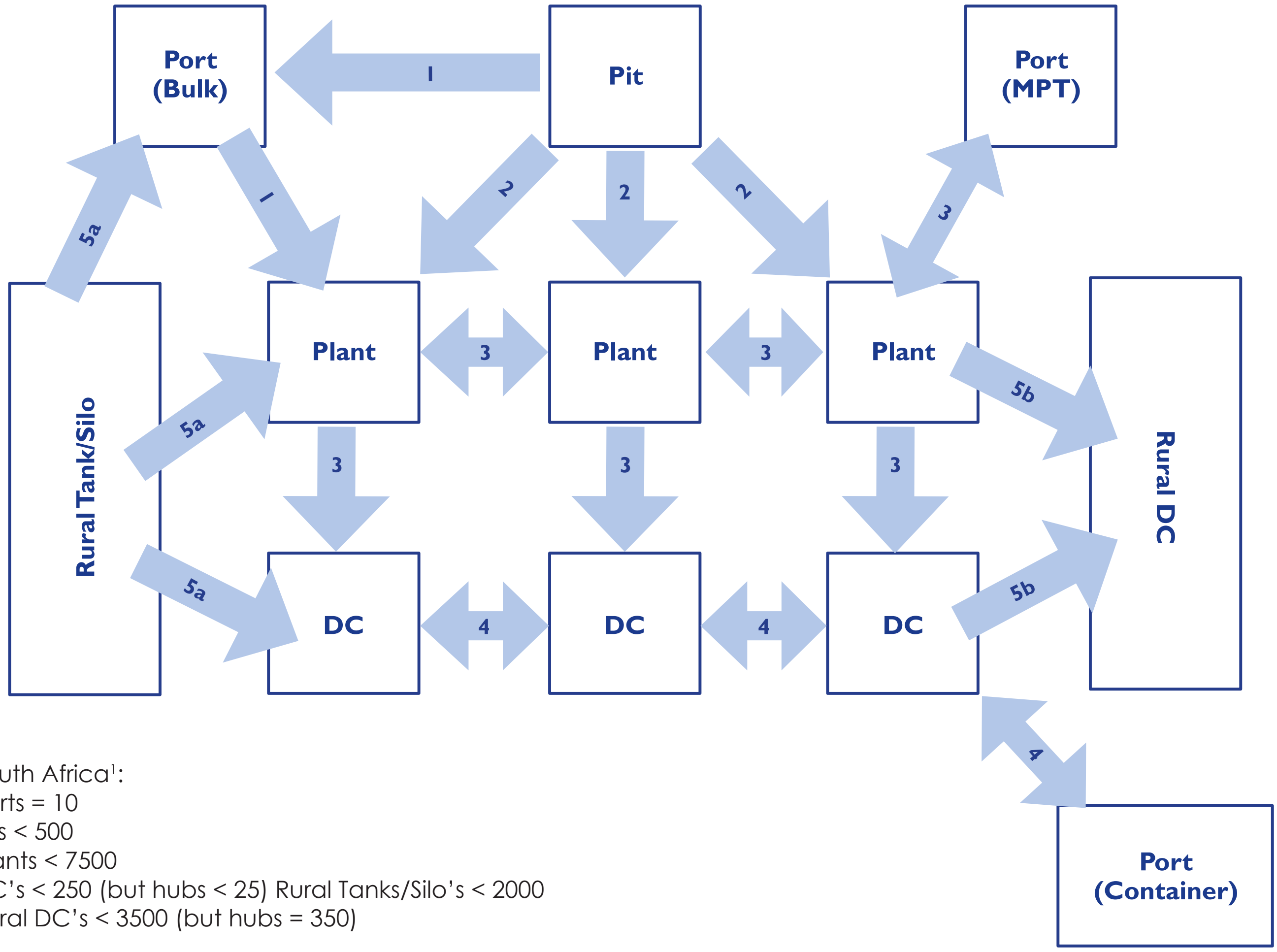
Highlights

- For total freight touching the Western Cape, the N7 is the only corridor with significant rail volumes. However, this is primarily due to the dedicated iron ore corridor (i.e. iron ore and manganese exports).
- Corridor GFB freight is dominated by road, with: 99.5% market share on the N1 corridor; 99.8% market share on the N2 corridor and 86.1% market share on the N7 corridor.
- The average travel distance of road freight on the N1, N2, N7, Metropolitan and Core Western Cape corridor is 1 391 km, 659 km, 409 km, 27 km and 83 km respectively.
- Due to the low rail market share, modal shift opportunities exist for long-distance road freight in the Western Cape (more detail in Scenario 1: Modal shift).

Background to the segmentation of freight flows based on economic structure

The segmentation definitions are illustrated in Figure 1. A pit refers to a source where raw materials are extracted from the earth. Ore from the pit can be transported to a bulk terminal, port or directly to a plant for beneficiation. Beneficiated ore can be transported to another plant (intermediate demand), directly to metropolitan or rural areas, to distribution centres (DC) for consolidation before it is transported to a metropolitan or rural area, or it can be exported.

Based on this view of freight flow segmentation, class 1 (T1) represents freight flow from a pit to a bulk port (exports) and from a bulk port to a plant (imports). T2 refers to direct flows from pit to plant. T3 are flows from one plant to another for beneficiation, to a distribution centre for final consumption, or between plants and Multi-Purpose Terminals (MPTs) for exports and imports. T4 represents commodity flows between distribution centres (typically over long distances between metropolitan areas) for final domestic consumption, or between DCs and port container terminals for exports and imports. T5 represents all flows to and from rural areas; T5a flows originate at a rural tank or silo, while T5b are all flows destined for a rural DC.



South Africa[1]:
Ports = 10
Pits < 500
Plants < 7500
DC's < 250 (but hubs < 25) Rural Tanks/Silo's < 2000
Rural DC's < 3500 (but hubs = 350)

Figure 1: The different typologies of freight flows[2]

As depicted in Figure 2, these segments can be summarised in terms of extraction, intermediate manufacturing, final manufacturing and consumption, and can be divided into imports, domestic flows, and exports. The transportation of domestic consumer goods from points of final manufacturing to points of consumption account for 36% of the Western Cape's total transportation cost. Seventy-five percent (75%) of the 17% of extraction to exports refers to the handling of iron ore and manganese exports in Saldanha.

[1] Indication of the number of nodes, terminals and distribution centres in South Africa.

[2] Havenga, J.H. (2012), "Rail renaissance based on strategic market segmentation principles", Southern African Business Review, Vol. 16 No. 1, pp. 1-21.

Beneficiation therefore represents a significant growth opportunity, changing the Western Cape's status from a "handler" of cargo to an industrial centre. If not for these minerals, the province's beneficiated exports and long-distance imports of final products would exceed the national average, indicating a pressing need to solve the cost concerns of this freight flow segment.

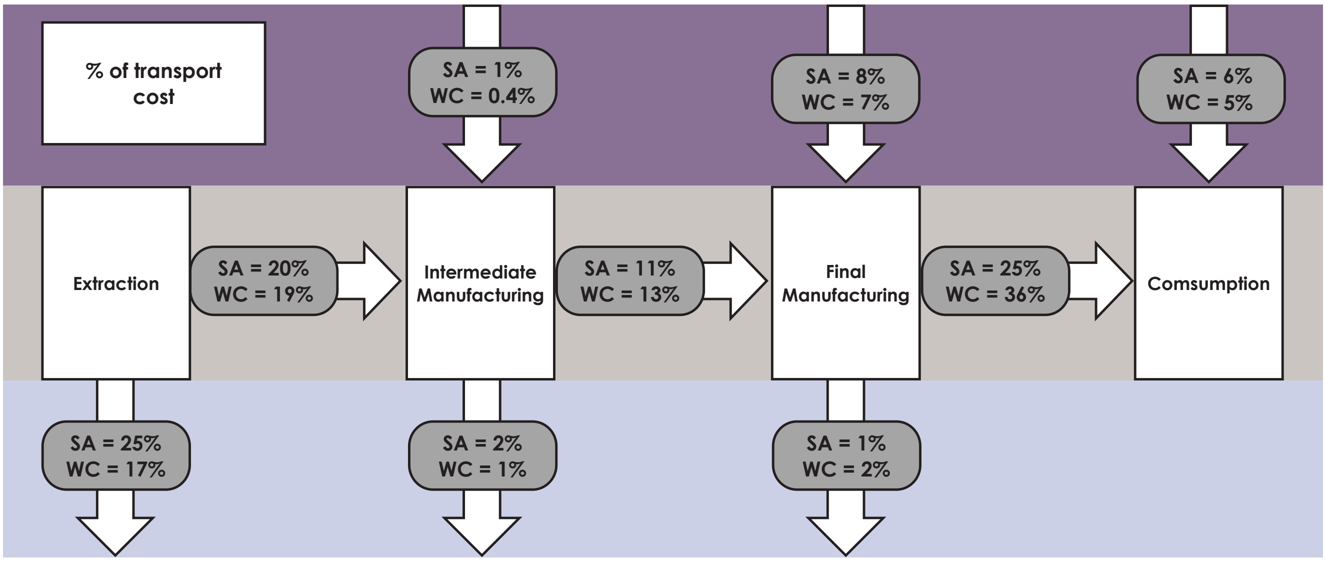


Figure 2: National and Western Cape transport cost per freight flow segment (2023)[2]

Western Cape freight flows informed by economic structure

An analysis of the 2023 modal split in tonnes for General Freight Business (GFB)[3] in the Western Cape confirms that the province transports relatively more manufactured goods, over long distances on road (refer to Figure 3). The data highlights two specific opportunities for rail. The "siding-to-siding" market defines long distance freight that is usually moved from large manufacturing plants to other plants for further beneficiation. In these cases, dedicated sidings are usually the best rail solution. Rail sidings are in place in South Africa, but many have fallen into disuse and have large maintenance backlogs. The potential devolution of low-density rail lines in the near future can offer opportunities for the province as these lines often serve rural areas and improving them can contribute to economic development in the province[4].

The other opportunity is palletisable and containerisable fast-moving consumer goods (FMCG) freight. This freight can be transported from private distribution centres through public intermodal terminals. This domestic intermodal opportunity is still absent in South Africa's rail/road service offering, due to management and resource challenges within Transnet, as well as caution from road hauliers owing to the impact on their traditional business models. The inability of the railway to develop these solutions collaboratively with road to capture long-distance FMCG freight is hampering the competitiveness of the Western Cape's industries due to the resulting impact on transport costs. The modal shift scenarios identify cost savings, should rail be able to realise these opportunities (see section on Scenario 1: Modal Shift).

The logistics challenges currently facing South Africa and efforts to revitalise Transnet, present opportunities for the public and the private sector to proactively establish terminal and consolidation centres to facilitate the modal shift of palletised and containerised freight.

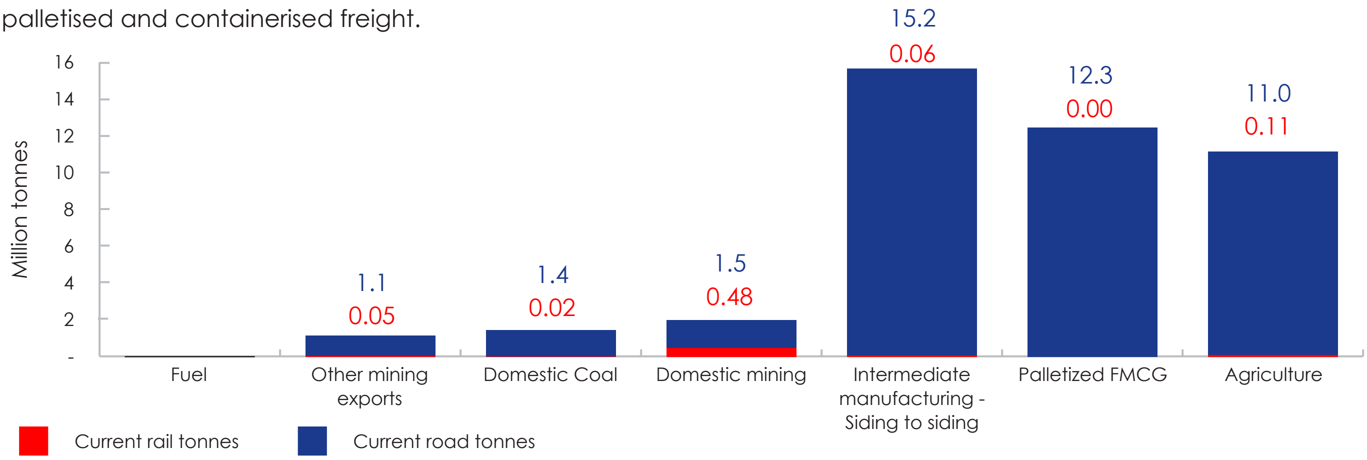


Figure 3: GFB road and rail tonnes per market segment in the Western Cape for 2023

[3] GFB is defined as the competitive market space, and consists of the total freight tonnes less iron ore export line, manganese exports, pipelines and, for the analysis that follows, stone and aggregate. The latter has been removed from the subsequent GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport.

[4] South African Freight Logistics Roadmap, 2023

Highlights

- Manufactured goods, transported over long distances on road, constitute a large volume of the Western Cape GFB freight.
- This presents two opportunities for rail:
  1. Siding-to-siding freight, that is, long-distance freight that is usually moved from large manufacturing plants to other plants for further beneficiation; and
  2. FMCG freight which can be palletised and containerised, and transported through domestic intermodal solutions.
- The inability of the railway to develop these solutions collaboratively with road to capture the long-distance FMCG freight impacts transport costs, and hence hampers the competitiveness of industries in the Western Cape.
- South Africa's logistics challenges and rail reform initiatives create opportunities for the public and private sector to establish terminal and consolidation centres, promoting the shift of palletised and containerised freight to alternative transportation modes.
- See section on Scenario 4: Rail freight potential in the Western Cape.

Economic forecast

The WC FDMTM considered 2029 and 2054 as the forecast years in the analysis. The total tonnes forecast per sector for 2029 and 2054 are given in Figure 1, both (a) with and (b) without the iron ore and manganese exports, crude oil in pipes, and stone.

While COVID-19's economic impact was considered in previous economic forecasts, this forecast did not consider the potential for continued economic volatility and disruptions to the supply chains. This forecast did, however, consider global climate change perspectives, as well as the short to medium term impact of climate phenomena such as El Niño[1].

The forecast for mining, when considering GFB, is pre-dominantly driven by titanium minerals mining on the West Coast, which is very short-haul and specific. This is evident from Figure 2, which shows the forecasted Western Cape freight flow tonne-kms by sector both (a) with and (b) excluding iron ore and manganese exports, crude oil in pipes, and stone. Evidently, manufacturing tonne-kms currently far exceed the mining tonne-kms when GFB freight is considered.

As shown by Figure 2, manufacturing commodities for the Western Cape are transported over long distances. The forecast also indicates the presence of a ceiling on the export lines[2]. This highlights a systemic problem with the long-term sustainability of the railway lines: their profitability depends on the global demand for South African minerals, despite their high economies of scale. The investment into the export lines was necessary, for both medium-term rail growth and the South African economy; however, it is not a long-term sustainable strategy, for either the railway or South Africa. The economic forecast suggests that the long-term strategy for the Western Cape should focus on developing and supporting efficient logistics solutions to support the growing manufacturing and agriculture sectors, which supply freight to the rest of the country over long distances.

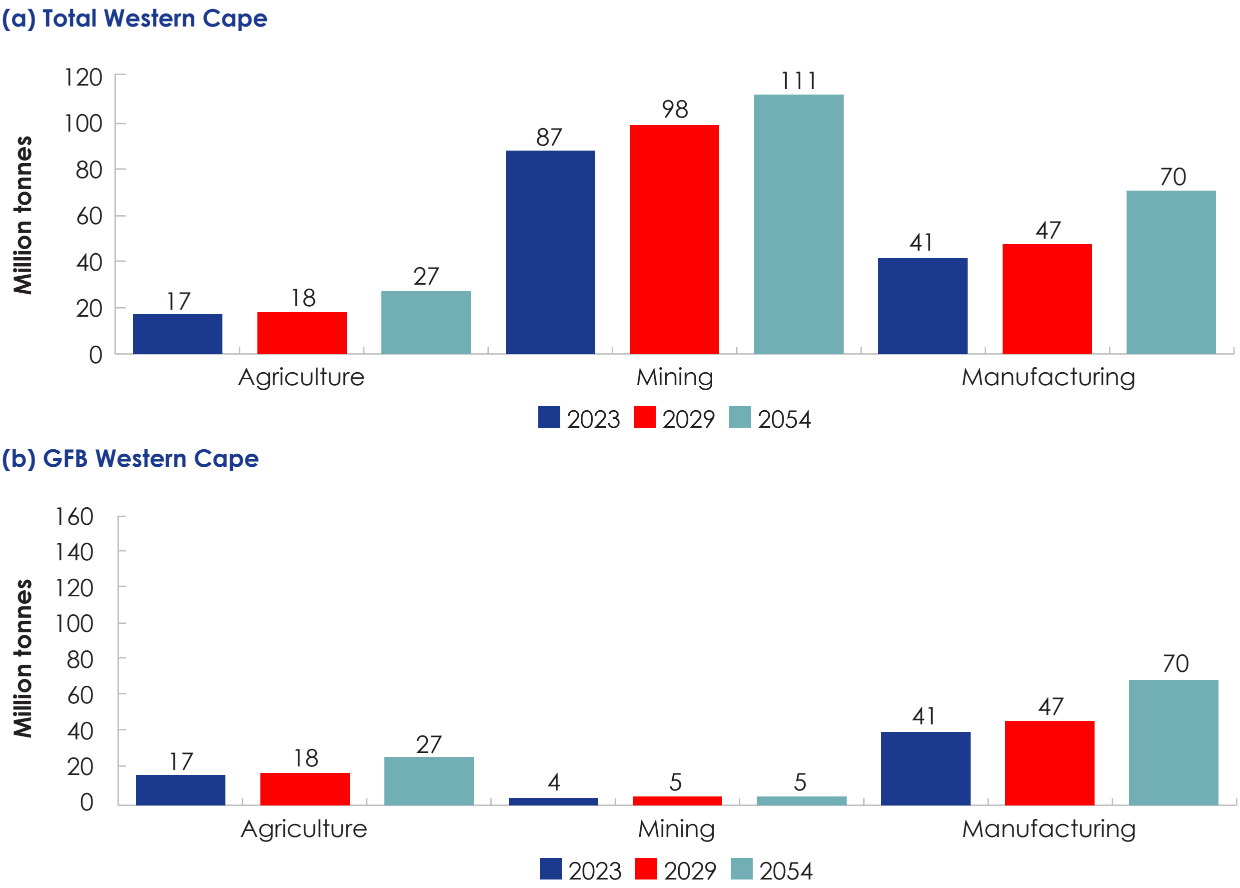
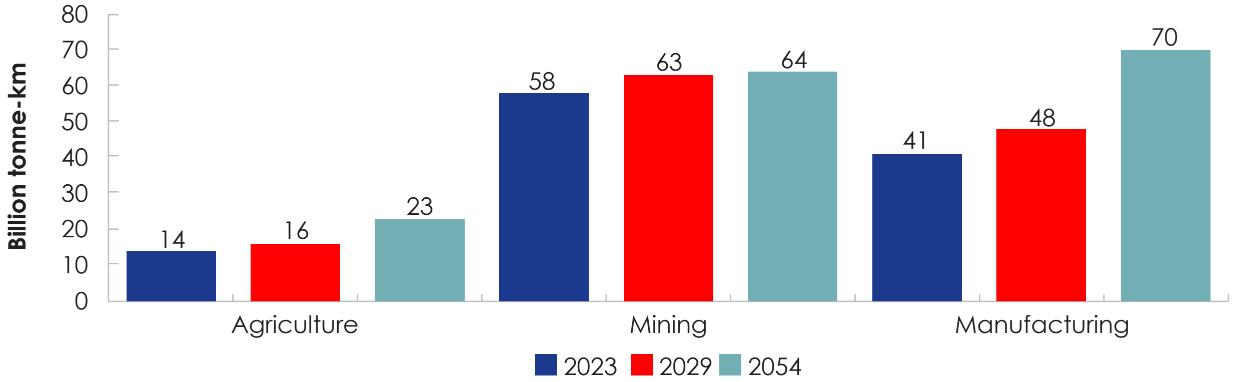


Figure 1: Total Western Cape freight flow forecast per sector (tonnes 2023)

[1] The term El Niño (Spanish for 'the Christ Child') refers to a warming of the ocean surface, or above-average sea surface temperatures, in the central and eastern tropical Pacific Ocean (United States Geological Survey, n.d.). From more information, see: https://www.usgs.gov/faqs/what-el-nino-and-what-are-its-effects

[2] Anglo American estimated a reserve life for Sishen till 2035 in its 2021 Kumba Ore Reserves and Mineral resources report (Anglo American, 2021).

(a) Total Western Cape



(b) GFB Western Cape

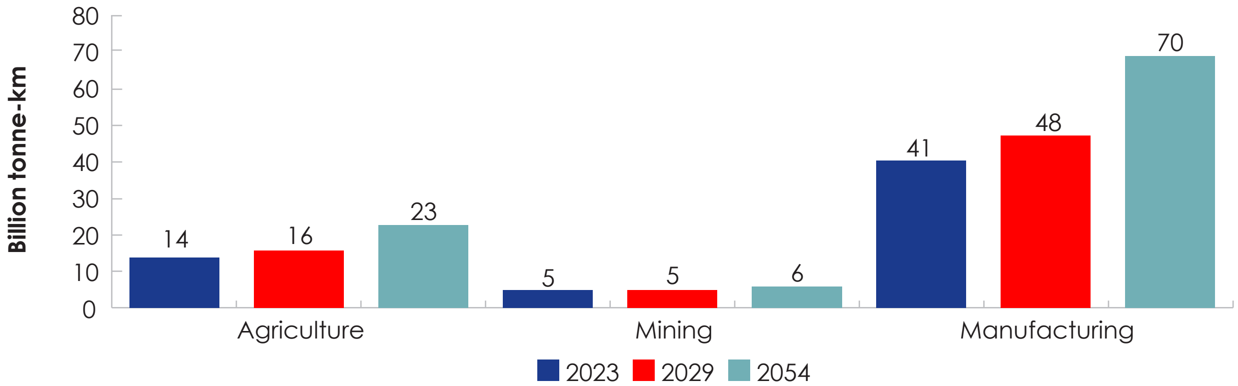


Figure 2: Total Western Cape freight flow forecast per sector (tonne-km 2023)

Highlights

- Iron ore and manganese exports constitute the majority of the Western Cape's mining sector freight intensity.
- Manufacturing and agricultural commodities from the Western Cape are transported over significantly longer distances than the mining commodities.
- The manufacturing sector is forecast to generate the largest logistics demand in the absence of the ring-fenced export lines.
- The economic forecast suggests the development of infrastructure that will support the growing manufacturing and agriculture sectors.

Freight transport costs

The freight transport cost model forms part of the national logistics cost model, which was developed by the research team to quantify the direct[1] national logistics costs. The freight transport costs are available on a district- to-district basis per commodity, and can be used to measure the impact of modal changes; they therefore indicate what the impact of certain macro- economic infrastructure-related decisions would be on the economy[2]. For the refinement of the WC FDM™, actual road freight transport rates were confidentially received from Logistics Service Providers (LSPs) and used to refine the fixed and variable road freight transport cost elements.

The different road transport cost elements are determined by vehicle type which, in turn, is determined by commodity type, typology, and route of travel. A commodity's "preferred" vehicle type will change as each of these variables changes. Once the vehicle type and volume are assumed, the cost elements can be assigned. The approach is based on the core freight transport cost drivers, namely weight and distance travelled. Each movement can also be attributed to one of 41 possible vehicle combinations, based on the commodity's destination and distance travelled. A separate rate per tonne-kilometre for each of the 41 vehicle types is applied. Other costs that are determined by the typology, such as fuel costs and toll fees, are defined and calculated separately.

Average annual distances and working days are applied to the various combinations, based on current practice, including waiting time for loading and unloading or any other relevant factors. As examples, the sources of information include logistics and supply chain service providers, FMCG manufacturers, retail groups, agricultural food producers, processors, timber plantations, the furniture industry, car carriers, the construction industry, mining (for transport of mined commodities, but excluding transport for mining activities). Payloads for each category are based on transport regulations. Where return loads are not possible or practical, the load factor is set at 50% (e.g., raw milk and liquid petroleum). In other cases, inputs from transporters and suppliers provide an acceptable average load factor. Emerging changes, such as making use of larger pallet footprints in secondary distribution, are taken into account. Few transporters and fleet owners can actually afford to operate without a return leg, which means that load factors increase with distance where commodities and return volumes (as determined in the FDM™) allow.

Within these cost measurement combinations, different cost drivers exist for fuel, wages, repairs and maintenance, depreciation, capital cost, insurance, tyres, tolls roads and licence fees.

It is necessary to distinguish between costs and tariffs.

Costs refer to the actual costs that are directly incurred by the freight movement. That will be the total cost for in-house transport as well as outsourced transport. In the case of outsourced transport, a margin is added to the cost, in order to charge a tariff.

Tariffs reflect both the margins and strategic pricing decisions of a transport company, in addition to cost recovery. A transport company, for example, could decide to fund return legs by only recovering variable cost, thus transporting freight below total cost. For the purposes of informing policy and investment decision- making, actual costs are used in modelling national and provincial logistics costs; the impact of margins and of strategic decision- making on costs can then be modelled in scenarios.

Road costs and rail tariffs are typically used (refer to Table 1).

Table 1: Overview of underlying aspects of costs and tariffs for road and rail transport

	Road	Rail
Costs	Can be calculated with a fixed and publicly available schedule[3].	Estimated using a well- researched algorithm. (Even the railway service providers find it difficult to apply activity- based rail costing. This is a global phenomenon, due to the very high fixed cost nature of rail business).
	The freight owner incurs road cost by utilising in-house road transport.	In-house rail transport is not possible.
Tariffs	Estimated through fieldwork and interviews in order to add margins to costs.	Precisely available for all consignments in South Africa, but confidential at the detail level.
	The freight owner incurs road tariffs by outsourcing road transport.	The freight owner incurs rail tariffs by utilising Transnet.

[1] Direct costs are internal, monetised costs of inputs and labour that are used in the provision of freight transport. These differ from externality costs that affect third parties who may not be direct users of freight transport services.

[2] For further detail on the methodology and macroeconomic application, refer to: Havenga, J.H. (2010), 'Logistics costs in South Africa: The case for macro-economic measurement', South African Journal of Economics, Vol. 78 No. 4, pp. 460-478.

[3] Data from the Road Freight Association provides detailed fixed and variable cost drivers for the different vehicle classes used in the WC FDMTM.

Rail tariffs are used due to the complexity of calculating actual rail costs. Furthermore, freight owners cannot incur actual rail costs since freight rail transport cannot be provided "in-house" (freight owners in South Africa do not own their own railway). Actual rail tariffs are confidential and cannot be disclosed, but were used in an aggregated way. In cases where rail costs are required for scenario analysis, costs are estimated based on an algorithm developed in conjunction with Transnet[4]. Road cost and tariffs are both possible for freight owners as only about 51% of freight transport in South Africa is outsourced. Where freight transport is provided in-house, the actual cost is all that is incurred by the freight owner. Where it is outsourced, the tariff incurred is made up of the transport supplier's cost and mark-up. For the purposes of comparison, an 8%[5] profit margin was assumed for road transport costs in 2023 (see Figure 2). One of the major drivers of efficiency in road freight is outsourcing, which also contributes to South Africa being more efficient than most BRICS partners in comparisons such as the World Bank Group's Logistics Performance Index (LPI).

The drivers for road freight transport costs are described in Table 2.

Table 2: Cost drivers for road freight transport for 2023

	Cost driver	Description
	Fuel	The price of fuel is based on the weighted average annual price for 2023, taking cognisance of the different inland and coastal prices, for 500 parts per million (ppm) diesel. Bulk rebates are ignored.
	Truck driver wages	Truck driver and assistant wages vary considerably across the country based on vehicle size, primary and secondary distribution tasks, region, operators, and the structure of remuneration packages. All assumptions, in line with wage agreements between the Road Freight Employers' Association and the National Bargaining Council for the Road Freight and Logistics Industry, include an allowance for company contributions, but exclude overtime and bonuses.
	Maintenance & Repairs	The assumed cost of maintenance is based on current vehicle manufacturer maintenance contract rates, expected economic component life and industry experience. The assumptions consider the complexity of each task, including typical operating conditions such as roads, topography, and traffic density. Repair and maintenance costs for refrigeration operations are calculated in hours.
	Depreciation	An annual depreciation percentage is considered per vehicle combination, as well as a residual value per vehicle.
	Cost of capital	All estimates are based on a cost estimate for new vehicles and trailing equipment. The initial cost of vehicles, trailers, bodies, and auxiliary equipment (such as refrigeration units) is based on the average of published selling prices of such items in the modelled year in question, less known fleet discounts.
	Insurance	Insurance cost assumes that the operator has a low risk rating. Premiums are currently set at 7% of the purchase price for vehicles, equipment, and trailers.
	Tyres	Tyre life is based on the typical casing life that is obtained in the various operations.
	Toll fees	Assumed route-incurred toll fees are applied proportionally to the number of trips that each movement accounts for, according to the size structure of the vehicle used for its toll fee class.
	Vehicle licence fees	Licence fees for vehicles and trailers are based on the average license fees of each province, as the licensing province of trucks is unknown, and nationally distributed[6].

[4] Note that actual rail costs at a consignment level are very difficult to calculate, even for the railways.

[5] This is based on confidential interviews.

[6] This average assumption is deemed sufficient, given the current status of road freight user-pay charges.

In 2023, road freight transport accounted for 87% of the total estimated freight transportation cost. The main cost drivers were fuel (R32.6 billion; 40.7% of total cost), maintenance and repairs (R11.5 billion; 14.4% of total cost), and truck driver wages (R7.9 billion; 9.9% of total cost)[7]. These costs are shown in Figure 1 and Table 3. Fuel cost increased by 62.3% against 2021 (driven by higher fuel prices), but decreased 2.2% against 2022 (driven by lower fuel prices). It appears that the fuel cost has stabilised after doubling between 2020 and 2022.

Figure 2 outlines the cents per tonne-km (c/tonne-km) for road and rail. The impact of the export lines on rail rates is evident. Given rail's high fixed cost, higher density means that the mode's c/tonne-km cost will decrease with each additional tonne- km of activity over the same track length. With its current low market share, the South African freight railway's challenge is that it needs a substantial modal shift from road to realise these density benefits and further emphasises the significance of resolving the rail crisis in South Africa (see section 9 on externality costs).

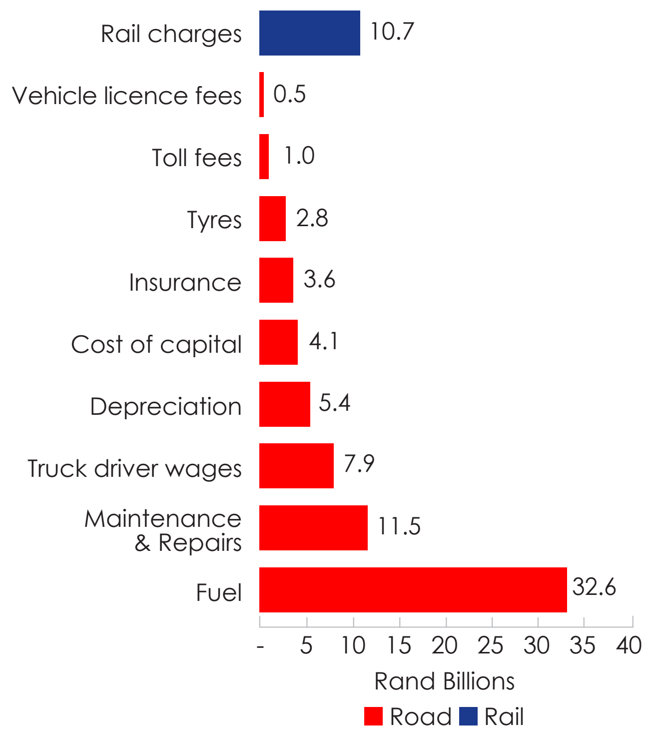


Figure 1: Transport cost components per mode for Western Cape freight (2023)

Table 3: Transport cost drivers

Cost driver	Cost (R bn)	% of total
Fuel	32.6	40.7%
Maintenance & Repairs	11.5	14.4%
Truck driver wages	7.9	9.9%
Depreciation	5.4	6.7%
Cost of capital	4.1	5.1%
Insurance	3.6	4.5%
Tyres	2.8	3.5%
Toll fees	1.0	1.2%
Vehicle licence fees	0.5	0.6%
Rail charges	10.7	13.4%
Total	**79.9**	**100%**

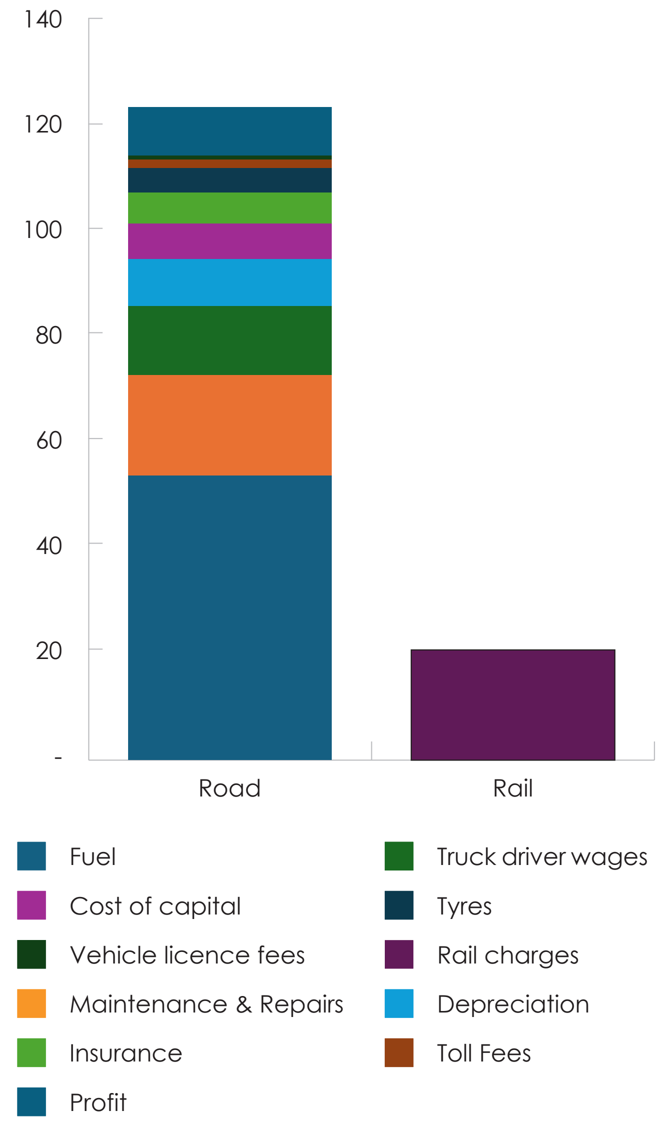


Figure 2: Transport cost in c/tonne-km per mode for Western Cape freight (2023)

Highlights

- In 2023, road freight transport accounted for 87% of the total transportation cost.
- The main road freight transport cost drivers were fuel (R32.6 billion; 40.7% of total cost), maintenance and repairs (R11.5 billion; 14.4% of total cost) and truck driver wages (R7.9 billion; 9.9% of total cost).
- Fuel cost increased by 62.3% against 2021 and decreased 2.2% against 2022, driven by lower fuel prices.
- With its current low market share, the South African freight railway's challenge is that it needs a substantial modal shift from road to realise density benefit and further emphasises the significance of resolving the rail crisis in South Africa.

[7] The model, as was stated, includes actual rail and pipeline tariffs (pipeline tariffs are not shown on the graph, as they are negligible — only 0.02% of total transport costs in the Western Cape).

Externality costs

The total estimated CO_2 emissions for South Africa (2023) are 402 million tonnes[1], of which approximately 12.1% (i.e. 48.6 million tonnes) are attributed to transport[2] (with an estimated 23.0 million tonnes stemming from freight transport specifically). To ensure a holistic view of transportation cost, externalities such as emissions need to be considered. Externality components are the costs associated with accidents & crashes, congestion, emissions, land use, noise and policing. These components are calculated as a relative cost per tonne-km per mode and can be applied to any subset of freight movements, such as the Western Cape. South Africa has an established national externality cost model[3] that can be used to estimate these costs. The rates are summarised in Table 1 and are the latest available 2017 values (no other, more recent rates are available).

Table 1: National externality cost rates per component, 2017 (cent per tonne-km)

Externality cost rate components	Road	Rail
Accidents & crashes	4.79	0.41
Congestion	2.95	N/A
Emissions	8.97	1.21
Landway	0.87	0.08
Noise	3.24	0.03
Policing	2.29	N/A

Emissions costs include not only CO_2 gasses, but also all other emissions produced by burning fuel during the engine's combustion process. The emissions produced per litre of burnt diesel are given in Table 2.

Table 2: Grams produced per litre and estimated costs, per component of emissions

Acronyms[4]	NO_x	PM metro	PM rural*	HC	CO	CO_2**	SO_2
Grams produced, per litre (g/l) of fuel burnt	26.5	1.19	1.19	0.70	4.00	2 688	12.56
Assumed cost per ton, based on international perceived values (Rand)	27 721	612 906	180 525	8 113	8 113	334	54 090

Considering the average fuel usage per tonne-km of all freight vehicles, the resultant emissions in grams per tonne-km are given in Table 3, which can be used to compare emissions per modes.

Table 3: Grams of emissions produced per mode per tonne-km

	NO_x	PM metro	PM rural*	HC	CO	CO_2**	SO_2
Road tonne-km	0.71	0.03	0.03	0.02	0.11	72.41	0.34
Rail tonne-km (electric)						28.34	
Rail tonne-km (diesel)	0.42	0.02	0.02	0.01	0.06	42.96	0.2
Rail tonne-km (weighted average of electric and diesel)	0.04	0.002	0.002	0.001	0.005	29.58	0.02

** While particulate matter (PM) is produced equally in metropolitan and rural areas per litre of fuel burnt, its perceived cost is higher in more densely populated areas*

*** To calculate the cost of CO_2 emissions for South Africa, a cost of R225 per tonne of CO_2 is assumed for 2010, in line with the proposals of the South African National Treasury (2010)[5] and McCarl and Sands (2007)[6]*

[1] https://ourworldindata.org/co2/country/south-africa#what-are-the-country-s-annual-co2-emissions

[2] https://www.iea.org/countries/south-africa/emissions

[3] For a detailed methodology of the externality costs model, refer:

Swarts, S., King, D., Simpson, Z., Havenga, J., and Goedhals-Gerber, L. (2012), 'Calculation of freight externality costs for South Africa, Journal of Transport and Supply Chain Management, Vol. 4 No. 1 and

Havenga, J.H. (2015), 'Macro-logistics and externality cost trends in South Africa – Underscoring the sustainability imperative', International Journal of Logistics Research and Applications, Vol. 18 No. 2, pp. 118 –139, https://doi.org/10.1080/13675567.2015.1015509.

[4] Acronyms: **NOx** = Nitrogen oxides; **PM metro** = Particulate matter metro; **PM rural** = Particulate matter rural; **HC** = Hydro Carbons; **CO** = Carbon Monoxide; **CO_2** = Carbon dioxide; **SO_2** = Sulphur dioxide

[5] Department of National Treasury (Republic of South Africa). (2010). Reducing Greenhouse Gas Emissions: The Carbon Tax Option. [Pretoria]: Department of National Treasury. https://www.treasury.gov.za/public%20comments/discussion%20paper%20carbon%20taxes%2081210.pdf

[6] McCarl, B.A. & Sands, R.D. Competitiveness of terrestrial greenhouse gas offsets: are they a bridge to the future?. Climatic Change, Vol. 80, pp. 109–126, https://doi.org/10.1007/s10584-006-9168-5.

The costs of accidents & crashes exceed the cost of damage to the involved vehicles, which is internalised through insurance policies. Apart from the direct cost of replacing or repairing a vehicle there are additional economic costs due to loss of life and productivity which can be quantified through value of statistical life tables. In South Africa, the Road Accident Fund levy directly internalises some, but not all of this externality cost.

Noise externality cost is based on the willingness to pay to avoid the proximity of living near noisy road or rail infrastructure. A small percentage of national GDP is used based on international benchmarks to estimate the total willingness to pay for South Africa and is then disaggregated across road and rail.

Congestion is the increase in travel time road users experience due to travel demand exceeding road capacity constraints. Large trucks take up the equivalent of roughly 3.5 passenger car equivalents on the road. It is calculated by taking the difference between average vehicle speeds and expected free flow speed across counted sections where the number of vehicles per hour per lane exceeds the free flow limit. As all vehicles are traffic and contribute toward congestion, different vehicle types' contribution are normalised to passenger car equivalents. This gives a split of the total time lost due to congestion to each vehicle use (passenger and freight) which is monetarily quantified based on a cost per hour.

Policing externality cost is based on the national estimated budget per person spent on traffic policing. This cost is attributed to freight activity based on the live vehicle population composition.

Apart from the necessity of initially connecting different areas of the country, there is an external cost associated with the expanded land use of transport infrastructure that could have been used for other economic activities. Roads are expanded to alleviate congestion, rather than finding more space-efficient means of transportation. This cost is attributed to freight according to an estimate of annual distance travelled per vehicle type and the live vehicle population.

The resultant total externality costs for Western Cape freight are given in Figure 1 and Table 4. Rail externality costs are negligible relative to road externality costs.

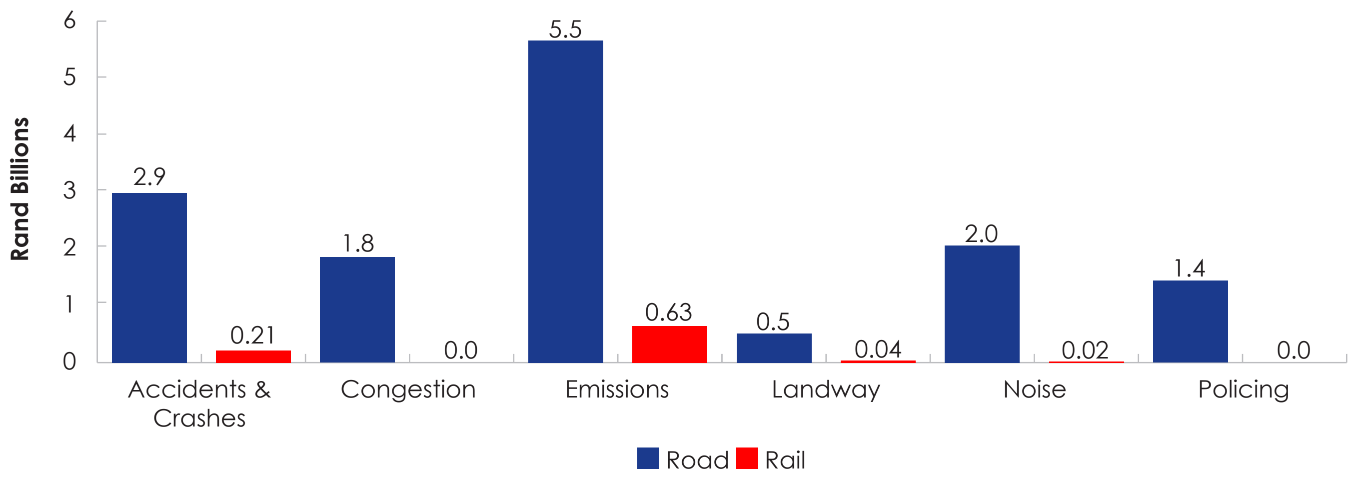


Figure 1: Externality costs for Western Cape freight (2023)

Table 4: Externality costs for Western Cape freight (2023)

Externality cost driver	Road Cost Rbn (% of driver cost)	Rail Cost Rbn (% of driver cost)	Total Cost Rbn (% of total)
Emissions	5.48 (90%)	0.63 (10%)	6.11 (41%)
Accidents & crashes	2.93 (93%)	0.21 (7%)	3.14 (21%)
Noise	1.98 (99%)	0.02 (1%)	2.00 (13%)
Congestion	1.80 (100%)	-	1.80 (12%)
Policing	1.40 (100%)	-	1.40 (9%)
Landway	0.53 (93%)	0.04 (7%)	0.57 (4%)
Total	14.12 (94%)	0.90 (6%)	15.02 (100%)

The total externality costs for road freight transport in the Western Cape for 2023 amount to R14.12 billion, which is 20.4% of direct road freight transport costs[7] for the same period. Road freight transport contributes 94% of the total land freight transport externality costs[7] of R15.02 billion.

[7] Total direct road cost for 2023 is R69.22bn. If the road externality cost of R14.12bn is internalised, the total road transport cost will increase by 20.4% to R83.34bn.

The four largest road freight transport externality cost drivers, namely, emissions, accidents & crashes, noise and congestion, contribute more than 80% to total freight transport externality costs in the province, impacting the general population while not being carried by the users of the service. When externality costs are not internalised, road freight operators are effectively cross subsidised by individuals living in polluted air (emissions) or next to noisy roads, or commuters travelling on congested routes. Furthermore, taxpayers fund the clearing of accidents & crashes and rehabilitation of damaged roads. The internalisation of externality costs can be induced through both "negative" and "positive" policy interventions. "Negative" policy instruments relate to measures such as congestion charges, emission taxes, noise controls, land use limitations and user-pay principles. "Positive" policy instruments relate to a regulatory framework supportive of the creation of industry associations, logistics hubs and public-private partnership models. This could encourage widespread modal shift to induce a systemic change by which most of rail-targetable freight is shifted to rail[8].

Highlights

- The total externality for road freight transport in the Western Cape amounts to R14.12 billion, which is 20.4% of current road freight transport costs.
- Road freight transport contributes 94% of the total freight transport externality cost of R15.02 billion.
- The four largest road freight transport externality cost drivers, namely emissions, accidents & crashes, noise, and congestion, contribute more than 80% to total freight transport externality costs in the province, impacting the general population while not being carried by the users of the service.
- The internalisation of externality costs can be induced through policy interventions.
- Policy interventions could induce a systemic change to shift rail-targetable freight to rail.

[8] Refer to Havenga, J.H. and Simpson, Z.P. (2016), 'Freight logistics' contribution to sustainability: Systemic measurement facilitates behavioural change', Transportation Research Part D: Transport and Environment, Vol. 58. pp. 320-331, https://doi. org/10.1016/j.trd.2016.08.035 for a case study on the internalisation of national externality cost.

Scenarios

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies and spatial planning. Pressing policy issues were identified, and high-level scenarios were developed to estimate the potential annual impact on the Western Cape's freight transport costs and Gross Domestic Product (GDP). The current results are indicative, with the purpose of encouraging discussions to increase the accuracy of the scenario development inputs. Once agreement is reached on the high-level scope and outcomes of these scenarios, priorities will be set to guide the implementation process for these scenarios.

Modal shift scenarios

The modal shift scenario is for commodities identified as rail-friendly, based on the density attributed to the origin and/or destination, packaging type and distance. To calculate the potential opportunity cost, at current prices, of a road-to-rail freight shift, or a lack thereof, the following baseline scenarios are quantified:

1. **Stagnant rail volumes**, where rail's volumes remain the same over the forecast period;
2. **Constant rail market share**, where rail's percentage remains the same over the forecast period;
3. **Growth in rail market** share where rail's market share grows to capture all the rail-friendly traffic (i.e. able to be shifted to rail).

The impacts on transport costs and emissions are calculated for each of these baseline scenarios.[1] That is, what is the potential for modal shift, given each of the three baselines.

Assumptions

- Assuming 2023 average transport costs per segment, total transport costs were calculated for each scenario.
- In the absence of an average cost per segment, the overall average cost per mode was used.
- Modal shifts for forecast years are calculated at 2023 prices. This provides a conservative estimate – it has been shown that as rail freight density increases, the mode becomes more efficient.
- Modal shift scenarios are developed for the Western Cape portion of each of the three (3) long-distance corridors traversing the Western Cape, namely the N1 (average travel distance of 1 391 km), N2 (659 km) and N7 (403 km), and for short-distance freight (77 km) transported locally in the Core Western Cape region.

Results

The modal shift scenario results are depicted in Tables 2, 4, 6 and 8.

N1 corridor

The key opportunities for modal shift on the N1 corridor are in the siding-to- siding and palletised Fast-Moving Consumer Goods (FMCG) segments. The volumes that could be shifted are shown in Table 1 and depicted graphically in Figure 1.

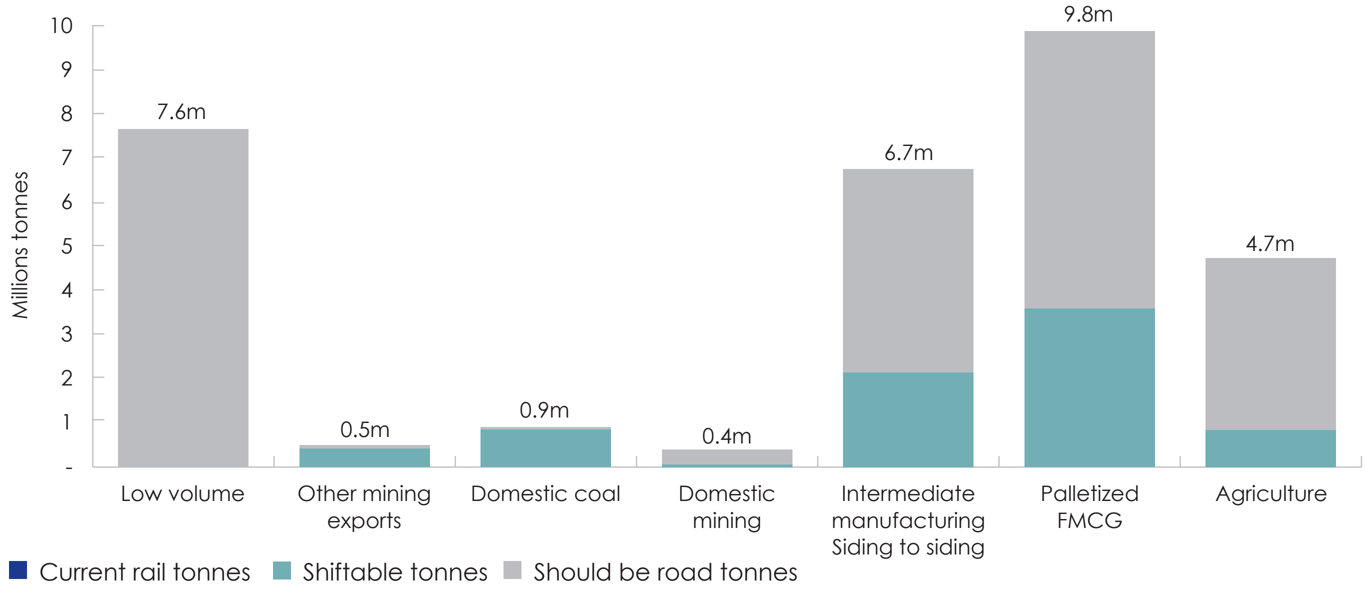


Figure 1: Modal shift opportunity per segment on the N1

[1] Where current rail rates are above road market rates it is assumed that freight switching to rail will do so at road market rates.

Table 1: Modal shift opportunity per segment on the N1

Segment	Road tonnes	Rail tonnes	Shiftable tonnes
Low volume targetable	7 588 118	354	(0.0%)
Other mining exports	490 698	-	419 695 (85.5%)
Domestic coal	862 244	-	775 222 (89.9%)
Domestic mining	390 890	-	48 843 (12.5%)
Intermediate manufacturing - Siding to siding	6 631 426	40 089	2 043 070 (30.8%)
Palletised FMCG	9 774 922	100	3 542 753 (36.2%)
Agriculture	4 563 740	98 989	778 284 (17.1%)
Total	**30 302 037**	**139 533**	**7 607 867 (25.1%)**

Transport costs[2] on the N1 corridor for these segments are currently 18.9% higher than costs under a scenario in which all shiftable freight was transported by rail (see Table 2). If rail volumes remain stagnant up to 2054, this premium will be 16.5%. If the rail market share remains constant up to 2054, this premium will be 16.4%.

Table 2: Cost and emission savings potential due to modal shift on the Western Cape section of the N1

Scenarios	Transportation cost before shift (Rbn)	% Transport cost premium with no modal shift	Shift Saving (Rbn)	CO_2 emission reduction (000' tonnes)
2023 - Current market share	47.1	18.9%	7.49	401.2
2029 - Stagnant rail volumes	54.1	17.6%	8.10	463.7
2029 - Constant market share	541.0	17.6%	8.08	462.9
2029 - Growth market share	45.2	-	-	-
2054 - Stagnant rail volumes	78.8	16.5%	11.14	684.0
2054 - Constant market share	78.7	16.4%	11.07	679.9
2054 - Growth market share	66.4	-	-	-

N2 corridor

The key opportunities for modal shift on the N2 corridor are in the siding-to- siding, palletised FMCG and agriculture segments. The volumes that could be shifted are shown in Table 3 and depicted graphically in Figure 2.

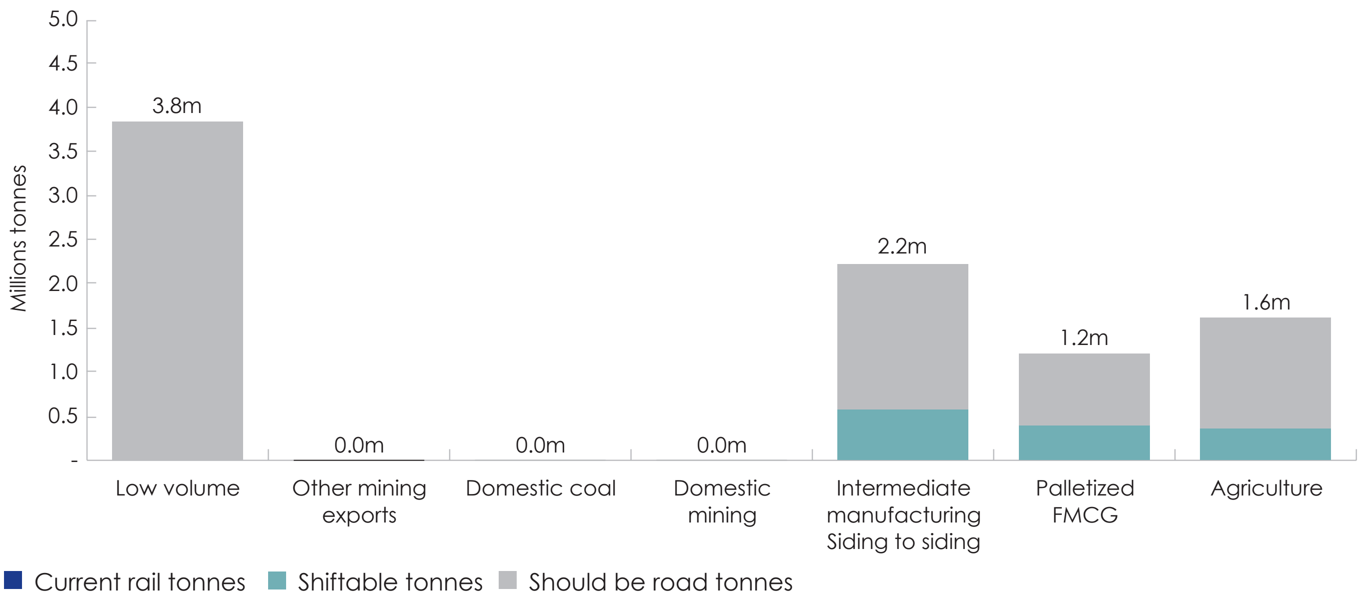


Figure 2: Modal shift opportunity per segment on the N2

[2] These transport costs are road and rail costs for the identified rail-friendly segments.

Table 3: Modal shift opportunity per segment on the N2

Segment	Road tonnes	Rail tonnes	Shiftable tonnes
Low volume targetable	3 814 180	-	(0%)
Other mining exports	3 750	-	3 207 (85.5%)
Domestic coal	-	-	(0%)
Domestic mining	34 730	-	4 340 (12.5%)
Intermediate manufacturing - Siding to siding	2 174 929	14 474	556 856 (25.6%)
Palletised FMCG	1 236 655	-	372 613 (30.1%)
Agriculture	1 648 426	-	334 111 (20.3%)
Total	8 912 670	14 474	1 271 128 (14.3%)

Transport costs on the N2 corridor across all segments are currently 2.8% higher than they would be if all shiftable tonnes were transported by rail (see Table 4). If rail volumes remain stagnant, this will be 2.0% by 2054.

Table 4: Cost and emission savings potential due to modal shift on the Western Cape section of the N2

Scenarios	Transportation cost before shift (Rbn)	% Transport cost premium with no modal shift	Shift Saving (Rbn)	CO_2 emission reduction (000' tonnes)
2023 - Current market share	5.8	2.8%	0.16	33.0
2029 - Stagnant rail volumes	6.5	2.8%	0.18	37.3
2029 - Constant market share	6.5	2.8%	0.18	37.2
2029 - Growth market share	6.3	-	-	-
2054 - Stagnant rail volumes	8.7	2.0%	0.17	48.7
2054 - Constant market share	8.7	2.0%	0.17	48.7
2054 - Growth market share	8.5	-	-	-

N7 corridor

The key opportunity for modal shift on the N7 corridor is in agriculture, and to a lesser extent siding-to-siding freight. The volumes that could be shifted are shown in Table 5 and depicted graphically in Figure 3.

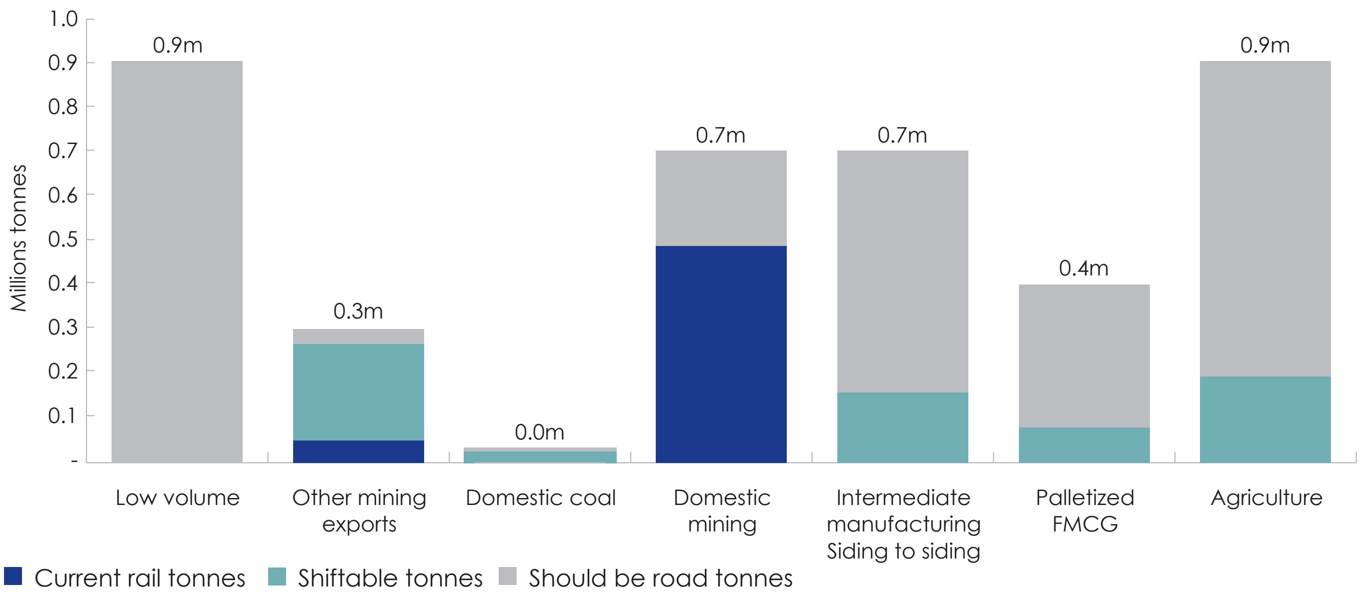


Figure 3: Modal shift opportunity per segment on the N7

Table 5: Modal shift opportunity per segment on the N7

Segment	Road tonnes	Rail tonnes	Shiftable tonnes
Low volume targetable	857 738	-	(0%)
Other mining exports	275 513	52 334	228 074 (82.8%)
Domestic coal	28 306	-	25 449 (89.9%)
Domestic mining	211 002	467 884	(0%)
Intermediate manufacturing - Siding to siding	737 043	-	152 573 (20.7%)
Palletised FMCG	361 030	-	79 306 (22.0%)
Agriculture	910 270	-	184 741 (20.3%)
Total	**3 380 902**	**520 218**	**670 143 (19.8%)**

Transport costs on the N7 corridor are currently 12.3% higher than they would be if all shiftable tonnes were transported by rail (see Table 6). If rail volumes remain stagnant, this will increase to 13.2% by 2054. If the rail market share remains constant this will be to 12.1%.

Table 6: Cost and emission savings potential due to modal shift on the Western Cape section of the N7

Scenarios	Transportation cost before shift (Rbn)	% Transport cost premium with no modal shift	Shift Saving (Rbn)	CO_2 emission reduction (000' tonnes)
2023 - Current market share	1.7	12.3%	0.19	9.6
2029 - Stagnant rail volumes	1.9	12.4%	0.21	10.6
2029 - Constant market share	1.9	12.1%	0.21	10.5
2029 - Growth market share	1.7	-	-	-
2054 - Stagnant rail volumes	2.5	13.2%	0.30	15.0
2054 - Constant market share	2.5	12.1%	0.27	14.0
2054 - Growth market share	2.2	-	-	-

Western Cape core traffic

The key opportunity for modal shift in the Western Cape core traffic is in agriculture, and to a lesser extent domestic coal and siding-to-siding traffic. The volumes that could be shifted are shown in Table 7 and depicted graphically in Figure 4. Due to the low freight transport distances and density outside metro areas, road transport is currently more competitive for certain commodities than rail, particularly in the agriculture and intermediate manufacturing segments.

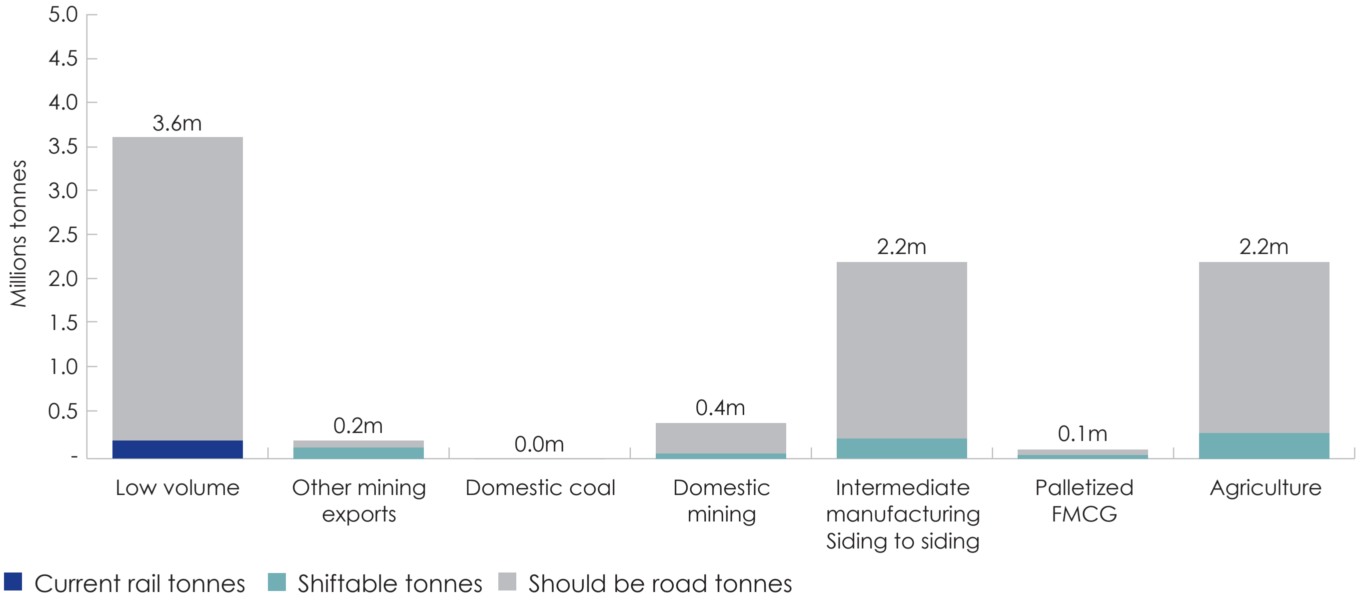


Figure 4: Modal shift opportunity per segment for Western Cape core traffic

Transport costs for the Core Western Cape across all segments are currently 1.5% higher in the absence of modal shift (see Table 7). Given that rail rates remain relatively high, it will be 1.4% if rail market share remains stagnant by 2054. This is due to the growth in freight flows, in which road is more competitive.

Table 7: Cost and emission savings potential due to modal shift on the Western Cape core traffic

Scenarios	Transportation cost before shift (Rbn)	% Transport cost premium with no modal shift	Shift Saving (Rbn)	CO_2 emission reduction (000' tonnes)
2023 - Current market share	0.60	1.5%	0.01	2.49
2029 - Stagnant rail volumes	0.64	1.5%	0.01	2.75
2029 - Constant market share	0.64	1.5%	0.01	2.74
2029 - Growth market share	0.63	-	-	-
2054 - Stagnant rail volumes	0.95	1.4%	0.01	4.09
2054 - Constant market share	0.95	1.4%	0.01	4.06
2054 - Growth market share	0.94	-	-	-

Summary

In 2023 the total transportation bill for freight touching the Western Cape was R79.9bn. The combined effect of the modal shift on the three corridors and core Western Cape traffic would have been a reduction of R7.85 billion or 9.81% in transport costs for the Western Cape (refer to the 2023 market share data in the tables above)[3].

Table 8: Summary - cost and emission savings potential due to modal shift in the Western Cape

Freight traffic zone	Shift saving 2023 (Rbn)	% saving on total Western Cape transport bill	CO^2 emission reduction (000' tonnes)
N1	7.49	9.37%	401.01
N2	0.16	0.20%	33.01
N7	0.19	0.24%	9.63
Core Western Cape	0.01	0.01%	2.49
Total	**7.85**	**9.81%**	**446.14**

Table 9 shows the targetable modal shift opportunities across all zonal groupings. Just as the cost savings suggest, the N1 has the largest potential for modal shift. Of the 87.6m tonnes of Western Cape road freight, a portion of 42.6m tonnes are suitable for a shift to rail. The non-suitable road freight consists of low density freight flows, fuel and commodities which have a dedicated rail solution, like the iron ore export line.

Table 9: High-level estimate of total shiftable tonnes per zonal grouping of Western Cape Freight.

Zonal Grouping	Road tonnes (million)	Rail tonnes (million)	Total tonnes (million)	Shiftable tonnes (million)	Shiftable tonne-kms (billion)	Estimated Transportation Cost Saving (R billions)
N1 Corridor traffic	22.7	0.14	22.9	7.6 (33.3%)	10.9	7.49
N2 Corridor traffic	5.1	0.01	5.1	1.3 (24.9%)	0.9	0.16
N7 Corridor traffic	2.5	0.52	3.0	0.7 (22.0%)	0.3	0.19
Metropolitan traffic	3.1	-	3.1	0.3 (8.3%)	0.01	0.008
Core Western Cape	5.2	0.02	5.2	0.8 (14.7%)	0.1	0.009
Non-Corridor traffic	3.9	0.03	4.0	1.3 (32.2%)	1.7	1.25
Total	**42.6**	**0.72**	**43.3**	**11.9 (27.4%)**	**13.9**	**9.11**

Highlights

- As rail traffic density increases, it becomes more efficient.
- An estimated 9.81% of the Western Cape's total freight transportation cost could have been saved in 2023 through modal shift.
- At current rail volumes, road is more competitive within the Core Western Cape area.
- The largest modal shift opportunity is for the N1 corridor freight. This could potentially reduce total transport costs by 9.37%.
- Modal shift potential is discussed further in Scenario 4, within the context of rail freight potential in the Western Cape.

Introduction

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. Pressing policy issues were identified, such as the provincial government's position on Performance Based Standards (PBS) vehicles and a high-level scenario was developed to estimate the potential annual impact on freight transport costs in the Western Cape. The current results are indicative, with the purpose of encouraging discussions to increase the accuracy of the scenario development outputs.

Overview

Implementation of PBS within the national context

The Performance Based Standards (PBS) pilot project aimed to introduce high productivity PBS demonstration vehicles (i.e. PBS vehicles) in South Africa's road freight transport sector[1]. The project began in 2004, led by role-players from the Council for Scientific and Industrial Research (CSIR), government, industry, and academia and has since grown to include 245 demonstration vehicles in various industries, with over 100 million kilometres of data collected and processed by 2018. T

Similar to the relationship between the Load Accreditation Programme (LAP), which has since evolved into the Road Transport Management System (RTMS), and the National Heavy Vehicle Accreditation Scheme (NHVAS) initiatives, the project was originally based on the Australian PBS scheme. However, it was specifically adapted to accommodate South Africa's unique conditions. A Smart Truck Steering Committee and Review Panel, guide and manage the project with a focus on safety and infrastructure performance standards.

At the outset of the PBS pilot project, key objectives were identified, including expanding operations across multiple industries and provinces while prioritising activity monitoring, research, and skills development. Since then, various partners in the road freight transport sector have joined the PBS initiative, such as Sappi, Mondi, ABInBev, Barloworld Transport, and others, along with original equipment manufacturers (OEMs) and trailer manufacturers. Various PBS-related research has helped establish the technical framework of the project, improve the safety and road wear impact of new vehicle designs, and optimise the vehicle assessment process. Subsequently, numerous PBS-related research papers, journal articles, theses, dissertations, and technology demonstrators have been published.

The project has, however, faced challenges since its inception, particularly through resistance from some authorities due to the increased length and weight of PBS vehicles compared to standard vehicles. Yet significant progress has been achieved in defining a feasible South Africa-specific PBS framework, driven by the project's promising results in improving road freight transport efficiency, safety, and environmental impact[1]. The project in its current form can continue until the Minister and Members of Executive Council (MINMEC) make a decision regarding the future of the PBS approach in South Africa. Therefore, until further notice, provinces may independently decide whether PBS permits may be issued.

Implementation of PBS within the Western Cape context

Using PBS vehicles across the national road network (i.e. across all province borders) requires provincial PBS permits to be obtained from each provincial government. Provincial PBS permits to operate on public roads have not been issued in the Western Cape since the start of the project, therefore, PBS vehicles have not legally been allowed to operate within its borders. Various road freight transport operators have expressed concern over this policy position, particularly due to its impact on using PBS vehicles in other provinces and because PBS usage is a major incentive for RTMS certification. The legality of operating a PBS vehicle in the Western Cape is not the only barrier to entry that could prevent freight being transported via PBS vehicles. If the logistics infrastructure at different facilities cannot accommodate the different dimensions of a PBS vehicle configuration, the potential benefit might be outweighed by the capital investment required to change the infrastructure to accommodate it.

Benefits of PBS implementation

The implementation of PBS vehicles has demonstrated significant benefits, including reductions in heavy vehicle trips, crash rates, fuel consumption and emissions. The mandatory RTMS certification for participating trucking organisations has further contributed to reduced overloading and speeding, along with improved driver skills and training.

The cost per tonne-km (i.e. Rand per tonne-km) of a PBS vehicle, just like any other vehicle, depends on the total distance that the vehicle drives in a year (kilometres per annum, i.e. kmpa), both when it is laden or empty. An average fuel consumption rate per kilometre was used and an assumption was made regarding how many kilometres the vehicle is driving laden, which is called the load factor. A load factor of 100% indicates that the vehicle is always transporting

[1] Nordengen, P., Berman, R., De Saxe, C. & Deiss, J. (2018). An overview of the performance-based standards pilot project in South Africa. *15th International Symposium on Heavy Vehicle Transport Technology (HVTT15) conference proceedings*. 2-5 October, Rotterdam, The Netherlands: HVTT [Electronic].Available: https://hvttforum.org/wp-content/uploads/2019/11/Nordengen-PERFORMANCE-BASED-STANDARDS-PILOT-PROJECT-IN-SOUTH-AFRICA.pdf [2023, November 26].

cargo when it is driving, which is practically unattainable, while a load factor of 50% assumes every return trip is empty. The more freight a vehicle can transport in a year (i.e. the higher its load factor is), the lower the fixed cost per tonne-km, such as the cost of capital, depreciation, insurance, licence fees and drivers' wages, will be. The variable cost (fuel, tyres, maintenance and toll fees) was assumed to increase linearly with the total calculated kmpa driven. Figure 1 illustrates the combined cost curves for PBS refrigerated and volume van vehicles[2]. Level 1 PBS vehicles have a 30% higher carrying capacity over the largest equivalent vehicle configurations included in the WC FDM™. All of the calculations in this scenario considered level 1 PBS vehicles to demonstrate a conservative cost comparison.

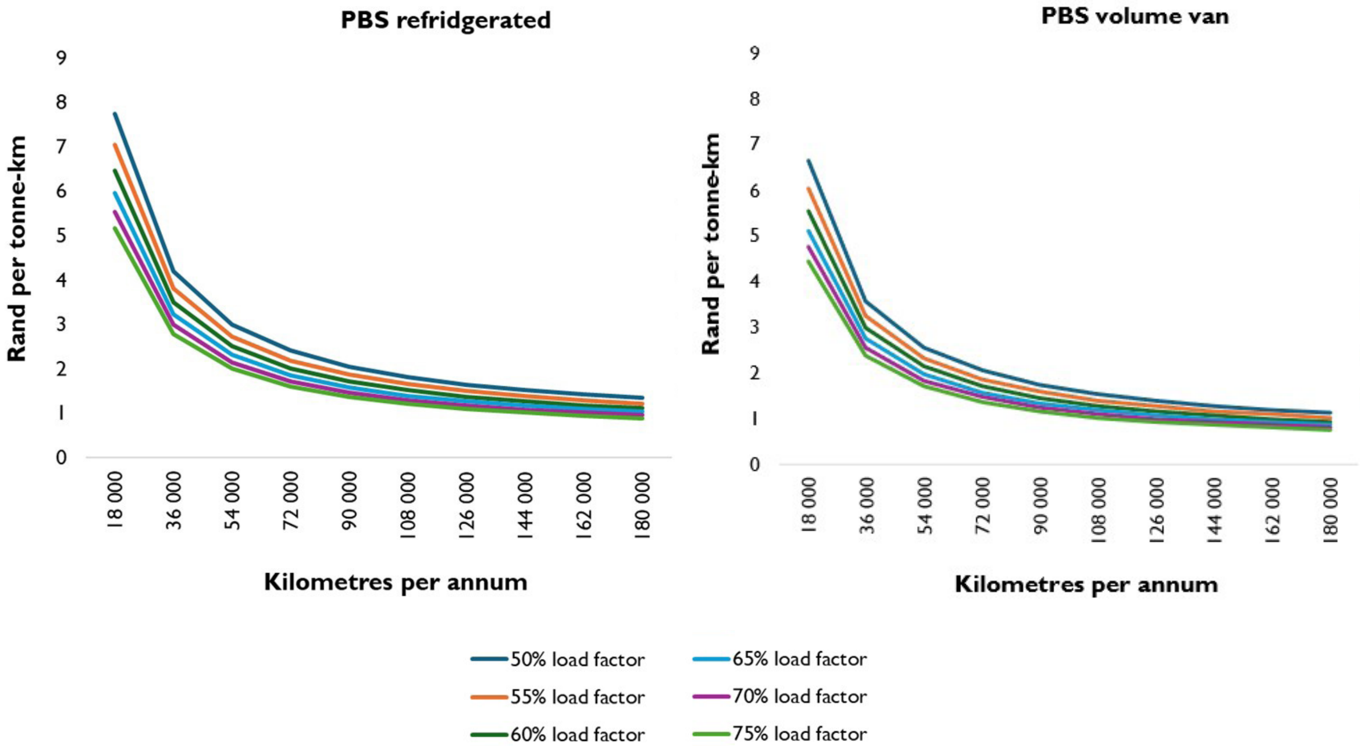


Figure 1: Cost per tonne-km for different load factors and kilometres per annum for a refrigerated PBS vehicle configuration (left) and volume van configuration (right)

The additional variable cost associated with a PBS configuration is outweighed by the benefit of the larger payload, which reduces the total number of trips and total kilometres required to transport the same amount of freight. Figure 2 illustrates the comparative advantage a PBS vehicle has over shorter vehicle combinations, for example the PBS configuration for transporting liquid bulk[3]. It becomes more expensive than a conventional bulk fuel vehicle when the average fuel consumption rate per kilometre is 0.7km/litre over 90 000 kmpa.

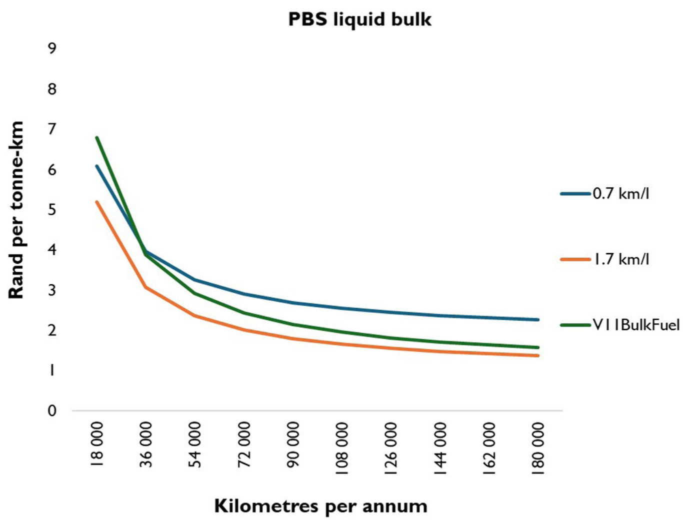


Figure 2: Extreme example of 0.7km per litre PBS liquid bulk configuration compared to a typical bulk fuel vehicle and a 1.7km/l PBS configuration

[2] Refer to the description of fridge/refridgerated and van body vehicle concepts according to the Road Freight Association's Vehicle Cost Index (VCI), Edition-033 (October 2024).

[3] V11 bulk fuel vehicle, which is a 6-axle articulated, 6x4 truck-tractor, tridem-axle semi trailer according to the Road Freight Association's Vehicle Cost Index (VCI), Edition-033 (October 2024).

Assumptions

Rather than attempting to identify a specific business case for the transport cost savings of operating PBS vehicles on specific OD pairs, PBS friendly commodities were identified to perform cost calculations for different PBS vehicle configurations across all OD pairs, which comprise of short and long distances, to determine the weighted impact of the cost savings PBS vehicles could have when transporting freight to and from the Western Cape.

PBS vehicles can carry loads up to 104 tonnes depending on their configuration and the commodity carried, but require special permits to be operated. To model the potential impact of allowing PBS vehicles to operate within the Western Cape, the following set of assumptions were used to calculate the transport cost associated with operating a PBS vehicle.

- An average PBS vehicle is capable of transporting 30% more freight than standard vehicles, which results in a 39 tonne payload for a refrigerated PBS configuration and a 44 tonne payload for a volume van PBS configuration. For liquid bulk, it is assumed that a PBS vehicle can transport 51 000 litres.
- These PBS configurations are used for OD flows related to the following commodities: Beverages, Citrus, Grapes, Deciduous Fruit, Subtropical Fruit, Maize, Wheat and Cement. Additionally, all liquid bulk and palletised freight are included since PBS trailers allow an additional 11 000 litres and 8 pallets to be carried, respectively (PBS friendly commodities).
- A liquid bulk PBS vehicle has a load factor of 50% since it always returns to its origin empty.
- The transport cost calculations for the volume van and refrigerated PBS configurations were calculated using a 50% and a 75% load factor.
- An average PBS vehicle is assumed to travel 150 000 kmpa over 260 working days.
- An average PBS vehicle is 60% less likely to be involved in an accident or crash.

Results

Transport cost

The assumptions above were used to calculate the high-level potential cost savings of using PBS vehicles instead of standard vehicles (i.e. the largest equivalent vehicle configurations included in the WC FDM™) when transporting PBS friendly freight with an origin and destination in the Western Cape. Figure 3 indicates the weighted transportation cost differences between using PBS and non-PBS vehicles across all distances and OD pairs. While some OD pairs were identified as suitable for PBS vehicles within the WC FDM™, the underlying logistics infrastructure might not be able to accommodate a PBS vehicle due to its increased length.

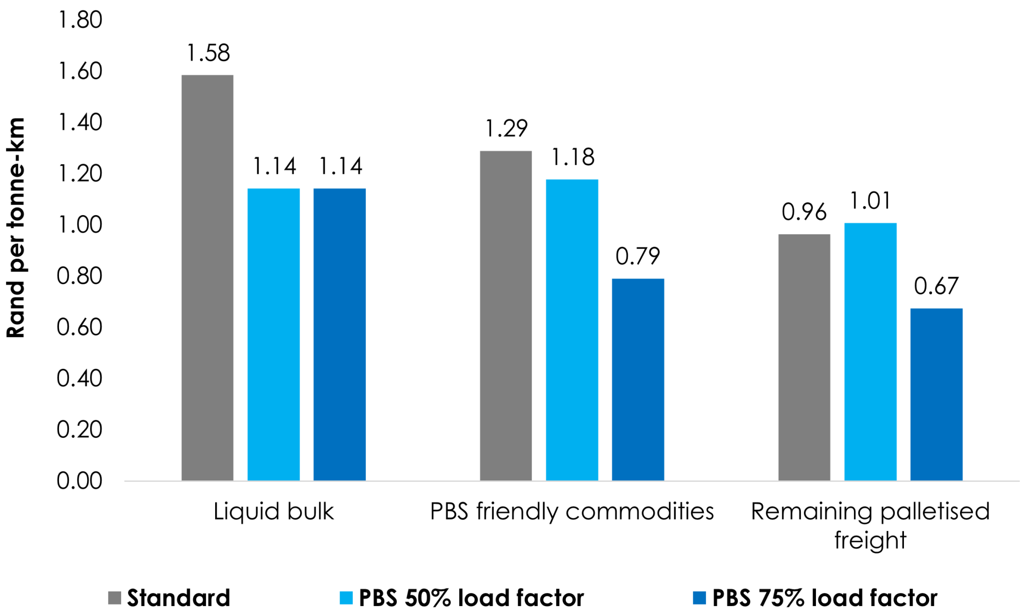


Figure 3: Road transport cost per tonne-kilometre for the scenario

Liquid bulk saw a transport cost saving of 28%, which is primarily driven by the typical V11 bulk fuel vehicle because both vehicles are assumed to have a 50% payload. There is a 9% transport cost saving for the PBS friendly commodities, even when the PBS vehicles are assumed to have a 50% load factor. This transport cost saving increases to 39% for the PBS friendly commodities if a load factor of 75% can be achieved. For the remaining palletised freight (over and above the PBS friendly commodities), using a PBS configuration results in a 5% cost increase. This is predominantly driven by the long distances of the underlying OD pairs and the primary vehicle used (a V18 Volume Van), which is assumed to be driving 180 000 kmpa with a 75% load factor. Using PBS vehicles at a 75% load factor would, however, result in a 30% transport cost reduction for the remaining palletised freight.

Number of laden trips

Figure 4 indicates the differences in number of laden trips required to transport the PBS friendly commodities and remaining palletised freight. Across the board, this is indicative of the increased payload capacity of PBS vehicles. The total number of laden trips are reduced by 25%, 39% and 35% for liquid bulk, PBS friendly commodities and the remaining palletised freight, respectively. This reduction of laden trips should be interpreted with caution because not all freight would be moved in PBS vehicles. These reductions in the percentage of trips are higher than the assumed 30% higher carrying capacity of a PBS vehicle over the largest equivalent vehicle configurations included in the WC FDM™. This is due to the non-PBS vehicles having a much smaller payload.

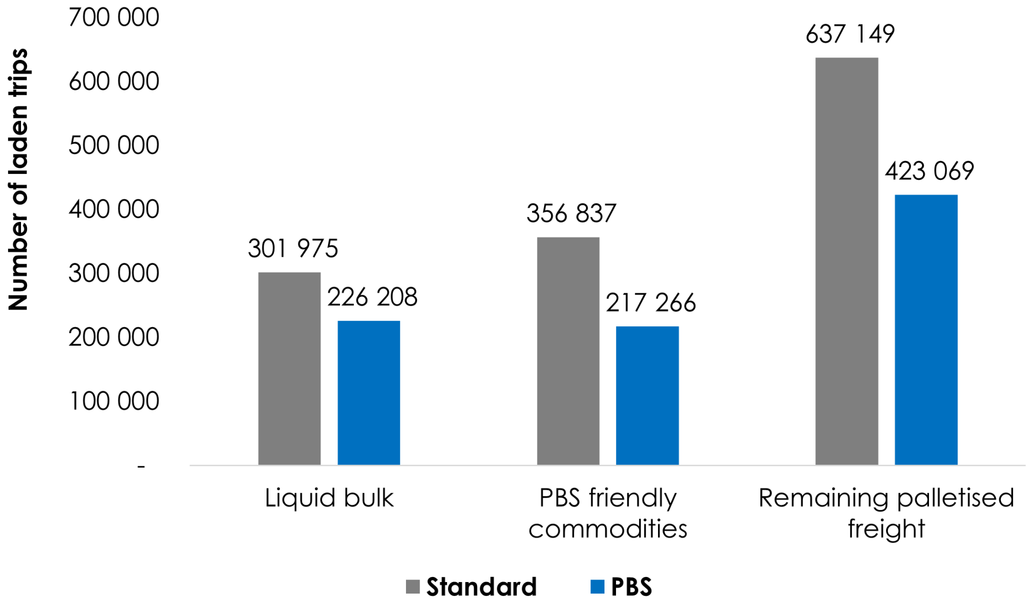


Figure 4: Number of laden trips required for the scenario

Total number of vehicles required

Figure 5 indicates the total number of vehicles required to transport the liquid bulk, PBS friendly commodities and remaining palletised freight. This is a function of the assumed kmpa, payload and load factor. It would require 10% less vehicles to transport liquid bulk with an origin or destination in the Western Cape if it was transported by PBS vehicles. PBS friendly commodities would require 7% less vehicles, however, a 50% load factor would result in a 22% increase in vehicles required to transport the remaining palletised freight.

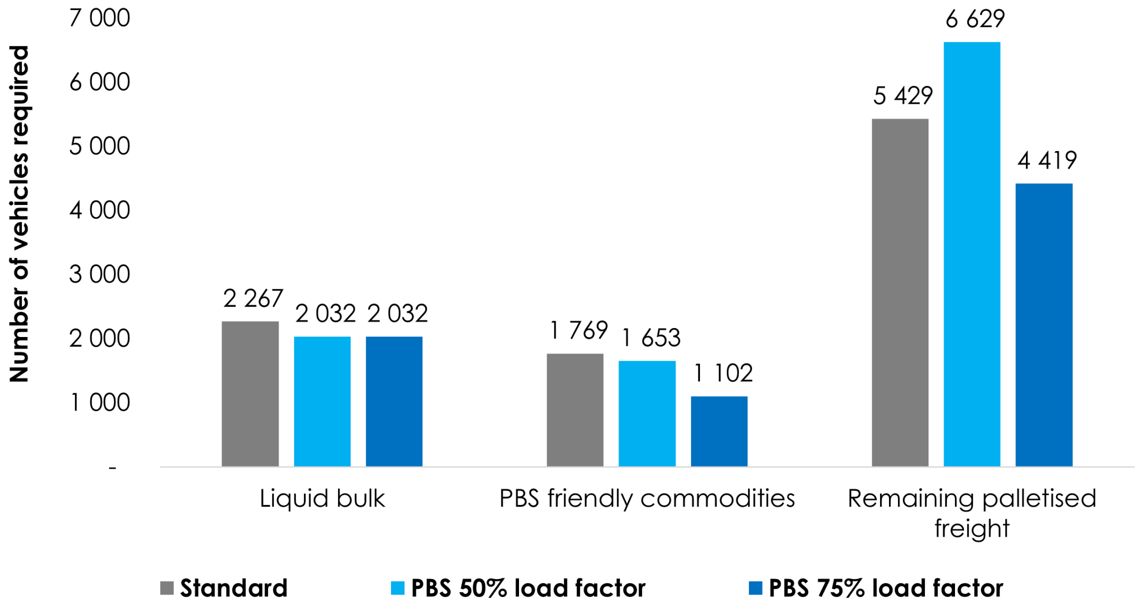


Figure 5: Total number of vehicles required to transport the freight for the scenario

[4] Graph 1 in Electric Transport Options in South Africa brochure, Eskom, 2019, available online: https://www.eskom.co.za/eas/wp-content/uploads/2021/05/ELECTRIC-TRANSPORT-OPTIONS-BROCHURE-v8-1.pdf

Total litres of fuel consumed

Figure 6 indicates the total fuel consumption to transport the liquid bulk, PBS friendly commodities and the remaining palletised freight. PBS configurations result in a 16% and 7% reduction of fuel consumption for liquid bulk and PBS friendly commodities, respectively, but a 8% increase for the remaining palletised freight. If the load factors of the PBS vehicles increase to 75%, the fuel saving for PBS friendly commodities and remaining palletised freight are 38% and 28%, respectively. This fuel saving will also provide the same direct reduction of emission externality cost.

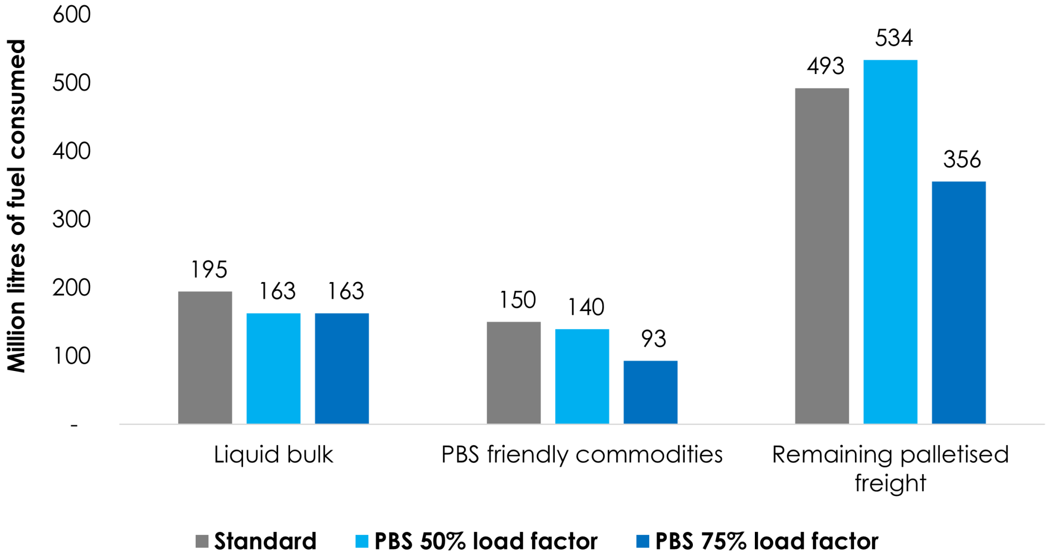


Figure 6: Total fuel consumption to transport freight annually for the scenario

Impacted roads

Figure 7 indicates the flow of PBS friendly commodities with an origin or destination in the Western Cape. For this scenario, the roads that account for 80% of the PBS friendly commodities are the N1, R46, N7, R45, R307, R399, N12, N2, R44, R302, R43, R60, M3, R301, R102, R310, and R312, as indicated in Figure 8.

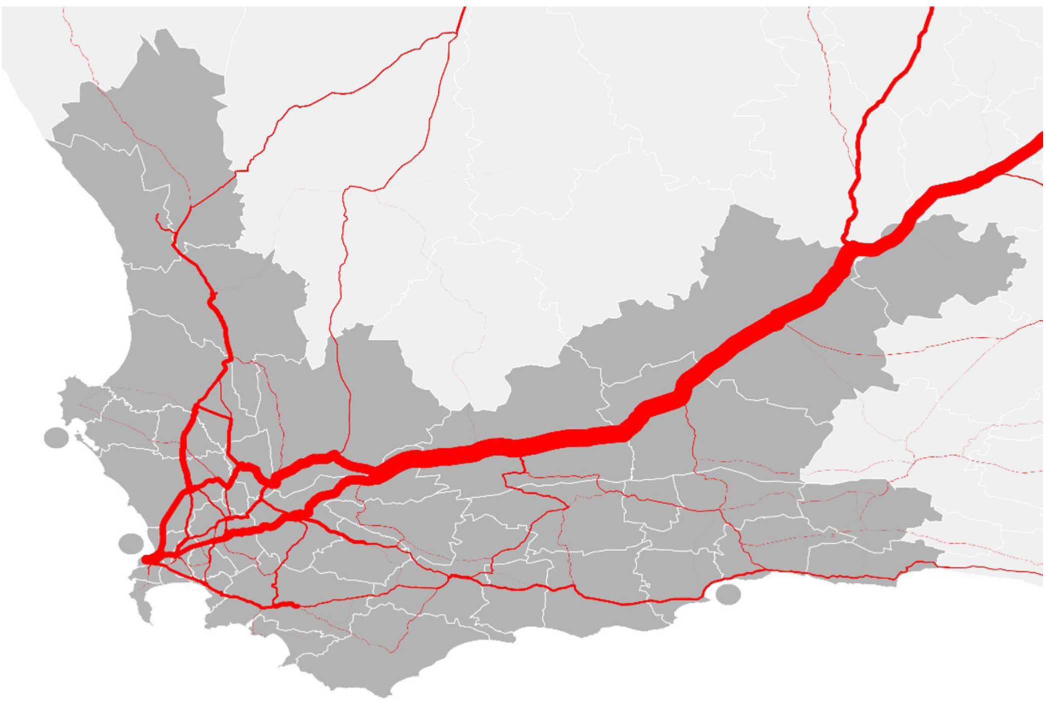


Figure 7: Freight flows of PBS friendly commodities in the Western Cape for the scenario

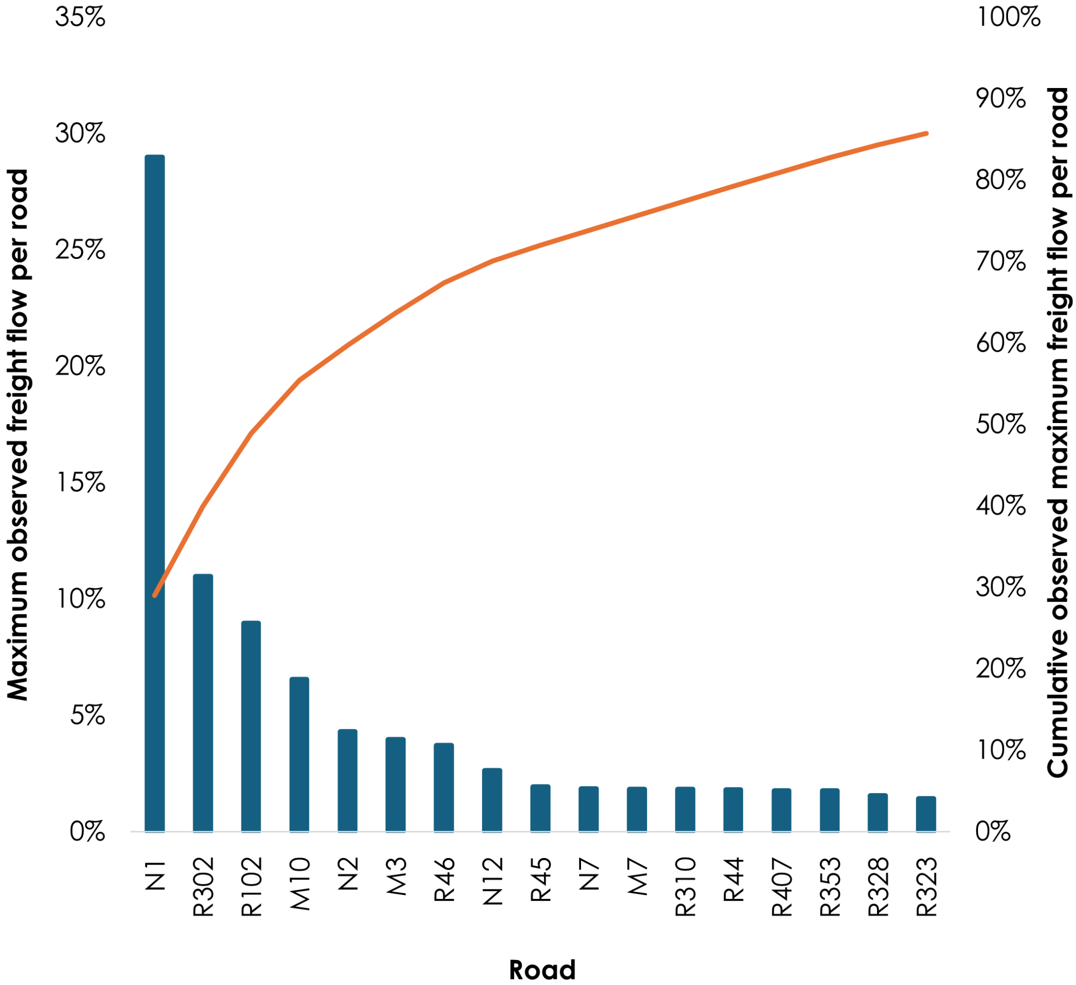


Figure 8: The distribution of prominent roads used to transport PBS friendly commodities via PBS vehicles in the Western Cape for the scenario

Figure 9 shows the flow of liquid bulk with an origin or destination in the Western Cape. For this scenario, the roads which account of 80% of the liquid bulk are the N1, N12, N2, N7, R60, R302, R45, M7, M3, R102, R407, R353 and R46, as indicated in Figure 10.

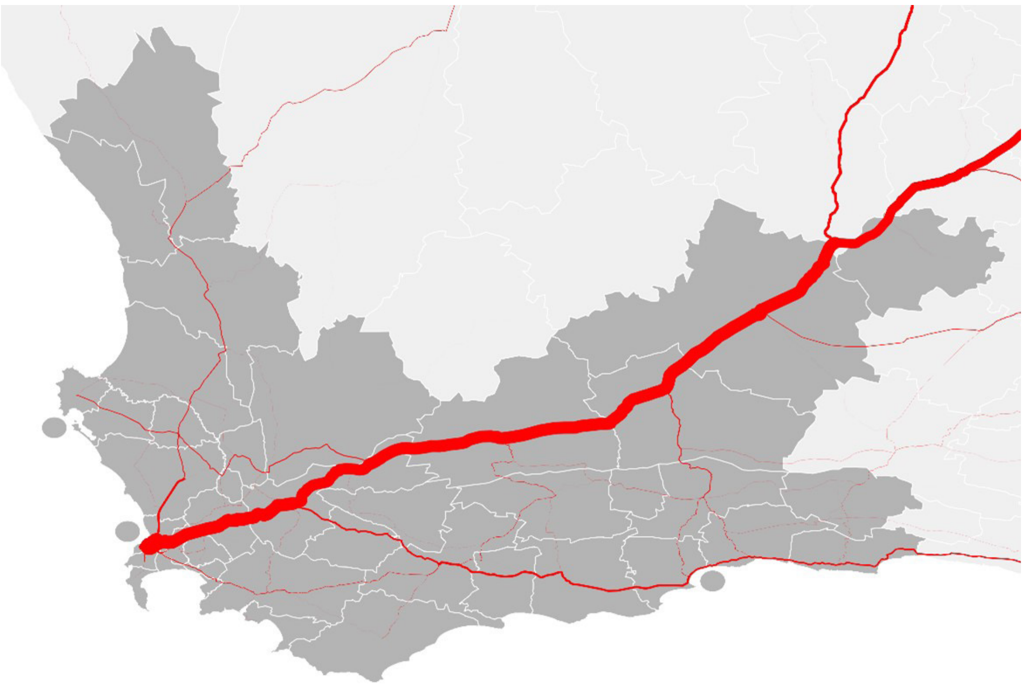


Figure 9: Freight flows of liquid bulk in the Western Cape for the scenario

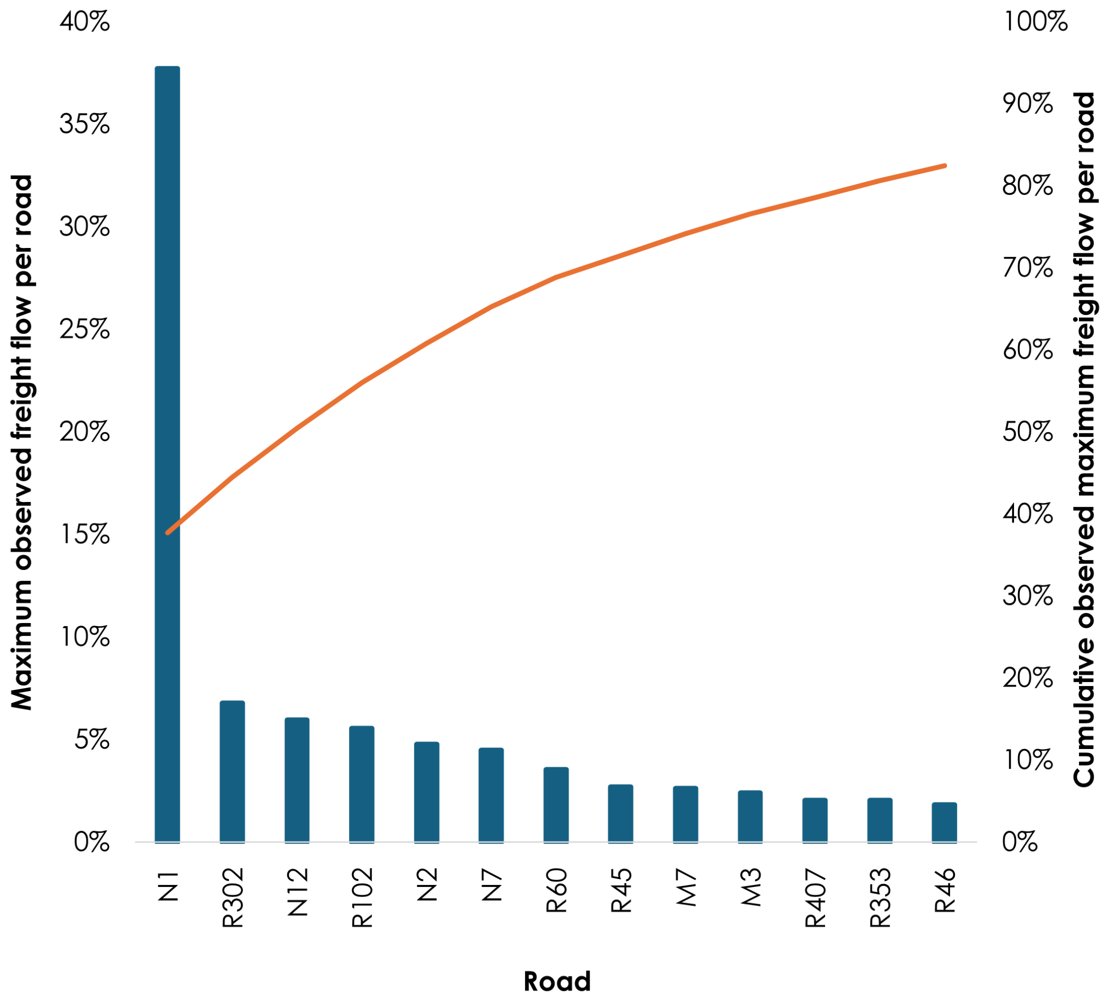


Figure 10: The distribution of prominent roads used to transport liquid bulk via PBS vehicles in the Western Cape for the scenario

Figure 11 shows the flow of the remaining palletised freight over and above the PBS friendly commodities with an origin or destination inside the Western Cape. For this scenario, the roads which account of 80% of this freight are the N1, N12, N2, N7, R60, R302, R45, M7, M3, R102, R407, R353 and R46, as indicated in Figure 12.

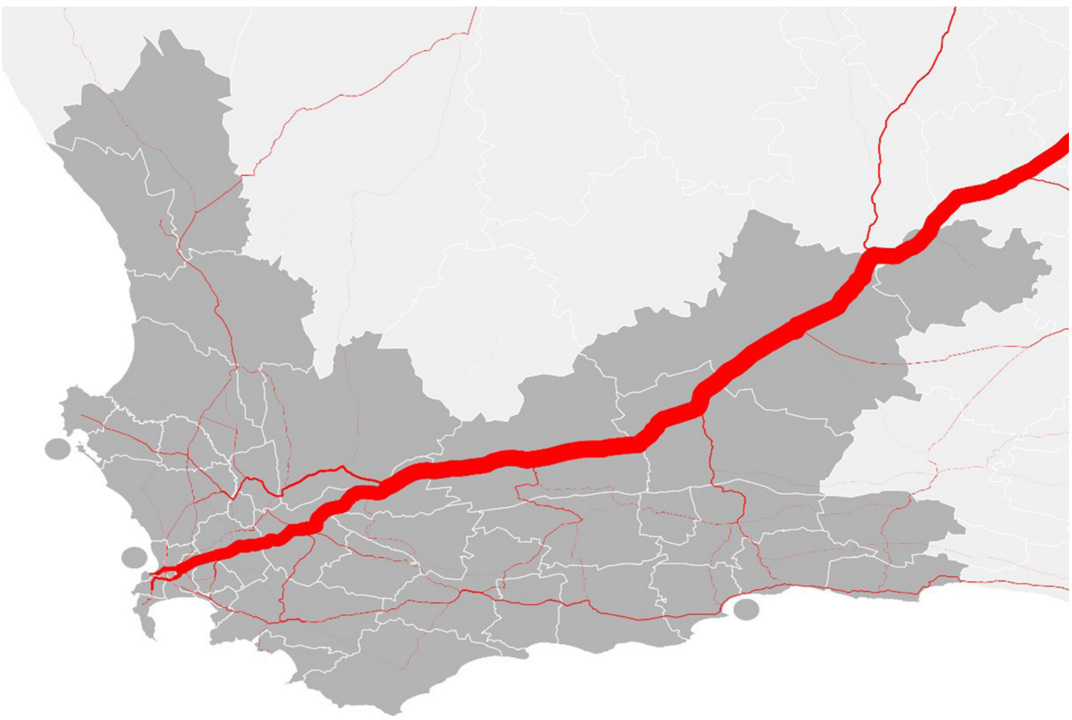


Figure 11: Freight flows of the remaining palletised freight (over and above the PBS friendly commodities) in the Western Cape for the scenario

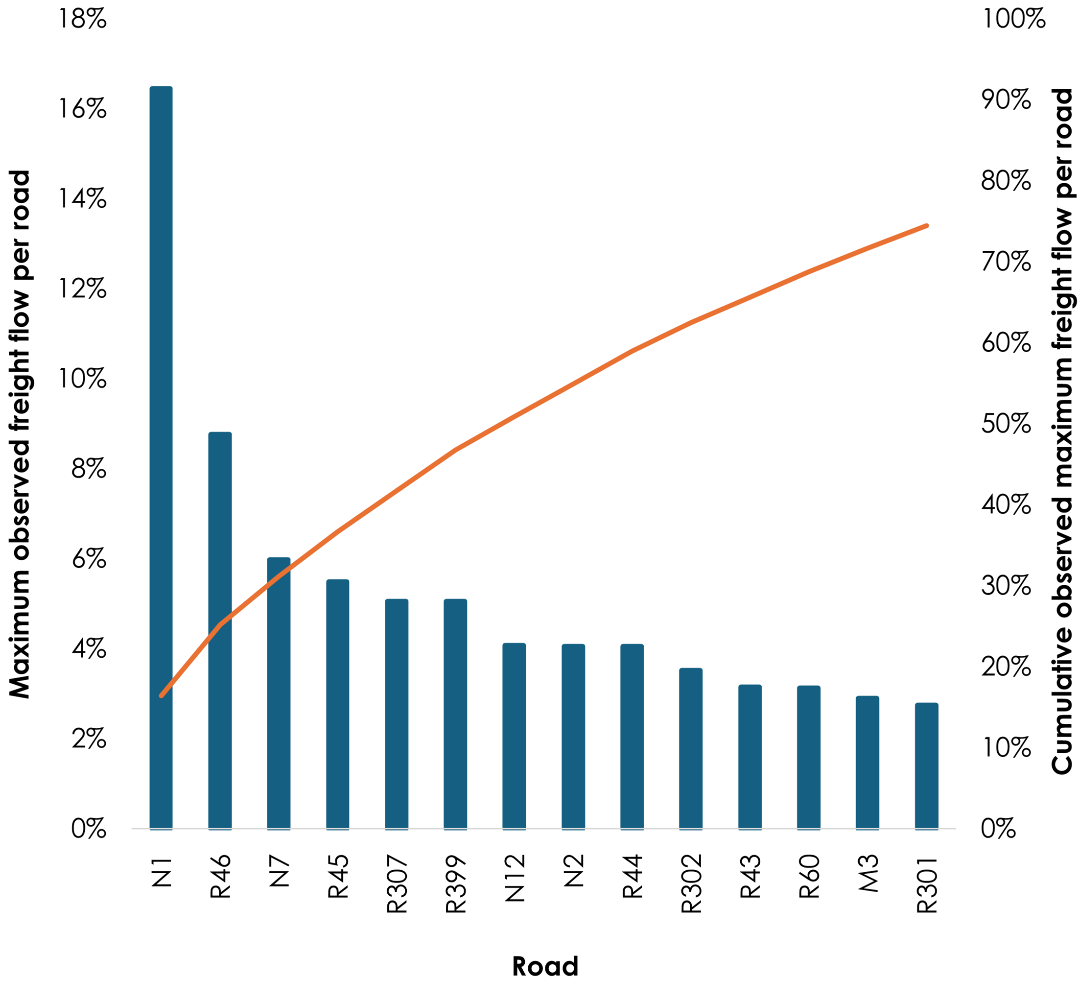


Figure 12: The distribution of prominent roads used to transport the remaining palletised freight (over and above the PBS friendly commodities) via PBS vehicles in the Western Cape for the scenario

Figure 13 shows the combined freight flows of all the identified commodities that could be moved with PBS vehicles with an origin or destination in the Western Cape. For this scenario, the roads which account of 80% of this freight are the N1, R302, R102, R46, N2, M10, N12, M3, N7, R45, R44, R60, M7, R307, R399 and R310, as indicated in Figure 14.

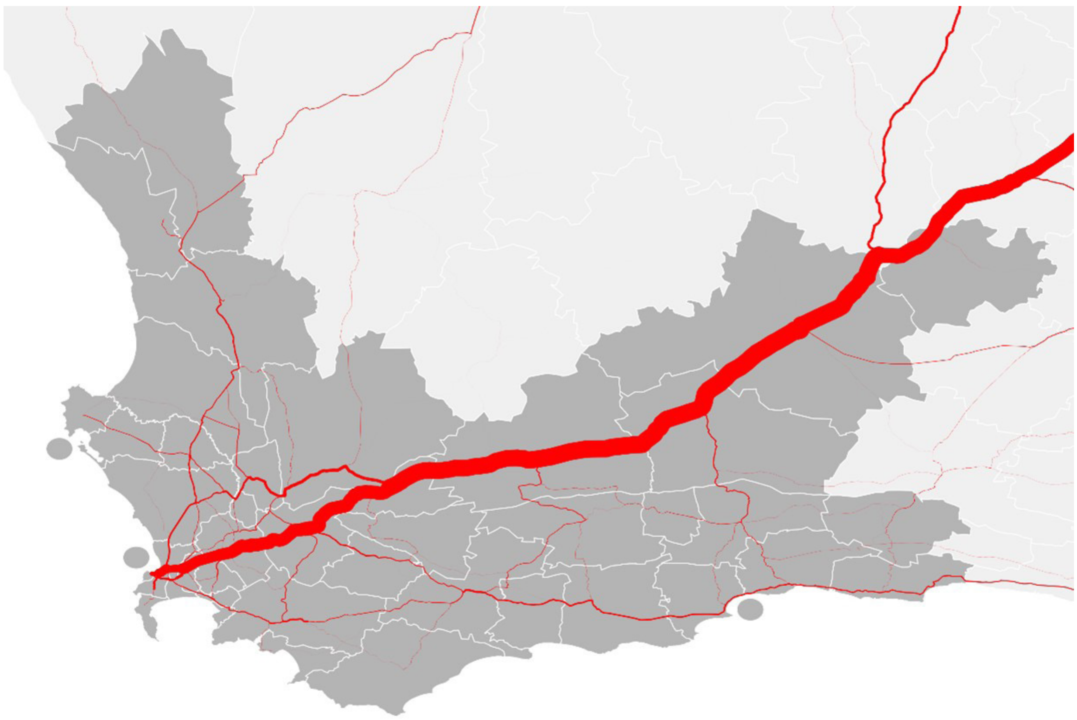


Figure 13: Combined freight flows of all the identified commodities that could be moved with PBS vehicles in the Western Cape for the scenario

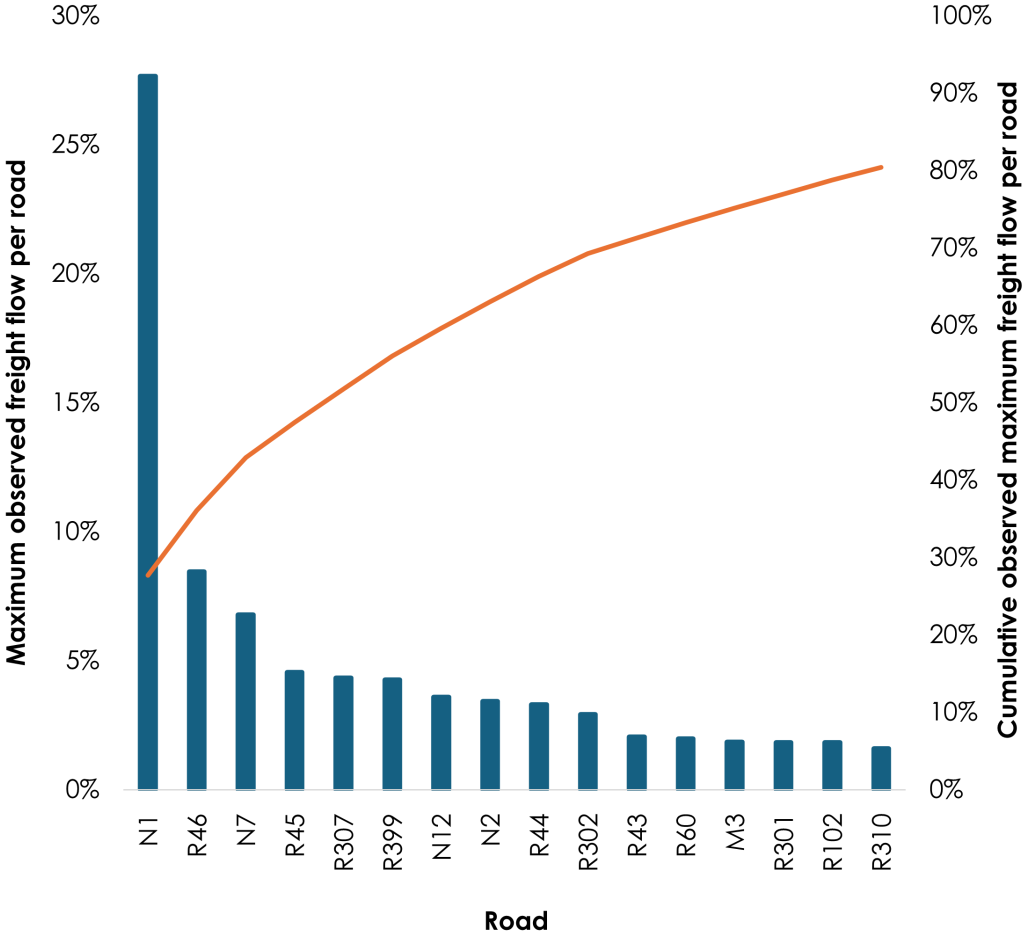


Figure 14: The distribution of prominent roads used to transport all the identified commodities that could be moved with PBS vehicles in the Western Cape for the scenario

Externality cost

The expected saving of accident and crashes externality cost were assumed to be proportional to the relative potential reduction in accidents and crashes, which are assumed to be 60%. The externality cost saving on accidents and crashes, therefore, amounted to 2.83 cent per tonne-km, which is 60% of the 4.79 cent per tonne-km figure from 2017. The reduction in emissions externality cost is directly linked to the litres of diesel consumed. Therefore, depending on the load factor of PBS vehicles and the different freight flows identified in the fuel consumption saving (see Figure 6), the emissions externality cost saving was between -0.75 to 3.41 cent per tonne-km.

Table 1: Emissions externality cost savings for different commodity groupings when transported with a PBS vehicle for the scenario

Commodity group	Emission externality cost saving PBS 50% load factor (cent per tonne-km)	Emission externality cost saving PBS 75% load factor (cent per tonne-km)
Liquid bulk	1.45	1.45
PBS friendly commodities	0.64	3.41
Remaining palletised freight	-0.75	2.49

Conclusion

This PBS scenario aimed to quantify the potential transport cost savings of operating PBS vehicles within the Western Cape context. Rather than focusing on specific business cases or OD pairs, the scenario provides a high-level quantification of the transport cost implications associated with operating a PBS vehicle. Depending on their annual tonne-km productivity, PBS vehicles have the potential to reduce the transport cost within the Western Cape. However, if PBS vehicles are underutilised due to the inability of freight owners or LSPs to generate enough tonne-km productivity, PBS vehicle configurations are more expensive to operate, as illustrated by the 50% load factor on the remaining palletised freight example. The Western Cape Government's policy position should be clear that these factors, along with those related to infrastructure (used roads, bridges, etc.), safety and compliance, need to be considered in PBS permit applications.

Highlights

- Transporting liquid bulk with PBS vehicles has the potential to reduce transport costs by up to 28%.
- Cost savings of 9% and 39% could be realised when transporting PBS friendly commodities with a 50% and 75% load factor, respectively.
- A 5% transport cost increase would be realised when transporting the remaining palletised freight (over and above what is classified as PBS friendly commodities) with a 50% load factor. However, at a 75% load factor, a 30% cost saving could be realised when transporting the remaining palletised freight.
- PBS vehicles have the potential to reduce the number of laden trips by 25% for liquid bulk, 39% for PBS friendly commodities and 35% for the remaining palletised freight.
- The use of PBS vehicles could result in a 16% and 7% reduction of diesel consumption for the transportation of liquid bulk and PBS friendly commodities, but an 8% increase for the remaining palletised freight if a 50% load factor is achieved. If the load factor of PBS vehicles could increase to 75%, the fuel saving for PBS friendly commodities and remaining palletised freight would be 38% and 28%, respectively. This fuel saving will also result in the same direct reduction of emissions externality cost.
- This scenario identifies that sixteen roads, including the N1, N2 and N7, are required for transporting approximately 80% of freight using PBS vehicles.

Introduction

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. Pressing policy issues were identified and high-level scenarios were developed to estimate the potential annual impact on freight transport costs in the Western Cape. The current results are indicative, with the purpose of encouraging discussions to increase the accuracy of the scenario development outputs.

Overview

The feasibility of a pipeline to supply jet fuel to Cape Town International Airport (CTIA) is investigated in this scenario. Conventional wisdom assumes that if such a pipeline made financial sense, it would have already been built. However, with the recent increase in trucks delivering fuel to the airport, the question has become topical again. The demand for jet fuel at the airport is inextricably linked to the flights arriving and departing from CTIA.

Domestic flights represent the majority of air traffic that arrive and depart from CTIA. Table 1 shows the total number of flights departing and arriving from CTIA between 2013 and 2023. The total number of flights increased from 87 388 to 98 540 over this period. This increase was primarily driven by the growth in international flights, which have largely stemmed from the success of the Wesgro Air Access initiative.

Table 1: Total number of flights (arrivals and departures) from CTIA[1]

Year	Domestic	Regional	International	Unscheduled	Total
2013	59 964	2 915	4 958	19 551	87 388
2014	63 038	2 914	4 886	19 544	90 382
2015	69 600	4 472	5 479	18 963	98 514
2016	71 044	5 082	6 520	17 335	99 981
2017	71 988	5 427	8 837	15 827	102 079
2018	68 522	4 806	10 232	16 296	99 856
2019	67 052	4 542	10 299	12 134	94 027
2020	26 920	1 277	3 683	14 016	45 896
2021	40 027	2 324	3 783	13 460	59 594
2022	51 962	3 539	9 211	23 361	88 073
2023	59 725	3 898	13 595	21 322	98 540

Over the period between 2013 and 2023, domestic flights experienced no growth, while unscheduled, regional and international flights grew by 9%, 34% and 174%, respectively (see Figure 1).

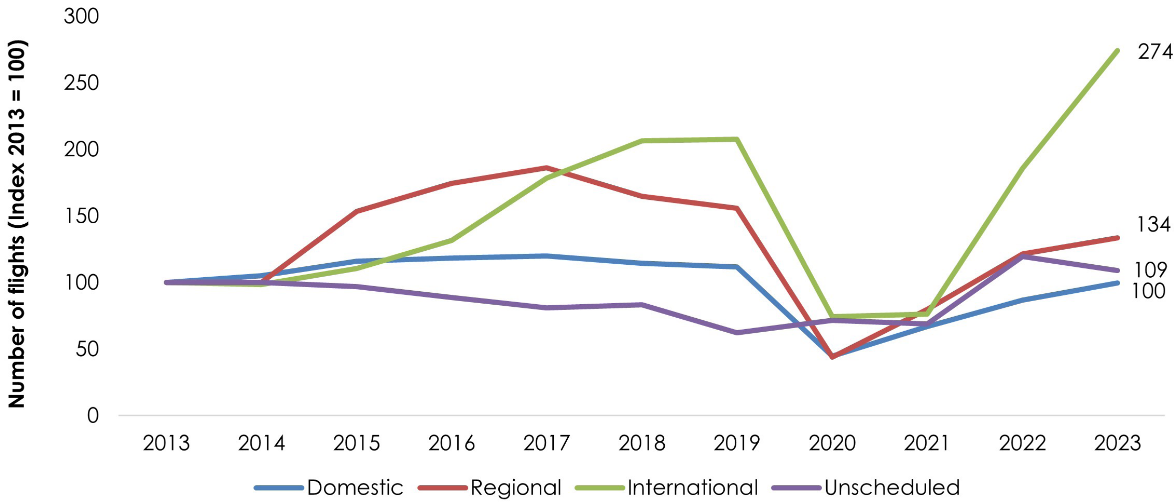


Figure 1: Indexed total number of flights arriving and departing CTIA between 2013 and 2023 (Index 2013 = 100)

[1] ACSA. 2024. *Cape Town International Airport – Aircraft movement data.* [Online]. Available at : https://www.airports.co.za/CTIA/stats/CPT%20AIRCRAFT.pdf

Figure 2 shows the total number of monthly flights that arrive and depart at CTIA for the period between 2013 and 2023 according to the flight type (i.e. international, regional, domestic or unscheduled). Although the unscheduled flights appear to have different peaks during different years, on average the trend indicates less flights during May to September. Conversely, regional and domestic flights appear to operate without a peak season. International flights peak between November and March, which coincides with summer in South Africa.

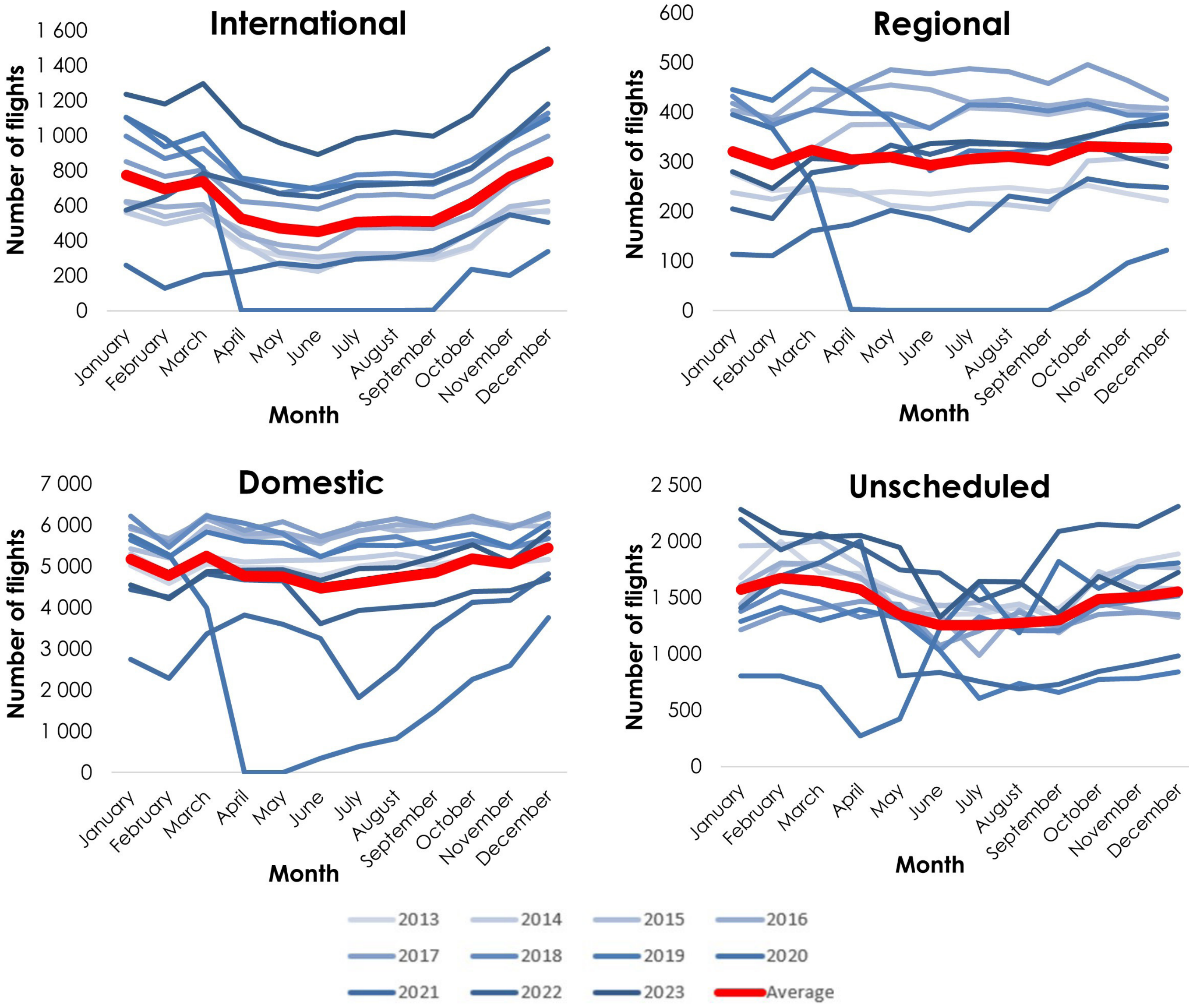


Figure 2: Total flights arriving and departing from CTIA between 2013 and 2023

With the increase in the total number of flights, there has been an increase for demand of jet fuel at the airport. With the number of domestic and regional flights that show little seasonality, the increase in fuel consumption at CTIA is attributed to the seasonality of international and unscheduled flights, which peak between November and March. In 2022, CTIA experienced a significant supply chain disruption and subsequently only had a week's worth of fuel supplies, prompting the airport to truck fuel in from other airports[2]. It has been reported that CTIA has a demand of 1.4 million to 2 million litres of fuel per day, depending on the time of year, with the Astron Refinery (see Figure 3) delivering up to 60 tankers of fuel per day[3].

The supply and sale of fuel at CTIA are both managed by a consortium of energy companies, not by the Airports Company South Africa (ACSA). The total number of flights from and to CTIA have nearly recovered to the peak in 2017, however, the composition of the flights has changed. Domestic flights have been replaced by international flights, which on average, consume considerably more fuel. This has led to a near constant stream of trucks (normally between 40 and 52, but up to 60 under certain circumstances, such as peak season and supply chain disruptions) arriving throughout the day and night to supply fuel to the airport, which usually stores between three-to-four months of fuel supply. This has prompted questions regarding the feasibility of a pipeline to supply fuel to the airport. Despite not being in control of the supply of fuel at the airport, ACSA, which owns CTIA (and other national airports), operate the refuelling of aircraft at CTIA using their infrastructure and vehicles. The consortium can source their fuel from other airports, imports at the Port of Cape Town (PoCT) or from refineries, the closest one being Astron Energy in Cape Town, as seen in Figure 3.

[2] https://www.news24.com/fin24/companies/cape-town-airport-has-less-than-a-week-of-jet-fuel-left-20220926
[3] https://www.tourismupdate.co.za/article/immigration-resources-major-concern-cape-town-airport

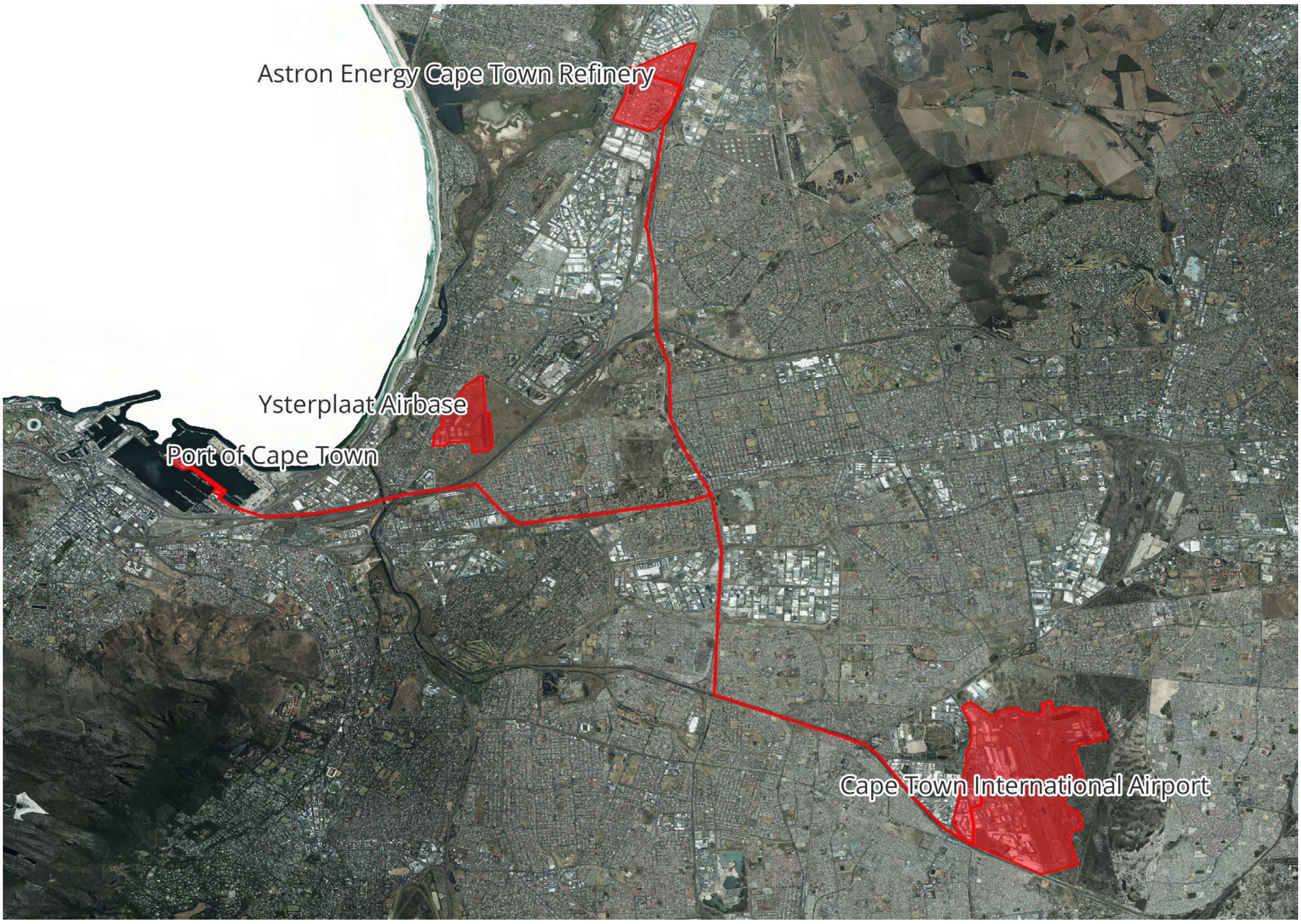


Figure 3: Points of interest and the potential pipeline route to supply jet fuel to CTIA

If a pipeline is constructed between the Astron Energy Refinery and CTIA, it would be approximately 22km in length (see Figure 3). Similarly, a 25km pipeline from the PoCT to CTIA could be constructed. This pipeline could have an offtake at Ysterplaat Airbase, but the operational requirements of supplying fuel to the airbase is currently unknown.

Methodology

The feasibility of a pipeline from the PoCT and the Astron Energy Refinery to CTIA is quantified by a high-level cost calculation of constructing a pipeline. This calculation is based on the most recent localised information available for pipeline construction cost in South Africa – namely the New Multi-Product Pipeline (NMPP), operated by Transnet Pipelines (TPL), which cost R23.4bn. However, the land acquisition cost per kilometre for the NMPP and a pipeline constructed in a dense metropolitan area should theoretically differ. Therefore, without visibility into what portion of the R23.4bn cost is attributable to land acquisition and without a benchmark for land acquisition cost in the City of Cape Town, the results of this high-level calculation should be used with caution. This is particularly important to note as the high density land use of the property between the points of interest and the PoCT would likely require land acquisition cost and environmental concerns to be considered.

The freight flows from the WC FDM™ are used to quantify the amount of jet fuel that will be transported with the pipeline, while TPL's financial data is used to calculate the operational cost to transport the jet fuel via a pipeline. This pipeline cost is then compared to the current road transport rates to deliver fuel at CTIA.

Assumptions

- Pipeline construction cost is assumed to be R32.7m per kilometre, which is based on the 715km NMPP, which cost R23.4bn to complete.
- The amortisation period for funding the pipeline is 25 years, compounded monthly.
- The assumed interest rate on the capital is 10%.
- No depreciation is included in the costs.
- 1 250 litres of jet fuel weigh one tonne.
- The cost of transporting jet fuel through the pipeline is R136 per million litre-kilometres, based on the 2023 TPL financial reporting.

Results

The key assumption driving the quantification of the feasibility of a jet fuel pipeline to CTIA is linear construction costs per tonne-kilometre. This means that the only driver that impacts the cost per tonne-kilometre is the density of the pipeline (i.e. the annual amount of jet fuel being transported by the pipeline). Figure 4 shows the decrease in cost per tonne-kilometre as the number of tonnes being transported by a pipeline increases. This graph is very similar to the pipeline cost per tonne-kilometre in the rough order of magnitude calculations published by Eskom in 2019[4]. The amortisation cost scaling linearly with pipeline length means that the cost per tonne-kilometre will only decrease if the operational cost per tonne-kilometre is lower than the annual amortisation cost. As seen in the assumptions, it was assumed that an operational cost of R136 per million litre-kilometres can be achieved, which is R0.17 per tonne-kilometre.

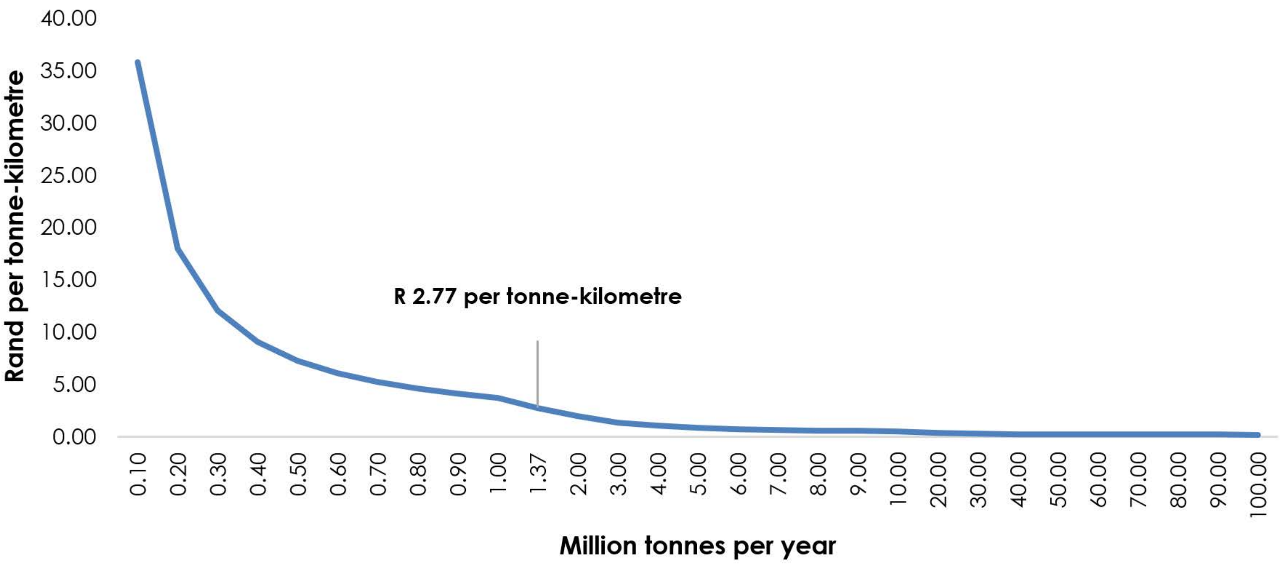


Figure 4: Rand per tonne-kilometre cost of operating a pipeline, assuming linear construction costs.

This means that given the assumed construction cost, based on the construction of the NMPP, **for the pipeline to compete with road, it needs to transport at least 1.37m tonnes (1.71m litres) per year to have the same transport cost as road.**

Construction Cost

The assumption of pipeline construction costs increasing linearly makes the calculation for the total cost of constructing the pipeline trivial:

The construction costs will, for instance, differ if a pipeline is constructed between the following origin and destinations:

- Astron Energy Refinery to CTIA (22km): R23.4bn / 715km x 22km = R720.0m
- PoCT to CTIA (25km): R23.4bn / 715km x 25km = R818.2m
- PoCT to the existing Astron Energy pipeline (13km): R23.4bn / 715km x 13km = R425.5m

In the WC FDM™, Astron Energy is in the Cape geographical district (district) and CTIA is in the Kuils River district. The jet fuel flows to CTIA according to the WC FDM™ are shown in Table 2. The road transport cost from the Astron Energy Refinery to CTIA is R2.77 per tonne-kilometre. Based on the locations of the district centroids, the distance from PoCT to Kuils River is 42.5km, resulting in a lower transport cost of R2.40 per tonne-kilometre from the PoCT to CTIA. The 23.5km distance from Cape to Kuils River, aligns more closely with the actual distance from the refinery to the airport.

Table 2: WC FDM™ freight flows of jet fuel to CTIA

Origin district	Destination district	Road tonnes	Road tonne-kilometres	Road transport costs
Cape	Kuils River	408 852	9 609 862	R26 576 985
Highveld Ridge	Kuils River	9 977	14 713 112	R18 154 067
Port Cape	Kuils River	88 751	3 770 521	R9 076 845
Port Durban	Kuils River	15 952	24 568 234	R30 507 610
Port East London	Kuils River	1	1 007	R1 338
Sasolburg	Kuils River	6 387	8 387 862	R10 785 107
Total		**529 920**	**61 050 597**	**R95 101 953**

[4] Graph 1 in Electric Transport Options in South Africa brochure, Eskom, 2019, available online: https://www.eskom.co.za/eas/wp-content/uploads/2021/05/ELECTRIC-TRANSPORT-OPTIONS-BROCHURE-v8-1.pdf

Based on current volumes, the pipeline between Astron Energy Refinery and CTIA has the potential to supply 408 852 tonnes (511 065 litres) of jet fuel annually to the airport. The operational cost of running the pipeline is estimated at R1.53m per year to cover expenses like maintenance and daily operations. The total cost for using the pipeline, which includes the annual operational cost and the annual amortisation cost (i.e. spreading the pipeline's capital investment over its useful life), amounts to R80.04 million per year. When divided across the total transported volume, this total cost translates to R8.90 per tonne-kilometre. This cost is more than three times higher than the road transport rate, which suggests that using road-based transport is significantly more cost-effective despite the pipeline's large capacity.

Similarly, a pipeline from the PoCT to CTIA, based on current volumes, would result in a transport cost of R40.38 per tonne-kilometre, as shown in Table 3.

Table 3: Cost calculations for pipelines from the Astron Energy Refinery and PoCT to CTIA, respectively.

Variable	Astron Energy to CTIA	PoCT to CTIA
Pipeline length	22	25
Construction cost (R m)	720	818
Load period (years)	25	25
Annual amortisation cost (R m)	78.51	89.22
Million litres per year	511.07	110.94
Million litre-kilometres per year	11 243	2 773
Total operating cost (R m)	1.53	0.38
Total annual cost (R m)	80.04	89.60
Million tonnes per year	0.41	0.09
Million tonne-kilometres per year	8.99	2.22
Rand per tonne-kilometre	**8.90**	**40.38**
Road transport rate	2.77	2.77
Rand per tonne-kilometre difference	-6.13	-37.62

Conclusion

Given the current pipeline construction cost assumptions, the pipeline would need to transport 1.37m tonnes (1.71m litres) of jet fuel annually to be competitive with road transport, which means the demand for jet fuel at the PoCT would need to triple, assuming the same distribution of supply origins. Therefore, given current volumes from the Astron Energy Refinery and the PoCT, the pipeline construction cost would need to be R9 731 950.40 per kilometre and R1 510 462 927.93 per kilometre, respectively, for these pipelines to be competitive with road. For context, these pipeline construction costs would be 3.36 and 15.49 times lower than the most recent successfully completed pipeline in the South Africa, respectively. In addition to cost, factors like safety, environmental impact, and operational reliability would significantly influence the viability of such pipelines. Pipelines are safer and more environmentally friendly than road transport, offering consistent performance and scalability for future demand. However, challenges such as permitting, regulatory compliance, and limited flexibility compared to road transport must also be considered when determining the optimal solution.

Highlights

- The demand for jet fuel at CTIA ranges from 1.4m to 2.0m litres per day, depending on the season, currently translating into 40 to 52 vehicles delivering jet fuel at the airport daily.
- CTIA usually has a three-to-four-month supply of fuel in storage.
- Fuel deliveries at CTIA have peaked at 60 vehicles within a 24-hour period from the Astron Energy Refinery, following a supply chain disruption at the PoCT that caused a temporary fuel supply shortage.
- Assuming a linear construction cost per kilometre, a pipeline to CTIA needs to transport at least 1.37m tonnes (1.71m litres) of jet fuel per year to be competitive with current road transport cost.
- At the current volumes, a pipeline from the Astron Energy Refinery to CTIA would need to be constructed at a cost 3.36 times lower than the benchmark NMPP construction cost per kilometre.
- At the current volumes, a pipeline from the PoCT to CTIA would need to be constructed at a cost 15.49 times lower than the benchmark NMPP construction cost per kilometre.

Introduction

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. These insights are especially valuable in addressing the pressing challenges faced by the country's logistics and transport infrastructure.

Overview

The South African logistics landscape is undergoing significant transformation, driven by substantial shifts in both design and operations. Historically, South Africa's rail network evolved over decades, shaped by outdated regulations and infrastructure. Regulatory changes have increasingly shifted commodities from rail to road transport over time, compelling the road freight sector to adapt to meet growing demands. Meanwhile, Transnet Freight Rail (TFR) continues to manage a legacy rail network that no longer fully aligns with contemporary freight requirements.

The operational landscape for TFR has shifted further with the establishment of the Rail Infrastructure Manager, which now oversees the rail network. Under this new framework, TFR is no longer the sole rail operator but one of several players accessing the network. This change presents challenges for the Rail Infrastructure Manager, which is tasked with funding and maintaining a rail network often seen as oversized and underutilised. The funding model, based on outdated access charges from a time when road transport was less efficient and subject to different regulations, is no longer sustainable. To address these challenges, a more sustainable funding approach is required. One potential solution involves downsizing the rail network under the infrastructure manager's oversight by devolving certain sections to provincial or local governments. While some of these sections may lack the traffic volumes to justify national funding, they could still play a critical role in provincial logistics.

South Africa's rail network is broadly classified into bulk mineral export lines, a core rail network, and branch lines. Bulk mineral corridors connect key mining hubs, such as iron ore and coal operations, to export sea ports. The core rail network links major economic centres like Cape Town, Johannesburg, Durban, and Gqeberha, while branch lines provide connectivity to smaller regions outside these hubs. The Roadmap for the Freight Logistics System in South Africa (Republic of South Africa, 2023) further categorises the rail network into four types, namely Bulk Mineral Corridors (BMC), Core Rail Network (CRN), Feeder Rail Systems (FRS), and Short Lines (see Figure 1).

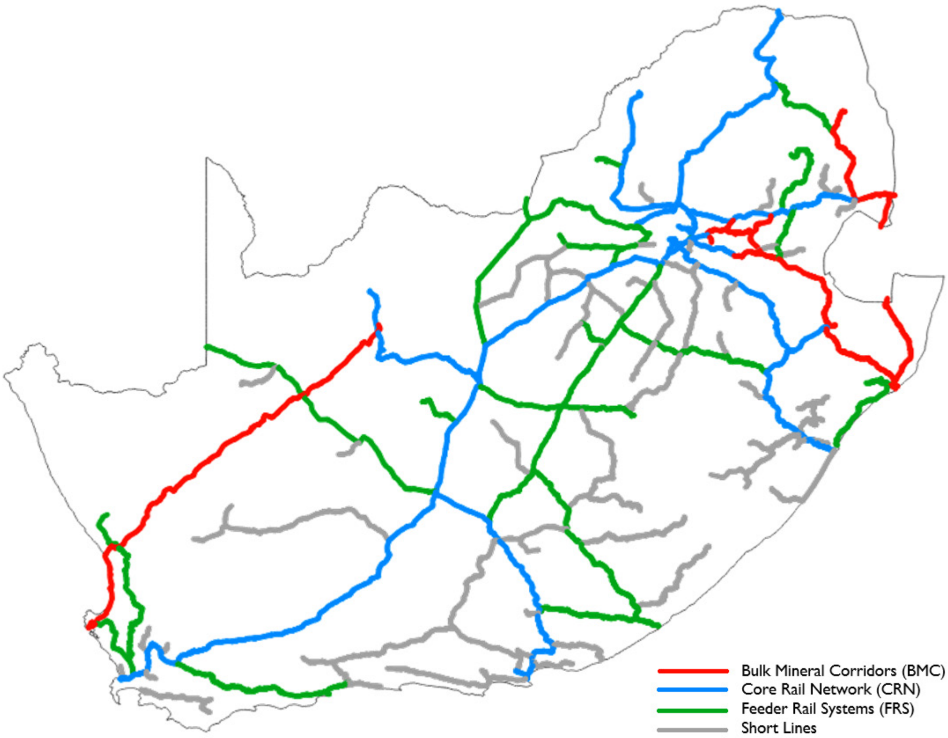


Figure 1: The tiered freight rail network for South Africa (Republic of South Africa, 2023:49)[1]

[1] Republic of South Africa. 2023. *Roadmap for the Freight Logistics System in South Africa*. Pretoria, South Africa: Republic of South Africa.

This network classification underscores the strategic importance of each segment, aiding resource allocation for maintenance and upgrades. Bulk mineral corridors and the core network play a pivotal role in national economic activity, while feeder and short lines are essential for provincial connectivity, despite lower traffic volumes.

A strategic approach to managing and funding these rail segments could ensure that South Africa's rail network remains viable, efficient, and capable of supporting both national and provincial logistics needs.

Figure 2 provides a zoomed in view for Western Cape feeder and short lines. Feeder lines include the Bitterfontein (green), Saldanha (red) and Worcester to George (pink) line while the Overberg (purple), Riebeek West, Ceres (orange) and Atlantis (blue) lines are classified as short lines.

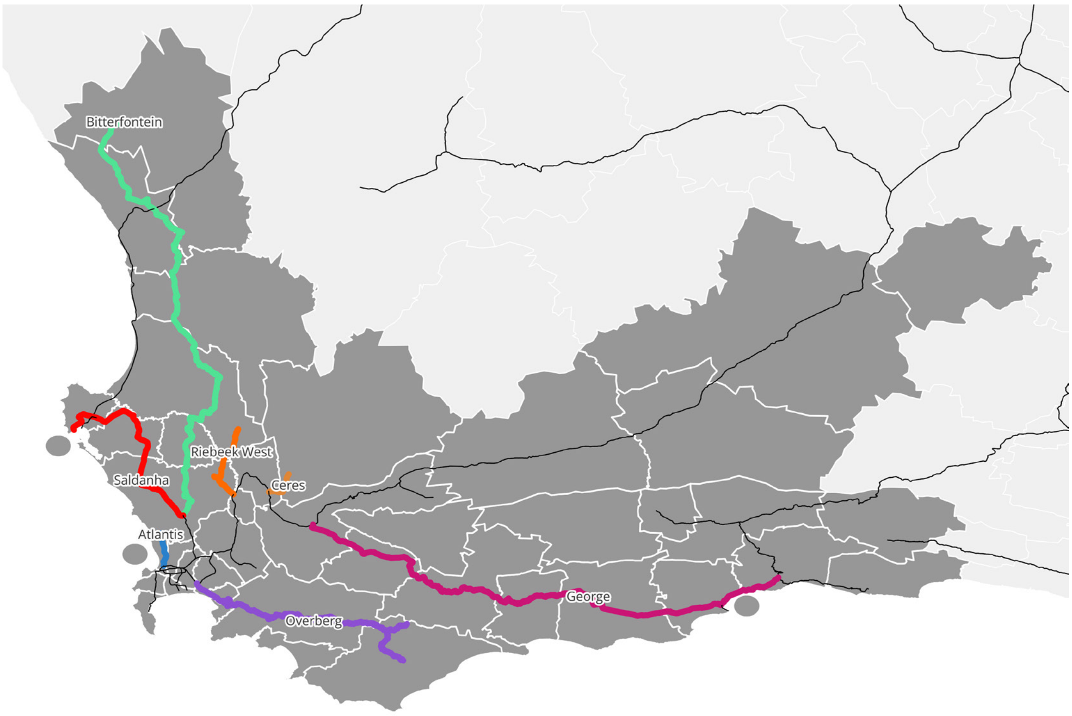


Figure 2: The branch lines within the Western Cape

Objective of the analysis

The logistics infrastructure in the Western Cape is well-established and plays a vital role in supporting economic growth. The Western Cape Government (WCG) needs to consider how rail-related decisions impact the key economic drivers of the province, particularly agriculture and manufacturing. **This analysis aims to assess current freight movement on both rail and road in relation to the branch lines (i.e. feeder and short lines) within the Western Cape and to identify potential freight rail opportunities across the branch lines for the WCG to pursue.**

WC FDM™ 2022 base year data was used to allocate rail and road freight flows to the Western Cape's feeder and short rail lines, offering insights into freight patterns related to commodity types, volumes, tonne-kilometres, and average transport distances. The results are presented visually through corridor maps and detailed tables. This analysis identifies the key commodities and industries linked to each corridor or rail line.

The rail analysis quantifies a base scenario of rail activity and provides potential levels of modal shift of rail-friendly freight[2] from road to rail. **The base scenario, also referred to as 'low hanging fruit", provides a full uptake and a lower uptake option.**

Methodology

A high-level transport cost comparison was performed with an analysis of the annual reduction in truck trips from the road network. Table 1 shows the calculated rail tariff applied to all the freight being shifted to rail. The rail cost from the WC FDM™ 2022 base year was applied, using a weighted tariff for every combination of different flow segmentations on the rail network (Core to Core/CC, Core to Branch/CB, Branch to Core/BC, Branch to Branch/BB, and none to core/NC) on a province-to-province basis.

The WC FDM™ utilises the externality cost rate for road, which is 21.37c per tonne-km more than rail. A shift from road to rail will, therefore, decrease externalities incurred by the transport of freight. The total estimated number of truck trips, based on the typical load factor, was calculated using data from the WC FDM™ 2022 base year.

[2] Rail-friendly freight is based on the density attributed to the origin and/or destination, packaging type and distance.

Table 1: Calculated weighted rail tariff based on 2022 actual rail tariffs

Rail Flow Segmentation	Origin Province	Destination Province	Tariff (R) per tonne-km
CC	Northern Cape	Western Cape	0.16
NC	Northern Cape	Western Cape	0.31
CC	Western Cape	Western Cape	0.46
BB	Western Cape	Western Cape	1.64
CB	Western Cape	Western Cape	0.88
CC	Limpopo	Western Cape	0.61
BC	Western Cape	Western Cape	1.28
BC	Free State	Western Cape	0.38
BC	North West	Western Cape	0.36
CC	Free State	Western Cape	0.52
CC	Western Cape	Gauteng	0.52
BC	Northern Cape	Western Cape	0.57
CC	Gauteng	Western Cape	0.39
CC	North West	Western Cape	0.44
BC	Western Cape	Eastern Cape	0.59
BC	Western Cape	Limpopo	0.52
CC	Western Cape	North West	0.52
CC	Western Cape	Free State	0.64

Results

1. Full uptake option

The following assumptions were applied in the quantification of rail-friendly freight to be shifted from road to rail:

a. Fruit exports from Elgin, Vredendal, Ceres (100%)

b. WC (excluding Malmesbury) palletised, long distance, to and from Gauteng (GT), Kwa-Zulu Natal (KZN) Limpopo (LMP) (100%)

c. Malmesbury palletised, long distance, to and from Gauteng (GT), Kwa-Zulu Natal (KZN) Limpopo (LMP) (100%)

d. Vredendal Dry bulk to and from Cape Town (100%)

e. Athlone Waste on Rail (100%)

f. Riebeek West Cement (45%)

g. Caledon Barley (100%)

The target of 45% of Riebeek West cement, identified as low hanging fruit, is based on historical rail data. Although there is more cement production in Riebeek West, much of it is not in a rail transportable form and is transported wet to construction sites. Table 2 provides a summary of the tonnes, reduction of truck trips, transport and externality cost savings for this scenario.

Table 2: Quantification of tonnes, truck trips, transport and externality cost saving of the base scenario (full uptake) modal shift

Commodity	Geographic extent	Branch line	Shiftable Tonnes	Reduction of truck trips	Transport cost saving (Rm)	Externality cost saving (Rm)
a) Fruit exports	Ceres	Ceres	249 279	8 310	43.9	7.0
	Elgin	Overberg	256 826	8 563	17.6	6.8
	Vredendal	Saldanha	255 019	8 501	70.5	13.3
b) Palletised	Long distance WC	All	6 388 271	198 005	4 257.5	2 015.8
c) Palletised (Food)	Malmesbury	Bitterfontein	760 328	24 586	438.3	176.3
d) Dry bulk	Vredendal	Bitterfontein	826	24	0.25	0.03
e) Waste	Athlone	Atlantis	105 098	21 020	24.5	0.6
f) Cement	Riebeek West	Riebeek West	212 535	7026	28.3	17.0
g) Barley	Caledon	Overberg	40 671	1 206	13.1	2.1
Total			**8 268 854**	**277 241**	**4 893.9**	**2 238.9**

Given the current state of rail in South Africa, there are concerns about the readiness of rail to handle all these volumes if they were to be shifted from road. A lower level of uptake of the base scenario, which allows for a more gradual modal shift, was subsequently investigated.

2. Lower uptake option

A more realistic short-term base scenario is quantified in Table 3, where the following percentage of modal shift can be achieved:

a. Fruit exports from Elgin, Vredendal, Ceres (50%)
b. WC (excluding Malmesbury) palletised, long distance, to and from Gauteng (GT), Kwa-Zulu Natal (KZN) Limpopo (LMP) (25%)
c. Malmesbury palletised, long distance, to and from Gauteng (GT), Kwa-Zulu Natal (KZN) Limpopo (LMP) (50%)
d. Vredendal Dry bulk to and from Cape Town (50%)
e. Athlone Waste on Rail (100%)
f. Riebeek West Cement (45%)
g. Caledon Barley (50%)

Depending on the level of uptake considered under the base scenario, a reduction of truck trips could be achieved ranging from between 100 000 to 280 000, annually. Additionally, a high-level estimate of the line haul transport cost saving is between R1.4bn and R4.9bn annually, depending on the ability of freight to be transported on rail. Similarly, the high-level estimate of the externality cost saving is between R0.6bn and R2.2bn.

Table 3: Quantification of tonnes, truck trips, transport and externality cost saving of the base scenario (lower uptake) modal shift

Commodity	Geographic extent	Branch line	Shiftable Tonnes	Reduction of truck trips	Transport cost saving (Rm)	Externality cost saving (Rm)
a) Fruit exports	Ceres	Ceres	124 639	4 155	22.0	3.5
	Elgin	Overberg	128 413	4 281	8.8	3.4
	Vredendal	Saldanha	127 509	4 251	35.2	6.7
b) Palletised	Long distance WC	All	1 597 068	49 501	1 064.4	503.9
c) Palletised (Food)	Malmesbury	Bitterfontein	380 164	12 293	219.1	88.1
d) Dry bulk	Vredendal	Bitterfontein	413	12	0.13	0.01
e) Waste	Athlone	Atlantis	105 098	21 020	24.5	0.6
f) Cement	Riebeek West	Riebeek West	212 535	7026	28.3	17.0
g) Barley	Caledon	Overberg	20 336	603	6.6	1.1
Total			**2 696 176**	**103 142**	**1 409.0**	**624.4**

Figure 3 shows a visual representation of where the reduction of truck trips will be in the Western Cape, while Figure 4 indicates on which parts of the railway the freight will be transported.

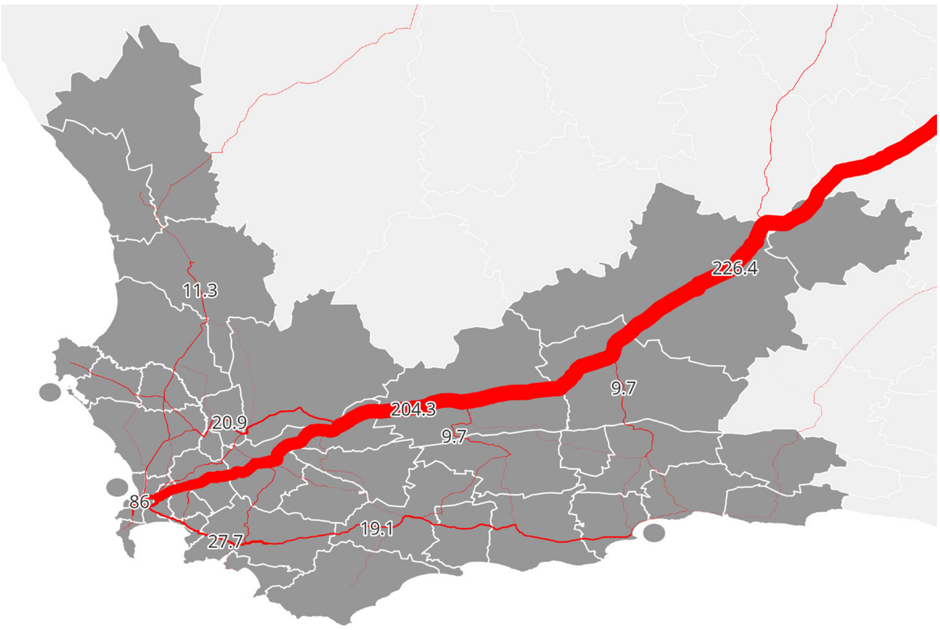


Figure 3: Visualisation of the annual truck trips removed from road due to the base (full uptake) scenario's modal shift to rail

Figure 4: Visualisation of the shiftable freight flows (thousand tonnes) on the rail network due to the base (full uptake) scenario's modal shift to rail

Conclusion

Table 4 provides a summary of the scenario discussed, highlighting the shiftable tonnes, the reduction in truck trips as well as the associated transport and externality cost savings for each level of uptake.

Table 4: Summary of the total tonnes shiftable, reduction of truck trips, transport and externality cost savings of the different levels of uptake of the base scenario

Scenario	Tonnes shiftable	Reduction of truck trips	Transport cost saving (Rm)	Externality cost saving (Rm)
Base – Lower uptake	2 696 176	103 142	1 409.0	624.4
Base – Full uptake	8 268 854	277 241	4 893.9	2 238.9

The analysis highlights the economic and environmental importance of rail transport in the Western Cape and the crucial role of provincial and local governments in its sustainability, especially if devolution occurs. Despite its potential, the rail network is underutilised, leading to inefficiencies in freight movement. A shift from road to rail presents significant opportunities, offering cost savings, environmental benefits, and reduced transport externalities. Disruptions to rail services could have severe economic impacts on local stakeholders. Strategic investments in rail infrastructure are essential to optimise freight efficiency, reduce carbon emissions, and support long-term sustainability. By prioritising the road-to-rail transition, the province can enhance its competitiveness in global supply chains and strengthen its economic position in an increasingly sustainability-focused world.

Highlights

- The scenario results show immediate potential for modal shift from road to rail on nearly all the branch lines in the province, covering rail-friendly commodities such as fruit exports, palletised freight, dry bulk, waste, cement and barley from road to rail.
- This scenario indicated that rail potential in the Western Cape could shift 2.7m tonnes from road to rail, leading to significant reductions in truck trips (over 100 000), transport cost (R1.4bn) and externality cost (R0.6bn) at a lower uptake. At full uptake, 8.3m tonnes could shift from road to rail in the Western Cape, which would save nearly 300 000 truck trips, R4.9bn transport cost and R2.2bn externality cost overall.

Introduction

The WC FDM™ freight flows are derived from economic activity, specifically activities that contribute to transportable GDP, which consists of the extraction of raw materials and manufacturing (also known as the primary and secondary economic sectors, respectively). Although waste does not directly contribute to the GDP, it has an indirect impact since its transportation and disposal require resources that could have been used for activities that contribute to the GDP.

The WC FDM™ waste forecast investigates a plausible relationship between waste being landfilled (i.e. waste landfilled) and commodity demand. Waste Management and the logistics behind it is itself a complicated subject. Waste landfilled is inherent not only to the consumption of goods but also to extraction and manufacturing processes. Therefore, a portion of transportable GDP will end up in landfills. The amount of waste landfilled per product type can also vary depending on the packaging type. For instance, wrapping four apples with plastic mesh on a paper container (which is covered with another layer of plastic) as opposed to 1.5 kg apples in a plastic bag.

The third goal of the Western Cape Integrated Waste Management Plan (IWMP) 2022 – 2027 is the effective and efficient utilisation of resources, which has the following objectives: Minimise the consumption of natural resources and promote the circular economy; stimulate job creation within the waste economy; and increase waste diversion through reuse, recovery, and recycling. The private sector, both locally and internationally, has also seen opportunities to reduce its waste footprint with zero-waste stores where consumers bring their own containers when purchasing goods. Waste landfilled is, therefore, a changing landscape depending on the manufacturer of final goods and consumer behaviour, both of which can be influenced by the local and provincial government.

When goods are not reused or recycled, they eventually end up in a landfill or polluting the environment. Knowing the lifespan of a landfill site is integral to any integrated waste management planning. Forecasting waste volumes is, therefore, an important but difficult task and what proves sufficient for one waste stream will not be for another. The difficulty of waste forecasting can be seen in a study of municipal waste landfilled in the City of Logan in Australia. The study used different Artificial Intelligence methodologies rather than previously used methodologies such as descriptive statistics, regression analysis, material flow modelling or time series analysis (Abbasi & Hanandeh, 2016). Their model accurately forecast waste landfilled from 2012 to 2014 based on training data from 1996 to 2012. The study predicted that Logan City will landfill 94 000 tonnes of Municipal Solid Waste by 2020. In reality, in the year 2020/21 the City of Logan landfilled 132 780 tonnes of municipal solid waste, of which 48 289 tonnes were diverted.

Waste Overview

For the WC FDM™ waste forecast the following data inputs were used:

- City of Cape Town waste data from 2010 to 2023,
- WC FDM™ 2017 to 2023,
- National Freight Demand Model (FDM™) 2014 to 2016, and
- P3041.2 - Manufacturing: Production and sales - Statistics South Africa[1]

Reliable provincial waste data was unavailable before 2017 and was, therefore, left out of the analysis. Waste landfilled data was compared to WC FDM™ and national FDM™ demand data for the City of Cape Town (CoCT) to establish a link between freight demand and waste landfilled. The P3041.2 indices were used to extrapolate the demand for 2010 to 2013 from the FDM™ data.

The data processing methodology for the three WC FDM™ waste streams for the CoCT is discussed below. Apart from the 6 major facilities in the CoCT, there are 24 other municipalities within the Western Cape that are served by 113 waste facilities (as can be seen in Figure 1) that report handling waste of which municipal, garden, organic (now included in the WC FDM™ 2023) and construction and demolition make up the majority. The forecast that was used for the CoCT municipal waste assignments was also applied to WC FDM™ districts. For 2023, of the 119 735 tonnes of organic waste reported in the Western Cape as GW20, 53 504 tonnes were landfilled within the City of Cape Town. Of the 53 504 tonnes, 52 835 tonnes were garden waste (GW20.01), whereof 43 651 tonnes (83%) were recycled. The remaining organic waste tonnes were food waste. Therefore, the organic waste forecast uses the same growth factors as the garden waste forecast on the assumption that fertilizer has the same link to organic waste landfilled as garden waste.

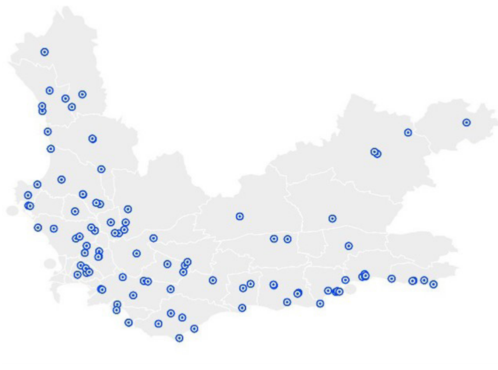


Figure 1: Waste facilities

[1] This statistical release contains information regarding indices of the physical volume of manufacturing production and the total value of sales of manufactured products, according to manufacturing divisions on a monthly basis. https://www.statssa.gov. za/?page_id=1861&PPN=P3041.2&SCH=73155

Abbasi, M. & Hanandeh, A.E. 2016. Forecasting municipal solid waste generation using artificial intelligence modelling approaches. Waste Management, 56:13-22, https://doi. org/10.1016/j. wasman.2016.05.018

1. GW01 – Municipal waste

Figure 2 shows the major catchment areas for each waste facility within the CoCT Municipality, with Figure 3 illustrating the waste collection and transfer process.

Figure 2: Catchment areas for the various refuse transfer stations and landfills in the CoCT Municipality.

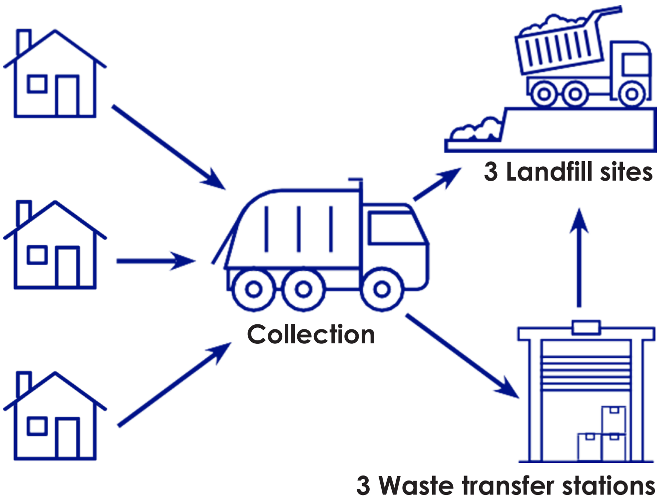


Figure 3: The waste collection and transfer process

Waste is not always taken directly to a landfill. There are three refuse transfer stations where waste gets dropped off and consolidated before being transported to one of the landfills.

For the WC FDM™, waste OD flows were generated based on the intersection of each WC FDM™ district with each of the municipal waste facilities catchment area. For districts that fall into multiple catchment areas, the waste flows were split between the different waste facilities.

It was assumed that municipal waste could be linked to the demand for processed foods and beverages. Unsurprisingly the demand for processed foods and beverages in the CoCT Municipality has grown since 2010. This contrasts with municipal waste landfilled, which has been on a slight decline since 2010 as seen in Figure 4.

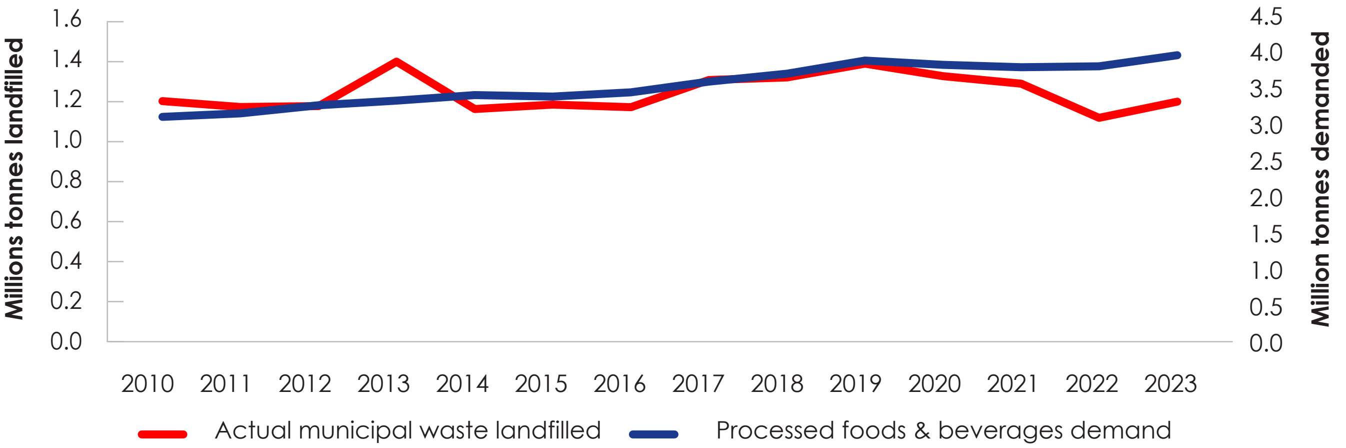


Figure 4: Municipal waste landfilled (left axis) and demand for processed foods and beverages (right axis) in CoCT Municipality 2010-2023.

Processed foods and beverages forecasts in the WC FDM™ considers population growth, therefore, population was not explicitly used as a means of the forecast, but it is indirectly accounted for.

For processed foods and beverages, if all the packaging is recycled and there is no wastage of the contents, then there is no waste landfilled. Conversely, if no packaging is recycled and all the contents go to waste, all demand for processed foods and beverages turns into waste. The amount of waste landfilled per tonne of processed foods and beverages per consumption is, therefore, subject to consumer behaviour regarding food waste and recycling. This behaviour is in turn shaped by initiatives like the Think Twice initiative pilot[2], which encouraged the separation of recyclable waste, and the Food Forward project[3], which encouraged the reduction of food waste.

[2] Western Cape Government. 2007. *Think Twice - The City's Environmental Initiative: Waste Separation at Source - Launched in Pinelands and Parts of Blaauwberg* [Online]. Available: https://www.westerncape.gov.za/news/think-twice-citys- environmental-initiative- waste-separation-source-launched-pinelands-and-parts [2022, November 18].

[3] Western Cape Government. 2022. *Food Forward Project* [Online]. Available: https://www.westerncape.gov.za/110green/projects/food-forward-project [2022, November 18].

It is, therefore, assumed that there is a constant relationship between the amount of packaging required for processed foods and beverages. However, it appears that waste reduction initiatives have been shaping consumer behaviour which led to a reduction of the municipal waste landfilled between 2010 and 2023, 'decoupling' demand for processed foods and beverages and municipal waste landfilled. When the 2023 (29.4%) ratio of municipal waste landfilled to the demand for processed foods and beverages is compared to the ratio for 2010 (38.3%), it indicates that waste landfilled has decreased by 9.1% as stated as a proportion of the demand for processed foods and beverages. Without these structural and behavioural changes, an additional 358 330 tonnes of municipal waste could have been landfilled in 2023. The estimated cumulative saving since 2010 amounts to 2.35m tonnes, which is currently equivalent to two years of municipal waste landfilled.

This reduction implies that a new baseline of waste landfilled is established, and that additional manufacturers and consumers further reduce their waste landfilled in the following year as seen in Figure 5.

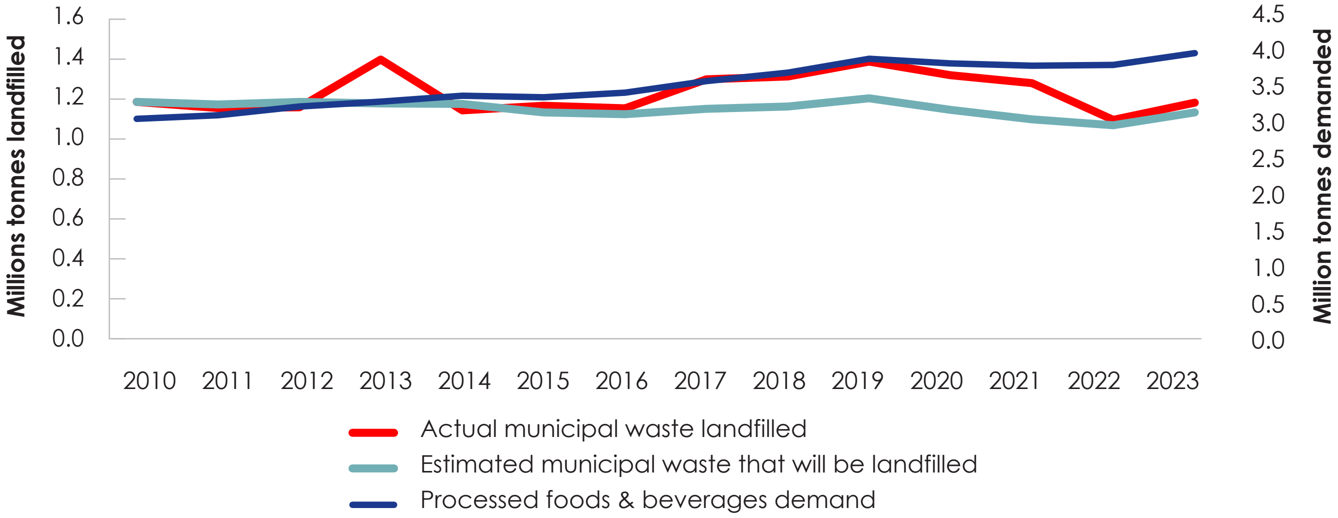


Figure 5: Actual and estimated municipal waste landfilled, assuming an accumulating 25 595 tonnes per year offset (left axis), and demand for processed foods and beverages (right axis) in CoCT Municipality 2010-2023.

For the waste forecast, it was assumed that the cumulative offset was still present in 2023, after which the proportion of waste to processed foods and beverages remains fixed at 29.4% for future years which leads to the municipal waste forecast for the CoCT as seen in Figure 6.

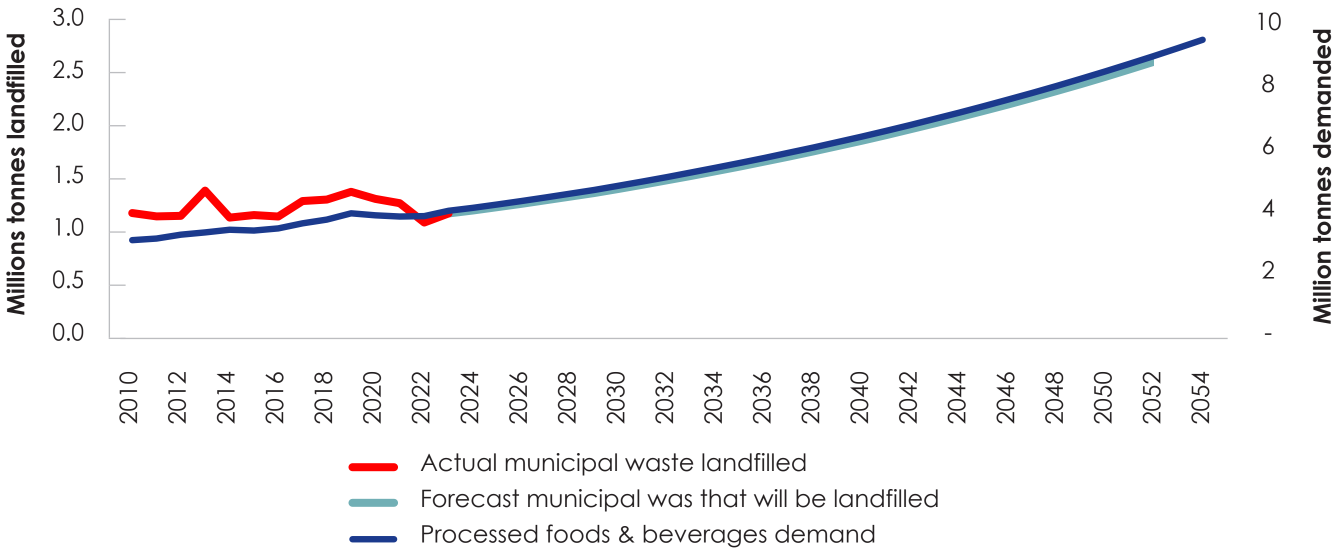


Figure 6: Processed foods and beverages demand in CoCT Municipality and municipal waste landfilled forecast.

Even though there is a definite disconnect between urban and rural municipal waste landfilled, the CoCT municipal forecast of 29.39% of processed foods and beverages is used to grow the 2023 municipal waste flows in the WC FDM™, as seen in Table 1.

Table 1: Municipal waste forecast for the Western Cape (million tonnes).

Origin	Actual	Forecast		
	2023	2024	2029	2054
CoCT	1.18	1.21	1.37	2.76
Rest of Province	0.32	0.26	0.30	0.59
Total	**1.50**	**1.47**	**1.67**	**3.35**

Given that there is no additional reduction at source or recycling uptake by consumers, municipal waste is forecast to increase 2.34 times by 2054, based on the forecast processed foods and beverage demand of the Western Cape.

2. GW20 – Organic waste

There are two main flows of organic waste (GW20), namely GW20.01 (garden waste) and GW20.02 (food waste), which have the same catchment as municipal waste. Garden waste is separated at source by being dropped off at drop-off points. Some of this garden waste is then composted by private companies and sold as compost material. Reliance Compost (Pty) Ltd is the principal composting company that transports all the garden waste to its composting site just outside Paarl. Some food waste ends up in landfills and is already included in municipal waste.

Demand for fertilizer was the most likely commodity that could be linked to garden waste landfilled within the CoCT Municipality. It should be noted that there would be a definite disconnect between the demand for fertilizer in the CoCT and the rest of the province, where fertilizer is used primarily for agricultural purposes, such as garden waste landfilled. However, because organic waste is included in the WC FDM™ 2023, it is assumed that the relationship between garden and organic waste landfilled and fertilizer is similar enough, in the absence of a similar length time series for provincial municipal data on organic waste landfilled.

Figure 7 shows the waste landfilled of GW20.01 as well as the demand for fertilizer in the CoCT from 2010 to 2023.

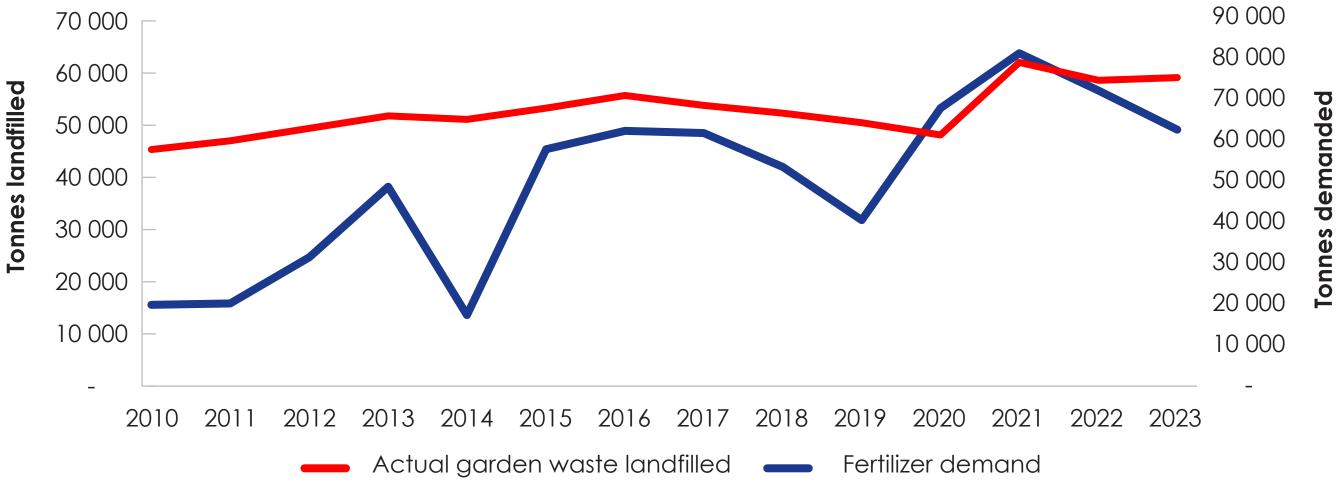


Figure 7: Garden waste landfilled (left axis) and demand for fertilizer (right axis) in CoCT Municipality 2010-2023.

The formula used to forecast the garden waste was GW20.01=X*(fertilizer demand), where X is the ratio (proportion) of cumulative garden waste landfilled to the cumulative fertilizer demand from 2010 to 2023. This proportion is 0.579; thus, for every tonne of fertilizer, demand is 579 kgs of garden waste landfilled. This relationship is expected to hold in the long term. The estimated garden waste landfilled can be seen in Figure 8.

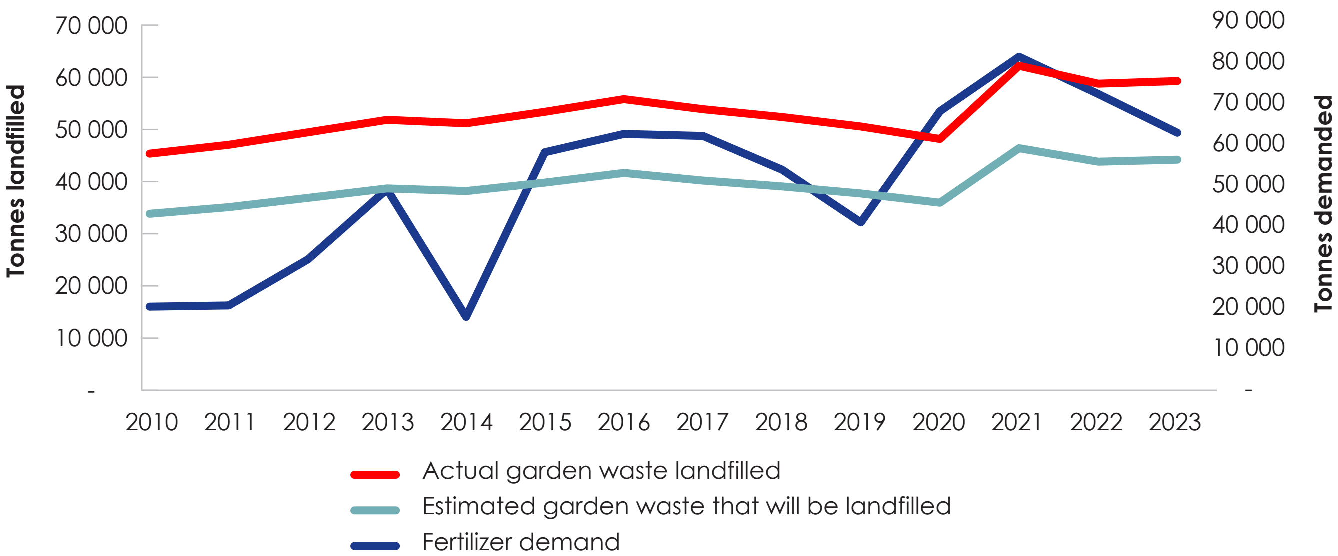


Figure 8: Actual and estimated garden waste landfilled (left axis) and fertilizer demand (right axis) in CoCT Municipality 2010-2023.

Due to the nature of how garden waste is landfilled and its durability, another avenue of analysis would be to consider a simplified material flow approach as it shares many similarities with construction and demolition waste (It is also stockpiled and partially reused). This is done by comparing the cumulative amount of garden waste landfilled to the cumulative demand for fertilizer from 2010 to 2023. That is the sum of garden waste divided by the sum of fertilizer demand for the CoCT, which comes to 597 kg of garden waste landfilled per tonne of fertilizer demand. This highlights the plausibility of using a simplified material flow approach for forecasting durable waste such as garden waste and construction and demolition waste. The forecasting of provincial garden waste can be seen in Figure 9.

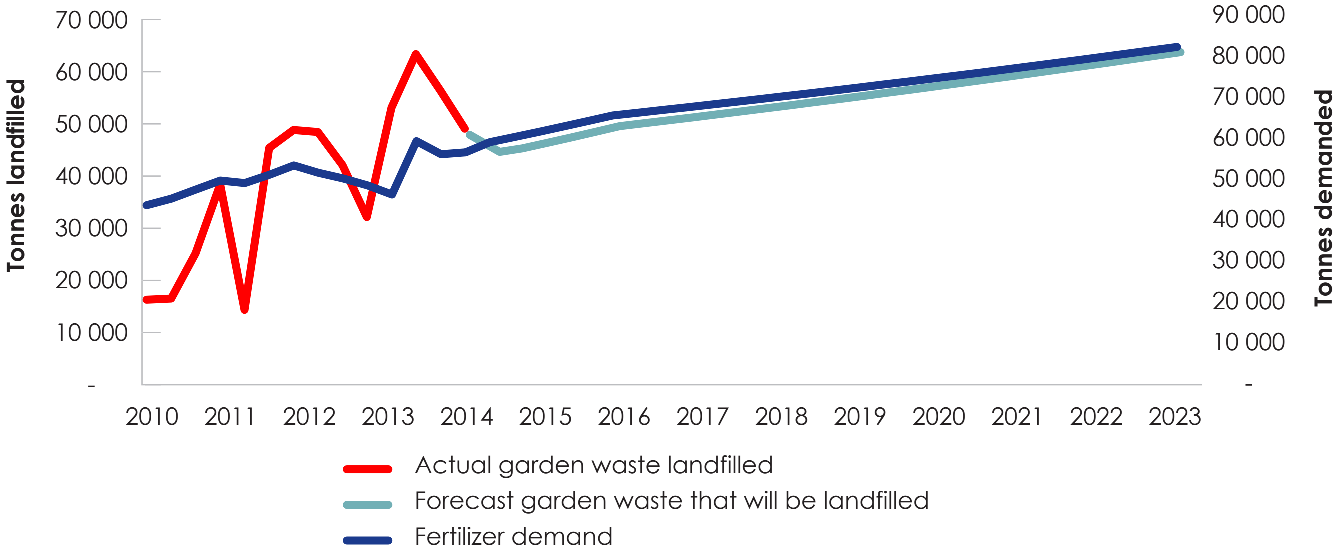


Figure 9: Fertilizer demand in CoCT Municipality and garden waste landfilled forecast.

Garden waste was forecast on the same principle as municipal waste: The rate of change between 2023 and 2024, 2029 and 2054 based on the forecast of fertilizer demand was applied to all garden waste landfilled within the province as can be seen in Table 2.

Table 2: Forecast garden waste landfilled for the Western Cape (million tonnes)

Origin	Actual	Forecast		
	2023	2024	2029	2054
CoCT	0.05	0.05	0.05	0.07
Rest of Province	0.05	0.04	0.05	0.06
Total	0.09	0.09	0.10	0.13

Based on the forecast demand for fertilizer, the total amount of garden waste landfilled is set to increase by 34% by 2054.

3. GW30 – Construction and demolition waste

Figure 10 shows the movement of construction and demolition waste. Residents, as well as companies, can drop off small quantities of builders' rubble at one of the city's drop-off sites. There are 37 drop-off sites in Cape Town for this type of waste. From these sites, the waste is primarily taken directly to landfill. The catchment areas for construction and demolition waste are shown in Figure 2.

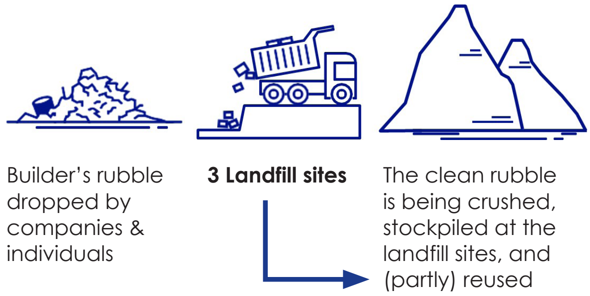


Figure 10: GW30 – Construction and demolition waste.

When considered in the context of the waste streams discussed up until now, construction and demolition waste is the most durable. All infrastructure and buildings are potential future sources of construction and demolition waste. Similar to how garden waste landfilled is dependent on the number of trees grown and eventually cut down or trimmed; construction and demolition waste landfilled is dependent on infrastructure, housing, or commercial construction projects. Therefore, it was assumed that the long-term construction and demolition waste landfilled could be explained by the demand for bricks and cement. As infrastructure is expanded and new buildings are constructed, the raw material stocks are moved from the respective sources to waste facility stockpiles for future re-use.

Figure 11 shows that there was a sharp increase in construction and demolition waste landfilled between 2014 and 2017.

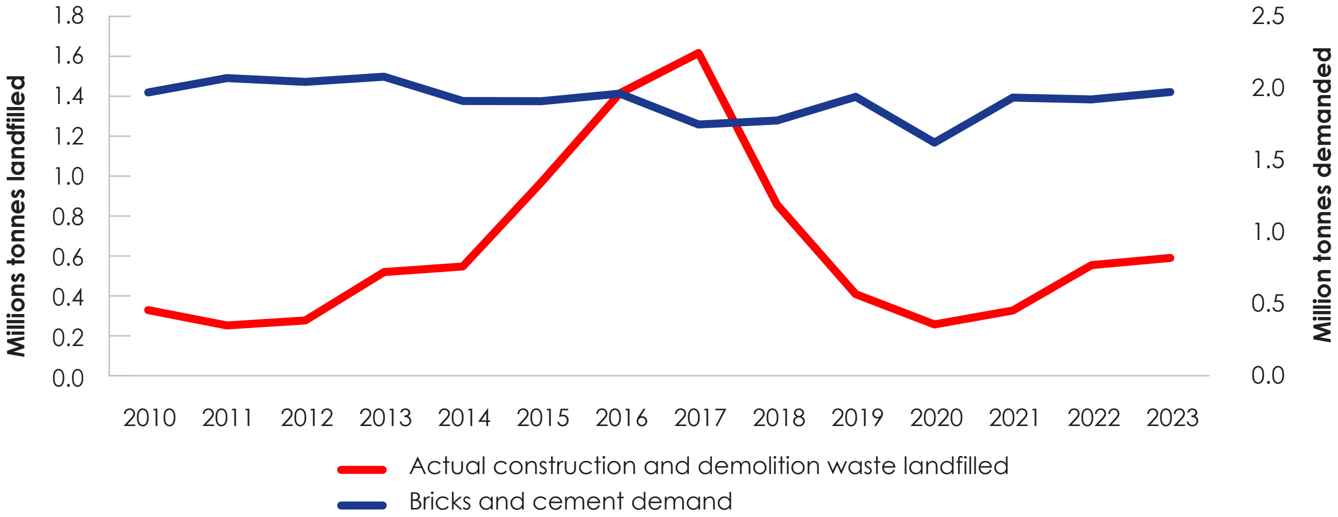


Figure 11: Construction and demolition waste landfilled (left axis) and the demand for bricks and cement (right axis) in CoCT Municipality 2010-2023.

Due to this significant spike in construction and demolition waste, a simplified Urban metabolism inspired approach was used to forecast the construction and demolition waste landfilled, rather than trying to estimate or account for what could be an apparent cyclical construction and demolition waste trend. The tonnes of construction and demolition waste were compared to the total tonnes of bricks and cement demand over the period 2010 to 2023. This fraction gives the medium- to long-term expected annual movement of construction materials from one stockpile (infrastructure and buildings) to construction and demolition waste stockpiles.

For every tonne of bricks and cement that is demanded in the CoCT, it is, therefore, estimated that 332 kg of construction and demolition waste is landfilled, as can be seen in Figure 12.

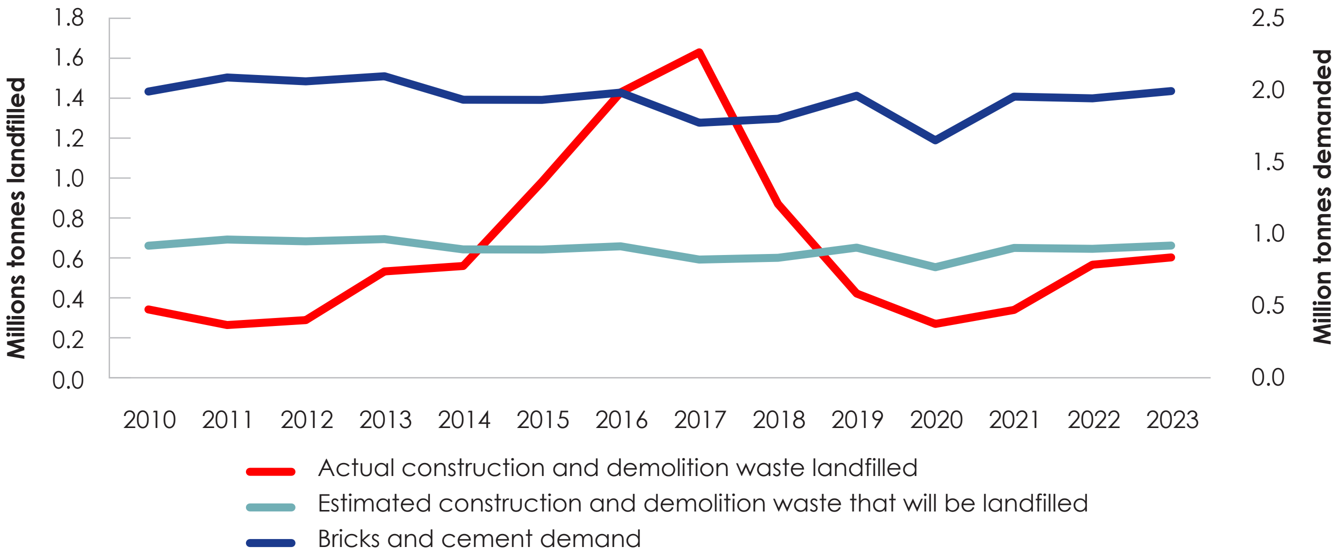


Figure 12: Actual and estimated construction and demolition waste landfilled (left axis) and the demand for bricks and cement (right axis) in CoCT Municipality 2010-2023.

The rate of change from 2023 to 2024, 2029 and 2054, respectively, was used to forecast construction and demolition waste supply for all the districts in the WC FDM™, despite the assumption that the turnover rate from buildings and infrastructure to stockpiles at waste facilities outside the CoCT municipality will be lower. However, as urbanisation, urban sprawl, and densification increase, the assumption might not be too unrealistic. This leads to a provincial construction and demolition waste forecast as can be seen in Figure 13.

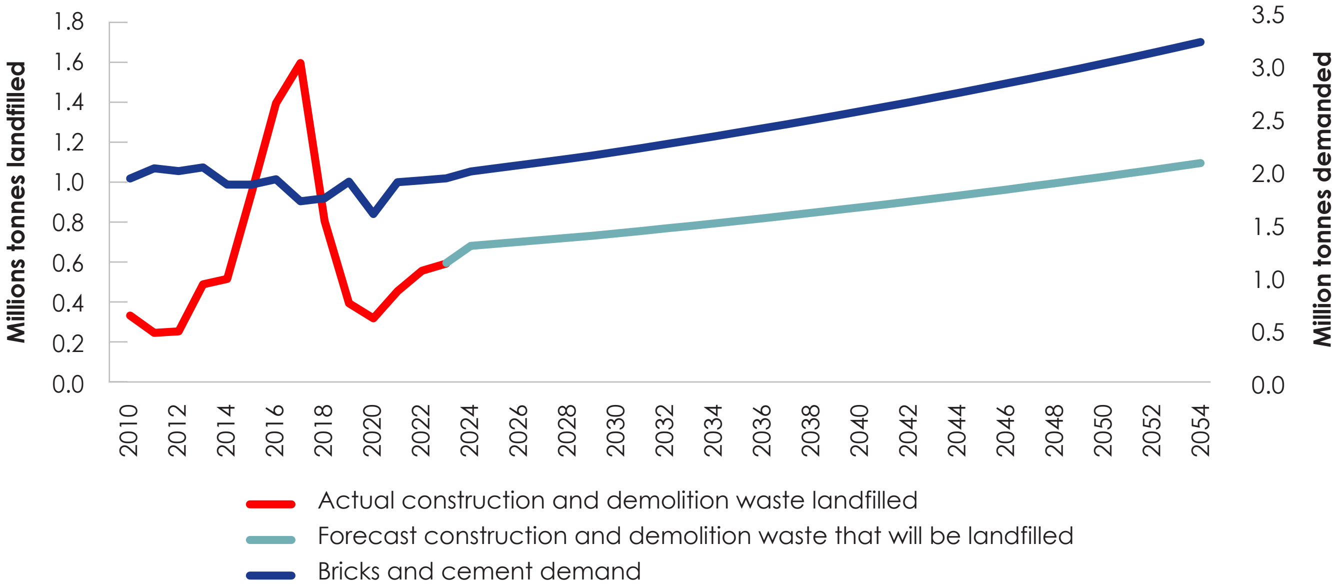


Figure 13: Bricks and cement demand in CoCT Municipality and construction and demolition waste landfilled forecast.

Table 3 shows the forecast construction and demolition waste landfilled. Given the medium- to long-term tempo of construction and waste landfilled, supply can be predicted by the growth in demand for bricks and cement in the CoCT – with construction and demolition waste landfilled in the Western Cape set to increase 3.01 times by 2054 .

Table 3: Forecast construction and demolition waste landfilled for the Western Cape (million tonnes)

Origin	Actual	Forecast		
	2023	**2024**	**2029**	**2054**
CoCT	0.59	0.68	0.73	1.10
Rest of Province	0.10	0.08	0.09	0.98
Total	**0.69**	**0.76**	**0.82**	**2.08**

Highlights

- Municipal waste reduction initiatives have seemingly been reducing the waste landfilled cumulatively by 34 000 tonnes per year since 2010 up until 2023, given that the demand for processed foods and beverages in the CoCT explains the waste landfilled.
- Municipal waste forecasts for the CoCT, based on demand for processed foods and beverages, in the absence of additional waste reduction measures such as recycling and reuse, are expected to increase to 2.76m tonnes per year by the year 2054.
- Garden waste landfilled is expected to increase by 34% by 2054 based on the forecast of fertilizer demand in the CoCT.
- Construction and demolition waste is expected to grow the fastest of the three waste streams, as mentioned in this chapter, based on the forecast of bricks and cement demand in the CoCT.

Table 1 below lists all the manufacturing freight flows that originate within the Western Cape (intra-provincial and outgoing traffic). The grouping 'Other commodities' is also detailed in Table 1.

Table 1: Manufacturing freight flows that originate within the Western Cape (2023)

Commodity	Million tonnes 2023	Percentage contribution
Processed Foods	9.00	29.5%
Beverages	3.37	11.0%
Diesel	3.37	11.1%
Other Petroleum Products	2.26	7.4%
Cement	2.10	6.9%
Other Manufacturing Industries	1.76	5.8%
Petrol	1.79	5.9%
Bricks	1.32	4.3%
Other Commodities:	5.88	19.1%
Animal feed	1.05	3.4%
Iron & Steel	0.70	2.3%
Jet fuel	0.54	1.8%
Slaughtered animal meat	0.48	1.5%
Metal products, machinery and electronic equipment	0.45	1.5%
Fertilizer	0.41	1.3%
Chemicals	0.36	1.2%
Textile Products	0.34	1.1%
Wood timber and products	0.29	0.9%
Pharmaceutical Products	0.27	0.9%
Paper	0.24	0.8%
Scrap metals	0.20	0.6%
Recycled paper	0.15	0.5%
Non-Ferrous Metal Products	0.13	0.4%
Soya bean products	0.11	0.3%
Printing and Publishing	0.08	0.2%
Motor Vehicle Parts & Accessories	0.03	0.1%
Pulp of wood and paper	0.03	0.1%
Transport Equipment	0.02	0.1%
Motor vehicles and trucks	0.00	0.0%
Tobacco Products	0.00	0.0%
Wood chips	0.00	0.0%
	30.85	**100.0%**

Other manufacturing industries consist of manufactured goods that can be classified by the following (HS2[1]) codes: (36) Explosives; pyrotechnic products; matches; pyrophoric alloys: certain combustible preparations. (71) Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coin. (90) Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus: parts and accessories thereof. (91) Clocks and watches and parts thereof. (92) Musical instruments; parts and accessories of such articles. (93) Arms and ammunition; parts and accessories thereof. (95) Toys, games and sports requisites; parts and accessories thereof. (96) Miscellaneous manufactured articles. (97) Works of art, collectors' pieces and antiques.

[1] Harmonised System is a standardised numerical method of classifying traded products. The first two digits (HS-2) identify the chapter the goods are classified in.

The Western Cape Freight Demand Model historically included all modes of transport except air freight data. It was first included in the 2020 WC FDM™ update but with limited integration due to the unavailability of detailed domestic air freight data.

Data gathering

While sufficient and reliable data is available for international air freight values and volumes, sparse data is available for domestic air freight volumes, specifically, data disaggregated by origin-destination and commodity. Commodity-related information is provided as a general description at best, yet commodity detail is usually completely absent.

The cause of this knowledge gap has been a significant topic of discussion within government and industry, with the following reasons often provided:

- The domestic air freight market's relatively small impact on economic growth;
- Data anonymity concerns since the market is relatively small, making it easy to trace the origin of data if information is shared;
- Owners of domestic air freight data want to protect their competitive advantage and intellectual property;
- Precise commodity-level information rarely being captured for most air freight parcels;
- Insufficient levels of awareness and promotion of the Western Cape's important and growing air freight agenda; and
- A lack of collaboration, information-sharing and transparency between air freight service operators.

As evident from the details above, there is a definite need for a domestic air freight database to be developed for the Western Cape. Government and industry stakeholders emphasised the need to improve the availability, reliability and level of detail of domestic air freight data since the market space is key to economic job creation and competitiveness in the province. Such a database would also allow for a more integrated and detailed air transport view in the WC FDM™, similar to current capabilities for other freight transport modes.

While addressing this need has clear advantages, it is important to realise that bridging this knowledge gap would be a complicated and resource-intensive task. The previously mentioned stakeholder engagements revealed that creating such a database will require active involvement from the South African Reserve Bank (SARB) and the South African Revenue Service (SARS). Furthermore, the creators of this envisaged database will need to get buy-in from air freight service operators such as South African Airways (SAA) and Airlink to ensure sufficient levels of data availability and transparency. Collaboration with South African airports (through Airports Company South Africa, i.e. ACSA), especially CTIA, and air transport-related industry associations and researchers/experts will also be vital. Moreover, all collaborating parties will need to help establish well-designed and purposeful data-capturing processes to ensure future air data is reliable, detailed and disaggregated by origin-destination and commodity. Since competitive advantage and intellectual property are of considerable concern to many of these parties, both government and industry will need to ensure data-sharing can benefit all stakeholders concerned.

Overview of international air freight

In 2023, 60 023 freight tonnes were transported via CTIA, whereof 36 597 tonnes (61%) were exported and 23 426 tonnes (39%) were imported. This shows a growth in total trade of 14.6% (7 634 tonnes) from the 2022 volumes of 52 389 tonnes; and 45% (18 624 tonnes) from the 2021 volumes of 41 399 tonnes. However, air trade volumes are still lower than the 63 006 tonnes transported in 2019. The extent of air freight arriving (import) and departing (export) from CTIA is depicted in Figure 1.

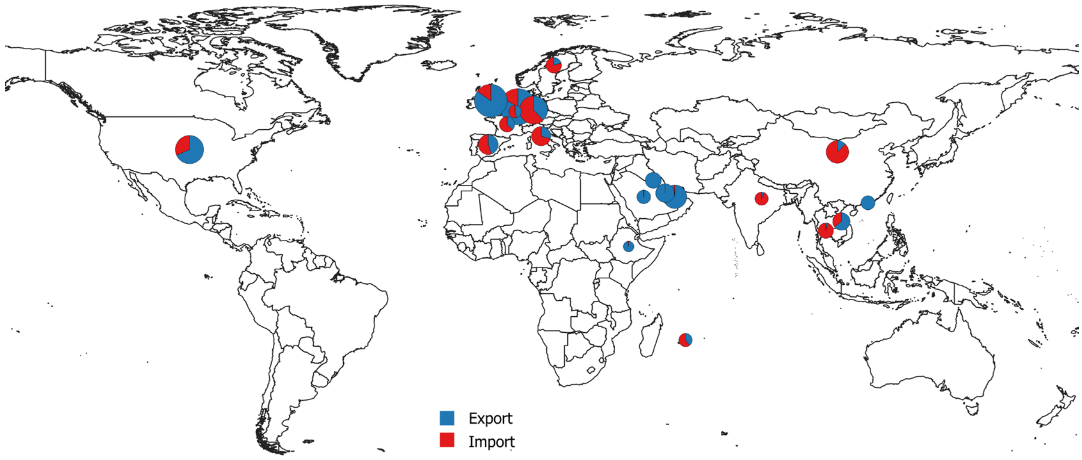


Figure 1: Map showing the import and export freight volumes for Cape Town International Airport in 2023

Tables 1 and 2 below show how the most significant air freight commodities have changed between 2021 and 2023 for exports and imports, respectively. As seen in Figure 2 and Table 1, CTIA predominantly exports food in its role as a facilitator of international trade. Note that food trade relates to the commodity groups of fresh foods, frozen foods, and foodstuffs and beverages for human consumption (see detailed breakdown in Tables 1 and 2 for exports and imports). Apart from food-related commodities, most of the air trade volumes in 2023 are related to perishable non-foods (4 465 tonnes); clothing and accessories (3 012 tonnes); machinery for general industrial uses (1 894 tonnes); other chemicals & products (1 083 tonnes) and pharmaceuticals (930 tonnes). Furthermore, while 2023's export and import volumes are higher than in 2022, imports are still lower than those traded in 2019.

Table 1: The most significant Cape Town air freight commodities between 2021 and 2023 based on export trade volumes

Exports by commodity in tonnes (% of total exports)	2021	2022	2023
Food	11 288 (52.7%)	17 031 (57.0%)	23 426 (64.0%)
Foods, Fresh	8 059 (37.7%)	14 603 (48.9%)	20 982 (57.3%)
Foods, Frozen	1 566 (7.3%)	1 254 (4.2%)	1 043 (2.8%)
Foodstuffs & Beverages for human consumption	1 662 (7.8%)	1 174 (3.9%)	1 402 (3.8%)
Perishable non-foods	4 186 (19.6%)	4 338 (14.5%)	4 465 (12.2%)
Basic industrial raw materials	589 (2.8%)	897 (3.0%)	875 (2.4%)
Colours & Dyes	354 (1.7%)	459 (1.5%)	650 (1.8%)
Machinery for general industrial uses	175 (0.8%)	651 (2.2%)	631 (1.7%)
Parts & components: power, agriculture, construction, mining, handling	213 (1.0%)	579 (1.9%)	598 (1.6%)
Clothing & Accessories	393 (1.8%)	489 (1.6%)	553 (1.5%)
Consumer goods for household consumption	370 (1.7%)	404 (1.4%)	526 (1.4%)
Consumer goods for personal consumption	516 (2.4%)	495 (1.7%)	495 (1.4%)
Odours & Flavours	413 (1.9%)	496 (1.7%)	448 (1.2%)
Other air commodities	2 905 (13.6%)	4 018 (13.5%)	3 929 (10.7%)
Total exports	**21 402**	**29 857**	**36 597**

Table 2: The most significant Cape Town air freight commodities between 2021 and 2023 based on import trade volumes.

Imports by commodity in tonnes (% of total imports)	2021	2022	2023
Food	3 067 (15.3%)	2 972 (13.2%)	2 962 (12.6%)
Foods, Fresh	1 256 (6.3%)	1 432 (6.4%)	1 374 (5.9%)
Foods, Frozen	119 (0.6%)	58 (0.3%)	54 (0.2%)
Foodstuffs & Beverages for human consumption	1 691 (8.5%)	1 482 (6.6%)	1 534 (6.5%)
Clothing & Accessories	1 854 (9.3%)	2 506 (11.1%)	2 459 (10.5%)
Machinery for general industrial uses	1 076 (5.4%)	1 298 (5.8%)	1 263 (5.4%)
Consumer goods for personal consumption	550 (2.7%)	627 (2.8%)	1 057 (4.5%)
Land Vehicle Parts	488 (2.4%)	647 (2.9%)	1 014 (4.3%)
Semiconductors	699 (3.5%)	811 (3.6%)	990 (4.2%)
Machinery & apparatus for scientific, medical or technical purposes	740 (3.7%)	727 (3.2%)	960 (4.1%)
Pharmaceuticals	979 (4.9%)	1 299 (5.8%)	930 (4.0%)
Other chemicals & products	686 (3.4%)	901 (4.0%)	901 (3.8%)
Semi-manufactured industrial consumables	729 (3.6%)	825 (3.7%)	847 (3.6%)
Other air commodities	9 128 (45.6%)	9 919 (44.0%)	10 043 (42.9%)
Total imports	**19 997**	**22 533**	**23 426**

As seen in Table 3, the largest trading partners for export air freight were the Netherlands and the United Kingdom, very similar to 2022. Export volumes to the Netherlands continued to increase in 2023 and were 35.9% (1 650 tonnes) higher than in 2021. Exports to the UK show an increase of 126.5% (2 946 tonnes) from 2021.

Table 3: The top 15 Cape Town air freight export trading partners between 2021 and 2023 based on the export trade volumes shown in Table 1

Top 15 export partners *(% of total exports)*	**2021**	**2022**	**2023**
Netherlands	4 590 (21.4%)	5 376 (18.0%)	6 240 (17.1%)
United Kingdom	2 329 (10.9%)	4 492 (15.0%)	5 274 (14.4%)
USA	1 390 (6.5%)	2 557 (8.6%)	3 175 (8.7%)
United Arab Emirates	1 098 (5.1%)	1 679 (5.6%)	3 167 (8.7%)
Qatar	500 (2.3%)	2 428 (8.1%)	2 005 (5.5%)
Germany	917 (4.3%)	1 737 (5.8%)	1 710 (4.7%)
Kuwait	223 (1.0%)	479 (1.6%)	1 497 (4.1%)
Hong Kong	891 (4.2%)	1 255 (4.2%)	1 151 (3.1%)
Vietnam	386 (1.8%)	550 (1.8%)	1 134 (3.1%)
Saudi Arabia	243 (1.1%)	523 (1.8%)	1 086 (3.0%)
Spain	1 385 (6.5%)	923 (3.1%)	1 020 (2.8%)
Ethiopia	607 (2.8%)	433 (1.4%)	643 (1.8%)
Italy	648 (3.0%)	488 (1.6%)	631 (1.7%)
Japan	603 (2.8%)	601 (2.0%)	549 (1.5%)
France	325 (1.5%)	401 (1.3%)	511 (1.4%)

2023 saw an interesting movement amongst import trading partners, with the Netherlands being surpassed by Italy, USA and Thailand. This is due to the Netherlands showing a slight decrease in volumes from 2022, while the latter countries showed increases. Similarly, the largest trading partners for import air freight, Germany and China, showed positive growth. On the other hand, Norway, India and France showed a slight decrease in volumes (see Table 4).

Table 4: The top 15 Cape Town air freight import trading partners between 2021 and 2023 based on the import trade volumes shown in Table 2

Top 15 import partners *(% of total imports)*	**2021**	**2022**	**2023**
Germany	2 215 (11.1%)	2 397 (10.6%)	2 813 (12.0%)
China	1 692 (8.5%)	2 065 (9.2%)	2 563 (10.9%)
Italy	1 609 (8.0%)	1 422 (6.3%)	1 514 (6.5%)
USA	994 (5.0%)	1 371 (6.1%)	1 456 (6.2%)
Thailand	859 (4.3%)	999 (4.4%)	1 325 (5.7%)
Netherlands	1 293 (6.5%)	1 440 (6.4%)	1 280 (5.5%)
Spain	1 109 (5.5%)	1 016 (4.5%)	1 257 (5.4%)
Norway	1 011 (5.1%)	1 250 (5.5%)	1 120 (4.8%)
United Kingdom	779 (3.9%)	823 (3.7%)	954 (4.1%)
India	841 (4.2%)	1 161 (5.2%)	953 (4.1%)
France	1 043 (5.2%)	1 111 (4.9%)	860 (3.7%)
Vietnam	551 (2.8%)	734 (3.3%)	631 (2.7%)
Mauritius	267 (1.3%)	473 (2.1%)	629 (2.7%)
Israel	639 (3.2%)	521 (2.3%)	620 (2.6%)
Belgium	462 (2.3%)	422 (1.9%)	501 (2.1%)

As seen in Table 5, CTIA's largest air freight food trade partners in 2023 are the United Kingdom, United Arab Emirates, and Netherlands. In the previous years, the volumes of the United Arab Emirates were significantly lower.

Table 5: The most significant Cape Town air freight trading partners between 2021 and 2023 based on food trade volumes

Food trade partner (% of total food trade)	2021	2022	2023
United Kingdom	1 814 (12.6%)	3 760 (18.7%)	4 574 (17.3%)
United Arab Emirates	934 (6.5%)	1 520 (7.6%)	2 929 (11.1%)
Netherlands	2 007 (13.9%)	2 480 (12.4%)	2 891 (10.9%)
Qatar	488 (3.4%)	2 363 (11.8%)	1 998 (7.6%)
Kuwait	197 (1.4%)	432 (2.2%)	1 466 (5.5%)
USA	212 (1.5%)	794 (4.0%)	1 455 (5.5%)
Norway	1 059 (7.3%)	1 320 (6.6%)	1 250 (4.7%)
Hong Kong	846 (5.9%)	1 226 (6.1%)	1 103 (4.2%)
Vietnam	362 (2.5%)	504 (2.5%)	1 089 (4.1%)
Spain	1 660 (11.5%)	860 (4.3%)	1 013 (3.8%)
Saudi Arabia	149 (1.0%)	421 (2.1%)	957 (3.6%)
Germany	529 (3.7%)	346 (1.7%)	709 (2.7%)
Italy	598 (4.1%)	438 (2.2%)	683 (2.6%)
Ethiopia	622 (4.3%)	420 (2.1%)	656 (2.5%)
France	280 (1.9%)	497 (2.5%)	516 (2.0%)
Taiwan	237 (1.6%)	276 (1.4%)	332 (1.3%)
China	624 (4.3%)	384 (1.9%)	301 (1.1%)