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Sibanye Gold's West Rand Tailings Retreatment Project

Transport Impact Assessment

Digby Wells and Associates (South Africa) (Pty) Ltd

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Glossary of Terms

COTO	Committee Of Transport Officials
CPP	Central Processing Plant
DoT	Department of Transport (South Africa)
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
GDRT	Gauteng Department of Roads and Transport
GTIA	Gauteng Transport Infrastructure Act
HCM	Highway Capacity Manual
HGV	Heavy Goods Vehicles
LDV	Light Delivery Vehicle
LOS	Level of Service
NMT	Non-motorised Transport
PCU	Passenger Car Unit
RTSF	Regional Tailings and Storage Facility
SATGR	South African Trip Generation Rates
TIA	Traffic Impact Assessment
TMH	Technical Methods for Highways
TRB	Transport Research Board (USA)
V/C	Volume Over Capacity ratio
Vph	Vehicles Per Hour

Executive Summary

Project overview

Aurecon was appointed by Digby Wells and Associates (South Africa) (Pty) Ltd, on behalf of Sibanye Gold Limited (SGL), to carry out a Traffic Impact Assessment (TIA) for the proposed SGL's West Rand Tailings Retreatment Project (WRTRP). This TIA is an input into the Environmental and Social Impact Assessment (ESIA) prepared by Digby Wells and Associates (South Africa) (Pty) Ltd

The project mainly involves the development of a Central Processing Plant (CPP) planned to ultimately treat 4 million tonnes of tailings per month. The residue from the CCP will be deposited at a new Regional Tailings Storage Facility (RTSF) to be constructed as part of the project. New pipelines of approximately 120km long will also be constructed for the transportation of tailings, water and slurry.

The proposed project is located near Glenharvie in Westonaria, Westrand, Gauteng. The project area has good accessibility to regional roads (R510, R28, R500) and national road N12. The proposed CPP site is located along Waterkloof Road; mid-way Kloof Main and Kloof No. 4 Shaft. And the proposed RSTF site is located along D962 Road.

The implementation of the project is planned in four phases comprising a planning and design phase (2015 - 2016), construction phase (2016 - 2020), operations phase (2019 - 2045); and decommissioning / closure (2045 and beyond) phase. Due to the huge capital investment required to implement the project, the construction and operation phases overlap as the project would have to generate income to fund itself over time.

Existing traffic and transport conditions

The road network that is expected to be affected by the project includes local roads immediately surrounding the proposed CPP and RTSF sites and major roads connecting the project area to the wider regional road network. The key affected roads include: N12 Moroka By-pass, D671(K170), Glenharvie Road, Waterkloof Road, and D962.

With the exception of the N12 which carries over 1,000 peak hour vehicles, the surrounding roads carry relatively low traffic volumes.

Currently, the majority of mining employees are transported by company buses and minibus taxis and there is low levels of pedestrian and cycling activity within the immediate surroundings of the proposed CPP and RTSF sites.

Development trip generation

It is anticipated that the project's impact on traffic and transport conditions will be most significant during the construction phase and the operational phase of the project as these phases are expected to generate the highest number of employee and heavy vehicle trips.

The CPP is expected to generate a total of 193 peak hour vehicle trips during the construction phase and 99 peak hour vehicle trips during the operational phase

The RSTF is expected to generate a total of 113 peak hour vehicle trips during construction and 12 peak hour vehicle trips during the operational phase.

The construction of the pipelines is only expected to generate approximately 17 peak hour vehicle trips, or 42 Passenger Car Units (PCUs).

Development traffic impact on the road network and transport

In order to establish the impact of the development traffic on the surrounding roads network, intersection capacity analysis was undertaken using SIDRA Intersection Software. The purpose of the analysis was to determine the existing and future volume/capacity ratios (v/c), delays (d) and level of service (LOS) for different years of assessment and the associated traffic impact of the development proposal.

The capacity analysis indicated that the analysed intersections are currently operating at acceptable LOS with the exception of the N12 / D671 intersection and D671 / Kloof Mine Access intersection which require upgrades to mitigate existing traffic impacts.

With the development additional traffic added onto the existing road network, all intersection will continue to operate at acceptable LOS apart from N12 / D671 intersection and D671 / Kloof Mine Access intersection which are still expected to operate at unacceptable LOS and experience significant delays. To improve the operations of N12 / D671 intersection and D671 / Kloof Mine Access intersection, it is recommended that both intersections be signalised.

It is important to note, the analysis demonstrated that the required intersection upgrades are meant to improve existing service levels at the two intersections discussed above. These upgrades are the responsibility of the planning authorities as they relate to existing traffic conditions and not additional traffic due to the proposed development. The analysis further indicated that the impact of the additional development traffic will be minimal. Notwithstanding, the use of points-men at the intersections of N12 / D671 and D671 / Kloof Mine Access is recommended as a short-term measure until upgrades that are required to address existing capacity problems are implemented by the planning authorities.

With regards to public transport, pedestrians and cyclist, since the employees will use company buses which will drop/pick them up within the project site, no additional users of these modes are expected. Therefore, no upgrade to improve public transport or pedestrian and cyclist facilities are recommended.

Access to CPP and RTSF

Access to the CPP site is proposed off Waterfkloof Road, at the current access to the Kloof No. 4 shaft. It is proposed that the current Kloof No. 4 Shaft access road will be realigned around the proposed CPP site. Access to the RTSF is proposed off the D962. The intersection spacing, at both accesses complies with the access spacing requirements for a Class 3 road in term of design guidelines. And the proposed intersection layouts at these access points have adequate capacity to accommodate both future background traffic and the proposed development traffic as the intersections are expected to operate at acceptable level of service.

Environmental impact assessment

The predicted impacts of the traffic generated by the project on the surrounding road network were quantitatively evaluated and relative significance was assigned to determine the manner in which these impacts are to be avoided, mitigated or managed. The evaluation considered direct or indirect impacts in terms of increased vehicle delays and traffic intensity, impact on increase in walking / cycling delays, threat to road safety; and possible deterioration in road surface conditions.

The evaluation indicated that the environmental impacts associated with the development proposal are expected to be minimal. However, the following recommendations which are aimed to minimising the development impact which should be the responsibility of the developer, have been made:

- Regular pedestrian and cycling activity awareness for staff working on site during all phases, as part of regular health and safety briefings;
- Road safety awareness campaigns within the neighbouring communities, mostly targeting schools and young people;
- Discourage site related traffic using roads through populated areas;
- Discourage right turns by heavy vehicles on busy priority-control roads, from a minor street during the peak hours;
- Discourage routing of heavy vehicles through residential areas;
- The developer is to engage the roads authorities regarding future maintenance needs of the surrounding road network;
- The developer is to ensure that the development's internal roads and access roads are kept to the required maintenance standards and to the satisfaction of roads authorities.

Conclusion

The project will have minimal impact on the existing road network, traffic and transport conditions. This study has demonstrated that the intersections studied in the current road network are operating well, except N12 / D671 and D671 / Kloof Mine Access intersections which require to be signalised and this is the responsibility of the planning authorities. In addition, no road upgrades or improvement to public transport, pedestrian and cyclist facilities are required to be implemented by the developer.

The qualitative evaluation of the environmental impact of the generated traffic shows that the significance of the cumulative traffic impacts associated with the project is minimal and the study has recommended mitigation measures to minimise or avoid the impact any traffic impact.

1 Introduction

1.1 Project background

Sibanye Gold Limited (SGL) has plans to recover gold and uranium from an estimated 1.3 billion tonnes of tailings in the broader West Rand area. The project is known as the West Rand Tailings Retreatment Project (WRTRP). Central to the proposed project is the development of a Central Processing Plant (CPP) and Regional Tailings Storage Facility (RTSF) with associated transportation pipelines and pump stations. The development operations will involve pumping of ore-bearing material from surrounding tailings storage facilities, using pipelines, to the CPP for processing. Extracted ore will be transported by trucks from the CPP and the waste material will be pumped to the RTSF.

SGL appointed Digby Wells and Associates (South Africa) (Pty) Ltd to carry out an Environmental Impact Assessment (EIA) of the project. Digby Wells and Associates (South Africa) (Pty) Ltd in turn appointed Aurecon to prepare a Transport Impact Assessment (TIA) to form part of the EIA.

This TIA study outlines the impact of the proposed project on the surrounding road network and transportation system in the study area. The study also assesses the environmental sensitivities that could be associated with the additional traffic generated by the project at all stages including planning, design, construction, operation, closure and post-closure.

A full TIA report was prepared by Siyazi Transportation Services Limpopo (Pty) Ltd. Detailed intersection analyses are provided in the Siyazi report (Siyazi, 2015). The Siyazi report will be submitted to planning authorities as part of the normal TIA process for development planning approvals.

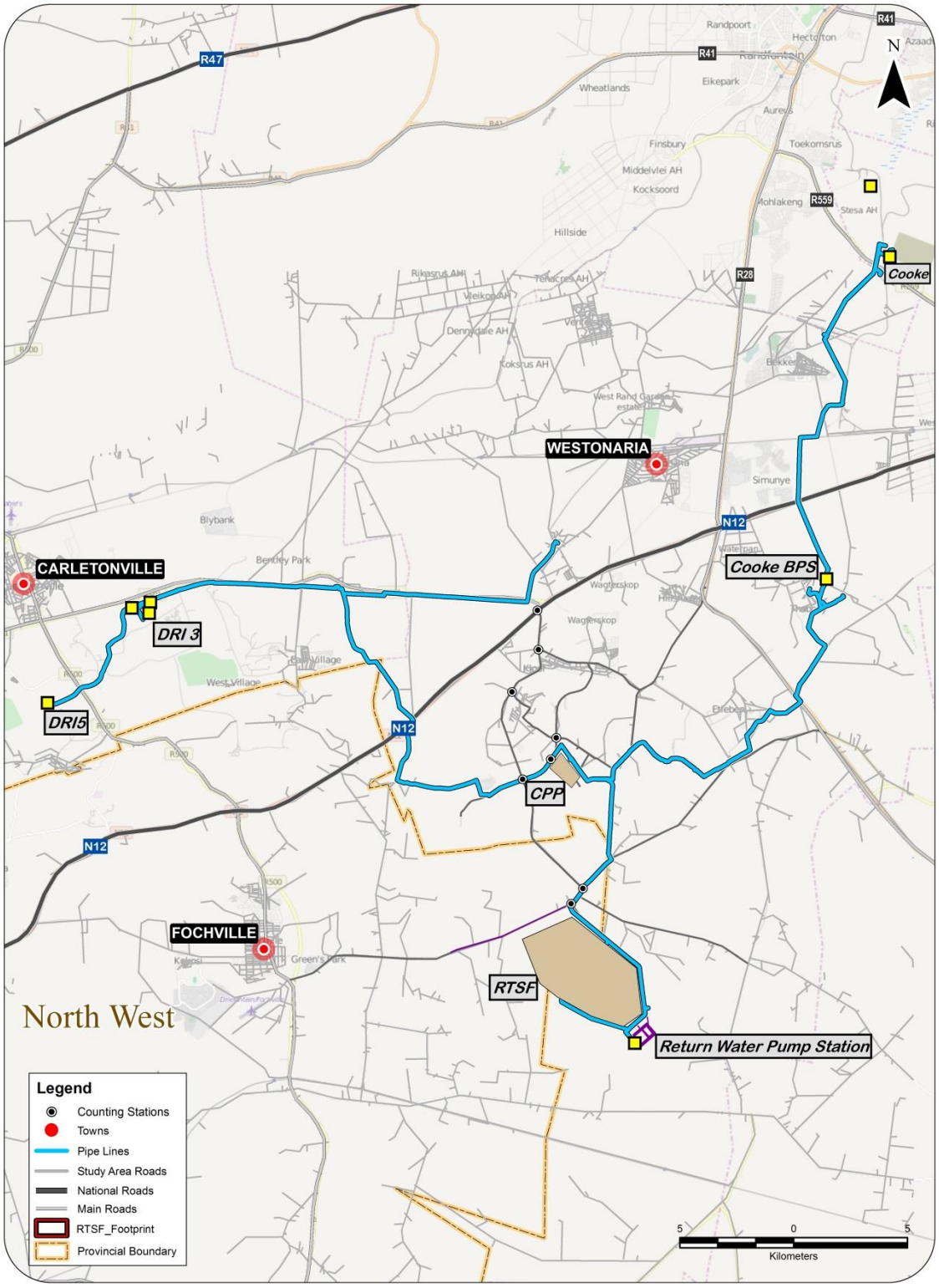
1.2 Site location

The proposed project is located near Glenharvie in Westonaria, Westrand, Gauteng. The area is an agricultural area surrounded by mining activities and communities founded on the mining legacy of the area. The project area has good accessibility to regional roads (R510, R28, R500) and national road N12. The proposed CPP site is located along Waterkloof Road; mid-way Kloof Main and Kloof No. 4 Shaft. And the proposed RSTF site is located along D962 Road, approximately 800m from the intersection of the D962 with the Kalbasfontein Road. The location of the site is shown in Figures 1 and 2.

1.3 Scope of this report

The scope of this report is limited to supporting the transport and traffic requirements as part of the EIA for the critical phases of the development. The scope includes the following:

- Description of surrounding road network and existing traffic conditions of critical intersections that potentially could be impacted by this development proposal;
- Impact assessment of the development traffic on the surrounding road network and recommendations on required road upgrades to mitigate traffic impact;
- Assessment of site accesses from the surrounding road network and recommendation on access configuration / geometry to meet development accessibility needs;
- Assessment of existing public transport provision and non-motorised transport (NMT) activity in the vicinity of the site and recommendations on appropriate facilities to accommodate the development generated public transport and NMT demand; and
- Recommend measures to be considered for mitigating the impact of the proposed development, from traffic engineering and transport planning perspectives.



SIBANYE GOLD TA

LOCALITY MAP

Figure 1 Locality Map

SIBANYE GOLD TA

STUDY AREA

Figure 2 **Aerial view of the site (CPP and RTSF sites)**

1.4 Terms of reference

This TIA was commissioned for purposes of demonstrating the impact of the proposed development on the existing transport system and the impact the additional traffic, due to the proposed development, could have on the environment. The TIA forms part of the EIA and the TIA report will be appended to the EIA report.

1.5 Declaration of independence

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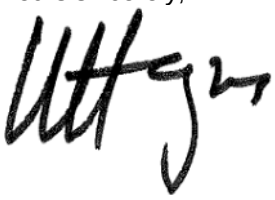
I, Werner Heyns as duly authorised representative of Aurecon South Africa (Pty) Ltd., hereby confirm my independence (as well as that of Aurecon South Africa (Pty) Ltd.) and declare that neither I nor Aurecon South Africa (Pty) Ltd have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of Sibanye Gold Limited (SGL) or Digby Wells and Associates (South Africa) (Pty) Ltd, other than fair remuneration for work performed, specifically in connection with the TIA Process for the proposed SGL West Rand Tailings Retreatment Project (WRTRP).

Yours sincerely,



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2 Proposed development

The ultimate WRTRP involves the construction of a large-scale Central Processing Plant (CPP) for the recovery of gold, uranium and sulphur from the available resources. The CPP, centrally located to the West Rand resources, will be developed in phases to eventually treat up to 4mt/month of tailings inclusive of current arisings. The resultant tailings will be deposited on a modern tailings storage facility (TSF) called the regional TSF (RTSF).

The following benefits are envisioned as a result of the implementation of the WRTRP:

- Investment of approximately R 9 billion into the West Rand District Municipality's economy;
- Significant job creation; it is estimated that 2 000 temporary opportunities will be created during the construction phase, with an estimated 500 sustainable employment opportunities once the project is operational;
- Protection of sensitive dolomitic aquifers and water resources through:
  - The removal of the historical TSFs, currently located on the dolomites.
  - The deposition of the reclaimed and reprocessed tailings onto the RTSF, which is to be constructed on impermeable bedrock, away from sensitive dolomitic areas.
- Removal of impacts associated with existing historical gold tailings facilities by reducing sulfur and uranium concentrations. The reduction in sulfur concentrations will in turn lower the risk of Acid Mine Drainage (AMD);
- Reduction of health risk to surrounding communities by addressing persistent dust fallout from TSF's spread over a vast area, into a single well-managed best practice designed RTSF.
- Release of valuable land for residential, commercial, and agricultural needs.
- Treatment of currently impacted water with the proposed Advanced Water Purification Facility (AWPF), which could potentially provide potable water for domestic and agricultural users, mitigating existing shortages

3 Approach and methodology

3.1 Study area

The study area that is likely to be used to access the CPP and RTSF development sites include the following roads:

- N12 Moroka By-pass;
- D671(K170);
- Glenharvie Road;
- Waterkloof Road; and
- D962.

It is expected that the following roads may be affected during the construction of pipelines:

- R501;
- N12;
- D962; and
- R559.

3.2 Assessment scenarios

The proposed project is planned to have the following phases:

- Planning and design (2015 to 2016);
- Construction (2016 to 2020);
- Operations (2018 to 2045); and
- Decommissioning and closure (2045 and beyond).

Due to the huge capital investment required to implement the project, the construction and operation phases overlap as the project would have to generate income to fund itself over time. Therefore, modular construction methods will be used on the project, thus allowing for construction and commissioning of the various sections of the project to be phased over time.

The project impact during the planning and design phase is considered very minimal as it will generate few light vehicles and occasional Light Delivery Vehicles (LDVs) or Heavy Goods Vehicles (HGVs) for various specialist investigations.

The project impact will be most significant during construction phase, as this will generate the highest number of employee and light delivery / heavy goods vehicle trips. Although the operational phase is expected to generate less traffic, its impact is critical in assessing over the long. It is expected that the decommissioning and closure phase will generate significantly less traffic. Therefore, from a traffic impact perspective, the most critical development phases are the construction and operational phases.

The following assessment years were thus considered:

- 2015 baseline;
- 2016 background traffic plus construction traffic;
- 2025* background traffic, without the proposed development (operational phase);
- 2025* background traffic, plus the proposed development traffic (operational phase).

*A design horizon of 5 years is normally required for TIAs (COTO, 2012), however a 10 year design year is used to maintain consistency with the detailed TIA that was already carried out by Siyazi (Siyazi, 2015) as part of development planning application process.

3.3 Traffic impact on the road network - capacity analysis

This Traffic Impact Assessment used SIDRA Intersection Software to undertake the intersection capacity analysis, since the intersections considered are reasonably well spaced and operate simplistically in terms of traffic control and flow. Detailed capacity analysis is not repeated in this study. Intersection capacity results are quoted from the Siyazi Limpopo (Pty) Ltd report (Siyazi, 2015). A background growth rate of 3% per annum was used for estimating future background traffic.

3.4 Access evaluation

Access to the site has been analysed using SIDRA Intersection Software.

3.5 Environmental Impact assessment and mitigation measures

An assessment of the significance of the environmental impact as a result of the proposed project from a traffic and transport point of view was qualitatively evaluated in terms of its extent (spatial scale), magnitude and duration (time scale). Any mitigation measures required were identified and specified

4 Existing traffic and transport conditions

4.1 Existing road network and traffic conditions

The surrounding road network is shown in Figure 1 and 2, and briefly discussed below. The current traffic demand was established from the Siyazi traffic count surveys. The traffic surveys were carried out on Friday 11 September 2015.

N12 Moroka By-pass

The N12 is an east-west major arterial that links Potchefstroom and Johannesburg. It is predominantly a four-lane dual carriageway east of Glenharvie, but narrows to a two-lane highway just west of the project area. It is surfaced and in a good condition. In the immediate vicinity of the project area, intersections on the N12 are at grade and priority controlled, with the N12 given priority over side roads.

The N12 carries approximately 1,000 and 1,300 vehicles per an hour (vph) in both directions during the AM and PM peak hours, respectively. Heavy vehicles account for about 15 to 20 percent of the through traffic on the N12. Due to the high volumes along N12, Minor roads with significant volumes of right turning vehicles experience high levels of delay due to the lack of gaps on the main traffic stream as vehicles travel at relatively high speeds thus posing a road safety risk.

D671 (K170)

The D671 Road is a minor arterial road linking the N12 with the D962 Road. It provides access to the Glenharvie community, the Kloof Mine as well as indirect access to Kloof shaft No 4 and 7. It is a two lane surfaced road, without a dividing island and it is in a relatively good surface condition.

It carries approximately 480 and 620 vph in both directions during the AM and PM peak hours respectively. The traffic on the D671 experiences significant delays at its intersection with the N12.

D962 Road

The D962 Road is a two lane minor arterial road running in an east-west direction between Randfontein Road and the R500 in Fochville. It is surfaced and in a relatively good conditions. It carries approximately 120 vph in both directions during both the AM and PM peak hours.

Glenharvie Road

This road is a two lane local distributor road providing access to the Glenharvie community and connects the D671 Road with the D1114 in Hillshaven. Access to the road is provided through service roads and generally does not have direct access to individual properties. It is surfaced and in a relatively good condition. It carries approximately 220 and 280 vph in both directions during the AM and PM peak hours respectively.

Waterkloof Road

Waterkloof Road is a two lane local distributor road, running in the north-south direction between Kloof No 7 Shaft and Glenharvie residential area. It mainly provides access to the Kloof mine. The road is surfaced and in relatively good condition. On average, the road carries approximately 120 vph in both directions during both the AM and PM peak hours.

4.2 Existing public transport, walking and cycling activities

During a site visit carried out on the 1 September 2015, no formal walking and cycling infrastructure, in the form of walkways and bus stops, was observed. Very little pedestrian activities were observed with the exception of the area near the residential areas. There was a strong visibility of coaches / buses transporting mining staff to the mine shafts.

4.3 Future road network planning

During the period 1973 to 1975 an investigation was undertaken to plan a road network for the Pretoria -Witwatersrand -Vereeniging (PWV) complex. This involved a Transportation Study, Road

Network planning, Town and Regional Planning and an Environmental investigation. As an output of this process the Strategic Road Network (SRN) for the Gauteng province was created.

An extract of SRN road planning for the area in the immediate vicinity of the proposed CPP and RTSF is provided in Figure 3. It is evident from the extract that the location of the RSTF is interfering with the strategic highway PWV planned for the area.

It terms of the Gauteng Transport Infrastructure Act (GTIA, Act 8 of 2001), a report is required for developments within 200m of the published centrelines of the routes or within 500m of intersection of any two published provincial routes. The location of the RTSF triggers a requirement of report as stated in Section 7 of the GTIA. The Section 7 report is not part of this study's scope of work. It is recommended that the Section 7 assessment be carried out prior to any detail design of the RTSF to obtain an earlier buy in from the relevant planning authorities.

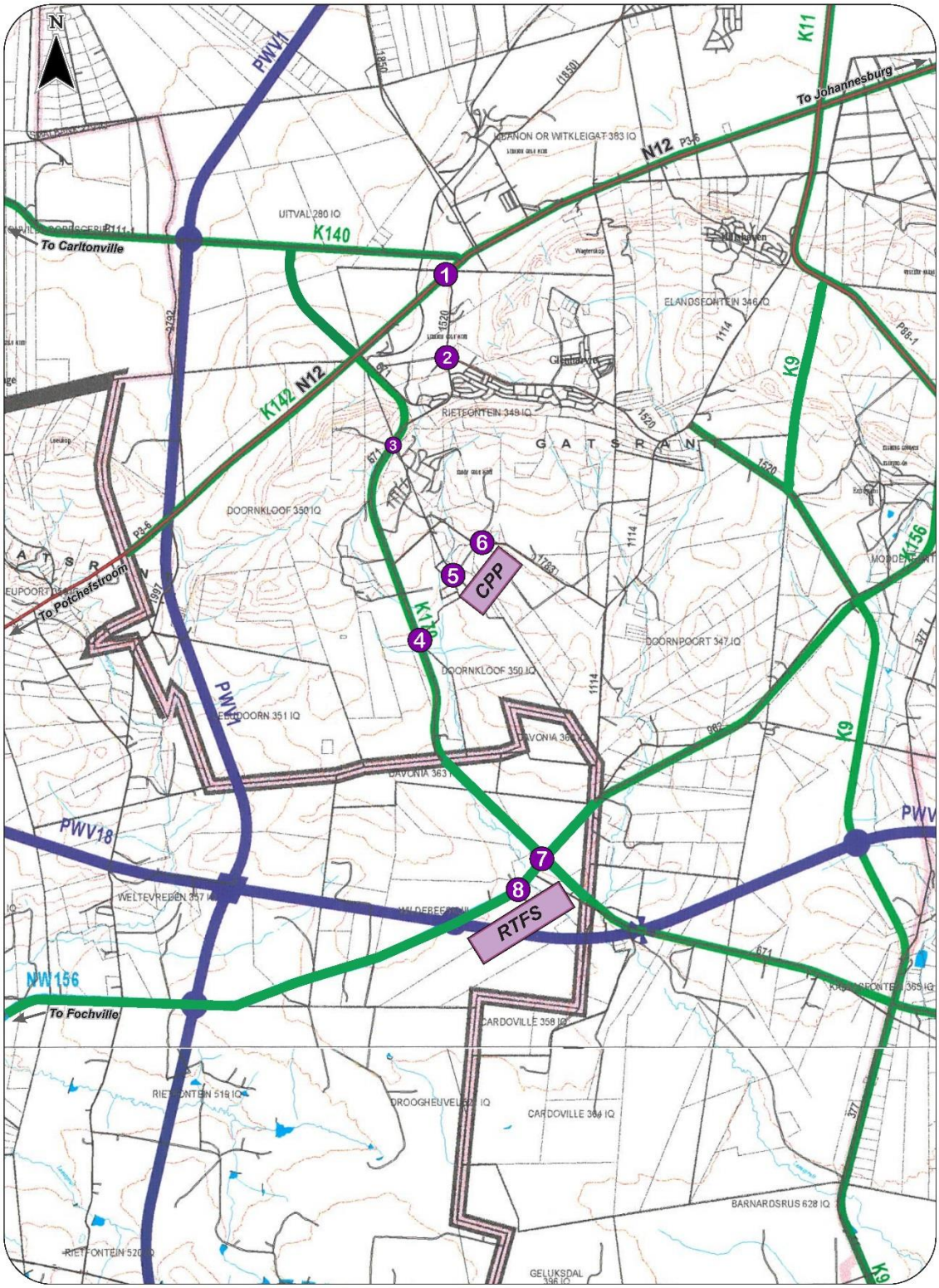

Figure 3 Extract of the Gauteng strategic road network

5 Trip generation

5.1 CPP and RTSF trip generation

Traditionally, development traffic is estimated by applying trip generation rates from the South African Trip Generation Rates manual (SATGR) (DoT, 1995) or the Committee of Transport Officials (COTO) (September 2012) South African Trip Data manual (TMH 17). However, neither the SATGR manual nor COTO manual have recommended trip rates for mining activities. As an alternative it was considered appropriate to estimate the mines trip generation from first principle using development and traveller characteristics (e.g. mode split, vehicle occupancy) along with estimated trip generation details provided by the client as shown in Table 1.

Table 1 Development trip generation indicators (CPP and RTSF)

Attribute	Facility	Construction Phase	Operational Phase
Employees (Employees per day)	CPP	2,000	500
	RTSF	825	75
	Total	**2,875**	**575**
Working Shifts	CPP and RTSF	Shift 1 – 06h00 to 18h00	Shift 1 – 07h00 to 15h00 Shift 2 – 15h00 to 23h00 Shift 3 – 23h00 to 07h00 Day Shift – 07h00 to 16h00
Delivery Vehicles (LGVs, HGVs and construction vehicles, per day)	CPP	151	25
	RTSF	147	1
	Total	**298**	**26**
Product Export (30 Tonne HGVs, per day)	CPP	-	23
	RTSF	-	-
	Total	**-**	**23**

The key trip generating activities for the development are employment trips, delivery vehicles for consumables, fuel, and materials, as well as haulage trucks for final products that will be transported to the various markets.

The following key assumptions were made in terms of trip generation estimation:

- All employment trips occur during either the AM or PM peak hours;
- Up to 95% of the employees use staff buses and the remainder use private vehicle;
- A vehicle occupancy of 3 persons per vehicle was assumed for private vehicles and 40 persons per vehicle for buses;
- All buses entering the site will exit within the same hour i.e. no bus holding within the site;
- Bus shuttles will have a capacity of 20 and 60-seater vehicles;
- 20% of all development-induced heavy vehicle traffic occurs during both the AM and PM peak hour i.e. 20% in the AM peak hour and another 20% in the PM peak hour;
- It is assumed that all heavy vehicles enter and leave the site within the same hour;

The expected development trips are provided in Tables 2 to 5 for the construction and operational phases.

Table 2: Development trip generation – Construction phase | Employee trips

Facility	Employees (employees / day)	Mode	Person trips per mode	Vehicle Occupancy	Vehicle Trips - AM			Vehicle Trips - PM		
					Total	In	Out	Total	In	Out
CCP	2,000	Car	116	3	39	39	0	39	0	39
		Bus	1,884	40	94	47	47	94	47	47
RTSF	825	Car	45	3	15	15	0	15	0	15
		Bus	780	40	39*	20	20	39	20	20
Total (CCP & RTSF – Construction phase employee trips)					**187**	**120**	**67**	**187**	**67**	**120**

***** Bus trips are calculated as two trips per bus due to the assumption all buses entering the site during the peak hour also exit out during the same peak hour i.e. assuming no bus holding within the site

Table 3: Development trip generation – Construction phase | Delivery trips

Facility	Deliveries (Trucks / day)	Vehicle Type	Vehicles Per Day (By type)	Vehicle Trip Rate	Vehicle Trips - AM			Vehicle Trips - PM		
					Total	In	Out*	Total	In	Out
CCP	151	LGVs & HGVs	141	0.40*	56	28	28	28	28	28
		Tipper Trucks	10	0.40*	4	2	2	4	2	2
RTSF	147	LGVs & HGVs	117	0.40*	47	23	23	47	23	23
		Tipper Trucks	30	0.40*	12	6	6	12	6	6
Total (CCP & RTSF – Construction phase delivery trips)					**119**	**59**	**59**	**119**	**59**	**59**

* 20% of daily delivery trips, with the assumption that all heavy vehicles enter and leave the site within the same hour

Table 4: Development trip generation – Operational phase | employee trips

Facility	Shift	Employees	Mode Share	Vehicle Occupancy	Vehicle Trips - AM			Vehicle Trips - PM		
					Total	In	Out	Total	In	Out
CCP	Day Shift	123	Car	3	27	27	0	27	0	27
			Bus	40	2	1	1	2	1	1
	3 Shifts	377	Car	3	46	23	23	46	23	23
			Bus	40	2**	1	1	2**	1	1
			Mini-bus	10	2**	1	1	2**	1	1
RTSF	3 Shifts	75	Private	3	6**	3	3	6**	3	3
			Mini-bus taxi (Pvt)	10	4**	2	2	4**	2	2
Total (CCP & RTSF – Operational phase employee trips)					**89**	**58**	**31**	**89**	**31**	**58**

* * Bus trips are calculated as two trips per bus due to the assumption: all buses entering the site during the peak hour also exit during the same peak hour i.e. assuming no bus holding within the site

** Shift change-overs, one shift entering the site, one shift exiting the site

Table 5: Development trip generation – Operational phase | delivery / export trips

Facility	Generator	Vehicles Per Day	Vehicle Types	Vehicle Trip Rate	Vehicle Trips - AM			Vehicle Trips - PM		
					Total	In	Out	Total	In	Out
CPP	Deliveries	25	LGVs & HGVs	0.4	10	5	5	10	5	5
	Export	23	HGVs	0.4	10	5	5	10	5	5
RTSF	Deliveries	1	LGVs & HGVs	2.0*	2	1	1	2	1	1
Total (CCP & RTSF)					**22**	**11**	**11**	**22**	**11**	**11**

* Assuming the RTSF trip can happen during either the AM or PM peak hour, with an in and out trip during the same peak hour.

The trip generation calculations show that the CPP is expected to generate a total of 193 peak hour vehicle trips during the construction phase, of which 133 are employment related and 60 are related to delivery and export activities. The RSTF is expected to generate a total of 113 peak hour vehicle trips, during the same phase, of which 54 are employment related and 59 are related to delivery activities.

The CPP is expected to generate a total of 99 peak hour vehicle trips during the operational phase, of which 79 are employment related and 20 are related to delivery and export activities. The RSTF is expected to generate a total of 12 peak hour vehicle trips, also during the operational phase, of which 10 are employment related and 2 are related to delivery activities.

5.2 Pipeline construction

The construction of the pipelines will be phased such that all sites will utilise the same fleet of construction vehicles. The typical fleet requirements of each site as well at the expected daily and peak hour trip generation estimates are tabulated below. The pipeline construction is expected to start in 2016 and continue, in stages, until 2024.

Table 6: Pipeline construction - trip generation

Vehicle Type	Fleet Size	Daily Trip Rate (Per Vehicle)	Total Trips Per Day	Peak Hour Trips
Light Delivery Vehicles (LDV)	4	6	24	5
Staff bus (20-seat)	2	2	4	1
Flatbed truck (HGV)	1	2	2	1
Diesel tanker (HGV) (1 delivery per week)	1	2	2	1
Tipper truck (HGV)	4	4	16	3
Construction material deliveries (HGV) (3 deliveries per day)	1	6	6	1
Concrete delivery (HGV) (6 deliveries per day)	1	12	12	2
Low bed trucks for equipment delivery (HGV) (5 deliveries per day)	1	10	10	2
Other deliveries (LGV / HGV) (5 deliveries per day)	1	6	6	1
Total			**82**	**17**

It is expected that the pipeline construction activities will generate approximately 80 LGV and HGV trips per day or 17 vehicle trips during peak hour (or 42 Passenger Car Units (PCUs)). As each site is likely to generate less than 50 peak hour vehicles, no capacity analysis was carried out for the pipeline construction activities as negligible impact is expected. The capacity analysis results presented in the Section 6 relates to the CPP and RTSF site activities.

6 Traffic impact on road network - Capacity analysis

Capacity analysis was carried out by Siyazi as part of the detailed TIA. The analysis results are summarised in this section. The traffic flow diagrams are included in Appendix B. All intersection capacity modelling results are extracted from the Siyazi report, with commentary and result analysis by Aurecon.

6.1 Assessment criteria

The performance criteria to determine the level of service (LOS) are provided in Table 7 below. The level of service (LOS), delay (d) and volume / capacity (v/c) have been defined in accordance with the Highway Capacity Manual 2000 (TRB, 2000).

Table 7: Performance (LOS) Criteria

Level Of Service (LOS)	Average delay (d) per vehicle (Seconds)	
	Signal and Roundabouts	Stop and Give-Way / Yield Signs
A	d ≤ 10	d ≤ 10
B	10 < d ≤ 20	10 < d ≤ 15
C	20 < d ≤ 35	15 < d ≤ 25
D	35 < d ≤ 55	25 < d ≤ 35
E	55 < d ≤ 80	35 < d ≤ 50
F	d > 80	d ≥ 50

Level of Service (LOS) at intersections is a measure of intersection performance, determined based on delay for signalised and unsignalised intersections. In most urban areas an overall rating of A to D is normally considered acceptable. Levels of service C or better are considered desirable and levels of service E and F are normally undesirable (DoT, 1995) and (COTO, 2012).

6.2 Scenario 1 – 2015 Baseline

Table 8 Capacity analysis results – Scenario 1: 2015 Baseline

Intersection			AM			PM		
Name	**Type**	**Approach**	**V/C**	**Delay (Sec)**	**LOS**	**V/C**	**Delay (Sec)**	**LOS**
Int No 1 N12 / D671 Rd	Priority Control	N12 – SB	0.178	3.2	A	0.210	2.5	A
		D671 – WB	1.312	349.7	F	6.931	5,426.1	F
		N12 – NB	0.087	0.1	A	0.180	0.1	A
		Overall	**1.312**	**53.8**	**F**	**6.931**	**1,221.8**	**F**
Int No. 2 D671 Rd / Glenharvie Rd	Priority Control	D671 – SB	0.143	1.2	**A**	0.052	2.4	**A**
		Glenharvie – WB	0.240	11.9	B	0.336	14.4	B
		D671 – NB	0.063	1.6	A	0.166	1.1	A
		Overall	**0.240**	**3.8**	**A**	**0.336**	**4.5**	**A**
Int No. 3 D671 Rd / Kloof Mine	Priority Control	D671 – SB	0.122	3.1	**A**	0.150	3.8	**A**
		Kloof Mine – WB	0.458	18.4	C	1.348	355.1	F
		D671 – NB	0.080	2.1	**A**	0.130	0.9	**A**
		Overall	**0.458**	**6.9**	**A**	**1.348**	**117.7**	**F**

Intersection			AM			PM		
Name	Type	Approach	V/C	Delay (Sec)	LOS	V/C	Delay (Sec)	LOS
Int No. 4 D671 / Waterkloof Rd	Priority Control	D671 – SB	0.055	6.4	A	0.055	6.8	A
		Waterkloof Road – WB	0.058	12.5	**B**	0.107	12.5	**B**
		D671 – NB	0.020	4.4	A	0.007	4.5	A
		Kloof No. 7 – EB	0.042	11.1	**B**	0.073	10.5	**B**
		Overall	**0.058**	**8.2**	**A**	**0.107**	**9.3**	**A**
Int No. 5 Waterkloof Road / Kloof No. 4	Priority Control	Waterkloof Rd – SB	0.035	1.8	**A**	0.033	1.1	**A**
		Kloof No.4 – WB	0.052	9.7	A	0.216	8.9	A
		Waterkloof Rd – NB	0.037	4.6	**A**	0.064	3.2	**A**
		Overall	**0.052**	**5.3**	**A**	**0.033**	**6.4**	**A**
Int No. 6 Waterkloof Rd / Waterkloof Mine Access	Priority Control	Waterkloof Rd – SB	0.022	0.8	**A**	0.011	1.0	**A**
		D1783 Road – WB	0.049	8.8	A	0.097	9.0	A
		Waterkloof Rd – NB	0.031	1.9	**A**	0.078	0.1	**A**
		Kloof Mine Access – EB	0.013	6.9	**A**	0.006	7.4	**A**
		Overall	**0.049**	**4.0**	**A**	**0.097**	**3.4**	**A**
Int No. 7 D671 Rd / D961 Rd	Priority Control	D962 Road – SB	0.019	2.5	**A**	0.047	2.1	**A**
		D962 Road – NB	0.038	4.7	A	0.030	3.6	A
		D671 Road – EB	0.013	9.5	**A**	0.052	9.8	**A**
		Overall	**0.038**	**4.6**	**A**	**0.052**	**4.3**	**A**
Int No. 8 D962 Rd / RTSF Access	Priority Control	D962 Rd – SB	0.031	0.2	**A**	0.071	0.1	**A**
		RFST Access – WB	0.003	7.8	A	0.003	7.3	A
		D962 – NB	0.099	0.1	**A**	0.067	0.1	**A**
		Overall	**0.099**	**0.2**	**A**	**0.071**	**0.2**	**A**

The analysis results show that all analysed intersections are operating at acceptable levels of service, with minimum delays except for two intersections:

N12 / D671 intersection

At this intersection, both N12 approaches are operating at acceptable Level of Service (LOS) with minor vehicle delays. However, there are significant delays on the minor road, D671, during the PM peak due to the high right turning vehicles (in excess of 370 vph). Due to the excessive delays on the D671 approach, the intersection is on overall operating at an unacceptable LOS (i.e. LOS F).The main cause of the delays is the lack of gaps in the main traffic stream on the N12 to allow traffic on the minor approach to enter the intersection safely. Due to the excessive waiting time on the minor road, drivers on the side road will often take unsafe gaps which can result in accidents. This is a serious concern that needs to be addressed to solve the existing operational aspect of the intersection.

It is understood that the upgrade of the intersection is currently being considered by Gauteng Department of Roads and Transport (GDRT). This upgrade comprises of additional acceleration and deceleration lanes on the N12. There is also a proposed alternative design for the provision of a ramp to replace the current right turn from the D671. The timelines for these upgrades are not certain (Siyazi, 2015).

D671 Rd / Kloof Mine Access intersection

The D671 approaches are operating at acceptable LOS with minor vehicle delays. However, during the PM peak hour, the Kloof Mine Access approach experiences major delay due to the high volume of right turning movement, which result in poor LOS for the overall intersection. Upgrades are required to improve the current operational conditions of the intersection.

Upgrades tested to improve existing traffic conditions

Upgrade options were tested to improve the current operational conditions of N12 / D671 intersection and D671 Rd / Kloof Mine Access intersection.

For N12 / D671 intersection, a traffic signal was tested in addition to the upgrades that are currently being considered by the GDRT. These upgrades demonstrated a potential to improve the operational conditions of the intersection from LOS F to LOS B, which implies a significant improvement.

One of the GDRT proposals is summarised in the image below:

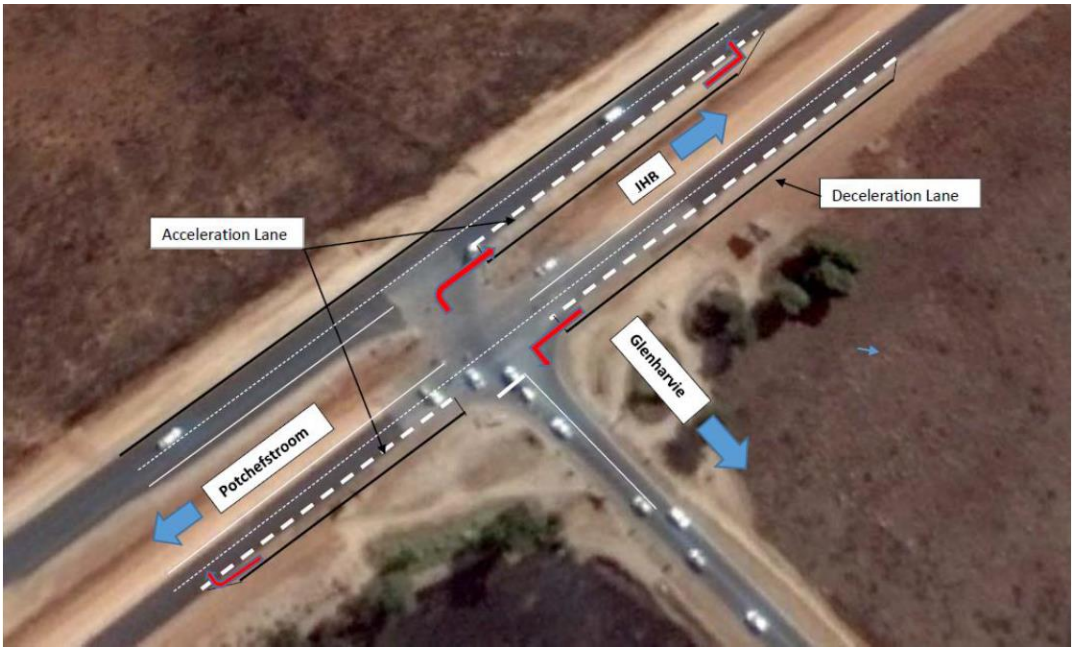

Figure 4 N12 / D671 upgrade proposal that is being considered by GDRT

Source: (Siyazi, 2015)

For D671 / Kloof Mine Access intersection, both the installation of a traffic light and upgrading the intersection to a roundabout were tested. Both options could reduce the levels of service to within acceptable thresholds. The signalised option is preferred over the roundabout due to the significant portion of heavy vehicles in the local traffic.

The results for Scenario 1 analysis with the tested improvements are provided in the table below:

Table 9: Capacity analysis results – Scenario 1: 2015 Baseline

Intersection			AM			PM		
Name	**Type**	**Approach**	**V/C**	**Delay (Sec)**	**LOS**	**V/C**	**Delay (Sec)**	**LOS**
Int No 1 N12 / D671 Rd	Traffic Signal	N12 – SB	0.468	10.9	B	0.673	13.4	B
		D671 – WB	0.476	19.2	B	0.698	19.5	B
		N12 – NB	0.230	7.1	A	0.576	10.8	B
		Overall*	**0.476**	**11.1**	**B**	**0.698**	**13.8**	**B**
Int No. 3 D671 Rd / Kloof Mine	Traffic Signal	D671 – SB	0.320	15.1	**B**	0.500	19.6	**B**
		Kloof Mine – WB	0.327	18.0	B	0.504	16.3	B
		D671 – NB	0.203	13.4	**B**	0.433	16.5	**B**
		Overall*	**0.327**	**15.4**	**B**	**0.504**	**17.4**	**B**

6.3 Scenario 2 – 2016 with construction traffic

In this scenario, 2016 projected background traffic plus construction traffic was analysed with road upgrades as outlined in the previous section.

Table 10: Capacity analysis results – Scenario 2: 2016 background, with construction traffic

Intersection			AM			PM		
Name	**Type**	**Approach**	**V/C**	**Delay (Sec)**	**LOS**	**V/C**	**Delay (Sec)**	**LOS**
Int No 1 N12 / D671 Rd	Traffic Signal	N12 – SB	0.586	11.7	B	0.715	14.6	B
		D671 – WB	0.582	19.3	B	0.787	21.8	C
		N12 – NB	0.251	8.1	A	0.612	11.9	B
		Overall*	**0.592**	**12.1**	**B**	**0.787**	**15.4**	**B**
Int No. 2 D671 Rd / Glenharvie Rd	Priority Control	D671 – SB	0.186	1.0	**A**	0.070	2.4	**A**
		Glenharvie – WB	0.312	14.3	B	0.606	23.3	C
		D671 – NB	0.089	1.7	A	0.226	1.3	A
		Overall*	**0.312**	**3.9**	**A**	**0.606**	**6.8**	**A**

Intersection			AM			PM		
Name	**Type**	**Approach**	**V/C**	**Delay (Sec)**	**LOS**	**V/C**	**Delay (Sec)**	**LOS**
Int No. 3 D671 Rd / Kloof Mine	Traffic Signal	D671 – SB	0.347	13.8	**B**	0.478	18.8	**B**
		Kloof Mine – WB	0.352	19.4	B	0.514	16.9	B
		D671 – NB	0.233	12.6	**B**	0.492	16.6	**B**
		Overall*	**0.352**	**14.7**	**B**	**0.514**	**17.3**	**B**
Int No. 4 D671 / Waterkloof Rd	Priority Control	D671 – SB	0.073	5.8	A	0.070	6.3	A
		Waterkloof Road – WB	0.165	13.3	**B**	0.247	13.8	**B**
		D671 – NB	0.094	5.7	A	0.060	5.1	A
		Kloof No. 7 – EB	0.059	12.3	**B**	0.088	11.4	**B**
		Overall*	**0.165**	**8.5**	**A**	**0.247**	**9.7**	**A**
Int No. 6 Waterkloof Rd / Waterkloof Mine Access	Priority Control	Waterkloof Rd – SB	0.038	5.4	**A**	0.020	5.4	**A**
		D1783 Road – WB	0.270	11.4	B	0.823	28.3	D
		Waterkloof Rd – NB	0.160	7.2	**A**	0.135	6.2	**A**
		Kloof Mine Access – EB	0.020	9.8	**A**	0.009	10.2	**B**
		Overall*	**0.270**	**8.9**	**A**	**0.823**	**19.8**	**C**
Int No. 7 D671 Rd / D961 Rd	Priority Control	D962 Road – SB	0.112	5.7	**A**	0.069	5.4	**A**
		D962 Road – NB	0.068	4.9	A	0.070	6.8	A
		D671 Road – EB	0.136	10.3	**B**	0.223	9.7	**A**
		Overall*	**0.136**	**6.5**	**A**	**0.223**	**8.3**	**A**
Int No. 8 D962 Rd / RTSF Access	Priority Control	D962 Rd – SB	0.105	3.8	**A**	0.096	1.9	**A**
		RFST Access – WB	0.112	9.7	A	0.139	9.7	A
		D962 – NB	0.068	0.4	**A**	0.075	0.4	**A**
		Overall*	**0.112**	**3.1**	**A**	**0.139**	**3.0**	**A**

The analysis results demonstrate that the existing road network, with the stated improvement, will have adequate capacity to accommodate both the background traffic and the development's construction traffic. The development's construction traffic has minimal impact on the operational condition of the local road network.

It is important to note that the required upgrades are the responsibility of the planning authorities to implement since they are aimed to improve existing situation. However, the timelines for potential

implementation of the required upgrades are currently unknown. The signals may also require detail signal warrant studies as well as synchronisation and or co-ordination with adjacent intersections.

A short term solution to signal installation could be the use of points-men during the peak periods. Although this may be a challenge during days with adverse weather conditions, it is deemed to be just as effective as the traffic signals in normal weather conditions and has an advantage of real-time allocation of green times based on approach traffic demand.

The use of points-men is therefore recommended for implementation by the developer during the AM and PM peak hours at N12 / D671 intersection and D671 Rd / Kloof Mine Access intersection for the duration of the construction phase, pending the possible implementation of the signal control by the roads and planning authorities.

6.4 Scenario 3 – 2025 Background, without the proposed development traffic (operational phase baseline)

The scenario is based on the scenario 2 network. The demand however account for background growth up to the year 2025, however, the development traffic is not included. This scenario forms the basis upon which the operational phase impact of the proposed development is determined.

Table 11: Capacity analysis results – Scenario 3: 2025 background, without the proposed development traffic

Intersection			AM			PM		
Name	**Type**	**Approach**	**V/C**	**Delay (Sec)**	**LOS**	**V/C**	**Delay (Sec)**	**LOS**
Int No 1 N12 / D671 Rd	Traffic Signal	N12 – SB	0.588	11.5	B	0.777	17.0	B
		D671 – WB	0.603	20.8	C	0.805	25.4	C
		N12 – NB	0.288	7.4	A	0.665	13.8	B
		Overall*	**0.603**	**11.8**	**B**	**0.805**	**17.7**	**B**
Int No. 2 D671 Rd / Glenharvie Rd	Priority Control	D671 – SB	0.193	1.2	**A**	0.070	2.4	**A**
		Glenharvie – WB	0.403	15.8	C	0.606	23.3	C
		D671 – NB	0.088	2.0	A	0.226	1.3	A
		Overall*	**0.403**	**4.8**	**A**	**0.606**	**6.8**	**A**
Int No. 3 D671 Rd / Kloof Mine	Traffic Signal	D671 – SB	0.332	14.6	**B**	0.450	17.9	**B**
		Kloof Mine – WB	0.334	18.5	B	0.537	17.7	B
		D671 – NB	0.243	13.1	**B**	0.505	15.5	**B**
		Overall*	**0.334**	**15.0**	**B**	**0.537**	**16.8**	**B**
Int No. 4 D671 / Waterkloof Rd	Priority Control	D671 – SB	0.074	6.5	A	0.075	6.9	A
		Waterkloof Road – WB	0.086	13.3	**B**	0.164	13.8	**B**
		D671 – NB	0.028	4.5	A	0.009	4.5	A
		Kloof No. 7 – EB	0.057	11.4	**B**	0.098	10.7	**B**
		Overall*	**0.086**	**8.5**	**A**	**0.164**	**9.6**	**A**

Intersection			AM			PM		
Name	**Type**	**Approach**	**V/C**	**Delay (Sec)**	**LOS**	**V/C**	**Delay (Sec)**	**LOS**
Int No. 6 Waterkloof Rd / Waterkloof Mine Access	Priority Control	Waterkloof Rd – SB	0.029	4.3	**A**	0.014	3.9	**A**
		D1783 Road – WB	0.155	9.7	A	0.582	14.7	B
		Waterkloof Rd – NB	0.055	5.2	**A**	0.115	5.4	**A**
		Kloof Mine Access – EB	0.017	7.1	**A**	0.008	7.8	**A**
		Overall*	**0.155**	**7.2**	**A**	**0.582**	**11.1**	**B**
Int No. 7 D671 Rd / D961 Rd	Priority Control	D962 Road – SB	0.026	2.6	**A**	0.063	2.1	**A**
		D962 Road – NB	0.050	4.7	A	0.040	3.6	A
		D671 Road – EB	0.019	9.8	**A**	0.040	10.2	**B**
		Overall*	**0.050**	**4.6**	**A**	**0.075**	**4.4**	**A**
Int No. 8 D962 Rd / RTSF Access	Priority Control	D962 Rd – SB	0.041	0.1	**A**	0.095	0.1	**A**
		RFST Access – WB	0.003	8.0	A	0.003	7.7	A
		D962 – NB	0.133	0.1	**A**	0.090	0.1	**A**
		Overall*	**0.133**	**0.2**	**A**	**0.095**	**0.1**	**A**

The existing network, with improvements discussed in section 5.3, will have adequate capacity to accommodate background traffic growth over the 10 year design horizon.

6.5 Scenario 4 – 2025 Background, plus the proposed development traffic (Operational phase)

The network and demand assumptions in this scenario are similar to those made in scenario 3. However the development traffic was added to the network to test the traffic impact of the proposed development during the operational phase.

Table 12: Capacity analysis results – Scenario 4: 2025 background, plus the proposed development traffic (operational)

Intersection			AM			PM		
Name	**Type**	**Approach**	**V/C**	**Delay (Sec)**	**LOS**	**V/C**	**Delay (Sec)**	**LOS**
Int No 1 N12 / D671 Rd	Traffic Signal	N12 – SB	0.612	11.7	B	0.777	17.0	B
		D671 – WB	0.645	21.2	C	0.805	25.4	C
		N12 – NB	0.288	7.7	A	0.665	13.8	B
		Overall*	**0.645**	**12.1**	**B**	**0.805**	**17.7**	**B**
Int No. 2 D671 Rd / Glenharvie Rd	Priority Control	D671 – SB	0.210	1.1	**A**	0.080	2.2	**A**
		Glenharvie – WB	0.370	17.2	C	0.660	26.7	D
		D671 – NB	0.096	2.0	A	0.239	1.3	A
		Overall*	**0.436**	**4.9**	**A**	**0.660**	**7.2**	**A**
Int No. 3 D671 Rd / Kloof Mine	Traffic Signal	D671 – SB	0.359	13.8	**B**	0.441	17.3	**B**
		Kloof Mine – WB	0.370	19.5	B	0.558	18.0	B
		D671 – NB	0.254	12.7	**B**	0.542	15.6	**B**
		Overall*	**0.370**	**14.7**	**B**	**0.558**	**16.8**	**B**
Int No. 4 D671 / Waterkloof Rd	Priority Control	D671 – SB	0.077	6.5	A	0.075	6.9	A
		Waterkloof Road – WB	0.132	14.0	**B**	0.164	13.8	**B**
		D671 – NB	0.037	4.8	A	0.009	4.5	A
		Kloof No. 7 – EB	0.057	11.7	**B**	0.098	10.7	**B**
		Overall*	**0.132**	**8.7**	**A**	**0.164**	**9.6**	**A**

Intersection			AM			PM		
Name	**Type**	**Approach**	**V/C**	**Delay (Sec)**	**LOS**	**V/C**	**Delay (Sec)**	**LOS**
Int No. 6 Waterkloof Rd / Waterkloof Mine Access	Priority Control	Waterkloof Rd – SB	0.030	0.8	**A**	0.015	0.8	**A**
		D1783 Road – WB	0.113	10.6	A	0.239	11.0	B
		Waterkloof Rd – NB	0.057	4.2	**A**	0.103	0.057	**A**
		Kloof Mine Access – EB	0.034	8.4	**A**	0.018	9.2	**A**
		Overall*	**0.133**	**6.0**	**A**	**0.239**	**5.4**	**A**
Int No. 7 D671 Rd / D961 Rd	Priority Control	D962 Road – SB	0.037	3.7	**A**	0.070	2.5	**A**
		D962 Road – NB	0.054	4.7	A	0.042	3.8	A
		D671 Road – EB	0.031	9.8	**A**	0.093	10.2	**B**
		Overall*	**0.054**	**5.0**	**A**	**0.093**	**4.8**	**A**
Int No. 8 D962 Rd / RTSF Access	Priority Control	D962 Rd – SB	0.041	0.7	**A**	0.094	0.3	**A**
		RFST Access – WB	0.015	9.3	A	0.016	9.4	A
		D962 – NB	0.131	0.1	**A**	0.088	0.1	**A**
		Overall*	**0.131**	**0.5**	**A**	**0.094**	**0.5**	**A**

The intersection capacity analysis results indicate that the additional development traffic will only have a minor impact on the immediate road network. All intersections are expected to operate at acceptable LOS given the network upgrades as discussed previosly are implemented by the planning authority.

6.6 Proposed CPP and RTSF layout

CPP access

Access to the CPP site is proposed off Waterkloof Road, at the current access to the Kloof No. 4 shaft. It is proposed that the current Kloof No. 4 Shaft access road will be realigned around the proposed CPP site. The intersection spacing complies with the access spacing requirements for a Class 3 road. The conceptual layout of the proposed access intersection is shown below.

Figure 5 Conceptual layout of the CPP access, off Waterkloof Road (Siyazi, 2015)

RTSF access

Access to the RTSF is proposed off the D962, approximately 800m from the intersection of the D962 with the Kalbasfontein Road. The intersection spacing complies with the access spacing requirements for a Class 3 road as stated in TRH26 (COTO, 2012). The conceptual layout of the proposed access intersection is shown below.

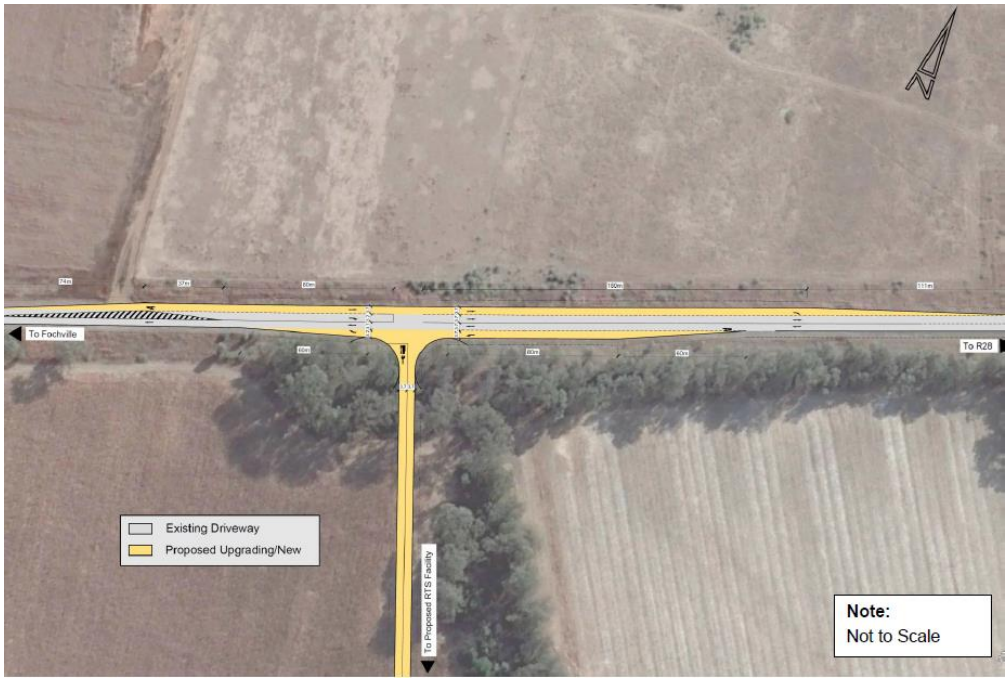

Figure 6 Conceptual layout of the RTSF access, off the D962 Road (Siyazi, 2015)

There is sufficient provision of stacking space on the access roads to accommodate the traffic entering the sites from the public roads.

The capacity analysis results of both proposed access layouts show that the intersections will perform at acceptable LOS (see Section 6.5.).

7 Public transport, walking and cycling

7.1 Public transport

The majority of mining employees are transported by company buses and minibus taxis. It is expected that this will continue both during the construction phase and the operational phase. From the trip generation estimates, it is expected that 65 inbound bus trips will be generated by the CPP during the construction phase. During the operational phase this is expected to reduce to at least one inbound bus trip and one taxi trip during the peak hour. The RTSF site is expected to generate 20 inbound bus trips during the construction phase. During operations, the site is expected to generate at least two minibus taxi trips.

Public transport facilities (i.e. bus/taxi lay-by) will be provided on site for staff buses and minibuses to drop off and pick up passengers thus no facilities are recommended on the external road network.

7.2 Walking and cycling

Both the RSTF and CPP sites are not located within walking distance to the residential areas, and are therefore not expected to generate primary walking trips. There may however be some pedestrian traffic on main roads near the accesses if public transport operators offer public transport service to mining staff and visitors in the form of buses and taxis. The independent taxi services are not expected to occur most frequently due to the staff buses and minibuses that will be provided to transport employees. Additional pedestrian activities are therefore not expected to be significant on roads immediately surrounding the development sites, but cannot be entirely ruled out.

It is recommended that pedestrian activity from the surrounding public roads be continuously monitored. Should there be a significant demand; pedestrian walkways should be along the frontage of the CPP and the RSTF.

No cycling activities were observed during the site visit. There are currently no cycle ways provided on roads near the development site. No physical cycling infrastructure is proposed at this stage. However cycling activities around the development site should be regularly monitored and appropriate provisions be made if significant cycling activities are observed.

8 Environmental assessment

The predicted impacts of the traffic generated by the proposed WRTRP on the surrounding road network have been evaluated and detailed in this section of the report. The purpose of this impact evaluation is to assign relative significance to the predicted traffic impacts associated with the mining activities and to determine the impact before and after implementation of mitigation measures.

The development traffic is expected to have direct or indirect impacts on the following:

- Increase in vehicle delays and traffic intensity;
- NMT delays;
- Road safety; and
- Road surface conditions.

The ESIA also examines other areas in which transport is part of the overall impact. These impacts are studied in more detail by other specialists. The list of these impacts is provided below:

- Noise;
- Visual impacts;

- Vibration;
- Air Quality;
- Ecological; and
- Heritage and conservation areas.

8.1 Criteria for environmental considerations

The impact assessment criteria are based on guidance provided by the Institute of Environmental Assessment (1993) - Guidelines for the Environmental Assessment of Road Traffic as well as South African legislation and consist of the following:

- Nature of impacts (direct/indirect, positive/ negative);
- Duration (short/medium/long term, permanent(irreversible) / temporary (reversible), frequent/seldom);
- Extent (geographical area, size of affected population/habitat/species);
- Intensity (minimal, severe, replaceable/irreplaceable);
- Probability (high/medium/low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

With the exception of nature of impact which indicates whether the impact is positive or negative, each criterion is weighted on a scale of 1 to 7 as detailed in Appendix A with 1 indicating no or negligible impact and 7 the highest level of impact. The significance of an impact is established using an impact/risk assessment formula shown below.

Significance = (Intensity + Extent + Duration) x Probability x Nature

Any significant impact is then described in terms of proposed mitigation measure(s). It is important to note that the significance of an impact is considered in concert with the probability of that impact occurring. Lastly, the reversibility of the impact is estimated.

The environmental impact of the additional traffic due to the proposed development traffic is discussed below. The calculations of significance ratings are provided in Tables 11 and 12.

8.2 Impact on vehicle delays and traffic conditions

As has been demonstrated in Section 5 it is expected that the proposed development will result in additional traffic being added to the network. The development impact is expected to be the highest during the construction of the CPP and RTSF and significantly less during the operational phase and other phases.

For the pipeline construction activities, it is expected that 17 peak hour vehicle trips will be generated. With Passenger Car Unit (PCU) conversion, assuming that all vehicles are Light Goods Vehicles (LGVs) and Heavy Goods Vehicles (HGVs), this could equate to approximately 42 PCUs. As the demand is less than 50 PCUs, it is therefore expected that the impact of the pipeline construction activities will be negligible.

8.2.1 Construction phase (CPP & RTSF)

With the exception of the N12 the roads in the immediate surroundings carry relatively low traffic volumes. As indicated in Figure B-4, at most the development is expected to add about 65 peak hour

vehicles on any individual section of the road network i.e. D671 approach to the N12 during the PM peak hour. The development traffic is therefore expected to be minor during the construction phase. However there are two locations where there are significant delays modelled (i.e. intersection of the N12 with the D671 and the D671 with Kloof Mine access). At these intersections even the slightest increase in traffic is expected to result in significant increase in delays by virtue of some approaches already operating at capacity (existing condition).

Traffic lights were tested at the two intersection and the analytical results demonstrated that they would operate significantly better. Mitigating background or existing traffic problems is considered to be the responsibility of the roads and planning authorities (plans are in place to introduce mitigation measures, the timing of such measures are unknown however). However due to the unknown timelines and budget allocations, it is proposed that the developer make use of points-men during the peak hours, pending implementation of the traffic signals or other upgrades. This will result in the net impact of the development traffic to be negligible, by virtue of removing existing bottlenecks.

8.2.2 Operational Phase

During the operational phase, the development is expected to generate relatively low volumes traffic. However the impact is over a longer period. This result in the significance rating showing that impact would still be minor, but quantitatively larger than the construction phase rating.

The mitigation measure of using either points-men or traffic lights at intersection 1 (N112 / D671) and 3 (D671 / Kloof Mine) does reduce the development impact, but the rating continues to remain on the same minor (Negative) category.

8.3 Impact on pedestrians and cyclist delays

The additional traffic will result in minor increase in delay time for cyclist and pedestrian crossing the major roads. The highest number of development traffic that is assigned to individual road sections is on the local roads. The local roads, such as the D671, Waterkloof Road and the D962 currently do not have significant pedestrian and cycling activity.

8.3.1 Construction phase

The main construction activities will not have a significant impact on pedestrian and cyclist delays as the roads around the CPP and RTSF sites have very little pedestrian and cycling activity. Some of the pipeline construction activities, however, may be closer to residential areas, where existing users may be impacted upon. The pipeline activities will generate relatively low peak hour volumes, and the net impact of construction activities on existing and future walking and cycling delays is expected to be minor.

As a mitigation for possible impact on pedestrians and cyclist, the following mitigation measures are proposed:

- Regular pedestrian and cycling activity awareness / training as part of formal driver training and health and safety briefings;
- Discourage site related traffic from using roads going through populated areas;
- Carrying out regular road safety awareness campaigns within the neighbouring communities, mostly targeting schools and young people.

With the above mitigation the environmental impact rating can be improved from minor to negligible.

8.3.2 Operational phase

During the operational phase the environmental significance rating is estimated to be minor. Even with mitigation, as discussed above, the impact on cyclists and pedestrians will still be rated minor, but with

a slightly improved significance value. This is due to the longer impact period for the operational phase, over the project life, rather than the short period for the construction phase.

8.4 Impact on road safety

An increase in the number of heavy vehicles can lead to an increase in the speed differential of the vehicles on road network. The heavy vehicles are generally slower and require larger gaps and follow-up headways. There is generally low tolerance of heavy vehicles by drivers of lighter vehicles. This is evident in the aggressiveness of lane changing and overtaking by vehicles following heavy vehicles. This in turn leads to problems with road safety as a result of additional heavy vehicles on the road network.

8.4.1 Construction phase

The number of heavy vehicles that are expected to be generated by the proposed development is the highest during the construction phase. The local roads generally carry low traffic volumes with the exception of the N12 which carries high volumes of traffic during the peaks. The impact is therefore expected to be minor, but requiring some mitigation.

The following mitigation measures are recommended:

- Carrying out regular road safety awareness training for drivers;
- Discourage right turns by heavy vehicles on busy priority-control roads, from a minor street during the peak hours;
- Discourage routing of heavy vehicles through residential areas;

With the above mitigation, it is expected that the impact on road safety will be negligible during the construction phase.

8.4.2 Operational phase

The development's impact on road safety is expected to be minor and will improve to negligible impact with mitigation as recommended above.

8.5 Impact on road surfacing conditions

Heavy vehicles generally increase the wearing out rate of road surfaces. It is therefore expected that an increase in heavy vehicles due to the proposed development will have some impact on the surfacing conditions of the surrounding road network.

8.5.1 Construction phase

With the exception of minor access roads to local mines and mine shafts, the key roads are all surfaced, and in excellent condition. These roads carry relatively low traffic volumes. The additional heavy vehicle traffic is not expected to have a major impact on road surfacing conditions.

Road maintenance, on the public road network, is not a responsibility of individual developers. It is therefore recommended that the developer engage with the planning authorities regarding future maintenance needs of the surrounding road network;

It is recommended that the developer ensures that the development's internal and access roads are kept to the required maintenance standards and to the satisfaction of planning authorities.

8.5.2 Operational phase

The environmental significance of the development's impact on road surfacing conditions is expected to be minor during operations, but with a slightly higher significance value by virtue of the impact lasting over a longer period of time than during the construction phase.

Table 13 Development traffic's environmental impact ratings (Construction)

No.	Activity / Interaction	Dimension	Rating		Motivation	Significance
1	Increase in traffic volumes and vehicle delays due to additional development traffic	**Pre-mitigation**				
		Duration	Medium Term, 2 - 3 years	3	The construction phase in not expected to last more than 3 years	Minor (negative) -50
		Extent	Local	3	Most of the impact will be on the local road network. Although the development traffic will make use of regional freight corridors, the number of vehicles assigned to any individual route will reduce as multiple route choices exist outside the study area. The increased delays are therefore only expected on the local road network.	
		Intensity / Severity	On-going serious social issues	4	Increased traffic will result in minor increase in delays across most of the network. However there are intersections where delays are currently high and even the slightest increase in traffic is likely to results in significant increase in delays	
		Probability	Likely	5	It is likely that the additional development traffic could result in an increase in average vehicle delays and minor deterioration of service levels on the surrounding road network	
		Nature	Negative	-1	Increased delays are negative to both the environment and driver behaviour	
		Mitigation	***Use of points-men at Intersections 1 and 3 during peak hours, for the duration of the construction phase.***			
		Post-mitigation				
		Duration	Medium Term, 2 - 3 years	3	The construction phase in not expected to last more than 3 years	Negligible (negative) -32
		Extent	Local	3	Most of the impact will be on the local road network. Although the development traffic will make use of regional freight corridors, the number of vehicles assigned to any individual route will reduce as multiple route choices exist outside the study area. The increased delays are therefore only expected on the local road network.	
		Intensity / Severity	Minor medium term social impact	2	With mitigation, there impact of the additional development traffic will be minor. Delay will only be expected on days with adverse weather conditions where points-men cannot be deployed.	
		Probability	Probable	4	It is probable for delays to occur on the local road network, mostly on days when points-men are not deployed. However, this not expected to occur on regular basis.	
		Nature	Negative	-1	Increased delays are negative to both the environment and driver behaviour	

No.	Activity / Interaction	Dimension	Rating		Motivation	Significance
2	Increase in delays for cyclists and pedestrians as result of the additional traffic on the network due to the proposed development.	**Pre-mitigation**				
		Duration	Medium Term, 2 - 3 years	3	The construction phase in not expected to last more than 3 years	Minor (negative) -36
		Extent	Local	3	Most of the impact will be on the local road network.	
		Intensity / Severity	On-going social issues	3	There is currently low level of pedestrian and cycling activity on the affected roads except near residential areas. The development impact on pedestrians and cyclist is therefore expected to be minor. However, on roads affected by pipeline construction activities, some increase in delays by pedestrian and cyclist crossing the road can be expected.	
		Probability	Probable	4	It is likely that the additional development traffic could result in an increase in average vehicle delays and minor deterioration of service levels on the surrounding road network	
		Nature	Negative	-1	Increased delays are negative to both the environment and driver behaviour	
		Mitigation	***- Regular pedestrian and cycling activity awareness by drivers as part of the formal driver training and regular health and safety briefings; - Site related heavy vehicles need to avoid low order roads in residential areas, as far as reasonably practicable; - Regular road safety awareness campaigns within the neighbouring communities.***			
		Post-mitigation				
		Duration	Medium Term, 2 - 3 years	3	The construction phase in not expected to last more than 3 years	Negligible (negative) -27
		Extent	Local	3	Most of the impact will be on the local road network, with some traffic distributing on the key freight corridors beyond the extent of the study area	
		Intensity / Severity	On-going social issues	3	With mitigation, there impact of the additional development traffic will be minor. Delay will only be expected on days with adverse weather conditions where points-men cannot be deployed.	
		Probability	Likely	3	Even with mitigation, pedestrians and cyclist delays would still experience some delay. However avoidance of roads that are prone to pedestrian and cycling traffic can reduce the probability of delays increasing significantly.	
		Nature	Negative	-1	Increased delays are negative to both the environment and driver behaviour	

No.	Activity / Interaction	Dimension	Rating		Motivation	Significance
3	Road safety conditions could be impacted negatively by an increase in heavy vehicles due the proposed development.	**Pre-mitigation**				
		Duration	Medium Term, 2 - 3 years	3	The construction phase in not expected to last more than 3 years	Minor (negative) -40
		Extent	Local	3	Most of the impact will be on the local road network. The number of heavy vehicles assigned to roads outside the study area will reduce as multiple route choices become available.	
		Intensity / Severity	On-going serious social issues	4	Increase in heavy vehicles could result in increased speed differential on the major roads. Some drivers may not be tolerant of heavy vehicles on their path and this could lead to increased driver aggressiveness. Heavy vehicles require more time when turning right at major intersections. There is a risk of drivers taking less than optimal gaps if the delays are high.	
		Probability	Probable	4	It is probably that increased number of heavy vehicles on the network could trigger some deterioration in the road safety conditions on the local road network.	
		Nature	Negative	-1	Deterioration of road safety conditions is negative in nature.	
		Mitigation	***- Regular driver awareness campaigns / training; - Discourage right turns by heavy vehicles on busy roads where heavy vehicles have to give way to fast moving vehicles; - Discourage routing of heavy vehicles through residential areas***			
		Post-mitigation				
		Duration	Medium Term, 2 - 3 years	3	The construction phase in not expected to last more than 3 years	Negligible (negative) -27
		Extent	Local	3	Most of the impact will be on the local road network. The number of heavy vehicles assigned to roads outside the study area will reduce as multiple route choices become available.	
		Intensity / Severity	On-going social issues	3	With mitigation, the severity of road safety impact by the development is expected to reduce.	
		Probability	Likely	3	The probability of the road safety conditions deteriorating is likely to be reduced with implementation of the recommended mitigation measures.	
		Nature	Negative	-1	Deterioration of road safety conditions is negative in nature.	

No.	Activity / Interaction	Dimension	Rating		Motivation	Significance
4	Impact on road surface conditions of the local road network as a result of an increase in heavy vehicles due to the proposed development.	**Pre-mitigation**				
		Duration	Medium Term, 2 - 3 years	3	The construction phase in not expected to last more than 3 years	Minor (negative) -40
		Extent	Local	3	Most of the impact will be on the local road network. The number of heavy vehicles assigned to roads outside the study area will reduce as multiple route choices become available.	
		Intensity / Severity	On-going serious social issues	4	Heavy vehicles increase the rate at which road surfacing wear out and other structural pavement defects / deformations that could lead to formation of potholes.	
		Probability	Probable	4	It is probably that increased number of heavy vehicles on the network could trigger some deterioration in the road safety conditions on the local road network.	
		Nature	Negative	-1	Deterioration of road surface conditions is negative in nature.	
		Mitigation	***- The developer should engage with the planning authorities concerning maintenance of public roads near the development sites; - The developer should ensure that the internal roads and access roads are maintained regularly and to acceptable maintenance standards.***			
		Post-mitigation				
		Duration	Medium Term, 2 - 3 years	3	The construction phase in not expected to last more than 3 years	Minor (negative) -40
		Extent	Local	3	Most of the impact will be on the local road network. The number of heavy vehicles assigned to roads outside the study area will reduce as multiple route choices become available.	
		Intensity / Severity	On-going serious social issues	4	Heavy vehicles increase the rate at which road surfacing wear out and other structural pavement defects / deformations that could lead to formation of potholes.	
		Probability	Probable	4	It is probably that increased number of heavy vehicles on the network could trigger some deterioration in the road safety conditions on the local road network.	
		Nature	Negative	-1	Deterioration of road surface conditions is negative in nature.	

Table 14 Development traffic's environmental impact ratings (Construction)

No.	Activity / Interaction	Dimension	Rating		Motivation	Significance
1	Increase in traffic volumes and vehicle delays due to additional development traffic	**Pre-mitigation**				
		Duration	Project life	5	Duration of the project	Minor (negative) -60
		Extent	Local	3	Most of the impact will be on the local road network. Although the development traffic will make use of regional freight corridors, the number of vehicles assigned to any individual route will reduce as multiple route choices exist outside the study area. The increased delays are therefore only expected on the local road network.	
		Intensity / Severity	On-going serious social issues	4	Increased traffic will result in minor increase in delays across most of the network. However there are intersections where delays are currently high and even the slightest increase in traffic is likely to results in significant increase in delays	
		Probability	Likely	5	Additional traffic is likely to increase average vehicle delays on the network.	
		Nature	Negative	-1	Increased delays are negative to both the environment and driver behaviour	
		Mitigation	***Use of points-men at Intersections 1 and 3 during peak hours, for the duration of the construction phase.***			
		Post-mitigation				
		Duration	Project life	5	Duration of the project	Minor (negative) -40
		Extent	Local	3	Most of the impact will be on the local road network. Although the development traffic will make use of regional freight corridors, the number of vehicles assigned to any individual route will reduce as multiple route choices exist outside the study area. The increased delays are therefore only expected on the local road network.	
		Intensity / Severity	Minor medium term social impact	2	With mitigation, there impact of the additional development traffic will be minor. Delay will only be expected on days with adverse weather conditions where points men can not be deployed.	
		Probability	Probable	4	It is probable for delays to occur on the local road network, mostly on days when points men are not deployed. However, this not expected to occur on regular basis.	
		Nature	Negative	-1	Increased delays are negative to both the environment and driver behaviour	

No.	Activity / Interaction	Dimension	Rating		Motivation	Significance
2	Increase in delays for cyclists and pedestrians as result of the additional traffic on the network due to the proposed development.	**Pre-mitigation**				
		Duration	Project life	5	Duration of the project	Minor (negative) -40
		Extent	Local	3	Most of the impact will be on the local road network.	
		Intensity / Severity	Minor medium-term social impact	2	There is currently low level of pedestrian and cycling activity on the affected roads except near residential areas. The development impact on pedestrians and cyclist is therefore expected to be minor. However, on roads affected by pipeline construction activities, some increase in delays by pedestrian and cyclist crossing the road can be expected.	
		Probability	Likely	4	It is likely that the additional development traffic could result in an increase in average vehicle delays and minor deterioration of service levels on the surrounding road network	
		Nature	Negative	-1	Increased delays are negative to both the environment and driver behaviour	
		Mitigation	***- Regular pedestrian and cycling activity awareness by drivers as part of the formal driver training and regular health and safety briefings; - Site related heavy vehicles need to avoid low order roads in residential areas, as far as reasonably practicable; - Regular road safety awareness campaigns within the neighbouring communities.***			
		Post-mitigation				
		Duration	Project life	5	Duration of the project	Minor (negative) -36
		Extent	Local	3	Most of the impact will be on the local road network, with some traffic distributing on the key freight corridors beyond the extent of the study area	
		Intensity / Severity	low level impact	1	Reduced routing of development related traffic and better awareness of other road users will result in reduced friction between drivers and pedestrians / cyclist.	
		Probability	Probable	4	Even with mitigation, pedestrians and cyclist delays would still experience some delay. However avoidance of roads that are prone to pedestrian and cycling traffic can reduce the probability of delays increasing significantly.	
		Nature	Negative	-1	Increased delays are negative to both the environment and driver behaviour	

No.	Activity / Interaction	Dimension	Rating		Motivation	Significance
3	Road safety conditions could be impacted negatively by an increase in heavy vehicles due the proposed development.	**Pre-mitigation**				
		Duration	Project life	5	Duration of the project	Minor (negative) -48
		Extent	Local	3	Most of the impact will be on the local road network. The number of heavy vehicles assigned to roads outside the study area will reduce as multiple route choices become available.	
		Intensity / Severity	On-going serious social issues	4	Increase in heavy vehicles could result in increased speed differential on the major roads. Some drivers may not be tolerant of heavy vehicles on their path and this could lead to increased driver aggressiveness. Heavy vehicles require more time when turning right at major intersections. There is a risk of drivers taking less than optimal gaps if the delays are high.	
		Probability	Probable	4	It is probably that increased number of heavy vehicles on the network could trigger some deterioration in the road safety conditions on the local road network.	
		Nature	Negative	-1	Deterioration of road safety conditions is negative in nature.	
		Mitigation	***- Regular driver awareness campaigns / training; - Discourage right turns by heavy vehicles on busy roads where heavy vehicles have to give way to fast moving vehicles; - Discourage routing of heavy vehicles through residential areas***			
		Post-mitigation				
		Duration	Project life	5	Duration of the project	Negligible (negative) -33
		Extent	Local	3	Most of the impact will be on the local road network. The number of heavy vehicles assigned to roads outside the study area will reduce as multiple route choices become available.	
		Intensity / Severity	On-going social issues	3	With mitigation, the severity of road safety impact by the development is expected to reduce.	
		Probability	Likely	3	The probability of the road safety conditions deteriorating is likely to be reduced with implementation of the recommended mitigation measures.	
		Nature	Negative	-1	Deterioration of road safety conditions is negative in nature.	

No.	Activity / Interaction	Dimension	Rating		Motivation	Significance
4	Impact on road surface conditions of the local road network as a result of an increase in heavy vehicles due to the proposed development.	**Pre-mitigation**				
		Duration	Project life	5	Duration of the project	Minor (negative) -48
		Extent	Local	3	Most of the impact will be on the local road network. The number of heavy vehicles assigned to roads outside the study area will reduce as multiple route choices become available.	
		Intensity / Severity	On-going serious social issues	4	Heavy vehicles increase the rate at which road surfacing wear out and other structural pavement defects / deformations that could lead to formation of potholes.	
		Probability	Probable	4	It is probably that increased number of heavy vehicles on the network could trigger some deterioration in the road safety conditions on the local road network.	
		Nature	Negative	-1	Deterioration of road surface conditions is negative in nature.	
		Mitigation	***- The developer should engage with the planning authorities concerning maintenance of public roads near the development sites; - The developer should ensure that the internal roads and access roads are maintained regularly and to acceptable maintenance standards.***			
		Post-mitigation				
		Duration	Project life	5	Duration of the project	Minor (negative) -48
		Extent	Local	3	Most of the impact will be on the local road network. The number of heavy vehicles assigned to roads outside the study area will reduce as multiple route choices become available.	
		Intensity / Severity	On-going serious social issues	4	Heavy vehicles increase the rate at which road surfacing wear out and other structural pavement defects / deformations that could lead to formation of potholes.	
		Probability	Probable	4	It is probably that increased number of heavy vehicles on the network could trigger some deterioration in the road safety conditions on the local road network.	
		Nature	Negative	-1	Deterioration of road surface conditions is negative in nature.	

9 Conclusions and recommendations

This TIA is an input into the Environmental and Social Impact Assessment (ESIA) by Digby Wells for the proposed West Rand Tailings Retreatment Project (WRTRP), which includes the development of a Central Processing Plant (CPP), Regional Tailings Storage Facility (RTSF) and transportation pipelines.

A traffic count survey was conducted by Siyazi Limpopo (Pty) Ltd at key intersection on the surrounding road network in the project area. The survey results were used to establish existing traffic condition on which the impact of the traffic generated by the project was assessed. A site visit was also conducted by Aurecon to observe current public transport, pedestrian and cycling activities as well as traffic operations in the vicinity of the project area.

The traffic count survey and capacity analysis (using SIDRA intersection software) at analysed intersections indicated that the surrounding road network currently has adequate capacity and the all intersection are operating at acceptable Levels of Service (LOS), with the exception of the N12 / D671 intersection and D671 / Kloof Mine Access intersection which require to be signalised to improve capacity. These road upgrades are the responsibility of the planning authorities, not the developer, as they will address existing traffic conditions.

The project is expected to generate vehicle trips as detailed below:

- The CPP is expected to generate a total of 193 peak hour vehicle trips during the construction phase and 99 peak hour vehicle trips during the operational phase
- The RSTF is expected to generate a total of 113 peak hour vehicle trips during construction and 12 peak hour vehicle trips during the operational phase.
- The construction of the pipelines is only expected to generate approximately 17 peak hour vehicle trips, or 42 Passenger Car Units (PCUs).

The additional traffic expected to be generated by the project was added to the network to determine the development impact. The analysis results demonstrated that the additional traffic will have a minor impact on the future traffic conditions of the surrounding road network. Thus no road upgrades are required to be implemented by the developer in this regard. It is, however recommended that points-men be used by developer at the N12 / D671 and D671 / Kloof Mine Access as an interim measure to allow safe use of the local road network during the construction phase.

Assessment was also carried out on the potential impact of the project on public transport, walking and cycling activities. The developments impact on these activities is expected to be minor and no improvements to the existing public transport and pedestrian/ cycling facilities are recommended. It is recommended, however, that pedestrian/cyclist activities on the surrounding public roads be continuously monitored. Should there be a significant increase in demand in these modes of transport due to the project activities, taxi/bus lay-bys and pedestrian walkways should be provided along the frontage of the CPP and the RSTF to promote a safe environment for public transport users, pedestrians and cyclists.

An assessment was conducted to evaluate the significance of the traffic impacts. Although the significance of the impacts were determined as minimal or having low impact, the following mitigation measures aimed at minimising any traffic impact caused by the project are recommended to be implemented by the developer:

- Regular pedestrian and cycling activity awareness for staff working on site during all phases, as part of regular health and safety briefings;

- Road safety awareness campaigns within the neighbouring communities, mostly targeting schools and young people;
- Discourage site related traffic using roads through populated areas;
- Discourage right turns by heavy vehicles on busy priority-control roads, from a minor street during the peak hours;
- Discourage routing of heavy vehicles through residential areas;
- The developer is to engage the roads authorities regarding future maintenance needs of the surrounding road network; and
- The developer is to ensure that the development's internal roads and access roads are kept to the required maintenance standards and to the satisfaction of roads authorities.

Provided the above comments and recommendations are considered, the proposed project is supported from a transport planning and traffic engineering perspective.

Appendices

Appendix A
Impact rating criteria

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 7-1. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this EIA/EMP Report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 7-2, which is extracted from Table 7-1. The description of the significance ratings is discussed in Table 7-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 7-1: Impact assessment parameter ratings

Rating	Severity/Irreplaceability		Spatial scale	Duration/Irreversibility	Probability
	Environmental	Social, cultural and heritage			
7	Very significant impact on the environment. Irreparable damage to highly valued species, habitat or eco system. Persistent severe damage. The positive impact will result in a significant improvement to the initial/post disturbance environmental status and will benefit ecological and natural resources.	Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order. The positive impact will be of high significance which will result the improvement of the socio-economic status of a greater area beyond the boundary of the directly affected of the community and/or promote archaeological and heritage awareness and contribute towards research and documentation of sites and artefacts through phase two assessments.	International The effect will occur across international borders	Permanent: No Mitigation No mitigation measures of natural process will reduce the impact after implementation.	Certain/ Definite. The impact will occur regardless of the implementation of any preventative or corrective actions.
6	Significant impact on highly valued species, habitat or ecosystem. The positive impact is of high significance which will result in a vast improvement to the environment such as ecological diversification and/or rehabilitation of endangered species	Irreparable damage to highly valued items of cultural significance or breakdown of social order. The positive impact will be of high significance and will result in the upliftment of the surrounding community and/or contribute towards research and documentation of sites	National Will affect the entire country	Permanent: Mitigation measures of natural process will reduce the impact.	Almost certain/Highly probable It is most likely that the impact will occur.

Rating	Severity/Irreplaceability		Spatial scale	Duration/Irreversibility	Probability
	Environmental	**Social, cultural and heritage**			
		and artefacts through phase two assessments			
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate The positive impact will be moderately high and will have a long term beneficial effect on the natural environment	Very serious widespread social impacts. Irreparable damage to highly valued items The positive impact will be moderately high and will result in visible improvements on the socio-economic environment of the local and regional community, and/or promote archaeological and heritage awareness through mitigation	**Circle/ Region** Will affect the entire Circle or region	Project Life The impact will cease after the operational life span of the project.	Likely The impact may occur.
4	Serious medium term environmental effects. Environmental damage can be reversed in less than a year The positive impact on the	On-going serious social issues. Significant damage to structures / items of cultural significance The positive impact on the socio-economic environment will be of a	**Commune Area** Will affect the whole municipal area	Long term 6-15 years	Probable Has occurred here or elsewhere and could therefore occur.

Rating	Severity/Irreplaceability		Spatial scale	Duration/Irreversibility	Probability
	Environmental	**Social, cultural and heritage**			
	environment will be moderate with visible improvement to the natural resources and regional biodiversity	moderate extent and benefits should be experience across the local extent and/or potential benefits for archaeological and heritage conservation			
3	Moderate, short-term effects but not affecting ecosystem function. Rehabilitation requires intervention of external specialists and can be done in less than a month. The positive impact will be moderately beneficial to the natural environment, but will be short lived.	Ongoing social issues. Damage to items of cultural significance. The positive impact will be moderately beneficial for some community members and/or employees, but will be short lived and/or there will be a moderate possibility for archaeological and heritage conservation	**Local** Local extending only as far as the development site area	Medium term 1-5 years	Unlikely Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur.
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants. The positive impacts will be minor and slight environmental improvement will be visible.	Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected. Minor positive impacts on the social/cultural and/ or economic environment	**Limited** Limited to the site and its immediate surroundings	Short term Less than 1 year	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the project but has happened elsewhere. The

Rating	Severity/Irreplaceability		Spatial scale	Duration/Irreversibility	Probability
	Environmental	Social, cultural and heritage			
					possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures
1	Limited damage to minimal area of low significance, (e.g. ad hoc spills within plant area). Will have no impact on the environment. The positive impact on the environment will be insignificant and will not result in visible improvements	Low-level repairable damage to commonplace structures. The positive impact on social and cultural aspects will be insignificant	**Very limited** Limited to specific isolated parts of the site.	Immediate Less than 1 month	Highly unlikely/None Expected never to happen.

Table 7-2: Probability/Consequence Matrix

Probability \ Significance	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Consequence

Table 7-3: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive)
36 to 72	An important positive impact. The impact is insufficient by itself to justify the implementation of the project. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	An important negative impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe effects	Moderate (negative)
-109 to -147	A very serious negative impact which may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects	Major (negative)

Appendix B
Traffic flow diagrams

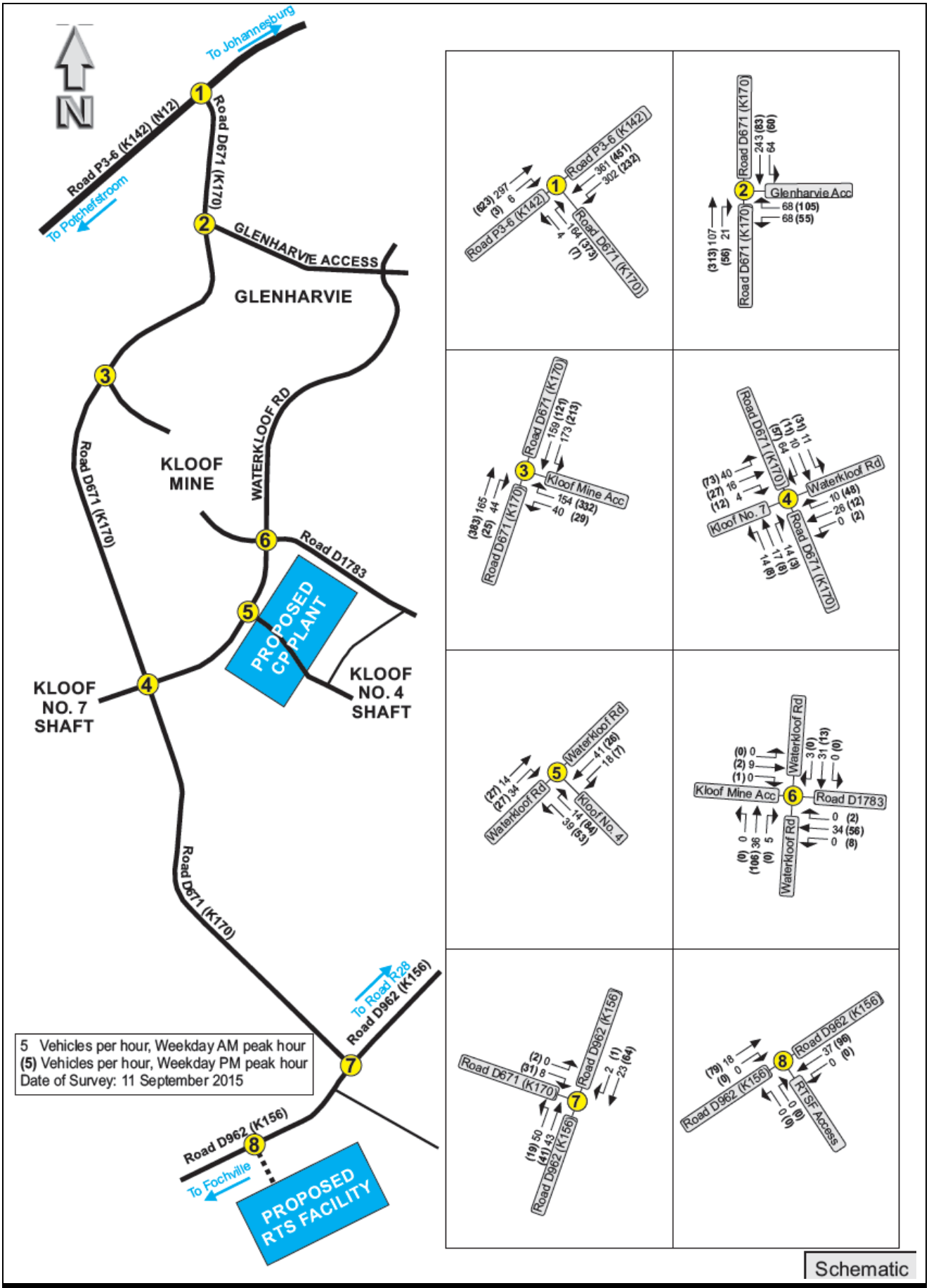

FIGURE B-1: BASE YEAR, 2015, PEAK HOUR TRAFFIC WITHOUT THE PROPOSED DEVELOPMENT (SCENARIO 1)

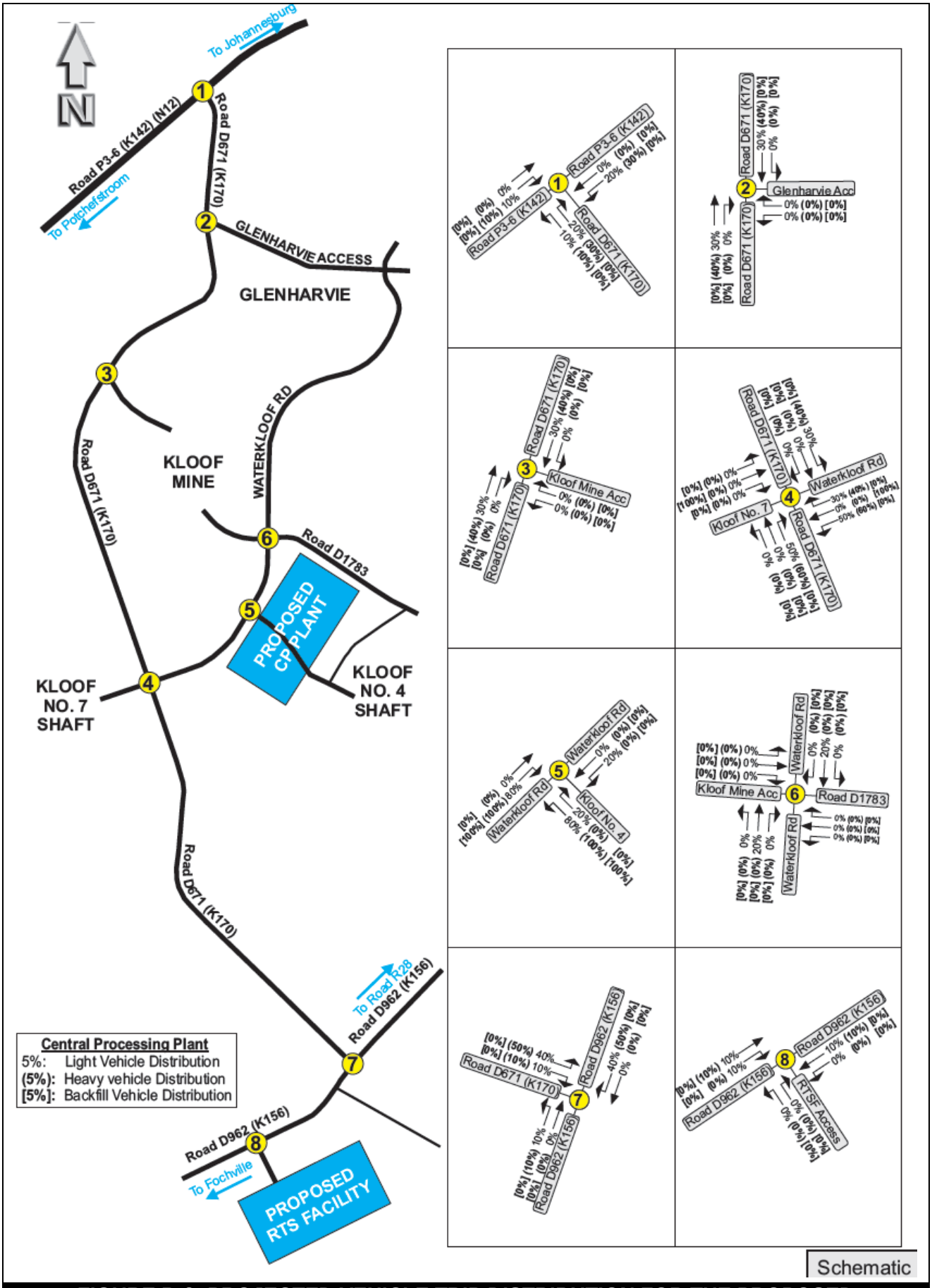

FIGURE B-2: PROJECTED VEHICLE TRIP DISTRIBUTION FOR THE PROPOSED DEVELOPMENT (CPP CONSTRUCTION PHASE)

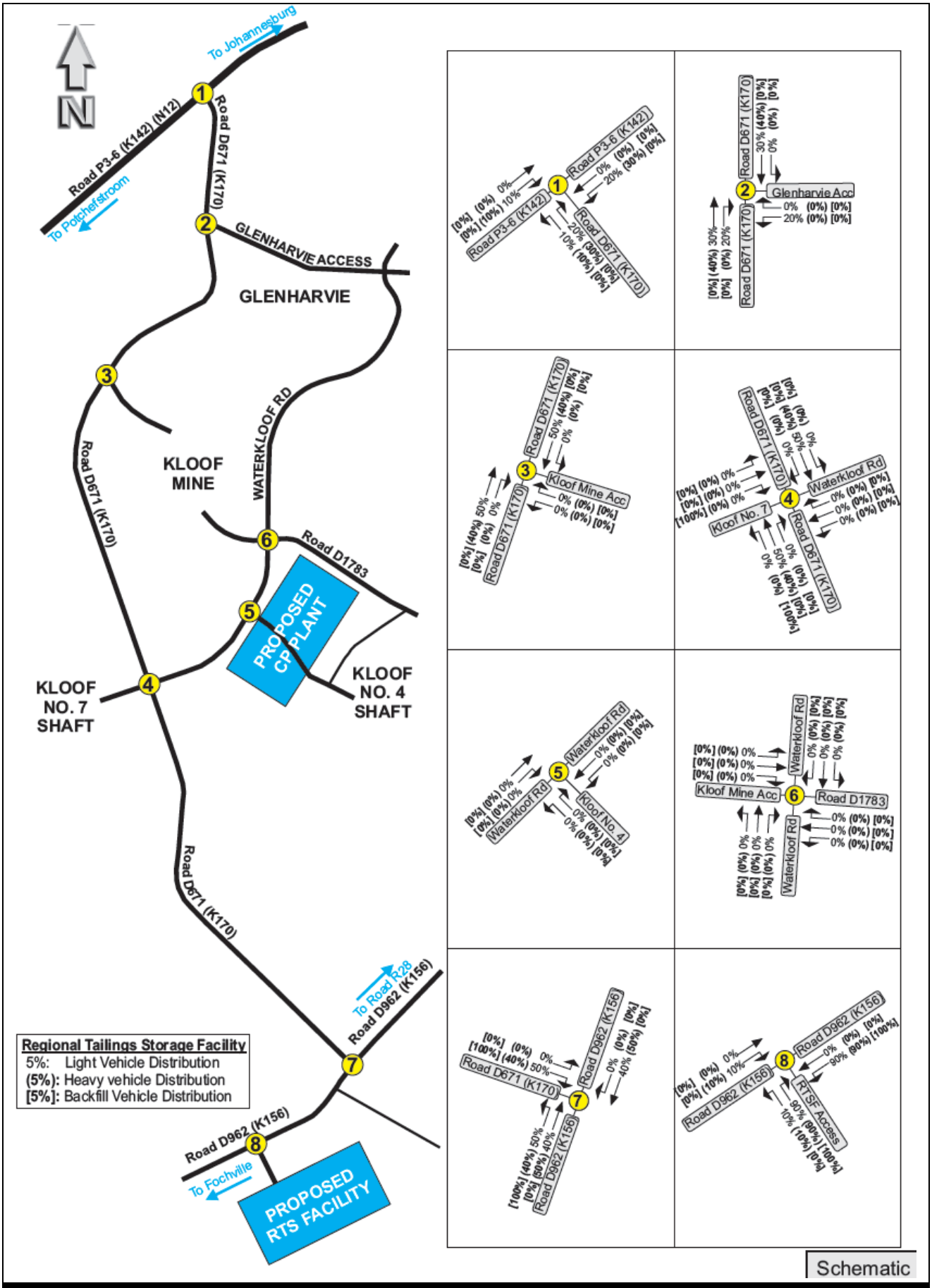

FIGURE B-3: PROJECTED VEHICLE TRIP DISTRIBUTION FOR THE PROPOSED DEVELOPMENT (RTSF CONSTRUCTION PHASE)

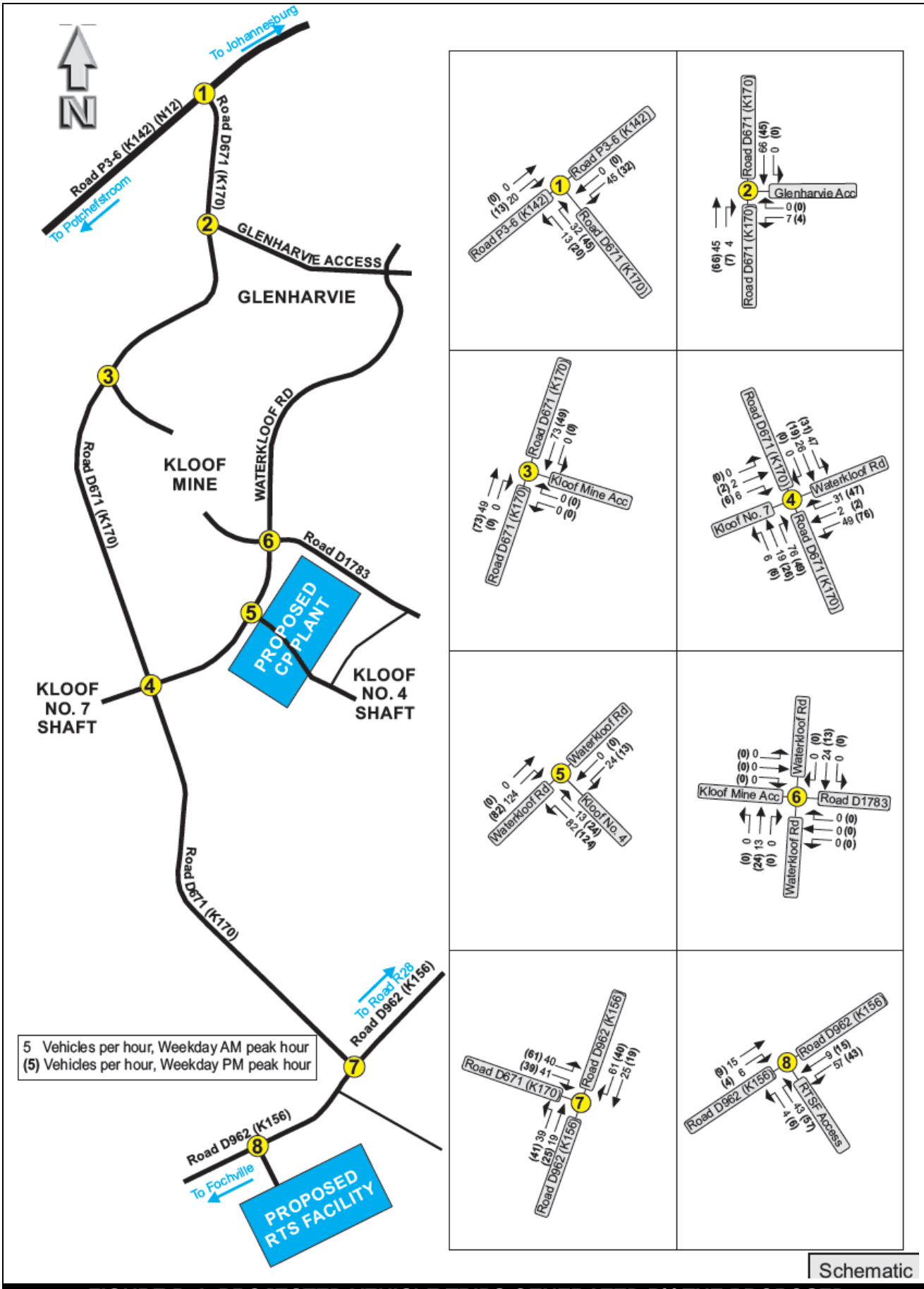

FIGURE B-4: PROJECTED VEHICLE TRIPS GENERATED BY THE PROPOSED DEVELOPMENT (CONSTRUCTION PHASE)

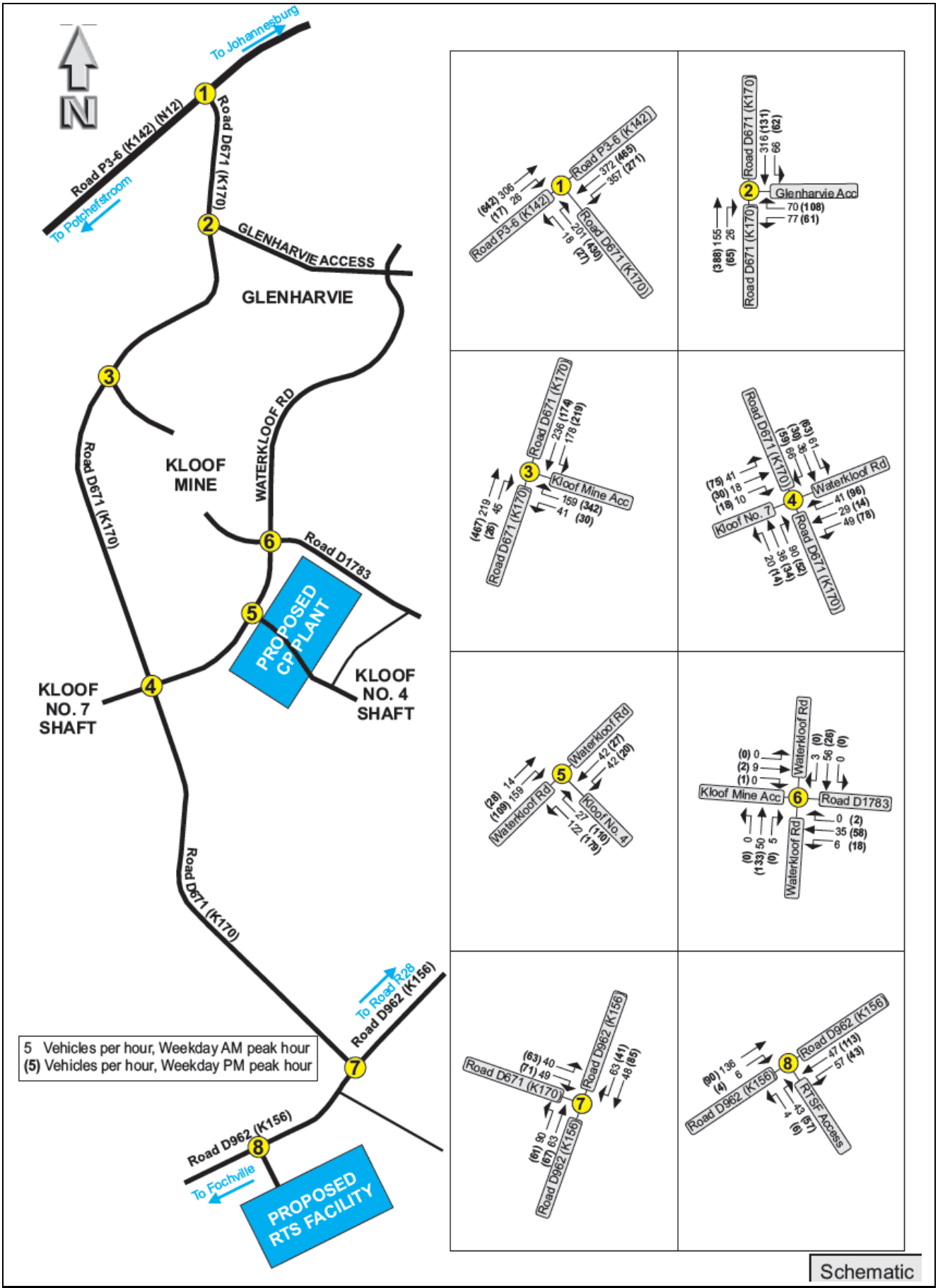

FIGURE B-5: PROJECTED 2016 PEAK HOUR TRAFFIC WITH BACKGROUND TRAFFIC GROWTH, WITH THE PROPOSED DEVELOPMENT (CONSTRUCTION PHASE) (SCENARIO 2)

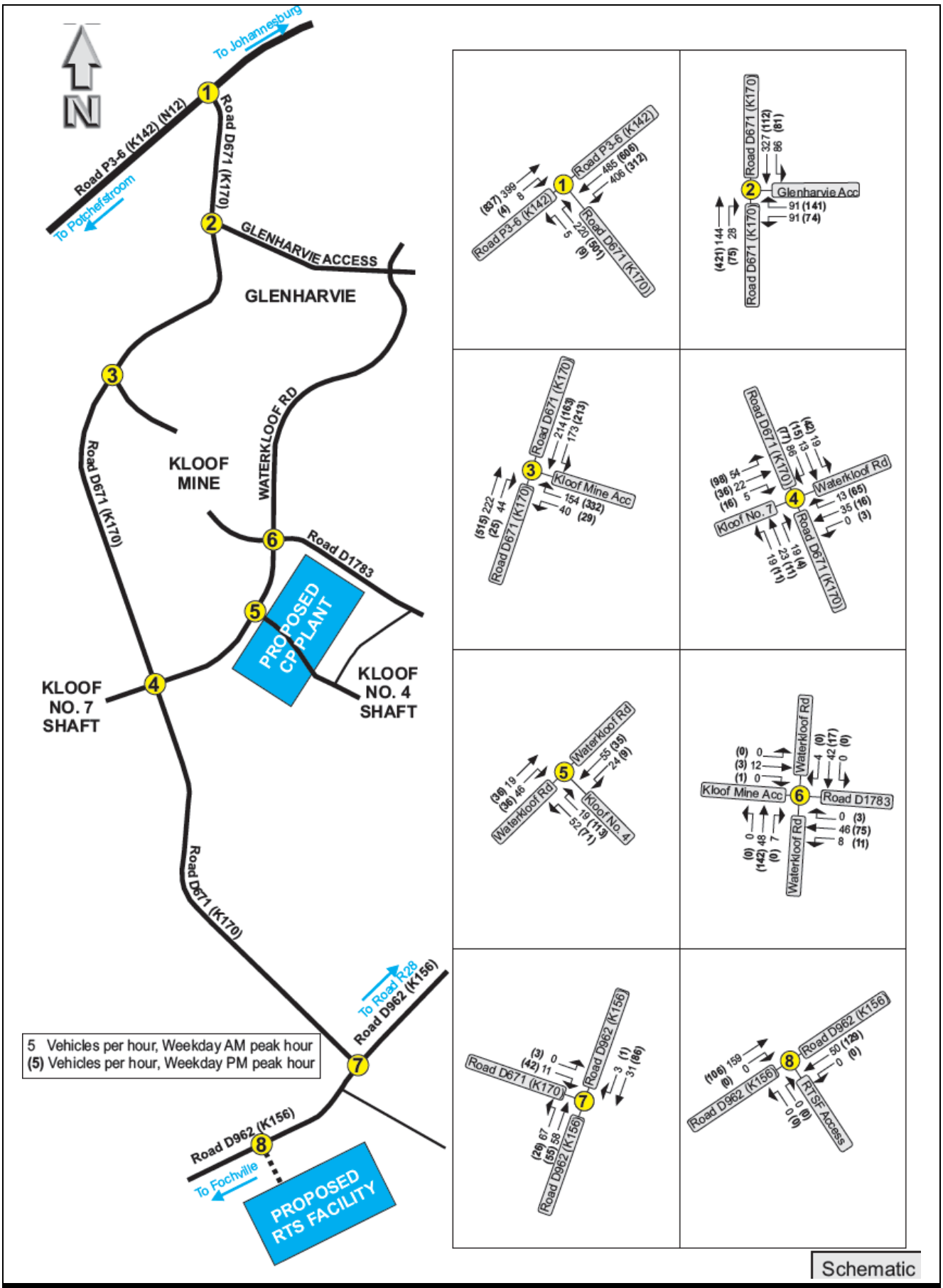

FIGURE B-6: PROJECTED 2025 PEAK HOUR TRAFFIC WITH BACKGROUND TRAFFIC GROWTH WITHOUT THE PROPOSED DEVELOPMENT (SCENARIO 3)

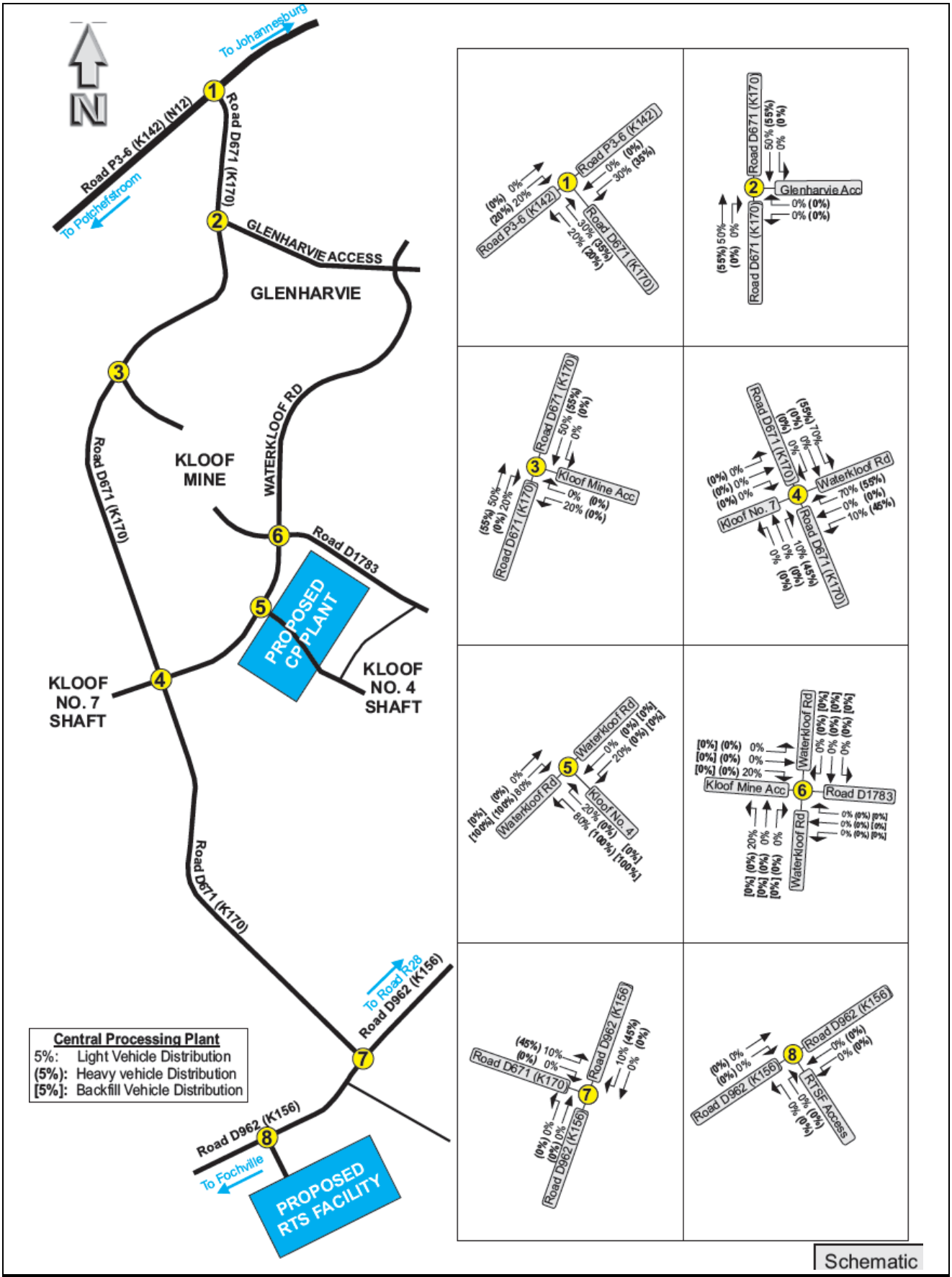

FIGURE B-7: PROJECTED VEHICLE TRIP DISTRIBUTION FOR THE PROPOSED DEVELOPMENT (CPP OPERATIONAL PHASE)

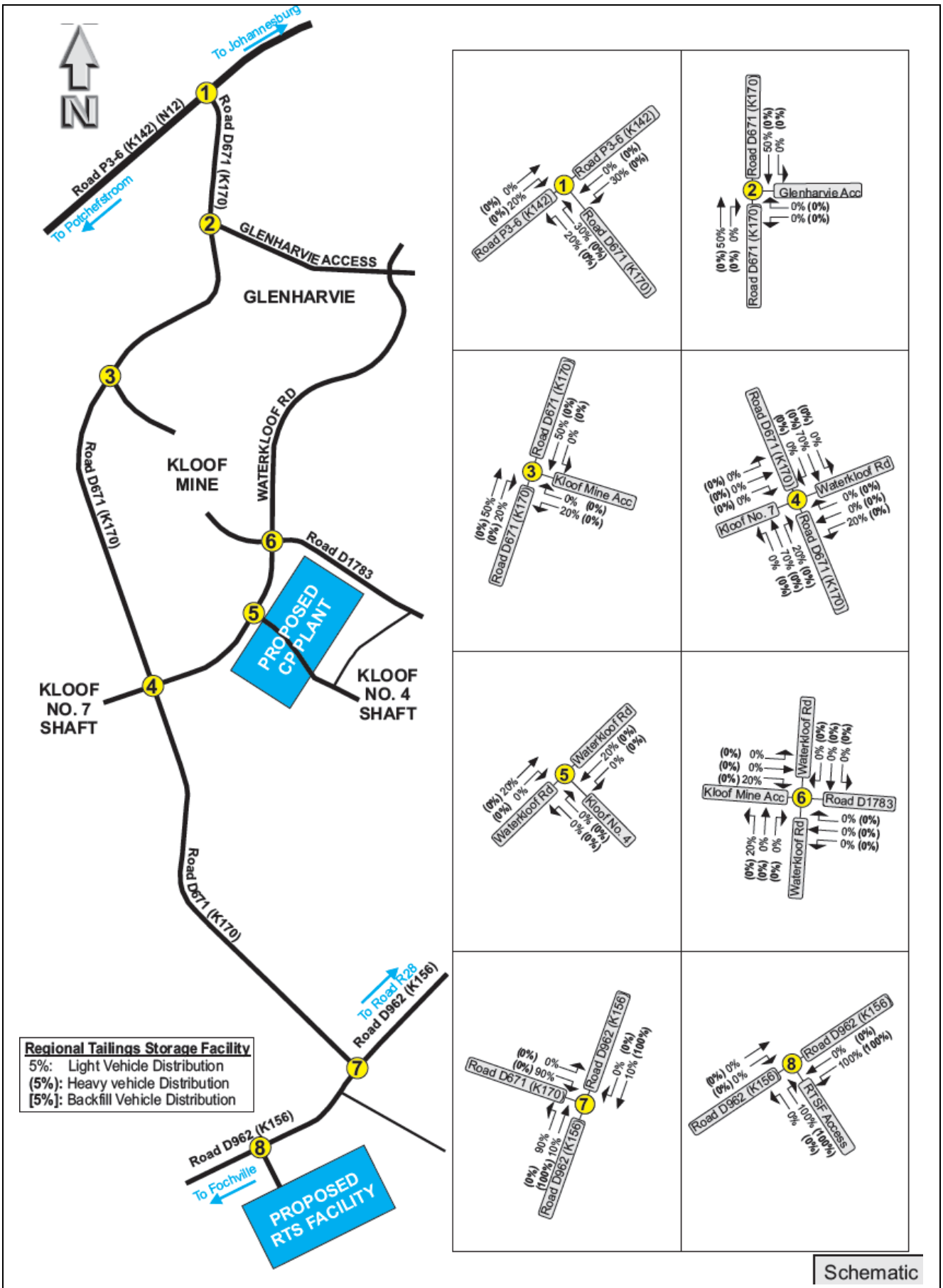

FIGURE B-8: PROJECTED VEHICLE TRIP DISTRIBUTION FOR THE PROPOSED DEVELOPMENT (RTSF OPERATIONAL PHASE)

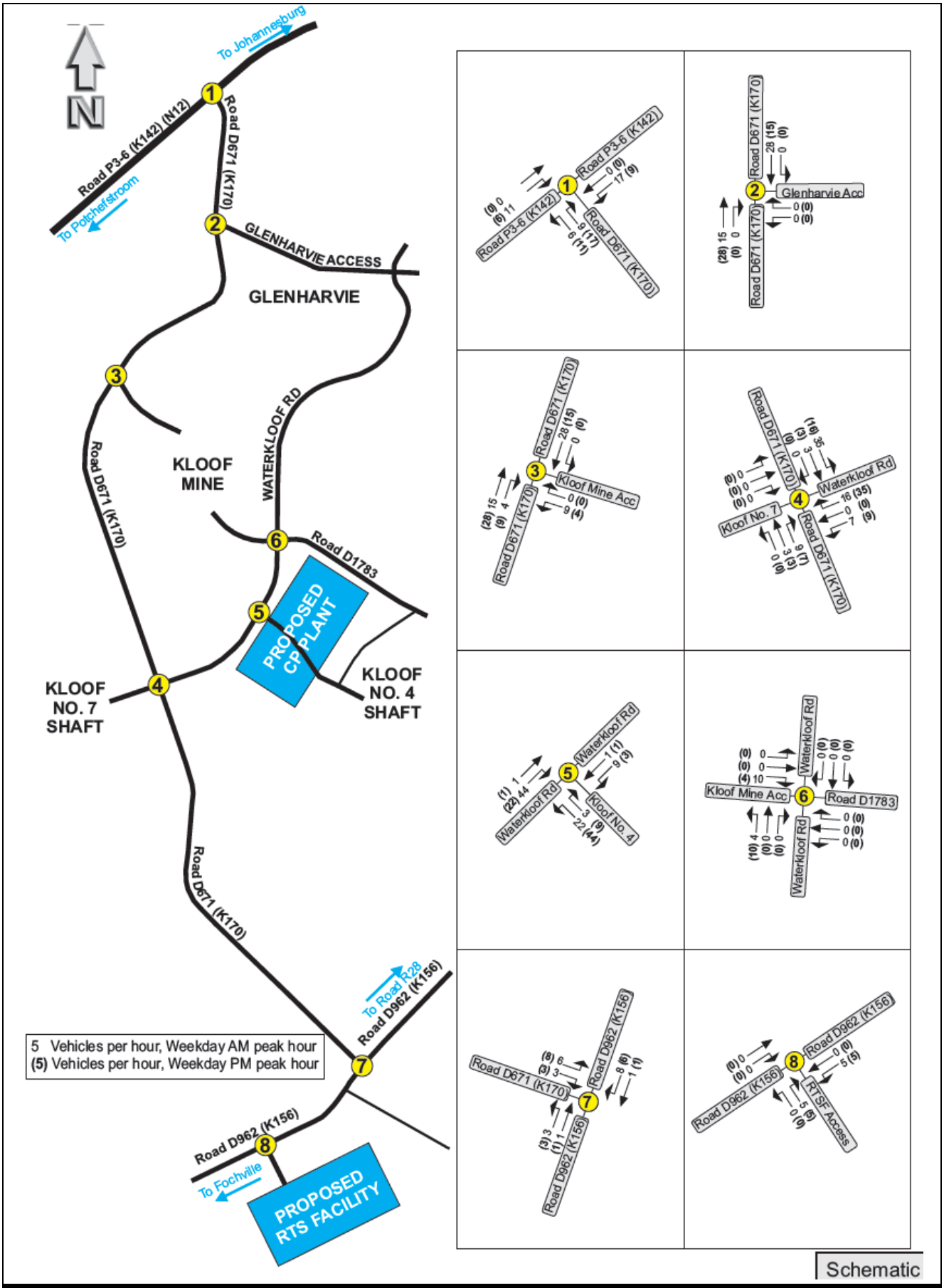

FIGURE B-9: PROJECTED VEHICLE TRIPS GENERATED BY THE PROPOSED DEVELOPMENT (OPERATIONAL PHASE)

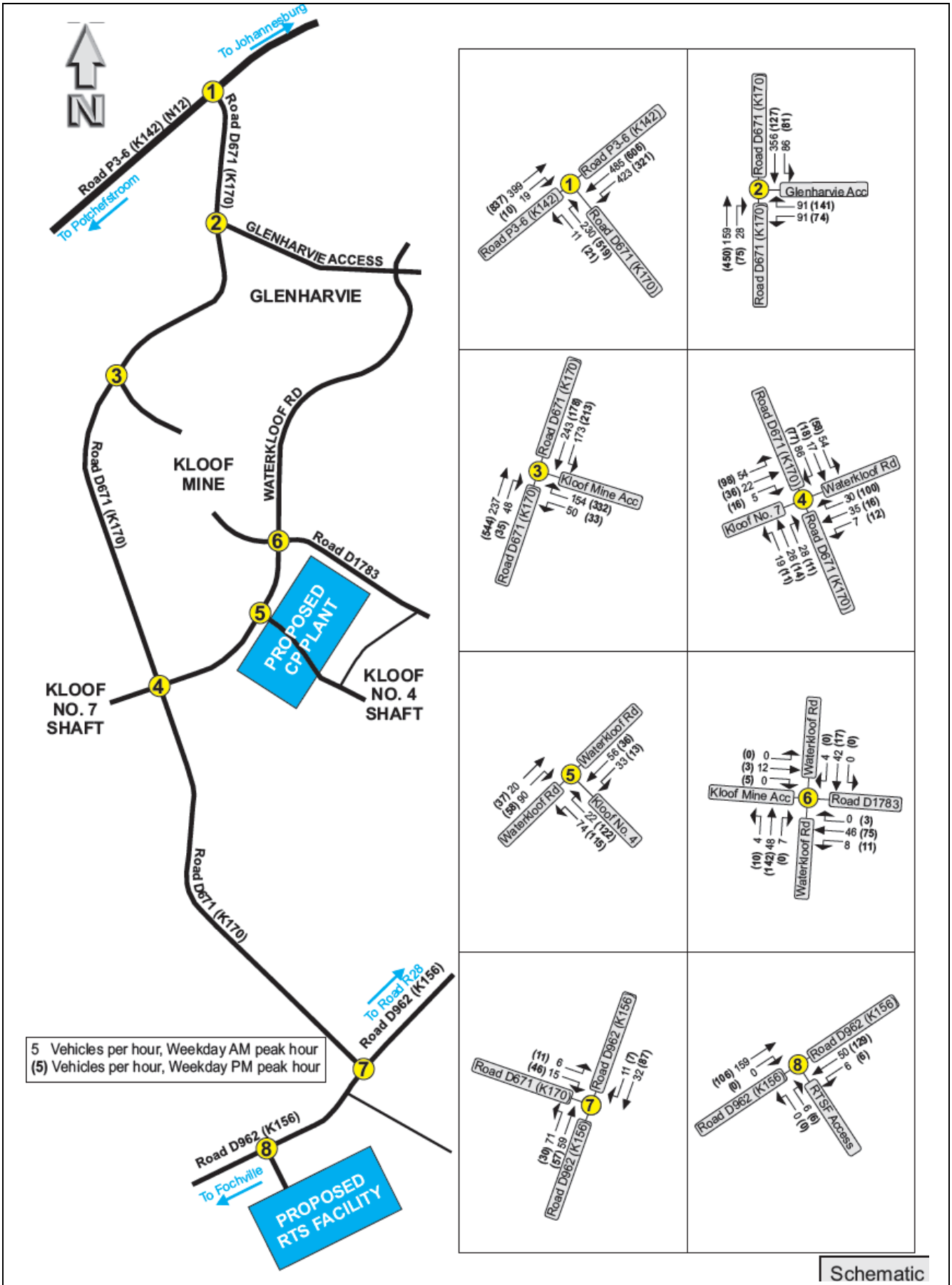

FIGURE B-10: PROJECTED 2025 PEAK HOUR TRAFFIC WITH BACKGROUND TRAFFIC GROWTH WITH THE PROPOSED DEVELOPMENT (SCENARIO 4)

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