THE WINGFIELD INTERCHANGE PROJECT: A NETWORK APPROACH TO IMPROVING MOBILITY CHALLENGES IN CAPE TOWN

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ABSTRACT

The National Route N1 between Koeberg interchange and Sable Road is the highest trafficked road in the Western Cape with a current AADT of 152 000 vehicles per day. In comparison, the AADT in the year 2000 was 84000. Daily traffic on this section of the N1 has therefore increased by 80% over the last 24 years, or an average growth of 2.5% per annum without any major intervention to the freeway network. This traffic growth together with the gradual increase in the city's population has resulted in this section of the N1 being one of the most congested links in Cape Town - contributing to the city ranking among the most congested in the world. The mobility along this corridor has therefore been severely compromised, resulting in intolerable travel time and constrained development potential. To address these mobility challenges, the WCG, through the Wingfield Interchange Project will implement a phased road network upgrade scheme, which will include the upgrade of ten (10) interchanges and collector-distributor (C-D) road system along the N1 and N7. This paper provides an overview of the planned network upgrades and how these will address Cape Town's mobility challenges.

Keywords: Wingfield Interchange, Western Cape Government, City of Cape Town.

1. INTRODUCTION

A rapid rise in Cape Town's urban population has led to an increase in travel demand, resulting in high congestion levels across some of the major routes in the City (City of Cape Town, 2017). This high level of congestion is undesirable as it imposes large direct costs on the road user and the economy through delays and reduction in traffic flow. Other concerns such as the lack of safe and reliable public transport services have contributed to the increased use of private vehicles. Moreover, a decline in the rail service over the past decade has resulted in the mode shift from rail to road-based transport, further increasing demand on the road network and exacerbating capacity constraints. Providing holistic and sustainable urban transportation solutions to reduce congestion has thus become critical.

The Western Cape Government's Department of infrastructure has formulated a strategic infrastructure project, the Cape Town Freeway Integrator (CTFI) for integrating major routes in the city with the aim of improving mobility, unlocking growth potential and accelerating development. The Southern Growth Corridor (SGC), commonly known as The Wingfield Interchange Project (WIP), is one of the first mega-infrastructure projects that form part of the CTFI.

2. BACKGROUND

The City of Cape Town's (CoCT) population was estimated to be 4 758 433 in 2021 and further estimated to gradually increase to 5 133 369 by 2025. This equates to an approximate 7.9% growth in a 5-year planning cycle, or an average growth of 1.6% per annum (WCG, 2021). In comparison, the 2001 Census figure for the Cape Town Metropolitan Municipality population was 2 893 246. The Cape Town population has therefore almost doubled in the last 20 years.

The N1 between Koeberg Interchange and Sable Road is the highest trafficked road in the Western Cape with an AADT of 152 000 vehicles per day in the Year 2024, compared to an AADT of 84 000 vehicles in Year 2000. These figures show that daily traffic on this section of the N1 has increased by 80% or an average of 2.5% per annum over the last 24 years without any major intervention to the freeway network.

The above-mentioned population increase, traffic growth, and a lack of major freeway infrastructure improvement culminates and has contributed to Cape Town's congestion challenges. The 2019 TomTom Traffic Index suggested that Cape Town is the most congested city in South Africa, ranked at 101st most congested city in the world with a TomTom Congestion Level of 32% (TomTom, 2019). This corresponds to 32% extra travel time for any trip, anywhere in the city, at any time compared to what it would be in a free flow state. In recent years, the congestion challenge has further deteriorated, with the INRIX survey revealing that in 2024, Cape Town road users, on average, experienced a delay of 94 hours per year compared to travel time during the off-peak period. This delay was 83 hours in 2023 – an increase of 13% (INRIX, 2024).

There is sufficient evidence in the literature illustrating the futile nature of transport strategies which solely focus on increased road space for private vehicles as a tool for relieving urban congestion (Goodwin, 1996; Kitamura, 1994). The evidence shows that while this approach may alleviate traffic congestion in the short term, it does not provide sustainable long-term solutions to the congestion challenge due to the 'induced traffic' phenomenon. On the other hand, there is consensus that concerns over induced traffic do not preclude the increase in road space for private vehicles, and that a balance between supply and demand for road space should be established within an integrated transport policy framework (Goodwin, 1998; Bell, 1995). This is particularly essential in a developing country with relatively poor infrastructure and in need of rapid economic growth.

To establish the necessary balance between supply-side and demand-side strategies, the planning and traffic modelling for the WIP was done using the CoCT EMME Model and assumes full implementation of the 2032 CoCT Integrated Public Transport Plan (IPTP). The WIP is therefore a complementary requirement to support the projected transport demand, which implies that the full benefits of the WIP will not fully materialise until the IPTP has been sufficiently implemented.

3. STUDY AREA

The WIP is located in the Western Cape where the National Route N1 and the National Route N7 converge at the Wingfield Interchange, just east of Cape Town as indicated in Figure 1.

The project study area includes the section of the N1 between Koeberg Interchange (M5) and Parrow North (M14) Interchange. It also includes Jakes Gerwel Drive (M7) between

Frans Conradie Drive (M25) and the Wingfield Interchange. To the north of the Wingfield Interchange, it includes the section of the N7 up to Refinery Interchange.

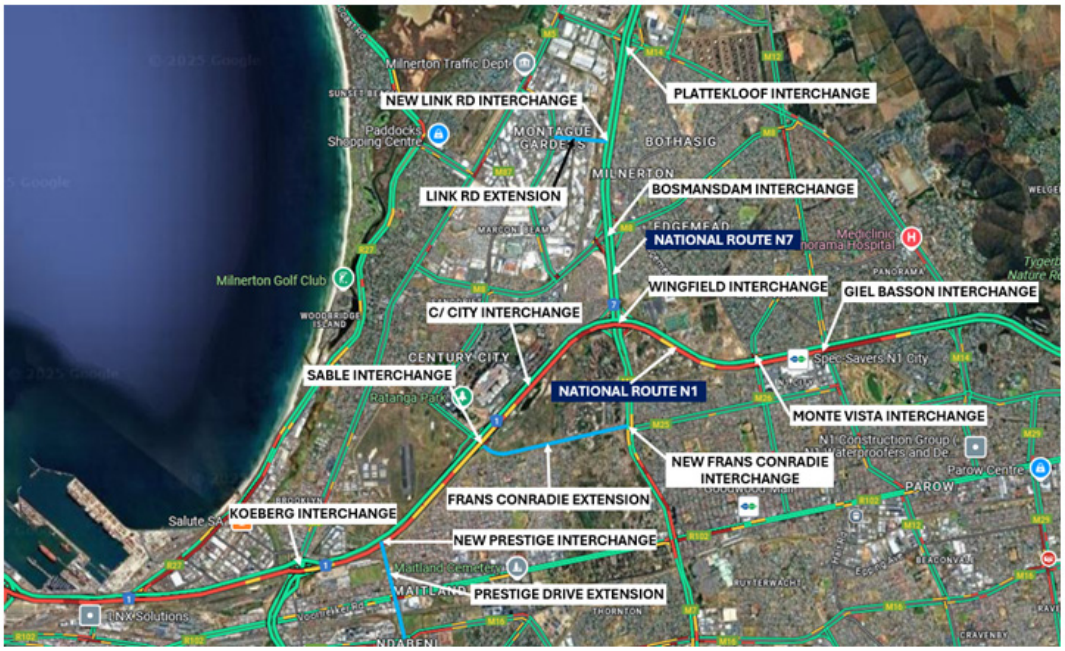

Figure 1: Wingfield Interchange project study area

4. NETWORK CHALLENGES

The existing N7 over N1 bridges at the Wingfield Interchange are in a critical condition with inadequate vertical clearance and at the end of their design life, and thus require demolition and replacement. In addition, traffic congestion and weaving challenges along the N1 and N7 both upstream and downstream of the Wingfield Interchange need to be addressed. This project investigates and proposes wider network solutions involving other major metropolitan routes, which would have the benefit of reducing traffic demands on the trunk routes. These other metropolitan routes include Frans Conradie Drive Extension, Prestige Drive Extension and a Link Road from Montague Drive to the N7.

The identified network challenges are as follows:

- The on-ramp inbound merge at the Monte Vista Boulevard Interchange causes a queue on the N1 with a tailback reaching Jip de Jager Drive Interchange on-ramp merge. The inbound on-ramp merge is also causing long queues on both the northern and southern approaches to the interchange on Monte Vista Boulevard, mainly due to the high inbound traffic movement.

- The on-ramp inbound merge at the Wingfield Interchange results in queue build up on the N1, eventually causing a queue on the N1 that merges with the queue caused by the Monte Vista Boulevard Interchange on-ramp. It also results in a queue on the N7 with a tailback to the Bosmansdam Road Interchange.

- The bottleneck at the Koeberg Road Interchange, with only two through lanes, causes a queue that eventually merges with the queue caused by the Wingfield Interchange merge.

- The bottleneck at the Bosmansdam Road/Montague Gardens Intersection, due to insufficient capacity, causes queue build up on Bosmansdam Road and eventually onto N7. The queue build-up negatively impacts traffic from the N1 merging onto the N7 due to inadequate interchange spacing between Wingfield and Bosmansdam Interchange. As a result, the auxiliary lane lengths are not adequate to accommodate weaving, merging and diverging manoeuvres.

- The bottleneck at the Plattekloof Road/Koeberg Road Intersection together with insufficient capacity at the Refinery Interchange, causes a queue build up on Plattekloof Road and the respective Refinery Interchange on- and off-ramps.

- The bottleneck on Jakes Gerwel Drive (M7) at the Jakes Gerwel Drive/Frans Conradie Drive Intersection, due to a lane drop from 3 to 2 through lanes on Jakes Gerwel Drive in the southbound direction, causes substantial queue build-up on the northern approach of the intersection; and

- The bottleneck at the Sable Road Interchange ramp terminals, due to insufficient capacity, causes queue build-up on the north-eastern approach of Sable Road, mainly due to the high inbound traffic movement.

5. TRAFFIC ANALYSIS

5.1 Existing Traffic Data

The traffic analysis began with an evaluation of existing traffic conditions and the causes of congestion within the study area.

Traffic flow data from August 2013 were collected for all road links in the study area using SANRAL Traffic Counting Stations. In instances where the counting stations did not provide sufficient data coverage, data were further supplemented with new traffic counts at various intersections during the peak periods. Moreover, Google Maps and TomTom traffic data were used to understand congestion patterns, including the spatial and temporal development of congestion across the road network.

The intersection capacity analyses conducted on SIDRA revealed several locations operating near or over capacity. Additionally, accident data from 2010 to 2014 and pedestrian activity studies highlighted critical safety and movement issues, particularly along the N7 near Dunoon and Acacia Park Train Station.

5.2 Existing Traffic Data

The CoCT EMME Model served as the primary tool for forecasting future traffic demand.

The CoCT EMME Model is a robust macroscopic transport model designed to analyse the impact of changes in the transport network and land use patterns in the Cape Metropolitan Area. The model incorporates a projected 50% increase in residential households (500,000 additional units) over a 20-year period, aligning with a pragmatic densification scenario that supports Transit-Oriented Development (TOD). This model also formed the basis for the CoCT's Integrated Rapid Public Transport Network (IRPTN), developed using 2012 and 2013 data.

It is worth noting that the model assumes full implementation of the 2032 CoCT Integrated Public Transport Plan (IPTP), including rail, MyCiti Bus Rapid Transport (BRT), Non-Motorised Transport (NMT) and other public transport infrastructure. The WIP is therefore

not an alternative to these public transport systems but rather a complementary requirement to support the projected transport demand.

The 2012 and 2013 traffic volume and public transport models were successfully calibrated. It was then applied as a conventional four-step travel demand model (trip generation, trip distribution, modal split, and trip assignment) to investigate future land use scenarios and transport proposals. The AM peak hour was fully calibrated, while the PM peak hour was approximated by inverting the origin-destination matrices then calibrating the results using actual traffic counts and refining it with EMME's Matrix Adjustment Tool.

5.3 Micro-Simulation Model Analysis

While the EMME macroscopic model provides an overview of travel patterns on a road network, micro-simulation is essential for capturing localized causes of congestion, such as vehicle path crossings, turn pocket overflows, late merging, and other real-world dynamics that significantly affect traffic congestion and travel times.

VISSIM was used to complement EMME by analysing localized traffic issues, including weaving, lane usage, and merging behaviour. It simulated real-world conditions for both the 2013 baseline (Status Quo) and the 2032 future scenarios.

The microsimulation allowed for the testing of various scenarios in real-time, making it easier to identify and address bottlenecks. The results of the model revealed that addressing these bottlenecks required not only increased freeway capacity but also broader network improvements. Furthermore, the analysis showed that the average speed on the freeway network during the morning peak hour in 2019 was 44 km/h. Vehicles traveling in the peak flow direction averaged 22 km/h (Level of Service (LOS) F), while those in the off-peak direction averaged 88 km/h (LOS C). These findings were consistent with real-time measurements, confirming successful model calibration.

Local and international guidelines specify a minimum acceptable design standard of LOS D for transport infrastructure. Thus, capacity improvements are already necessary to ensure the freeway serves its intended purpose.

The 2032 forecast, under a "Do Nothing" scenario, predicts that average speeds on the freeway network during the morning peak hour would decrease to 14 km/h, resulting in gridlock in the peak direction. Despite the EMME model accounting for a significant shift to public transport, projected 2032 passenger car volumes clearly indicate that extensive road network upgrades are also required.

With the WIP intervention, the 2032 traffic model anticipates an average speed of 51 km/h during the morning peak hour, alongside a 25.4% increase in traffic volumes on the freeway network. This represents a 264% improvement over the "Do Nothing" scenario and restores the network to acceptable LOS for 2032.

6. PROPOSED ULTIMATE SCHEME

Figure 2 shows the extent of the wingfield project as well as the proposed interventions.

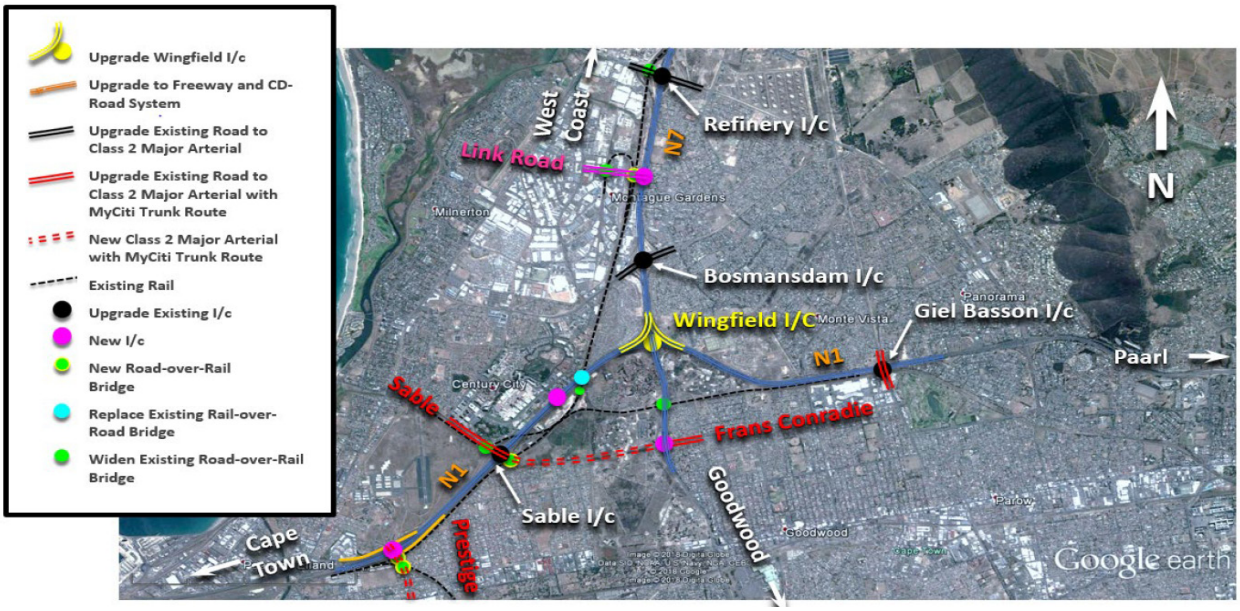

Figure 2: Wingfield proposed scheme

6.1 Freeway Collector-Distributor Road System

For both the N1 and N7, the proposed ultimate cross-section includes three core lanes on the Class-1 freeway and two core lanes on the adjacent Class-1 C-D roads, running parallel on either side of the freeway in each direction. Together, these will form a total of five lanes per direction.

The C-D road system will span the full length of the N1 between the future Prestige Drive Interchange in the west and the Parow North Interchange in the east, and the N7 between the future Frans Conradie Drive Interchange in the south and the Refinery Interchange in the north. This system extends the existing C-D road system at Century City in the outbound direction and comprises two C-D lanes and three core lanes in each direction. While the C-D lanes maximise local access, the core lanes are designed to prioritise mobility.

The C-D road system improves connectivity to the local road network by enabling additional access interchanges at the Link Road Interchange, Century City Drive Interchange, Prestige Drive Interchange, and Giel Basson Interchange.

The introduction of a C-D Road System along the length of N1 and N7 will result in a significant increase in the average operating speeds, as it will mostly address the problem areas identified in the sections above, either by providing more access to developments and communities along the N1 and N7, or by providing more capacity in the problematic merge areas at the Wingfield, Bosmansdam Road and Monte Vista Boulevard Interchanges.

6.2 Interchange Upgrades

The following existing interchanges will be upgraded to improve capacity and accommodate the C-D road network:

Wingfield Interchange: Central to the ultimate scheme is the replacement of the two N7 road-over-road bridges over the N1 at the Wingfield interchange. These bridges have exceeded their design life and are in a critical state. The existing interchange will be

upgraded to a fully directional configuration with elevated ramps on two levels above the existing cloverleaf interchange (currently consisting of two levels). This will result in a four-level system interchange.

With this configuration, the turning movements from the Express Collector-Distributor (C-D) roads onto either freeway will be accommodated by the loop ramps of the cloverleaf interchange, while the elevated directional ramps will accommodate direct freeway to freeway turning movements between the core lanes of either freeway without the need to merge with local traffic.

Pattekloof Road Interchange: The Plattekloof Interchange was the first package of the WIP to be implemented. This interchange has been upgraded to accommodate a dual carriageway with dedicated NMT crossing, improving capacity, and facilitating the future N7 freeway and Collector-Distributor (C-D) road cross-section and alignment.

Bosmansdam Road Interchange: The existing bridge structures of the interchange crossing the N7 must be replaced to accommodate the wider N7 with C-D Roads and the Wingfield Interchange directional ramps. This presents an opportunity to upgrade Bosmansdam Road Interchange and not necessarily be limited to the existing interchange type or configuration.

Giel Basson Drive Interchange: The existing layout is a partial diamond interchange, with one (1) on-ramp and one (1) off-ramp on the eastern side of the interchange. There are no ramps going to or coming from Cape Town CBD on the western side of the interchange. The interchange will be upgraded to a full diamond interchange with dedicated BRT lanes.

Monte Vista Boulevard Interchange: The existing interchange will be upgraded by widening the bridge to provide additional southbound right-turn lane onto the inbound C-D road and NMT facilities along the eastern side of Monte Vista Blvd crossing the bridge.

Sable Road Interchange: The upgraded interchange will form a connection between the N1 and the M7 through Frans Conradie Extension. This interchange will be upgraded to improve capacity at the ramp terminals and accommodate dedicated BRT lanes.

Century City Drive Interchange: The existing left-in left-out interchange on Century City C-D Road will be upgraded to a full access interchange connected to the C-D Roads.

6.3 Frans Conradie Drive Extension

The existing Frans Conradie Drive in Goodwood will be extended with a minimum of two lanes in each direction and include provisions for BRT services in the median and dedicated NMT facilities along the outer edges. The new arterial will connect the existing Frans Conradie Drive to a new single-point diamond interchange at the M7 intersection and an upgraded Sable Road Interchange on the N1.

6.4 Link Road Extension

The existing Link Road from Montague Drive in Montague Gardens will be upgraded to a Class 2 arterial road with two lanes in each direction and dedicated NMT facilities along the outer edges. The upgraded and extended arterial will connect Montague Drive with a new half-diamond interchange (Link Road Interchange) on the N7 C-D Roads.

6.5 Prestige Drive Extension

The existing Prestige Drive in Maitland, which transitions into 1st Avenue in Kensington, will be upgraded to a Class 2 arterial road with a minimum of two lanes in each direction. In addition, this upgrade will provide for BRT services in the median and NMT along the outer edges.

The upgraded and extended arterial will connect Sunrise Circle on Jan Smuts Drive (M16) to a new half-diamond interchange (Prestige Drive Interchange) on the N1 C-D Roads. It will also cross Voortrekker Road at an upgraded signalised intersection.

6.6 Public Transport

The City is prioritising the right development in the right locations, along major road and rail corridors in Cape Town. This approach, coupled with a focus on public transport and NMT, will reduce travel times and costs, as well as deliver important environmental benefits.

The WIP will establish the following two (2) important public transport corridors for both future BRT and NMT routes, included in the City's IPTN plan 2032 published in 2014:

- Prestige Drive as part of BRT Trunk Route T17 – linking Maitland and Century City; and

- Frans Conradie Drive as part of BRT Trunk Route T19 – linking Parow and Century City.

Although rail is considered the "backbone" of any metro transport system, the rail system in the City is currently in crisis. The full benefits of integrated transport will not be enjoyed without the severe problems in rail being addressed, given the importance of this transport mode in Cape Town. The WIP is an example of the cooperative governance required to make rail a reality again. In collaboration with rail authorities (PRASA and Transnet), the WIP will provide the necessary bridge infrastructure within the Project footprint to facilitate the Cape Town - Atlantis; and the Langa - Mutual - Chempet future commuter rail corridors.

7. IMPLEMENTATION OF THE WINGFIELD PROJECT

Given the scale and complexity of the project, the ultimate scheme was divided into 12 packages which can be funded and implemented as separate standalone projects either concurrently or sequentially phased to suit available budgets and resources. These packages were carefully selected based on a set of criteria aimed at maximizing the benefits of each individual package in terms of congestion relief while minimizing abortive work and disruption to traffic. The relocation of high-voltage electrical services was also separated from the roadworks and treated as four distinct packages due to the specialized nature and significant costs involved. This strategy not only mitigates risk to the Department but also avoids the practical difficulties of managing clashes that arise from having multiple contractors working simultaneously on the same section of freeway.

Table 1: Implementation packages and cost

Package No.	Description	Cost Estimate
1	Refinery Interchange upgrade & dualling of Plattekloof Road	R 200,000,000.00
2	Sable Road Interchange upgrade	R 235, 000,000.00
3	Frans Conradie Drive Extension from the M7 to Sable Road Interchange	R 626,000,000.00
4	Frans Conradie & Jakes Gerweld at-grade intersection upgraded to a grade-separated interchange	R 308,000,000.00
5	Wingfield Interchange & New directional ramps & C-D Roads	R 2,466,000,000.00
6	Link Road Interchange plus C-D Roads with Link Road to Montague Drive and railway overpass	R 360,000,000.00
7	Bosmansdam Road Interchange upgrade	R 300,000,000.00
8	Century City Drive Interchange with C-D roads	R 137,000,000.00
9	Prestige Drive Extension and Interchange on the N1	R 499,000,000.00
10	Monte Vista Blvd and Giel Basson Drive I/c plus C-D	R 355,000,000.00
11	Wingfield Interchange outstanding directional ramps	R 1,152,000,000.00
Total		**R 6,403,000,000.00**

Table 1 indicates the proposed packages and high-level implementation costs. The construction sequence does not necessarily need to follow the above order; however, there are clear advantages to programming certain packages in sequence. For example, implementing Package 3 (Frans Conradie Extension) before Package 5 (Replacement of the N1/N7 bridges) is beneficial as it alleviates traffic congestion at both the Wingfield and Bosmansdam Road Interchanges, thereby facilitating traffic management during construction. Similarly, implementing Package 6 (Link Road Interchange) before Package 7 (Bosmansdam Interchange), would relieve the congestion at Bosmansdam Road Interchange and assist with accommodation of traffic from the north. Importantly, all roads packages, except for Packages 1 and 2, depend on the prior completion of one or more electrical packages in order to create the necessary space for planned road improvements, and therefore the electrical works needed to be strategically programmed at the outset.

Building on this, the proposed construction sequence seeks to strike a balance between the key objective of replacing the aging Wingfield Interchange bridges as quickly as possible while minimizing disruption to commuters. Given the high traffic volumes on the N1 and N7 and the strategic importance of these corridors, the implementation strategy was meticulously crafted to optimize traffic flow and minimize inconvenience during the rollout. To support this, SMEC developed a mesoscopic traffic model to fully understand the impacts of various construction phasing alternatives and to refine the phasing strategy and traffic accommodation proposals. Notably, Packages 1 and 2, which are unaffected by electrical services and critically reduce congestion around Century City, were prioritized as the first to address immediate congestion concerns and allow sufficient time for comprehensive stakeholder engagement and the necessary land acquisition processes for the successful roll out of the project.

Package 1, the upgrade of the Refinery Interchange, was successfully completed at a cost of R200 million over 30 months. It involved upgrading Plattekloof Road to a dual carriageway by constructing a new N7 overpass, and demolishing and replacing the existing bridge to support the future widened N7 cross-section. Construction commenced in 2021 and was completed in April 2024, providing immediate congestion relief during peak AM and PM periods. Looking ahead, Package 2, the upgrade of the Sable Road Interchange, is scheduled for implementation in 2026 subject to available funding. The roll-out of the balance of the scheme is considered to be practically achievable within a period of 10-15 years, however, the extensive financial requirements pose a significant challenge.

The Department of Infrastructure receives an annual budget of approximately R10 billion, which is distributed across various programs, including public works infrastructure and human settlements. Of this, about 50% – or R5 billion – is allocated to transport infrastructure, however the majority earmarked strictly for maintenance, leaving limited resources for upgrades and capital expansion projects. This financial challenge is further exacerbated by the increasing frequency of extreme whether events and flooding, as experienced in 2023 and 2024, which necessitates the reprioritization of committed funds to address flood damage. Consequently, while completing the ultimate scheme within 10-15 years is theoretically possible, the reality of relying solely on internal funding could push the timeline beyond 30 years. Therefore, the Department is actively seeking external funding support through various channels to ensure the project's completion within a shorter, more appropriate timeline, given the urgency of the current congestion issues and the project's significant potential to enhance regional traffic flow, safety, and economic development.

8. CONCLUSION

The aim of this paper was to highlight the WCGs initiatives for improving mobility, safety and unlocking development potential in Cape Town through the WIP. These initiatives were prompted by aging infrastructure, particularly the N7 bridges over the N1 at the Wingfield Interchange which have reached their design life and in need of replacement. In addition, Cape Town’s population growth, rapid motorisation and the lack of road capacity improvements over the last decades has led to intolerable levels of congestion along major routes such as the N1 and N7. This congestion is further compounded by the decline in rail service and concerns pertaining to the lack of safe and reliable public transport, which dissuades choice users from utilising public transport, thus increasing road space demand beyond the available capacity.

The modelling of the current and future scenarios revealed that the average speed on the freeway network in the study area during the morning peak-hour is 44km/hour, and that this will reduce to 14km/h by 2032 if the freeway network is not improved. This will result in a gridlock on the freeway system, and the proposed scheme seeks to mitigate this problem.

The scheme includes the construction of a two-lane C-D road system and three core lanes, forming a total of five lanes in each direction along the N7 and N1 within the study area. Furthermore, seven (7) existing interchanges will be upgraded to increase capacity and accommodate the C-D roads, while three (3) new interchanges will be built. A number of these interchanges were designed and modelled to provide for the full implementation of the 2032 CoCT Integrated Public Transport Plan, including rail, MyCiti BRT, NMT and other public transport infrastructure. Therefore, through these improvements, the WCG not only seeks to improve road capacity, but also appreciates the role of a reliable public

transport system in managing travel demand. These upgrades will be essential for congestion relief and economic development for the CoCT.

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