Western Cape Government

Transport and Public Works

WESTERN CAPE FREIGHT DEMAND MODEL

2018 Model | Report | April 2020

WESTERN CAPE FREIGHT DEMAND MODEL (WCFDM)

The first version of the Western Cape Freight Demand Model (WCFDM) was developed during the 2017/18 FY, utilising the then latest 2015 national FDM, and available 2017 data, to estimate a 2017 WCFDM. Since then the WCFDM has been updated annually, making this the third iteration of the WCFDM and the basis for this report. The major new inputs were an updated national Freight Demand Model™ (updated for 2018 during the course of 2019), and the full calendar year WC-specific data which became available for 2018. Additional research (including various data sources) was also conducted to enhance the data inputs for the WCFDM.

The WCFDM enables data-driven policy development and infrastructure plans with the primary focus on enabling the most efficient freight transport configuration in the province. This includes both reducing the cost of transport supply as well as spatial management that will reduce demand. The WCFDM results, therefore, provide significant insights into the current state and possible futures for the freight system in the province. However, the WCFDM output database is substantial and requires in-depth data analysis and discussion to extract this value and determine the usefulness of these metrics for planning, decision-making and stakeholder engagement. Moreover, the results of the analysis need to be aligned with the strategic direction of the Western Cape Government, the updated Western Cape Freight Strategy and Implementation Programme. This WCFDM report, therefore, aims to give context to the development of the WCFDM in terms of its data sources and methodology and presents various results that support strategic decision-making and implementation of the Western Cape Freight Strategy.

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Western Cape Freight Demand Model (WCFDM)

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Executive summary

The WCFDM 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 and costs associated with freight flows to, from, and within the Western Cape, as well as potential scenarios for improvement.

Methodology

The national and provincial freight demand models comprise 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.

Data

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), and publicly available industry and business data.

National freight flows

Freight to, from, and within the Western Cape constitutes 17.7% of the total national freight (tonnes), and 10.7% if the two export commodities are excluded. The Western Cape contributes 11.2% to the national transportable GDP and 37.3% of the total tonne-kms (32.8% when excluding bulk export freight). With the exclusion of bulk exports, the manufacturing sector freight contributes 54.2% and 65.4% of national and provincial tonne-kms, respectively, and the agricultural sector contributes 15.1% and 20.1%, respectively. Manufactured goods constitute 44.8% of Western Cape and 30.1% of national general freight business (GFB)[1] tonnes. Western Cape consignments are transported over the highest average transport distance of any province in South Africa. The beneficiation efforts of the province are hampered by significant transport and spatial challenges, and high logistics costs considerations.

Provincial modal split

The total freight with an origin or destination in the Western Cape amounted to 148.7m tonnes in 2018. The modal split of the total Western Cape freight is 57% on road and 43% on rail. For GFB freight, 93% is transported on road and 7% on rail. Rail is used mainly for low value, bulk agricultural and mining (e.g., iron ore) commodities. The manufacturing sector is dominant in GFB freight volumes. In this category, 70% of transported commodities consist of processed foods, other agriculture, beverages and other manufacturing. Opportunities exist in the Western Cape for long-distance GFB rail freight.

[1] GFB is defined as the competitive market space and consists of the total freight tonnes less iron ore exports, manganese exports, and pipelines.

Provincial trade

The Western Cape GFB freight (66.7 million tonnes) is split approximately equally between intra-Western Cape freight (21 million tonnes), freight transported to other provinces (23.5 million tonnes) and freight received from other provinces (22 million tonnes). Waste is an intra-provincial flow only, and amounts to 2.5 million tonnes (12% of intra-provincial flow). Fifty percent (50%) of intra-Western Cape freight and 74% of freight to other provinces, amounting to 27.8 million tonnes, consist of manufacturing commodities. Processed foods represent the largest manufactured commodity group (32%), followed by beverages (10%). KwaZulu-Natal is the Western Cape's main GFB trading partner, followed closely by Gauteng.

Corridors

Rail has a 3.6% tonnage market share of non-ring-fenced[2] total Western Cape road and rail freight. In terms of tonne-kilometres, the share is 3.1%. Corridor freight transport is dominated by road, with 97% non-ring-fenced tonnage market share on the N1 corridor, 99% on the N2 corridor and 77% on the N7 corridor. The average travel distance of freight on the N1, N2 and N7 is 1405 km, 666 km and 386 km, respectively. Modal shift opportunities exist for long-distance road freight in the Western Cape.

Flow segmentation

Manufactured goods, transported over long distances on road, present 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 palletisable and containerisable freight, which can be transported through domestic intermodal solutions from private distribution centres through public intermodal terminals. The inability of the railway to develop these solutions collaboratively with road impacts transport cost, and as such hampers the competitiveness of industries in the Western Cape.

Economic forecast

Iron ore and manganese exports constitute the majority of the Western Cape's mining sector freight intensity[3]. 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 that the development of infrastructure will support the growing manufacturing and agriculture sectors.

Freight transport costs

In 2018, road freight accounted for 83% of the total transportation cost. The main road freight transport cost drivers were fuel (R19.5 bn; 36.7% of total cost), maintenance and repairs (R8.2bn), and driver wages (R4.8bn). The South African freight railway's challenge is that it needs a substantial modal shift from road to realise density benefits.

Externality costs

The total externality cost for road freight transport in the province amounts to R13.48 billion, which is 30.6% of current direct road freight transport costs. Road freight transport contributes 93% of the total freight transport externality cost of R14.49 billion, of which 80% is contributed by the four largest cost drivers (i.e., emissions, accidents, noise and congestion). These impact the general population while not being carried by the users of the service. Policy interventions could induce the internalisation of externality costs, and a systemic shift of rail-targetable freight to rail.

Scenarios

The model was used to evaluate three future scenarios, namely, (1) a shift in freight from road to rail (modal shift); (2) the adoption of a road transport management system (RTMS); and (3) the movement of waste on rail.

The ***modal shift*** scenario is based upon the fact that dense rail traffic is more efficient. The scenario indicates that an estimated 6.7% of the Western Cape's total freight transportation cost could be saved through modal shift at current rail tariffs, with the largest opportunity being the N1 corridor freight (a potential 6.2% total transport cost saving). At current rail volumes, road is more competitive within the Western Cape Core area (see Corridors chapter).

The ***RTMS*** adoption scenario reflects the objectives of the freight strategy: freight intensity for the same task can be decreased through reduction in kilometres (through better planning and load factors). Emissions can be reduced by fewer kilometres as well as maintenance efficiency and improved driver behaviour. Increased RTMS adoption could reduce carbon emissions by 0.48m tonnes. RTMS has the potential to reduce the transportation cost of freight touching the Western Cape by 4.5% if 50% of vehicles currently not certified become certified. Increased RTMS adoption has the potential to save R0.16bn in road wear reduction. Although universal adoption is difficult, improved law enforcement would have the same or a comparable effect.

The ***waste on rail*** scenario estimates that the annual externality cost savings would be between R1.5 million to R2.3 million if waste is transported by rail in the province.

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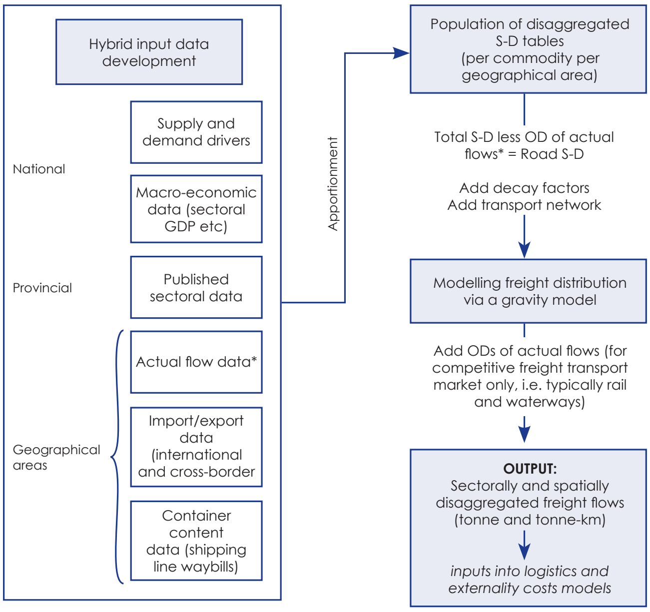
[2] "Ring-fenced" freight is freight that is usually part of a specific ring-fenced system that is not impacted by provincial-level strategic interventions, for example iron ore from Sishen to Saldanha. Non-ring-fenced freight refers to the freight that falls outside of this definition.

[3] 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 improved 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).

Western Cape Freight Demand Model (WCFDM) ***Methodology***

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 are the 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). These 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 model was first developed and used in 1998. The model was improved in 2006 to become a complete repeatable model, and has since been updated annually with Transnet sponsorship. The WCFDM was developed for the first time in 2017/18, based on the national FDM, with the objective of adding richer and more refined known data for the province and 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.

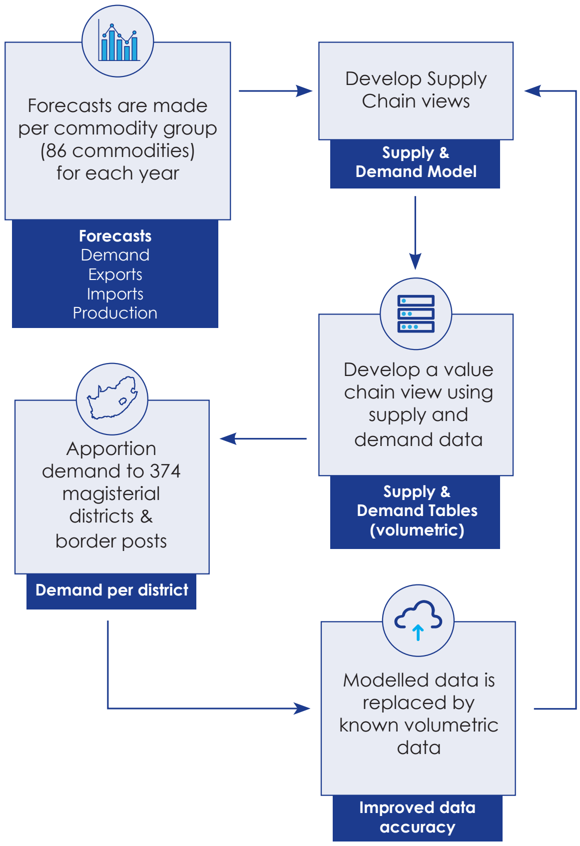


Figure 2: Econometric model

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. The balance of supply and demand is then modelled as road flows, by means of 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 per commodity.

Transport resistance is determined by well-researched distance decay factors for each commodity. Distance decay varies from one commodity to another based on many characteristics, including its value, nature and utility.

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), while 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.

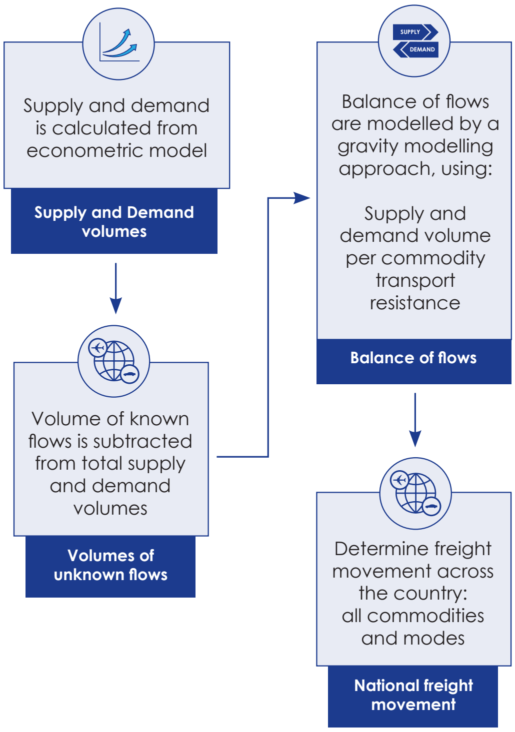


Figure 3: Flow model

The Western Cape Freight Demand Model (WCFDM)

The WCFDM is confined to those 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, and pipeline). A geographic representation of the WCFDM districts is presented in Figure 4.

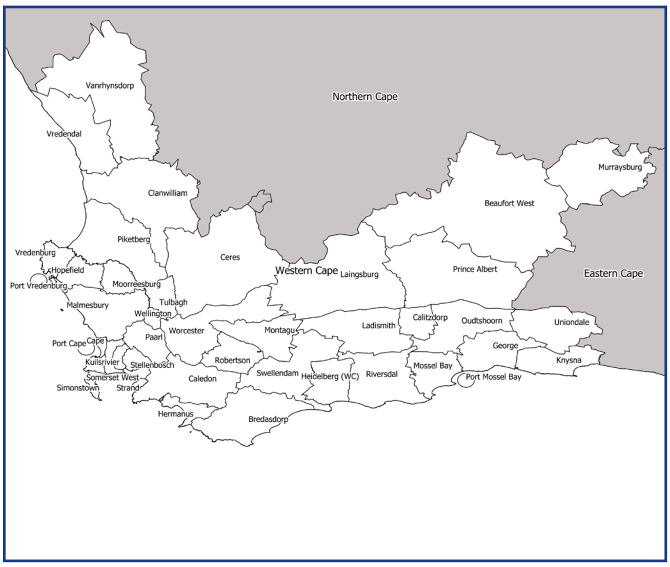


Figure 4: Geographical districts within the Western Cape

Data sources

During the development of the WCFDM, the following data sources were used:

- Interviews with Logistics Service Providers (LSP) regarding costs and tariffs;
- Transnet Freight Rail data;
- Transnet National Ports Authority data – bulk and containers;
- Western Cape specific data: agriculture crops, waste and mining data;
- Publicly available data for industry and businesses.

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

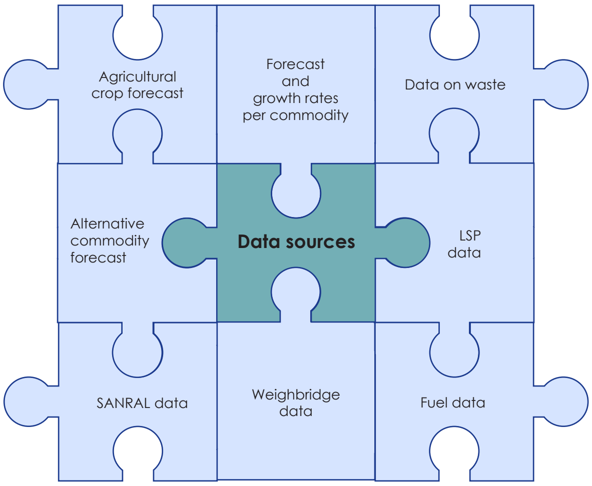


Figure 5: Data Sources

1. Forecasts and growth rates: Revised in line with the national FDM for imports, exports, production, intermediate demand and final demand/consumption in WCFDM.
2. Waste: Data collected and included in the model.
3. Logistics Service Provider (LSP) interview data: 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 alignment comparisons made between data from industry, the South African Petroleum Industry Association (SAPIA) and the Department of Energy.
5. Weighbridge data: Used to validate WCFDM flows. It largely confirmed the modelled WCFDM 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 crop forecast data: Latest data, including estimated current crops and future plantings and yields, were incorporated.

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-11-2017-0290.

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Western Cape Freight Demand Model (WCFDM)
Overview of 2018 National Freight Demand Model

Of the 863.4m tonnes of freight being moved in the country, 152.5m tonnes (17.7%) of freight have either an origin or destination, or both, within the Western Cape, as shown in Figure 1 (a). This figure is skewed by the iron ore (55.4m tonnes) and manganese exports (4.3m tonnes), which are almost entirely destined for the Port of Saldanha. This ring-fenced freight is shown in Figure 1(b). Without the two export commodities that originate outside of the boundaries of the province, 10.7% of all national freight moves through the Western Cape, as shown in Figure 1 (b). The iron ore and manganese export lines account for 6.4% and 0.5% of the national freight, respectively. This highlights that a large portion of freight that moves through the Western Cape does so without contributing significantly to the province's[1] Gross Domestic Product (GDP).

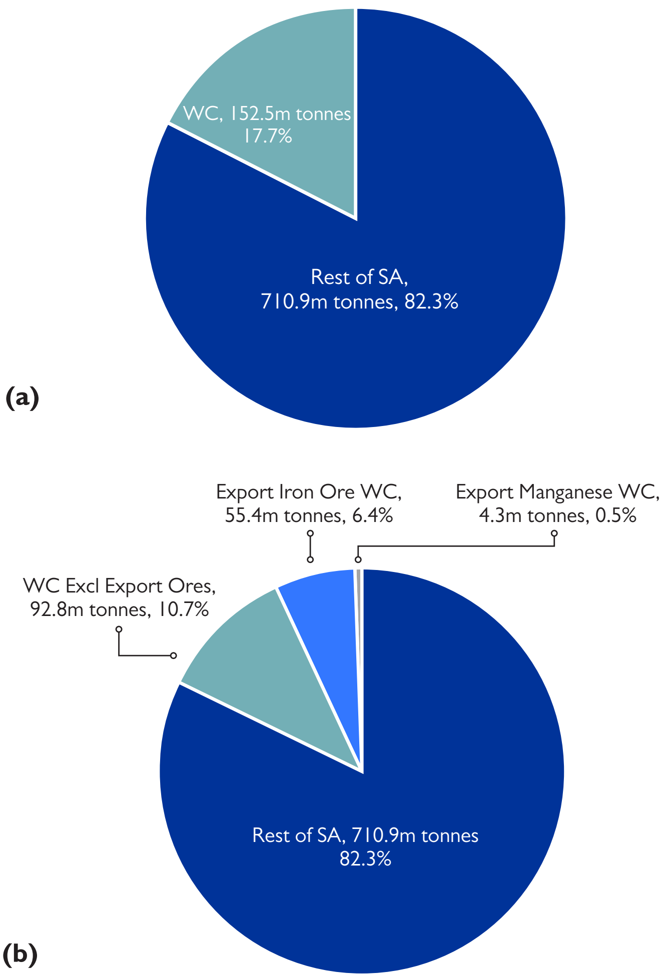

Figure 1: Western Cape freight as percentage of national freight (WC = Western Cape)

Figure 2 shows the total contribution of the Western Cape freight volumes as a percentage of the total national freight volumes, both per tonne and per tonne-km. If the export lines are included in the freight moving in the Western Cape, the results show a very high freight transport intensity[2] in terms of tonne-kms, with 17.7% of the national tonnes accounting for 37.3% of the national tonne-kms.

The difference in the Western Cape percentage share of the national total shows how moving bulk freight over long distances can affect freight intensity measurements. Therefore, in order to conduct a fair analysis of the remaining non-bulk freight, that is, General Freight Business (GFB) freight, the bulk lines (iron ore export, manganese export and pipelines[3], hereafter referred to as "the bulks" or "bulk commodities") have been excluded from the Western Cape freight, considering that they skew the freight intensity. The export coal and conveyor belt coal are excluded from the national freight.

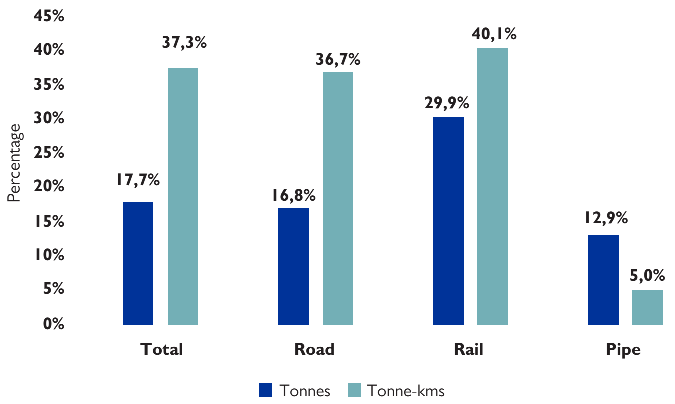

Figure 2: Western Cape volumes as a percentage of South Africa's total freight (2018)

With the bulk commodities excluded from freight flows, Figure 3 shows that the freight intensity in the Western Cape in terms of tonne-kms is still high compared to the intensity based on tonnes. The Western Cape is one of nine provinces, but contributes one in three national GFB tonne-kms (32.8%) and only accounts for 15.7% of the national GFB tonnes.

In addition, rail's contribution is low compared to that of road, especially given the long distances to inland markets. The national FDM indicates that rail's corridor market share is the highest on the Natal corridor (next to the N3), and low on the Cape corridor (next to the N1). Historically, the majority of rail freight developments were concentrated along the Natal corridor, even though it is much shorter than the Cape corridor. Therefore, due to the long distances and less development along the Cape corridor, the Western Cape experiences a lower relative rail market share (with bulk commodities excluded). The Western Cape is therefore in a position where the leveraging of initiatives that encourage modal optimisation and transportation cost efficiencies for GFB traffic will have the greatest positive effect.

[1] The iron ore and manganese mining contribute to the primary sector GDP of the Northern Cape. The export of the commodities at the port of Saldanha contributes to the tertiary sector GDP of the Western Cape.

[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 improved 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).

[3] The other bulk commodities of significance to the South African economy are coal exports through Richards Bay and conveyor belt coal to power stations. The physical flows of these two bulk commodities do not interact directly with the Western Cape's economy.

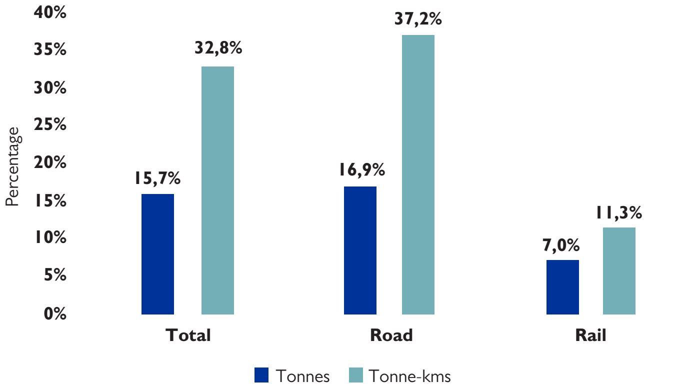

Figure 3: Western Cape GFB volumes as a percentage of South Africa's total GFB freight (2018)

Table 1 shows the Western Cape's overarching freight position. Due to the slightly larger tertiary sector[4] of the Western Cape, the province's contribution to transportable GDP is lower than its contribution to total GDP. Although the Western Cape contributed only 11.2% to the national transportable GDP, it contributed 37.3% of the total tonne-kms, or 32.8% when excluding the bulks.

Table 1: Western Cape's overarching freight position (2018)

	South Africa	Western Cape	%
GDP (R Billions current prices)	4 874	663	**13.6%**
Transportable GDP (Rbn current prices)[5]	1030	115	**11.2%**
Tonnes (Millions)	863	152	**17.7%**
Tonnes (Millions) GFB	563	88	**15.7%**
Tonne-km (Billions)	314	117	**37.3%**
Tonne-km (Billions) GFB	192	63	**32.8%**

The contribution of the Western Cape's mining sector to the total provincial freight in tonnes was 63.1%, which approaches the sector's 66.4% contribution to the total national freight in tonnes, as shown in Figure 4. As described before, the significant role played by the mining sector in the province's freight flow economy is attributable to the provision of an export gateway for iron ore through the Saldanha Bay port. When the bulks exports are excluded, the contribution of the GFB mining tonnes to the Western Cape's total sectoral freight flows declines to 38.6%, with manufacturing (mostly consisting of agro-processing) and agriculture increasing to 44.8% and 16.6%, respectively (compared to the sectoral contribution to total tonnes).

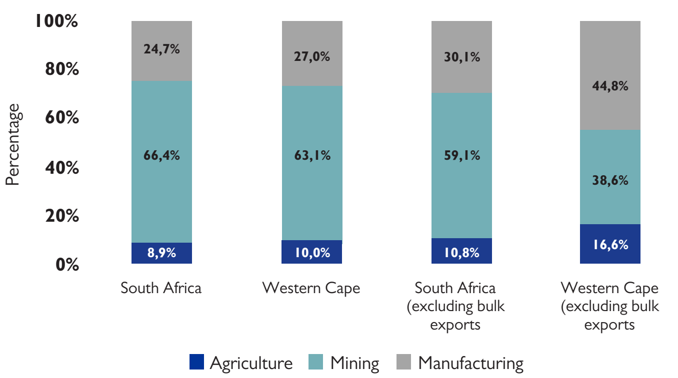

Figure 4: Tonnes per sector as percentage of total tonnes for South Africa and the Western Cape (2018)

Figure 5 shows the percentage contribution of tonne-kms per sector, both nationally and at a Western Cape level and both including and excluding bulks.

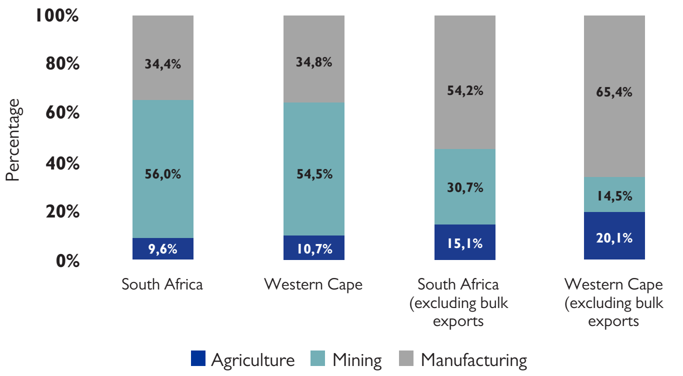

Figure 5: Tonne-kms per sector as percentage of total tonne-kms for South Africa and the Western Cape (2018)

As described above, in 2018 the mining sector contributed approximately two thirds of the freight flow tonnes both nationally and in the Western Cape, while accounting for 56.0% and 54.5% of the tonne-kms respectively. The relatively lower tonne-km contribution is due to the Western Cape's mining activities being relatively shorter haul (mostly the Namaqua Dunes projects) than mining activities in the rest of South Africa. The manufacturing sector freight makes up 24.7% of national tonnes and 27.0% of Western Cape tonnes. This sector's freight makes up 34.4% of national tonne-kms and 34.8% of Western Cape tonne-kms.

The agricultural sector freight makes up 8.9% of national tonnes and 10.0% of Western Cape tonnes; and 9.6% of national tonne-kms and 10.7% of Western Cape tonne-kms.

The discrepancy between tonne-km and tonnes contribution, especially in the manufacturing sector, results from the Western Cape's longer inter-provincial trading distances compared to any other province in South Africa; this requires longer trips for exporting and importing finished goods and processed and unprocessed food.

A comparison between the total tonne-kms per sector and the tonnes shows that, on average, manufacturing and agricultural commodities are being moved over longer distances than mining commodities. This becomes more evident when excluding the bulk exports. The manufacturing sector contributes 54.2% of the national tonne-kms after the bulk exports have been excluded, and 65.4% in the Western Cape. The agriculture sector contributes 15.1% of the national GFB tonne-kms and 20.1% in the Western Cape.

[4] The primary sector refers to economic activity pertaining to the extraction of raw materials/goods from the earth (mining and agricultural commodities). The secondary sector receives products from the primary sector (either from the domestic economy or imported) for economic activities related to construction, the manufacturing of intermediate demand goods for further manufacturing processes, and the manufacturing of final consumer products. The tertiary sector consists of the production of services such as banking, insurance and telecommunications.

[5] While national economies are segmented into the primary, secondary and tertiary sectors, the FDM only accounts for transportable GDP, that is, the primary (agriculture and mining) and secondary sectors. The tertiary (economic) sector is not transportable and therefore not accounted for in the FDM.

South Africa's beneficiation is on average more successful in the Western Cape. Manufactured goods constitute 44.8% of the Western Cape's GFB tonnes, while only 30.1% of the national GFB tonnes consist of manufacturing commodities. However, there are significant transport challenges, spatial issues and high logistics costs that impact this strategy in the Western Cape. One of the advantages of beneficiation is that it reduces transport costs relative to GDP (delivered higher value commodities will always attract a lower transport cost percentage than lower value commodities). However, beneficiated commodities in the national context must still be moved to markets and if these markets are relatively further away, transport costs will be relatively higher. This is because these commodities compete with local or imported commodities closer to the market.[6] This implies that greater transport efficiency is required.

[6] In practical terms, a tin of preserved food that is moved from the Western Cape to Gauteng has to, for example, compete with locally produced food from Gauteng and Mpumalanga or cheap imports from Durban, all of which are closer.

Highlights

- 17.7% of national freight has either an origin or destination, or both, within the Western Cape.
- Excluding the two export commodities, 10.7% of all national freight moves through the Western Cape.
- The Western Cape contributed 11.2% to the national transportable GDP; it contributed 37.3% of the total tonne-kms, and 32.8% when excluding the bulks.
- Excluding the bulk exports:
  - The manufacturing sector freight constitutes 54.2% of national tonne-kms and 65.4% in the Western Cape.
  - The agricultural sector freight contributes 15.1% of national GFB tonne-kms and 20.1% in the Western Cape.
- Manufactured goods comprise 44.8% of the Western Cape's GFB tonnes, and only 30.1% of national GFB tonnes.
- The average transport distance of each Western Cape consignment is higher than the national average; this is the highest for any province in South Africa.
- The Western Cape has significant transport and logistics cost challenges and spatial considerations that impact its beneficiation efforts.

Western Cape Freight Demand Model (WCFDM)
Western Cape Trade – Modal split

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 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.

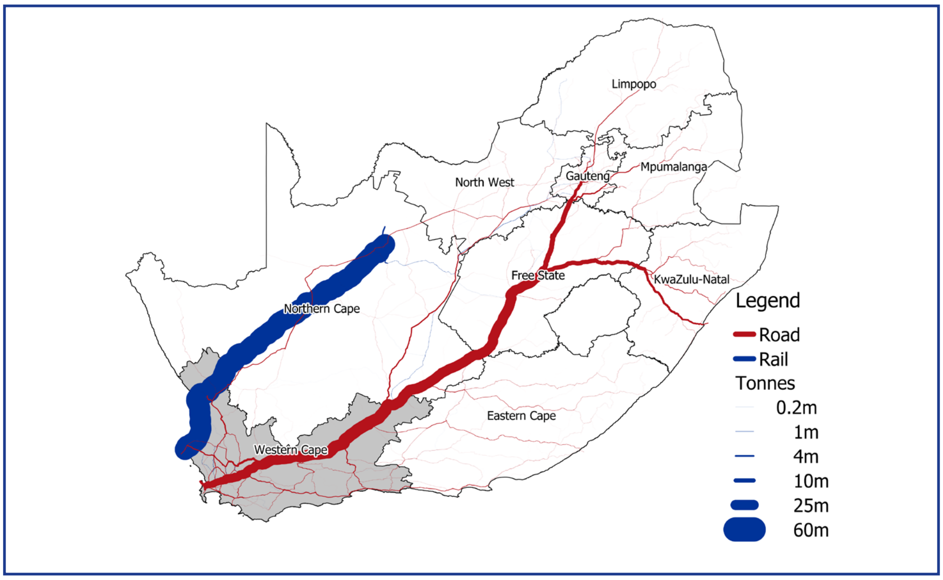

Figure 1: Total freight with an origin or destination in the Western Cape scaled to iron ore export line (2018)

Modal split

Total road and rail freight with an origin or destination in the Western Cape in 2018 amounted to 148.7m tonnes and is shown in Figure 1.

The total tonnes per sector are given in Figure 2. The waste data, while not complete due to unavailability, refers to flows in the greater Cape Town metro areas. At a conservative estimate of 2.8m tonnes, the waste has a substantial impact on local flows, congestion, and externalities.

The GFB tonnes are shown in Figure 3, in which the dominance of manufacturing is evident.

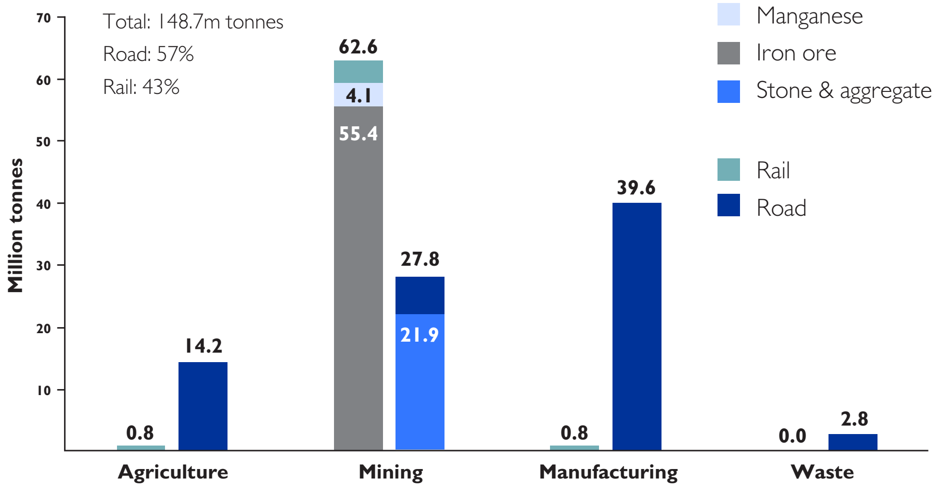

Figure 2: Total road and rail tonnes per sector in the Western Cape (2018)

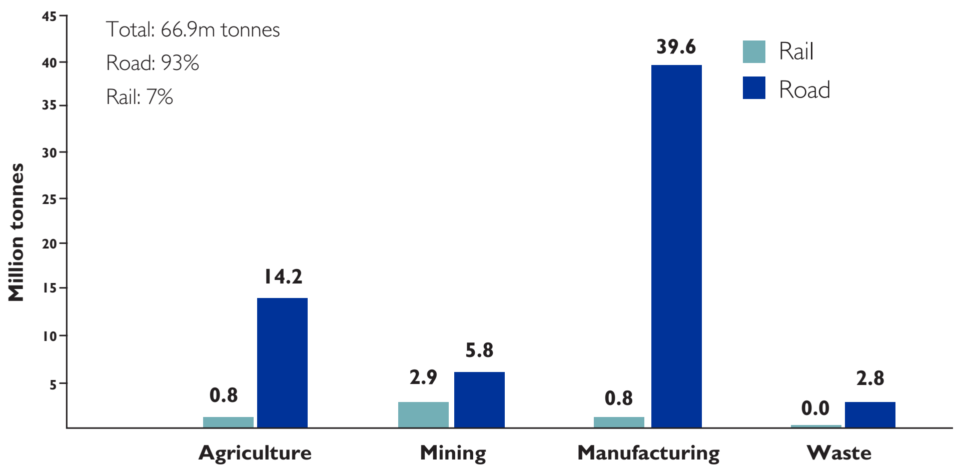

Figure 3: GFB road and rail tonnes per sector (2018)

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Figure 4 shows GFB rail freight movements that touch the Western Cape (same scale as Figure 1).

The largest rail flow is 1.78m tonnes of domestic iron ore destined for the smelter at Saldanha. The contrast with Figure 1 highlights the limited role of rail, once the bulk have been removed.

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 6 shows rail versus road market share, per commodity and Table 1 provides the rail volumes and market share for commodities that have rail market share.

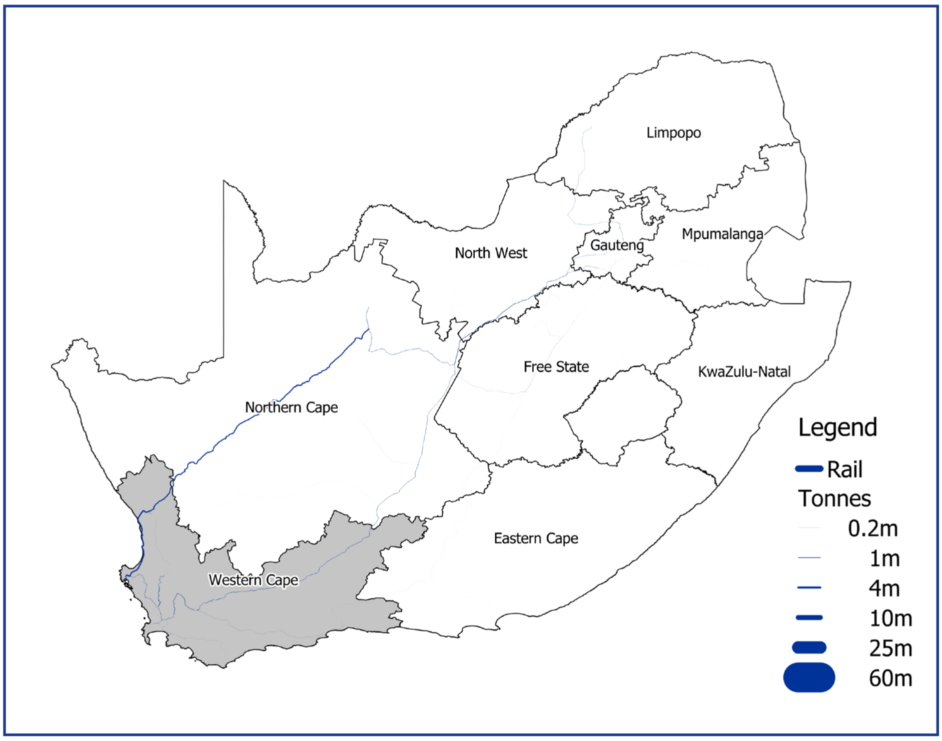


Figure 4: GFB rail freight that touches the Western Cape (2018)

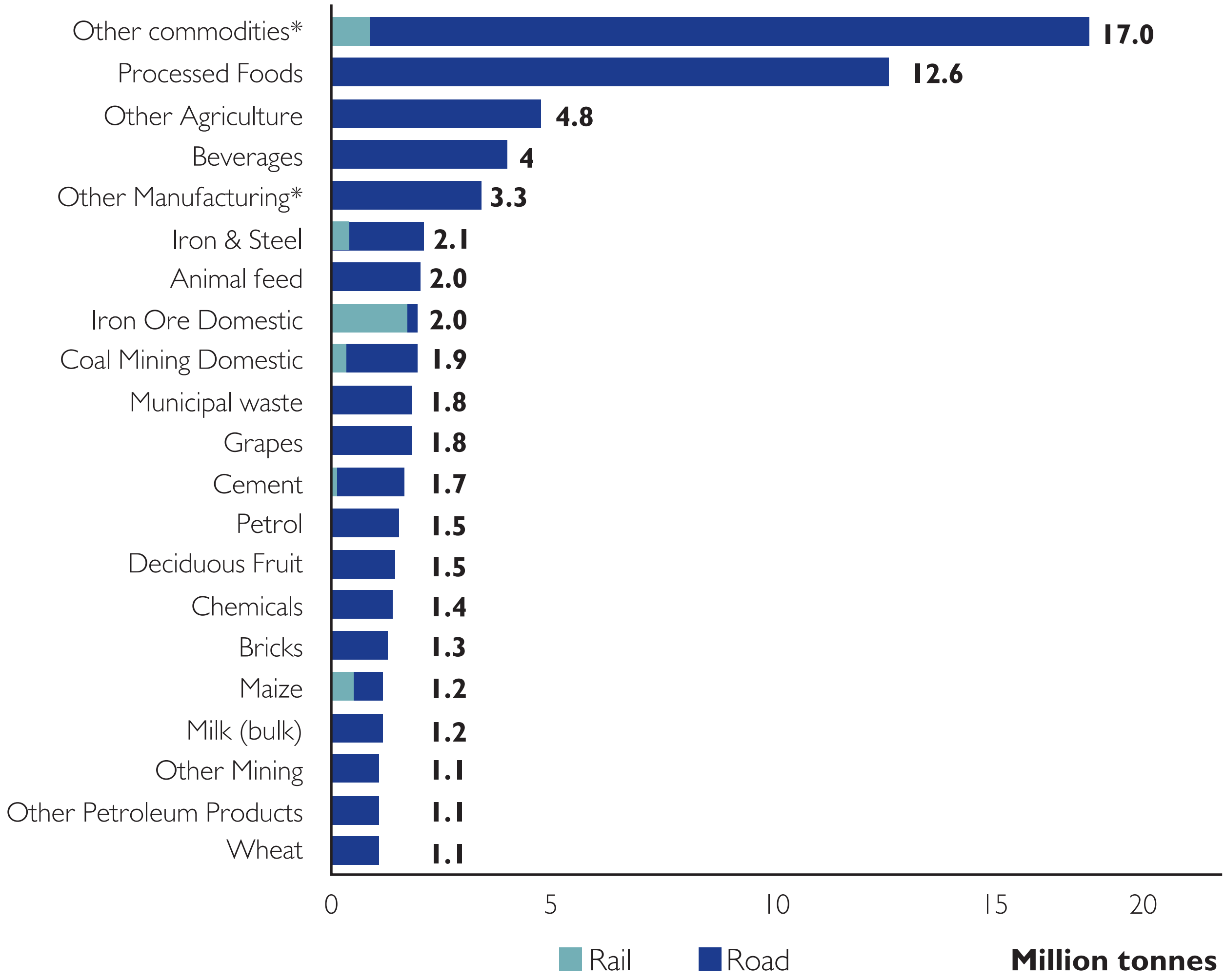


Figure 5: Western Cape related GFB freight per commodity per mode (2018)

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

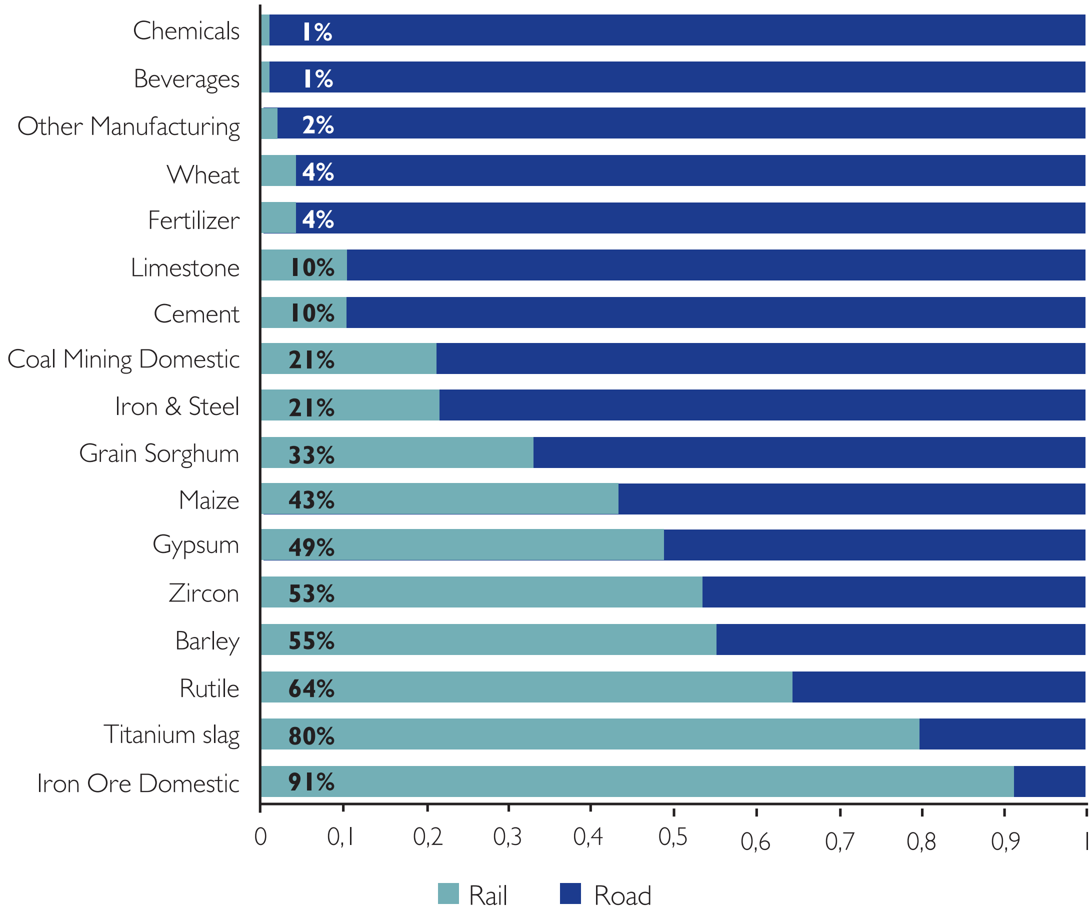


Figure 6: Western Cape related GFB freight modal market share per commodity (2018)

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.

Table 1: Rail volumes and market share (2018)

Commodity on rail	Volume (million tonnes)	Marketshare
Iron Ore Domestic	1.785	91%
Titanium	0.332	80%
Rutile	0.031	64%
Barley	0.191	55%
Zircon	0.119	53%
Gypsum	0.090	49%
Maize	0.536	43%
Grain Sorghum	0.003	33%
Iron & Steel	0.451	21%
Coal Mining Domestic	0.412	21%
Cement	0.175	10%
Limestone	0.087	10%
Fertilizer	0.045	4%
Wheat	0.046	4%
Other Manufacturing Industries	0.062	2%
Beverages	0.056	1%
Chemicals	0.012	1%

Rail tonnes in the Western Cape have been growing faster than national rail tonnes, as can be seen in Figure 7.

Note that it is mostly inter-provincial freight volumes that are growing, as the tonne-kms have been growing faster than tonnes since 2014. The national increase in volumes has been driven by the three major export commodities: iron ore, manganese, and coal. The decrease in 2018 is largely driven by a decrease in coal movements, despite the increase in manganese exports and chrome volumes. However, coal, iron ore and magnetite exports volumes were also responsible for lower volumes, which highlights that the rail sector is still very much reliant on mineral exports. Apart from mining commodities, rail lost 520 000 tonnes of wheat from 2016 – 2018.

From the indexed GFB tonnes (i.e., excluding export iron ore and manganese), it is evident that rail is not gaining general freight market share (see Figure 8).

In 2015 and 2016, rail lost long-distance volumes, as the tonne-kms increased less than the tonnes for those two years. For the Western Cape, which has the longest average freight travel distance, it would make economic sense to try to increase rail market share on long-distance GFB freight where possible.

The decrease from 2017 to 2018 in the Western Cape's GFB tonnes is attributed to a decrease in market share of most commodities, with a few exceptions such as maize, iron and steel since total GFB tonnes touching the Western Cape increased by 3.1m tonnes from 2017 to 2018. Despite the lower volumes, Western Cape tonne-kms increased in 2018 due to maize, container and cement freight being moved longer distances on rail. This illustrates that, in the absence of mineral exports, a long-term solution for increased rail volumes is yet to be found. Increases in commodity flows are typically cyclical and do not provide a sufficiently stable market to support capital expansion. Instead, growth in stable, long-distance, densified flows is required to optimise rail's core competencies and justify enduring capital investments.

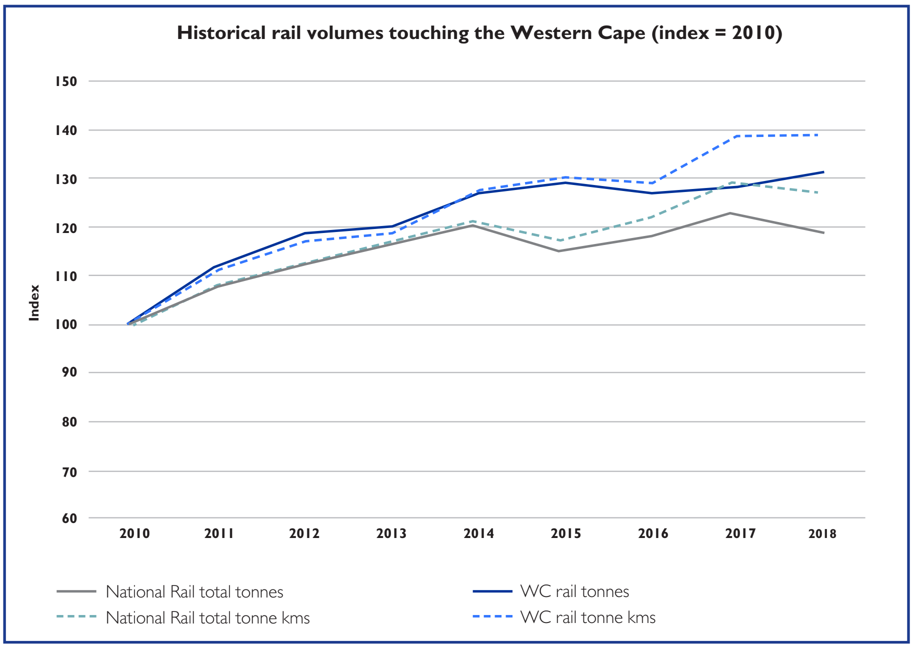


Figure 7: Time series of indexed rail tonnes and tonne-kms from 2010 to 2018 (index = 2010)

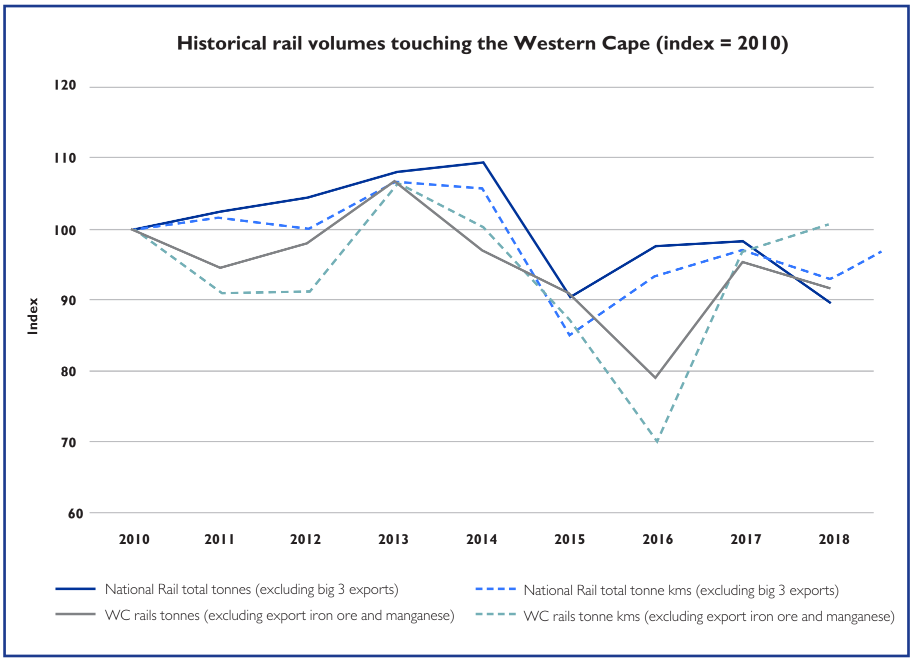


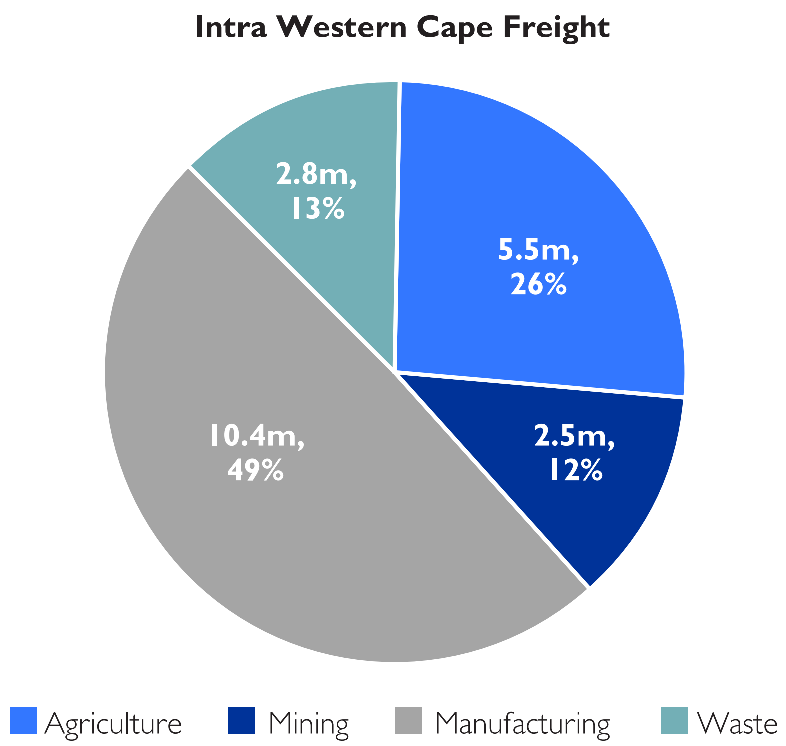
Figure 8: Time series of indexed GFB rail tonnes and tonne-kms from 2010 to 2018 (index = 2010)

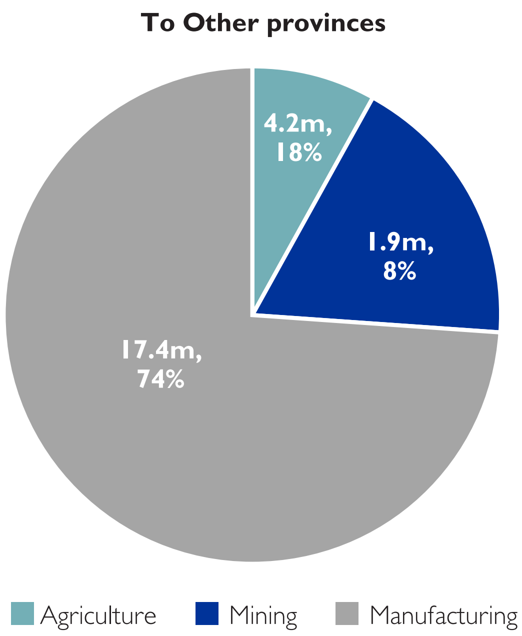
Highlights

- Total freight (2018) with an origin or destination in the Western Cape amounted to 148.7m tonnes.
- Modal share in the Western Cape is 57% (road), 43% (rail) for total freight and 93% (road, 7% (rail) for GFB freight.
- The mining sector is dominant due to export iron ore.
- Rail's presence is driven by mining sector (iron ore).
- Rail is used mainly for mining and agricultural commodities – low value, bulk commodities (domestic iron ore).
- The manufacturing sector is dominant in GFB freight volumes.
- 70% of GFB commodities consist of processed foods, other agriculture, beverages and other manufacturing.
- Western Cape opportunities exist for rail on long-distance GFB freight.

The 66.7 million tonnes of Western Cape General Freight Business (GFB)[1] freight is split approximately equally at 21.2 million tonnes intra-Western Cape freight, 23.5 million tonnes transported to other provinces and 21.9 million tonnes received from other provinces. These flows are shown per sector in Figure 1. In the 2018 model update, 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 and, is thus only an intra-provincial flow. At 13% (2.8 million tonnes), it forms a substantial part of intra-provincial tonnes and is expected to grow, according to the Western Cape Integrated Waste Management Plan 2017-2022.

The Western Cape receives relatively more mining (19%) and agricultural (24%) commodities, while sending only 8% and 18%, respectively. There is a strong manufacturing base in the Western Cape, as 57% of intra-Western Cape freight and 74% of freight to other provinces are manufacturing commodities.





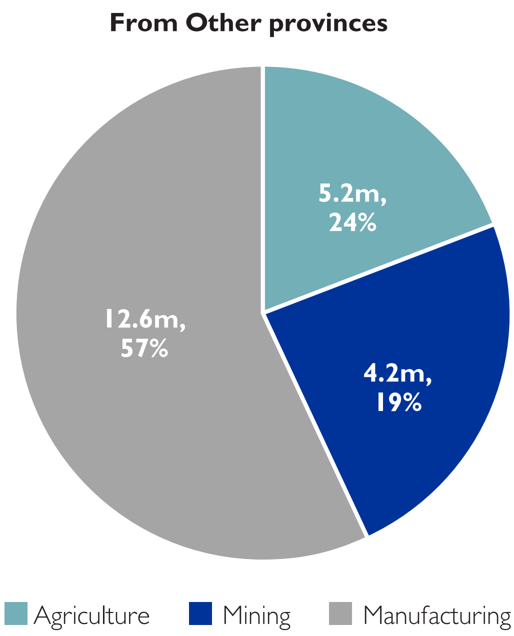


Figure 1: Provincial GFB freight-flows per sector (tonnes 2018)

[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.

An industry breakdown of the Western Cape manufacturing sector is shown in Figure 2 (i.e., the intra-Western Cape manufacturing freight flow tonnes, as well as the manufacturing tonnes flowing to other provinces, to depict the manufacturing base of the province). Of the 27.8 million manufacturing tonnes that the Western Cape distributes within the province (10.4 million tonnes) and sends to other provinces (17.4 million tonnes), the largest commodity group is processed foods, which contributes 32%, followed by beverages (10%). Provided that there is no structural change to the South African economy, processed foods will continue to be the mainstay of the Western Cape's manufacturing sector.

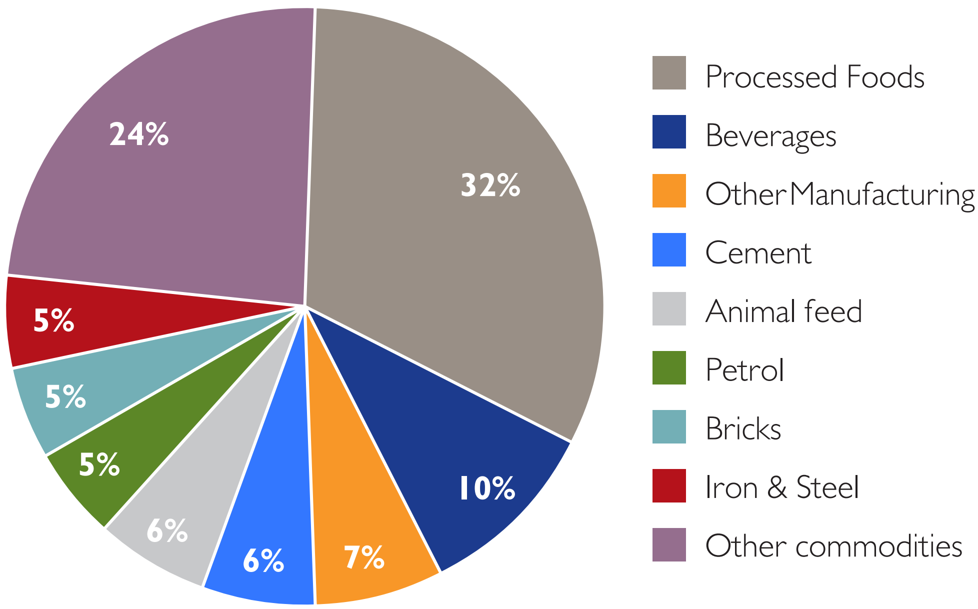


Figure 2: Manufacturing commodities with origin Western Cape (intra-provincial and outgoing, 2018)

KwaZulu-Natal is the Western Cape's main GFB trading partner, followed closely by Gauteng. The Western Cape receives 6.1 million tonnes (25.9%) of its GFB freight from KwaZulu-Natal and 3.6 million tonnes (17.2%) from Gauteng. Of all the GFB freight originating from the Western Cape, 5.7 million tonnes (23.8%) are destined for Gauteng and 4.8 million tonnes (20.4%) for KwaZulu-Natal, as shown in Figure 3.

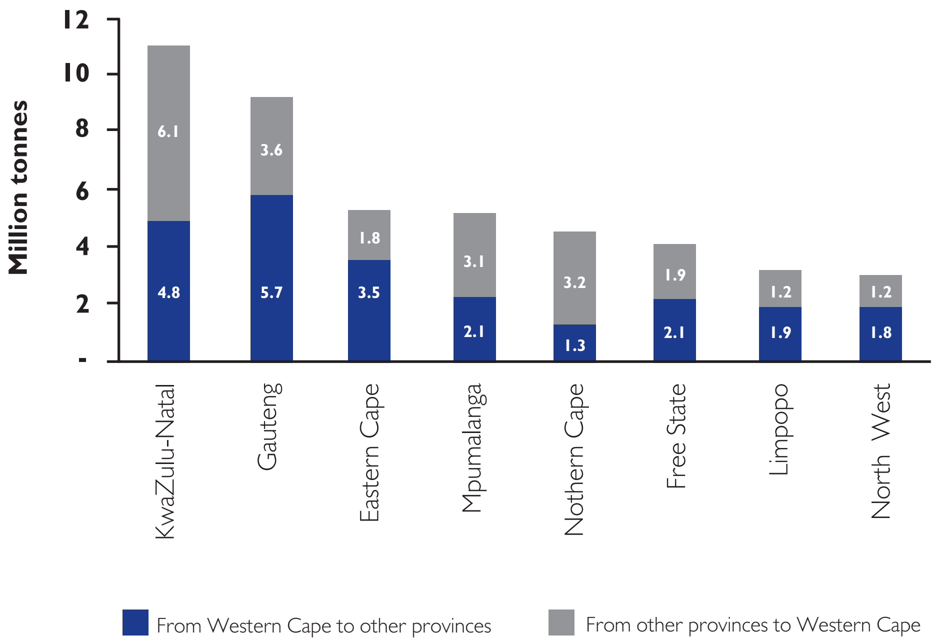


Figure 3: Western Cape inter-provincial GFB freight (2018)

Highlights

- The Western Cape GFB freight (66.7 million tonnes) is split fairly equally between intra Western Cape freight (21.2 million tonnes), freight transported to other provinces (23.5 million tonnes) and freight received from other provinces (22 million tonnes).
- Waste is an intra-provincial flow only and amounts to 2.8 million tonnes (12% of intra-provincial flow).
- Fifty percent (57%) of intra-Western Cape freight and 74% of freight to other provinces are manufacturing commodities, amounting to 27.8 million tonnes.
- The largest commodity group in the Western Cape's manufacturing sector, is processed foods (32%), followed by beverages (10%).
- KwaZulu-Natal is the Western Cape's main GFB trading partner, followed closely by Gauteng.

Western Cape Freight Demand Model (WCFDM)
Corridors

In order to determine corridor freight on the N1, N2 and N7, the magisterial districts for 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); and
5. Metropolitan (a combination of the Cape Town Metropolitan area and its peripheral areas).

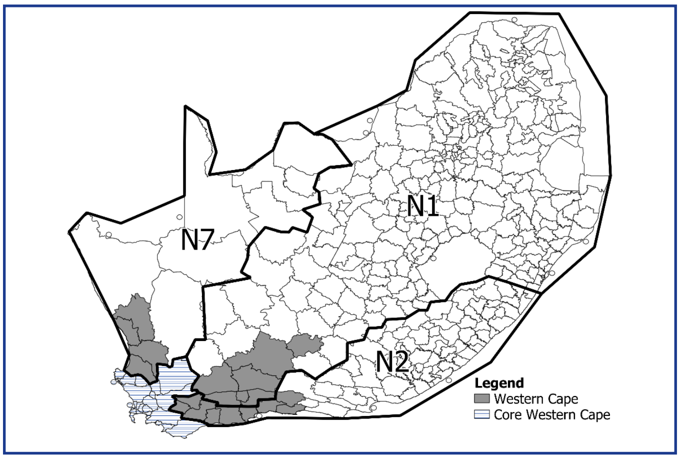


Figure 1: Corridor definitions for Western Cape freight

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

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

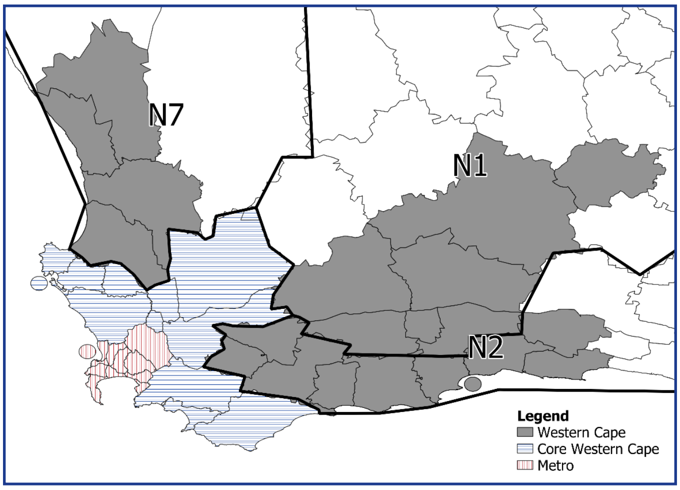


Figure 2: OD pairs for Cape Town Metropolitan freight

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 the volumes and percentage split of the General Freight Business (GFB)[1] road and rail freight per zone.

Table 1: GFB road and rail freight (tonnes) per zone (2018)

Zonal Grouping	Road tonnes (million) (% of zone freight)	Rail tonnes (million) (% of zone freight)	Total (million)
N1 Corridor traffic	29.0 (96.1%)	1.2 (3.9%)	30,2
N2 Corridor traffic	7.1 (98.8%)	0.1 (1.2%)	7,2
N7 Corridor traffic	3.0 (51.8%)	2.8 (48.2%)	5,8
Metropolitan traffic	8.2 (99.5%)	0.04 (0.5%)	8,3
Core Western Cape	6.1 (95.9%)	0.3 (4.1%)	6,4
Non-corridor traffic	8.9 (98.6%)	0.1 (1.4%)	9
Total	62.4 (93.3%)	4.5 (6.7%)	66,9

The 5.8 million tonnes of N7 corridor freight include what is deemed "ring-fenced" freight, that is, freight that is usually part of a specific ring-fenced system that is not impacted by provincial-level strategic interventions. In the Western Cape's case, the majority of the GFB rail freight on the N7 is transported on the Iron Ore Export Line. Even though the export line follows the N7 quite closely, it cannot really be regarded as GFB for which road can compete.

[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.

The ring-fenced freight has been removed from Table 2. The very low contribution of rail to N1 freight, which is a very long corridor, is an issue of great concern that needs to be resolved.

Table 2: GFB (excluding domestic iron ore and coal) road and rail freight (tonnes) per zone (2018)

Zonal Grouping	Road tonnes (million) (% of zone freight)	Rail tonnes (million) (% of zone freight)	Total (million)
N1 Corridor traffic	28.2 (97.0%)	0.9 (3.0%)	29,1
N2 Corridor traffic	7.1 (98.8%)	0.1 (1.2%)	7,2
N7 Corridor traffic	3.0 (76.6%)	0.9 (23.4%)	3,9
Metropolitan traffic	8.2 (99.5%)	0.04 (0.5%)	8,3
Core Western Cape	5.6 (95.6%)	0.3 (4.4%)	5,9
Non-corridor traffic	8.5 (98.7%)	0.1 (1.4%)	8,6
Total	60.7 (96.4%)	2.3 (3.6%)	63,0

Table 3 shows the tonne-km per zone.

Table 3: GFB (excluding domestic iron ore and coal) road and rail freight (tonne-km) per zone (2018)

Zonal Grouping	Road tonne-kms (billion) (% of zone freight)	Rail tonne-kms (billion) (% of zone freight)	Total tonne-kms (billion)
N1 Corridor traffic	39.6 (97.1%)	1.2 (2.9%)	40,8
N2 Corridor traffic	4.7 (99.0%)	0.05 (1.0%)	4,8
N7 Corridor traffic	1.2 (74.7%)	0.4 (25.3%)	1,6
Metropolitan traffic	0.2 (99.3%)	0.001 (0.7%)	0,2
Core Western Cape	0.4 (94.3%)	0.3 (5.7%)	0,5
Non-corridor traffic	9.8 (98.8%)	0.1 (1.2%)	9,9
Total	55.9 (96.9%)	1.8 (3.1%)	57,7

The tonne-kilometre view confirms a slightly smaller rail market share, indicating that longer distance freight is transported by road. This means that a long-distance market exists that can potentially benefit from rail's economies of scale, given that rail operators can provide a competitive service.

Table 4 shows the breakdown of road freight per corridor. Note that 46.6% of Western Cape road freight travels on the N1 road corridor, with an average distance travelled of 1 405 km.

Table 4: Freight intensity per zone (2018)

Zonal Grouping	Road tonnes (million)	Percentage on route
N1 Corridor traffic	28,2	46,5%
N2 Corridor traffic	7,1	11,7%
N7 Corridor traffic	3,0	4,9%
Metropolitan traffic	8,2	13,5%
Core Western Cape	5,6	9,2%
Non-corridor traffic	8,5	14,1%
Total	60,7	100,0%

Highlights

- **Rail** has a **3.6%** tonnage **market share** of non-ring-fenced total Western Cape road and rail freight. In terms of tonne-kilometres, the share is 3.1%.
- Corridor freight is dominated by **road**, with **97% market share on the N1 corridor**, 99% market share on the N2 corridor and **77% market share** on the **N7 corridor**.
- The average travel distance of freight on the N1 and N2 is 1405 km and 666 km, respectively.
- **Modal shift opportunities** exist for long-distance road freight in the Western Cape.

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 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 distribution centre.

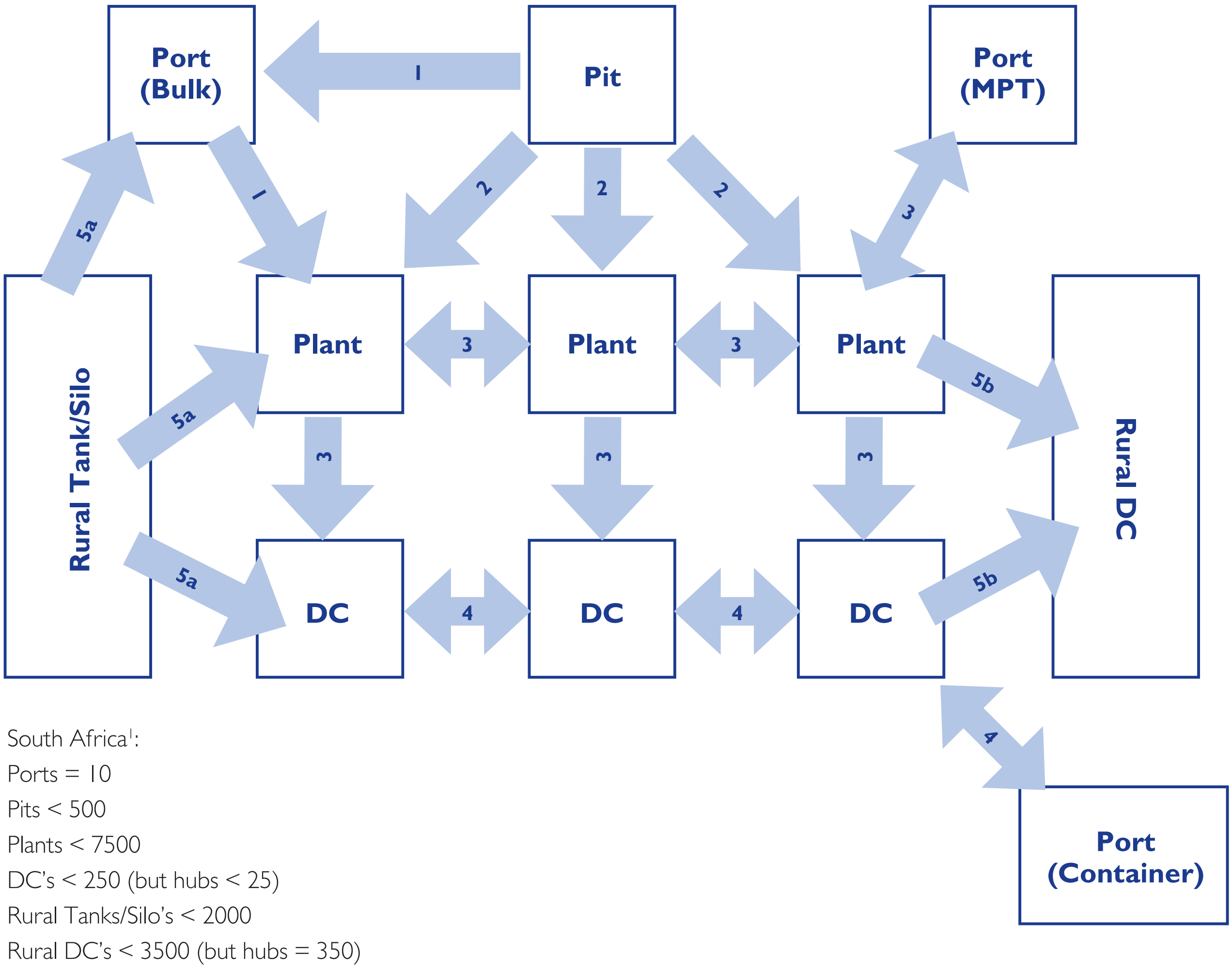


Figure 1: The different typologies of freight flows[2]

As depicted in Figure 2, these segments can be summarised in terms of 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 35% of the Western Cape's total transportation cost. Eighty-two percent of the 18% of extraction to exports refers to the handling of iron ore and manganese exports in Saldanha. Beneficiation thereof

[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.

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.

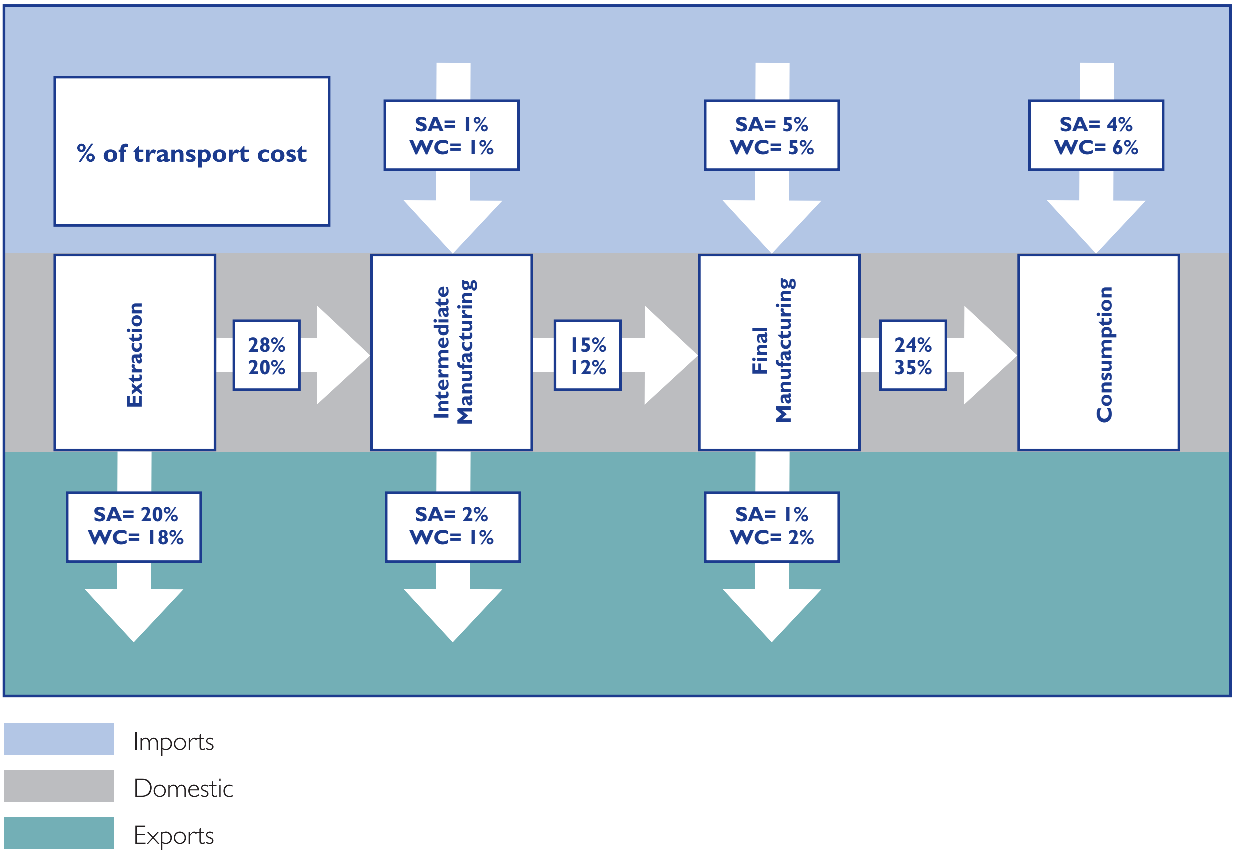


Figure 2: National and Western Cape transport cost per freight flow segment (2018)[2]

Western Cape freight flows informed by economic structure

An analysis of the 2018 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 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 revival of branch lines are on Transnet's strategic agenda, but progress is slow[4]. The other opportunity is palletisable and containerisable 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 owing to the 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").

[3] 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.

[4] Transnet's branch lines are reported to comprise approximately 35% (7 278km) of its 20 000 km network. Only 54% of these branch lines are reported to be active. Transnet. (2019), 'Freight Rail 2019', available at: https://www.transnet.net/InvestorRelations/AR2019/Freight%20Rail.pdf (accessed 24 April 2020).

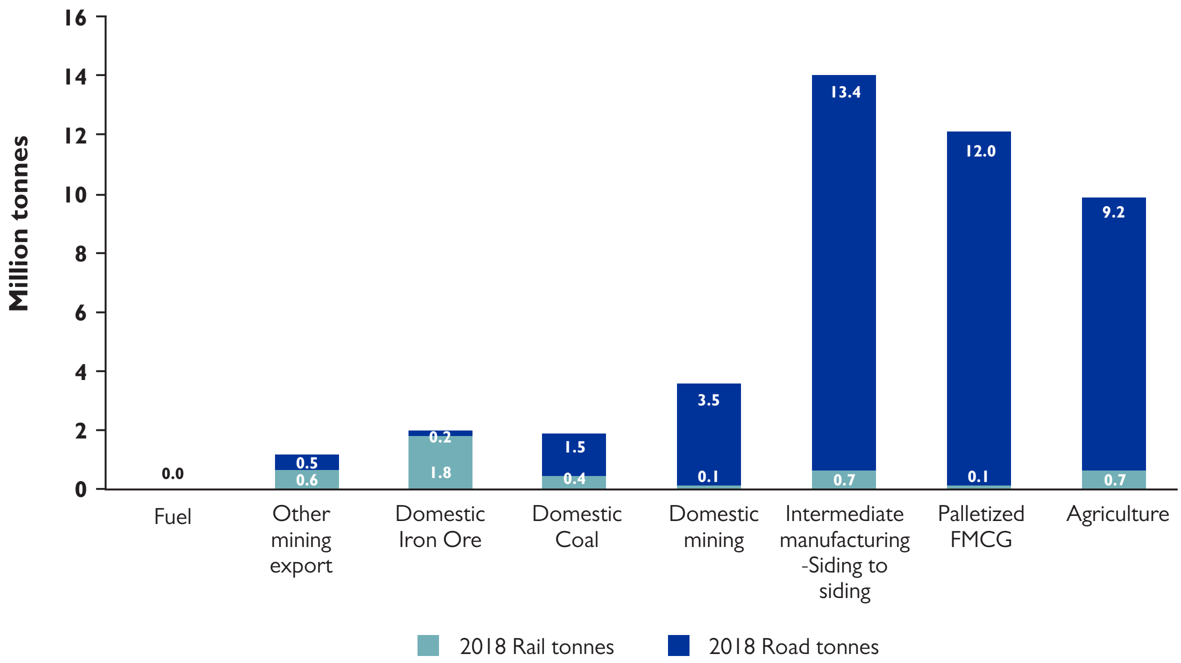


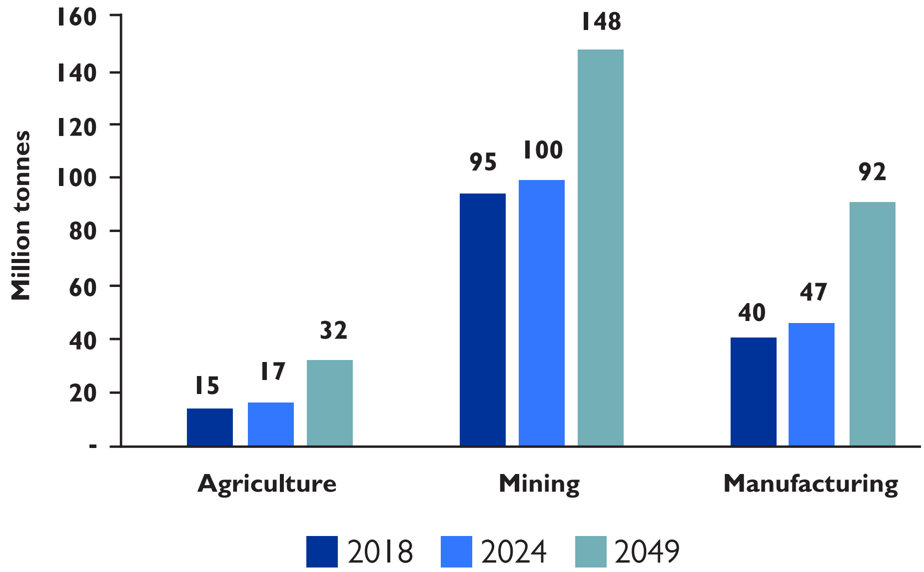
Figure 3: GFB road and rail tonnes per market segment in the Western Cape for 2018

Highlights

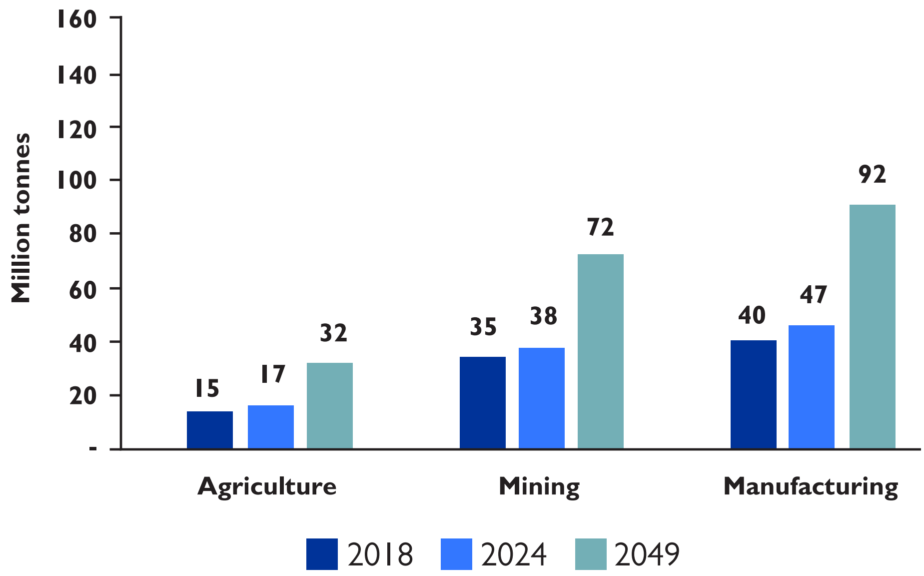
- Manufactured goods, transported over long distances on road, constitute a large volume of the Western Cape GFB freight.
- This presents two opportunities for rail:
  1. Siding-to-siding freight, that is, long-distance freight that is usually moved from large manufacturing plants to other plants for further beneficiation; and
  2. FMCG palletisable and containerisable freight, which can be transported through domestic intermodal solutions from private distribution centres through public intermodal terminals.
- 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.

Economic forecast[1]

The WCFDM considered 2024 and 2049 as the forecast years in the analysis. The total tonnes forecast per sector for 2024 and 2049 are given in Figure 1, both with and without the iron ore and manganese export volumes.



(a) Total Western Cape

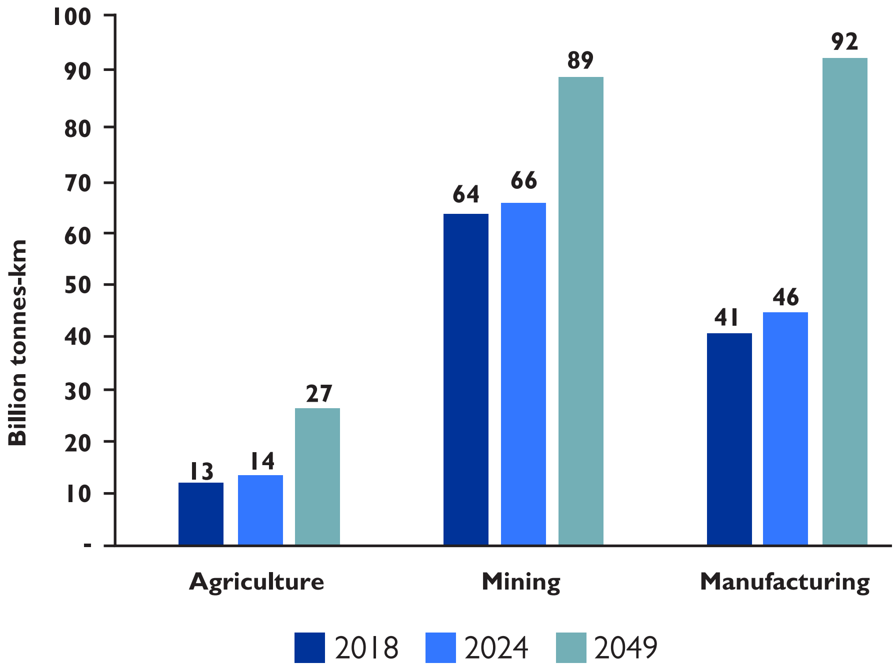


(b) Excluding export iron ore and manganese

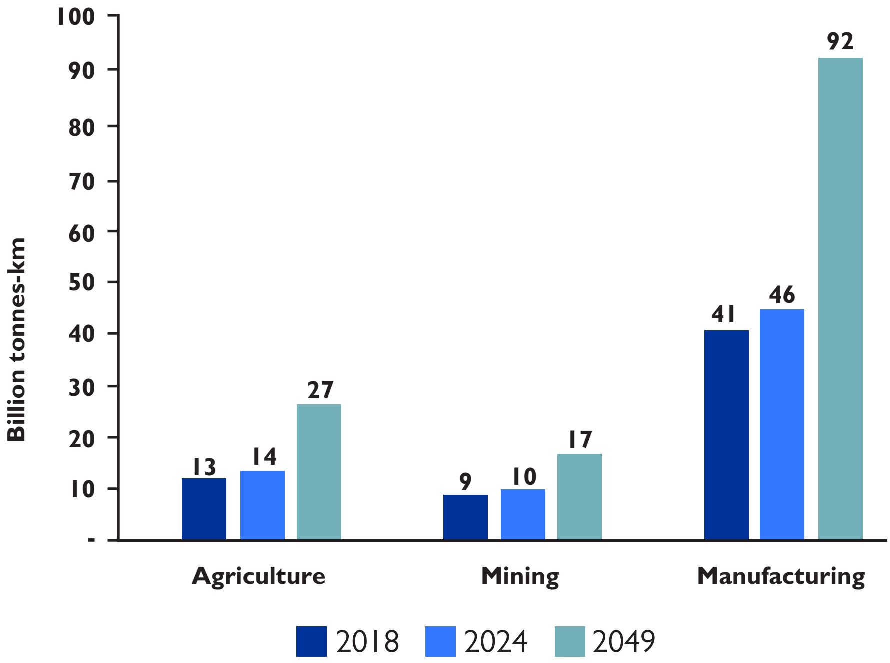
Figure 1: Total Western Cape freight flow forecast per sector (tonnes 2018)

The forecast for mining, excluding these ring-fenced export lines, is predominantly driven by sand mining on the West Coast, which is very short-haul and specific. This is evident from Figure 2, which shows that the manufacturing tonne-kms currently far exceed the mining tonne-kms when the export lines are excluded.

As evidenced by Figure 2, manufacturing commodities for the Western Cape are transported over long distances. The forecast also illustrates that there is 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.



(a) Total Western Cape



(b) Excluding export iron ore and manganese

Figure 2: Total Western Cape freight flow forecast per sector (tonne-km 2018)

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.

[1] The forecasting work took place before COVID-19 and therefore does not reflect the impact of COVID -19 on the economy in the WCFDM.

[2] Anglo American, estimated a 14-year reserve life for Sishen in its 2018 global reserves report (Anglo American, 2018).

Freight transport cost

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 WCFDM, actual road freight transport rates were confidentially received from Logistics Service Providers (LSP) 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 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 WCFDM.

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 50% of freight transport in South Africa is outsourced. Where freight transport is done 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, a 10% profit margin was assumed for road transport costs in 2018[5] (see Figure 2).

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

Table 2: Cost drivers for road freight transport

Cost driver	Description
Fuel	The price of fuel is based on the pump price for 500 parts per million (ppm) diesel. Bulk rebates are ignored.
Driver's wage	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.
Repairs and maintenance	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 roads	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 licences	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 a confidential survey conducted in the 2018/2019 financial year.

[6] This average assumption is deemed sufficient, given the current status of road freight user-pay charges. For example, Western Cape licence fees amount to R312 M (0.6%) of road costs (fees in other provinces will be similarly negligible).

In 2018, road freight transport accounted for 83% of the total freight transportation cost. The main cost drivers were fuel (R19.5 billion; 36.7% of total cost), maintenance and repairs (R8.2 billion), and driver wages (R4.8 billion)[7]. These costs are shown in Figure 1 and Table 3.

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 (see the sections on externality cost and Scenario 1: Modal shift).

[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).

Highlights

- In 2018, road freight transport accounted for 83% of the total transportation cost.
- The main road freight transport cost drivers were fuel (R19.5 bn; 36.7% of total cost), maintenance and repairs (R8.2bn) and driver wages (R4.8bn).
- 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 benefits.

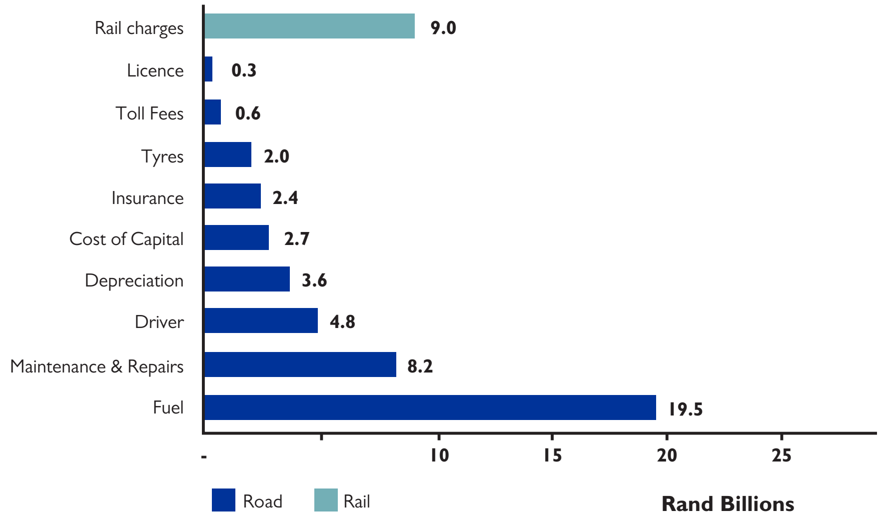


Figure 1: Transport cost components per mode for Western Cape freight (2018)

Table 3: Transport cost drivers

Cost driver	Cost (R bn)	% of total
Fuel	19.5	36.7%
Maintenance and Repairs	8.2	15.4%
Driver's wage	4.8	9.1%
Depreciation	3.6	6.7%
Cost of Capital	2.7	5.1%
Insurance	2.4	4.5%
Tyres	2.0	3.7%
Toll Fees	0.6	1.2%
Vehicle licences	0.3	0.6%
Rail charges	9.0	17.0%
Total	**53.1**	

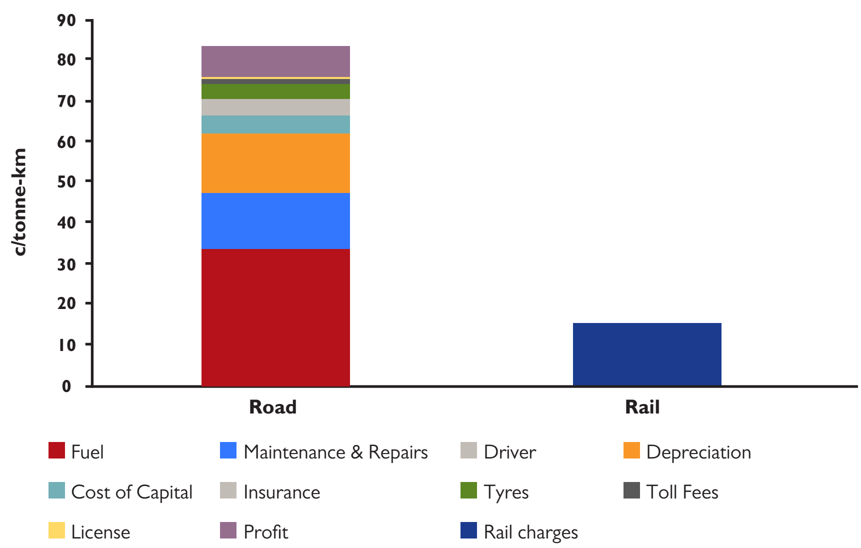


Figure 2: Transport cost in c/tonne-km per mode for Western Cape freight (2018)

Externality cost

The total estimated CO_2 emissions for South Africa are 422 million tonnes[1], of which approximately 25 million tonnes are for freight. In order to have a holistic view of transportation cost, externalities such as emissions need to be taken into account. The externality components are the costs associated with accidents, congestion, emission, 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[2] that can be used to estimate these costs. The rates are summarised in Table 1.

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

	Road	Rail
Accidents	4.79	0.41
Congestion	2.95	
Emissions	8.97	1.21
Landway	0.87	0.08
Noise	3.24	0.03
Policing	2.29	

Emissions costs include not only CO_2 gasses, but all emissions that are produced by burning fuel. The emissions produced per litre of burnt diesel are given in Table 2.

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

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

Acronyms[3]	NOx	PM metro	PM rural*	HC	CO	CO_2**	SO_2
Grams produced, per litre 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

Table 3: Gram produced of emissions 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 CO2 emissions for South Africa, a cost of R225 per tonne of CO2 is assumed for 2010, in line with the proposals of the South African National Treasury (2010) and McCarl and Sands (2007)*

[1] https://www.iea.org/data-andstatistics/?country=SOUTHAFRIC&fuel=CO2%20emissions&indicator=Total%20CO2%20emissions

[2] 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.

[3] 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

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

The total externality costs for road freight transport in the Western Cape amount to R13.48 billion, which is 30.6% of current direct road freight transport costs[4]. Road freight transport contributes 93% of the total freight transport externality costs of R14.49 bn.

The four largest road freight transport externality cost drivers, namely, emissions, accidents, noise and congestion, contribute 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 or next to noisy roads, or commuters travelling on congested routes. Furthermore, tax payers fund the clearing of accidents and rehabilitation of damaged roads. Accidents further negatively impact Growth Domestic Product growth due to loss of skilled labour in fatal or debilitating crashes.

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[5].

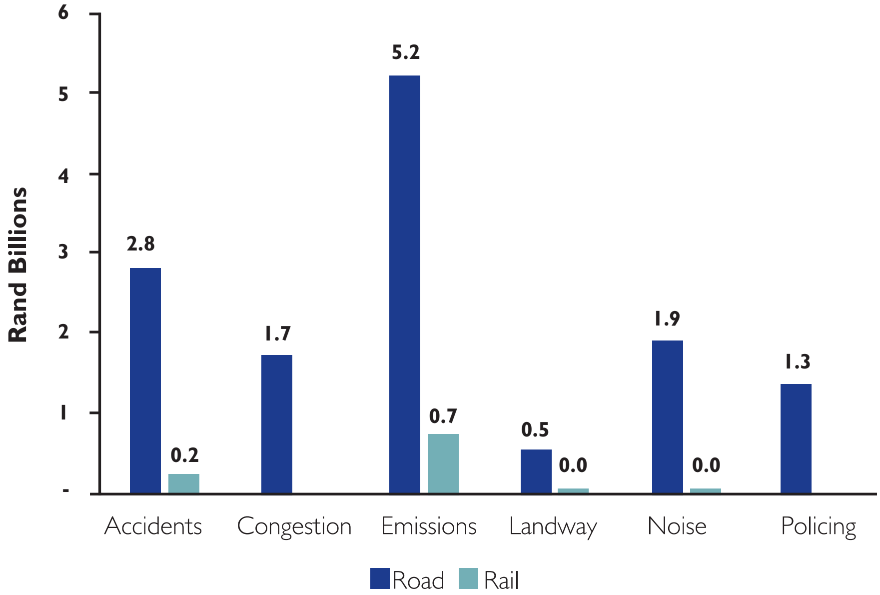


Figure 1: Externality costs for Western Cape freight

Externality cost driver	Road Cost Rbn (% of driver cost)	Rail Cost Rbn (% of driver cost)	Total Cost Rbn (% of total)
Emissions	5.23 (88%)	0.71 (12%)	5.94 (41%)
Accidents	2.79 (92%)	0.24 (8%)	3.03 (21%)
Noise	1.89 (99%)	0.02 (1%)	1.91 (13%)
Congestion	1.72 (100%)	-	1.72 (12%)
Policing	1.34 (100%)	-	1.34 (9%)
Landway	0.51 (92%)	0.05 (8%)	0.56 (4%)
Total	**13.48 (93%)**	**1.01 (7%)**	**14.49**

Table 4: Externality costs for Western Cape freight

Highlights

- The total externality for road freight transport in the Western Cape amounts to R13.48 billion, which is 30.6% of current road freight transport costs.
- Road freight transport contributes 93% of the total freight transport externality cost of R14.49 billion
- The four largest road freight transport externality cost drivers, namely emissions, accidents, noise and congestion contribute 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.

[4] That is if externality cost is internalised within the road transport cost: total direct road cost of R44.1bn plus the R13.48bn total externality cost for road.

[5] 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 costs

Scenarios

The WCFDM enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. Pressing policy issues were identified in consultation with DTPW and high-level scenarios were developed to estimate the potential annual impact on freight transport costs and Gross Domestic Product (GDP) in the Western Cape. 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 that have been identified as rail friendly, based on the density attributed to the origin and/or destination, packaging type and distance. Three scenarios are quantified in terms of the change in rail market share namely:

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 scenarios.

Assumptions

- Assuming 2018 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 2018 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, N2 and N7, as well as for short distance freight transported locally in the Core Western Cape region.

Results

The modal shift scenario results are depicted in Table 1 to Table 4.

N1 corridor

The key opportunities for modal shift on the N1 corridor are in the siding-to-siding and palletised FMCG segments. The volumes that could be shifted are depicted in Figure 1[1].

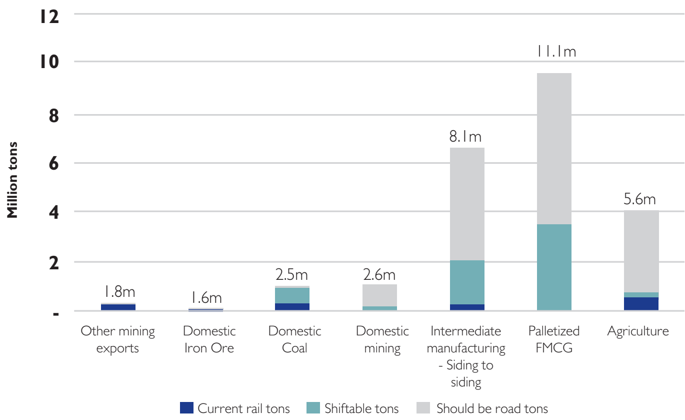


Figure 1: Modal shift opportunity per segment on the N1

Transport costs on the N1 corridor for these segments are currently at a 17.1% premium, compared to costs under a scenario in which all shiftable freight was transported by rail (see Table 1). If rail volumes remain stagnant up to 2049 this premium will increase to 17.4%.

Table 1: 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)
2018 - Current market share	22.7	17.1%	3.31	343.9
2024 - Stagnant rail volumes	25.5	17.4%	3.79	394.4
2024 - Constant market share	25.5	17.2%	3.74	389.0
2024 - Growth market share	21.7		-	
2049 - Stagnant rail volumes	51.2	17.4%	7.57	823.8
2048 - Constant market share	50.6	16.1%	7.00	765.8
2048 - Growth market share	43.6		-	-

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 depicted in Figure 2.

[1] For this analysis, which focuses on modal shift to rail, the segments in Figure 1 to Figure 4 are sorted according to rail's suitability (including density and number of OD pairs)

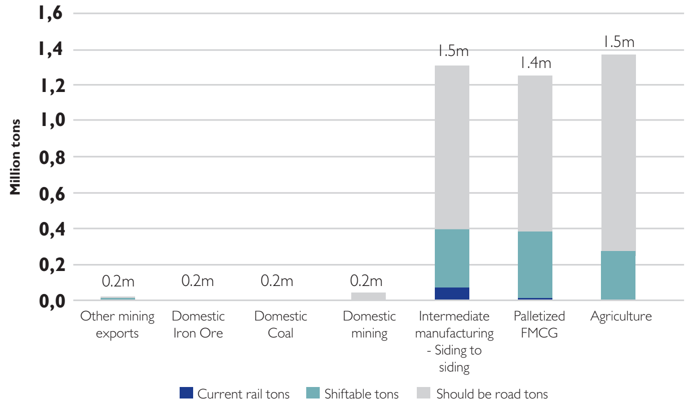


Figure 2: Modal shift opportunity per segment on the N2

Transport costs on the N2 corridor across all segments are currently 7.7% more higher than they would be if all shiftable tonnes were transported by rail (see Table 2). If rail volumes remain stagnant this will increase to 7.9% by 2049.

Table 2: 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)
2018 - Current market share	2.2	7.7%	0.16	25.9
2024 - Stagnant rail volumes	2.6	7.8%	0.19	30.1
2024 - Constant market share	2.6	7.7%	0.18	29.7
2024 - Growth market share	2.4		-	
2049 - Stagnant rail volumes	4.9	7.9%	0.36	59.1
2049 - Constant market share	4.9	7.7%	0.35	57.2
2049 - Growth market share	4.5		-	-

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 depicted in Figure 3.

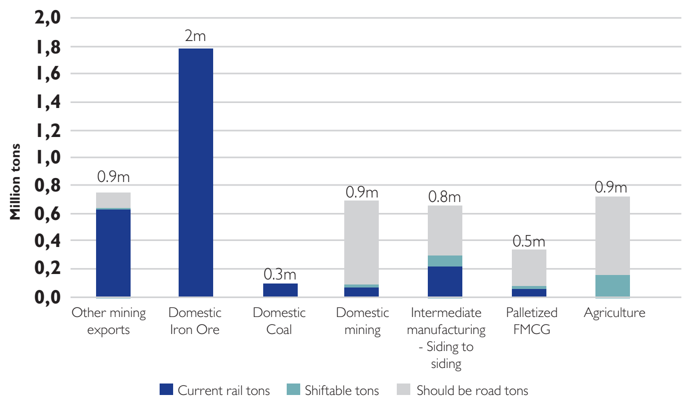


Figure 3: Modal shift opportunity per segment on the N7

Transport costs on the N7 corridor are currently 6.7% higher than they would be if all shiftable tonnes were transported by rail (see Table 3).This excludes the Domestic Iron Ore, which is transported via the Iron Ore Export Line. If rail volumes remain stagnant this will increase to 23.5%, by 2049. If rail market share remains constant this will increase to 6.7%.

Table 3: 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)
2018 - Current market share	1.0	6.7%	0.06	4.2
2024 - Stagnant rail volumes	1.3	10.9%	0.12	7.1
2024 - Constant market share	1.2	6.9%	0.08	5.0
2024 - Growth market share	1.1		-	
2049 - Stagnant rail volumes	3.0	23.5%	0.57	28.7
2049 - Constant market share	2.5	6.5%	0.16	9.9
2049 - Growth market share	2.4		-	-

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 depicted in Figure 4. Due to the low freight transport distances and density outside metro areas, road is currently more competitive for certain commodities than rail in segments such as agriculture and intermediate manufacturing.

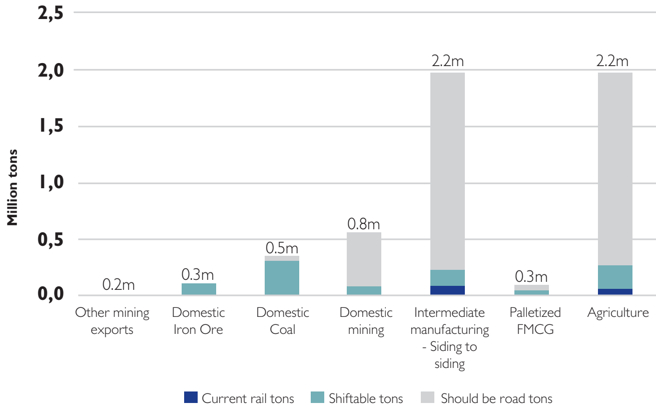


Figure 4: Modal shift opportunity per segment for Western Cape core traffic

Transport costs for the Core Western Cape across all segments are currently 5.7% higher in the absence of modal shift (see Table 4). By 2049 if rail market share remains stagnant this will decrease to 4.2%, given that rail rates remain relatively high. This is due to the growth in the freight flows in which road is more competitive.

Table 4: Cost and emission savings potential due to modal shift in 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)
2018 - Current Market share	0.5	5.7%	0.03	2.2
2024 - Stagnant rail volumes	1.1	2.9%	0.03	3.1
2024 - Constant market share	1.1	2.9%	0.03	3.3
2024 - Growth market share	1.0			
2049 - Stagnant rail volumes	1.4	4.2%	0.06	6.4
2049 - Constant market share	1.4	4.0%	0.05	5.9
2049 - Growth market share	1.3			

Summary

In 2018 the total transportation bill for freight touching the Western Cape was R53.1bn. The combined effect of the modal shift on the three corridors and core Western Cape traffic would have been a reduction of R3.57 billion or 6.7% in transport costs for the Western Cape (the 2018 market share data in the tables above)[2].

Table 5: Summary - cost and emission savings potential due to modal shift in the Western Cape

Freight traffic zone	Shift saving 2018 (Rbn)	% saving on total Western Cape transport bill	CO_2 emission reduction (000' tonnes)
N1	3.31	6.2 %	343.9
N2	0.16	0.3 %	25.9
N7	0.06	0.1 %	4.2
Core Western Cape	0.03	0.1 %	2.2
Total	3.57	6.7%	376.2

Highlights

- As rail traffic becomes dense, it becomes more efficient.
- An estimated 6.7% of the Western Cape's total freight transportation cost could be saved through modal shift at current rail tariffs.
- At current rail volumes, road is more competitive within the WC Core area.
- The largest modal shift opportunity is for the N1 corridor freight. This could potentially save 6.2% of total transport cost.

[2] These results refer to the transport cost saving. Additional investments can be included in a high-level business case.

Western Cape Freight Demand Model (WCFDM)
Scenario 2: Road Transport Management System

Assumptions

The adoption of Road Transport Management System (RTMS) principles has been proven to reduce logistics costs. The RTMS scenario is modelled to calculate the savings that would result from its wider adoption. Generalised savings figures for RTMS adoption are taken and conservatively adjusted from a Council for Scientific and Industrial Research (CSIR) study[1] and applied to the WCFDM tonne-kms to quantify how such a culture shift will impact logistics costs.

Although some transporters have already implemented RTMS, it is assumed that 50% of the current freight can shift to RTMS. It is further assumed that adherence to RTMS principles will result in a 5% fuel efficiency gain for the same number of vehicle kilometres driven due to better skilled drivers. The total number of trips are also assumed to be reduced by 20% for the same freight intensity. Finally, it is also assumed that RTMS will result in a 10% of road wear reduction. These assumptions are summarised in Table 1.

Table 1: Summary of RTMS savings assumptions

Assumptions	
Additional RTMS adoption rate	50%[2]
RTMS fuel efficiency gain	5%
RTMS load factor efficiency gain	20%
RTMS road wear reduction	10%

Results

It is estimated of that an additional 50% adoption rate of RTMS will result in a 12% fuel saving. This is achieved through a combination of fuel efficiency gains and vehicle kilometre reduction. A 12% fuel saving will also result in a 12% carbon emissions saving equivalent to, 0.48m tonnes of CO_2.

Table 2: Summary of RTMS scenario results

	Current	50% shift to RTMS	Saving	Reduction
Distance driven by trucks (billion kms)	2.65	2.39	0.26	10%
Litres of fuel used by trucks (billions)	1.45	1.27	0.18	12%
CO_2 emissions (million tonnes)	3.90	3.42	0.48	12%

The reduction in fuel consumption as a result of better driving practices and reduced vehicle kilometres amount to a saving of R2.4bn. Furthermore, it is estimated that the reduction in road wear will result in a R0.16bn road wear reduction. An additional 50% adoption of RTMS in the Western Cape has the potential to reduce the total transportation bill for freight touching the Western Cape by R2.4bn or 4.5% of total direct freight transport costs.

Highlights

- The scenario results mirror the freight strategy and talks to its objectives:
  - * Freight intensity for the same task can be reduced through fewer kilometres (caused by better planning and load factors)
  - * Emissions can be reduced by less kilometres as well as maintenance efficiency and improved driver behaviour
- Increased RTMS adoption could reduce carbon emissions by 0.48m tonnes.
- RTMS has the potential to reduce the transportation cost of freight touching the Western Cape by 4.5% if 50% of all vehicles become certified in addition to those that already comply.
- Increased RTMS adoption has the potential to save R0.16bn in road wear reduction.
- Although universal adoption is difficult, improved law enforcement would have the same or comparable effect.

[1] Steenkamp AJ, Nordengen PA, Berman R, Kemp L., *Investigation into the smart truck pilot project: Progress made and way forward.* 2017,

[2] This is a percentage of operators that are currently not RTMS certified.

Western Cape Freight Demand Model (WCFDM)
Scenario 3: Waste on Rail

The City of Cape Town Municipality is the largest generator of municipal waste in the Western Cape, accounting for 64% of the province's municipal waste disposal of 1.7m tonnes in 2018. Due to this concentration of waste generation in the City of Cape Town Municipality, and the high direct and externality costs of road transport, the City has focussed on transporting as much waste by rail as possible. Most of the City of Cape Town's major waste facilities have access to the rail network, as can be seen in Figure 1. This makes the transportation of municipal waste by rail worth investigating and expanding.

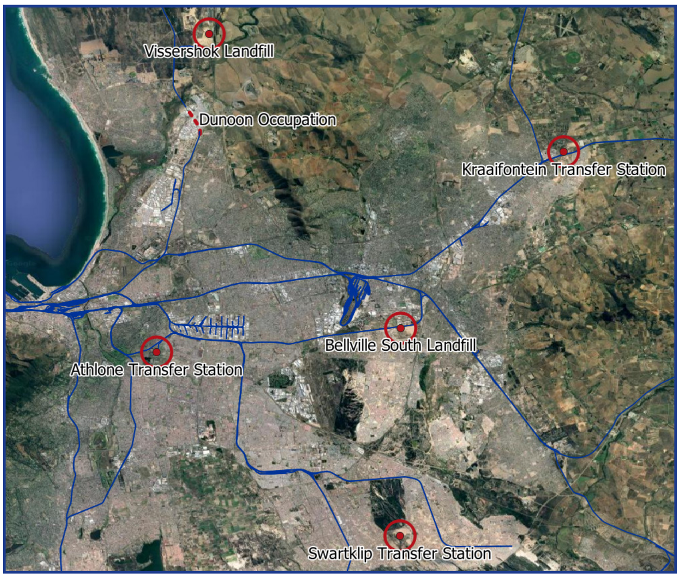


Figure 1: City of Cape town waste locations and rail infrastructure

Historically, the City transported waste by rail from the Athlone transfer station to the Vissershok landfill. Figure 2 shows the volumes of waste transported by rail since 2003.

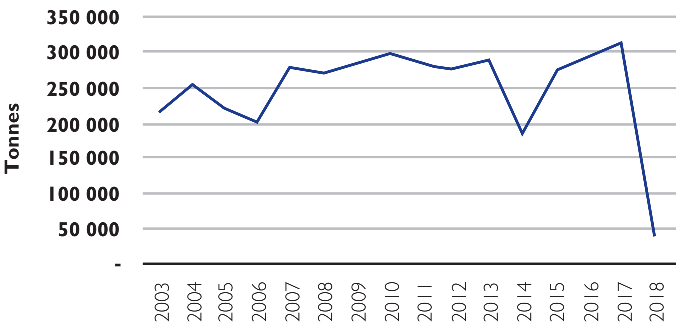


Figure 2: Tonnes of waste moved on rail from Athlone transfer station to Vissershok landfill

Due to land occupation of the track, this service ceased to operate in March 2018. When operational, an average of 600 – 900 tonnes of waste were moved to Vissershok per night. This has negatively affected the Athlone transfer station's capacity to move waste to Vissershok.

The Bellville South Landfill closed in 2018, and it is likely that municipal waste that would have gone to Bellville South has since been transferred to Vissershok. Therefore, municipal waste that can be moved to Vissershok by rail originates from the Athlone and Kraaifontein facilities. The Swartklip transfer station does not have access to the rail network. However, if its waste is transferred to the Athlone facility by road for consolidation, it could be further transported by rail.

Table 1 shows the externality cost reductions that could be achieved if all the waste from the refuse transfer stations is transported by rail.

Table 1: 2018 Municipal waste volumes.

Waste facility	Disposal	Transfer	Total Tonnes	Annual externality cost reduction
Athlone		117 784	117 784	R0.63m
Bellville	46 161		46 161	R0.29m
Kraaifontein		120 223	120 223	R0.87m
Swartklip		141 707	141 707	R0.53m
Total	**46 161**	**379 714**	**425 875**	**R2.31m**

Transporting 238 000 tonnes of waste by rail at Athlone and Kraaifontein will result in an externality cost saving of R1.5m. If the volumes that were landfilled at the Bellville South Landfill before it closed are included and split between Athlone and Kraaifontein, the externality savings would increase to R1.8m. Lastly if, the Swartklip waste is transported to Athlone for consolidation, a further R0.5m in externality cost could be saved.

Highlights

- The City of Cape Town Municipality accounted for 64% of the province's municipal waste disposal in 2018.
- Efforts to transport waste by rail was hampered by land occupation on the track (between Athlone transfer station and Vissershok landfill).
- There is potential to transport municipal waste from the Athlone and Kraaifontein facilities to the Vissershok landfill.
- Estimated annual externality cost savings, if waste is transported by rail in the province, are between R1.5 million to R2.3 million.

Western Cape Freight Demand Model (WCFDM)
Waste data gathering and analysis process

Waste Overview

The WCFDM freight flows are derived from economic activity, specifically activities that contribute to the transportable GDP[1]. Although the generation of waste does not contribute to the GDP, it still needs to be transported and disposed of. This results in additional transportation costs that must be accounted for.

Waste is generated during the extraction and manufacturing activities, as well as after the final consumption of goods. A portion of the transportable GDP will end up in landfill.

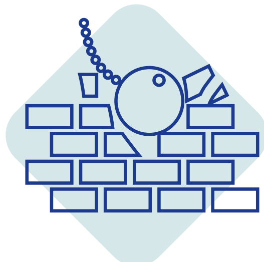
The WCFDM waste data is a combination of reported WC Department of Environmental Affairs and Development Planning (DEA&DP) and City of Cape Town waste data. The major waste streams are displayed on the right.

The City of Cape Town (CoCT) is the largest waste generating area in the Province and is responsible for 64% of the Province's municipal waste handling of 1.7m tonnes in 2018.

The data processing methodology for the three largest waste streams for the CoCT are discussed below.

GW[2]01 Municipal waste (also including GW99 other waste)

GW20 Organic or garden waste



GW30 Construction and demolition waste

1. GW01 – Municipal waste

Figure 1 shows the approximate catchment areas for each waste facility within the City of Cape Town Municipality and Figure 2 the waste collection and transfer process.

Figure 1: Catchment areas for the various refuse transfer stations and landfills in the CoCT Municipality.

[1] The transportable GDP consists of the extraction of raw materials and manufacturing, also referred to as the primary and secondary economic sectors, respectively.

[2] GW = General waste

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 WCFDM, waste OD flows were generated based on the intersection of each WCFDM district to 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.

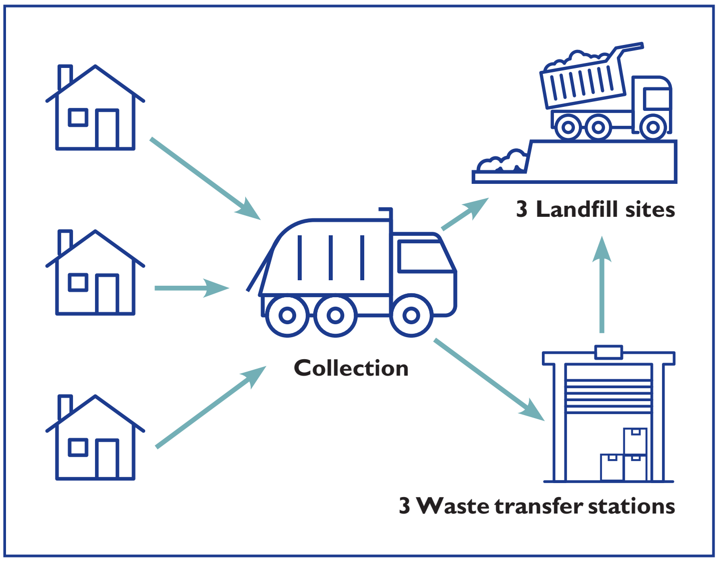


Figure 2: The waste collection and transfer process

2. GW30 – Construction and demolition waste

Figure 3 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, with the exception of construction waste from the Athlone refuse transfer station. The catchment areas for construction and demolition waste are shown in Figure 4.

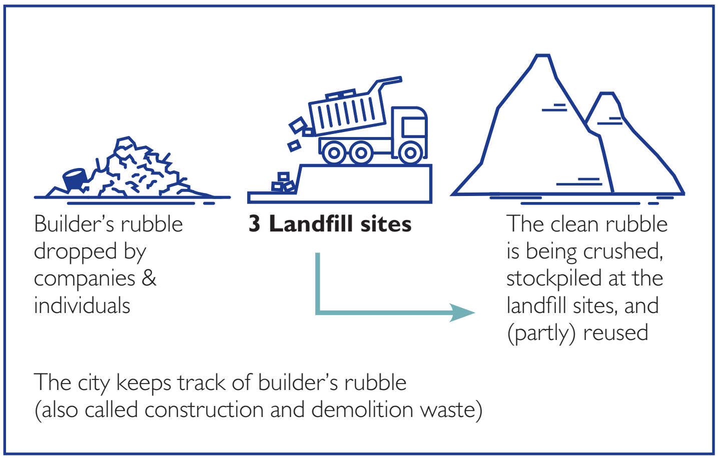


Figure 3: GW30 – Construction and demolition waste.

3.1 GW20.01: Garden waste

There are various flows of organic waste. This waste has the same catchment as municipal waste. Some of it ends up in landfills (this is already included in municipal waste, sometimes separated as GW20.02 "food waste"). Most of this waste is GW20.01 (garden waste) that is separated at source (e.g. 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, and transports all the garden waste to its composting site just outside Paarl.

4.1 GW20.01: Provincial waste

Apart from the CoCT, there are 24 other municipalities within the Western Cape that are served by 60 waste facilities. The same methodology that was used for the City of Cape Town Municipal waste assignments to WCFDM districts, was applied to the rest of the Province.

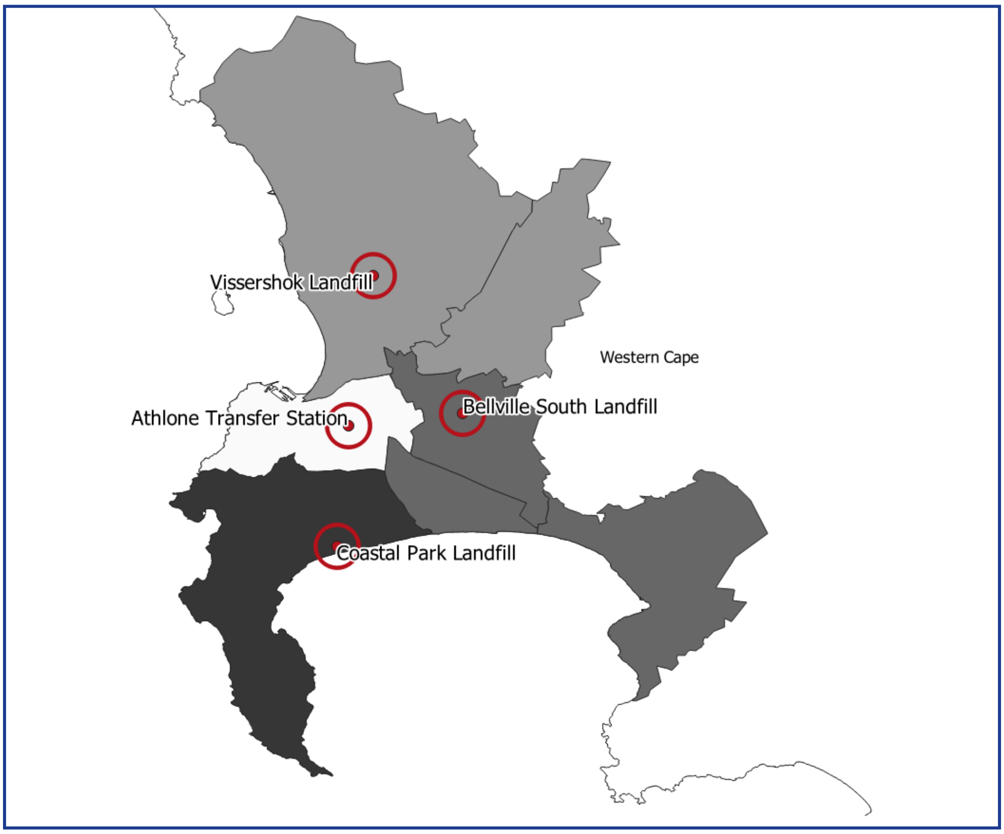


Figure 4: Catchment areas of industrial builder's rubble flow dropped off directly at landfill sites. This can come from anywhere in Cape Town, and it could go to any of the 3-landfill sites.

Western Cape Freight Demand Model (WCFDM)
Detail on "Other manufacturing industries" and the grouping "Other commodities"

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 (2018)

Commodity	Million tonnes 2018	Percentage contribution
Processed Foods	8.90	32.0%
Beverages	2.79	10.0%
Other Manufacturing Industries	1.91	6.9%
Cement	1.69	6.1%
Animal feed	1.64	5.9%
Petrol	1.51	5.4%
Bricks	1.34	4.8%
Iron & Steel	1.29	4.6%
Other commodities:		
Other Petroleum Products	1.10	4.0%
Fertilizer	0.86	3.1%
Wood timber and products	0.77	2.8%
Diesel	0.73	2.6%
Metal products, machinery and electronic equipment	0.46	1.6%
Chemicals	0.40	1.4%
Slaughtered animal meat	0.40	1.4%
Textile Products	0.39	1.4%
Paper	0.31	1.1%
Scrap metals	0.26	0.9%
Pharmaceutical Products	0.21	0.7%
Soya bean products	0.18	0.6%
Non-Ferrous Metal Products	0.16	0.6%
Recycled paper	0.15	0.5%
Printing and Publishing	0.10	0.4%
Transport Equipment	0.10	0.3%
Jet fuel	0.09	0.3%
Motor Vehicle Parts & Accessories	0.04	0.2%
Tobacco Products	0.01	0.0%
Pulp of wood and paper	0.01	0.0%
Motor vehicles and trucks	0.00	0.0%
Gas	0.00	0.0%
	27.80	100.0%

Other manufacturing industries consist of manufactured goods that can be classified by the following (HS2) 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.