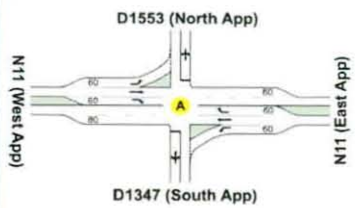
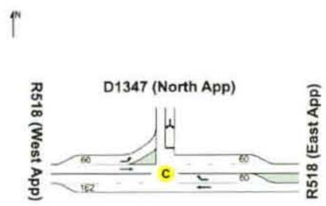
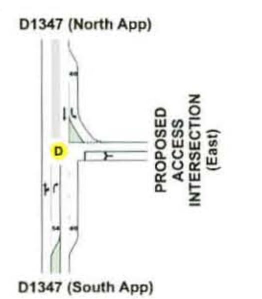
TABLE 2.1: RECOMMENDED ROAD NETWORK IMPROVEMENTS AT INTERSECTIONS																			
POINT	INTERSECTION	APPROACH	IMPROVEMENTS RECOMMENDED																GEOMETRY DETERMINED BY MEANS OF SIDRA
			Approach Traffic Control				Extra Lanes Required (m)												
			Free-Flow	Stop	Roundabout	Traffic Light System	Left Turn Taper / Slip Lane	Left Turn Deceleration Lane	Acceleration Lane	Acceleration Lane in Middle of Road	Dedicated Right Turn Lane	Number of Extra Through Lanes	Improvements Only Required from a Road Safety Perspective	Reflective Studs Required at Intersection	Road Markings Required	Road Signs Required	Public Transport Loading & Off-Loading	Pedestrian Walkways	
OPERATIONAL PHASE																			
A	Road N11 (P83/1) , D1347 and D1553	*Northern*	-	Yes	-	-	-	-	-	-	-	-	Yes	Yes	Yes	Yes	-	-	
		Eastern	Yes	-	-	-	Yes, Slip Lane	Yes	Yes	-	Yes	-	Yes		Yes	Yes	Yes	-	
		Southern	-	Yes	-	-	-	-	-	-	-	-	Yes		Yes	Yes	-	-	
		Western	Yes	-	-	-	Yes, Slip Lane	-	Yes	-	Yes	-	Yes		Yes	Yes	Yes	-	
B	Road D1347 and D1754 (More detailed input required should Road D1347 be surfaced with asphalt in future)	*Northern*	Yes	-	-	-	-	-	-	-	-	-	Yes	-	No	Yes	-	-	
		Eastern	-	Yes	-	-	-	-	-	-	-	-	Yes		No	Yes	-	-	
		Southern	Yes	-	-	-	-	-	-	-	-	-	Yes		No	Yes	-	-	
		Western	-	Yes	-	-	-	-	-	-	-	-	Yes		No	Yes	-	-	

TABLE 2.1: RECOMMENDED ROAD NETWORK IMPROVEMENTS AT INTERSECTIONS																			
POINT	INTERSECTION	APPROACH	IMPROVEMENTS RECOMMENDED																GEOMETRY DETERMINED BY MEANS OF SIDRA
			Approach Traffic Control				Extra Lanes Required (m)												
			Free-Flow	Stop	Roundabout	Traffic Light System	Left Turn Taper / Slip Lane	Left Turn Deceleration Lane	Acceleration Lane	Acceleration Lane in Middle of Road	Dedicated Right Turn Lane	Number of Extra Through Lanes	Improvements Only Required from a Road Safety Perspective	Reflective Studs Required at Intersection	Road Markings Required	Road Signs Required	Public Transport Loading & Off-Loading	Pedestrian Walkways	
OPERATIONAL PHASE																			
C	Road R518 (P19/2) and D1347	*Northern*	-	Yes	-	-	-	-	-	-	-	-	Yes		Yes	Yes	-	-	
		Eastern	Yes	-	-	-	-	-	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	-	
		Western	Yes	-	-	-	Yes, Slip Lane	Yes	-	-	-	-	Yes		Yes	Yes	-	-	
D	Road D1347 and the proposed access road should Road D1347 be surfaced with asphalt in future.	*Northern*	Yes	-	-	-	Yes, Slip Lane	Yes	-	-	-	-	Yes		-	Yes	Yes	-	
		Eastern	-	Yes	-	-	-	-	-	-	-	-	Yes	Yes	-	Yes	-	-	
		Southern	Yes	-	-	-	-	-	Yes	-	Yes	-	Yes		-	Yes	Yes	-	

Note: It might contributes towards the general road safety and access control at point D, if intersection at Point D be constructed at least 250m towards the northern and southern direction of the proposed access point respectively.

FIGURE 2.1: RECOMMENDED UPGRADING OF THE INTERSECTION OF ROADS N11 (P83/1) AND D1347 (POINT A)

FIGURE 2.2: RECOMMENDED UPGRADING OF THE INTERSECTION OF ROADS R518 (P19/2) AND D1347 (POINT C)

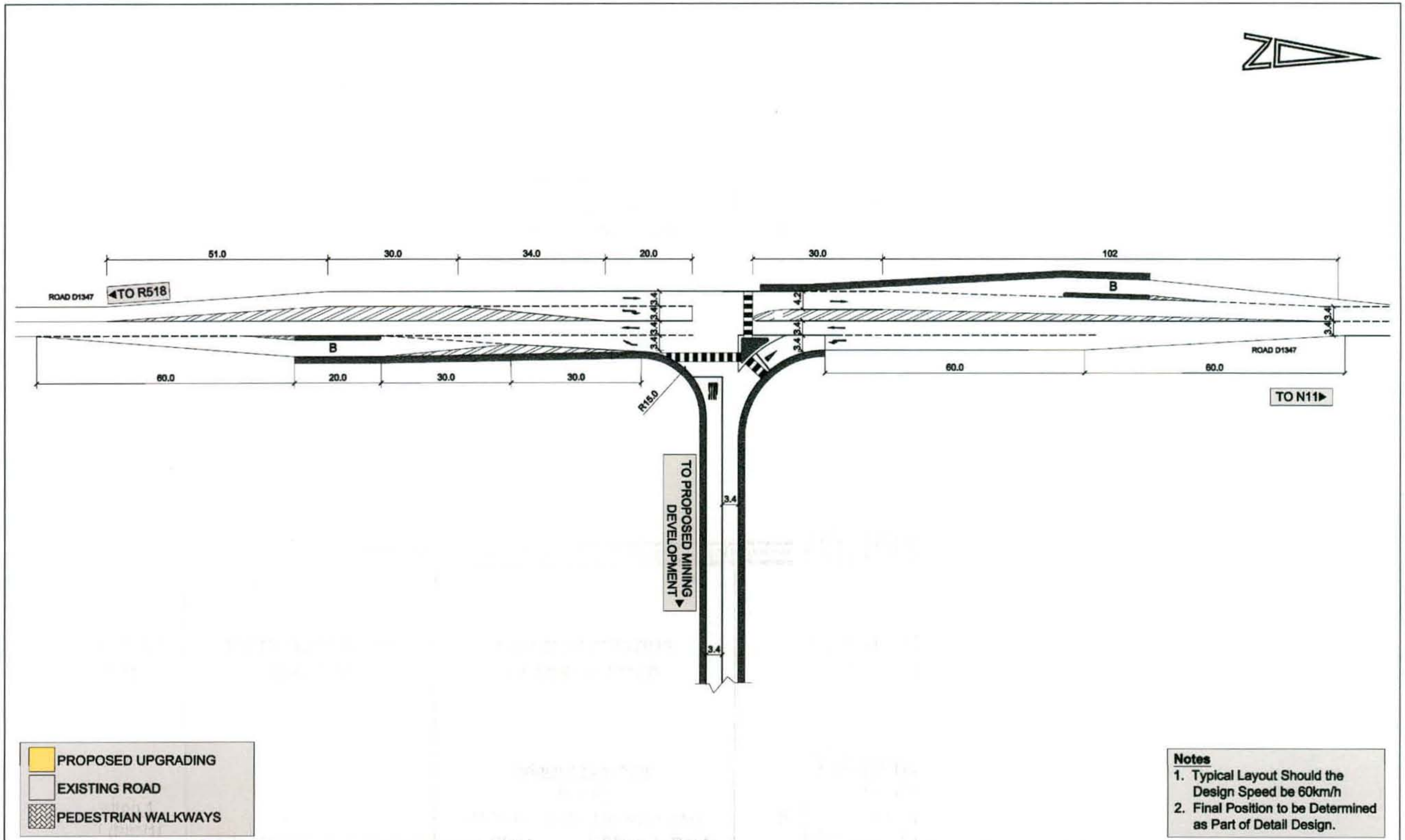


FIGURE 2.3: RECOMMENDED LAYOUT OF THE INTERSECTION OF ROAD D1347 AND THE PROPOSED ACCESS WHEN ROAD D1347 WILL BE SURFACED WITH ASPHALT IN THE FUTURE (POINT D)

Section 3

DETAILED INFORMATION RELATED TO FINDINGS AND RECOMMENDATIONS

The purpose of **Section 3** is to provide the detailed information related to the findings and recommendations:

a) The *status quo* of the land use, as well as the road characteristics
b) The future land use, as well as the road characteristics
c) The current and future levels of service at the relevant intersection that would provide access to the proposed mining development
d) Other traffic-related issues such as permanent accesses and sight distances.

The following subsections elaborate on the above mentioned.

3.1 STATUS QUO OF LAND USE, AS WELL AS ROAD CHARACTERISTICS

The following information is discussed in terms of the *status quo* of the existing land use and road characteristics:

a) Existing land use information
b) Existing road characteristics
c) Traffic counts conducted as a basis for making traffic calculations

3.1.1 EXISTING LAND USE INFORMATION

The relevant property of the proposed mining development is currently zoned as Agricultural. For the purpose of this TIA, the following assumptions are made:

a) That the anticipated average rate of growth will be included as background traffic for the respective road sections
b) That the absorption rate by all other types of completed developments will maintain the same status for the next ten years.

3.1.2 EXISTING ROAD CHARACTERISTICS AND MODAL DISTRIBUTION

The following are relevant as part of this section:

a) **Table 3.1** contains information related to the intersections under investigation and includes the following:

   i) Relevant intersection
   ii) Intersection control
   iii) Pedestrian activities
   iv) Photo of the intersection

b) **Figure 3.1** provides a diagrammatic presentation of the existing road layout for the area under investigation

c) **Table 3.2** provides information concerning the relevant road sections under investigation and includes the following:

   i) Relevant road section
   ii) Picture of road section
   iii) Existing class of road
   iv) Proposed class of road
   v) Road reserves widths
   vi) Lane widths
   vii) Median widths
   viii) Type of Pavement
   ix) Anticipated traffic growth per annum
   x) Road Authority

d) **Table 3.3** provides a copy of the "TYPICAL ROAD CHARACTERISTICS AND ACCESS MANAGEMENT REQUIREMENTS" as provided by the *National Guidelines for Road Access Management in South Africa.* The relevant table is only provided for reference purposes.

TABLE 3.1: SUMMARY OF INTERSECTION CONTROL AT INTERSECTION UNDER INVESTIGATION				
POINT	**DESCRIPTION**	**INTERSECTION CONTROL**	**PEDESTRIAN ACTIVITIES**	**INTERSECTION PHOTO**
A	Roads N11 (P83/1), D1347 and D1553 Roads D1347 and D1553 are staggered (35m apart)	Free-flow on Road N11 (P83/1)	Medium	
B	Roads D1347 and D1754	Free-flow on Road D1347	Low	
C	Roads R518 (P19/2) and D1347	Free-flow on Road R518 (P19/2)	Low	

Note: *See* ***Figure A-1*** *of Appendix for more detail concerning the locality.*

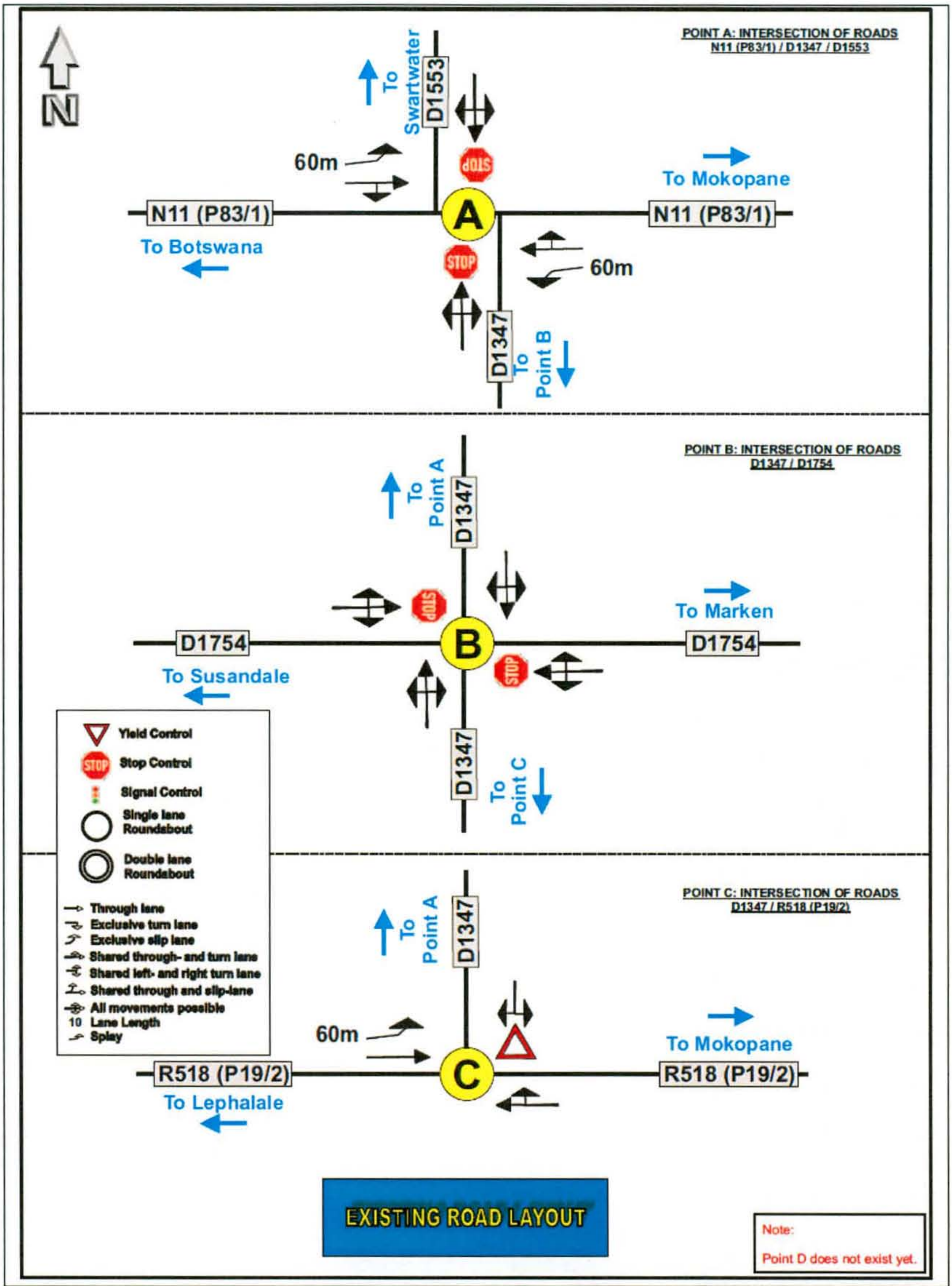


FIGURE 3.1: EXISTING ROAD LAYOUT

TABLE 3.2: SUMMARY OF ROAD CHARACTERISTICS											
RELEVANT ROAD SECTION	**PICTURE OF ROAD SECTION**	**ASSUMED EXISTING CLASS OF ROAD**	**POSSIBLE FUTURE CLASS OF ROAD**	**Road Authority**	**Road Reserve (M)**	**Number of Lanes**	**Lane Width**	**Type Of Surface**	**Median**	**Anticipated Traffic Growth Per Annum Over 10 Years**	**Speed Limit**
Road Section 1 **Road N11 (P83/1)** Road link between Groblersbrug Border Post (Botswana) and Mokopane.		**Primary Function:** Mobility (Vehicle priority. Through route) **Class:** Principal Arterial; **Class No.:** 1; **Route No.:** N **Description:** Non-freeway National Road mainly rural **Spacing between Intersections:** 1.6km	**Proposed Function:** Mobility (Vehicle priority, through route) **Class:** Principal Arterial; **Class No.:** 1; **Route No.:** N **Description:** Non-freeway National Road mainly rural **Spacing between Intersections:** 1.6km	SANRAL	40m	One lane per direction	3.7m wide	Asphalt	None.	3%	100 km/h
Road Section 2 **Road D1347** Road link between Roads N11 (P83/1) and R518 (P19/2) providing access to local communities.		**Primary Function:** Activity & Access **Class:** Activity arterial / spine; **Class No.:** 3; **Route No.:** A **Description:** Activity Arterial **Spacing between Intersections:** 200m to 500m	**Proposed Function:** Mobility (Vehicle priority, through route) **Class:** Minor Arterial; **Class No.:** 3; **Route No.:** M **Description:** Minor Arterial Urban **Spacing between Intersections:** 600m ± 20%	District Road managed by RAL	25m	One lane per direction	3.0m wide	Gravel	None.	2%	60 km/h

TABLE 3.2: SUMMARY OF ROAD CHARACTERISTICS (Continue)											
RELEVANT ROAD SECTION	PICTURE OF ROAD SECTION	ASSUMED EXISTING CLASS OF ROAD	POSSIBLE FUTURE CLASS OF ROAD	Road Authority	Road Reserve (M)	Number of Lanes	Lane Width	Type Of Surface	Median	Anticipated Traffic Growth Per Annum Over 10 Years	Speed Limit
Road Section 3 **Road D1553** Access road to local communities		**Primary Function:** Activity & Access **Class** / **Class No.** / **Route No.** Activity arterial / spine / 3 / A **Description:** Activity Arterial **Spacing between Intersections:** 200m to 500m	**Proposed Function:** Activity & Access **Class** / **Class No.** / **Route No.** Activity arterial / spine / 3 / A **Description:** Activity Arterial **Spacing between Intersections:** 200m to 500m	District Road managed by RAL	25m	One lane per direction	3.0m wide	Gravel	None.	2%	60 km/h
Road Section 4 **Road D1754** Local road providing access to local communities		**Primary Function:** Activity & Access **Class** / **Class No.** / **Route No.** Residential Street / 5 / N/a **Description:** Residential Collector **Spacing between Intersections:** 200m to 300m	**Proposed Function:** Activity & Access **Class** / **Class No.** / **Route No.** Residential Street / 5 / N/a **Description:** Residential Collector **Spacing between Intersections:** 200m to 300m	District Road managed by RAL	30m	One lane per direction	3.0m wide	Gravel	None.	2%	60 km/h

TABLE 3.2: SUMMARY OF ROAD CHARACTERISTICS (Continue)											
RELEVANT ROAD SECTION	PICTURE OF ROAD SECTION	ASSUMED EXISTING CLASS OF ROAD	POSSIBLE FUTURE CLASS OF ROAD	Road Authority	Road Reserve (M)	Number of Lanes	Lane Width	Type Of surface	Median	Anticipated Traffic Growth Per Annum Over 10 Years	Speed Limit
Road Section 5 **Road D3111** Local road providing access to local communities		**Primary Function:** Activity & Access **Class** / **Class No.** / **Route No.** Residential Street / 5 / N/a **Description:** Residential Collector **Spacing between Intersections:** 200m to 300m	**Proposed Function:** Activity & Access **Class** / **Class No.** / **Route No.** Residential Street / 5 / N/a **Description:** Residential Collector **Spacing between Intersections:** 200m to 300m	District Road managed by RAL	25m	One lane per direction	3.0m wide	Gravel	None.	2%	60 km/h
Road Section 6 **Road R518 (P19/2)** Road link between Lephalale and Mokopane		**Primary Function:** Mobility (Vehicle priority, through route) **Class** / **Class No.** / **Route No.** Minor Arterial / 3 / R **Description:** Minor Provincial Road Rural **Spacing between Intersections:** 800m and more	**Proposed Function:** Mobility (Vehicle priority, through route) **Class** / **Class No.** / **Route No.** Minor Arterial / 3 / R **Description:** Minor Provincial Road Rural **Spacing between Intersections:** 800m and more	RAL	40m	One lane per direction	3.6m wide	Asphalt with shoulders	None.	3%	100 km/h

TABLE 3.3: TYPICAL ROAD CHARACTERISTICS AND ACCESS MANAGEMENT REQUIREMENTS (NATIONAL GUIDELINES OF ACCESS MANAGEMENT)

Primary Function	Class (Table 3.2)	Class no.	Route no.	Description	Mobility: Through traffic component	Mobility: Travel distance	Mobility: Travel speed km/h	Access: Access to property	Access: Parking	Access: Inter-section control	Access: Access spacing	Design: Typical cross section	Design: Road reserve width	Design: Distance between km	Design: % of Built km (urban)	Traffic: % of Travel km	Traffic: ADT	Public Facilities: Public trans-port stops	Public Facilities: Pedes-trian footways
Mobility (vehicle priority, through route)	Principal arterial	1	N/R	Freeway rural	exclusively	>40 km	120	not allowed	no	inter-change	>2,4 km	4 lane freeway	60-80 m	-			>25 000	no	no
			N	non-freeway National road mainly rural	exclusively	>40 km	100-120	not allowed	no	priority	>1,6 km	2 lane highway with surfaced shoulder	60 m	-		33%	>10 000	yes at inter-sections	no
			N/R/M	Freeway/ motorway urban	exclusively	>10 km	80-120	not allowed	no	Inter-change	1,6-2,4 km	4/8 lane freeway	45-70 m	4,0-12,0	3%		50 000-120 000	no	no
	Major arterial	2	R	major provincial road rural	predom-inant	>20 km	80-120	not allowed	no	priority	>1,6 km	2 lane with surfaced shoulder lane divided	50-60 m	-		17%	<10 000	yes at inter-sections	no
			R/M	major arterial metropolitan	predom-inant	5-20 km	80-90	not allowed	no	co-ordinated traffic signal	800 m ± 10%	4/6 lane divided	40-60 m	1,5-4,0	3%		20 000-50 000	yes at inter-sections	restricted or separated
	Minor arterial	3	R	Minor provincial road rural	predom-inant	>20 km	80-100	not allowed	no	priority	>800 m	2 lane gravel shoulder	30-50 m	-		24%	<10 000	yes at inter-sections	some-limit conflict
			M	Minor arterial urban	major	3-10 km	70-80	generally not allowed	no	co-ordinated traffic signal	600 m ± 20%	4 lane divided or undivided	25-40 m	0,8-1,5	5%	24%	10 000 40 000	yes at inter-sections	some-limit conflict
Activity and access	Activity arterial/ spine		A	Activity arterial	minor	<2km (if con-tinuous) 3-4 km if destination	50-60	limited	limited, preference to public transport stops	traffic signals round-about or priority	inter-sections 200-500m, property Access from side and back	4 lane divided	25-40 m	-	1%	3%	15 000-25 000	yes at inter-sections	yes
	Activity street	4	N/a	collector non-residential, CBD street commercial industiral street	discourage	0,5-3 km	40-50	all property	yes	traffic signal, priority or round-about	inter-sections 200-300m combine individual accesses ± 40 m	4 lane undivided one-way in CBDs	20-30 m	-	9%	6%	5 000-15 000	yes any-where	yes
	Residen-tial street	5	N/a	residential, collector	discourage	0,5-2 km	40-50	small develop-ments	yes on street	priority or round-about	-	2 lane undivided 10,5 m wide	20-25 m	-	12%	10%	<5 000	yes any-where	yes
			N/a	Local street	prevent	<0,5-1 m	30-40	individual houses	yes on verge	priority of mini-circle	-	2 lane mountable kerbs	12-15 m	N/a	67%	7%	<1 000	not bus routes	not normally
	Non-motorized	6	N/a	pedestrian/ cycleway	ban	<1 km	80m/ minute	as required	no	pedes-trian signal	500 m maximum	Block paving	6 m	-				no, unless busway	yes

3.1.3 TRAFFIC COUNTS AS BASIS FOR MAKING TRAFFIC CALCULATIONS

In order to gain a better understanding of the existing traffic patterns and movements adjacent to the proposed development, 12-hour manual traffic counts were conducted at intersections that would potentially be affected by the proposed mining development.

It is standard traffic engineering practice to conduct 12-hour manual traffic counts at all intersections that could potentially be affected by a proposed development, as close as possible to a month-end Friday when traffic movement is expected to be at its highest. From the 12-hour manual traffic counts, the AM and PM peak hours are determined respectively, and used for any further calculations.

Traffic counts were conducted at the following intersections on Friday 06 May 2011:

a) Point A: Intersection of Roads N11 (P83/1), D1347 and D1553
b) Point B: Intersection of Roads D1347 and D1754
c) Point C: Intersection of Roads R518 (P19/2) and D1347

The combined hourly totals of all the vehicles for the respective traffic surveys conducted on Friday 06 May 2011 between 06:00 and 18:00 are indicated in **Tables A-1 to A-3** of **Appendix A** of this report. The description of vehicle movements at the respective intersections appears in **Figure A-3** of **Appendix A**.

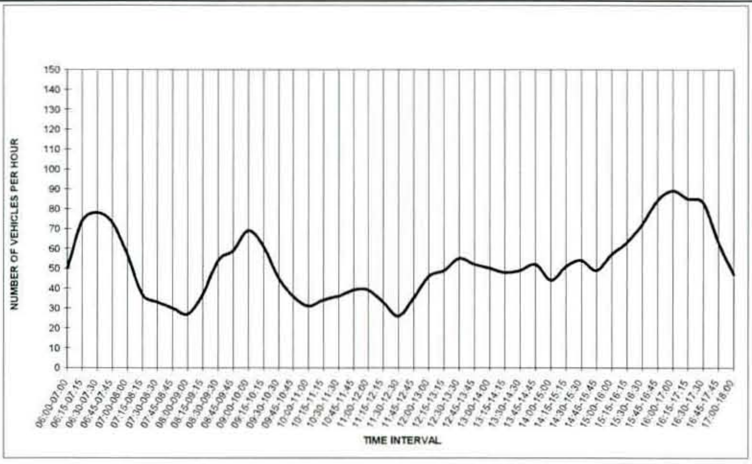
The respective peak-hour flows for the traffic counts at the relevant intersection were identified as indicated in **Table 3.4** below.

TABLE 3.4: PEAK HOUR PERIODS AT RELEVANT INTERSECTIONS

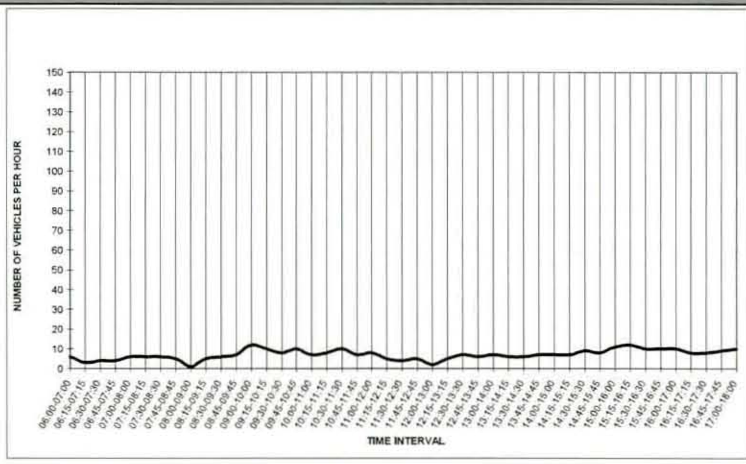
POINT	INTERSECTION	AM PEAK	NUMBER OF VEHICLES	PM PEAK	NUMBER OF VEHICLES
A	Roads N11 (P83/1), D1347 and D1553	06:30 – 07:30	78	16:00 – 17:00	89
B	Roads D1347 and D1754	07:00 – 08:00	6	15:15 – 16:15	12
C	Roads R518 (P19/2) and D1347	08:00 – 09:00	86	16:15 – 17:15	146

Due to the long distances between the intersections under investigation, the peak periods as obtained from the 12-hour manual traffic counts for the respective intersections were used for conducting the relevant calculations for each intersection.

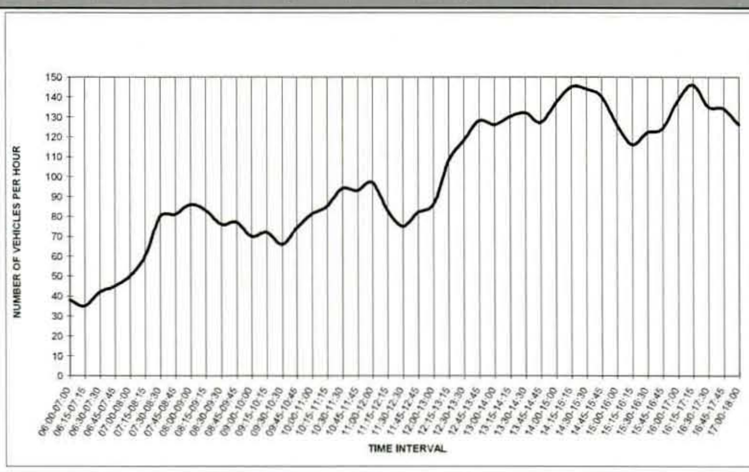
Figure 3.2 indicates the hourly traffic pattern, per 15-minute interval, for all modes of vehicles at the relevant intersections between 06:00 and 18:00 on Friday 06 May 2011.



POINT A
INTERSECTION OF ROADS N11 (P83/1), D1347 AND D1553
(06 MAY 2011)



POINT B
INTERSECTION OF ROADS D1347 AND D 1754
(06 MAY 2011)



POINT C
INTERSECTION OF ROADS R518 (P19/2) AND D1347
(06 MAY 2011)

FIGURE 3.2: HOURLY TRAFFIC PATTERN PER 15-MINUTE INTERVAL FOR ALL MODES OF VEHICLES (06:00 to 18:00)

3.2 DETERMINATION OF FUTURE LAND USE AND ROAD CHARACTERISTICS

The following are relevant:

a) Land use information, including possible future developments in the area
b) Information about the expected future modal distribution
c) Determination of the vehicle trips expected to be generated by the proposed mining development
d) Determination of the total traffic expected to be generated by the proposed mining development at the relevant intersections.

The subsections below elaborate on the above mentioned future land use and road characteristics.

3.2.1 LAND USE INFORMATION, INCLUDING POSSIBLE FUTURE DEVELOPMENTS IN THE AREA

The proposed mining development will entail the development of an open pit mine, including mineral processing facilities, mine residue disposal facilities and various support infrastructure and services. There are no known future developments in the direct vicinity of the proposed Moonlight Iron Ore mining development.

3.2.2 INFORMATION ABOUT THE EXPECTED FUTURE MODAL DISTRIBUTION

Figures B-2 and **B-3 of Appendix B** indicate, in percentages, the expected trips distribution, respectively, of heavy and light vehicles for the AM and PM peak periods for the relevant scenarios of the operational phase.

3.2.3 DETERMINATION OF VEHICLE TRIPS EXPECTED TO BE GENERATED BY THE PROPOSED DEVELOPMENT

Tables 3.5 and 3.6 indicate the trip generation rates, the number of vehicle trips which are expected to be generated by the proposed mining development and the distribution of the vehicle trips to and from the respective areas of the development respectively for the construction and operational phases. The trip generation rates are based on the *South African Trip Generation Rates*, Second Edition, 1995, and assumptions made based on experience where information was not available.

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TABLE 3.5: TRIP GENERATION RATES, EXPECTED NUMBER OF VEHICLE TRIPS TO BE GENERATED BY THE PROPOSED MINING ACTIVITIES AND THE DISTRIBUTION OF VEHICLE TRIPS (CONSTRUCTION PHASE)

Item	Component	Num Workers per Day	% Workers Active during Peak Hour	Num Workers Active per Peak Hour	Num Trucks per Day	% Trucks Active during Peak Hour	Num Trucks Active during Peak Hour	Assumed Ave. Num Persons per Veh	Comments	Trip Generation Calculations for Peak Hour: If Inward Movement Is Relevant Value = 1	Num Veh Trips for Inwards Direction	If Outward Movement Is Relevant Value = 1	Num Veh Trips for Outwards Direction	Total Num Veh Trips Generated During Peak Hour (In & Out)	Calculated Trip Generation Rate per Veh during Peak Hour	Final Trip Information for Traffic Engineering Calculations: Trip Dist. % In	Trip Dist. % Out	Trip Generation In	Trip Generation Out
AM Peak Hour																			
1.	Construction workers (using own transport)	50	100%	50				1.2	Trips per worker (1.2 persons per vehicle)	1	42	0	0	42	**0.83**	100%	0%	42	0
2.	Construction workers (transported via 50 seater buses)	950	100%	950				50.0	50 persons per bus (bus delivers workers and leaves site empty)	1	19	1	19	38	**0.04**	50%	50%	19	19
3.	Heavy vehicles delivering consumables				8	20%	2	1.0	20% of delivery vehicles expected during peak periods	1	2	1	2	4	**2.00**	50%	50%	2	2
													TOTAL	84				63	21
PM Peak Hour																			
1.	Construction workers (using own transport)	50	100%	50				1.2	Trips per worker (1.2 persons per vehicle)	0	0	1	42	42	**0.83**	0%	100%	0	42
2.	Construction workers (transported via 50 seater buses)	950	100%	950				50.0	50 persons per bus (bus delivers workers and leaves site empty)	1	19	1	19	38	**0.04**	50%	50%	19	19
3.	Heavy vehicles delivering consumables				8	20%	2	1.0	20% of delivery vehicles expected during peak periods	1	2	1	2	4	**2.00**	50%	50%	2	2
													TOTAL	84				21	63

TABLE 3.6: TRIP GENERATION RATES, EXPECTED NUMBER OF VEHICLE TRIPS TO BE GENERATED BY THE PROPOSED MINING ACTIVITIES AND THE DISTRIBUTION OF VEHICLE TRIPS (OPERATIONAL PHASE, PIPELINE TO TRANSPORT PRODUCT)																			
Item	Component	Num Workers per Day	% Workers Active during Peak Hour	Num Workers Active per Peak Hour	Num Trucks per Day	% Trucks a Active during Peak Hour	Num Trucks Active during Peak Hour	Assumed Ave. Num Persons per Veh	Comments	Trip Generation Calculations for Peak Hour						Final Trip Information for Traffic Engineering Calculations			
										If Inward Movement Is Relevant Value = 1	Num Veh Trips for Inwards Direction	If Outward Movement Is Relevant Value = 1	Num Veh Trips for Outwards Direction	Total Num Veh Trips Generated during Peak Hour (In & Out)	Calculated Trip Generation Rate per Veh during Peak Hour	Trip Dist. %		Trip Generation	
																In	Out	In	Out
TRANSPORT PRODUCT WITH PIPELINE (AM PEAK HOUR)																			
MINING WORKERS																			
1.	Supervision, Mechanics, Managers and Engineers (using own transport) **DAY SHIFT**	42	100%	42				1.2	Trips per worker (1.2 persons per vehicle) one shift traffic in, one shift traffic out	1	35	0	0	35	**0.83**	100%	0%	35	0
2.	Mining shift workers (transported via 50 seater buses) **2 SHIFTS PER DAY**	138	50%	69				50.0	50 persons per bus (bus delivers workers and leaves with previous shift workers)	1	2	1	2	4	**0.06**	50%	50%	2	2
3.	Heavy vehicles delivering consumables to open pit				8	20%	2	1.0	20% of delivery vehicles expected during peak periods	1	2	1	2	4	**2.00**	50%	50%	2	2
PROCESS PLANT WORKERS																			
4.	Administrative and Management personnel (using own transport) **DAY SHIFT**	90	100%	90				1.2	Trips per worker (1.2 persons per vehicle)	1	75	0	0	75	**0.83**	100%	0%	75	0
5.	Maintenance personnel (using own transport) **3 SHIFTS PER DAY**	24	25%	6				1.2	Trips per worker (1.2 persons per vehicle)	1	5	1	5	10	**1.67**	100%	0%	10	0
6.	Operations personnel (Transported via 50 seater buses) **3 SHIFTS PER DAY**	200	25%	50				50.0	50 persons per bus (bus delivers workers and leaves with previous shift workers)	1	1	1	1	2	**0.04**	50%	50%	1	1
7.	Maintenance personnel (Transported via 50 seater buses) **DAY SHIFT**	50	100%	50				50.0	50 persons per bus (bus delivers workers and parks on site)	1	1	0	0	1	**0.02**	100%	0%	1	0
8.	Heavy vehicles delivering consumables to plant				5	20%	1	1.0	20% of delivery vehicles expected during peak periods	1	1	1	1	2	**2.00**	50%	50%	1	1
TOTAL (TRANSPORT PRODUCT WITH PIPELINE)														133				127	6

Item	Component	Num Workers per Day	% Workers Active during Peak Hour	Num Workers Active per Peak Hour	Num Trucks per Day	% Trucks a Active during Peak Hour	Num Trucks Active during Peak Hour	Assumed Ave. Num Persons per Veh	Comments	Trip Generation Calculations for Peak Hour						Final Trip Information for Traffic Engineering Calculations			
										If Inward Movement Is Relevant Value = 1	Num Veh Trips for Inwards Direction	If Outward Movement Is Relevant Value = 1	Num Veh Trips for Outwards Direction	Total Num Veh Trips Generated during Peak Hour (In & Out)	Calculated Trip Generation Rate per Veh during Peak Hour	Trip Dist. %		Trip Generation	
																In	Out	In	Out
TRANSPORT PRODUCT WITH PIPELINE (PM PEAK HOUR)																			
MINING WORKERS																			
1.	Supervision, Mechanics, Managers and Engineers (using own transport) **DAY SHIFT**	42	100%	42				1.2	Trips per worker (1.2 persons per vehicle) one shift traffic in, one shift traffic out	0	0	1	35	35	**0.83**	0%	100%	0	35
2.	Mining shift workers (transported via 50 seater buses) **2 SHIFTS PER DAY**	138	50%	69				50.0	50 persons per bus (bus delivers workers and leaves with previous shift workers)	1	2	1	2	4	**0.06**	50%	50%	2	2
3.	Heavy vehicles delivering consumables to open pit				8	20%	2	1.0	20% of delivery vehicles expected during peak periods	1	2	1	2	4	**2.00**	50%	50%	2	2
PROCESS PLANT WORKERS																			
4.	Administrative and Management personnel (using own transport) **DAY SHIFT**	90	100%	114				1.2	Trips per worker (1.2 persons per vehicle)	0	0	1	75	75	**0.83**	0%	100%	0	75
5.	Maintenance personnel (using own transport) **3 SHIFTS PER DAY**	24	25%	6				1.2	Trips per worker (1.2 persons per vehicle)	1	5	1	5	10	**1.67**	0%	100%	0	10
6.	Operations personnel (transported via 50 seater buses) **3 SHIFTS PER DAY**	200	25%	50				50.0	50 persons per bus (bus delivers workers and leaves with previous shift workers)	1	1	1	1	2	**0.04**	50%	50%	1	1
7.	Maintenance personnel (transported via 50 seater buses) **DAY SHIFT**	50	100%	50				50.0	50 persons per bus (bus delivers workers and parks on site)	0	0	1	1	1	**0.02**	0%	100%	0	1
8.	Heavy vehicles delivering consumables to plant				5	20%	1	1.0	20% of delivery vehicles expected during peak periods	1	1	1	1	2	**2.00**	50%	50%	1	1
													TOTAL	133				6	127

3.2.4 DETERMINATION OF THE TOTAL TRAFFIC EXPECTED TO BE GENERATED AT THE RELEVANT INTERSECTIONS

The detailed traffic-related investigations were conducted for the Operational Phase, since it is the worst case scenario. The following figures are relevant:

a) **Figure B-1:** Base year, 2011, peak hour traffic without the proposed mining development (Scenario 1)
b) **Figure B-2:** Projected trip distribution for the proposed mining development (heavy vehicles delivering consumables)
c) **Figure B-3:** Projected trip distribution for the proposed mining development (light vehicles and buses transporting workers)
d) **Figure B-4:** Projected vehicle trips generated by the proposed mining development
a) **Figure B-5:** Base year, 2011, peak hour traffic with the proposed mining development (Scenario 2)
b) **Figure B-6:** Projected 2021 peak hour traffic without the proposed mining development (Scenario 3)
c) **Figure B-7:** Projected 2021 peak hour traffic with the proposed mining development (Scenario 4)

3.3 DETERMINATION OF THE LEVELS OF SERVICE AT THE RELEVANT INTERSECTIONS

The ***"SIDRA Intersection"*** software was used as an aid for the design and evaluation of the relevant intersections. The following intersections were evaluated for levels of service:

a) Point A: Intersection of Roads N11 (P83/1), D1347 and D1553
b) Point B: Intersection of Roads D1347 and D1754
c) Point C: Intersection of Roads R518 (P19/2) and D1347
d) Point D: Intersection of Road D1347 and proposed access to the Mine Development.

In Appendix C, Tables C-1 to C-4 indicates the levels of service and the degree of saturation calculated for the relevant intersections for the various scenarios:

a) **Table C-1:** Levels of service for various approaches for the year 2011, without the proposed mining development (Scenario 1)

b) **Table C-2:** Levels of service for various approaches for the year 2011, with the proposed mining development (Scenario 2)

c) **Table C-3:** Levels of service for various approaches for the year 2021, without the proposed mining development (Scenario 3)

d) **Table C-4:** Levels of service for various approaches for the year 2021, with the proposed mining development (Scenario 4)

From **Tables C-1 to C-4** it is possible to note:

a) That no additional infrastructure is required from a traffic capacity point of view at the relevant intersections.

b) That the relevant intersections will operate at acceptable levels of services.

See Figures 2.1 to 2.3 for more detailed information concerning specific proposed intersection layouts.

Table 3.7 provides a summary of the available reserve capacity on the various road sections of the roads that had been investigated. The assumed free-flow capacity of individual lanes is relevant provided that related intersections have reserve capacity available.

TABLE 3.7: AVAILABLE RESERVE CAPACITY FOR VARIOUS ROAD SECTIONS

Intersection	Direction of Road Section	Capacity per Lane	Actual Number of Vehicles per Lane				Reserve Capacity Available per Lane			
			2011		2021		2011		2021	
			AM	PM	AM	PM	AM	PM	AM	PM
Roads N11 (P83/1), D1347 and D1553 (Point A)	North	1300	5	5	6	6	1295	1295	1294	1294
	East	1500	32	48	41	64	1468	1452	1459	1436
	South	1300	61	3	65	3	1239	1297	1235	1297
	West	1500	22	73	28	87	1488	1427	1272	1213
Roads D1347 and D1754 (Point B)	North	1300	108	11	108	13	1192	1289	1192	1287
	East	1300	2	0	2	0	1298	1300	1298	1300
	South	1300	5	86	5	86	1295	1214	1295	1214
	West	1300	0	24	0	25	1300	1276	1300	1275
Roads R518 (P19/2) and D1347 (Point C)	North	1300	69	4	69	5	1231	1296	1231	1295
	East	1500	27	106	36	142	1473	1394	1464	1358
	West	1500	58	104	78	117	1442	1396	1422	1383

3.4 OTHER TRAFFIC-RELATED ISSUES

Table 3.8 provides a summary of the following:

a) Access related issues
b) Road safety
c) Available sight distances
d) Gravel road conditions
e) Road diversion
f) Non-motorised transport
g) Public transport.

TABLE 3.8: SUMMARY OF OTHER TRAFFIC RELATED ISSUES				
Item	**Description of Element**	**General Comments**	**Specific Issues**	**Actions Required**
1.	**ACCESS RELATED ISSUES**			
1.1	**Intersection Spacing**	a) Intersection at Points A, B and C are existing intersections.	a) The final accurate position of Point D should still be determined.	a) The planning process related to the relevant intersection should comply with the relevant design requirements b) Figure 2.3 provides a tentative layout for Intersection D.
1.2	**Access to the Farm Good Hope immediately East of the Moonlight Farm**	a) Access to the Farm Good Hope is currently through the Moonlight Farm	a) With the development of the proposed mine on the Moonlight Farm, the access to the Good Hope Farm will be blocked off	a) An alternative access route from Road D1347 will be provided along the southern mine boundary to the Good Hope Farm b) During the detail designing of the proposed alternative access route, access separation guidelines should be used to determine an acceptable location for access from Road D1347
1.3	**Access to the Farm Karnemelksfontein to the East of the Moonlight Farm**	a) Access to the Karnemelksfontein Farm is currently through the Moonlight Farm	a) With the development of the proposed mine on the Moonlight Farm, the access to the Karnemelksfontein Farm will be blocked off	a) An alternative access route from Road D1347 will be provided along the southern mine boundary to the Karnemelksfontein Farm b) During the detail designing of the proposed alternative access route, access separation guidelines should be used to determine an acceptable location for access from Road D1347
2.	**ROAD SAFETY ISSUES**			
2.1	**General Road Safety**	The following are typical elements related to the road network, which cause road safety problems in rural areas and which need to be addressed on a continuous basis: a) Intersection layout, with specific reference to the lack of dedicated right turn lanes, where there is heavy vehicle movement b) Pedestrian movements (Road Crossings) c) Intersection alignment, such as staggered intersections d) Insufficient public transport facilities e) Access control for vehicle movement f) Fencing to control animal movement g) Lack of reflective studs for visibility during the night at strategic points h) Lack of pedestrian walkways to separate pedestrian and vehicle movements at strategic points i) Lack of provision and quality of road marks j) Lack of provision and quality of road signs k) Improper road safety training for workers as well as adjacent community /ies	a) None.	a) In general the report was compiled so as to address the road safety issues as far as practically possible. b) See **Table 2.1 and Figures 2.1, 2.2** and **2.3** for the recommended upgrading at the relevant intersections. c) Collaborate with relevant Roads Agency Limpopo to set up a road maintenance plan to maintain the relevant road network.
2.2	**Intersection of the Roads N11 (P83/1), D1553 and D1347 (Point A)**		a) The staggered road alignment of Roads D1553 and D1347 on Road N11 (P83/1) is not within acceptable road design standards b) Angle at which the respective roads link to each other	a) Re-align the intersection of Road D1553 with Road N11 (P83/1) to be in line to the intersection with Road D1347 as indicated in **Figure 2.1**
2.3	**Intersection of Roads D1347 and D1754 (Point B)**		a) None	a) None

TABLE 3.8: SUMMARY OF OTHER TRAFFIC RELATED ISSUES				
Item	**Description of Element**	**General Comments**	**Specific Issues**	**Actions Required**
2.4	**Intersection of Roads R518 (P19/2) and D1347 (Point C)**		a) Quality of road surface at intersection is not good. b) Quality of road markings are poor	a) Provide a proper pedestrian crossing as indicated in **Figure 2.3 and Table 2.1**
3.	**AVAILABLE SIGHT DISTANCES**			
3.1	**Available Sight Distances**	a) During the site visit it was determined visually that the available sight distances are acceptable for the relevant intersections under investigation.	a) None.	a) None.
4.	**GRAVEL ROAD CONDITION**			
	Road D1347 (Between Points A and C)	a) The Road D1347 is currently a graded gravel road.	a) Road drainage is poor b) Road surface slippery in rainy season.	a) The Pavement Design Engineer related to the project should provide more input concerning the matter b) Collaborate with Roads Agency Limpopo to ensure a well prepared road maintenance plan
5.	**ROAD RE-ALIGNMENT**			
	Road D1347 in the vicinity of the proposed Mining Development	a) A portion of the proposed mining development intended to be located over a section of Road D1347. The owners of the proposed mining development therefore intend to divert the relevant section of Road D1347. (See **Figure A-2 of Appendix A** for a geographical presentation of the proposed road diversion in terms of the proposed site layout)	a) Vehicle movements will not be effected by the proposed re-alignment, accept for a limited longer distance	a) The necessary negotiations should be conducted with Roads Agency Limpopo concerning the proposed realignment, by the Road Design Engineer related to the project
6.	**NON-MOTORISED TRANSPORT**			
6.1	**Non-Motorised Transport**	a) There are currently a generous volume of pedestrians in the vicinity of the intersection of Roads N11 (P83/1) , D1553 and D1347 (Point A) b) There are currently a low volume of pedestrian movements in the vicinity of the intersection of Roads R518 (P19/2) and D1347 (Point C) c) There are villages located along Road D1347 that generates non-motorised related trips.	a) No pedestrian crossings and pedestrian walkways are present at the intersection of Roads N11 (P83/1), D153 and D1347 (Point A) b) Uncontrolled animals and children movements observed within Road D1347 road reserve where villages are located.	a) It is recommended that pedestrian crossings and walkways at the relevant intersection should be provided. b) Special attention should be given to pedestrian road safety where villages are located along Road D1347. One method will be by providing workers and villagers with road safety training. c) The matter should be brought under the attention of the Road Agency Limpopo, in order to maintain fencing where villages are located, in order to keep animals and children from moving freely within the road reserve.

TABLE 3.8: SUMMARY OF OTHER TRAFFIC RELATED ISSUES				
Item	**Description of Element**	**General Comments**	**Specific Issues**	**Actions Required**
7.	**PUBLIC TRANSPORT**			
7.1	**Public Transport**	a) Two types of public transport commuters are relevant: i) Firstly, workers who will travel to and from the proposed mining development during the construction and operational phases ii) Secondly, visitors during the construction and operational phases	a) Workers will be transported via 50 seater buses from and to site during the construction and operational phases b) It is anticipated that public transport to the proposed development will be limited. c) As part of site visit it was noted that passengers in the broader community are dropped off and collected at point A. Road N11 (P83/1) is a main public transport corridor	a) It is recommended that a dedicated loading and off-loading area should be provided for public transport close to the operational area of the mine where workers can be loaded and off-loaded in a safe environment as part of the construction and operational phases. b) It is recommended to provide loading and off-loading bays at point A along Road N11 (P83/1).

APPENDIX A

INFORMATION RELATED TO STATUS QUO

POINT	INTERSECTION STATUS	INTERSECTION	GPS CO-ORDINATES	
			LATITUDE	LONGITUDE
A	Existing	Roads N11 (P83/1), D1553 and D1347	S23°9'50.96"	E28°12'40.41"
B	Existing	Roads D1347 and D1754	S23°21'23.81"	E28°11'32.29"
C	Existing	Roads R518 (P19/2) and D1347	S23°34'25.44"	E28°10'28.05"

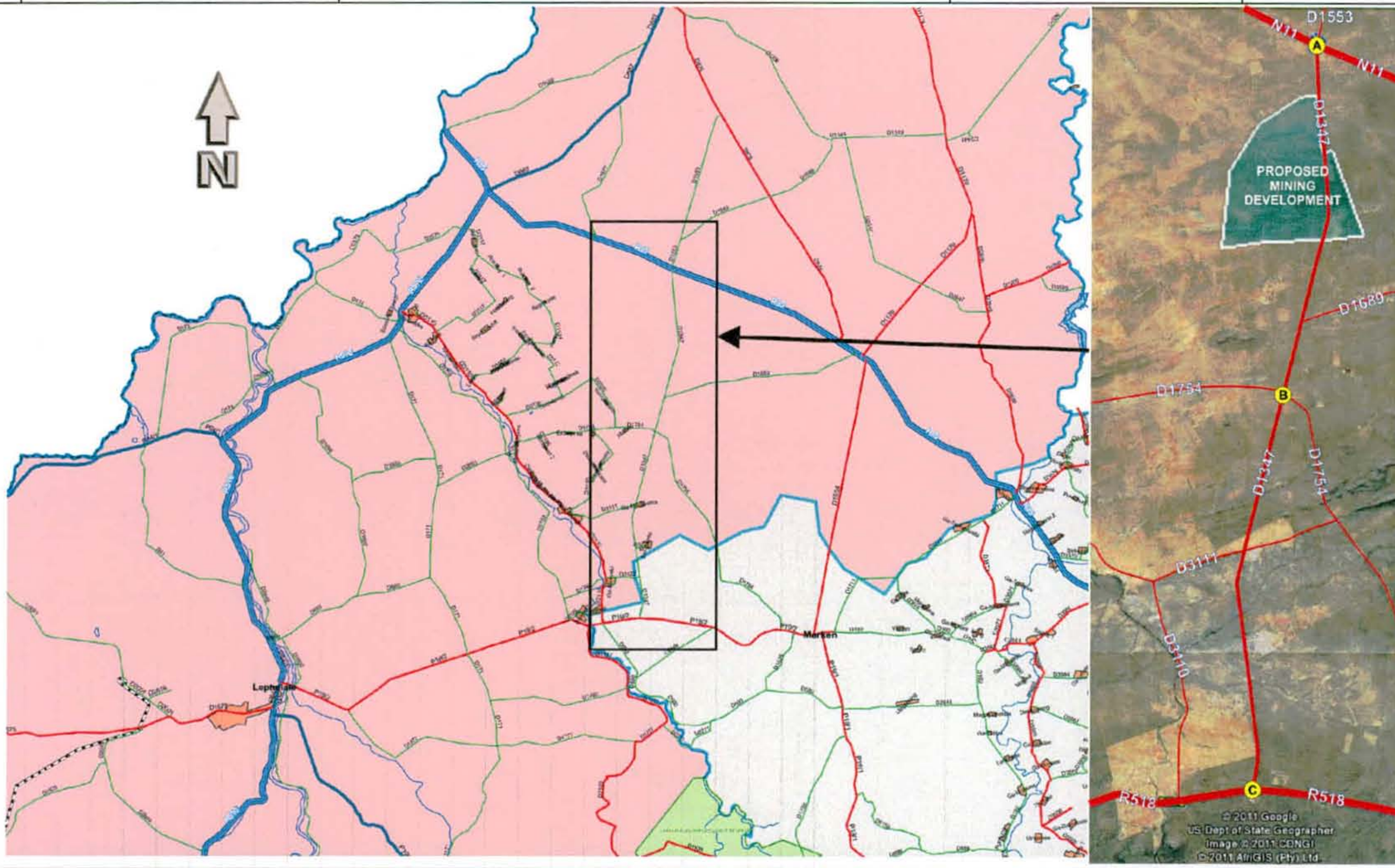


FIGURE A-1: LOCALITY OF PROPOSED DEVELOPMENT

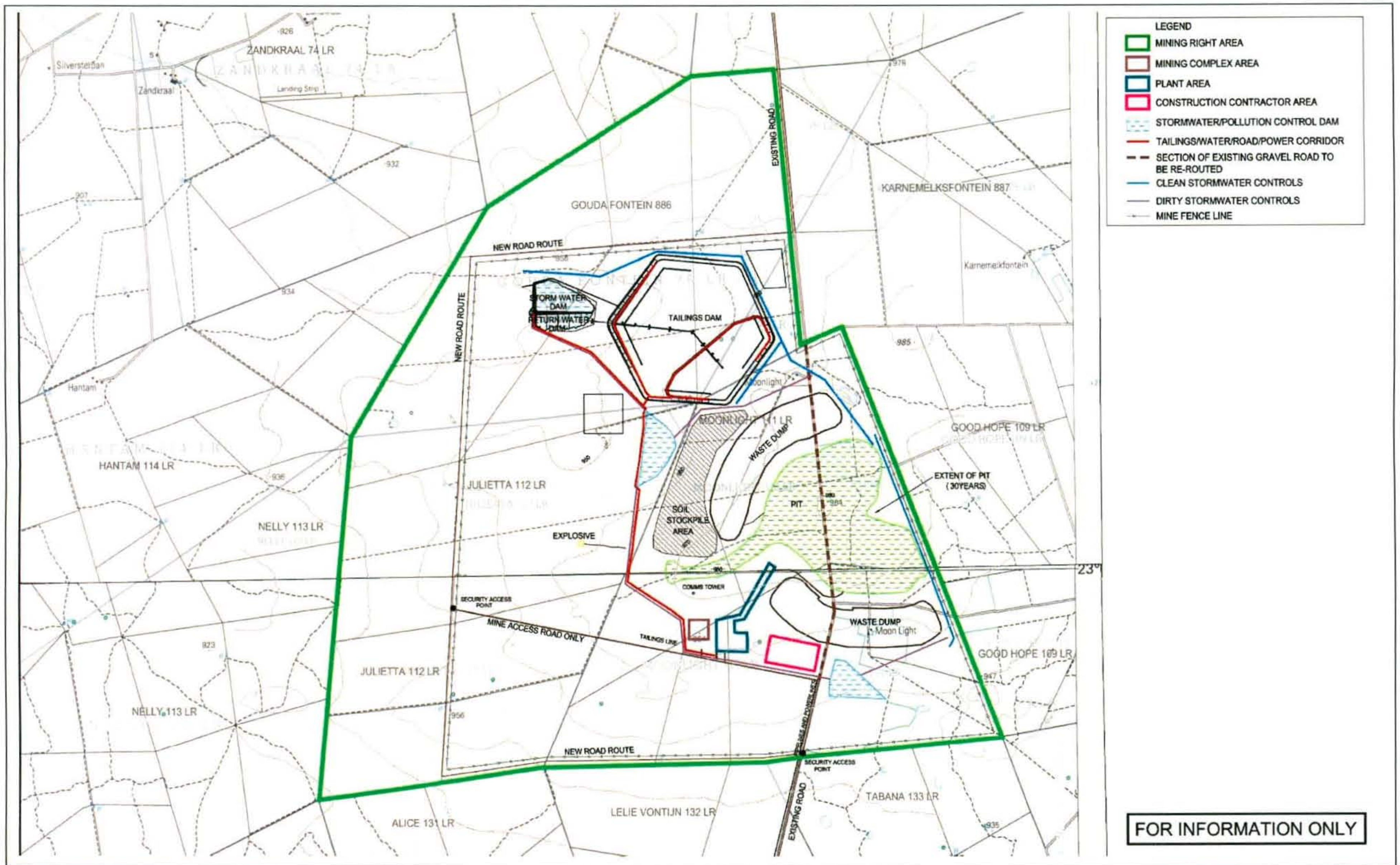


FIGURE A-2: PROPOSED SITE LAYOUT AND ROAD DIVERSION

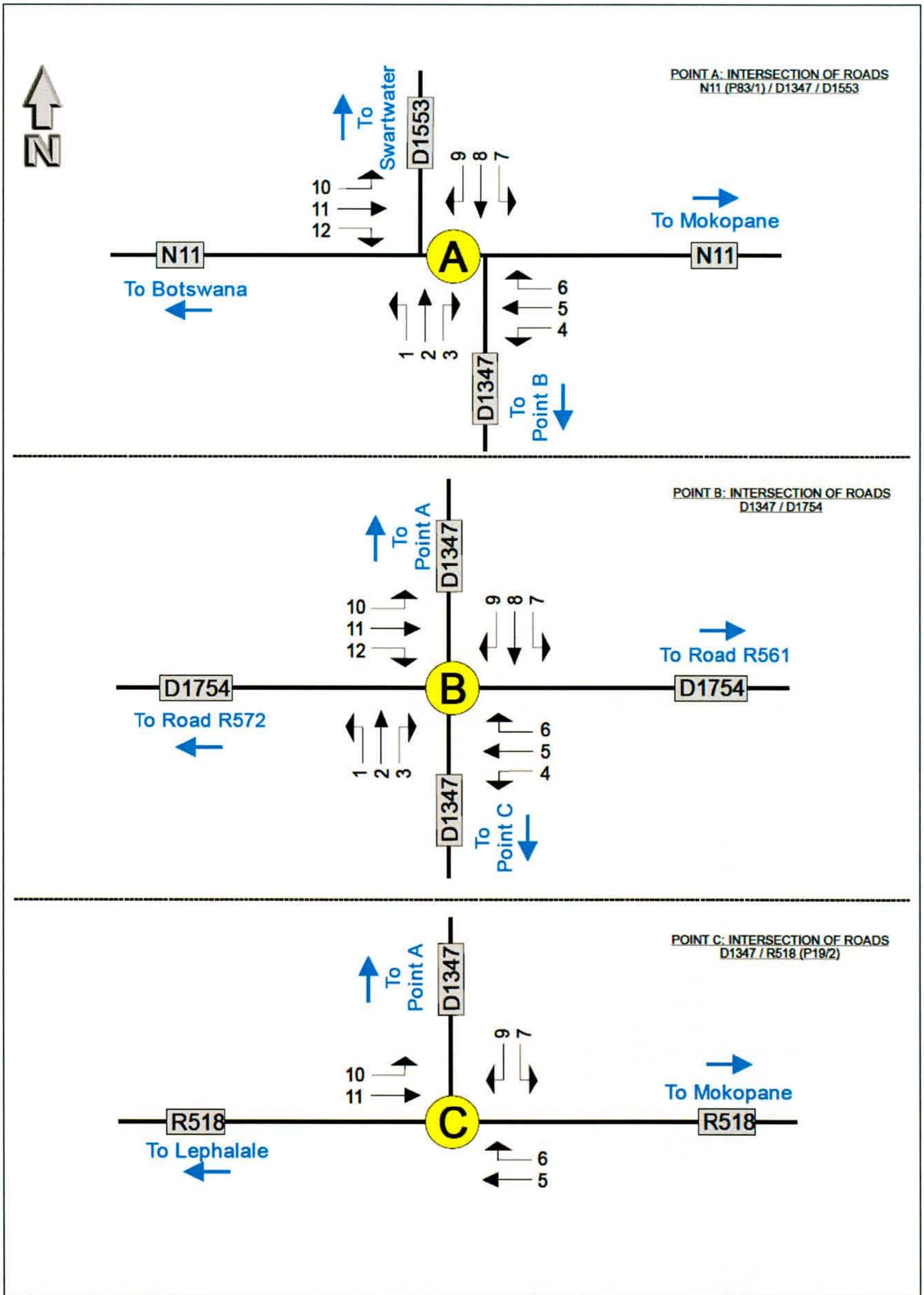


FIGURE A-3: RELEVANT MOVEMENTS TO TRAFFIC COUNTS

TABLE A-1: HOURLY TRAFFIC COUNTS FOR ALL VEHICLES SIMULTANEOUSLY AT THE INTERSECTION OF ROADS N11 (P83/1), D1347 AND D1553, POINT A (06th OF MAY 2011)													
TIME INTERVALS	MOVEMENTS												
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
06:00-07:00	2	0	3	2	11	1	1	10	2	1	16	1	50
06:15-07:15	4	0	4	6	16	2	7	16	2	2	14	1	74
06:30-07:30	4	0	6	5	15	2	7	15	2	3	18	1	78
06:45-07:45	3	0	5	5	14	2	6	12	4	4	16	2	73
07:00-08:00	3	0	3	5	10	3	7	6	3	4	10	3	57
07:15-08:15	1	0	3	4	5	2	1	0	3	4	11	3	37
07:30-08:30	1	0	1	4	7	2	2	0	2	3	9	2	33
07:45-08:45	1	0	1	4	8	1	2	0	0	1	11	1	30
08:00-09:00	0	0	1	4	9	0	1	0	0	1	11	0	27
08:15-09:15	0	0	0	2	15	1	1	0	0	1	16	1	37
08:30-09:30	0	0	0	1	23	1	0	0	0	1	27	1	54
08:45-09:45	0	0	0	1	27	1	0	0	0	1	28	1	59
09:00-10:00	0	0	0	1	30	2	0	0	1	1	32	2	69
09:15-10:15	1	0	0	0	27	1	0	4	1	0	26	1	61
09:30-10:30	2	0	0	0	20	1	0	4	1	0	16	1	45
09:45-10:45	2	0	0	0	16	1	0	4	1	0	11	1	36
10:00-11:00	2	0	0	0	18	0	0	4	0	0	7	0	31
10:15-11:15	1	0	0	0	15	2	0	0	0	0	16	0	34
10:30-11:30	0	1	0	0	16	2	1	0	0	0	16	0	36
10:45-11:45	0	1	0	0	15	2	1	0	1	1	18	0	39
11:00-12:00	0	1	0	0	12	2	1	0	2	1	20	0	39
11:15-12:15	0	1	0	1	12	0	1	0	2	1	15	0	33
11:30-12:30	0	0	0	2	10	0	0	0	2	1	11	0	26
11:45-12:45	1	0	0	2	15	0	0	0	2	0	15	0	35
12:00-13:00	1	0	0	2	20	0	0	0	1	0	22	0	46
12:15-13:15	1	0	1	2	20	0	0	0	2	0	21	2	49
12:30-13:30	2	0	1	1	19	0	0	0	3	0	27	2	55
12:45-13:45	1	0	1	1	19	0	0	0	3	0	24	3	52
13:00-14:00	1	0	1	2	15	0	0	0	3	0	25	3	50
13:15-14:15	1	1	0	1	15	0	0	0	2	0	26	2	48
13:30-14:30	0	1	0	1	17	0	0	0	1	0	26	3	49
13:45-14:45	0	1	0	1	17	0	0	0	0	0	31	2	52
14:00-15:00	0	1	1	0	14	0	1	0	0	0	25	2	44
14:15-15:15	0	0	1	0	19	1	1	0	0	0	28	1	51
14:30-15:30	0	0	1	1	17	1	3	0	0	2	29	0	54
14:45-15:45	1	0	3	2	12	1	3	0	0	3	24	0	49
15:00-16:00	2	1	3	2	15	1	2	0	1	4	26	0	57
15:15-16:15	2	1	3	2	20	1	3	0	1	4	26	0	63
15:30-16:30	2	1	4	2	27	2	2	0	1	4	27	0	72
15:45-16:45	1	1	2	1	34	2	3	0	1	3	36	0	84
16:00-17:00	0	0	1	1	40	2	4	0	0	3	38	0	89
16:15-17:15	0	0	1	1	36	1	3	0	0	3	40	0	85
16:30-17:30	0	0	0	2	36	1	2	0	0	1	41	0	83
16:45-17:45	0	0	0	2	28	1	1	0	0	1	30	0	63
17:00-18:00	0	0	0	3	17	1	0	0	0	2	24	0	47

TABLE A-2: HOURLY TRAFFIC COUNTS FOR ALL VEHICLES SIMULTANEOUSLY AT THE INTERSECTION OF ROAD D1347 AND D1754, POINT B (06th OF MAY 2011)													
TIME INTERVALS	MOVEMENTS												
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
06:00-07:00	0	2	0	0	0	0	0	0	1	3	0	0	6
06:15-07:15	0	1	0	0	0	0	0	0	0	2	0	0	3
06:30-07:30	0	1	0	0	0	0	0	1	0	2	0	0	4
06:45-07:45	0	2	0	0	0	0	0	1	0	1	0	0	4
07:00-08:00	0	1	0	0	0	1	2	2	0	0	0	0	6
07:15-08:15	0	1	0	0	0	1	2	2	0	0	0	0	6
07:30-08:30	0	2	0	0	0	1	2	1	0	0	0	0	6
07:45-08:45	0	1	0	0	0	1	2	1	0	0	0	0	5
08:00-09:00	0	1	0	0	0	0	0	0	0	0	0	0	1
08:15-09:15	0	1	1	0	0	0	0	1	0	0	1	1	5
08:30-09:30	0	0	1	0	0	0	0	2	0	0	1	2	6
08:45-09:45	0	0	1	0	0	0	0	3	0	0	1	2	7
09:00-10:00	0	1	1	0	0	1	2	4	0	0	1	2	12
09:15-10:15	0	1	0	0	0	1	2	3	1	0	0	2	10
09:30-10:30	0	1	0	0	0	1	2	2	1	0	0	1	8
09:45-10:45	0	1	0	0	0	1	2	1	1	3	0	1	10
10:00-11:00	0	2	0	0	0	0	0	0	1	3	0	1	7
10:15-11:15	0	2	0	0	0	0	0	0	2	3	1	0	8
10:30-11:30	0	2	0	0	0	0	0	1	3	3	1	0	10
10:45-11:45	0	2	0	0	0	0	0	1	3	0	1	0	7
11:00-12:00	0	0	0	0	0	0	0	2	4	0	2	0	8
11:15-12:15	0	0	0	0	0	0	0	2	2	0	1	0	5
11:30-12:30	0	0	0	0	0	0	0	2	1	0	1	0	4
11:45-12:45	0	0	0	0	0	0	0	3	1	0	1	0	5
12:00-13:00	0	0	0	0	0	0	0	2	0	0	0	0	2
12:15-13:15	0	1	0	0	0	0	0	2	1	1	0	0	5
12:30-13:30	0	1	0	0	0	0	0	3	2	1	0	0	7
12:45-13:45	0	1	0	0	0	0	0	2	2	1	0	0	6
13:00-14:00	0	1	0	0	0	0	1	2	2	1	0	0	7
13:15-14:15	0	0	1	0	0	0	1	2	1	0	1	0	6
13:30-14:30	0	0	1	0	0	0	2	0	1	1	1	0	6
13:45-14:45	0	0	1	0	0	0	2	0	2	1	1	0	7
14:00-15:00	0	0	1	0	0	0	1	0	3	1	1	0	7
14:15-15:15	0	1	0	0	0	0	1	0	3	2	0	0	7
14:30-15:30	0	2	0	0	0	0	0	0	4	3	0	0	9
14:45-15:45	0	2	0	0	0	0	0	0	3	3	0	0	8
15:00-16:00	0	2	0	0	0	0	0	0	4	5	0	0	11
15:15-16:15	0	2	0	0	0	0	0	0	4	6	0	0	12
15:30-16:30	2	1	0	0	0	0	0	1	2	4	0	0	10
15:45-16:45	2	1	0	0	0	0	0	1	2	4	0	0	10
16:00-17:00	2	1	0	0	1	0	0	3	1	2	0	0	10
16:15-17:15	2	0	0	0	1	0	0	3	1	1	0	0	8
16:30-17:30	0	0	0	0	1	0	0	2	2	1	0	2	8
16:45-17:45	0	0	0	0	1	0	0	3	2	1	0	2	9
17:00-18:00	0	0	0	0	0	0	0	1	2	5	0	2	10

TABLE A-3: HOURLY TRAFFIC COUNTS FOR ALL VEHICLES SIMULTANEOUSLY AT THE INTERSECTION OF ROADS R518 (P19/2) AND D1347, POINT C (06th OF MAY 2011)							
TIME INTERVALS	MOVEMENTS						
	5	6	7	9	10	11	TOTAL
06:00-07:00	17	0	1	0	0	20	**38**
06:15-07:15	16	0	0	0	0	19	**35**
06:30-07:30	18	0	0	1	0	23	**42**
06:45-07:45	24	0	0	1	0	20	**45**
07:00-08:00	31	0	0	3	0	16	**50**
07:15-08:15	36	0	0	3	1	20	**60**
07:30-08:30	52	2	1	2	1	22	**80**
07:45-08:45	53	2	1	2	1	22	**81**
08:00-09:00	56	2	1	1	1	25	**86**
08:15-09:15	54	2	1	1	0	25	**83**
08:30-09:30	40	0	0	1	0	35	**76**
08:45-09:45	38	0	0	1	0	38	**77**
09:00-10:00	33	0	0	0	1	36	**70**
09:15-10:15	31	1	0	0	1	39	**72**
09:30-10:30	32	1	0	1	1	31	**66**
09:45-10:45	35	1	0	1	1	36	**74**
10:00-11:00	36	1	0	2	0	42	**81**
10:15-11:15	44	0	0	2	0	39	**85**
10:30-11:30	53	0	0	1	1	39	**94**
10:45-11:45	51	0	0	1	1	40	**93**
11:00-12:00	64	0	0	0	1	32	**97**
11:15-12:15	53	0	0	0	1	29	**83**
11:30-12:30	45	1	0	0	0	29	**75**
11:45-12:45	41	1	0	0	1	39	**82**
12:00-13:00	28	1	1	0	1	55	**86**
12:15-13:15	38	1	1	1	1	66	**108**
12:30-13:30	45	0	2	1	1	69	**118**
12:45-13:45	44	0	2	3	0	79	**128**
13:00-14:00	39	0	1	3	0	83	**126**
13:15-14:15	31	0	1	3	0	95	**130**
13:30-14:30	24	1	1	3	0	103	**132**
13:45-14:45	22	2	2	2	1	98	**127**
14:00-15:00	29	2	2	2	2	100	**137**
14:15-15:15	33	2	3	1	3	103	**145**
14:30-15:30	35	1	2	1	4	101	**144**
14:45-15:45	41	0	1	0	3	95	**140**
15:00-16:00	40	0	2	0	2	82	**126**
15:15-16:15	36	0	1	0	2	77	**116**
15:30-16:30	34	0	1	1	1	85	**122**
15:45-16:45	33	1	2	1	1	86	**124**
16:00-17:00	37	1	1	1	2	96	**138**
16:15-17:15	38	1	1	1	1	104	**146**
16:30-17:30	38	3	1	0	1	92	**135**
16:45-17:45	43	2	0	1	1	87	**134**
17:00-18:00	40	2	0	2	0	82	**126**

APPENDIX B

TRIP INFORMATION RELATED TO THE PROPOSED DEVELOPMENT

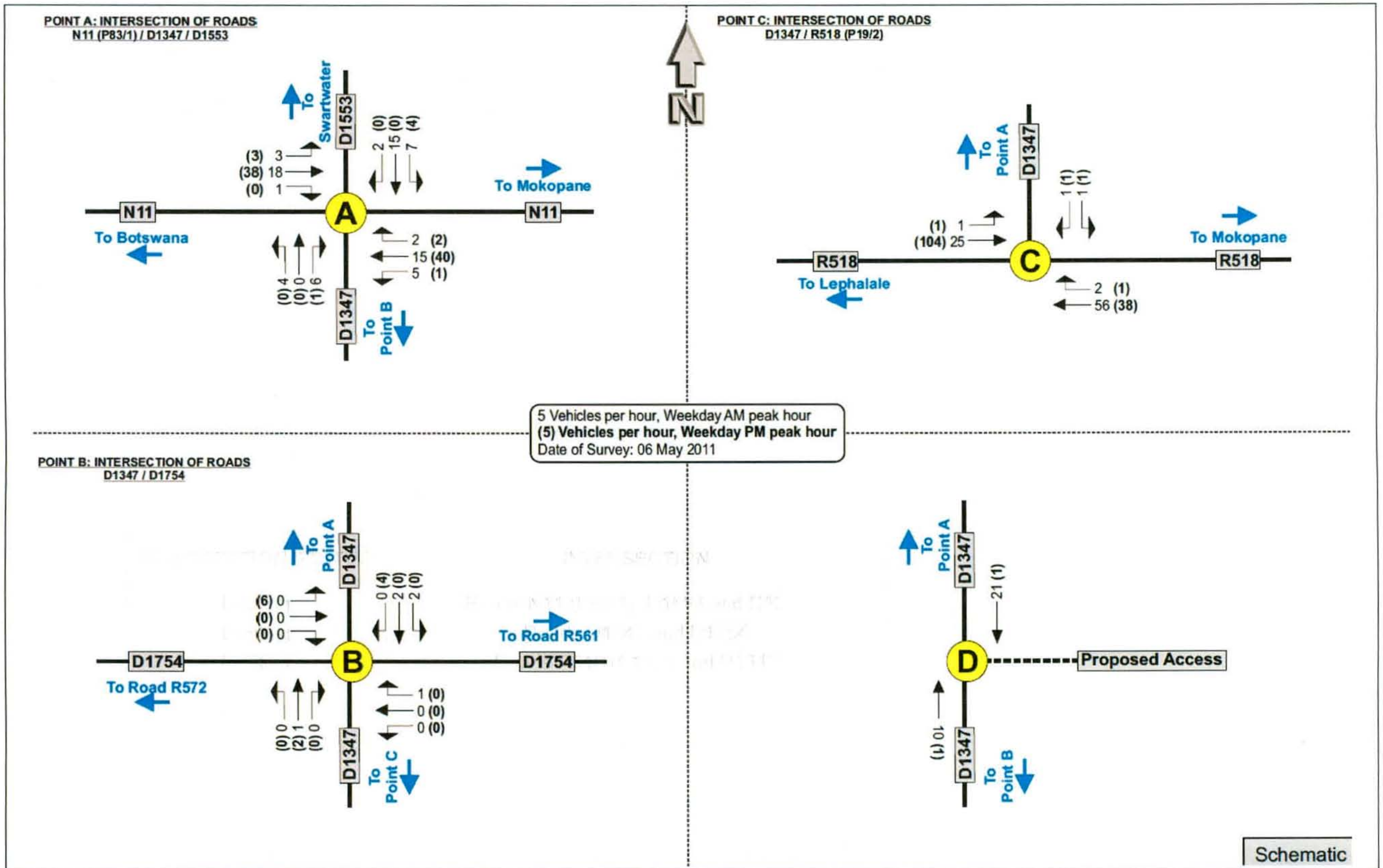


FIGURE B-1: BASE YEAR 2011 PEAK HOUR TRAFFIC WITHOUT THE PROPOSED MINING DEVELOPMENT (SCENARIO 1)

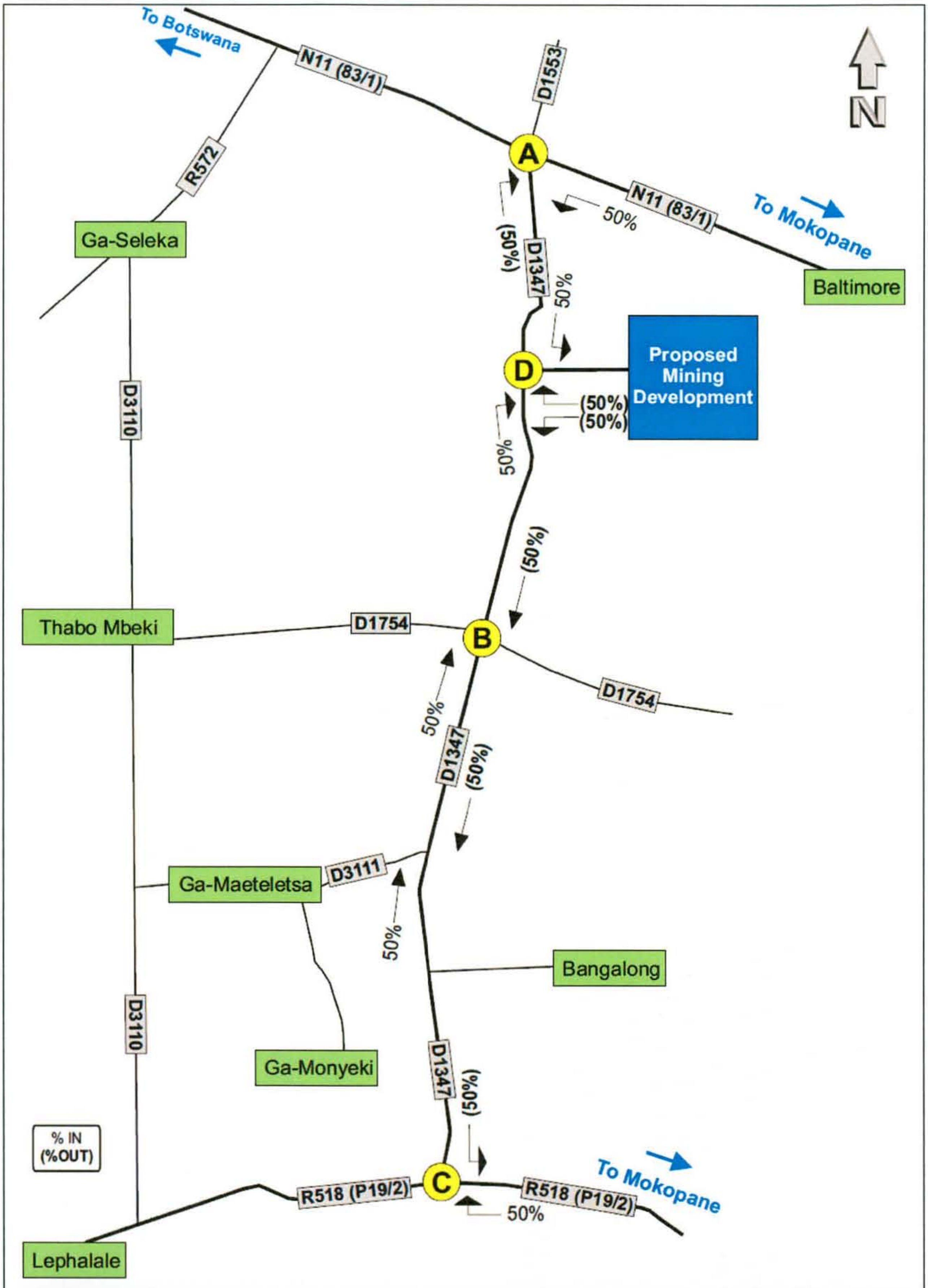


FIGURE B-2: PROJECTED TRIP DISTRIBUTION OF HEAVY VEHICLES FOR THE PROPOSED MINING DEVELOPMENT (DELIVERY OF CONSUMABLES)

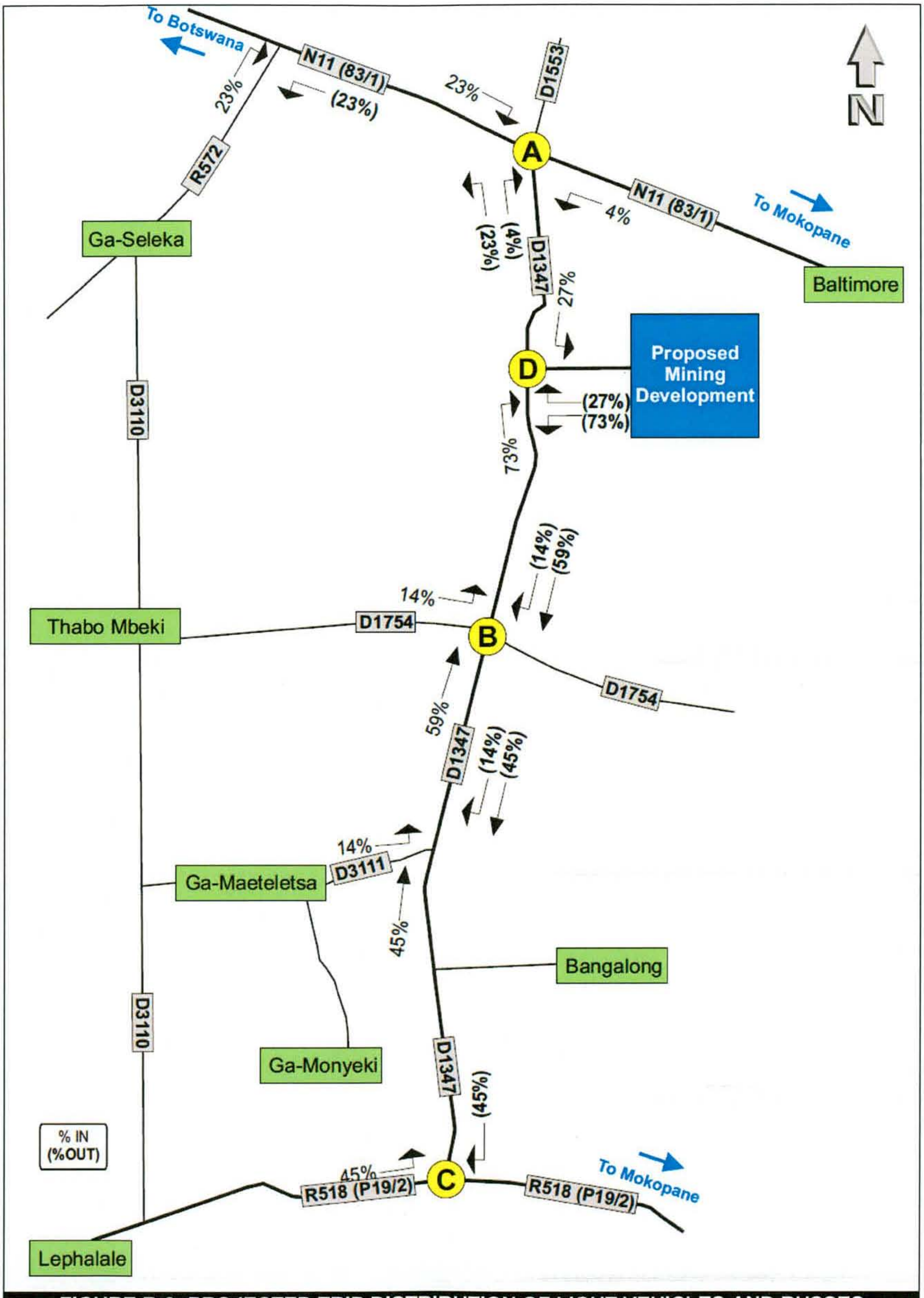


FIGURE B-3: PROJECTED TRIP DISTRIBUTION OF LIGHT VEHICLES AND BUSSES TRANSPORTING WORKERS FOR THE PROPOSED MINING DEVELOPMENT

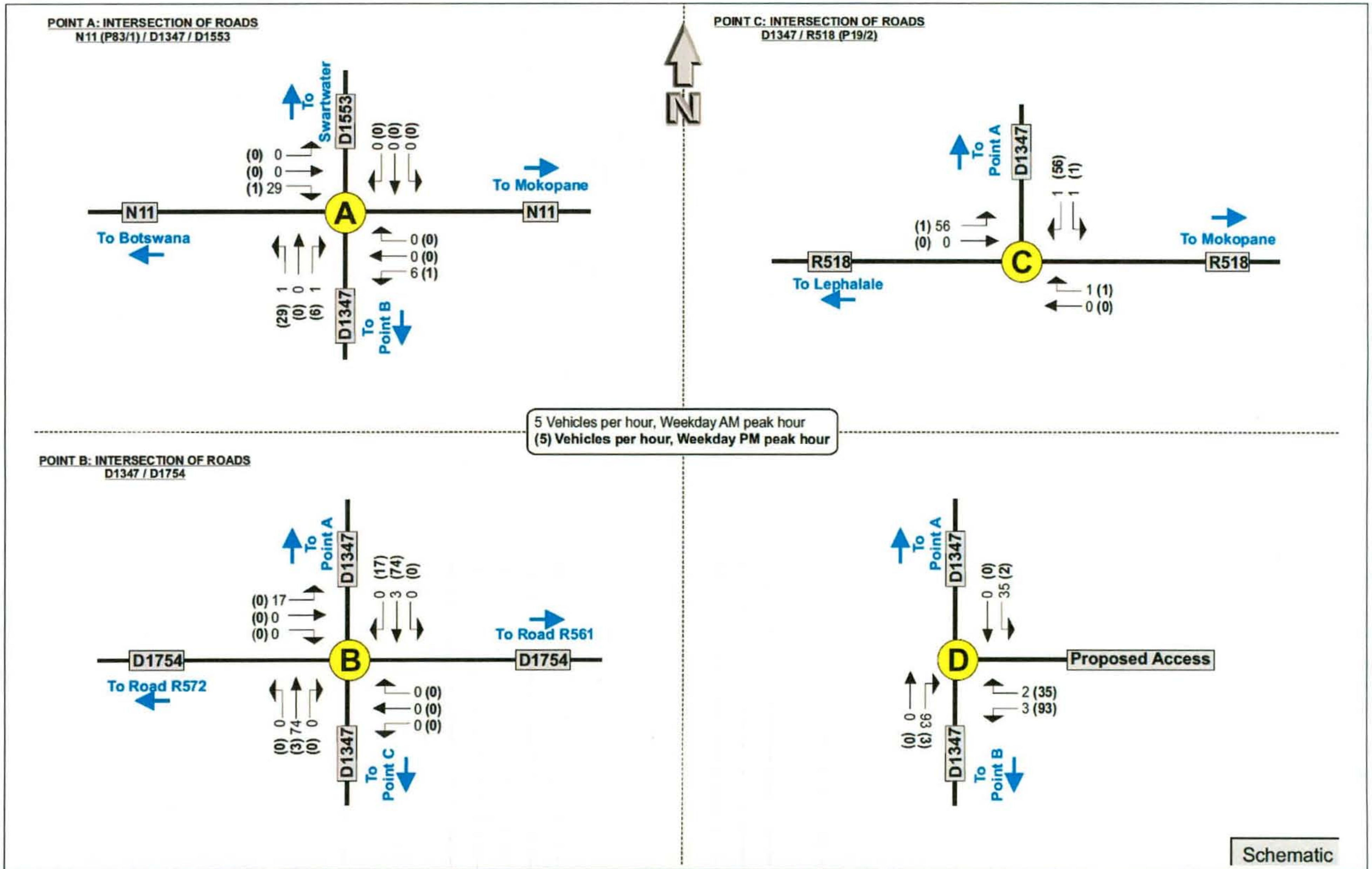


FIGURE B-4: PROJECTED VEHICLE TRIPS GENERATED BY THE PROPOSED MINING DEVELOPMENT

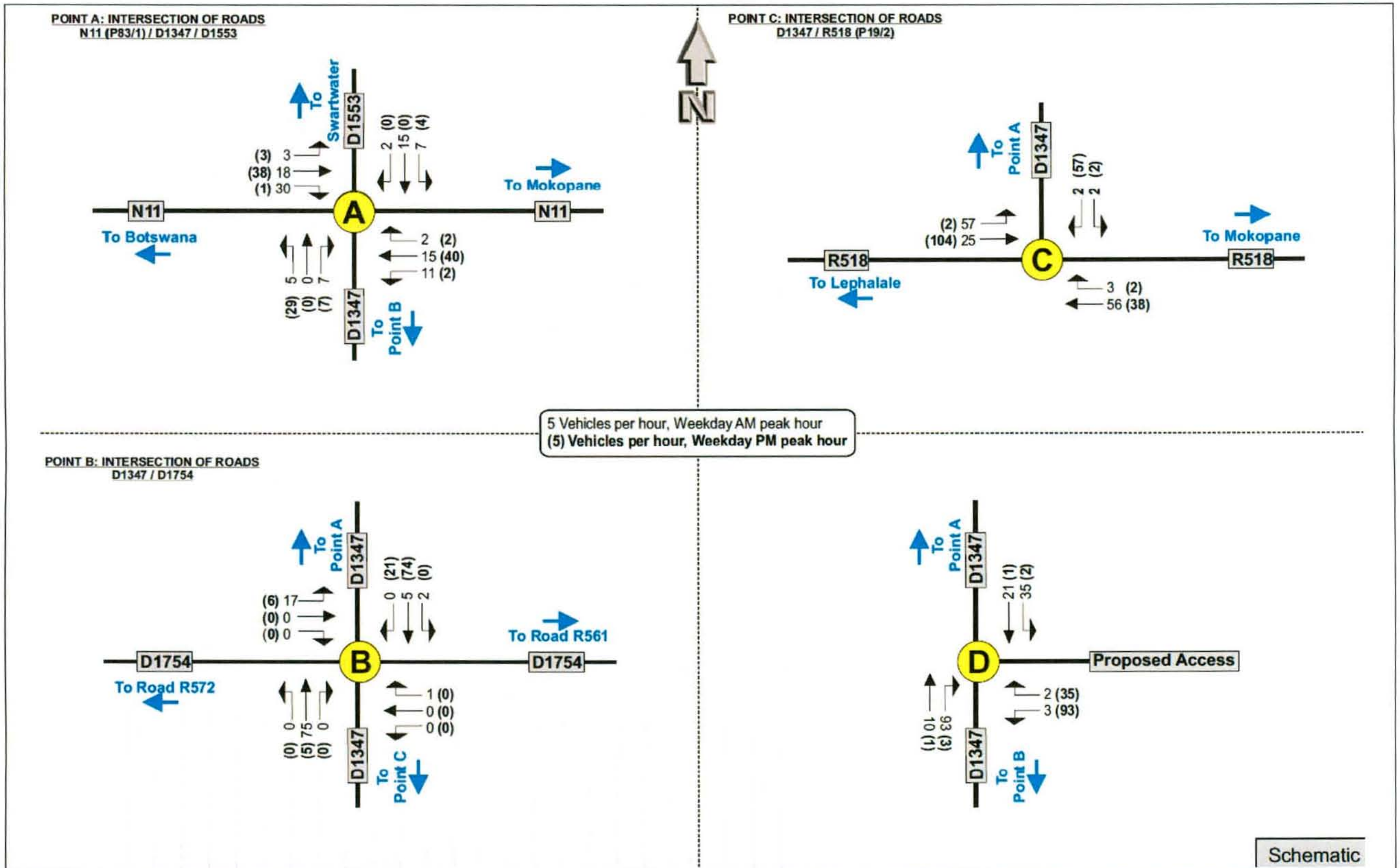


FIGURE B-5: BASE YEAR 2011 PEAK HOUR TRAFFIC WITH THE PROPOSED MINING DEVELOPMENT (SCENARIO 2)

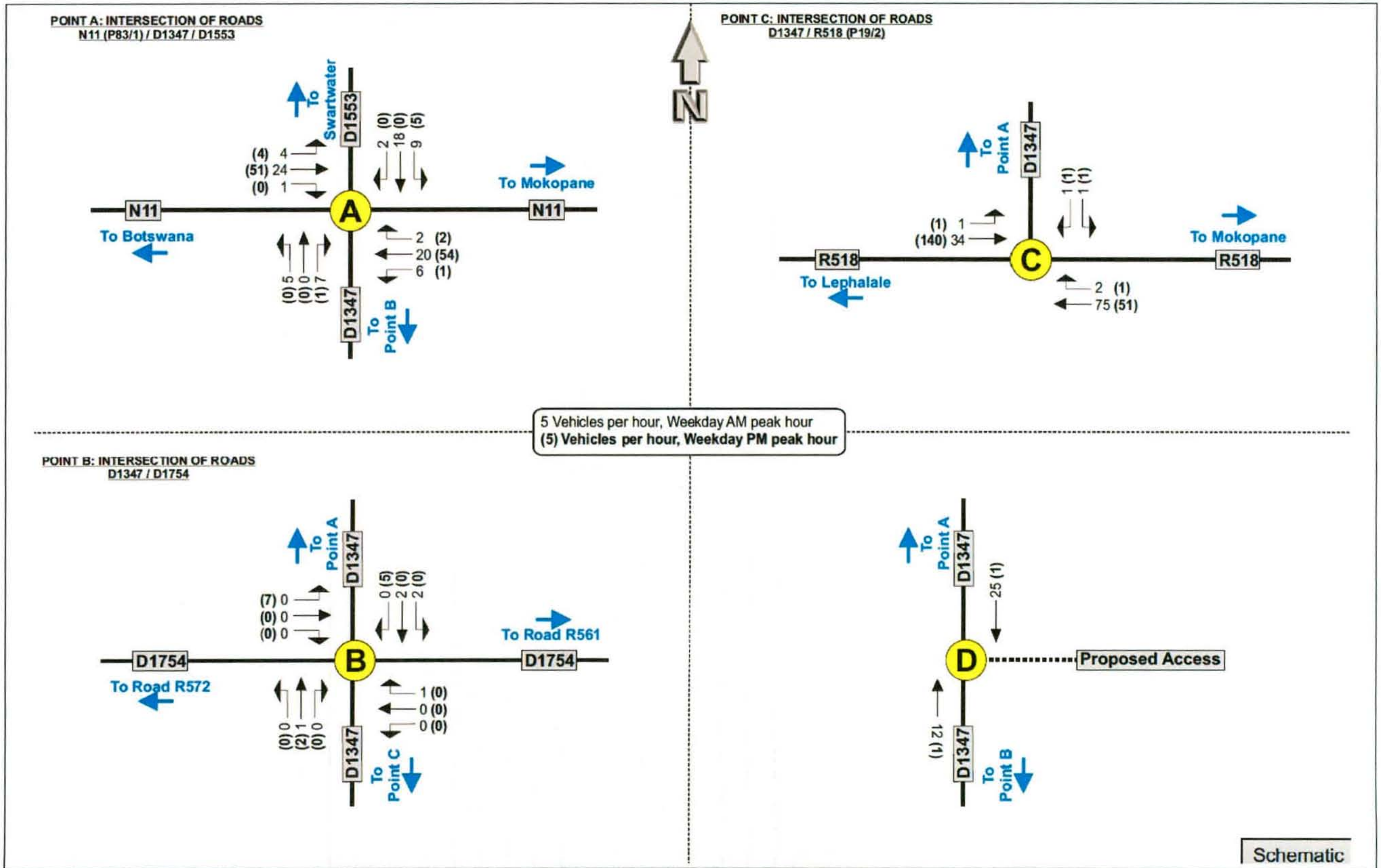


FIGURE B-6: PROJECTED 2021 TRAFFIC WITHOUT THE PROPOSED MINING DEVELOPMENT (SCENARIO 3)

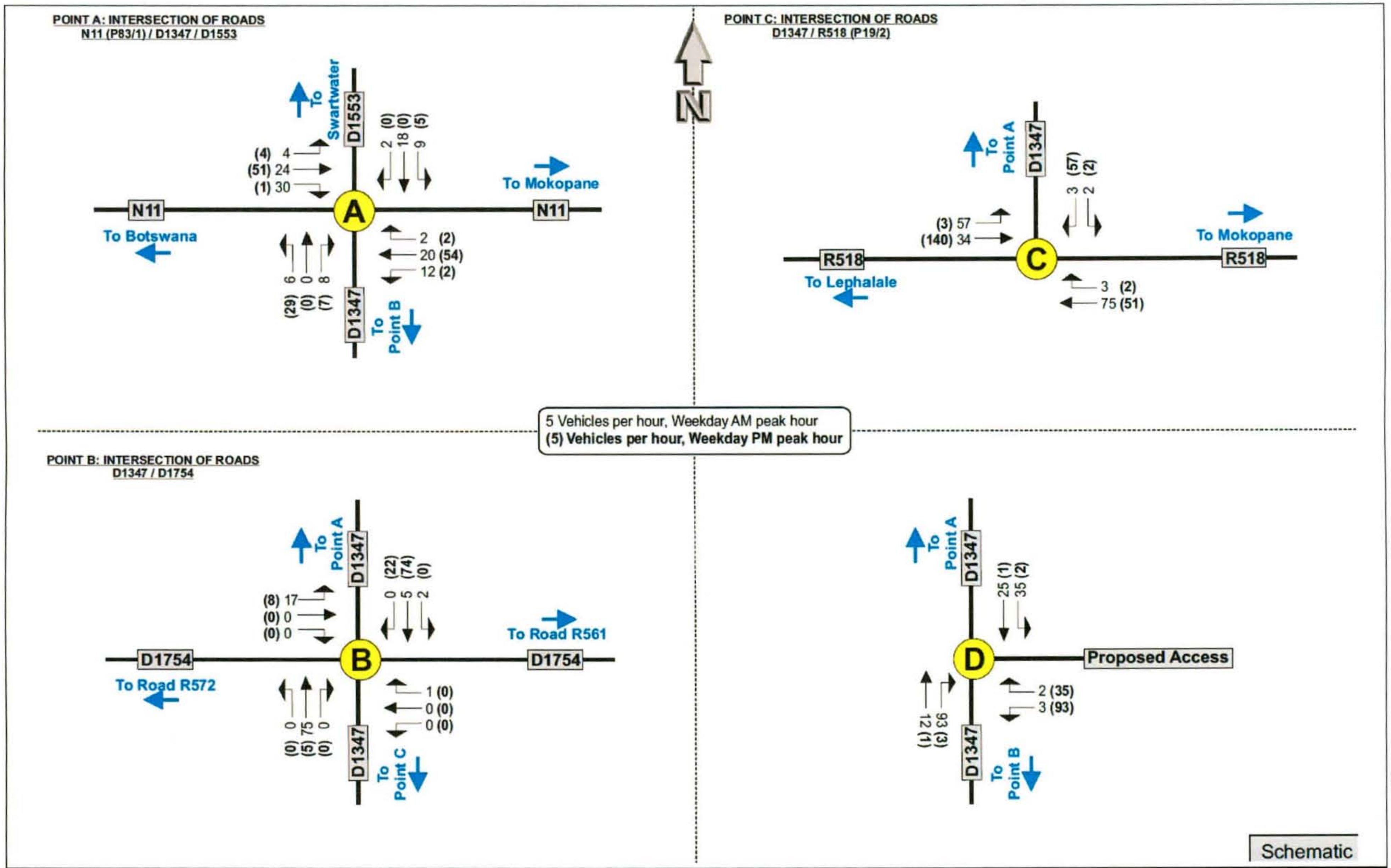


FIGURE B-7: PROJECTED 2021 TRAFFIC WITH THE PROPOSED MINING DEVELOPMENT (SCENARIO 4)

APPENDIX C

SIDRA CALCULATION RESULTS

TABLE C-1: LEVELS OF SERVICE FOR VARIOUS APPROACHES FOR THE YEAR 2011 WITHOUT THE PROPOSED MINING DEVELOPMENT (SCENARIO 1)

***Point A**: INTERSECTION OF ROADS N11 (P83/1), D1347 AND D1553*						
Type of intersection control: Free-flow on Road N11						
APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1553)	12.6	B	0.032	12.5	B	0.007
East (N11 (P83/1))	3.0	A	0.011	0.9	A	0.026
South (Road D1347)	12.7	B	0.016	12.8	B	0.004
West (N11 (P83/1))	1.7	A	0.012	1.1	A	0.024
Intersection	**6.9**	**B**	**0.032**	**2.1**	**A**	**0.026**

***Point B**: INTERSECTION OF ROADS D1347 AND D1754*						
Type of intersection control: Free-flow on Road D1347						
APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	5.0	A	0.009	7.0	B	0.006
East (Road D1754)	10.6	B	0.010	10.5	B	0.005
South (Road D1347)	5.6	B	0.006	4.2	A	0.004
West (Road D1754	10.6	B	0.010	10.6	B	0.012
Intersection	**7.5**	**B**	**0.010**	**8.3**	**B**	**0.012**

***Point C**: INTERSECTION OF ROADS R518 (P19/2) AND D1347*						
Type of intersection control: Free-flow on Road R518						
APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	13.2	B	0.004	11.5	B	0.002
East (Road R518)	0.6	A	0.050	0.6	A	0.022
West (Road R518)	0.3	A	0.021	0.1	A	0.059
Intersection	**0.8**	**A**	**0.050**	**0.4**	**A**	**0.059**

***Point D**: INTERSECTION OF ROAD D1347 AND THE PROPOSED ACCESS ROAD*
Type of intersection control: Free-flow on Road D1347
Intersection not relevant for Scenario 1

TABLE C-2: LEVELS OF SERVICE FOR VARIOUS APPROACHES FOR THE YEAR 2011 WITH THE PROPOSED MINING DEVELOPMENT (SCENARIO 2)

***Point A*: INTERSECTION OF ROADS N11 (P83/1), D1347 AND D1553**

Type of intersection control: Free-flow on Road N11

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1553)	13.2	B	0.034	11.3	B	0.006
East (N11 (P83/1))	4.3	A	0.010	0.8	A	0.023
South (Road D1347)	13.1	B	0.020	11.2	B	0.043
West (N11 (P83/1))	6.2	A	0.038	0.8	A	0.021
Intersection	**7.9**	**B**	**0.038**	**4.5**	**A**	**0.043**

***Point B*: INTERSECTION OF ROADS D1347 AND D1754**

Type of intersection control: Free-flow on Road D1347

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	4.2	A	0.015	1.9	A	0.099
East (Road D1754)	12.7	B	0.014	11.7	B	0.006
South (Road D1347)	0.3	A	0.148	2.9	A	0.006
West (Road D1754	12.3	B	0.084	11.0	B	0.013
Intersection	**3.0**	**A**	**0.148**	**2.8**	**A**	**0.099**

***Point C*: INTERSECTION OF ROADS R518 (P19/2) AND D1347**

Type of intersection control: Free-flow on Road R518

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	13.9	B	0.009	12.4	B	0.101
East (Road R518)	0.5	A	0.047	0.4	A	0.022
West (Road R518)	6.5	A	0.060	0.2	A	0.059
Intersection	**4.4**	**A**	**0.060**	**4.1**	**A**	**0.101**

***Point D*: INTERSECTION OF ROAD D1347 AND THE PROPOSED ACCESS ROAD**

Type of intersection control: Free-flow on Road D1347

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	5.5	A	0.035	5.8	A	0.002
East (Proposed Access Road)	9.2	A	0.007	8.3	A	0.142
South (Road D1347)	8.6	A	0.090	6.9	A	0.003
Intersection	**7.5**	**A**	**0.090**	**8.2**	**A**	**0.142**

TABLE C-3: LEVELS OF SERVICE FOR VARIOUS APPROACHES FOR THE YEAR 2021 WITHOUT THE PROPOSED MINING DEVELOPMENT (SCENARIO 3)

***Point A*: INTERSECTION OF ROADS N11 (P83/1), D1347 AND D1553**

Type of intersection control: Free-flow on Road N11

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1553)	12.7	B	0.039	12.7	B	0.009
East (N11 (P83/1))	2.7	A	0.015	0.8	A	0.035
South (Road D1347)	12.8	B	0.019	13.2	B	0.004
West (N11 (P83/1))	1.7	A	0.016	1.1	A	0.034
Intersection	**6.7**	**B**	**0.039**	**1.9**	**A**	**0.035**

***Point B*: INTERSECTION OF ROADS D1347 AND D1754**

Type of intersection control: Free-flow on Road D1347

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	5.0	A	0.009	7.2	B	0.007
East (Road D1754)	10.6	B	0.010	10.6	B	0.005
South (Road D1347)	5.6	B	0.006	4.2	A	0.004
West (Road D1754	10.6	B	0.010	10.6	B	0.013
Intersection	**7.5**	**B**	**0.010**	**8.5**	**B**	**0.013**

***Point C*: INTERSECTION OF ROADS R518 (P19/2) AND D1347**

Type of intersection control: Free-flow on Road R518

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	13.6	B	0.004	11.8	B	0.003
East (Road R518)	0.6	A	0.066	0.7	A	0.030
West (Road R518)	0.3	A	0.029	0.1	A	0.080
Intersection	**0.7**	**A**	**0.066**	**0.4**	**A**	**0.080**

***Point C*: INTERSECTION OF ROADS R518 (P19/2) AND D1347**

Type of intersection control: Free-flow on Road R518

Intersection not relevant for Scenario 3

TABLE C-4: LEVELS OF SERVICE FOR VARIOUS APPROACHES FOR THE YEAR 2021 WITH THE PROPOSED MINING DEVELOPMENT (SCENARIO 4)

Point A: INTERSECTION OF ROADS N11 (P83/1), D1347 AND D1553

Type of intersection control: Free-flow on Road N11

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1553)	13.4	B	0.042	11.4	B	0.007
East (N11 (P83/1))	3.9	A	0.013	0.6	A	0.030
South (Road D1347)	13.3	B	0.023	11.4	B	0.044
West (N11 (P83/1))	5.7	A	0.038	0.7	A	0.029
Intersection	**7.6**	**B**	**0.042**	**3.9**	**A**	**0.044**

Point B: INTERSECTION OF ROADS D1347 AND D1754

Type of intersection control: Free-flow on Road D1347

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	4.2	A	0.015	2.0	A	0.100
East (Road D1754)	12.7	B	0.014	11.7	B	0.006
South (Road D1347)	0.3	A	0.148	2.9	A	0.006
West (Road D1754	12.3	B	0.084	10.9	B	0.015
Intersection	**3.0**	**A**	**0.148**	**2.9**	**A**	**0.100**

Point C: INTERSECTION OF ROADS R518 (P19/2) AND D1347

Type of intersection control: Free-flow on Road R518

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	14.7	B	0.012	13.0	B	0.110
East (Road R518)	0.4	A	0.063	0.3	A	0.029
West (Road R518)	6.0	B	0.060	0.2	A	0.080
Intersection	**3.8**	**A**	**0.063**	**3.5**	**A**	**0.110**

Point D: INTERSECTION OF ROAD D1347 AND THE PROPOSED ACCESS ROAD

Type of intersection control: Free-flow on Road D1347

APPROACH	FRIDAY (AM)			FRIDAY (PM)		
	Delay	Level of Service	Degree of Saturation	Delay	Level of Service	Degree of Saturation
North (Road D1347)	5.1	A	0.038	5.8	A	0.002
East (Proposed Access Road)	9.3	A	0.007	8.3	A	0.142
South (Road D1347)	8.4	A	0.092	6.9	A	0.003
Intersection	**7.3**	**A**	**0.092**	**8.2**	**A**	**0.142**

APPENDIX D

LEVEL OF SERVICE CRITERIA

TABLE D-1: LEVEL OF SERVICE CRITERIA FOR UNSIGNALISED INTERSECTIONS		
LEVEL OF SERVICE	**AVERAGE TOTAL DELAY (SEC/VEH)**	**PERFORMANCE EVALUATION**
A	$\leq$ 5	Excellent
B	> 5 and $\leq$ 10	Very Good
C	>10 and $\leq$ 20	Good
D	>20 and $\leq$ 30	Average
E	>30 and $\leq$ 45	Poor
F	>45	Fail

TABLE D-2: LEVEL OF SERVICE CRITERIA FOR SIGNALISED INTERSECTIONS		
LEVEL OF SERVICE	**AVERAGE TOTAL DELAY (SEC/VEH)**	**PERFORMANCE EVALUATION**
A	$\leq$ 5	Excellent
B	> 5 and $\leq$ 15	Very Good
C	> 15 and $\leq$ 25	Good
D	> 25 and $\leq$ 40	Average
E	> 40 and $\leq$ 60	Poor
F	> 60	Fail

* Level of Service criteria obtained from *The Highway Capacity Manual (Special Report 2009)*

APPENDIX E

IMPACT RATINGS CRITERIA

TABLE E-1: CRITERIA USED IN THE ASSESSMENT OF IMPACTS

PART A: DEFINITION AND CRITERIA*

Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of severity, spatial extent and duration**
Criteria for ranking of the SEVERITY of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complains.
	M+	Moderate improvements. Will be within or better than the recommended levels. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly revisable. Less than the project life. Short term
	M	Revisable over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localized – Within the site boundaries
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national.

PART B: DETERMINING CONCEQUENCES

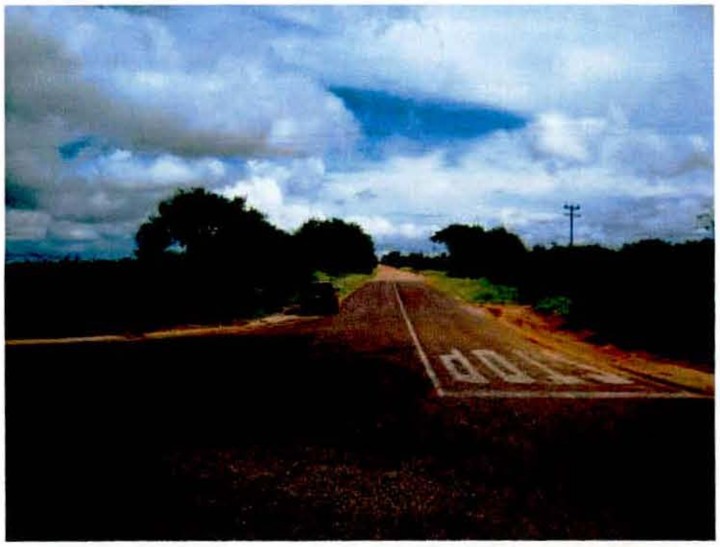
			SEVERITY = L		
DURATION	**Long term**	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**
			SEVERITY = M		
DURATION	**Long term**	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**
			SEVERITY = H		
DURATION	**Long term**	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	M	H
			Localized within site boundaries	Fairly widespread beyond site boundary local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continues	H	Medium	Medium	High
	Possible/ Frequent	M	Medium	Medium	High
	Unlikely/ Seldom	L	Low	Low	Medium
			L	M	H
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

ADDENDUM A
TO TRAFFIC IMPACT ASSESSMENT FOR THE PROPOSED MOONLIGHT IRON ORE MINE

SCENARIO WHERE THE PRODUCT IS TRANSPORTED VIA ROAD



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SIYAZI

LIST OF FIGURES

FIGURE AD-1: PROPOSED TRANSPORT ROUTES TO LEPHALALE

FIGURE AD-2: PROJECTED VEHICLE TRIPS AT THE RELEVANT INTERSECTIONS UNDER INVESTIGATION FOR THE YEAR 2021 (TRANSPORT ROUTES A AND B)

LIST OF TABLES

TABLE AD-1: TRIP GENERATION RATES, EXPECTED NUMBER OF VEHICLE TRIPS TO BE GENERATED BY THE PROPOSED MINING ACTIVITIES AND THE DISTRIBUTION OF VEHICLE TRIPS (OPERATIONAL PHASE, USING ROAD TO TRANSPORT PRODUCT) (AM AND PM PEAKS)

TABLE AD-2: LEVELS OF SERVICE FOR VARIOUS APPROACHES FOR THE YEAR 2021 WITH THE PROPOSED MINING DEVELOPMENT (ROAD TRANSPORT SCENARIO: ROUTE A)

TABLE AD-3: LEVELS OF SERVICE FOR VARIOUS APPROACHES FOR THE YEAR 2021 WITH THE PROPOSED MINING DEVELOPMENT (ROAD TRANSPORT SCENARIO: ROUTE B)

Addendum A was prepared on request from the client Metago Environmental Engineers (Pty) Ltd to assess what the impact on the relevant intersections under investigation as part of the Traffic Impact Assessment would be if the proposed Moonlight Mine would transport the magnetite product via road to Lephalale instead of pumping the magnetite product via the proposed pipeline.

The following figures and tables form part of **Addendum A** to provide more information on the road transport scenario:

a) **Figure AD-1:** Proposed possible Transport Routes to Lephalale
b) **Figure AD-2:** Projected vehicle trips at the relevant intersections under investigation for the year 2021 (Road transport Route A and B)
c) **Table AD-1:** Trip generation rates, expected number of vehicle trips to be generated by the proposed mining activities and the distribution of vehicle trips (Operational phase, Road to transport product)
d) **Table AD-2**: Levels of service for various approaches for the year 2021 with the proposed mining development (Road transport scenario: Route A)
e) **Table AD-3:** Levels of service for various approaches for the year 2021 with the proposed mining development (Road transport scenario: Route B)

It is possible to derive from **Tables AD-1 and AD-2** that for the scenario that road transport would have been used instead of the proposed pipeline, the impact that the proposed mining development could potentially have on the relevant intersections under investigation would have been manageable for the relevant timeframe that the Traffic Impact Assessment was prepared for, provided that the recommended layouts of the relevant intersections under investigation as indicated as part of the Main Traffic Impact Assessment in **Table 2.1** and **Figures 2.1 and 2.2** were provided in terms of road safety.

Even though the proposed number of heavy vehicle trips that could be generated by the proposed mining development would have a manageable impact at the relevant intersections under investigation in terms of safety, capacity and levels of service, the potential impact of the high number of heavy vehicle movement on the relevant roads network should be investigated in terms of the following

- Road surface layer design and expected lifespan
- Road safety, capacity and level of service at other intersections that was not investigated as part of the Traffic Impact Assessment (Inside and outside Lephalale)

The option to pump the Magnetite via pipeline will be the better solution in terms of the Traffic Impact since less heavy vehicles are on the road. It is therefore necessary that the matter be dealt with as part of the Economic Viability Analyses. The cost of the following should also be taken into consideration:

a) Potential accident costs and delays caused by heavy vehicles
b) Other road users costs
c) Maintenance of Roads System.

TABLE AD-1: TRIP GENERATION RATES, EXPECTED NUMBER OF VEHICLE TRIPS TO BE GENERATED BY THE PROPOSED MINING ACTIVITIES AND THE DISTRIBUTION OF VEHICLE TRIPS (OPERATIONAL PHASE, ROAD TO TRANSPORT PRODUCT) (AM PEAK)

Item	Component	Num Workers per Day	% Workers active during Peak Hour	Num Workers Active per Peak Hour	Num Trucks Per Day	% Trucks active during Peak Hour	Num Trucks active during Peak Hour	Assumed Ave. Num Persons per Veh	Comments	Trip Generation Calculations for Peak Hour						Final Trip Information for Traffic Engineering Calculations			
										If Inward Movement is relevant Value = 1	Num Veh Trips for Inwards Direction	If Outward Movement is relevant Value = 1	Num Veh Trips for Outwards Direction	Total Num Veh Trips Generated during Peak Hour (In & Out)	Calculated Trip Generation Rate per Veh during Peak Hour	Trip Dist. %		Trip Generation	
																In	Out	In	Out
AM Peak Hour																			
MINING WORKERS																			
1.	Supervision, Mechanics, Managers and Engineers (using own transport) **DAY SHIFT**	42	100%	42				1.2	Trips per Worker (1.2 Persons per Vehicle) One shift traffic in, one shift traffic out	1	35	0	0	35	**0.83**	100%	0%	35	0
2.	Mining Shift workers (Transported via 50 seater busses) **2 SHIFTS PER DAY**	138	50%	69				50.0	50 persons per bus (Bus deliver workers and leave with Previous Shift workers)	1	2	1	2	4	**0.06**	50%	50%	2	2
3.	Heavy vehicles delivering consumables to open pit				8	20%	2	1.0	20% of delivery vehicles expected during peak periods	1	2	1	2	4	**2.00**	50%	50%	2	2
PROCESS PLANT WORKERS																			
4.	Administrative and Management personnel (using own transport) **DAY SHIFT**	90	100%	90				1.2	Trips per Worker (1.2 Persons per Vehicle)	1	75	0	0	75	**0.83**	100%	0%	75	0
5.	Maintenance personnel (using own transport) **3 SHIFTS PER DAY**	24	25%	6				1.2	Trips per Worker (1.2 Persons per Vehicle	1	5	1	5	10	**1.67**	100%	0%	10	0
6.	Operations personnel (Transported via 50 seater busses) **3 SHIFTS PER DAY**	200	25%	50				50.0	50 persons per bus (Bus deliver workers and leave with Previous Shift workers)	1	1	1	1	2	**0.04**	50%	50%	1	1
7.	Maintenance personnel (Transported via 50 seater busses) **DAY SHIFT**	50	100%	50				50.0	50 persons per bus (Bus deliver workers and parks on site)	1	1	0	0	1	**0.02**	100%	0%	1	0
8.	Heavy vehicles delivering consumables to plant				5	20%	1	1.0	20% of delivery vehicles expected during peak periods	1	1	1	1	2	**2.00**	50%	50%	1	1
													TOTAL	134				127	6
8.	Vehicles transporting product				222	20%	44	1.0	20% of delivery vehicles expected during peak periods	1	44	1	44	88	**2.00**	50%	50%	44	44
													TOTAL	88				44	44

TABLE AD-1: TRIP GENERATION RATES, EXPECTED NUMBER OF VEHICLE TRIPS TO BE GENERATED BY THE PROPOSED MINING ACTIVITIES AND THE DISTRIBUTION OF VEHICLE TRIPS (OPERATIONAL PHASE, ROAD TO TRANSPORT PRODUCT) (PM PEAK) (Continue)

Item	Component	Num Workers per Day	% Workers active during Peak Hour	Num Workers Active per Peak Hour	Num Trucks Per Day	% Trucks active during Peak Hour	Num Trucks active during Peak Hour	Assumed Ave. Num Persons per Veh	Comments	Trip Generation Calculations for Peak Hour: If Inward Movement is relevant Value = 1	Num Veh Trips for Inwards Direction	If Outward Movement is relevant Value = 1	Num Veh Trips for Outwards Direction	Total Num Veh Trips Generated during Peak Hour (In & Out)	Calculated Trip Generation Rate per Veh during Peak Hour	Final Trip Information for Traffic Engineering Calculations: Trip Dist. % In	Trip Dist. % Out	Trip Generation In	Trip Generation Out
PM Peak Hour																			
MINING WORKERS																			
1.	Supervision, Mechanics, Managers and Engineers (using own transport) **DAY SHIFT**	42	100%	42				1.2	Trips per Worker (1.2 Persons per Vehicle) One shift traffic in, one shift traffic out	0	0	1	35	35	**0.83**	0%	100%	0	35
2.	Mining Shift workers (Transported via 50 seater busses) **2 SHIFTS PER DAY**	138	50%	69				50.0	50 persons per bus (Bus deliver workers and leave with Previous Shift workers)	1	2	1	2	4	**0.06**	50%	50%	2	2
3.	Heavy vehicles delivering consumables to open pit				8	20%	2	1.0	20% of delivery vehicles expected during peak periods	1	2	1	2	4	**2.00**	50%	50%	2	2
PROCESS PLANT WORKERS																			
4.	Administrative and Management personnel (using own transport) **DAY SHIFT**	90	100%	90				1.2	Trips per Worker (1.2 Persons per Vehicle)	0	0	1	75	75	**0.83**	0%	100%	0	75
5.	Maintenance personnel (using own transport) **3 SHIFTS PER DAY**	24	25%	6				1.2	Trips per Worker (1.2 Persons per Vehicle	1	5	1	5	10	**1.67**	0%	100%	0	10
6.	Operations personnel (Transported via 50 seater busses) **3 SHIFTS PER DAY**	200	25%	50				50.0	50 persons per bus (Bus deliver workers and leave with Previous Shift workers)	1	1	1	1	2	**0.04**	50%	50%	1	1
7.	Maintenance personnel (Transported via 50 seater busses) **DAY SHIFT**	50	100%	50				50.0	50 persons per bus (Bus deliver workers and parks on site)	0	0	1	1	1	**0.02**	0%	100%	0	1
8.	Heavy vehicles delivering consumables to plant				5	20%	1	1.0	20% of delivery vehicles expected during peak periods	1	1	1	1	2	**2.00**	50%	50%	1	1
													TOTAL	133				6	127
8.	Vehicles transporting product				222	20%	44	1.0	20% of delivery vehicles expected during peak periods	1	44	1	44	88	**2.00**	50%	50%	44	44
													TOTAL	88				44	44

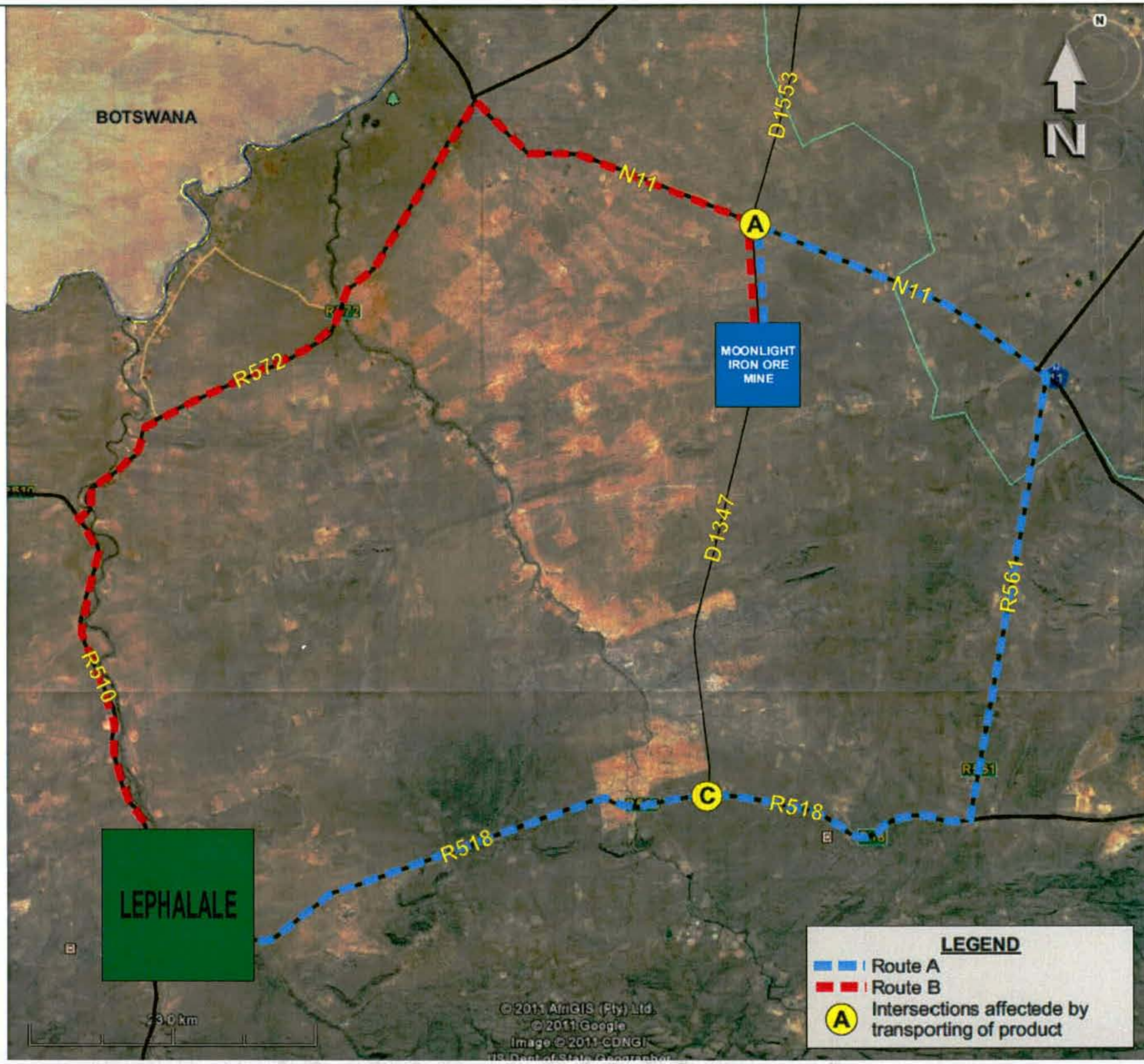

FIGURE AD-1: PROPOSED TRANSPORT ROUTES TO LEPHALALE

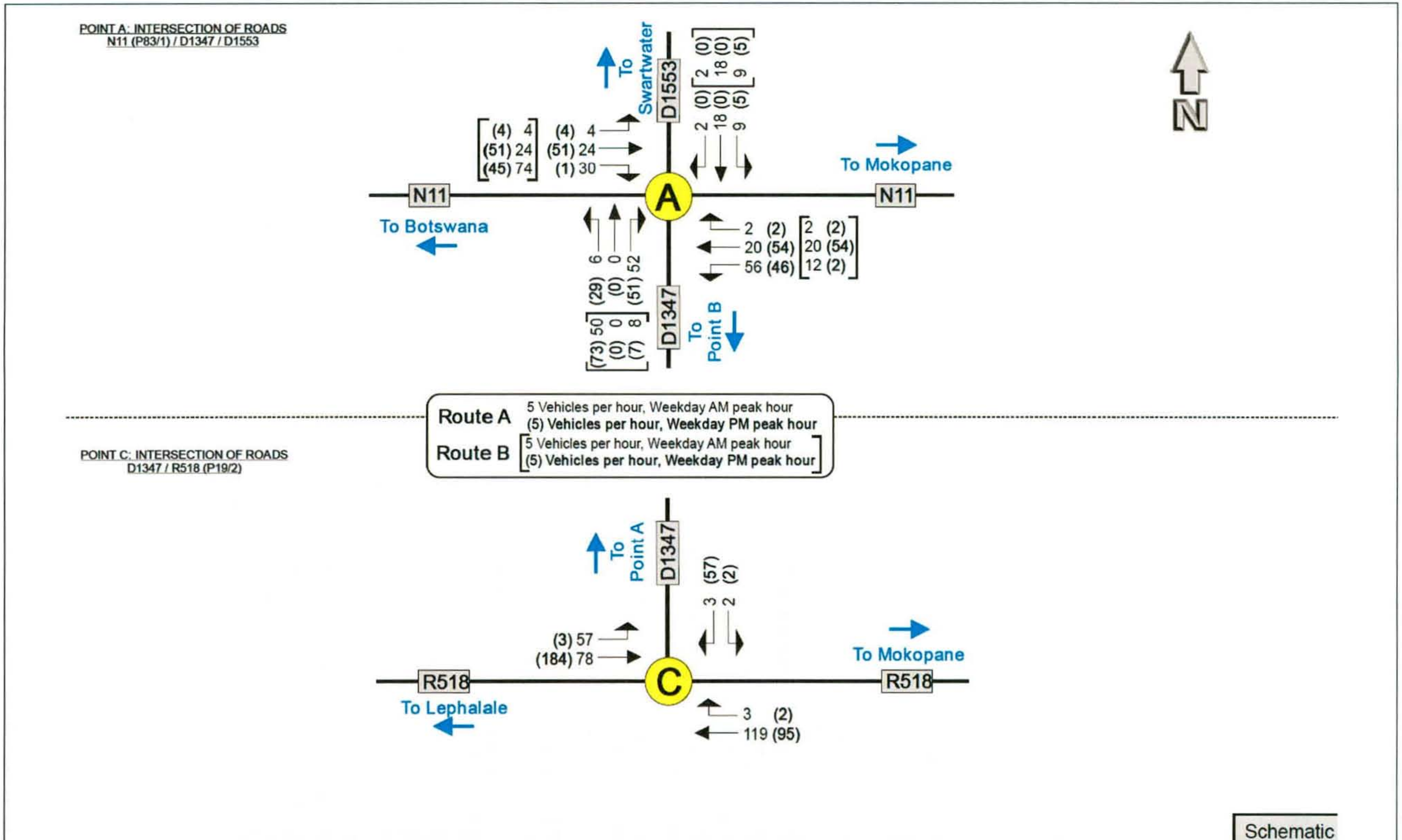

FIGURE AD-2: PROJECTED VEHICLE TRIPS AT THE RELEVANT INTERSECTIONS UNDER INVESTIGATION FOR THE YEAR 2021 (TRANSPORT ROUTES A AND B)

TABLE AD-2: LEVELS OF SERVICE FOR VARIOUS APPROACHES FOR THE YEAR 2021 WITH THE PROPOSED MINING DEVELOPMENT (ROAD TRANSPORT SCENARIO: ROUTE A)

Point A: INTERSECTION OF ROADS N11 (P83/1), D1347 AND D1553						
Type of intersection control: Free-flow on Road N11						
APPROACH	**FRIDAY (AM)**			**FRIDAY (PM)**		
	Delay	**Level of Service**	**Degree of Saturation**	**Delay**	**Level of Service**	**Degree of Saturation**
North (Road D1553)	13.2	B	0.040	11.4	B	0.007
East (N11 (P83/1))	6.2	B	0.062	3.6	A	0.041
South (Road D1347)	14.4	B	0.110	12.0	B	0.104
West (N11 (P83/1))	5.3	B	0.033	0.7	A	0.029
Intersection	**9.1**	**B**	**0.110**	**5.9**	**B**	**0.104**

Point C: INTERSECTION OF ROADS R518 (P19/2) AND D1347						
Type of intersection control: Free-flow on Road R518						
APPROACH	**FRIDAY (AM)**			**FRIDAY (PM)**		
	Delay	**Level of Service**	**Degree of Saturation**	**Delay**	**Level of Service**	**Degree of Saturation**
North (Road D1347)	16.8	C	0.016	14.1	B	0.110
East (Road R518)	0.3	A	0.101	0.2	A	0.054
West (Road R518)	3.8	A	0.066	0.1	A	0.1005
Intersection	**2.4**	**A**	**0.101**	**2.6**	**A**	**0.110**

TABLE AD-3: LEVELS OF SERVICE FOR VARIOUS APPROACHES FOR THE YEAR 2021 WITH THE PROPOSED MINING DEVELOPMENT (ROAD TRANSPORT SCENARIO: ROUTE B)

Point A: INTERSECTION OF ROADS N11 (P83/1), D1347 AND D1553						
Type of intersection control: Free-flow on Road N11						
APPROACH	**FRIDAY (AM)**			**FRIDAY (PM)**		
	Delay	**Level of Service**	**Degree of Saturation**	**Delay**	**Level of Service**	**Degree of Saturation**
North (Road D1553)	13.8	B	0.044	11.6	B	0.008
East (N11 (P83/1))	3.6	A	0.013	0.6	A	0.030
South (Road D1347)	12.7	B	0.074	11.3	B	0.081
West (N11 (P83/1))	7.0	B	0.082	4.2	A	0.040
Intersection	**8.9**	**B**	**0.082**	**5.9**	**B**	**0.081**

APPENDIX U: PRELIMINARY ENGINEERING DESIGN OF TSF AND RWD

Specialist report prepared by Metago, June 2011

Metago

PRELIMINARY DESIGN OF THE TAILINGS STORAGE FACILITY FOR THE PROPOSED MOONLIGHT IRON ORE PROJECT

Prepared For

Ferrum Crescent Limited

METAGO PROJECT NUMBER: T020-04

REPORT NO. 1 - Final

June 2011

Preliminary Design of the Tailings Storage Facility for the Proposed Moonlight Iron Ore Project

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Ferrum Crescent Limited

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PRELIMINARY DESIGN OF THE TAILINGS STORAGE FACILITY FOR THE PROPOSED MOONLIGHT IRON ORE PROJECT

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ACCRONYMS AND ABBREVIATIONS

Below a list of acronyms and abbreviations used in this report.

Acronyms / Abbreviations	Definition
ABA	Acid base accounting
ARD	Acid rock drainage
AMEC	AMEC Minproc SA (Pty) Ltd
DME	Department of Minerals and Energy (now Department of Mineral Resources)
DMR (previously DME)	Department of Mineral Resources (previously Department of Minerals and Energy)
DWA (previously DWAF)	Department of Water Affairs (previously Department of Water Affairs and Forestry)
ECA	Environmental Conservation Act
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
Ferrum	Ferrum Crescent Limited
FOS	Factor of safety
HDPE	High density polyethylene
LOM	Life of mine
mamsl	Metres above mean sea level
MAP	Mean annual precipitation
Metago	Metago Environmental Engineers (Pty) Ltd
MPRDA	Mineral and Petroleum Resources Development Act
NEMA	National Environmental Management Act
NWA	National Water Act
RoM	Run of mine
RoR	Rate of rise
RWD	Return water dam
SANS (previously SABS)	South African National Standards (previously South African Bureau of Standards)
SWD	Stormwater dam
tpm	Tonnes per month
TR102-2000	"*TR 102 – Southern African Storm Rainfall*", Smithers and Schultze, May 2000
TSF	Tailings storage facility
Turquoise Moon	Turquoise Moon Trading 157 (Pty) Ltd
USCS	Unified soil classification system

EXECUTIVE SUMMARY

Metago Environmental Engineers (Pty) Ltd. carried out the preliminary design of the tailings storage facility, as part of the EIA/EMP report for the proposed Moonlight Iron Ore project.

Overview and philosophy

The proposed Moonlight project plans to exploit the underground iron ore mineralisation areas by means of an open pit mine. The mine will produce a magnetite concentrate through milling and magnetic separation of the ore, on site. Apart from the magnetite concentrate, the process also produces tailings and discard/waste rock, which will be disposed of in a tailings storage facility (TSF). The discard/waste rock may also be disposed of in the waste rock dumps.

The proposed TSF will be sited in the northern portion of the mine property. Four sites for the TSF, in conjunction with other mine infrastructure, were considered. The other three sites are located to the west, south-west and south of the current TSF position. Of the sites considered, the selected site was the most appropriate taking environmental, safety and economic factors into account.

The basic design philosophy used for the TSF is one of disposing the tailings in such a manner that impacts on the surrounding environment and communities are minimised, while ensuring that it is structurally sound, safe to operate, and economically viable.

Design Objectives

The following design objectives were addressed:

Environmental Objectives:

- The TSF must be safe with minimal risk of failure;
- The TSF must be as visually unobtrusive as practical;
- Dust emissions must be minimised;
- Groundwater pollution must be contained and limited;
- Surface water pollution must be contained;
- Unpolluted surface water must be protected; and
- Disruption to watercourses must be avoided.

Operational Objectives:

- The TSF must be safe with minimal risk of failure;
- The TSF must accommodate approximately 128 million tonnes of tailings over a period of 30 years;

- The discard/waste rock material from the process plant operations may be used for either ongoing wall raising and/or ongoing rehabilitation of the TSF side slopes to reduce the dust emissions and improve erosion resistance of the otherwise highly erodible and potentially dusty magnetite tailings;
- The life of facility cost must be economically viable; and
- The design would lend itself to simple and practical operation.

The design did not have to take into account any perennial or non-perennial watercourses at (or near to) the proposed TSF site. This is due to the overall Moonlight site being located on a watershed, as well as the aridity of the region, which results in a low drainage density. Significant catchment areas upstream of the Moonlight site are consequently not present, while the dominant flow regime within the site is that of overland flow (and not channel flow).

General layout and staged development

The facility will consist of two paddocks. Simultaneous tailings deposition in the upper and lower paddocks of the TSF will be for the first 21 to 24 years until the two paddocks consolidate to form one.

At a tailings deposition rate of 355,500 dry tonnes per month, the required elevation of the main (lower) starter wall is 955 mamsl (9 m maximum height), and 966 mamsl (6 m maximum height) for the upper paddock containment wall. [The tailings production figure is considered worst case, assuming a 65% conversion of ROM production to tailings].

The TSF will be developed by the upstream method of tailings deposition (i.e. traditional "self-building" with tailings and/or discard material). The rate of rise of the TSF is limited to 1 m per year (or less) to ensure that the deposited tailings sufficiently dries and consolidates, and has sufficient shear strength to support newly placed tailings material.

The final elevation of the consolidated lower and upper paddocks of the TSF at LOM (at the end of year 30) will be 984 mamsl (maximum height of 37.5 m).

Detailed studies affecting the design

For any TSF design, a series of more detailed studies need to be completed to determine the physical characteristics of the receiving environment, the tailings product and the geometry of the proposed facility. The TSF design used typical tailings material characteristic information from other similar iron ore mining operations (namely, the Sishen and Thabazimbi iron ore mines). The applicability of the comparative data will need to be confirmed during the bankable feasibility, detailed design and/or commissioning phases of the TSF.

In addition, the following studies were completed:

- A geochemical characterisation (mineralogical assessment, ABA and paste pH testing) of the main lithologies of the iron ore deposit that were derived from previous drilling campaigns. No leach tests were undertaken.
- A geotechnical analysis of the natural foundation materials at the TSF site.
- A rate of rise and stage capacity calculation to determine the actual capacity of the envisaged layout, height-volume relationships for the proposed TSF and the rates of rise at all stages in the life of the TSF.
- A water balance for the proposed TSF that took into account water sources (e.g. rainfall), water losses (e.g. evaporation) and the resulting volumes that need to be stored by the return water dam (RWD) and stormwater dam (SWD).
- A seepage analysis to estimate the phreatic surface within the TSF and the expected water seepage rate into the foundation.
- A slope stability analysis to determine the adequacy of the slopes and to introduce any design features that would ensure adequate stability (i.e. toe and blanket drains).

From the studies, the following factors were taken into account for the TSF design.

The geochemical characterisation study found that the potential for acid generation, and the leaching of any metals of environmental concern, from the tailings and/or the waste discard/rock material is highly unlikely. Leach tests should however be undertaken to confirm the above.

The geochemical assessment also indicated that the tailings will contain amphibolites in the form of actinolite. Testwork on the actinolite has confirmed that this material is non-fibrous, and does not pose any health risks for workers or communities exposed to this mineral. [Fibrous forms of actinolite have implications for the respiratory health of workers and communities exposed to the mineral]. Nonetheless, the prevention of dusting has been a key focus area in the design of the TSF (ongoing rehabilitation of side slopes, minimise the height of the TSF, and robust closure measures).

The geotechnical investigation indicates that the generalised soil profile of the TSF site is either:

- 0.65 m topsoil directly underlain by hard quartz feldspar, or
- 0.85 m topsoil, underlain by 0.6 m silty sand material (SC – with small percentage of fines/clay), underlain by hard gneiss sandstone conglomerate.

The average depth of the test pits excavated (13 no. in total) was 1.4 m, and all the test pits were excavated to refusal depth.

The seepage analysis indicated that the water lost though the TSF to groundwater will be most sensitive to the tailings permeability that in turn is dependent on the particle size distribution, beaching characteristics and degree of consolidation of the tailings material. The expected particle size distribution of the tailings is ultra fine, and the hence the tailings material is anticipated to be slow draining and relatively impermeable.

The seepage (and stability analysis) also indicates that the toe and blanket drains are required to effectively control the phreatic surface within the TSF. The non-operation of the underdrains results in the phreatic surface daylighting on the slopes of the TSF, which will significantly increase the likelihood of sloughing on the outer TSF slopes. In addition, the possibility of a piping failure of the TSF (i.e. internal erosion of tailings between the supernatant pool and the outer TSF slope) significantly increases. The supernatant pool within the basin of the TSF should therefore be minimised at all times, and excess water from rainfall decanted timeously.

The stability analysis indicates that the factor of safety (FOS) for classical slip circle (or wedge type failure) of the TSF under normal and abnormal operating conditions (large pool) is significantly greater than the recommended minimum FOS of 1.3. This is largely due to the nature of the insitu material (sandy silt with small percentage of fines/clay), the 1V:4H slopes of the TSF, gentle sloping ground conditions and the estimated tailings strength parameters. The tailings strength parameters will be more accurately assessed during the bankable feasibility and/or detailed design, when a Moonlight tailings sample is available for laboratory testing.

The stage capacity study concluded that using the geometry for the proposed TSF, the full life of mine production (approximately 128 million tonnes of tailings) would be adequately accommodated. In addition, the rates of rise that would be encountered during the life of the facility would be adequate for the selected development method (i.e. 1 m per year or less).

The monthly climatic water balance for the TSF determined the sizing/volume required for the return water dam and stormwater dam downstream of the TSF. The water balance also estimated the TSF make-up water demand.

Approximately 33.5% of the water losses from the TSF (and RWD/SWD) are estimated to be through seepage to ground water and interstitial lock up in the deposited tailings. An estimated 46.6% of water contained in the tailings slurry pumped to the TSF is predicted to be recovered for re-use as process water in the concentrator plant. The remaining 19.9% of the water losses from the TSF (and RWD/SWD) is through evaporation.

Deposition strategy

The tailings slurry will be deposited by spigotting into the two paddocks. The supernatant pools are expected to migrate from the starter wall (and upper paddock wall) up-contour along the penstock outfall pipe. The supernatant pools will always be positioned around the operating intermediate penstock structure(s) from where the water is decanted to the return water dam. The intermediate penstock structures will be sealed as the pool sufficiently migrates past the penstock structures. Once the TSF consolidates to form one paddock, the supernatant pools will be centrally located in the TSF basin.

Tailings pipework and engineering control

The tailings slurry will be distributed around the two depositional paddocks by an inter-connected pipeline that is situated around the perimeter of each paddock of the TSF. Once the two paddocks consolidate, the pipeline will be situated around the perimeter of the consolidated TSF.

Water management

Water management for the facility comprises managing the process water released by the slurry, both as supernatant and seepage water, and managing the polluted and clean stormwater. The supernatant water together with any stormwater falling on the TSF basin is treated as process water, which is decanted to the return water dam (RWD) and stormwater dam (SWD) downstream of the TSF. Stormwater emanating from the side slopes and perimeter area of the TSF will be collected in a concrete lined solution trench surrounding the TSF and discharged into the RWD and SWD. All water in the RWD and SWD will be pumped back to the plant for reuse. Stormwater falling outside the TSF will be diverted via a diversion berm/channel on the upstream side of the TSF to the environment.

Risks and risk mitigation

The two key risks associated with the TSF design are facility failure and pollution.

The risk of failure of the facility is mitigated by the following:

- A gentle side slope angle (approximately 14° or 1V:4H), that will reduce the probability of failure;
- Adequately sized and suitably positioned decant and water storage facilities;
- Supernatant pool control and adequate freeboard; and
- Strict TSF monitoring protocols.

The risk of the facility polluting the environment comprises three aspects that will be mitigated as follows:

- Dust emissions, which will be reduced by the ongoing rehabilitation of the TSF side slopes, minimising the height of the TSF, and installing robust closure measures at LOM;

- Surface water pollution, which will be mitigated by containing any water that might be polluted and recycling it into the mine's own water system, and diverting any clean runoff around and away from the facility and other infrastructure; and
- Groundwater pollution, which will be minimised by operating the TSF correctly, lining the RWD with HDPE liner, and by leaving in place the insitu material in the TSF basin, to reduce seepage.

Cost estimates

The estimated cost of constructing the facility is R 109.1 million (excl. VAT).

The ongoing operating costs are roughly estimated at:

- R 1.50 (excl. VAT) per tailings tonne deposited (i.e. R 192 million over the 30 year life of mine) - this rate per tonne needs to be confirmed by a qualified tailings dam operator.
- R 11.1 million (excl. VAT) for ongoing LOM construction expenditure (toe and blanket drains, drain outlets and paddocks around the TSF).
- R 1 million (excl. VAT) per year for the associated external monitoring costs for the TSF (i.e. R 30 million over the 30 year life of mine).

The closure cost associated with the TSF is estimated to be R 69 million (excl. VAT).

The combined overall cost for the TSF is therefore estimated to be R 411.2 million (excl. VAT).

PRELIMINARY DESIGN OF THE TAILINGS STORAGE FACILITY FOR THE PROPOSED MOONLIGHT IRON ORE PROJECT

1 INTRODUCTION

Metago Environmental Engineers (Pty) Ltd (Metago) was requested by Turquoise Moon Trading 157 (Pty) Ltd (Turquoise Moon) on behalf of Ferrum Crescent Limited (Ferrum) to compile the tailings section of the EIA/EMP report for the proposed Moonlight Iron Ore project.

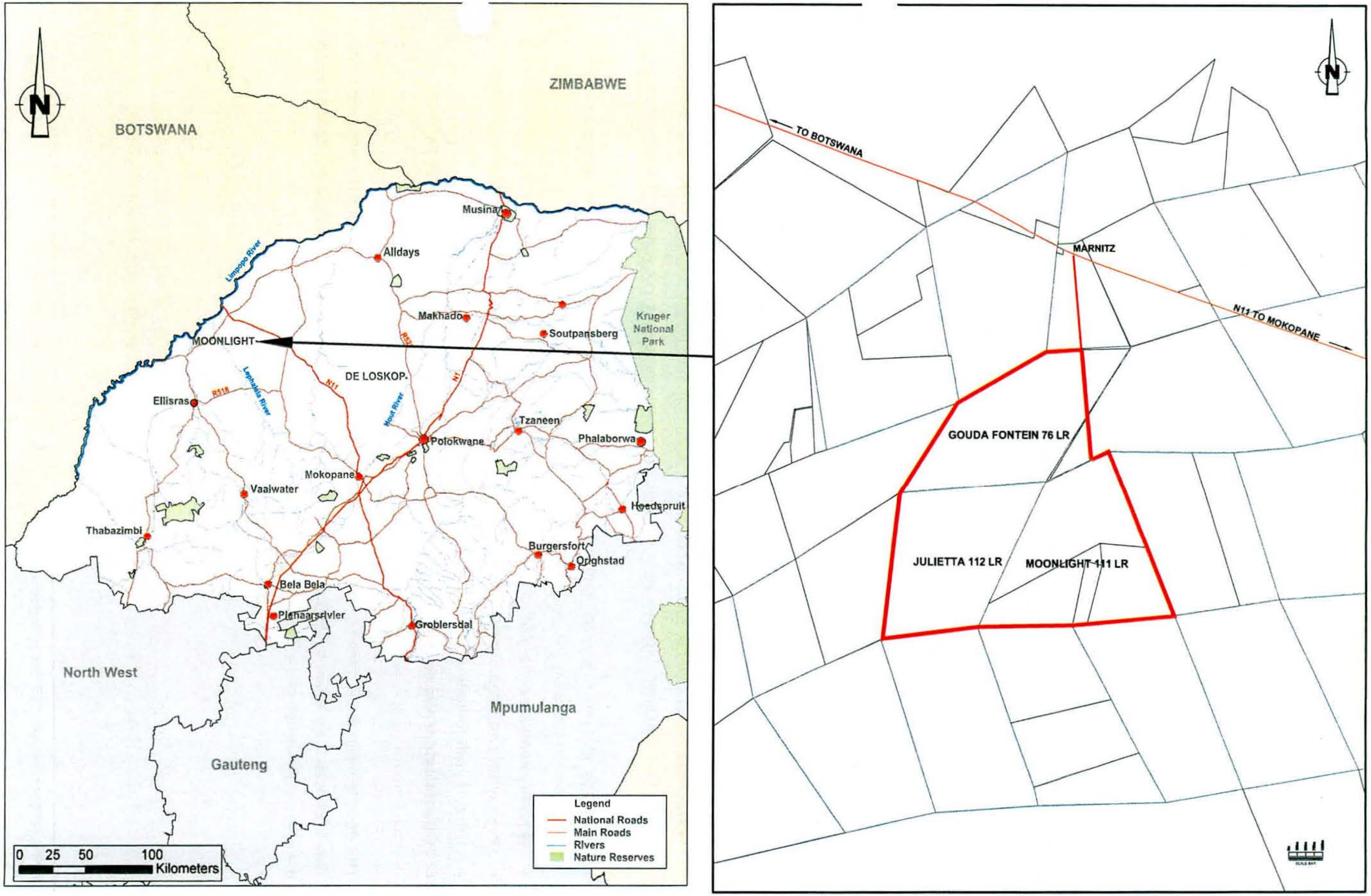
The proposed Moonlight Iron Ore project is located on the farms Moonlight 111LR, Gouda Fontein 76LR and Julietta 112LR. It is located along the N11 between Mokopane (Potgietersrus) and the Botswana border, near to the town of Marnitz, and approximately 60 km north and 145 km northwest of Lephalale (Ellisras) and Polokwane, respectively. See Figure 1.1.

The proposed mining project will target the underground iron ore mineralisation areas by means of an open pit mine, and will involve the establishment of new infrastructure typically associated with an iron ore mine and ore processing plant, including a new tailings storage facility (TSF), return water facility and associated infrastructure. The iron-making plant/smelter (and associated facilities) will be located off-site in an existing industrial area, most likely Lephalale. Other industrial areas that could also be considered are Mokopane, Polokwane, Thabazimbi or Selebi Phikwe (Botswana).

The TSF will need to accommodate 355,500 dry tonnes per month of tailings (4,266,000 dry tonnes per annum) for a period of 30 years.

This design report provides information on the investigation work, design criteria, preliminary design and sizing of the new TSF with associated infrastructure. The preliminary design drawings of the TSF are attached at the end of this report, and are to be read in conjunction with the text of this report.

Specific aspects of the investigation work and preliminary design conducted by Metago (and others) are summarised in the main body of the report and detailed in the Appendices.



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REGIONAL AND LOCAL SETTING OF THE PROPOSED MOONLIGHT IRON ORE PROJECT

Date : 06/2011	Scale : AS SHOWN
Project No : T020-04	FIGURE 1-1

2 TERMS OF REFERENCE AND SCOPE OF WORK

The terms of reference for the TSF and associated infrastructure are summarised as:

- Site selection investigation confirming the preferred location of the TSF, return water facility and associated infrastructure.
- Preliminary design of the TSF, return water facility and associated infrastructure including field investigation work.
- Quantification and costing of the TSF, return water facility and associated infrastructure.

2.1 SCOPE OF WORK FOR THE PRELIMINARY DESIGN

For the above-mentioned terms of reference, the following scope of work was undertaken:

- **Site selection** to identify suitable sites and confirm the preferred location of the TSF, return water facility and associated infrastructure.
- **Risk rating** (classification) of the TSF in terms of dam safety and the environment.
- **Geotechnical investigation** (undertaken together with AMEC) of the preferred location of the TSF and return water facility.
- **Stage capacity analysis** to generate the layout and optimise the capacity of the TSF.
- **Water balance** to size the return water facility to comply with Regulation 704 of the National Water Act and for licensing purposes and to assess the approximate return of water to the ore processing plant.
- **Seepage analysis** to provide input to the hydrogeological model and contaminant transport model to ascertain the future magnitude and extent of groundwater contaminant plumes.
- **Stability analysis** of the TSF to confirm the design geometry.
- **Preliminary engineering design** of the TSF and return water facility based on the findings above.
- **Closure, rehabilitation and aftercare issues** associated with the TSF.
- **Quantification and costing** of the TSF, return water facility and associated infrastructure.

The geochemical characterisation of the residue materials was not included in Metago's scope of work. This work was undertaken by AMEC Minproc SA (AMEC) and their recommendations incorporated into the preliminary design of the TSF.

3 DESIGN CRITERIA AND ASSUMPTIONS

3.1 PRODUCTION RATES

The run of mine (ROM) production is expected to be 6.5 million dry tonnes per annum, that will be converted into: 2.819 million dry tonnes of product (43.4%), 3.291 million dry tonnes of tailings (50.6%) and 0.390 million dry tonnes of discard/waste rock (6.0%). The conversion of ROM to tailings is therefore approximately 50.6%. The life of mine is anticipated to be 30 years (or more).

3.2 TAILINGS PRODUCTION RATES

For TSF design purposes, a more conservative approach has been adopted whereby it is assumed that 6.5 million dry tonnes ROM will generate 4.266 million dry tonnes of tailings i.e. the conversion of ROM to tailings is approximately 65.6%. These figures are derived from the AMEC "*Inception Study Report*" for Turquoise Moon (Report S2149, dated 31 October 2010) where an ore feed rate of 550 dry tonnes per hour generates 190 dry tonnes per hour of product (34.5%), and 360 dry tonnes per hour of tailings (65.6%).

The TSF must therefore accept on average 355,500 dry tonnes per month of tailings (4,266,000 dry tonnes per annum) for a period of 30 years. At an expected in-situ dry density of 2.0 tonnes per m^3 of tailings, this equates to a total volume of tailings of approximately 63,990,000 m^3 (127,980,000 tonnes). The expected in-situ dry density is based on data obtained from the Sishen and Thabazimbi iron ore mines since no tailings sample for the Turquoise Moon Project was available for testing.

These total volumes and tonnages have been used for the preliminary design of the TSF.

Plant utilisation is estimated by AMEC (who are responsible for the design of the process plant) to be at 90 % which equates to 7,900 hours per annum (or an average of 659 hours per month). Tailings delivery is therefore 540 dry tonnes per hour.

3.3 LIFE OF MINE

The latest mine plan/resource estimate for the project indicates that the life of mine (LOM) is 30 years. Additional iron ore resources are expected to the north and west of the current pit layout, and hence the LOM may be significantly longer than the 30 years proposed.

The TSF described in this report has been designed, up to preliminary level, to accommodate an average of 355,500 dry tonnes per month of tailings for a period of 30 years.

3.4 TAILINGS CHARACTERISTICS

3.4.1 PARTICLE SIZE DISTRIBUTION

No tailings samples were available for testing purposes. The particle size distribution of the tailings (as supplied by AMEC) is indicated in Table 3-1 below. This particle size distribution presented is considered to be the most likely scenario and hence the preliminary TSF design, which is based on these tailings characteristics, is neither conservative nor extreme.

TABLE 3-1: PARTICLE SIZE DISTRIBUTION OF TAILINGS

Sieve Aperture (mm)	% Passing (by Mass)	Sieve Aperture (mm)	% Passing (by Mass)
0.0025	0.3 %	0.0450	78.0 %
0.0040	1.2 %	0.0630	95.0 %
0.0100	12.0 %	0.0750	98.2 %
0.0250	50.4 %	0.0900	99.3 %
0.0300	61.0 %	0.1060	100.0 %
0.0380	64.3 %	0.1500	100.0 %

Based on the particle size distribution above, the ultra-fine nature of the tailings material indicates that the tailings is likely to dry slowly, crack extensively and erode easily (i.e. the potential for rat-holing and erosion gulleys on the outer slopes of the TSF, in the event of self-construction with tailings only, is significant). Also, the tailings material is expected to be slow draining and relatively impermeable.

The TSF design will be further refined during the detailed design phase, based on testwork of site specific material i.e. tailings derived from the Turquoise Moon ore body.

3.4.2 PARTICLE SPECIFIC GRAVITY

The particle specific gravity of the tailings is expected to be of the order of 4.1 (that is typical for iron ore materials, and is based on data obtained from the Sishen iron ore mine).

3.4.3 IN-SITU DENSITY OF TAILINGS

The in-situ density of the tailings is estimated to be of the order of 2.0 tonnes per cubic metre (based on similar TSF operations at the Sishen and Thabazimbi iron ore mines). The in-situ density will most likely only be confirmed during the operation of the TSF.

A conservative average void ratio over the entire TSF has, at this stage, been taken as 1.05 based on:

- The fact that segregation occurs on deposition resulting in a predominantly sand outer shell with very fine silt to clay sized material at or near the pool.
- The sand at the outer shell of the TSF can be expected to have a void ratio of about 0.8 while the very fine grained material at the pool which is settling and consolidating under saturated conditions will provide void ratios in excess of 1.2.

These values will need to be periodically monitored and re-assessed once the TSF is in operation.

3.4.4 TAILINGS GEOCHEMISTRY

The tailings geochemistry has been investigated by AMEC and described in Report A029-11-R1090 (see Appendix A). Further details are also given in Chapter 6.4 and 7.1 of this report.

The results of the mineralogical assessment and acid base accounting (ABA) tests indicate that the tailings material is highly unlikely to give rise to acid rock drainage (ARD) due to the lack of significant quantities of sulphides in the ore body (below 0.05%), and the alkaline neutralizing potential of apatite, calcite, dolomite and garnet that are present in the tailings material. Furthermore, there is unlikely to be any metal leachability issues since the tailings contains only small amounts of Mg (magnesium), Al (aluminium), Ca (calcium), Ti (titanium) and K (potassium).

The release of tailings dust from the top surface and non-rehabilitated sidewalls of the TSF always pose a potential risk to the surrounding environment in the absence of suitable mitigation measures. According to the AMEC report, the Moonlight tailings contain amphibolites in the form of actinolite. Testwork on the actinolite confirm that this material is non-fibrous. [Fibrous forms of actinolite have implications for the respiratory health of workers and communities exposed to the mineral].

Based on the above, the minimisation and prevention of tailings dust both during the operations and at closure of the TSF needs consideration – despite the fact that the actinolite is non-fibrous.

3.5 TAILINGS SLURRY CHARACTERISTICS

Tailings will be pumped to the TSF at a slurry density of 1.71 tonnes per m^3, which equates to 55 % solids by mass at a particle specific gravity of 4.1. This is in accordance with the AMEC process plant design.

For a tailings delivery of 540 dry tonnes per hour (i.e. 355,500 tonnes per month or 4,266,000 tonnes per year), the water delivery equates to roughly 442 tonnes (or roughly 442 m^3) per hour.

[Note: For a tailings delivery of 417 dry tonnes per hour (i.e. 274,260 tonnes per month or 3,291,108 tonnes per year – as per Chapter 3.1), the water delivery equates to roughly 341 tonnes (or roughly 341 m^3) per hour. This figure has been used for comparative purposes when determining the overall water demand for the TSF].

3.6 Tailings Deposition Method

Deposition of the tailings will be carried out using a conventional spigot delivery system. Spigot deposition is commonly used in the iron (magnetite) tailings industry and is suited to the anticipated tailings characteristics, climatic conditions and topography of the Moonlight project site.

3.7 Rate of Rise Criteria

The rate of rise (RoR) criteria adopted for the preliminary TSF design has been limited to 1 m/year. This is based on the operations data for the TSF's at Sishen mine, where self-construction using dried and consolidated tailings is undertaken.

At the Moonlight TSF, self-construction using dried and consolidated tailings will most likely be supplemented by discard material and/or waste rock from the plant and pit operations.

3.8 Legislative Requirements

The TSF and associated infrastructure has been designed in accordance with all current legislation regarding the construction, operation and closure of such facilities. In terms of current legislation, the TSF and the return water facility is exempt from Minimum Requirements (DWAF, 1998).

Of particular importance in the design of the TSF, return water facility and associated infrastructure are the following:

- Mineral and Petroleum Resources Development Act No 28 of 2002 (MPRDA), in particular Regulation R527;
- National Water Act No. 36 of 1998 (NWA), in particular Government Notice 704, which specifies a number of design requirements concerning clean and dirty water management;
- The Environmental Conservation Act (Act 73 of 1989) (ECA); and
- The National Environment Management Act: Air Quality Act (39 of 2004) (NEMA), which dictates standards for air quality and has impacts on dust mitigation measures in particular.

3.9 PREDICTIVE METHODS, ASSUMPTIONS AND UNCERTAINTIES

The predictive methods and tools used in the analyses and preliminary design of the TSF are considered best practise, and are based on the legislative requirements above (especially the MPRDA), as well as, industry established standards and guidelines, namely: SANS 10286:1998, "*Code of Practise for Mine Residue*" and the Chamber of Mines of South Africa, 1996, "*Guidelines for Environmental Protection – The Engineering Design, Operation and Closure of Metalliferous, Diamond and Coal Residue Deposits*".

All underlying assumptions made throughout the analyses and preliminary design of the TSF have been conservative (i.e. presenting the worst case) until such time that it can be proven otherwise. Wherever possible, these assumptions have also been based on similar TSF operations and/or design philosophies.

Uncertainties regarding any information provided and/or used in the analyses and preliminary design of the TSF have been highlighted and recommendations have been made that will need to be addressed during the bankable feasibility design phase, detailed design phase and/or operations phase of the TSF.

4 AVAILABLE INFORMATION

4.1 PREVIOUS REPORTS

The following information was available for the purposes of the preliminary design:

- *"Turquoise Moon Iron Project, Inception Study Report"*, AMEC Minproc, Report No. S2149, October 2010.
- *"Environmental Scoping Report for the Proposed Moonlight and De Loskop Iron Ore Project"*, Metago, Project No. T020-02, Report No. 1, November 2010.
- *"Hydrological Assessment and Conceptual Stormwater Management Plan for the Proposed Moonlight Iron Ore Mine"*, Metago Project No. T020-02, Report No. 2, May 2011.

4.2 SURVEY INFORMATION

The preliminary design was based on topographical survey data supplied by Ferrum. The topographical survey of the project area (i.e. digital terrain model with colour orthophotos) was completed in February 2011 by Southern Mapping Company (Pty) Ltd.

4.3 CLIMATIC DATA

4.3.1 REGIONAL CLIMATE

The region climatic type is classified as "Lowveld semi-arid". Most rainfall occurs during the summer with an average summer temperature of about 30ºC. The mean annual rainfall varies between 300 and 700 mm, with an average of 40 days of thunder per year. In general, it is expected that evaporation will be higher than precipitation throughout the majority of the year. Winds are predominantly from the east all year around, typically 5 to 10 m/s. Winters are cold, with average temperatures less than 10ºC. Frost occurs regularly.

4.3.2 RAINFALL AND EVAPORATION

The dominant rainy season extends from October to March, with the peak rainfall occurring in November to February. The average annual rainfall depths in the vicinity of the project area ranges from approximately 380 to 460 mm (see Table 4-1). Rain generally occurs as a result of thunderstorms.

TABLE 4-1: SOUTH AFRICAN WEATHER SERVICES STATIONS IN THE VICINITY OF THE PROJECT AREA

Station Name	Marnitz	Marnitz	Strydpan	Brekenhout-fonte	Wagonkop
Station No	A5E001	0719370 A	0719428 W	0719467 W	0718798 W
Latitude (South)	23º 10'	23º 10'	23º 7'	23º 17'	23º 18'
Longitude (East)	28º 13'	28º 13'	28º 14'	28º 16'	27º 57'
Altitude (mamsl)	962	944	954	995	820
Rainfall record length (years)	24	28	41	31	29
MAP (mm) from TR102 – 2000	419	391	389	384	395
Distance from Moonlight TSF site (km)	7	8	12	10	26
Elevation difference, based on a mean of 960 mamsl for Moonlight TSF site (m)	+2	-16	-6	+35	-140

The Marnitz Weather Station (A5E001) was selected as the station most applicable to the project site considering factors such as distance, altitude, length and completeness of rainfall records.

TABLE 4-2: MONTHLY RAINFALL AND EVAPORATION DATA

Month	Marnitz Weather Station (A5E001)	
	Average Rainfall Depth (mm)	Average Lake Evaporation (mm)
January	84.5	177.4
February	67.5	142.1
March	45.6	149.7
April	34.6	115.2
May	6.9	96.2
June	3.2	78.4
July	1.4	89.8
August	2.7	120.4
September	10.4	155.3
October	33.4	184.4
November	62.5	178.4
December	66.7	166.2
TOTAL	**419.4**	**1653.6**

The monthly rainfall and evaporation data from the Marnitz Weather Station has been used in the overall TSF water balance.

4.3.3 24-HR STORM EVENTS FOR VARIOUS RECURRENCE INTERVALS

The depths of rainfall for 24-hr storm events of various recurrence intervals, based on the Design Rainfall Estimation in South Africa dataset as part of the RLMA&SI methodology, are as follows:

- 1:20 year 24-hr storm event = 130 mm,
- 1:50 year 24-hr storm event = 157 mm,

- 1:100 year 24-hr storm event = 179 mm, and
- 1:200 year 24-hr storm event = 202 mm.

The 1:50 24-hr storm event has been used for the sizing of the TSF decant system and in the overall TSF water balance – for sizing the return water facility.

4.3.4 FLOODLINES

The 1:50,000 topographical map sheet indicates that there are no perennial or non-perennial streams at (or near to) the TSF site. This is due to the overall Moonlight site being located on a watershed, as well as the aridity of the region, which results in a low drainage density. Significant catchment areas upstream of the Moonlight site are consequently not present, while the dominant flow regime within the site is that of overland flow (and not channel flow).

Further details regarding the hydrology of the Moonlight site is given in the Metago report, "*Hydrological Assessment and Conceptual Stormwater Management Plan for the Proposed Moonlight Iron Ore Mine*", appended with the overall EMP document for the Moonlight Project.

5 SITE SELECTION REVIEW

The purpose of this section is to outline the criteria against which the alternative TSF sites were compared and to summarise important factors contributing to the elimination and selection of the site.

Four TSF sites (A, B, C and D) were investigated within the Moonlight mine boundary. The location of the sites is shown in Figure 5-1.

In accordance with the EMP requirements, a number of specialist investigations were carried out within the Moonlight mine boundary. These specialist investigations were undertaken to assess the baseline environmental data, sensitivities around each site and their suitability for the intended application.

The following specialist investigations were consulted during the TSF site selection process:

- **Air Quality:** "*Air Quality Impact Assessment for the Proposed Turquoise Moon Iron Ore Mine, Limpopo Province*", Airshed Planning Professionals, Report No. APP/10/MEE-14 Rev 1, May 2011.
- **Grazing:** "*Turquoise Moon: Veld Condition Assessment – Grazing Management Report*", Enviropulse, May 2011.
- **Soils and Land Capability:** "*Moonlight Iron Ore Project – Specialist Soils and Land Capability Impact Assessment and Management Planning*", Earth Science Solutions, Report No. MEE.TMS.S.10.060.055 Rev v1.5, May 2011.
- **Land Use:** "*Land-Use Assessment of the Proposed Moonlight Iron Ore Mining Operation*", Scientific Aquatic Services in association with Terra-Africa, Report No. 211059, May 2011.
- **Biodiversity:** "*Turquoise Moon - Moonlight Project Biodiversity Study and Impact Assessment*", Ecorex Consulting Ecologists, April 2011.
- **Hydrogeology:** "*Hydrogeological Investigation and Impact Assessment for the Proposed Moonlight Iron Ore Mine*", Metago Water Geosciences, Project ET020-05, Report No. 001/0132, May 2011.
- **Visual:** "*Visual Impact Assessment for the Proposed Moonlight Iron Ore Project, Limpopo Province*", Newtown Landscape Architects, Report 1293/E10L, May 2011.
- **Palaeontology:** "*Turquoise Moon Iron Project – Palaeontological Impact Assessment*", BPI for Palaeontological Research, University of the Witwatersrand, May 2011.
- **Heritage:** "*A Phase I Heritage Impact Assessment Study for the Moonlight Iron Ore Project in the Limpopo Province of South Africa*", Dr J. Pistorius, May 2011.
- **Noise:** *"Moonlight Iron Ore Project – Noise Study for EIA"*, Dr B. van Zyl, Report G909-R1, June 2011.
- **Socio-Economic:** *"Turquoise Moon Trading 157(Pty) Ltd – Socio-Economic Impact Assessment"*, Strategy4Good, May 2011.

Further details regarding the findings and conclusions of each of these specialist investigations, are given in the Baseline Environmental Section of the EMP Report.

Table 5-1 shows the TSF site selection matrix, including the parameters used to determine the site selection and the rating for each. The parameters are grouped into 5 main categories, each with an equal weighting factor of 0.2 (i.e. 5 x 0.2 = 1). Engineering and economics aspects account for 40% (2 x 0.2). Physical environment, biological environment and social aspects account for 60% (3 x 0.2).

The parameters considered for each site were given a score of one to three, one being the least preferable, and three being most preferable. The site with the highest weighted score overall, taking all the site requirements into account, was considered the most preferable.

Based on the site selection matrix, Site A is the preferred TSF site.

6 CLASSIFICATION OF THE TSF

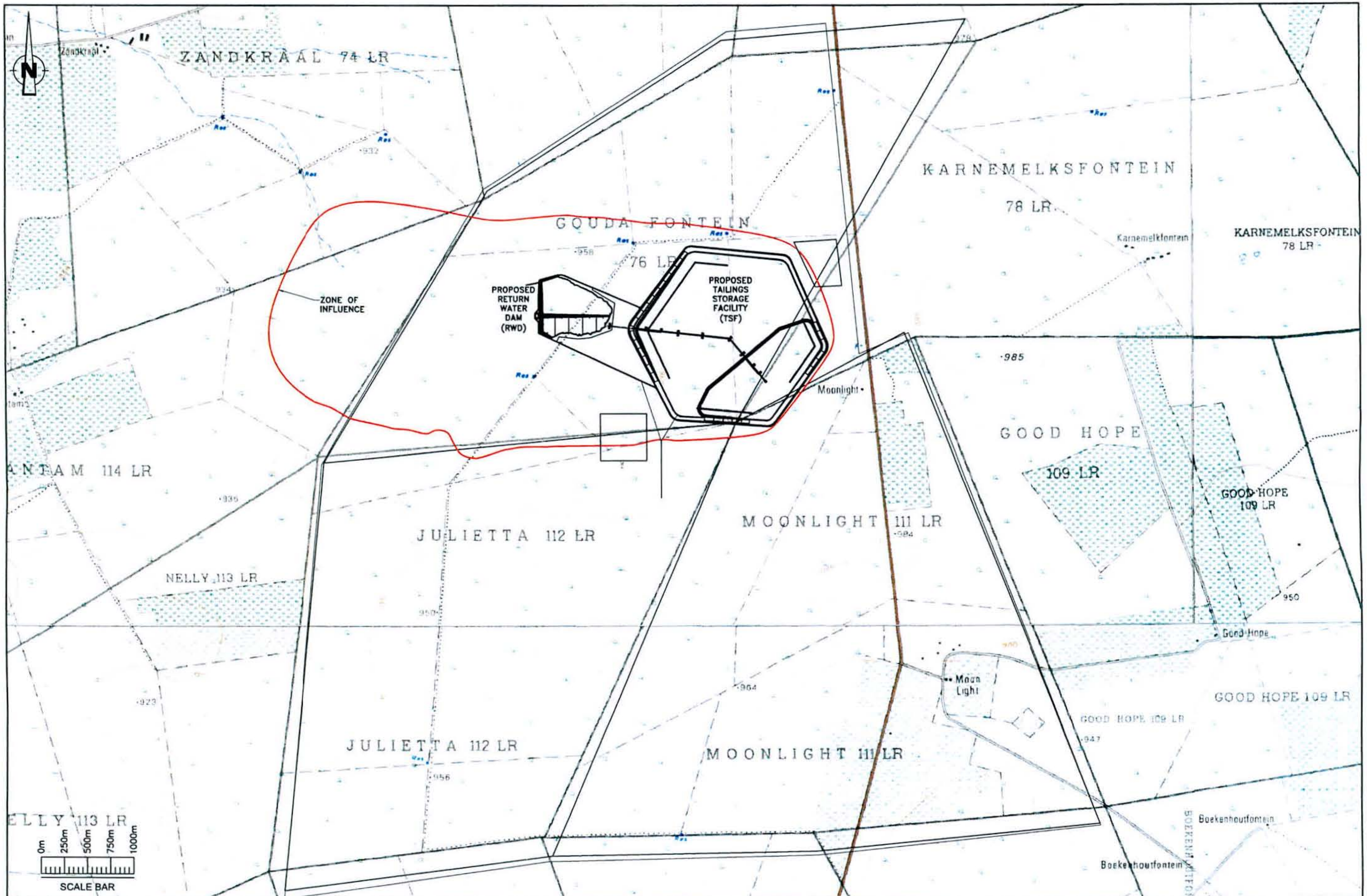
The classification of the Moonlight TSF in terms of the requirements of the SANS Code of Practice for Mine Residue Deposits (SANS 10286, previously SABS 0286:1998) is documented below.

6.1 SAFETY CLASSIFICATION

The preliminary safety classification of the TSF has been carried out in accordance with the requirements of SANS 10286. The safety classification system serves to provide a consistent means of differentiating between high, medium and low hazard deposits on the basis of their potential to cause harm to life or property. The classification system furthermore provides a basis for the implementation of safety management practices for specified stages of the life cycle of a TSF. The code prescribes the aims, principles and minimum requirements that apply to the classification procedure and the classification in turn gives rise to minimum requirements for investigation, design, construction, operation and decommissioning. The information used in the safety classification is presented in Table 6-1 to Table 6-3.

The approximate area that may be affected by a flow slide originating from the proposed TSF is shown in Figure 6-1. The area is based on the guideline values from the Code of Practice and the topography of the area.

Based on the safety classification criteria the Moonlight TSF has been classified as a **Medium Hazard** facility. The minimum requirements associated with the design, operation, management and closure of a Medium hazard Facility are summarised in Table 6-4.



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MOONLIGHT IRON ORE PROJECT ZONE OF INFLUENCE	Date : 17052011	Scale : NTS
	Project No : T020-04	FIGURE 6-1

TABLE 6-1: GENERAL INFORMATION FOR THE SAFETY CLASSIFICATION OF THE MOONLIGHT TSF

1	**General Information (Ref SANS 10286)**	
1.1	Name of Mine	Moonlight
1.2	Postal Address of the Mine	C/o Turquoise Moon Trading 157 (Pty) Ltd PO Box 877, Lonehill, 2062
1.3	Telephone No. of the Mine	C/o Turquoise Moon Trading 157 (Pty) Ltd (011) 510-0159
1.4	Magisterial District	Lephalale Local Municipality
1.5	DME Region	Limpopo
1.6	Nearest Town	Lephalale (Ellisras)
1.7	Direction and distance to town	South, approximately 60 km
1.8	Name of person responsible for residue deposit	Not yet appointed
1.9	Common name of deposit	Moonlight TSF
1.10	Name of closest river / stream to the deposit	Lephalala River (to the West, approximately 20 km)
2	**Safety Classification (Ref SANS 10286)**	
2.1	Description of Residue	Iron (Magnetite) Tailings
2.2	Is residue deposited hydraulically?	Yes
2.3	Is deposit still active?	N/A
2.4	Time since decommissioning.	N/A
2.5	Ultimate maximum height of deposit on closure (Crest elevation and lowest toe elevation)	37.8 m
2.6	Current maximum height of deposit	N/A
2.7	When did deposition start?	Planned for 2015
2.8	What is steepest overall outer slope of the deposit?	1 V : 4 H (or 14° from horizontal)
2.9	Steepest ground slope gradient measured on downstream perimeter of the deposit over a distance of 200m	21 m over 1850 m (1V:88H, or 0.65° from horizontal)
2.10	Is deposit located on undermined ground?	No
2.11	What is the shallowest depth to underground excavations?	N/A
2.12	Line diagram of the deposit showing : • Outline of deposit, approximate ground contours for a distance around deposit as defined in section 3 of classification system; • Zone of potential influence of a failure of the deposit (ref section 3) • Property / Infrastructure / Services located within the zone of influence	Refer Figure 6-1
3	**Determination of Zone of Influence**	
Step 1	Deposition is hydraulic, go to step 2	
Step 2	Deposit will shortly be active, go to step 4	
Step 3	NA	
Step 4	Zone of influence defined by : (Ref. Figure 6-1) Upstream (Southern Side) Sides (Eastern and Western Sides) Downstream (Southern Side)	 5 H from upstream toe = 5 x 20 m = 100 m 10 H from sides = 10 x 28.4 m = 284 m 100 H from downstream toe = 100 x 37.8 m = 3,780 m
Step 5	NA	

TABLE 6-2: SAFETY CLASSIFICATION CRITERIA FOR MOONLIGHT TSF

1	2	3	4	5
No. of Residents in Zone of Influence	No. of Workers in Zone of Influence [1]	Value of 3rd party property in Zone of Influence [2]	Depth to underground mine workings [3]	Classification
0	**< 10**	0 – R 2 m	**> 200 m**	Low Hazard
1 – 10	11 - 100	**R2 m – R 20 m**	50 m – 200 m	**Medium Hazard**
> 10	> 100	> R 20 m	< 50 m	High hazard

1. Not including workers employed solely for the purpose of operating the deposit
2. The value of third party property should be in the replacement value in 1996 terms.
3. The potential for collapse of the residue deposit into the underground workings effectively extends the zone of influence to below ground level.

Source : SANS 10286:1998, Table 2 – Safety Classification Criteria

TABLE 6-3: SAFETY CLASSIFICATION OF THE MOONLIGHT TSF

Criteria No.	Criteria	Comment	Safety Classification
1	No. of Residents in Zone of Influence	No formal or informal settlements are noted within the zone of influence, however there exists the possibility that 1 or more residents spend significant periods of time within the zone of influence.	**Low (to Medium) Hazard**
2	No. of Workers in Zone of Influence	The zone of influence to the west of the TSF covers a small section of the neighbouring farm that is very unlikely to have more than 11 workers in the area. There is no planned mine infrastructure to the west of the TSF and hence no mine workers are expected in this area.	Low Hazard
3	Value of 3rd party property in Zone of Influence	The zone of influence is calculated to be 3.8 km downstream in the event of a significant tailings flow slide. No formal assessment of the value of the 3rd party property within the zone of influence has been done, however it is likely to be more than R2 million.	**Medium Hazard**
4	Depth to underground mine workings	There are no mine workings beneath the proposed tailings storage facility site	Low Hazard

6.2 REQUIREMENTS ARISING FROM SAFETY CLASSIFICATION OF THE TSF

The Moonlight TSF is classified as having a medium safety hazard in terms of the requirements of the SANS Code of Practice for Mine Residue Deposits (Table 6-3). A summary of the minimum requirements associated with a medium hazard safety classification is shown in Table 6-4.

TABLE 6-4: MINIMUM REQUIREMENTS ASSOCIATED WITH A MEDIUM HAZARD TSF

PLANNING STAGE	DESIGN STAGE	OPERATION/ COMMISSIONING STAGE	DECOMMISSIONING STAGE
• Conceptualisation by owner. • Preliminary site selection by appropriate specialist. • Geotechnical investigation by suitably qualified person.	• Geotechnical report required. • Residue characterisation verified by laboratory analyses. • Design by Pr Eng. • Risk analysis optional. • Construction supervision by suitably qualified person.	• Risk analysis optional. • Suitably qualified person responsible for operation. • Pr Eng appointed to monitor. • Pr Eng to audit every two years.	• Pr Eng appointed to monitor. • Pr Eng to audit every two years.

6.3 ENVIRONMENTAL CLASSIFICATION

The preliminary environmental classification of the facility has been carried out in accordance with the requirements of SANS 10286. All mine residue deposits should be classified into one of the following two environmental categories:

- Residue deposits that have a potentially significant impact on any environmental component; or
- Residue deposits that have no potentially significant impact on the environment.

A geochemical and mineralogical characterisation of the Moonlight ore body (i.e. future tailings) has been carried out as part of the preliminary design of the facility - refer to Appendix A. The results of the characterisation have indicated that the tailings material is highly unlikely to give rise to acid rock drainage (ARD) due to the lack of significant quantities of sulphides in the ore body (below 0.05%), and the alkaline neutralizing potential of other minerals present in the tailings material. Furthermore, there is unlikely to be any metal leachability issues since the tailings contains only small amounts of Mg (magnesium), Al (aluminium), Ca (calcium), Ti (titanium) and K (potassium). Leachate from the TSF is therefore unlikely to adversely impact the quality of the groundwater in the vicinity of the TSF.

A groundwater assessment of the contaminated plume from the TSF (in excess of 100 years) indicates that the plume is not expected to extend beyond the site boundaries, since the open pit will act as a long term groundwater "sink" and will therefore "capture" contaminated groundwater. At closure, rehabilitation of the TSF will have a long-term positive impact on the groundwater quality, as the recharge rate of contamination will be reduced. Further details of the groundwater modelling are described in "*Hydrogeological Investigation and Impact Assessment for the Proposed Mining Activities – Moonlight Iron Ore Project*" (Metago Water Geosciences Project No. ET020-05, Report No. 1, May 2011) that is appended with the overall EMP document for the Moonlight Project.

In addition to the above, the release of tailings dust from the top surface and non-rehabilitated sidewalls of the TSF poses a potential risk to the surrounding environment in the absence of suitable mitigation measures.

The above factors indicate that the proposed Moonlight TSF should currently be classified as having **No Potentially Significant impact on the groundwater** and a **Potentially Significant impact on air quality**.

6.4 Requirements Arising from the Environmental Classification of the TSF

An environmental impact assessment must be carried out by suitably qualified persons for TSF's classified as having a potentially significant impact on the environment. The impact assessment must at least quantify the impact on those environmental components that could be significantly affected.

The impact assessment is documented in the Environmental Impacts Section of the EMP Report, and specific TSF mitigation measures include:

- Ongoing modelling of the TSF contaminant plume to determine the post-closure operation and to determine the need for a seepage interception system (if required). Following closure of the TSF, seepage rates (and the movement of the contaminant plume) is expected to drop.
- The ongoing rehabilitation and cladding/re-vegetation of the TSF side slopes during operations to reduce dusting and erosion. Following closure of the TSF, the top surface will be decommissioned, paddocked, rock clad and re-vegetated to reduce dusting and erosion.

In the managed scenario (i.e. ongoing contaminant plume modelling, the construction of a downstream seepage interception system (if required) and continuous rehabilitation and re-vegetation of the TSF), the TSF impacts on air and groundwater can all be managed to low significance. In this scenario there is little potential for significant impact on the environment.

7 SUMMARY OF ANALYSES FOR THE TSF DESIGN

Summaries of the various analyses carried out in the preliminary design of the TSF are presented below. More detailed discussions and information is presented in the appendices.

7.1 GEOCHEMICAL CHARACTERISATION OF TAILINGS

The geochemical characterisation study, compiled by AMEC, is attached in Appendix A.

The purpose of the study was to assess the hazard posed by any of the mine residue facilities (i.e. the TSF and waste rock stockpiles) to the surrounding environment, as well as, the likely long term water quality in the open pit. Only the geochemical data specifically related to the TSF is discussed further in this report.

Typically, the TSF can impact the environment through the following:

- The drying of the tailings material typically results in salts/precipitates accumulating at the top surface (due to capillary rise). The tailings along with the salts/precipitates are then released to the environment by air and water dispersion.
- Air dispersion of tailings and salts is through the generation of dust from the top surface and side slopes of the TSF that then settle on surrounding soil, vegetation and surface waters, potentially contaminating or degrading these resources.
- Water dispersion of tailings is through runoff from the top surface and side slopes of the TSF that is not captured as process water, potentially contaminating surrounding surface waters.
- Water dispersion of salts and other pollutants is by seepage through the TSF footprint and from associated facilities such as solution trenches, catchment paddocks and the return water dam, potentially contaminating ground water resources.

The geochemical characterisation study focused only on the quality of seepage from the TSF, but intuitively whatever applies to seepage also applies to runoff (i.e. surface water runoff from the TSF is expected to have similar geochemical characteristics to seepage from the TSF).

7.1.1 GEOCHEMICAL CHARACTERISATION METHODOLOGY

A selection of 45 samples, representing the main lithologies of the iron ore deposit, were used for mineralogical assessment, ABA and paste pH testing. No leach tests were undertaken. The 45 samples were all derived from the previous drilling campaigns of the deposit (i.e. prior to 2011).

The results of this study, together with the results of the seepage analysis were used to assess the impact of the proposed TSF on the surrounding groundwater as documented in the Metago Water Geosciences report, "*Hydrogeological Investigation and Impact Assessment for the Proposed Mining Activities – Moonlight Iron Ore Project*" (Project No. ET020-05, Report No. 001, May 2011) that is appended with the overall EMP document for the Moonlight Project.

7.1.2 GEOCHEMICAL CHARACTERISATION RESULTS

The results of the mineralogical assessment indicate that the percentage of pyrite in the tailings has been determined to be below 0.05% total sulphur. Apatite, calcite, dolomite and garnet will also report to the tailings. These minerals are able to release alkalinity to neutralize any potential acidity. On balance it can be concluded that the potential for acid generation is extremely limited and considering that there is also some available alkalinity in the system, the Moonlight tailings is unlikely to be acid generating.

Furthermore, mineralogical assessment indicates that the tailings will contain more silica and iron than the average Earth's crust composition with proportionally less Mg (magnesium), Al (aluminium), Ca (calcium), Ti (titanium) and K (potassium). Considering the lack of driving force for acid generation and that silica and iron will be the main components, it can be concluded that it is unlikely that there will be leaching of any metals of environmental concern from the tailings.

Lastly, the results of the mineralogical assessment indicate that the tailings will contain amphibolites in the form of actinolite. Testwork on the actinolite has confirmed that this mineral is non-fibrous, and does not pose any health risks for workers or communities exposed to this mineral. [Fibrous forms of actinolite have implications for the respiratory health of workers and communities exposed to the mineral].

7.1.3 GEOCHEMICAL CHARACTERISATION CONCLUSIONS

The following conclusions have been drawn from the geochemical characterisation:

- Leach tests on representative tailings samples should ideally be undertaken to confirm that there is unlikely to be any leaching of metals of environmental concern.
- With respect to closure of the TSF, as the tailings is not acid generating, the possibility of attaining a level of biodiversity and vegetation cover similar to that of the surrounding undisturbed land exists, provided that measures are put in place to deal with other factors such as the tailings erodability, moisture retention characteristics, microbial activity and the low nutrient levels present in the tailings.