Western Cape Freight Demand Model (WC FDM™)

Enhancement for Port of Cape Town

Final Report
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Table of Content

List of Figures

List of Tables

List of Acronyms

CTCT - Cape Town Container Terminal

EoDB - Ease of Doing Business

FDM - Freight Demand Model

GDP - Gross Domestic Product

NDP - National Development Plan

NIP - National Infrastructure Plan

NFFU - Normal Forty-Foot Unit

NTFU - Normal Twenty-Foot Unit

PoCT - Port of Cape Town

RFFU - Refrigerated Forty-Foot Unit

RTFU - Refrigerated Twenty-Foot Unit

TEU - Twenty-foot equivalent unit

WC - Western Cape

WC FDM - Western Cape Freight Demand Model™

WC FDM™ PE - Western Cape Freight Demand Model ™ Port Enhancement

Introduction

This report sets out the deliverables as per purchase order QR-005159 for the project "Enhancement of the Provincial Freight Demand Model™ (WC FDM™) for containerised cargo through the Port of Cape Town (PoCT). The objective of this project is to enhance the Western Cape Freight Demand Model (WC FDM™) to serve as an integrated evidence base for the short - to medium-term capacity planning and implementation of interventions. These interventions are to improve efficiency in the PoCT container cargo logistics chain and facilitate appropriate service level capacity development for the anticipated growth in exports from the Western Cape (WC).

This report used the recent WC FDM™ 2020 base year data, its corresponding WC FDM™ report 2021, and data received from Agrihub to provide feedback on the items as per the terms of reference. To that end, the report:

- presents an overview of the WC FDM™ methodology and data columns before the model was integrated with the Agrihub data,
- describes the received Agrihub data to illustrate how it enabled the required integration with the WC FDM™,
- provides an overview of the new data columns in the WC FDM™ to illustrate how the model has been enhanced by the integration,
- details various levels of data disaggregation enabled by the enhanced model, namely disaggregation by
    - containerised and non-containerised cargo,
    - container type,
    - month,
    - fruit commodity group, and
    - larger commodity groups
- models the impact of weather delays and the perishability of cargo with the various levels of data listed above, and
- concludes by making recommendations for efficiency improvements at the PoCT and future research.

Table 1 on the next page provides a more detailed overview of the links between sections of the report and the items as per the terms of reference.

Table 1: Overview of the report in relation to the items as per the terms of reference

Item	Terms of Reference	Related section(s) in report	Page(s)
4.1	FDM enhancement for containerised cargo	All	1-38
4.1.1	Disaggregate the data to isolate containerised cargo by specific container type, i.e., general purpose or refrigerated.	1.5 Disaggregation between containerised and non-containerised cargo for the Port of Cape Town	13
4.1.2	Reflect frequency of containerised cargo flows over the year for 2020, at least per month.	1.6 Port of Cape Town containers disaggregated per month	15
4.1.3	Provide a higher-frequency projection of cargo flows (monthly) for 2021 and 2026.	1.6.1 Port of Cape Town container projection for 2021; 1.6.2 Projection of Cape Town container projection for 2026	16; 18
4.4	Integrate the granular data on the volumes and frequency of fruit exports by type from the EoDB in PoCT action research project 1 on data integration (2020/21) into the existing Western Cape Freight Demand Model.	1.4 Integration with Agrihub data	6
4.5	Isolate the cargo flows to and from Port of Cape Town into a separate model and disaggregate these flows into containerised cargo and other. Containerised cargo must be further disaggregated into container type (general purpose, refrigerated and high-cube).	1.5 Disaggregation between containerised and non-containerised cargo for the Port of Cape Town	13
4.6	Provide a broad classification for the perishability of the containerised cargo.	1.8.1 Classification of containerised fruit cargo perishability	28
4.8	Develop a projection of containerised cargo flows per month for 2021 and 2026, and include the classification on perishability in the projections.	1.8.2 The impact of perishability on the containerised fruit cargo projection for 2021; 1.8.3 The impact of perishability on the containerised fruit cargo projection for 2026	31; 32
4.9	Superimpose a profile of past weather delays on the monthly containerised cargo demand projections to estimate risks related to terminal closure during seasonal peaks, with specific reference to the number of hours per month that the terminal may be unable to operate.	1.7 The impact of weather delays on monthly containerised fruit cargo flows	23
4.10	Map the major containerised cargo collection points in the Port of Cape Town logistics chain.	1.4.2 Container-focused dataset; 1.6.3 Port of Cape Town fruit flow disaggregation	8;19
4.11	Make recommendations regarding appropriate service level requirements and efficiency improvements in containerised cargo management for the Port of Cape Town. Recommendations should include the management of the empty container supply chain for improved efficiency.	Recommendations	33

Freight Demand Model enhancement for containerised cargo

The WC FDM™ is confined to those WC 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 WC FDM™, therefore, utilises in part the "FDM" (which is a registered trademark of GAIN Group (Pty) Ltd). 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).

1.1 Western Cape Freight Demand Model methodology

The WC FDM™ 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. 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 WC FDM™ was developed for the first time in 2017/18, based on the national FDM™, to add 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.

1.1.1 Econometric modelling

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

1.1.2 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, using gravity modelling.

Gravity modelling is based on the premise that freight flows between geographical districts are determined by supply and demand volumes for each commodity, and by a measure of transport resistance per commodity. Transport resistance is a commodity's propensity to be transported over a specific distance, with that propensity being determined by the utility and desirability which is traded-off with transport cost as a percentage of the delivered cost. Propensity is, therefore, estimated through a decay function for each commodity in question. In cases where the transport cost percentage is very low, the commodity will move even if the utility and desirability are low. Distance and travel time are the most common measures of transport resistance. Road cost components, such as diesel consumption and truck wear-and-tear, also typically have a linear relationship with distance and time. A distance-decay function describes the attraction value between origins (supply) and destinations (demand). The decay factor determines the slope of the decay function and its relative change over distance and time. 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 several geographical districts).

Refer to the following sources for a more technical description of the model:

- chapter 8 of Prof Jan Havenga's doctoral dissertation (2007),
- a research article by Havenga (2013), and
- chapter 6 of a book by Havenga, Witthöft, De Bod and Simpson (2020).

1.2 Pre-existing Western Cape Freight Demand Model data

Table 2 on the next page provides an overview of all the data columns that exist in the WC FDM™ before its enhancement. The table shows the names of each of the model's columns, along with detailed descriptions of what each column name refers to.

Table 2: Pre-existing Western Cape Freight Demand Model data columns

Column Name	Column Description
B_ID	The branch line ID corresponding to the branch line that is in md_or
CARGO_TYPE	The cargo type refers to how the commodity will be moved defined based on in what form the commodity will be handled during transportation.
COMMODITY_NAME	The name of the commodity
COMTYPE	4 letter code - representing the abbreviated commodity name
corridor	Fixed length corridor definition based on the grouping of the org_md and des_md in ORIGINNEWG and DESTINATIO
D_B_Detail	Destination branch line detail
D_B_Line	Destination branch line identifier
DBP	Two character code representing the origin and destination type whether it's a D - District, B - Border or P - Port
des_densit	The density of freight activity in newdest
DESTINATIO	The larger grouping area of which md_des forms part of which is used to define the corridor
DISTANCE	The physical transportation network distance in kilometres between md_or and md_des
Distance group	Grouping categories of distances
Distance_C	Distance category that classifies the DISTANCE field into buckets
DProvince	The province that the md_des is in
Economic_0	The second leg of the economic corridor defined for the corridor definition in ORIGINDEST or corridor. M - metro flows, R - Rural flows, CR - Corridor
Economic_C	The first leg of the economic corridor defined for the corridor definition in ORIGINDEST or corridor. M - metro flows, R - Rural flows, CR - Corridor
FDM_COM_Code	WCFDM Commodity Code - A unique identifier for each commodity
Flow	Flow identifier for branch lines
GFB	Classification of flow GFB - General freight business, ExpL - Export line, Bulk - Bulk freight
impexpdom	Import Export or Domestic identifier
INDUSTRY_GROUP	Industry grouping classification of the different commodities
label1	Unique code for each origin district. This code link is used to link to the GIS shapefiles. This field refers to the label of the origin MD
label2	Unique code for each origin district. This code link is used to link to the GIS shapefiles. This field refers to the label of the destination MD
MainEcCor	The main economic corridor - The part of Economic_C and Economic_0 which is used more by the commodity flow.
md_des	Name of the destination MD - where the freight from each line goes to.
md_or	Name of the origin MD - where the freight from each line comes from
National road allocated	The national road corridor assignment defined based on the different combinations of md_or and md_des pairs
newdes	The larger grouping area of which md_des forms part of which is used to define the corridor
newor	The larger grouping area of which md_or forms part of which is used to define the corridor
O_B_Detail	Origin branch line detail
O_B_Line	Origin branch line identifier
OProvince	The province that the md_org is in
or_density	The density of freight activity in newor
ORIGINDEST	Non-fixed length corridor definition based on the combination of ORIGINNEWG and DESTINATIO
ORIGINNEWG	The larger grouping area of which md_or forms part of which is used to define the corridor
PACKAGING_TYPE	The packaging group in which the commodity will be transported
Rail_Frien	Rail friendly corridor defined for the ORIGINDEST or corridor fields
SECTOR	The sector of the economy of which the commodity forms part of
Segmentation	Segmentation identifier
T_Class	Freight segmentation class

Source: WC FDM™

Since these metrics and fields are what had to be enhanced, the dataset was used as this project's starting point. From there, flows relevant to the PoCT were isolated into a separate dataset to be integrated and enhanced with the data received from Agrihub.

1.3 Pre-existing Freight Demand Model application for Western Cape fruit exports

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies and spatial planning by estimating their potential annual impact on freight transport costs and GDP in the WC. The WC FDM Report 2020, which was recently developed for the WC Department of Transport and Public Works, proposed the development of a hinterland terminal at Bitterfontein and fruit consolidation terminals at Vredendal and Elgin as its third and fourth scenarios, respectively. Since these high-level scenarios are related to WC fruit exports and the potential success of the PoCT, both are included as an appendix at the end of this report.

1.4 Integration with Agrihub data

The fruit flow data received from Agrihub contained pallet-focused and container-focused datasets that were integrated into the existing WC FDM™. These datasets were compiled during the Ease of Doing Business (EoDB) in PoCT research project Agrihub has worked on between 2019 and 2022. As a result, the data is mostly related to WC fruit exports, with some fruit types excluded or not represented significantly from a national perspective.

1.4.1 Pallet-focused datasets

This dataset defined pallet movements from producers to cold stores and included data descriptors such as:

- flow locations by origin and destination names,
- fruit categorisation information such as types, qualities, and sizes,
- intake and shipping dates,
- quantity variables such as mass, pallets, and cartons,
- reference numbers to the Agrihub's container-focused dataset, and
- vessel names.

Apart from enabling a more specific description of what the fruit flows are, these fruit types also helped to link the Agrihub data with the existing WC FDM™ fruit commodities and validate resulting data connections. Detailed datasets related to the following fruit types were received: grapefruit; lemons; oranges; pome fruit;

soft citrus; stone fruit; and table grapes. Agrihub commodities such as grapefruit, lemons and oranges could thereby be grouped together as one WC FDM™ citrus commodity group. An example of such a pallet-focused dataset received for 2021 is shown in Table 3.

Table 3: Extract of data received for pallets, per fruit type, per month, for the 2021 season

Shipped Month	Citrus	Grapes	Deciduous Fruit
January	-	118 705	32 740
February	100	84 897	40 467
March	2 632	128 863	96 564
April	21 219	22 096	72 710
May	36 076	870	79 455
June	72 017	-	57 629
July	80 676	-	48 134
August	108 374	-	52 654
September	84 459	-	32 679
October	40 328	6	24 794
November	4 235	12 833	29 557
December	154	70 316	22 430
Annual total	450 270	438 586	589 813

Source: Agrihub data (2021)

Most of the data related to fruit types spanned from 2020 to date, although the pome fruit and soft citrus datasets did not include 2020 data while the oranges dataset just included data for 2021. Although 2022 data was available for some fruit reaching towards the end of April and early May, the dataset was not complete for the 2022 season.

While a considerable volume of avocado and other subtropical fruit exporters uses the PoCT for exports, no subtropical fruit data was available. The dataset also did not include any berries since these fruit types were not part of the scope of the studies wherein Agrihub collected data. However, most berries are flown out of Cape Town International Airport or O.R. Tambo International Airport due to the short product storage life.

A monthly disaggregation of the Agrihub data provides visibility of the seasonal patterns experienced by each commodity group and the specific underlying commodities as shown in Figure 1 on the next page. Evidently, table grapes are the dominant fruit type by pallets exported through the PoCT in 2021.

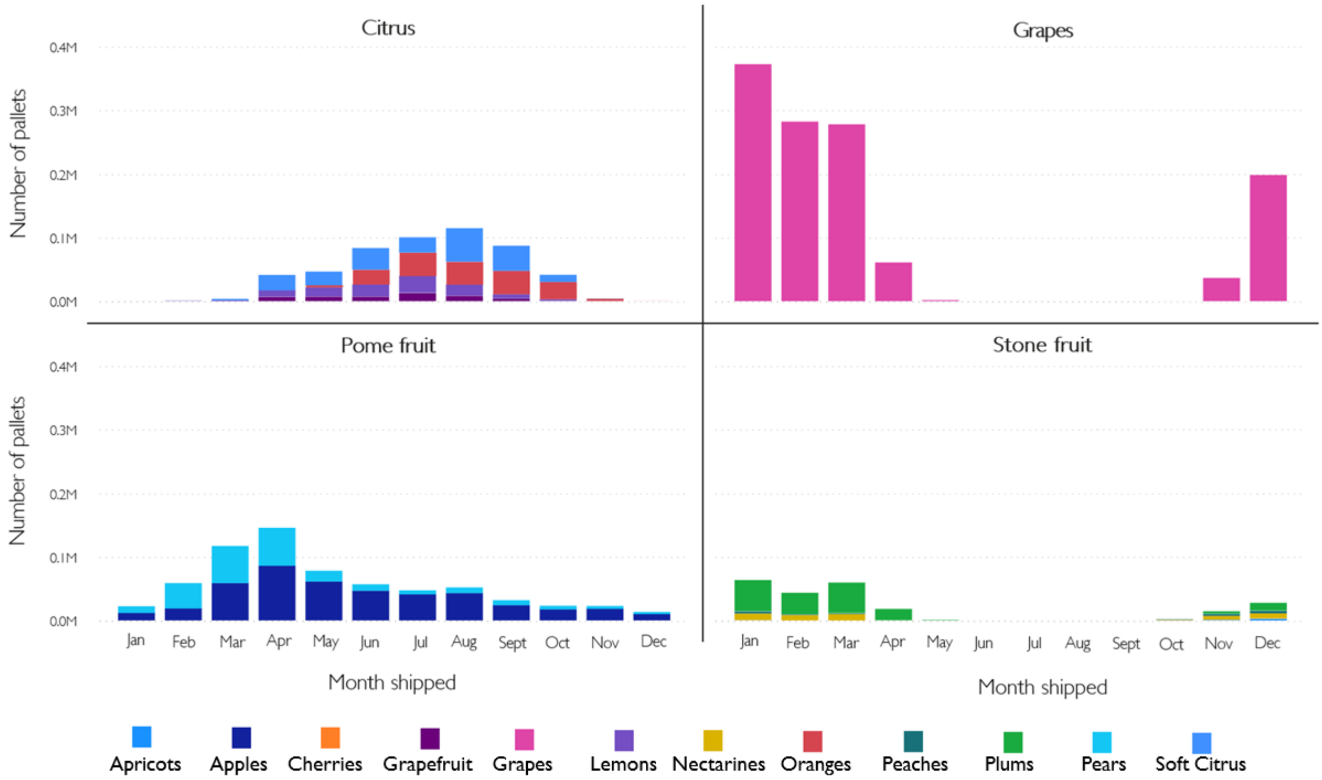

Figure 1: Monthly disaggregation of fruit types linked to the Port of Cape Town

Source: Agrihub (2021)

1.4.2 Container-focused dataset

This dataset defined container movements from cold stores to the PoCT (port of loading), and included the following details:

- Cold store locations
- Container movement dates and times
- Reference numbers to the Agrihub's pallet-focused datasets

The location of these cold stores and container volumes by fruit commodity group types are mapped in Figure 2 on the next page. As seen by the treemap chart on the bottom right of the map, the citrus fruit commodity group represents most of these container movements. Pome fruit also contributes a considerable share, followed by the lesser contribution of the grapes and stone fruit commodity groups.

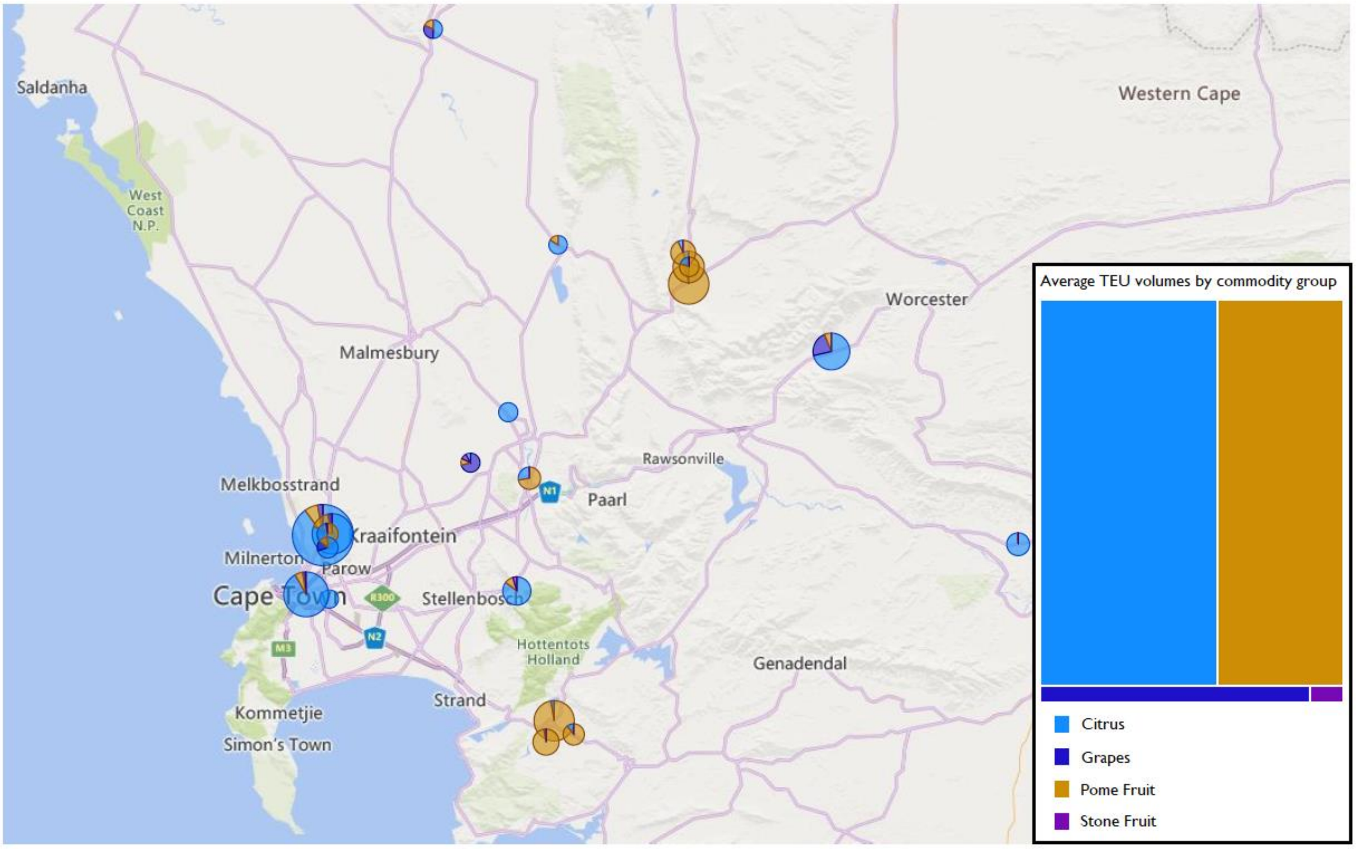

Figure 2: Locations and relative volumes of fruit cold stores linked to the Port of Cape Town

Source: Agrihub (2021)

Enhanced Western Cape Freight Demand Model outputs after integration

The integration with Agrihub data helped enhance the WC FDM™ with multiple new columns to enable full visibility of the objectives and deliverables of this project. The output of this project is the enhanced WC FDM™ module for the PoCT as a separate datafile. The new additional columns within this datafile are shown in Tables 4 to 7 that follow below.

Table 4 presents the new columns that are related to all years, i.e., the 2020 base year, 2021, and the 2026 forecast year – which are in sync with the WC FDM™ years.

Table 4: New enhanced Western Cape Freight Demand Model data columns after integration – all years

Column Name	Column Description	Data field type
Month #	Each month number	Number
Month Name	Each month name	Text
Export Import	Import or Export to indicate direction	Text

Source: Western Cape Freight Demand Model ™ Port Enhancement (WC FDM™ PE)

The first three columns relate to the disaggregation of flows as either export or import, along with when these flows occur. The 'Export Import' field provides the direction of flows, namely if it is departing or arriving at the PoCT. To address the when-disaggregation, a column was added for the month as both a number ('Month #') and text ('Month Name') field. Essentially, this represents a duplication of the same information, as the number field was added simply to enable easier sequential sorting by month and avoid issues with text fields sorting alphabetically by default.

Tables 5 to 7 essentially present the same new data columns; however, the information presented in each is year-specific and, therefore, named and grouped separately for 2020 (Table 5), 2021 (Table 6) and 2026 (Table 7). These columns allow further disaggregation of PoCT-related flows and are explained in detail for the 2020 base year (Table 5) below. It is important to note that the following explanations also apply to the new data columns for 2021 (Table 6) and 2026 (Table 7).

Table 5: New enhanced Western Cape Freight Demand Model data columns after integration – 2020

Column Name	Column Description	Data field type
Bulk Tons - 2020	Bulk tons (non containerised port volumes) in 2020	Number
NTFU - Tons - 2020	Normal Dry 20 foot containers tonnage in 2020	Number
NFFU - Tons - 2020	Normal Dry 40 foot containers tonnage in 2020	Number
RTFU - Tons - 2020	Refrigerated 20 foot containers tonnage in 2020	Number
RFFU - Tons - 2020	Refrigerated 40 foot containers tonnage in 2020	Number
Total Container Tons - 2020	Total container tonnage in 2020	Number
NTFU - # - 2020	Number of Normal Dry 20 foot containers in 2020	Number
NFFU - # - 2020	Number of Normal Dry 40 foot containers in 2020	Number
RTFU - # - 2020	Number of Refrigerated 20 foot containers in 2020	Number
RFFU - # - 2020	Number of Refrigerated 40 foot containers in 2020	Number
Total Container TEUs - 2020	Total number of container TEUs in 2020	Number
Fruit - Very High - 2020 TEUs	Number of TEUs containing fruit of Very High perishability for 2020	Number
Fruit - High - 2020 TEUs	Number of TEUs containing fruit of High perishability for 2020	Number
Fruit - Moderate - 2020 TEUs	Number of TEUs containing fruit of Moderate perishability for 2020	Number
Fruit - Low - 2020 TEUs	Number of TEUs containing fruit of Low perishability for 2020	Number
Agriculture - 2020 TEUs	Number of TEUs containing remaining Agriculture commodities for 2020	Number
Mining - 2020 TEUs	Number of TEUs containing Mining commodities for 2020	Number
Manufacturing - 2020 TEUs	Number of TEUs containing Manufacturing commodities for 2020	Number

Source: WC FDM™ PE

Before the enhancement of the WC FDM™, the model only had data on total volumes. The enhanced model can now disaggregate the total volumes into non-containerised (also called bulk) and containerised volumes, which is enabled by the new 'Bulk Tons – 2020' and 'Total Container Tons – 2020' data columns, respectively. The containerised volumes can be split further thanks to the added 'NTFU - Tons – 2020', 'NFFU - Tons – 2020', 'RTFU - Tons – 2020' and 'RFFU - Tons – 2020' data columns. These standardised codes are used to represent a Normal Twenty-Foot Unit (NTFU), Normal Forty Foot Unit (NFFU), Refrigerated Twenty-Foot Unit (RTFU) and Refrigerated Forty Foot Unit (RFFU), respectively. Normal container or dry container are used as interchangeable terms for a NTFU (20 foot) and NFFU (40 foot), while reefer container or refrigerated container are likewise used for a RTFU (20 foot) and RFFU (40 foot). These six new fields, therefore, provide insight into non-containerised (bulk) and containerised tonnes, while the latter can be split further into the tonnes related to each type of container.

These container types can also be split into the number of containers by using these new data columns: 'NTFU - # - 2020', 'NFFU - # - 2020', 'RTFU - # - 2020' and 'RFFU - # - 2020'. It is important to note that this data is not yet in TEU form, since a 40-foot container represents two 20-foot containers. To enable greater comparison between the number of dry – and refrigerated 20 and 40-foot containers, a summation column accounts for the difference between 20 and 40-foot containers to calculate the total number of TEUs ('Total Container TEUs – 2020'). Therefore, total trade is equal to bulk plus containers, which is visible in this data.

Each fruit commodity has been allocated a relative perishability value that allows the fruit to be classified into four separate perishability groups, represented by the following new data columns: 'Fruit - Very High - 2020 TEUs', 'Fruit - High - 2020 TEUs', Fruit - Moderate - 2020 TEUs' and 'Fruit - Low - 2020 TEUs'. The last three data columns, namely 'Agriculture - 2020 TEUs', 'Mining - 2020 TEUs' and 'Manufacturing - 2020 TEUs', were also added to provide further insight into perishability.

The inclusion of remaining agriculture enables assumptions to be made about the perishability of agricultural commodities other than fruit. Likewise, the addition of mining and manufacturing data presents the opportunity to explore how these commodities' perishability might change in comparison to that of fruit and other agricultural commodities. For instance, both mining and manufacturing commodities might have no perishability, but the value represented by high-value manufacturing might mean that it would be more important to have those commodities reach the market relative to low-value mining commodities.

Table 6: New enhanced Western Cape Freight Demand Model data columns after integration – 2021

Column Name	Column Description	Data field type
Bulk Tons - 2021	Bulk tons (non containerised port volumes) in 2021	Number
NTFU - Tons - 2021	Normal Dry 20 foot containers tonnage in 2021	Number
NFFU - Tons - 2021	Normal Dry 40 foot containers tonnage in 2021	Number
RTFU - Tons - 2021	Refrigerated 20 foot containers tonnage in 2021	Number
RFFU - Tons - 2021	Refrigerated 40 foot containers tonnage in 2021	Number
Total Container Tons - 2021	Total container tonnage in 2021	Number
NTFU - # - 2021	Number of Normal Dry 20 foot containers in 2021	Number
NFFU - # - 2021	Number of Normal Dry 40 foot containers in 2021	Number
RTFU - # - 2021	Number of Refrigerated 20 foot containers in 2021	Number
RFFU - # - 2021	Number of Refrigerated 40 foot containers in 2021	Number
Total Container TEUs - 2021	Total number of container TEUs in 2021	Number
Fruit - Very High - 2021 TEUs	Number of TEUs containing fruit of Very High perishability for 2021	Number
Fruit - High - 2021 TEUs	Number of TEUs containing fruit of High perishability for 2021	Number
Fruit - Moderate - 2021 TEUs	Number of TEUs containing fruit of Moderate perishability for 2021	Number
Fruit - Low - 2021 TEUs	Number of TEUs containing fruit of Low perishability for 2021	Number
Agriculture - 2021 TEUs	Number of TEUs containing remaining Agriculture commodities for 2021	Number
Mining - 2021 TEUs	Number of TEUs containing Mining commodities for 2021	Number
Manufacturing - 2021 TEUs	Number of TEUs containing Manufacturing commodities for 2021	Number

Source: WC FDM™ PE

Table 7: New enhanced Western Cape Freight Demand Model data columns after integration – 2026

Column Name	Column Description	Data field type
Bulk Tons - 2026	Bulk tons (non containerised port volumes) in 2026	Number
NTFU - Tons - 2026	Normal Dry 20 foot containers tonnage in 2026	Number
NFFU - Tons - 2026	Normal Dry 40 foot containers tonnage in 2026	Number
RTFU - Tons - 2026	Refrigerated 20 foot containers tonnage in 2026	Number
RFFU - Tons - 2026	Refrigerated 40 foot containers tonnage in 2026	Number
Total Container Tons - 2026	Total container tonnage in 2026	Number
NTFU - # - 2026	Number of Normal Dry 20 foot containers in 2021	Number
NFFU - # - 2026	Number of Normal Dry 40 foot containers in 2021	Number
RTFU - # - 2026	Number of Refrigerated 20 foot containers in 2021	Number
RFFU - # - 2026	Number of Refrigerated 40 foot containers in 2021	Number
Total Container TEUs - 2026	Total number of container TEUs in 2021	Number
Fruit - Very High - 2026 TEUs	Number of TEUs containing fruit of Very High perishability for 2026	Number
Fruit - High - 2026 TEUs	Number of TEUs containing fruit of High perishability for 2026	Number
Fruit - Moderate - 2026 TEUs	Number of TEUs containing fruit of Moderate perishability for 2026	Number
Fruit - Low - 2026 TEUs	Number of TEUs containing fruit of Low perishability for 2026	Number

Agriculture - 2026 TEUs	Number of TEUs containing remaining Agriculture commodities for 2026	Number
Mining - 2026 TEUs	Number of TEUs containing Mining commodities for 2026	Number
Manufacturing - 2026 TEUs	Number of TEUs containing Manufacturing commodities for 2026	Number

Source: WC FDM™ PE

1.5 Disaggregation between containerised and non-containerised cargo for the Port of Cape Town

As mentioned earlier in the report, these new data columns could now be used to disaggregate PoCT-related cargo flows into either containerised or non-containerised (bulk) flows. The PoCT's disaggregated port flow volume contributions for 2020 are shown in Figure 3, which also indicates the direction of the flows.

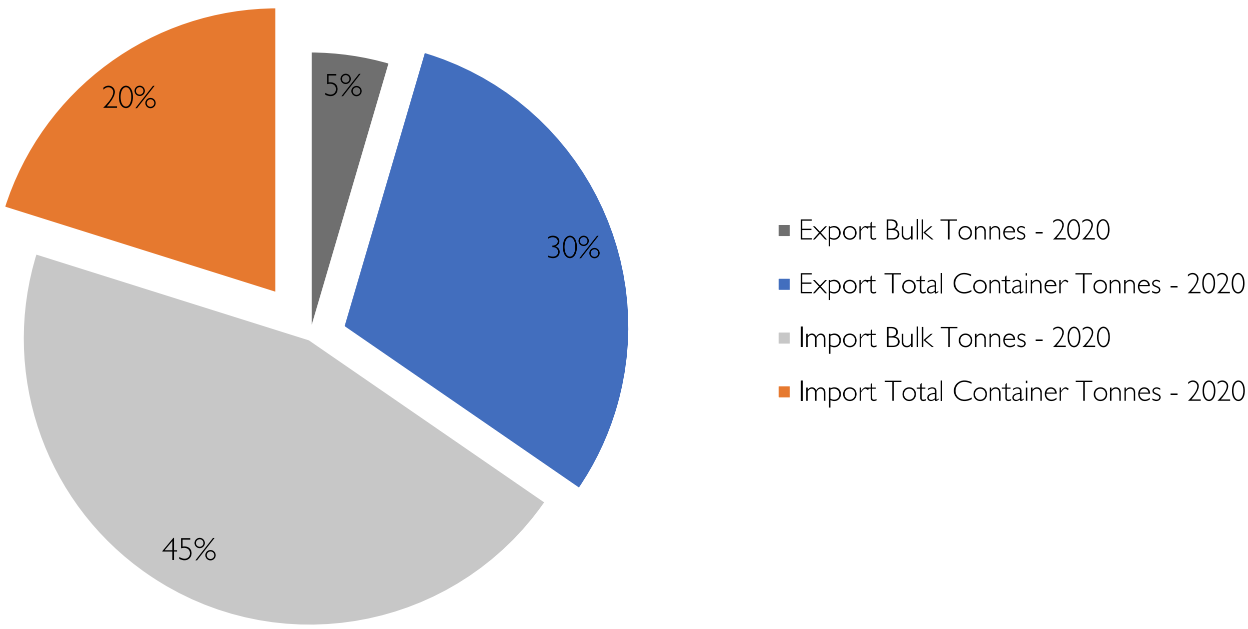

Figure 3: Disaggregated port volumes by direction, for non-containerised and containerised for 2020

Source: WC FDM™ PE

Non-containerised (bulk) imports of 4.3 million tonnes represent nearly half (45%) of the PoCT's flows, while containerised imports of 1.9 million tonnes account for a further 20%. This supports the PoCT's reputation as a predominantly import-orientated port (6.2 million tonnes, 65% of all flows). While the containerised exports of 2.9 million tonnes contribute a substantial 30% to the port's total flows, non-containerised (bulk) exports of 0.4 million tonnes represent a mere 5% thereof. The biggest portion of the non-containerised (bulk) imports is liquid petroleum fuels.

Export and import containerised cargo can be disaggregated further by container type, namely Dry – and Reefer 20 – and 40-foot containers. Figure 4 splits the total flow contributions of containerised exports and imports, namely 30% (2.9 million tonnes) and 20% (1.9 million tonnes) respectively, according to the volumes related to each container type.

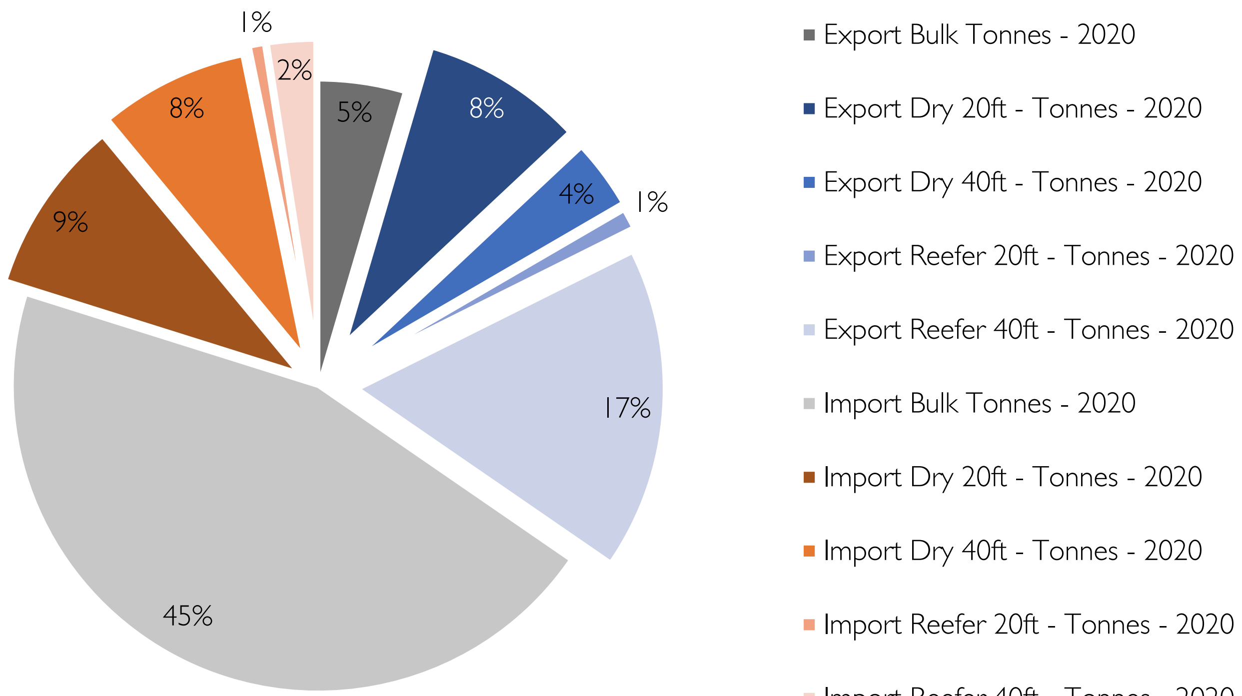

Figure 4: Disaggregated port volumes by direction, for non-containerised and per container type for 2020

Source: WC FDM™ PE

It is evident from the pie chart that Dry 20-foot containers account for most (45.4%) of containerised imports (9% of PoCT trade), followed closely by the 38.7% contribution of the larger 40-foot counterparts (8% of PoCT trade). Refrigerated containers are, therefore, used for relatively few containerised imports – more specifically 3.7% (1% of PoCT trade) and 12.2% (2% of PoCT trade) for smaller 20-foot and larger 40-foot reefer containers respectively. In contrast, Reefer 40-foot containers represent most (56.4%) of containerised exports (17% of PoCT trade) – which is double the next closest 28.2% contribution (8% of PoCT trade) of Dry 20-foot containers. Most of the significant 17% contribution can be ascribed to fruit commodity exports. The larger dry counterparts represent 12.0% (4% of PoCT trade), while the contribution of smaller refrigerated containers is nearly negligible in comparison at 3.4% (1% of PoCT trade). Table 8 on the next page shows the exact breakdown of these volumes in tonnes.

Table 8: The Port of Cape Town's containerised flow volumes by container type for 2020

Container type	Export tonnes (% of containerised exports)	Import tonnes (% of containerised imports)	Total tonnes (% of container trade)
Dry 20ft	805 088 (28.2%)	869 665 (45.4%)	1 674 753 (35.1%)
Dry 40ft	342 727 (12.0%)	740 731 (38.7%)	1 083 457 (22.7%)
Reefer 20ft	96 594 (3.4%)	70 411 (3.7%)	167 006 (3.5%)
Reefer 40ft	1 612 218 (56.4%)	234 957 (12.2%)	1 847 175 (38.7%)
Total	**2 856 627 (59.9%)**	**1 915 764 (40.1%)**	**4 772 391 (100%)**

Source: WC FDM™ PE

1.6 The Port of Cape Town's containerised commodities

The container exports and imports tonnes per commodity are shown in Figures 5 and 6, respectively. The full list of the commodities is shown for exports and imports are attached as appendixes to this report.

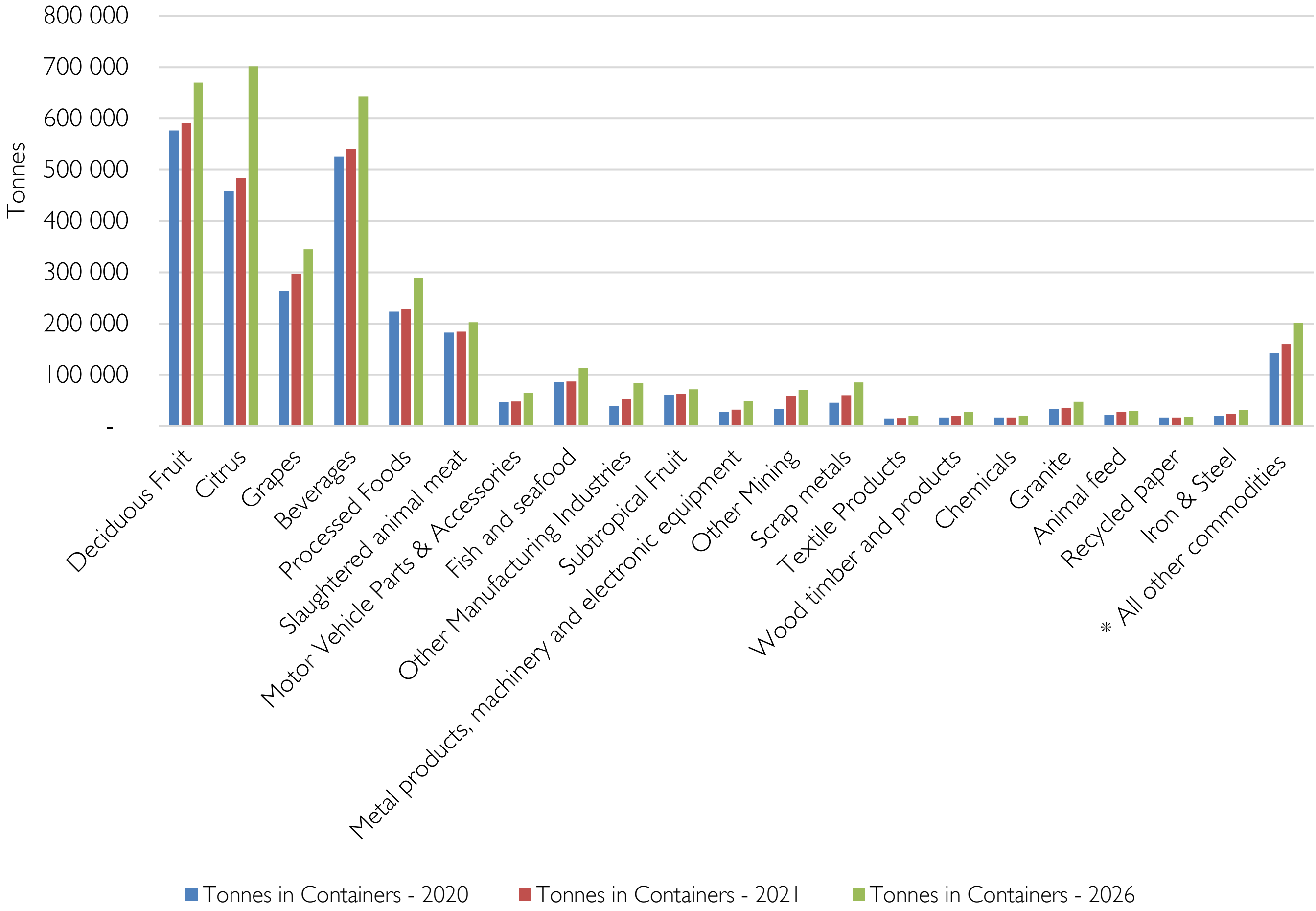

Figure 5: Tonnes per commodity for export containers

Source: WC FDM™ PE

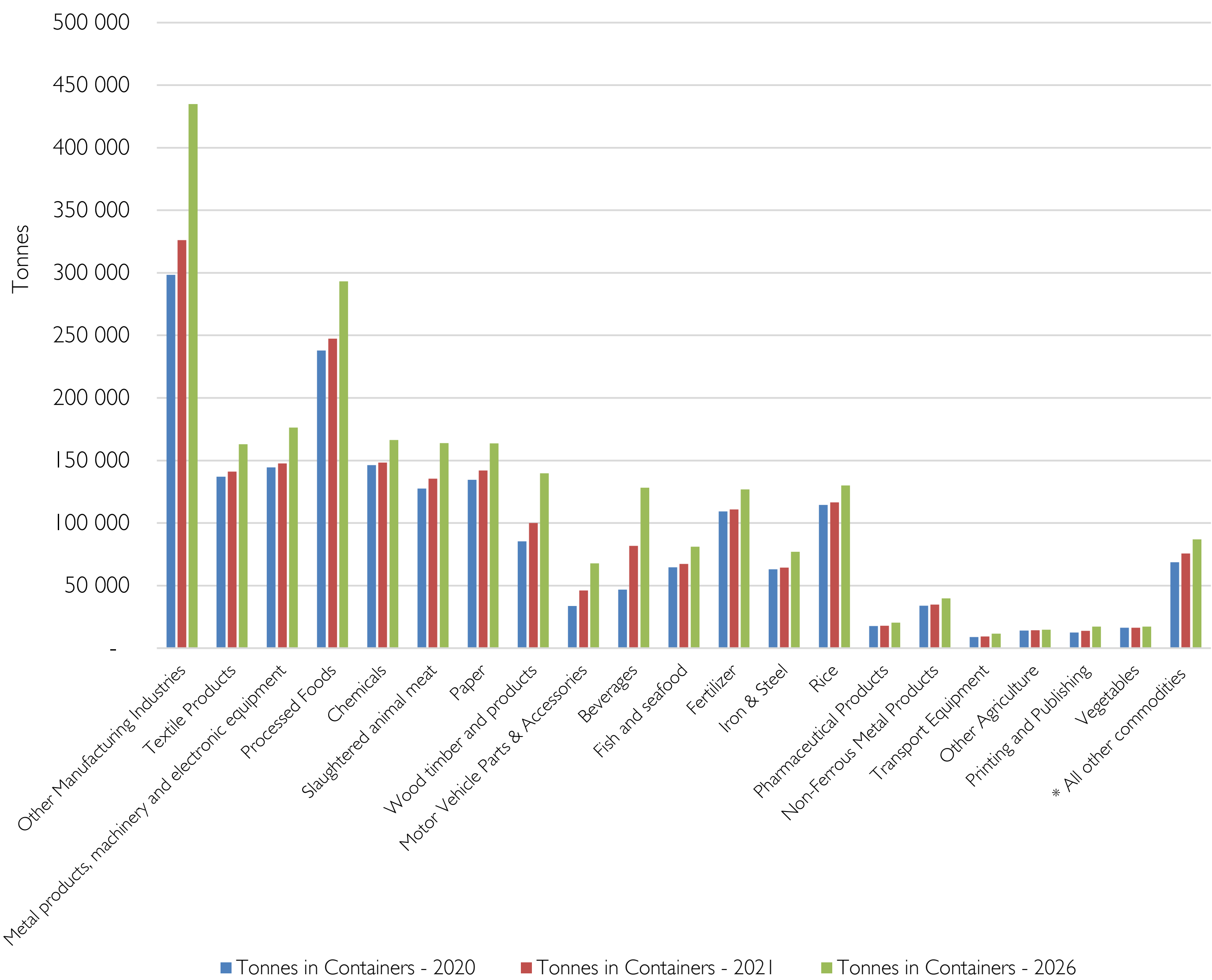

Figure 6: Tonnes per commodity for import containers

Source: WC FDM™ PE

1.7 Port of Cape Town containers disaggregated per month

The data also allows the frequency of the PoCT's containerised cargo flows to be split by month. Figure 7 on the next page shows the Port's monthly export TEUs by container type for 2020.

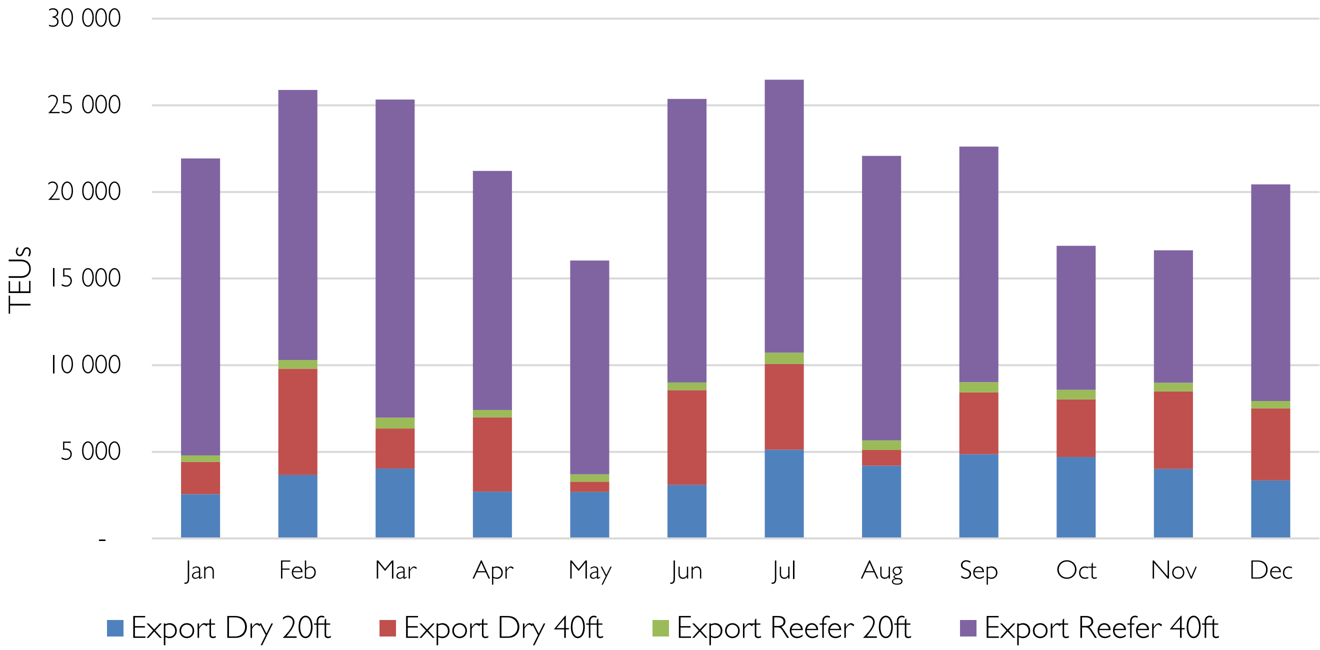

Figure 7: Export TEUs per month and per type for 2020

Source: WC FDM™ PE

July is the busiest month for export containers (26 474 TEUs), while May is the least busy (16 035 TEUs). Figure 8 provides the same disaggregation, but for the PoCT's containerised cargo imports.

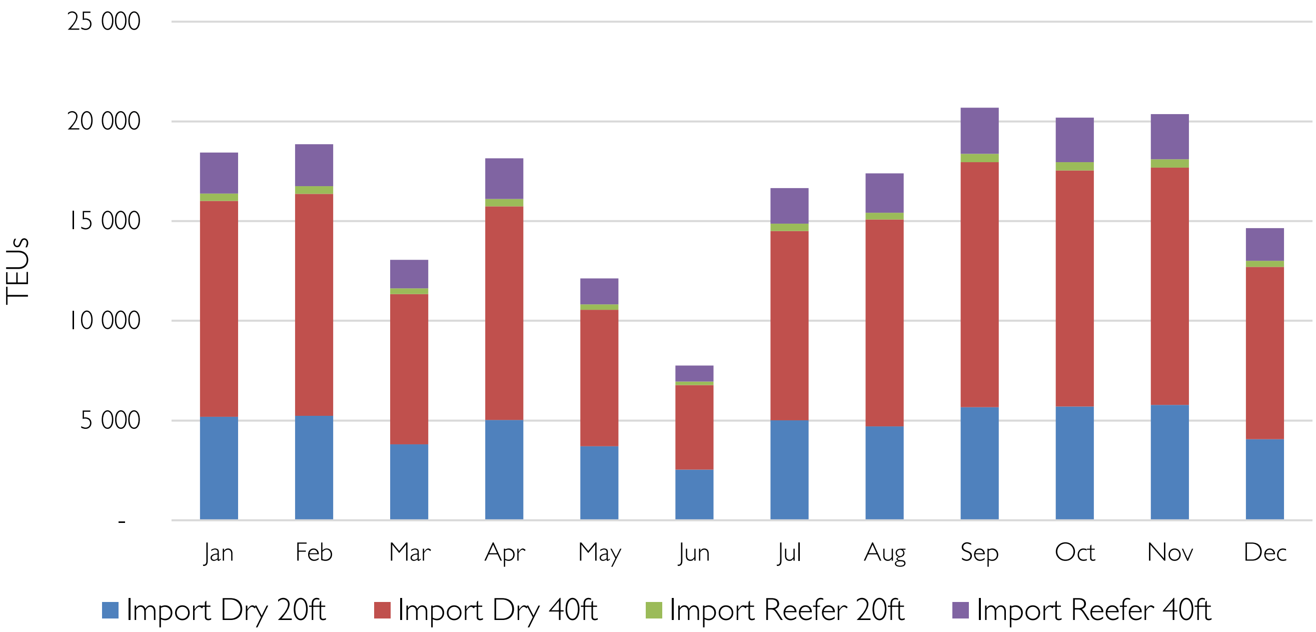

Figure 8: Import TEUs per month and per type for 2020 (WC FDM™ PE)

Source: WC FDM™ PE

The graph shows September is the busiest month for import containers (20 693 TEUs), with June being a very quiet month for container imports in comparison (7 765 TEUs). It is important to note the difference between the graphs in Figures 7 and 8, which shows that the Port exports more containers than it imports in 2020.

1.7.1 Port of Cape Town container projection for 2021

Since the enhanced WC FDM™ includes data beyond the base year, it is also possible to provide a higher-frequency projection of these disaggregated monthly cargo flows for 2021. Figure 9 shows the Port's monthly export TEUs by container type for 2021. The graph shows February is the busiest month for export containers (27 419 TEUs) in 2021, although just narrowly more than the months of March, June, and July. October is the least busy month (17 703 TEUs).

Figure 10 on the next page shows this information for the PoCT's import containers. As in 2020, September is the busiest month for import containers (22 253 TEUs) in 2021 – with October and November also being similarly busy months. Like in 2020, the least busy month for container imports in 2021 is June with 8 347 TEUs.

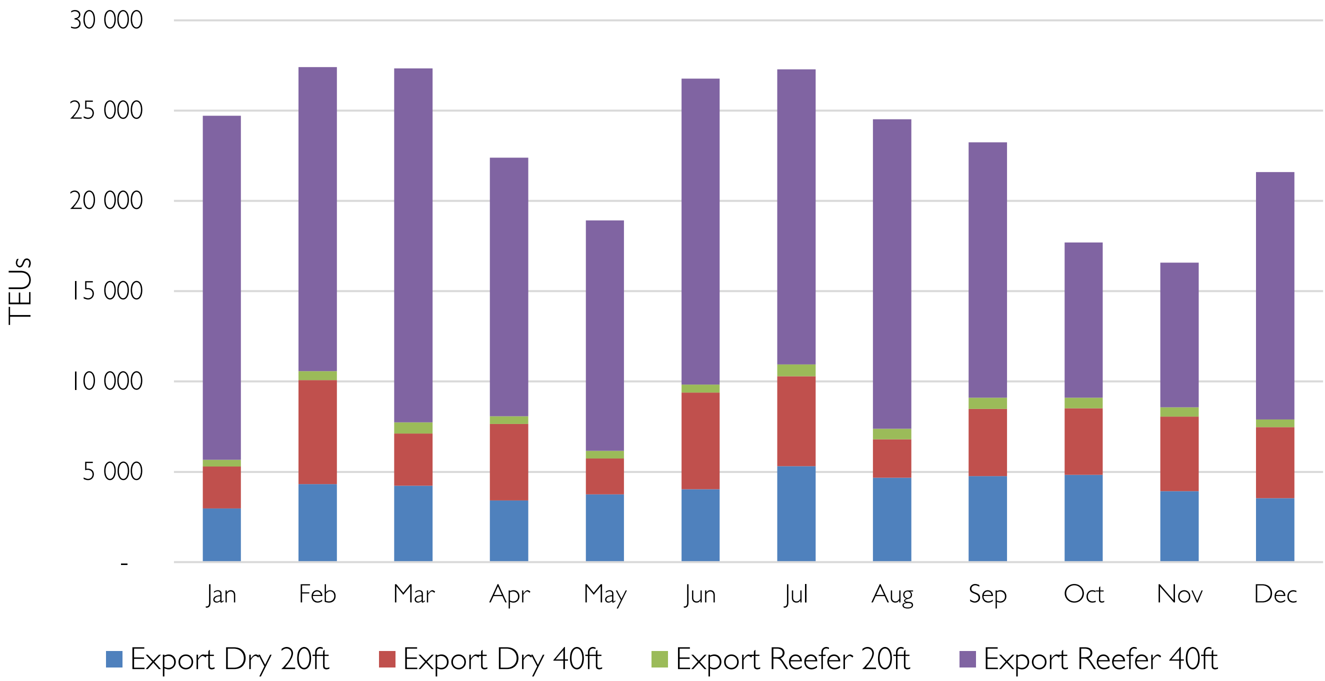

Figure 9: Export TEUs per month and per type for 2021

Source: WC FDM™ PE

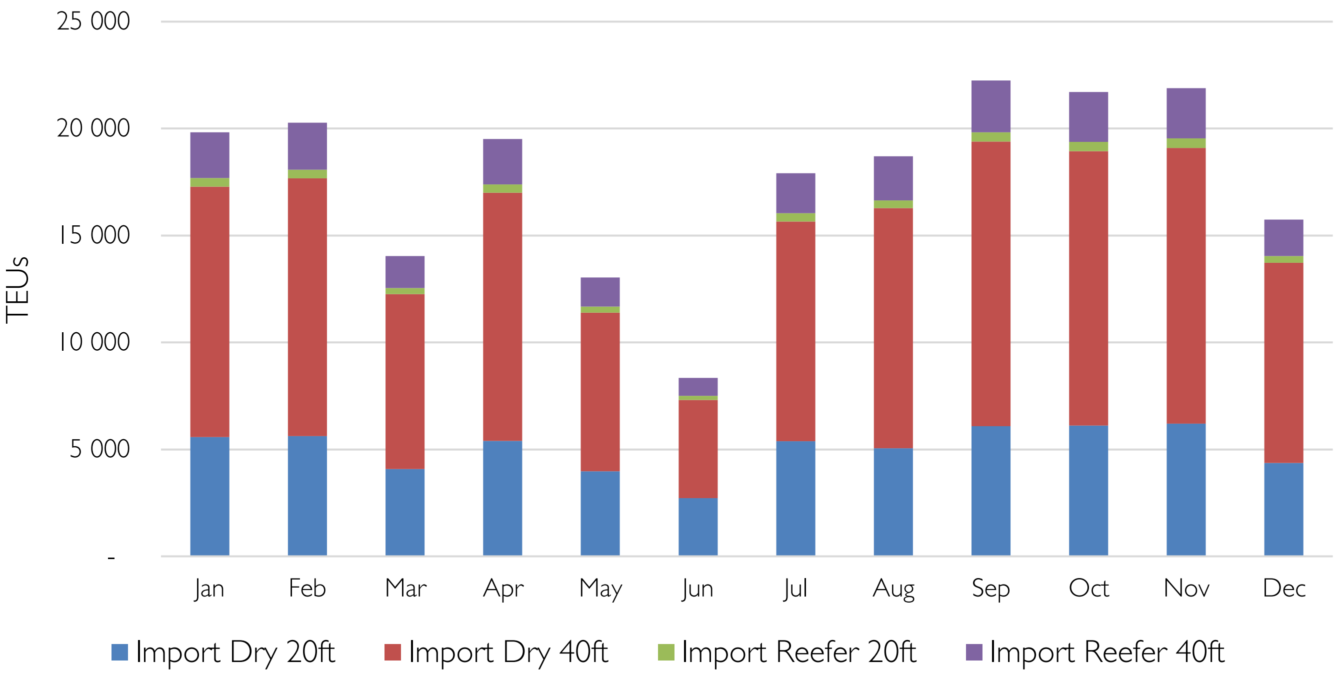

Figure 10: Import TEUs per month and per type for 2021

Source: WC FDM™ PE

As in 2020, the PoCT's containerised cargo exports are considerably more than the imports in 2021 by comparing the flow volumes in Figures 9 and 10.

1.7.2 Port of Cape Town container projection for 2026

For the same reasons discussed above, it is possible to provide disaggregated monthly cargo flows for the 2026 forecast year. Figure 11 shows the Port's monthly export TEUs by container type for 2026.

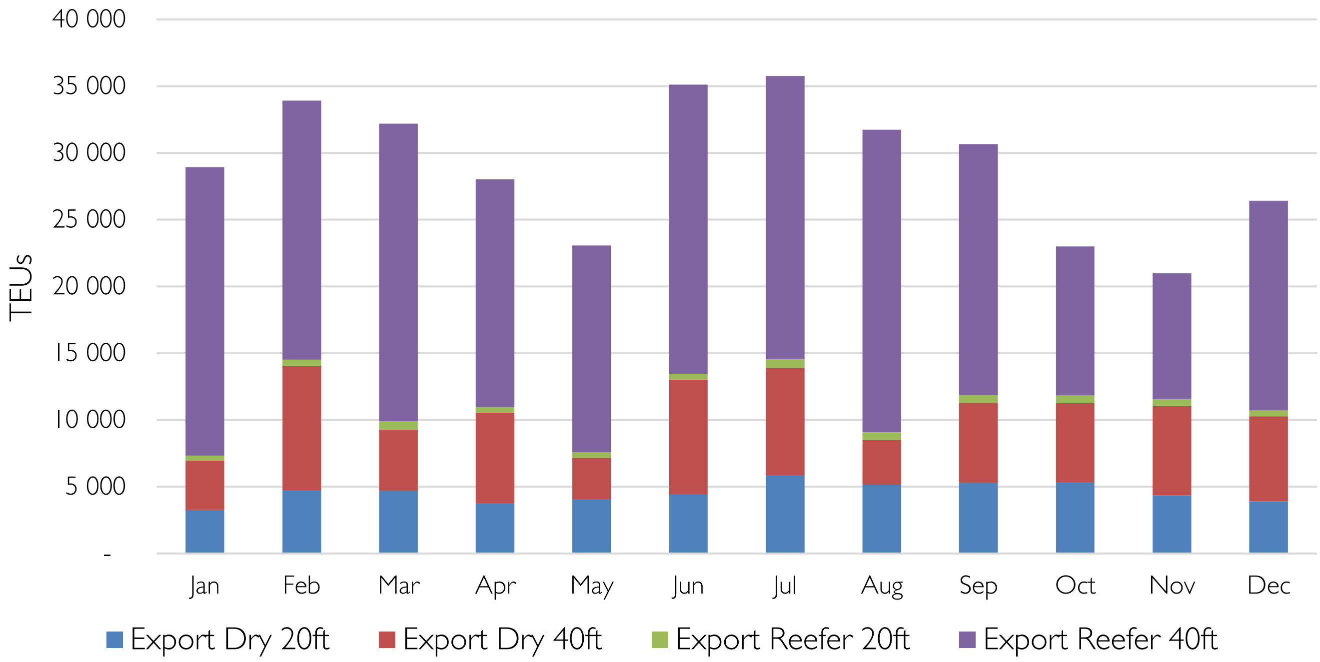

Figure 11: Export TEUs per month and per type for 2026

Source: WC FDM™ PE

As with the 2020 base year, July is the busiest month for export containers (35 351 TEUs) in 2026, which represents narrowly less movement than June's 35 116 export TEUs. November is the least busy month for containerised exports with 20 994 TEUs.

Figure 12 on the next page shows this information for the PoCT's import containers. As in both 2020 and 2021, September is the busiest month for import containers (28 127 TEUs) in 2026. Furthermore, as in 2021, October and November are expected to be nearly as busy as September. The least busy month for container imports in 2026 is expected to be June (10 423 TEUs), echoing 2020 and 2021's data.

Once again, the PoCT's containerised cargo exports are considerably more than the imports in 2026 when the flow volumes in Figures 11 and 12 are compared. The national FDM™ container model's output for the PoCT was used for the WC FDM™, which sees the growth in container volumes between 2020 and 2026 having a compound annual growth rate of 5.1%.

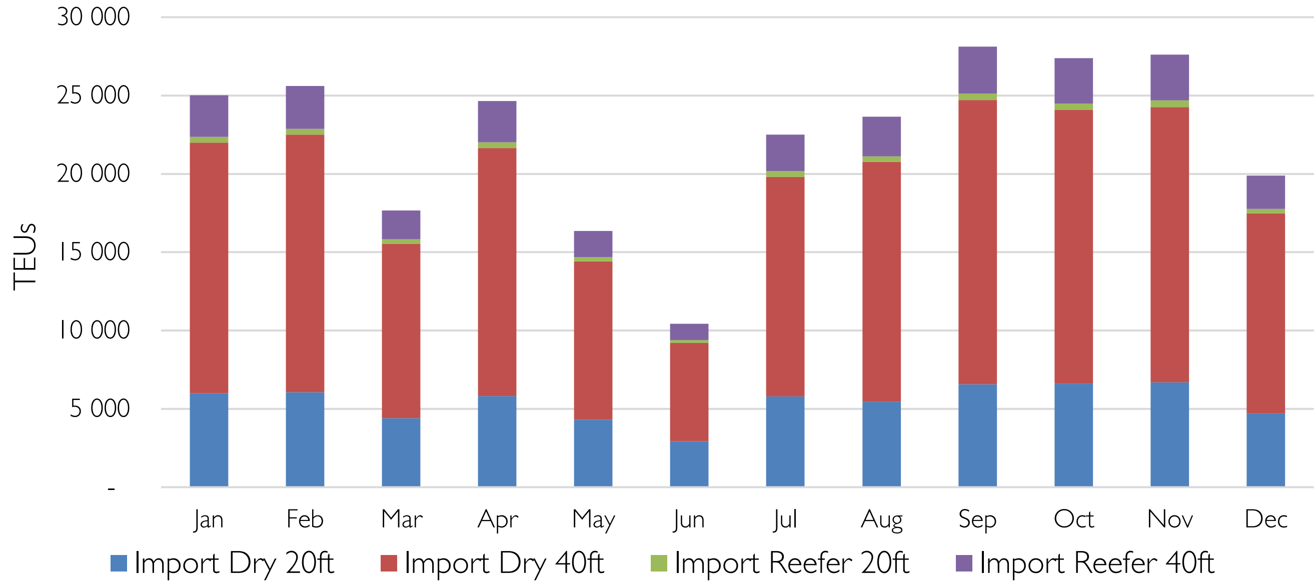

Figure 12: Import TEUs per month and per type for 2026

Source: WC FDM™ PE

1.7.3 Port of Cape Town fruit flow disaggregation

The enhanced WC FDM™ also enables the PoCT's containerised fruit flows to be isolated from all trade and disaggregated further into fruit commodity groups and individual fruit commodities. The Port's monthly fruit flow volumes for 2020, measured by the number of TEUs, are shown in Figure 13.

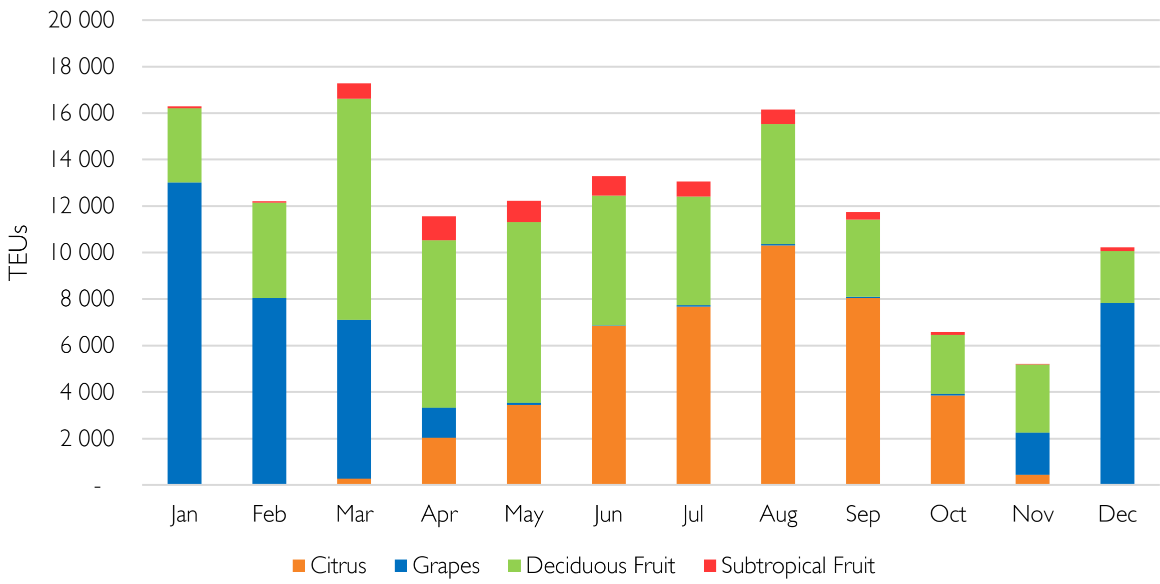

Figure 13: Fruit volumes split per month for 2020

Source: WC FDM™ PE

This graph provides a great overview of these fruit commodity groups' seasonality. Grapes are predominantly handled at the Port during the warmer Summer months (December to March), while the PoCT's citrus flows mostly occur during the Winter and late Spring – reaching a peak during August. Deciduous fruit is handled throughout the year, especially during late Summer and Autumn (March to May). The Port has relatively little subtropical fruit flows, which occur around the middle of the year. This graph, therefore, allows its users to determine which fruit commodity group will be most impacted by a disruption in a certain month or timeframe.

Earlier in the report, container volumes by fruit commodity group were mapped using the data received from Agrihub (see Figure 2). With the enhanced model, it is now possible to show more detailed freight flow maps of the Agrihub fruit commodity groups. Figure 14 maps the major containerised fruit cargo locations as received from Agrihub, and flows modelled on assumed routes in the PoCT's logistics chain for 2021.

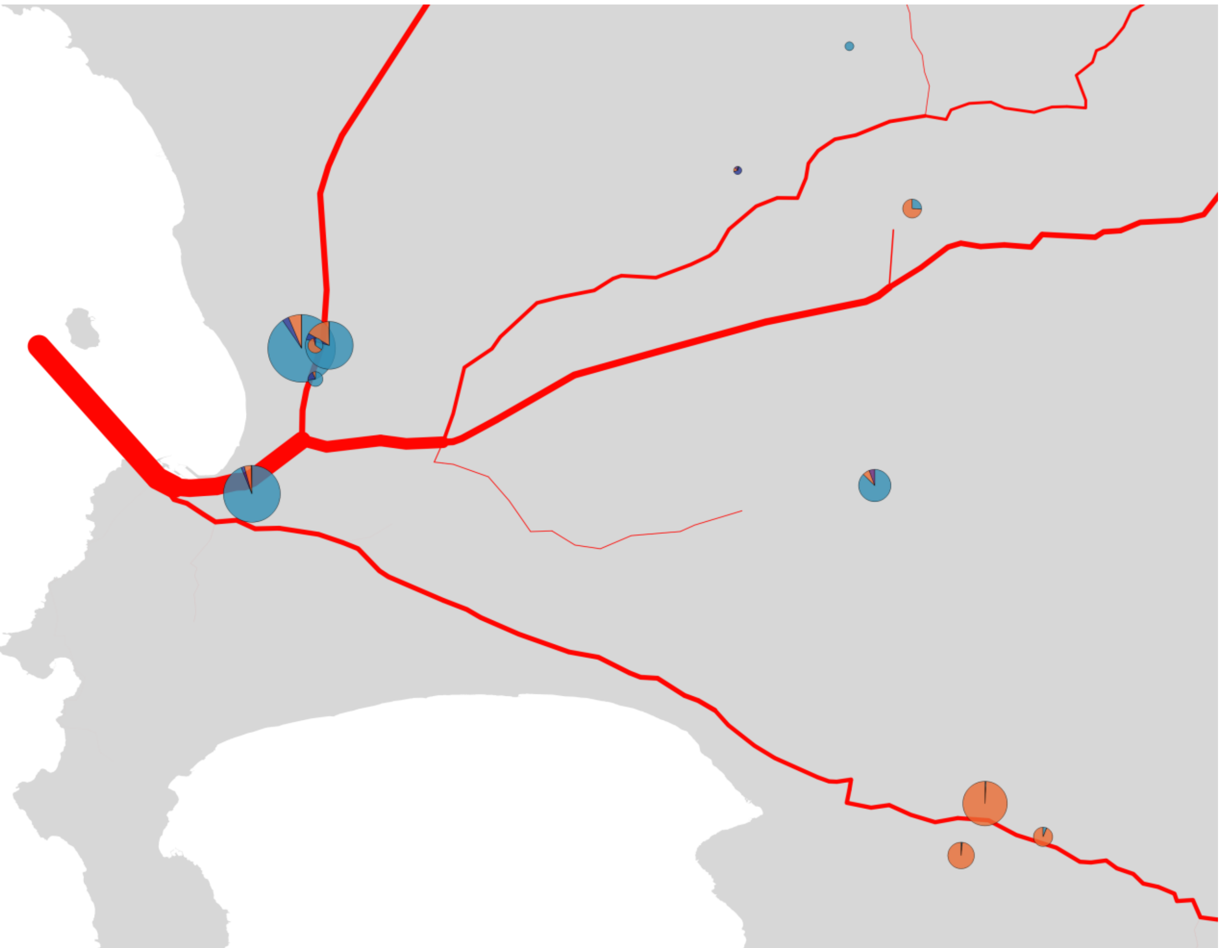

Figure 14: Fruit commodity group flows linked to the Port of Cape Town

Source: WC FDM™ PE (2021)

The flows are indicated by the red lines on the map, with the thickness of the lines representing the size of the flows. The pie chart colours on the map show each major location's flows according to the contribution of each fruit commodity group – namely citrus (light blue), deciduous fruit, and grapes (dark blue). Deciduous fruit consists of the pome fruit (orange) and stone fruit (purple) commodity groups as categorised by Agrihub. Since no Agrihub data was received for the subtropical fruit commodity group, it is important to note that subtropical fruit flows are excluded from these maps. Subtropical fruit data is based on inland origin production locations from aerial satellite imagery (as used for most agriculture production), and export volumes from PPECB data. The subtropical fruit products exported at Cape Town is predominantly avocados, as well as some litchis and mangos.

These flows can also be mapped separately for each fruit commodity group. Figures 15 to 17 map the major containerised fruit cargo locations as received from Agrihub and flows modelled on assumed routes in 2021 for the citrus, deciduous fruit, and grapes fruit commodity groups, respectively.

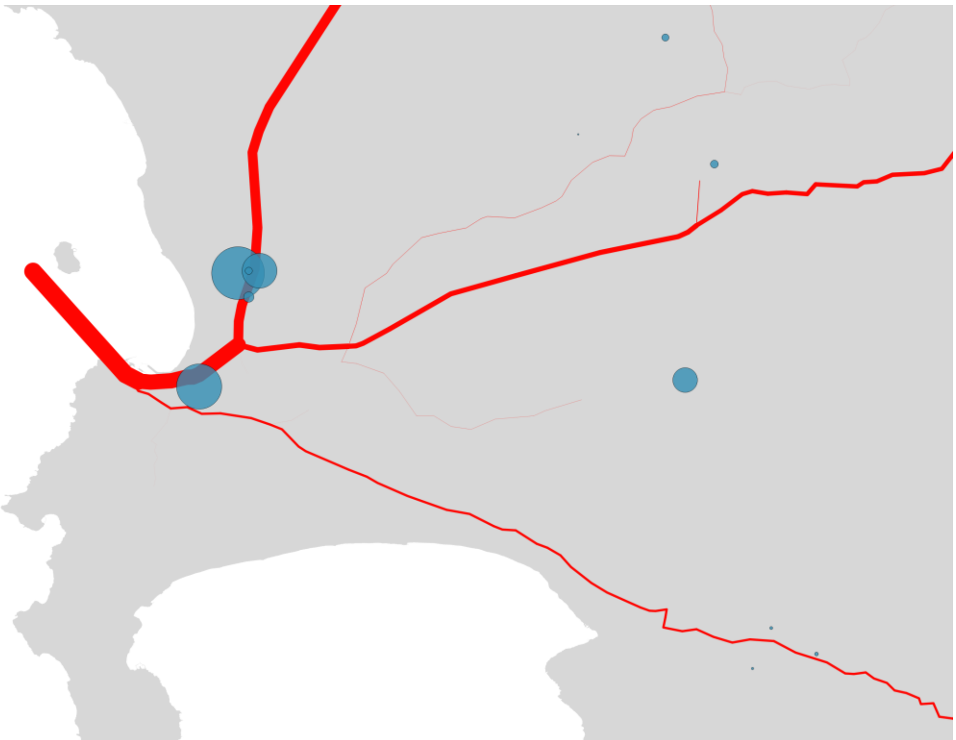

Figure 15: Citrus fruit commodity group flows linked to the Port of Cape Town

Source: WC FDM™ PE (2021)

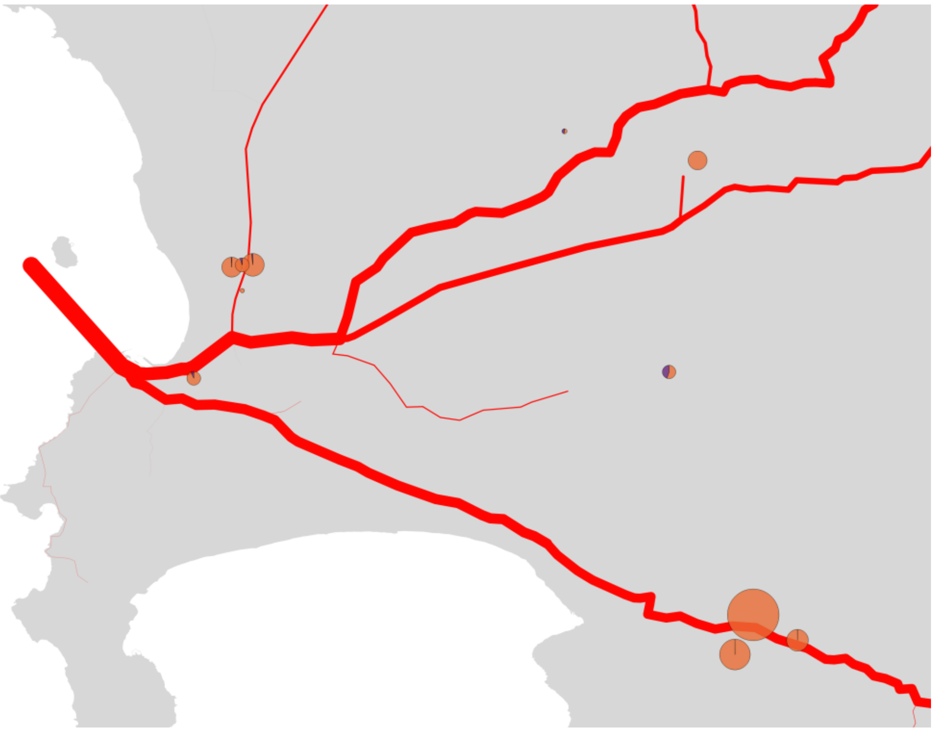

Figure 16: Deciduous fruit commodity group flows linked to the Port of Cape Town

Source: WC FDM™ PE (2021)

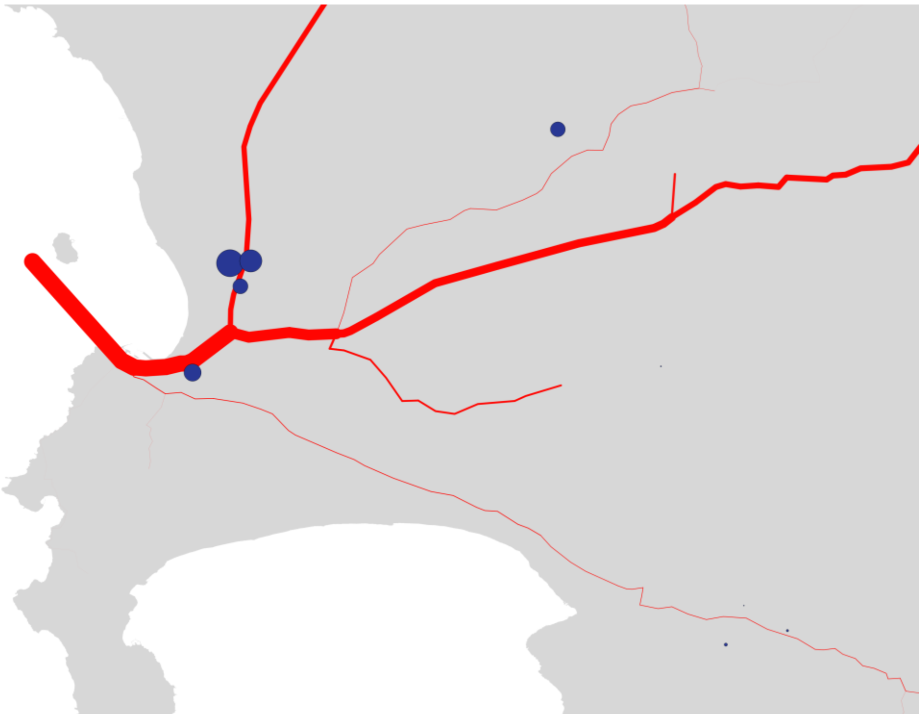

Figure 17: Grapes fruit commodity group flows linked to the Port of Cape Town

Source: WC FDM™ PE (2021)

1.8 The impact of weather delays on monthly containerised fruit cargo flows

Historical weather data was obtained for the years 2011-2020 for the PoCT to superimpose a profile of past weather delays onto the flows that have been discussed until now. This allows the impact of weather delays on the Port's containerised cargo flows to be visualised, which can help estimate the risks related to the Cape Town Container Terminal (CTCT) being closed during seasonal peaks.

Figure 18 shows the operation time lost per month during every year within that period. It is important to note that this operation time lost refers to the number of hours per month that the CTCT was unable to operate due to various weather disruptions. The historical weather data shows significant delays especially around November to March, with the months of April to August affected the least by weather delays.

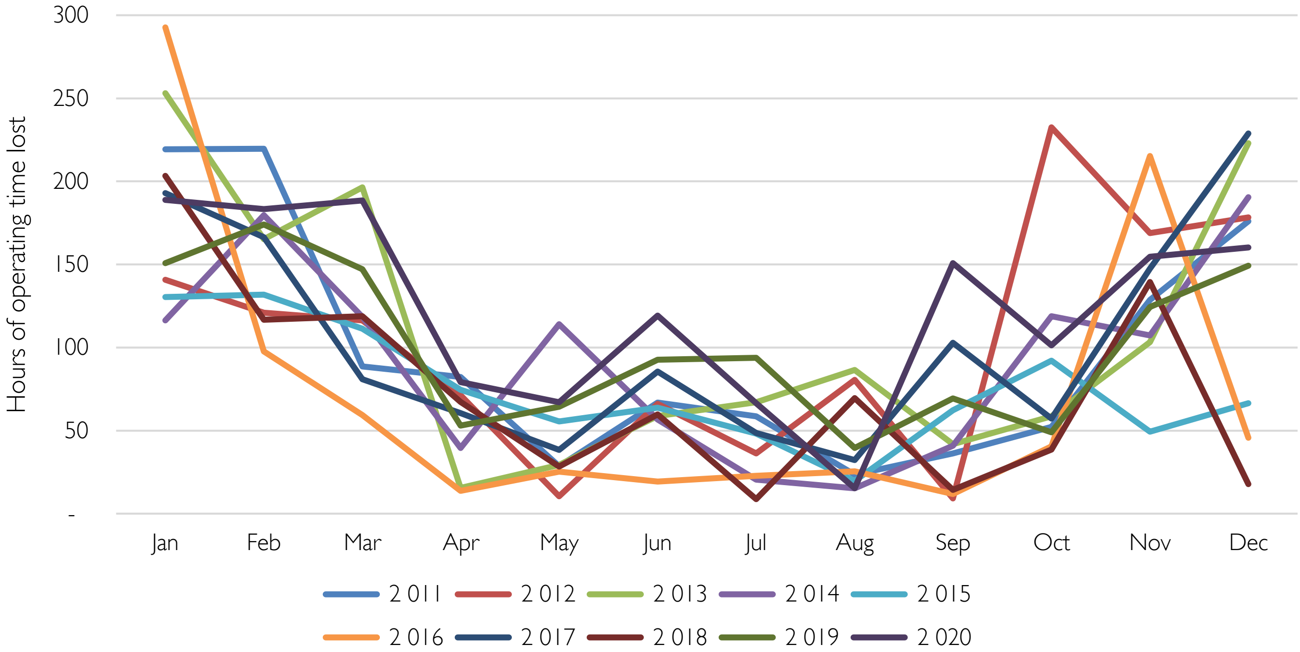

Figure 18: Historical hours of operation time lost per month due to weather delays

Source: WC FDM™ PE

The months of January and December are the most disrupted, i.e., the months that have seen the most operation time lost historically, based on data from 2011 to 2020. For the most part, this is essentially due to these months being the windiest of the year for the CTCT area. Given wind has a significant influence on the terminal's ability to operate, the reason behind the u-shaped curve in Figure 18 is clear. The figure also shows that the annual weather delay profile remained consistent.

Using both 2021 and this historical weather delay data, the dotted line graphs shown in Figure 19 on the next page show the average (black), minimum (green), and maximum (red) number of hours lost per month. This allows greater comparison of the monthly weather profile. The figure also includes an accompanying pie chart, which provides a breakdown of the weather delay causes. As mentioned before, the wind is the biggest cause of weather delays at the CTCT – with it labelled as the reason behind approximately 89% of all the weather delays at the terminal between 2011 and 2021. In comparison, fog, and the ranging of vessels both contributed an equal 6%, to the CTCT's historic weather delays. Due to its negligible contribution (1%), the 'Other' category shown in the pie chart groups together the minor causes of historic weather delays at the terminal – namely 'Meeting', 'Navis down' and 'Other'. For more detail on these causes of weather delays, Table 9 on the next page provides an overview of the number of times the causes were cited as causes of weather delays each year.

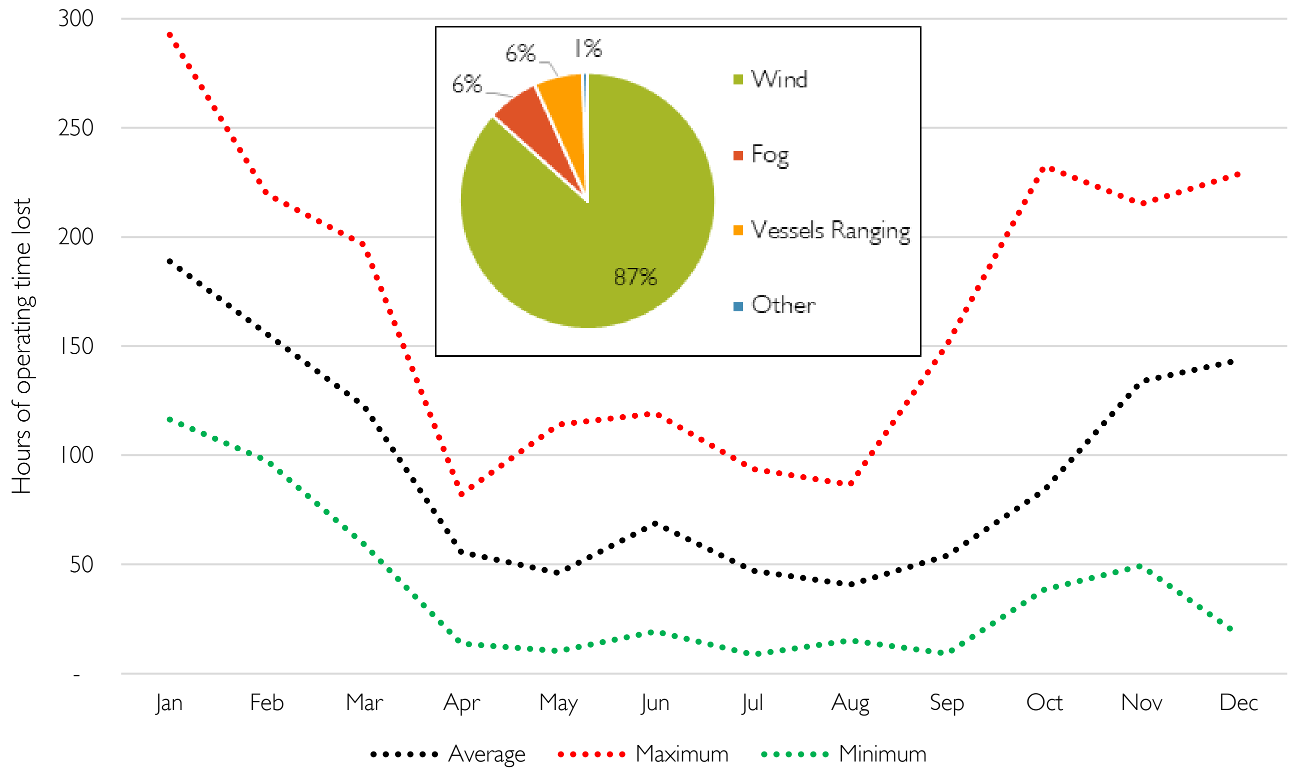

Figure 19: Average, minimum, and maximum number of hours of operation time that was lost per month due to weather delays from historical data, with the main causes of these delays shown in the pie chart

Source: WC FDM™ PE

Table 9: Annual overview of weather delay causes from 2011 to 2021

Year	The annual number of hours delayed					
	Fog	Meeting	Navis down	Other	Vessels Ranging	Wind
2011	70	-	-	5	30	1 065
2012	67	2	-	17	-	1 145
2013	58	-	-	8	94	1 138
2014	36	-	-	1	152	929
2015	87	-	-	9	53	757
2016	57	6	-	-	47	759
2017	50	6	-	1	1	1 006
2018	54	13	1	3	128	683
2019	121	-	-	1	77	1 009
2020	139	-	-	-	144	1 192
2021	32	-	-	-	-	494

Source: Transnet Port Terminals CPT

This information can be superimposed on the disaggregated fruit flows shown in Figure 13 to portray the vulnerability of fruit types during specific months relative to the weather capacity challenges experienced by the CTCT. Figure 20 on the next page provides this view, with the average hours lost line from Figure 19 used to portray the impact of weather delays on monthly containerised fruit flows. The line is included in most of the report's remaining graphs since it plays an important part in addressing the required outcomes of the project. To complement and simplify the further analysis, the exact values represented by the average hours lost line are shown in Table 10. Further information from TPT was not possible to obtain. Since information such as the operation capacity per hour per day is unknown, it is unfortunately impossible to link hours lost to capacity lost.

Table 10: Average hours lost

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number of hours	189	156	123	56	46	69	47	41	54	84	134	144

Source: WC FDM™ PE

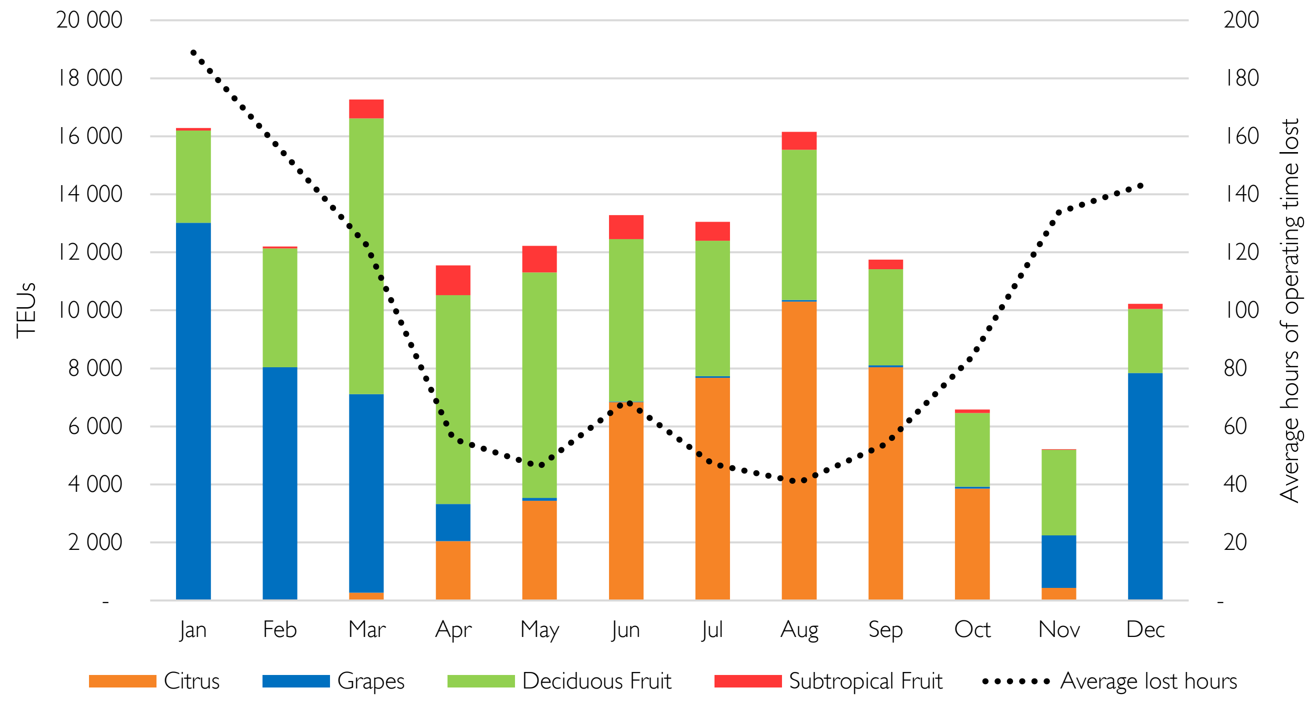

Figure 20: TEUs per fruit type for 2020 compared to operation lost time

Source: WC FDM™ PE

Looking further than fruit only, the impact of weather capacity challenges on all the CTCT's trade can be assessed. Figure 21 on the next page shows the total TEU volumes handled by the terminal per month, including the average hours lost due to weather delays, in 2020. The flows are disaggregated by sector, i.e., by their relation to the agriculture, mining, or manufacturing sectors of the economy. Since fruit flows are key to the outcomes of this project, agriculture flows are split into 'Fruit and 'Other Agriculture'. Empty and transshipment containers are also isolated as a flow category due to their many pivotal differences from full containers. Together, this provides a more holistic idea of how the overall terminal and/or its key separate containerised flows are impacted by weather delays throughout the year.

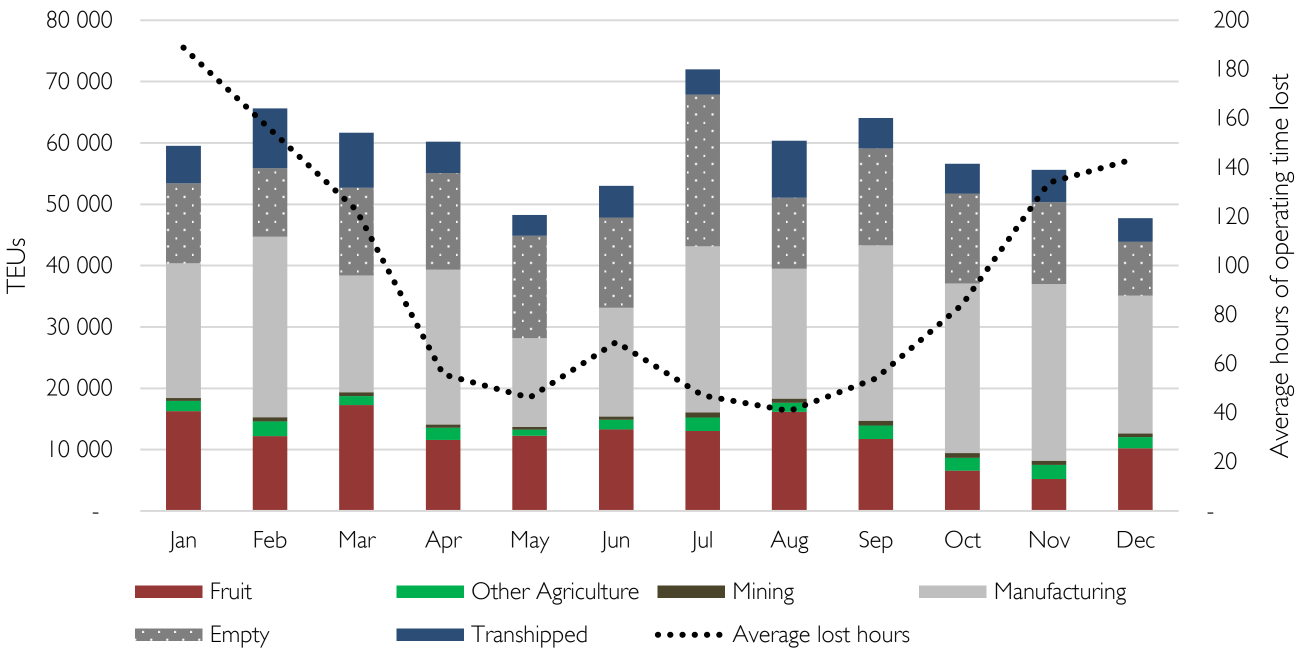

Figure 21: Total Cape Town Container Terminal TEUs for 2020

Source: WC FDM™ PE

When all the CTCT's containerised trade is considered, July is the busiest month (72 018 TEUs) in 2020, while it also has the highest number of empty and transhipment container TEUs – namely 28 880. Fortunately, it is also a month with relatively low operation time being lost due to weather delays. On the other hand, December is the least busy month with 47 754 TEUs being handled at the terminal during 2020 – narrowly less than the 48 259 TEUs of May. December also had the least number of empty and transhipment container TEUs (12 669). However, December is shown to be affected heavily by operation downtimes due to weather – especially wind. Relative to the number of full containers, May has a high number of empty and transshipment container TEUs (41.6% of its total TEUs), while December's empty and transshipment container TEUs represent only 26.5% of the month's total TEUs.

Therefore, this information is due for further consideration and interpretation. Although the weather delays during the month of July are not that significant, the volumes handled during the month are very high. Large volumes of additional empty refrigerated containers arrive, presumably for the utilization of citrus exports. This might imply that a weather delay in July can be seen as more problematic than a weather delay in December, even though weather delays happen far more frequently in December than in July. Further investigation and research must be undertaken to determine what effect a possible delay might cause, and which volumes per month are more acceptable to delay – especially after perishability is considered.

1.9 The impact of the perishability of containerised fruit cargo on monthly flows

1.9.1 Classification of containerised fruit cargo perishability

Kader (2002) describes the relative perishability and potential storage life of various fresh fruit types. This author's work is seen as a benchmark for the typical shelf life of different fruit types given optimal storage conditions. Biological factors that impact fruit deterioration are respiration, ethylene production, compositional changes, growth and development, transpiration or water loss, physical damage, and physiological and pathological breakdown. All of these are related to the impacts of time duration, the fruit's immediate environment and impacts from handling the fruit or the packaging/container it is in. The environmental factors that influence deterioration are temperature, relative humidity, atmospheric composition, ethylene, and light amongst others.

Postharvest technologies and procedures exist to minimize the occurrence of deterioration and include temperature management procedures, control of relative humidity and various other environmental practices such as specific packaging, air movement and exchange, removal of ethylene, and controlled or modified atmosphere and sanitation. Despite all these possible interventions, time duration to market remains the number one enemy of all the procedures and protocols to maintain the market value of produce from origin to shelf.

From Kader's (2002) research, an index of relative perishability (very low, low, moderate, high, and very high) is proposed that indicates the relationship between various fruit types and typical storage life. Table 11 on the next page is an interpretation from Kader (2002) showing details of this relationship to Agrihub commodity groups. This expected storage life is based on ideal conditions, according to the specific fruit type's temperature and humidity specifications. It should be noted that some of these fruit types' storage life can be extended beyond these proposed values from Kader (2002) with very specific packing and controlled climate interventions, amongst others. For this report and data analysis, these values were used for the classification of relative perishability.

Table 11: Relative perishability of fruit included in the Agrihub dataset

Agrihub Commodity	Commodity Name	Relative Perishability	Storage Life
GF	Grapefruit	Moderate	4-8 weeks
LE	Lemons	Low	8-16 weeks
OR	Oranges	Moderate	4-8 weeks
SC	Soft Citrus	Moderate	4-8 weeks
GR	Table Grapes	High	2-4 weeks
AP	Apples	Moderate	4-8 weeks
PR	Pears	Moderate	4-8 weeks
AC	Apricots	Very High	< 2 weeks
CH	Cherries	Very High	< 2 weeks
NE	Nectarines	High	2-4 weeks
PE	Peaches	High	2-4 weeks
PL	Plums	High	2-4 weeks

Source: Kader (2002)

Note: The Agrihub dataset did not include details on any subtropical fruit types. These fruit types (avocadoes, mangoes, bananas, guavas, etc.) were all classified as "High" relative perishability (Kader, 2002)

These perishability classifications were built into the Agrihub dataset per detailed sub-commodity and translated into related WC FDM™ commodity groups. This enabled the team to interpret the perishability of all fruit commodities passing through the CTCT, as indicated in Figure 22.

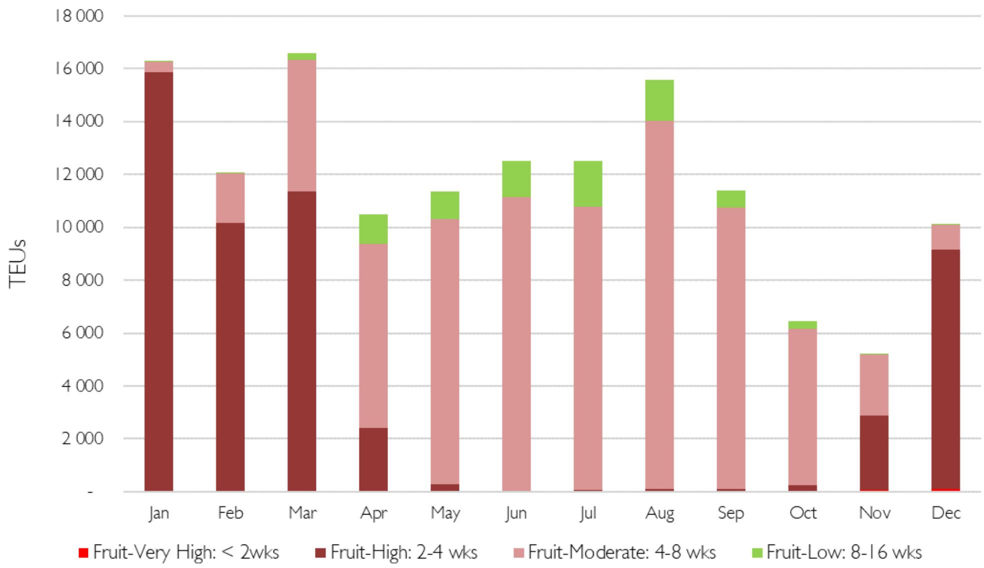

Figure 22: Fruit containers disaggregated into perishability categories for 2020 according to underlying Agrihub commodity groups and monthly volumes

Source: WC FDM™ PE

It will be noted that a negligible volume of "*Very high*" perishability fruit is using the CTCT due to the long duration of maritime shipping to destination countries. Exporters rather use air transport as the preferred mode due to the faster transit and relatively short, expected storage life. The most "vulnerable" fruit types using the CTCT are the "*High*" relative perishability fruits such as table grapes, nectarines, peaches, and plums. These are all concentrated around the summer months when ambient temperatures are at their highest and the most port wind disruptions and delays are experienced. A large percentage of all citrus fruit as well as pome fruit (apples and pears) falls in the "*Moderate*" category and are harvested and shipped within the colder, ambient winter months also requiring less energy for refrigeration. Small volumes of lemons fall in the "*low*" perishability category and are shipped mostly in the autumn and winter months.

Figure 23 provides a more holistic overview of the impact perishability has on the CTCT's operations in 2020 by adding information on the TEUs related to other agriculture, mining, and manufacturing – along with the average hours lost line discussed earlier in the report. This allows for more considered trade-offs related to prioritizing fruit, other agriculture, mining, or manufacturing to be made, according to the terminal's operational capacity (which is largely influenced by weather delays) and cargo's perishability classification.

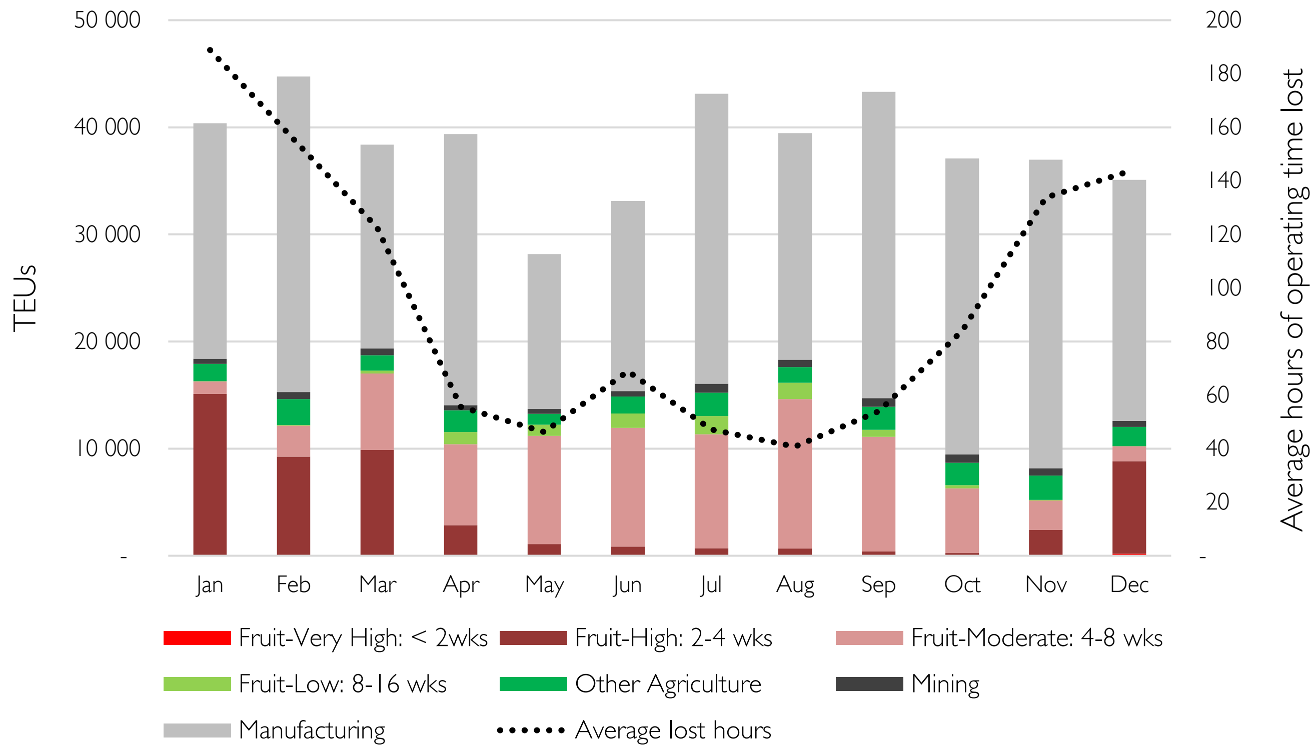

Figure 23: Monthly breakdown of the perishability of fruit and other sectors with average hours of operating time lost for 2020

Source: WC FDM™ PE

Kader identified various environmental factors that influence deterioration. One of these factors is temperature, which can influence the relative perishability and potential storage life of various fresh fruit types. The shelf life of the fruit can therefore be extended through proper temperature management. Temperature breaks reduce the quality, shelf life, marketability, and revenue-generating potential of the fruit. Research by Goedhals-Gerber, Stander and Van Dyk (2017) indicated that 81% of the temperature breaks in reefer containers carrying summer fruit originate within the CTCT. This was further supported by research on pome fruit in the export cold chain (South African leg), which identified three areas of temperature breaks, namely (1) during the packhouse and cold-store stages, (2) when the containers entered the port of export by truck and delays occurred before the containers were plugged into a power source inside the reefer stacks and (3) when the container was unplugged from the stacks and loaded onto the vessel (just before the actual time of departure [ATD]). Temperature breaks are prevalent in export cold chains, such as at gate-in, ATD, the actual time of arrival (ATA) of the vessel in the port of import and inside a container at its doors (Goedhals-Gerber, Haasbroek, Freiboth & Van Dyk, 2015; Goedhals-Gerber *et al.*, 2017). Other research also highlights the need for more collaboration between the producers, fruit exporters, logistics service providers, the CTCT, and shipping lines (Goedhals-Gerber, Fedeli & Van Dyk, 2021).

1.9.2 The impact of perishability on the containerised fruit cargo projection for 2021

As with the previous graph for 2020, Figure 24 on the next page shows the impact of perishability on the CTCT's containerised fruit cargo projection for 2021, along with the TEU flows related to the terminal's other trade and the impact of weather delays on the terminal's operation time.

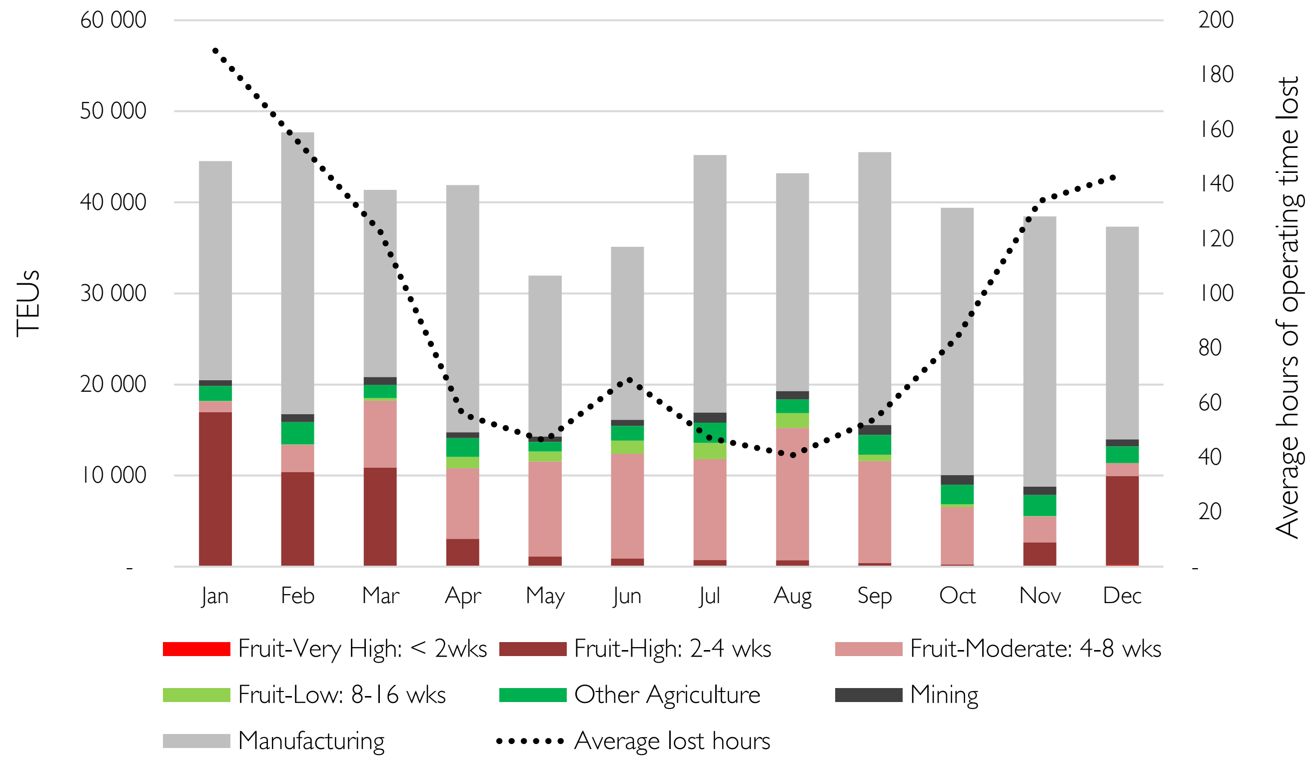

Figure 24: Monthly breakdown of the perishability of fruit and other sectors with average hours of operating time lost for 2021

Source: WC FDM™ PE

1.9.3 The impact of perishability on the containerised fruit cargo projection for 2026

Figure 25 on the next page shows the same information as the previous graph for 2021, but for the relevant projected flows and average operation time lost at the CTCT during 2026.

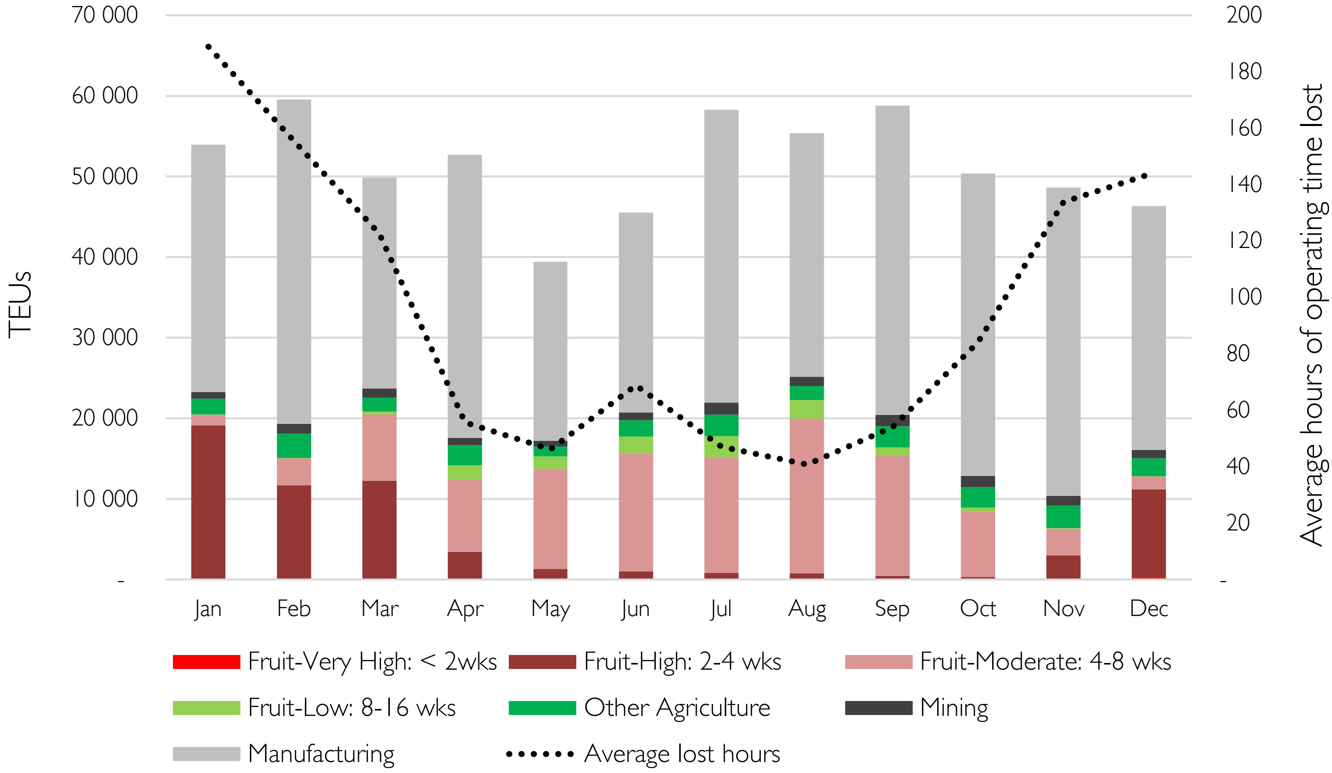

Figure 25: Monthly breakdown of the perishability of fruit and other sectors with average hours of operating time lost for 2026

Source: WC FDM™ PE

Recommendations

The enhanced WC FDM™ and subsequent analysis of its data as discussed during this report enable the following recommendations for containerised cargo management for the PoCT. These recommendations aim to inform appropriate service level requirements and efficiency improvements that are required to address some of the Port's challenges that were illustrated by the enhanced data. To that end, these include recommendations related to weather delays, intelligence, container usage and future research.

1.10 Protect the Cape Town Container Terminal against the impact of weather delays

While it is difficult to avoid weather delays, the CTCT can mitigate the impact thereof by increasing the capacity of the terminal's quay wall crane, while also addressing the capacity for dry cargo.

1.10.1 By increasing the quay wall crane capacity

Additional quay wall cranes operating on a vessel can increase capacity, which can assist the terminal to increase the efficiency of its operations when not affected by delays. This will compensate for operation time that is lost when delays occur.

1.10.2 By increasing the dry port capacity

Adding a dry port offshore will help increase the terminal's capacity during uptimes. Such a dry port, located a fair distance away from the CTCT, will enable dry cargo to be shuttled to the terminal directly when it needs to be loaded on a ship. This allows the terminal to prioritize the handling of containerised cargo to – as with the prior recommendation – increase efficiency to counteract the impact of downtimes.

1.11 Improve terminal intelligence

Intelligence related to the CTCT can be improved by increasing the level of data coordination between various CTCT stakeholders and performing various calculations to enable appropriate trade-offs to be made, which will in turn inform better decision-making related to the terminal.

1.11.1 By increasing the data coordination between the terminal's stakeholders

Current cooperation between agricultural producers, both mining and manufacturing industry members, and the PoCT's operations needs attention, especially in terms of data coordination and information sharing related to strategic planning and implementation data. For example, after a delay in catching up terminal operation, cold stores might be closed in evening while port is still operating. So improved co-ordination between parties could utilize capacity to catch up lost time.

1.11.2 By calculating the value of loss due to weather and other delays at the terminal

Calculating the loss related to the delay of all the CTCT product types will provide powerful arguments to demonstrate the impact of different trade-off scenarios – namely prioritizing certain products or carrying higher inventories of specific products.

1.12 Re-think current container approaches

The way containers are currently used at the CTCT can be improved by adopting new alternative approaches to realise greater efficiency, for example by manufacturing refrigerated containers locally and using empty refrigerated containers for dry imports.

1.12.1 Manufacturing reefer containers locally

While manufacturing reefers might seem outside the scope of this project, it could play a significant role in alleviating efficiency problems at the terminal. Furthermore, it could have a profound boosting effect on the City of Cape Town's overall economy, far beyond merely aiding export reefer container cargo. By starting to manufacture refrigerated containers using existing manufacturers, the number of containers that need to be imported will also decrease. This can realise greater benefits if a production target of about 5 000 containers per month, roughly 60 000 annually, is reached. By incentivizing local manufacturers this approach can be feasible and can assist in increasing port capacity.

Currently, a high number of empty reefer containers need to be imported to be re-packaged and used for the PoCT's fruit exports. Reducing the handling of these empty containers that arrive at the CTCT will also aid the terminal. This could give the terminal a way to manage the number of empty container volumes. If there are operation hours lost at a certain time due to weather delays, the number of imported empty containers can be adjusted accordingly to free up capacity to enable easier fruit handling.

Another advantage of this option is the injection of work for Saldanha since this could act as an additional incentive to get the steel mill active again. This can make a positive contribution to the port by enabling more reefer containers to be manufactured – and, in turn, help improve the larger economy.

1.12.2 Using reefer containers for dry imports

Certain dry commodities can be put inside refrigerated containers, meaning fewer empty reefers would need to be imported, increasing the capacity at the terminal, and increasing efficiency by doing more with less. During focus group discussion, shipping line stakeholders commented that it is a common practice to relocate empty reefer containers filled with non-refrigerated cargo in dry mode (van Eeden in 2018). This is sometimes referred to as non-operating reefers.

1.13 Recommendations for future research

The data received from Agrihub, the WC FDM™ and the role of the Western Cape Government are key areas that have future implications for the PoCT and CTCT-related research, projects, and outcomes.

1.13.1 Agrihub data

In terms of raw fruit data, the data received from Agrihub is the best sourced fruit data received to date for the FDM™ and allowed for more disaggregation than what was possible before. The data thereby assisted greatly with the breakdown of fruit types, with it possible to go into the details of many fruit commodities, their production time, and perishability. In particular, the monthly disaggregation of fruit flows was not done before and using the Agrihub data allowed the weights per container in the WC FDM™ to be streamlined and assisted in improving the overall balancing of the volumes. Therefore, the Agrihub data confirmed what was known in the WC FDM™ before this project, but also allowed it to be enhanced suitably to address the specific project objectives. The WC FDM™ should continue to source Agrihub data for future updates.

However, there are a few suggestions for improvement of the data. There were a couple of challenges in terms of the accuracy of production regions, i.e., the origin locations for Agrihub's fruit data. These production regions do not exactly overlap with the districts in the WC FDM™. A better understanding of those locations in Agrihub's data would be helpful to improve their mapping with the model's districts. This would help create more known flows. Lastly, improved data integration is required between the various owners of PoCT-related data in South Africa, along with improved information-sharing and collaboration between related projects.

1.13.2 Western Cape Freight Demand Model

As mentioned in an earlier recommendation, the calculation of loss related to CTCT delays is an important functional capability that must be explored to improve efficiency at the port and the terminal. The enhanced WC FDM™ can be used to make these calculations in future projects.

Furthermore, as seen in this report, the PoCT's containerised cargo flows could be mapped for a few fruit commodity groups. If the production region challenge mentioned above is addressed, more fruit data from Agrihub can be matched to the districts in the WC FDM™ to produce flow maps for additional fruit commodities.

1.13.3 The role of the Western Cape Government

It is important to consider what the National Development Plan (NDP) envisages for freight transport by 2050 to determine how the WC Government should be involved in the PoCT's planning and coordination (Department of Public Works and Infrastructure, 2021:22). The National Infrastructure Plan (NIP) specifies conditions that must be met to ensure that freight transport delivers on this vision (Department of Public Works and Infrastructure, 2021:26).

One of these conditions is that planning systems must be regularised and integrated into the policy planning and execution of state institutions. Moreover, this planning must occur regularly and be supported and informed by robust information systems and evidence. To ensure these systems are effective, State oversight must be simply designed – with the functions and mandates delineated clearly according to applicable governance rules (Department of Public Works and Infrastructure, 2021:27).

The NIP proposes a strategic element, namely that the necessary state capacity must be developed to oversee freight transport delivery and regulate it effectively. This strategy emphasises the promotion of centres for transport planning excellence and the integration and stabilisation of transport regulations (Department of Public Works and Infrastructure, 2021:28). In the context of Western Cape Provincial Government, developing this planning and coordination capability will assist it to become a stronger, more capable, and responsible regulator. This will enable its policy positioning and regulatory frameworks to help ensure that the port and terminal are reformed to optimise their service delivery.

The NIP also proposes transport hubs to stimulate industrial diversification. This will be enabled by Special Economic Zone (SEZ) which will surround intermodal linkage nodes. These will be owned and driven by local authorities and/or privately with private investment and monetisation. This includes "Super Hubs" (freight villages, ports, dry ports, and border posts), logistic service centres, intermodal terminals, and rural hubs (Department of Public Works and Infrastructure, 2021:28).

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Appendixes

Tonnes per commodity for export containers

Commodity	Tonnes in Containers - 2020	Tonnes in Containers - 2021	Tonnes in Containers - 2026	Container TEUs - 2020	Container TEUs - 2021	Container TEUs - 2026
Deciduous Fruit	576 638	591 053	669 722	57 543	58 981	65 834
Citrus	458 733	483 964	702 037	42 680	45 027	64 540
Grapes	263 388	297 705	345 122	38 467	43 859	49 473
Beverages	526 052	540 427	642 614	36 093	37 080	46 484
Processed Foods	223 391	228 529	289 216	17 631	18 036	24 860
Slaughtered animal meat	182 792	184 620	202 783	16 553	16 718	18 242
Motor Vehicle Parts & Accessories	46 825	48 216	64 831	7 371	7 590	11 026
Fish and seafood	86 335	87 199	113 573	6 849	6 918	9 136
Other Manufacturing Industries	38 834	52 348	84 545	4 734	6 382	10 661
Subtropical Fruit	60 988	62 696	71 979	5 188	5 333	6 073
Metal products, machinery and electronic equipment	28 155	32 562	48 767	3 369	3 896	6 170
Other Mining	33 810	60 108	71 079	1 963	3 490	4 375
Scrap metals	45 596	60 610	85 252	2 552	3 393	4 914
Textile Products	15 153	16 054	19 992	2 274	2 409	3 076
Wood timber and products	17 025	20 274	27 661	1 616	1 924	2 625
Chemicals	17 215	17 269	20 553	1 684	1 689	2 297
Granite	33 851	35 879	47 440	1 418	1 503	1 954
Animal feed	22 020	28 262	29 778	1 157	1 485	1 552
Recycled paper	17 134	17 305	18 281	1 451	1 466	1 548
Iron & Steel	20 317	23 793	31 503	1 227	1 437	2 215
Manganese Exports	33 072	34 922	41 705	1 184	1 251	1 496
Paper	12 401	12 476	13 171	1 198	1 205	1 277
Other Agriculture	10 975	11 203	13 392	1 128	1 151	1 412
Non-Ferrous Metal Products	17 413	17 874	22 590	898	921	1 469
Stone	8 657	20 345	37 827	388	912	1 759
Vegetables	9 367	9 461	10 482	865	873	965
Zircon	15 806	17 493	21 750	590	653	998
Transport Equipment	2 432	2 493	3 291	526	540	788
Pharmaceutical Products	2 844	2 887	3 491	495	502	611
Salt	10 965	10 495	10 856	519	497	517
Potatoes	3 104	3 135	3 372	249	251	270
Chrome	5 306	6 198	7 743	199	232	328
Motor vehicles and trucks	450	534	70	180	214	28
Copper	3 047	3 430	4 234	164	184	229
Fertilizer	1 440	1 442	1 582	111	111	122
Pulp of wood and paper	198	217	245	86	94	114
Other Petroleum Products	1 214	1 351	1 696	74	82	105
Printing and Publishing	552	552	635	79	79	94
Rutile	1 306	1 364	1 598	49	52	60
Iron Ore Exports	994	1 126	1 171	36	41	43
Other Non-Ferrous Metal Mining	450	386	436	20	17	21
Tobacco Products	112	115	122	11	12	13
Eggs (poultry)	22	23	33	8	8	10
Ferrochrome	138	155	159	6	7	7
Precious metal ore	11	13	18	3	3	4
Petrol	38	39	-	2	2	-
Diesel	20	31	-	1	2	-
Cement	21	21	24	1	1	2
Barley	15	15	15	1	1	1
Grain Sorghum	2	2	2	0	0	0
Jet fuel	-	-	-	-	-	-
TOTAL	**2 856 627**	**3 048 671**	**3 788 437**	**260 890**	**278 514**	**349 798**

Source: WC FDM™ PE

Tonnes per commodity for import containers

Commodity	Tonnes in Containers - 2020	Tonnes in Containers - 2021	Tonnes in Containers - 2026	Container TEUs - 2020	Container TEUs - 2021	Container TEUs - 2026
Other Manufacturing Industries	298 382	326 249	434 849	38 855	42 484	58 953
Textile Products	137 144	141 106	163 014	29 439	30 289	34 963
Metal products, machinery and electronic equipment	144 485	147 587	176 348	22 289	22 767	27 898
Processed Foods	238 023	247 435	293 123	18 436	19 166	23 638
Chemicals	146 315	148 422	166 312	12 476	12 656	14 609
Slaughtered animal meat	127 639	135 461	163 862	10 694	11 349	13 663
Paper	134 551	141 902	163 675	10 680	11 264	13 344
Wood timber and products	85 419	100 098	139 859	8 398	9 842	13 789
Motor Vehicle Parts & Accessories	33 645	46 157	67 807	5 897	8 090	12 112
Beverages	46 827	81 658	128 143	3 456	6 026	9 635
Fish and seafood	64 711	67 332	81 088	5 412	5 631	6 869
Fertilizer	109 327	110 901	126 867	5 360	5 437	6 262
Iron & Steel	63 118	64 481	77 045	4 881	4 986	6 258
Rice	114 435	116 417	130 102	4 688	4 770	5 312
Pharmaceutical Products	17 591	17 908	20 429	3 185	3 243	3 760
Non-Ferrous Metal Products	33 816	34 806	39 684	3 012	3 100	3 631
Transport Equipment	8 776	9 263	11 532	1 783	1 882	2 385
Other Agriculture	14 079	14 256	14 797	1 365	1 382	1 465
Printing and Publishing	12 496	13 860	17 119	1 240	1 375	1 715
Vegetables	16 269	16 415	17 244	1 243	1 254	1 295
Motor vehicles and trucks	2 442	2 884	3 267	596	703	806
Deciduous Fruit	7 644	7 816	8 832	683	698	794
Grapes	4 334	4 432	5 008	629	644	722
Other Petroleum Products	2 458	5 490	6 968	237	529	680
Cement	12 281	12 725	15 125	464	481	575
Pulp of wood and paper	4 562	5 089	6 209	398	444	511
Other Mining	3 244	5 759	9 472	243	432	761
Stone	7 436	6 847	5 891	399	367	331
Subtropical Fruit	2 347	2 410	2 790	308	316	378
Citrus	3 551	3 519	3 348	313	310	295
Animal feed	3 481	3 519	4 030	287	290	329
Salt	2 835	2 925	3 298	196	202	238
Bricks	3 036	3 111	3 465	161	165	182
Other Non-Ferrous Metal Mining	202	412	684	63	128	211
Soya beans	1 074	1 084	1 138	101	102	101
Granite	1 906	1 912	2 039	76	76	81
Recycled paper	930	1 005	1 238	69	75	92
Cotton	801	792	746	53	52	49
Potatoes	507	510	525	51	52	51
Gas	601	608	678	38	38	43
Alumina	307	307	33	23	23	2
Wheat	296	263	301	20	18	21
Barley	381	369	320	17	16	14
Gypsum	602	352	89	25	15	4
Precious metals and precious stones (Refined)	72	70	72	14	14	14
Grain Sorghum	318	327	95	13	14	4
Sunflower Seed	215	212	197	13	13	12
Copper	244	275	329	11	12	13
Scrap metals	217	243	322	10	11	16
Maize	157	154	148	8	8	8
Eggs (poultry)	31	31	31	8	8	8
Petrol	47	90	-	4	8	-
Tobacco Products	31	36	48	5	6	8
Chrome	127	126	125	5	5	5
Jet fuel	-	-	-	-	-	-
Soya bean products	-	-	-	-	-	-
Diesel	-	-	-	-	-	-
TOTAL	**1 915 764**	**2 057 417**	**2 519 761**	**198 333**	**213 270**	**268 912**

Source: WC FDM™ PE

Scenarios

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. Pressing policy issues were identified and high-level scenarios were developed to estimate the potential annual impact on 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.

Bitterfontein hinterland terminal

Utilising the terminal at Bitterfontein for freight to/from the Namaqualand region and Namibia border, and to/from the extended Cape Town metropolitan region was considered. This scenario considers the transfer of road freight at the Bitterfontein terminal and utilising the Bitterfontein rail line (approximately 490km from Bitterfontein to Cape Town).

Currently, no freight beyond Bitterfontein and towards Namaqualand or Nambia is transported on rail. The volumes and modal split of commodities related to the Bitterfontein catchment area are shown in Figure 1. The Bitterfontein catchment area includes rail freight from the Vanrhynsdorp district to the Port of Saldanha, Hopefield and Malmesbury. The road freight movement is along the N7 across the Piekenierskloof Pass towards Bitterfontein, Springbok and Vioolsdrif. Most of the commodities can be palletised and containerised, and are, therefore, suitable for rail transport.

The branch line is in relatively good condition, with enough available capacity for all freight along this route. Currently, there is only a small rail station handling granite at Bitterfontein, but a large terminal will not be required for these volumes. While ample land space is available, the development of a hinterland port concept will require industry collaboration and participation to ensure the levels of involvement required for a successful intermodal solution for the Western Cape.

The advantage of a terminal at Bitterfontein would be the elimination of truck travel over the Piekenierskloof Pass and the congestion experienced and created by these trucks[1], especially in the CBD of Cape Town and the Port. In 2016, the average number of trucks travelling over the Piekenierskloof Pass were 686 trucks per day, representing 20.9% of the daily vehicle traffic. By 2019, that number grew to 759 trucks, with trucks' contribution towards daily vehicle traffic also rising to 22.1%. It will also allow trucks travelling to and from Namibia a quicker turnaround time between trips.

The annual volume of this freight is currently only around 79 098 tonnes per annum, which is approximately one train every week. This volume, however, is forecasted to increase to around 92 363 and 155 973 tonnes by the years 2026 and 2051 respectively. Currently, the freight transportation cost and externality cost savings per annum could be R33.4 million and R10.3 million, respectively, if all road freight is shifted to rail.

The Bitterfontein rail line to Cape Town is indicated in Figure 2, with the Namaqualand/Namibia border and the extended metropolitan region considered as potential catchment areas.

[1] Based on SANRAL's Integrated Transportation Information System (ITIS) data, which is available online at https://itis.nra.co.za/Portal/

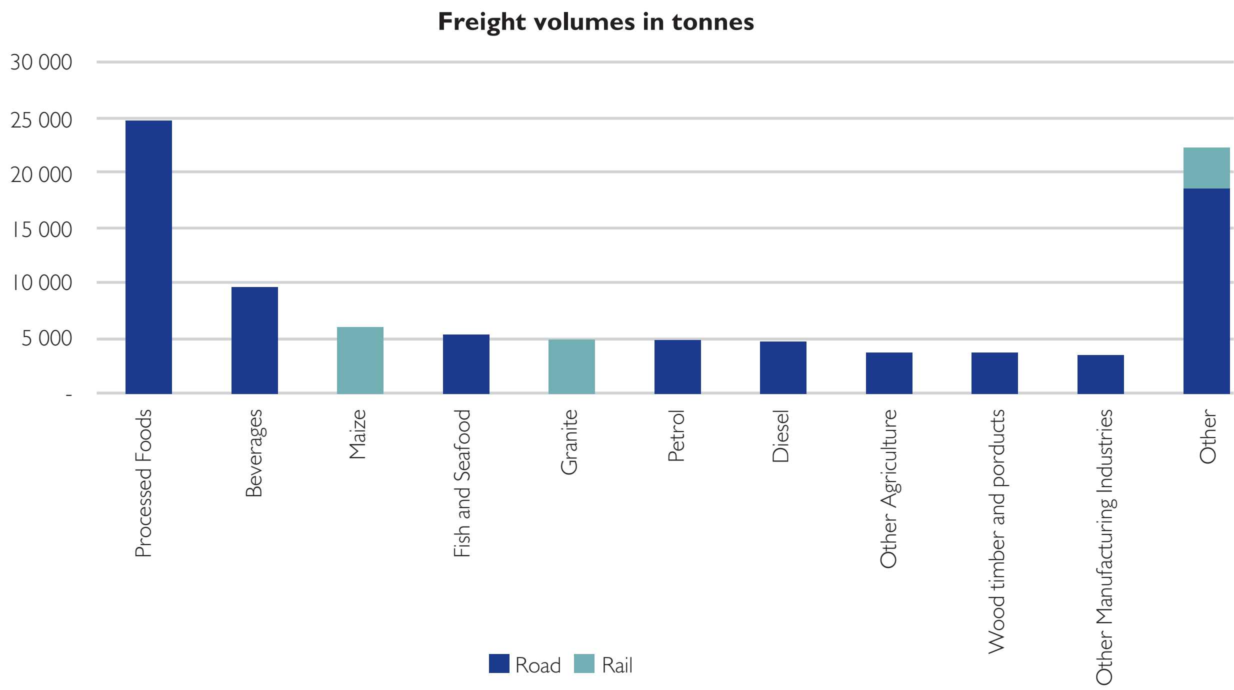

Figure 1: Modal split for the Bitterfontein catchment area

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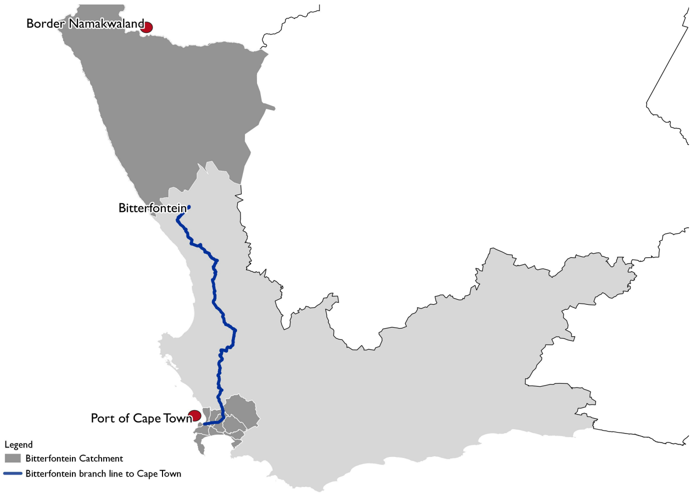

Figure 2: Bitterfontein line to Cape Town and potential catchment areas (the circles indicate the port and border)

Highlights

- Bitterfontein as a hinterland terminal could be a road to rail strategy to address road safety, while reducing congestion and turnaround times of road freight vehicles.
- The freight transportation cost and externality cost savings per annum will be R33.4 million and R10.3 million, respectively, if all road freight is shifted to rail.
- The branch line is in relatively good condition, with enough available capacity for all freight along this route. The development of a hinterland port concept will require industry involvement to ensure a successful intermodal solution for the Western Cape.

Western Cape Freight Demand Model (WC FDM™) ***Scenario 4: Fruit container consolidation terminal Vredendal and Elgin***

Scenarios

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. Pressing policy issues were identified and high-level scenarios were developed to estimate the potential annual impact on 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.

Fruit container consolidation terminal

The Western Cape is responsible for more than half of South Africa's total agricultural exports, with the agriculture sector showing growth during a COVID-19 stricken 2020[1]. In recent years, various media reports[2] have highlighted road congestion to the Port of Cape Town, pressure on efficiency, and the need to lower the currently high costs of doing business. The consolidation of freight could make the logistics costs cheaper and more effective[3]. By investing in the correct infrastructure configuration that ensures the lowest overall total logistics costs at the highest possible GDP output, South Africa can gain a major international competitive advantage.

This scenario considers the development of two fruit consolidation terminals in Vredendal and Elgin by using the Bitterfontein rail line (Vredendal to Port of Cape Town) and Caledon rail line (Elgin to Port of Cape Town). As mentioned in the previous scenario, the Bitterfontein rail line is in a relatively good condition and has sufficient capacity for all freight along this route. Similarly, the Caledon rail line is in a good condition and operational. This scenario proposes the transfer of road freight from the catchment areas around Vredendal and Elgin to fruit consolidation terminals in Vredendal and Elgin.

This scenario does not consider any other initiatives to consolidate freight and the use of rail. Such activities will have a compound effect and result in a reduction of rail rates. The potential of future volumes will also further increase density.

The distance to the Port of Cape Town from Vredendal and Elgin is 303km and 70km respectively. The freight will utilise the rail line from Elgin to the Port of Cape Town and Vredendal to the Port of Cape Town as depicted in Figure 1. The benefit of these consolidation terminals is to reduce road and port congestion at the Port of Cape Town but also to improve the turnaround time of road vehicles.

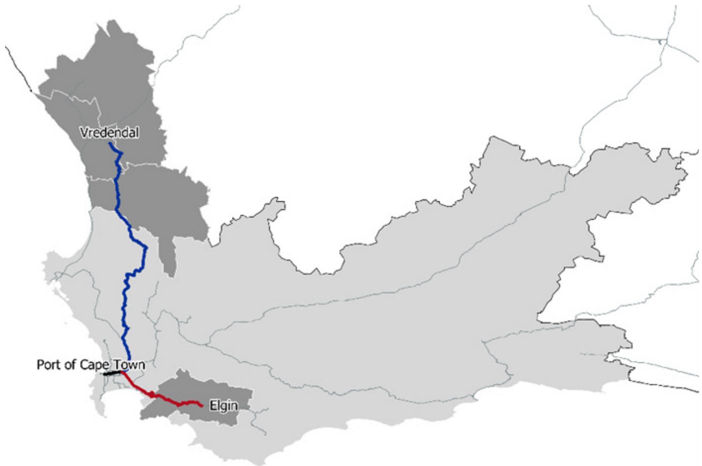

Figure 1: Rail lines and catchment areas for fruit consolidation terminals

Table 1 shows the current and expected fruit export volumes through the Port of Cape Town from the Elgin and Vredendal areas. All this freight is currently moving on road, with the N2 and N7 predominantly used for Elgin and Vredendal, respectively. Elgin's biggest fruit exports are that of deciduous fruit, with 294 300 tonnes in 2020 – which is expected to increase to 651 521 tonnes by 2051. Vredendal's biggest fruit exports are that of citrus, with 181 603 tonnes in 2020 – which is expected to increase to 664 428 tonnes by 2051.

Table 1: Fruit export volumes through the Port of Cape Town from the Vredendal and Elgin catchment areas in tonnes

Fruit terminal	Commodity	2020	2026	2051
Elgin	Deciduous Fruit	294 300	341 298	651 521
Elgin	Grapes	4 747	5 668	12 825
Elgin	Citrus	4 392	5 942	16 069
Elgin	Subtropical Fruit	42	50	105
Vredendal	Citrus	181 603	245 678	664 428
Vredendal	Grapes	35 906	42 874	97 005
Vredendal	Deciduous Fruit	5 800	6 726	12 840
Vredendal	Subtropical Fruit	15	18	38
Total		526 805	648 252	1 454 831

Although fruit from the area is primarily exported, Vredendal and Elgin also produce fruit for domestic use and consumption. Most of the exports go through the Port of Cape Town, as shown in Figure 2. Table 2 provides a breakdown of other port use for fruit exports from the area.

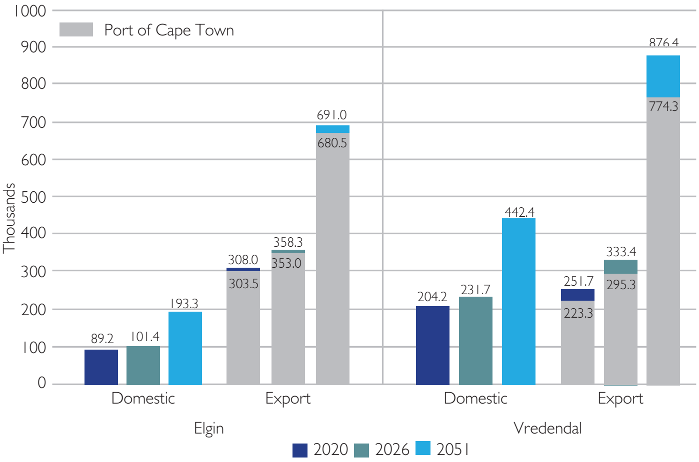

Figure 2: Vredendal and Elgin area fruit volumes

The fruit exports from Vredendal and Elgin to the Port of Cape Town generate an estimated 17 560 trips per annum. If all fruit exports from Vredendal and Elgin are considered, this number would represent 18 656 trips or 51 trucks per day.

Table 2: Current export ports for fruit from Vredendal and Elgin

Catchment area	Export port	Tonnes
Elgin	Port Cape	303 481
	Port Durban	945
	Port East London	1
	Port Port Elizabeth	3 595
Vredendal	Port Cape	223 324
	Port Durban	22 096
	Port Port Elizabeth	6 247
	Total	559 689

Terminal at Vredendal can be considered for fruit exports

Figure 3 shows the 2020 potential fruit volumes that can be directed to the Vredendal fruit consolidation terminal is 224 327 tonnes, with an expected growth to 777 115 tonnes in 2051. This is more than 50% of the current rail volumes on the rail line. The increased density on the rail line could result in a reduction of 20%[4] of the rail rates.

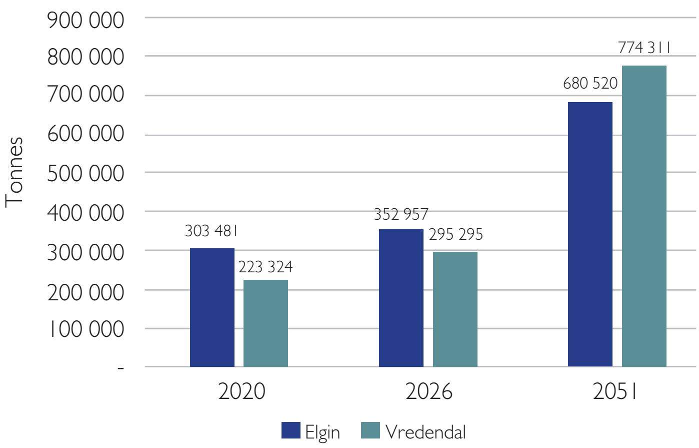

Figure 3: Fruit volumes and forecasts for Vredendal and Elgin catchment areas

Terminal at Elgin can be considered for fruit exports

In the catchment area of Elgin, 303 481 tonnes of 2020 fruit volumes could be directed to the Elgin fruit consolidation terminal which is about 6 times the current rail volumes. This increased density on the line should reduce the rail rate significantly. The forecast as shown in Figure 3 shows growth of 680 520 tonnes in 2051.

Cost saving implications for Vredendal and Elgin

Table 3 illustrates the potential cost saving implications for modal shift of fruit exports originating from the Vredendal and Elgin catchment areas. Given the current rail rate, moving the transport of fruit export volumes to the Port of Cape Town from road to rail is expected to result in a transport cost saving of R4.5 million (6.8%) and R7.8 million (15.2%) for Vredendal and Elgin, respectively. Similarly, a reduction in externality cost can also be realised through the proposed modal shift, with potential savings of R11.9 million and R8 million for Vredendal and Elgin, respectively.

Table 3: Potential cost saving implications of the establishment of fruit container consolidation terminals at Vredendal and Elgin

Fruit terminal	Road transport cost	Modal shift transport cost saving	Modal shift externality cost saving
Elgin	R51.1m	R7.8m (15.2 %)	R8.0m
Vredendal	R65.1m	R4.5m (6.8 %)	R11.9m
Elgin - Non-PoCT exports	R3.6m	R2.9m (81.8%)	R0.9m
Vredendal - Non-PoCT exports	R34.8m	R27.1m (77.9%)	R9.0m

Given that alleviation of (land or seaside) congestion at the Port of Cape Town is achieved, the fruit exports from Vredendal and Elgin that are currently destined for ports other then the Port of Cape Town will shift there. If this shifted freight is also transported by rail, the additional transport and externality cost saving will be R30.0 million and R9.9 million, respectively. Table 3 provides this information in further detail.

[1] Wesgro. 2022. *Agribusiness, agri-processing, furniture* [Online]. Available: https://www.wesgro.co.za/export/sector/agriculture- agro-processing-agribusiness [2022, March 15].

[2] Cape Town is the most congested city in South Africa and 29th most congested globally, with drivers spending an average of 124 hours a year in traffic. Operational inefficiencies at the Port of Cape Town leads to significant delays, which increased the number of teams required to operate the port's cranes and have led to citrus exports being redirected to the Eastern Cape ports to ensure supply chain continuity. These issues have delayed the processing of cargo severely, leading to frustrated importers and exporters and the fear of significant losses. The port efficiency is also hampered by the lack of sufficient equipment. COVID-19 has also had a severe effect on service levels, that nearly halved due to the impact of the virus.

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

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The advantage of a terminal at Elgin would be the elimination of truck travel over the Sir Lowry's Pass and the congestion experienced and created by these trucks, especially in Somerset West. In 2016, the average number of trucks travelling over the Sir Lowry's Pass were 1 393 trucks per day, representing 7.9% of the daily vehicle traffic. By 2019, that number declined to 1 224 trucks, with trucks' contribution towards daily vehicle traffic also rising to 8.41%. It is, however, important to note that vehicle counts were only conducted for 6.9% of the year in 2019.

However, if truck counts conducted at Gordon's Bay (before) and Kromco (after) the pass are considered, it shows a marginal increase over that time. The average number of trucks counted at Gordon's Bay were 1 573 and 1 594, and 1 178 and 1 241 at Kromco, in 2016 and 2019, respectively. Therefore, increased congestion over Sir Lowry's Pass continues to be a challenge.

The annual volume of this freight is currently only around 303 481 tonnes per annum, which is approximately three trains each week. This volume, however, is forecasted to increase to around 352 957 and 680 520 tonnes by the years 2026 and 2051 respectively.

Highlights

- Due to congestion at the Port of Cape Town, a portion of the fruit exports from the Vredendal and Elgin catchment areas are being exported through other ports in the country.
- Fruit consolidation terminals for export fruit can assist in the road to rail strategy by directing fruit exports by rail from Elgin and Vredendal to the Port of Cape Town leading to:
  - A transport cost saving of R12.3 million and an externality cost saving of R19.9 million at current rail rates.
  - If the Port of Cape Town is congestion-free, an additional transport cost saving of R30.0 million and an additional externality cost saving of R9.9 million at current rail rates.