COMPARISON OF NEW PEAK HOUR TRIP GENERATION RATES WITH EXISTING RATES IN THE SOUTH AFRICAN TRIP DATA MANUAL

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ABSTRACT

Peak hour trip generation rates are important for the calculation of the number of trips generated by a development during a peak hour. In South Africa, trip generation rates are obtained from the trip data manual documented in the Technical Methods for Highways (THM 17). Trip generation rates can be obtained from multiple sources, TMH 17 is one of them. The TMH 17 manual acknowledges that the trip rates currently used were based on insufficient data, and in some cases international data that may not be necessarily applicable to South African traffic conditions. There is therefore, a need to develop trip generation rates that are based on local data and comparable to international data in South Africa.

This paper compares a new peak hour trip generation rates with the current TMH 17 rates for office developments in Tshwane. A study area was determined by identifying office developments according to the requirements of TMH 17. Manual vehicular traffic counts were undertaken at five office building sites. Out of the five sites investigated, trip generation rates for office development at Ingersol/Lois intersection were close to the values presented in TMH 17, with the PM peak rate slightly higher than the current rate. Although valid, the results presented are preliminary and will be refined when five additional sites are included in the study to make a total sample of ten sites as per TMH 17 requirements.

1. INTRODUCTION

1.1 Background

The South African Trip Data Manual (TMH 17) is the document that is used to obtain different traffic parameters in South Africa. The traffic parameters include trip generation rates, trip length, road construction cost and general traffic parameters. These parameters are commonly used for the calculation of engineering service contributions, traffic impact and site traffic impact. According to TMH17, the traffic parameters were developed based on limited local data, and supplemented by international data that may not necessarily be applicable to the South African traffic conditions. Thus, there is insufficient data for trip generation rates for land use development in South Africa as per TMH 17. It is imperative to

ensure that the current traffic parameters are correctly estimated as a small difference in the trip generation rates for instance could lead to either over estimation or under estimation of traffic generation. This could have a major impact on the transport decisions that are made by Municipalities, Provincial and National Transport Departments across the country.

Traffic generation is the first of the four steps of travel demand forecasting that determines the amount of total vehicular trips generated by the proposed development. The trip generation and other traffic characteristics of a development depend not only on the type of development but also on its size, for example, “Gross Leasable Area (GLA)”, Dwelling Units”, “Rooms”, etc. The GLA of a development is the total floor area designed for tenant occupancy and exclusive use (ITE, 2004). It is the area for which tenants pay rent and which produces income for the owner of the development. The GLA is normally measured in m^2 (square metres) and is typically measured between the centrelines of inner and outside walls. Generally, areas that are excluded from the definition of GLA are open roof areas, verandas or balconies, canopies erected on the street frontage of a shop, parking areas, malls, entrance halls and foyers at shopping centres, accommodation for the lift room and other mechanical or electrical equipment required for the functioning of the building, areas reasonably used in connection with the cleaning, maintenance and care of the building.

Moreover, the number of trips generated depends on the trip generation rate used. Trip generation rate is a traffic parameter that is required for calculating traffic generated (Technical Methods for Highways - TMH 17, 2013). According to Pitsiava – Latinopoulou et al. (2001), a trip rate is the most important tool in calculating trip generation and its incorrect prediction can lead to incorrect traffic generation calculation and ultimately adoption of incorrect mitigation measures as well as adoption of incorrect traffic growth management strategies. Equation 1 is used to determine generated trips.

$$Generated\ trips\ =\ \frac{Gross\ Leasable\ Area\ (GLA)*Trip\ rate}{100} \qquad (1)$$

$$Where\ GLA\ =\ size\ of\ the\ development\ in\ m^2$$

The impact of the proposed land use (i.e. new development) results in the increase of vehicular trips which in turn results in the reduction of the capacity of the existing road network (Anil et al., 2001). The impact of vehicular traffic emanating from the proposed land use on the existing network is assessed by a Traffic Impact Study (TIS) (City Council of Pretoria, 1998). Trip generation analysis is affected by factors such as traffic patterns, demographics as well as infrastructure (Shihana and Kazunori, 2000) and therefore, the application of developed countries trip generation models in developing countries should be discouraged (Pitsiava – Latinopoulou et al., 2001). It is of utmost importance for developing countries to have their own local data manual (Shihana and Kazunori, 2000) as the use of international data for local conditions can lead to errors in determining trip rates as well as traffic generation estimates (Anil et al., 2014). According to Ewing et al. (1996) the errors on trip rates and trip generation results in implementation of improper mitigation measures.

This paper presents trip rates for office developments in Tshwane and compares them to the rates in TMH 17.

1.2 Objective

The main objective of this paper is to develop peak hour trip generation rates that are applicable to use in the Tshwane area for office developments and to compare them with existing rates in the South African Trip Data Manual. The comparison of the rates (developed and existing) is imperative as a small difference in the trip generation rates could lead to either over estimation or under estimation of traffic generation. This could have a major impact on the transport decisions made by Municipalities, Provincial and National Transport Departments across the country.

2. METHODOLOGY

2.1 Selection of the site

The site selection procedures recommended by TMH 17 were followed in this study. These requirements include occupancy of the site where a site must have a reasonable full occupancy, must be mature (two years or older), must not be isolated, and the site information must be available on aspects such as the land use type and size of the development. Random visual site inspections were conducted so that the required sample to utilise in the scientific study could be reached. This exercise continued for one week and the main idea was to identify office developments that are already in operation and that meet TMH 17 requirements. In the interim only five sites were selected for this as the study to establish the base data for an extended study.

Department of International Relations and Cooperation offices in Rietondale, all office developments along Ingersol road from where it intersects with Lois road, Erf 10 and 11 Highveld, Persequor park Extension 10 and adjacent offices all gaining access from Hotel street as well as office developments at Mante and Garsfontein form part of the study area. These sites are located in the Suburban area of Tshwane and are used for professional, administrative, consulting services and do not include call centres. In terms of demographics, these sites employ professionals, people with some kind of higher education that either fall in the medium to high income group. During visual inspections low to very low usage of Public Transport was identified.

- *Department of International Relations and Cooperation (DIRCO)*

Department of International Relations and Cooperation formerly known as Department of Foreign Affairs is a government Department situated in Rietondale which forms part of Region 3 in the Tshwane area. The development is accessed along Soutpansberg (M22). This road links different areas such as Queenswood, Koedoespoort and Kilnerpark with the Central Business District. One access point is utilised for both entry and exit and is controlled by boom gates. Full utilisation of parking was identified during a visual inspection.

- *Different office developments along Ingersol street*

Ingersol street intersects with Lois Avenue. The intersection of Lois and Ingersol is situated in Lynnwood Glen which forms part of Region 6 in the Tshwane area. The developments along Ingersol street comprises mainly of offices which include Pretorium trust and Road Accident Fund (RAF) amongst others. Each of these offices have their own access which are either boom controlled or remote controlled. Counts were however taken at the intersection point of Ingersol and Lois as it is the only entry and exit point linking with the larger road network. Full utilisation of parking was identified during a visual inspection.

- *Persequor Extension 10 and other office developments along Hotel street*

Meiring Naude is a high order road which provides access to different office developments. Amongst them is Persequor Extension 10 which is found along Hotel street and other adjacent office developments. These developments have separate accesses however counts were taken where Meiring Naude intersects with Hotel. Access is controlled by boom gates and full utilisation of parking was identified.

- *Erf 10 and 11 Highveld*

Erf 10 and 11 consists of different office developments used for professional, administrative and consulting services. Both erven each have separate access points which are both obtained from Einstein Combretum. Counts were however taken from the point where Einstein combretum intersects with Oak Avenue. The surrounding area predominantly consists of offices and a high car usage was identified during a visual inspection as well as full utilisation of parking.

- *Office developments at Garsfontein/Mante intersection*

The office development is situated in the eastern part of Tshwane forming part of region 6. The development has one access point controlled by a boom gate. A moderate utilisation of parking was identified during a visual inspection.

2.2 Survey information/Process

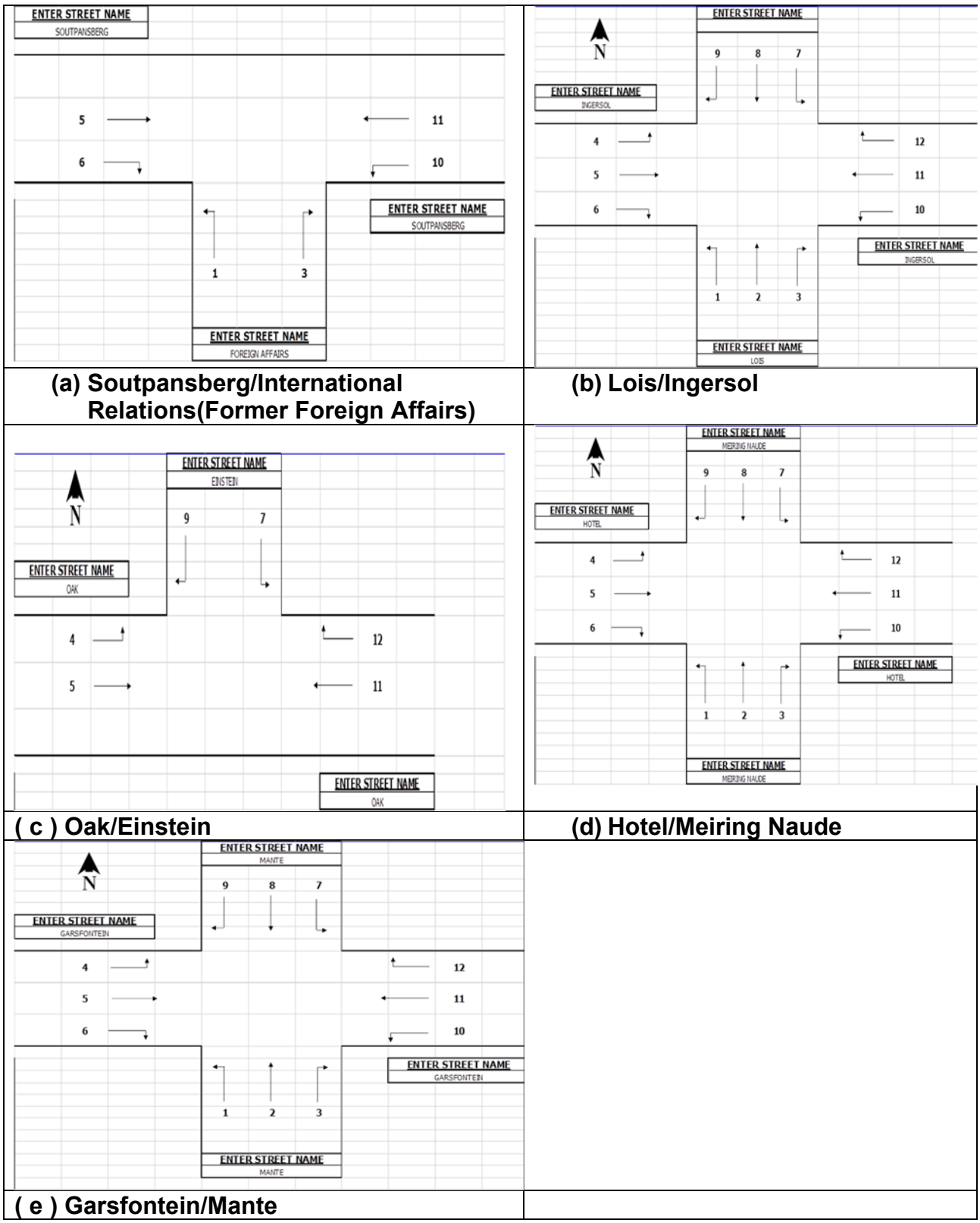

Figure 1 – Intersection Layouts

Figure 1 shows intersection layouts were counts were taken. TMH 17 recommends that counts be taken on the street immediately adjacent to the development and that trip generation preferably be based on the peak hour of the adjacent street and not of the development as the count on the adjacent street will also allow the determination of typical peak hour factors on street adjacent to developments of a particular land use however where a street count is not available it is assumed that the peak hour of the development corresponds with that of the adjacent street. These factors are important in the analysis of the traffic impact of a development.

2.3 Data collection

Traffic counts were readily available for Ingersol/Lois and Meiring Naude/Hotel intersections from the City of Tshwane's traffic counts data base. Counts for Ingersol/Lois and Meiring Naude/Hotel were taken on 11 February 2016 and 29 September 2016 sequentially. Additional vehicular traffic counts were taken at Soutpansberg/International Relations, Mante/Garsfontein and Oak/Einstein intersections on 08 November 2017, 15 November 2017 and 21 November 2017 respectively. They were taken within a period between 2 hours and 24 hours for weekday AM peak hour (06:00 to 08:30), weekday Midday peak hour (11:30 – 14:00) and weekday PM peak hour (16:00 to 18:30). Street counts were taken manually at 15 minute intervals and were differentiated between in-and-out bound directions to determine directional split. The Gross Leasable Area (GLA) utilised in the calculations of trip rates was attained from internal and external town planners, traffic engineers and approved building plan files from City of Tshwane Municipality Building control office. This data is therefore regarded as reliable. Below is raw data for different intersections:

Table 1: Raw data of Soutpansberg/International Relations intersection

	FULL INTERSECTION			ACCESS	ACCESS				
				15-Min Flows					
Time	15-min Pk	PHV	PHF	In	Out	In+Out	PHV	PHF	InSplit
AM peak raw data									
06:00 TO 06:15	251			9	3	12			
06:15 TO 06:30	531			15	5	20			
06:30 TO 06:45	720			34	6	40			
06:45 TO 07:00	697	2199	0.76	31	8	39	111	0.69	79.5%
07:00 TO 07:15	579	2527	0.88	44	9	53	152	0.72	83.0%
07:15 TO 07:30	591	2587	0.90	54	9	63	195	0.77	85.7%
07:30 TO 07:45	658	2525	0.91	83	16	99	254	0.64	83.8%
07:45 TO 08:00	664	2492	0.94	104	14	118	333	0.71	88.1%
08:00 TO 08:15	486	2399	0.90	74	10	84	364	0.77	88.1%
08:15 TO 08:30	540	2348	0.88	99	21	120	421	0.88	82.5%
PM peak raw data									
16:00 TO 16:15	449			28	76	104			
16:15 TO 16:30	419			21	72	93			
16:30 TO 16:45	470			17	65	82			
16:45 TO 17:00	414	1752	0.93	12	50	62	341	0.82	19.4%
17:00 TO 17:15	428	1731	0.92	16	58	74	311	0.84	21.6%
17:15 TO 17:30	499	1811	0.91	21	49	70	288	0.88	30.0%
17:30 TO 17:45	655	1996	0.76	12	68	80	286	0.89	15.0%
17:45 TO 18:00	587	2169	0.83	17	67	84	308	0.92	20.2%

Table 2: Raw data of Lois/Ingersol intersection

	FULL INTERSECTION			ACCESS	ACCESS				
				15-Min Flows					
Time	15-min Pk	PHV	PHF	In	Out	In+Out	PHV	PHF	InSplit
AM peak raw data									
06:00 TO 06:15	94			16	2	18			
06:15 TO 06:30	120			18	5	23			
06:30 TO 06:45	217			23	11	34			
06:45 TO 07:00	213	644	0.74	45	18	63	138	0.55	71.4%
07:00 TO 07:15	303	853	0.70	70	17	87	207	0.59	80.5%
07:15 TO 07:30	325	1058	0.81	63	19	82	266	0.76	76.8%
07:30 TO 07:45	338	1179	0.87	75	24	99	331	0.84	75.8%
07:45 TO 08:00	339	1305	0.96	73	29	102	370	0.91	71.6%
08:00 TO 08:15	302	1304	0.96	67	29	96	379	0.93	69.8%
08:15 TO 08:30	227	1206	0.89	65	21	86	383	0.94	75.6%
PM peak raw data									
16:00 TO 16:15	465			15	163	178			
16:15 TO 16:30	328			13	91	104			
16:30 TO 16:45	444			16	154	170			
16:45 TO 17:00	299	1536	0.83	10	122	132	584	0.82	7.6%
17:00 TO 17:15	390	1461	0.82	10	129	139	545	0.80	7.2%
17:15 TO 17:30	429	1562	0.88	6	157	163	604	0.89	3.7%
17:30 TO 17:45	410	1528	0.89	2	145	147	581	0.89	1.4%
17:45 TO 18:00	386	1615	0.94	1	136	137	586	0.90	0.7%

Table 3: Raw data of Hotel and Meiring Naude intersection

	FULL INTERSECTION			ACCESS	ACCESS				
				15-Min Flows					
Time	15-min Pk	PHV	PHF	In	Out	In+Out	PHV	PHF	InSplit
AM Peak Raw Data									
06:00 TO 06:15	605			31	13	44			
06:15 TO 06:30	653			37	18	55			
06:30 TO 06:45	915			53	37	90			
06:45 TO 07:00	1148	3321	0.72	83	39	122	311	0.64	68.0%
07:00 TO 07:15	1109	3825	0.83	91	42	133	400	0.75	68.4%
07:15 TO 07:30	1059	4231	0.92	70	29	99	444	0.83	70.7%
07:30 TO 07:45	875	4191	0.91	91	41	132	486	0.91	68.9%
07:45 TO 08:00	885	3928	0.89	121	35	156	520	0.83	77.6%
08:00 TO 08:15	971	3790	0.89	69	39	108	495	0.79	63.9%
08:15 TO 08:30	774	3505	0.90	81	35	116	512	0.82	69.8%
PM Raw data									
16:00 TO 16:15	968			26	89	115			
16:15 TO 16:30	852			21	79	100			
16:30 TO 16:45	1024			32	104	136			
16:45 TO 17:00	811	3655	0.89	27	104	131	482	0.89	20.6%
17:00 TO 17:15	798	3485	0.85	17	94	111	478	0.88	15.3%
17:15 TO 17:30	757	3390	0.83	15	80	95	473	0.87	15.8%
17:30 TO 17:45	700	3066	0.95	13	66	79	416	0.79	16.5%
17:45 TO 18:00	620	2875	0.90	8	60	68	353	0.80	11.8%

Table 4: Raw data of Oak and Einstein intersection

	FULL INTERSECTION			ACCESS	ACCESS				
				15-Min Flows					
Time	15-min Pk	PHV	PHF	In	Out	In+Out	PHV	PHF	InSplit
AM peak raw data									
06:00 TO 06:15	269			6	1	7			
06:15 TO 06:30	273			9	0	9			
06:30 TO 06:45	333			11	1	12			
06:45 TO 07:00	343	1218	0.89	13	2	15	43	0.72	86.7%
07:00 TO 07:15	392	1341	0.86	23	4	27	63	0.58	85.2%
07:15 TO 07:30	420	1488	0.89	16	5	21	75	0.69	76.2%
07:30 TO 07:45	459	1614	0.88	19	7	26	89	0.82	73.1%
07:45 TO 08:00	475	1746	0.92	17	5	22	96	0.89	77.3%
08:00 TO 08:15	509	1863	0.92	20	11	31	100	0.81	64.5%
08:15 TO 08:30	326	1769	0.87	10	6	16	95	0.77	62.5%
PM peak raw data									
16:00 TO 16:15	605			6	25	31			
16:15 TO 16:30	519			5	17	22			
16:30 TO 16:45	490			3	10	13			
16:45 TO 17:00	440	2054	0.85	4	8	12	78	0.63	33.3%
17:00 TO 17:15	486	1935	0.93	5	9	14	61	0.69	35.7%
17:15 TO 17:30	474	1890	0.96	8	12	20	59	0.74	40.0%
17:30 TO 17:45	389	1789	0.92	6	11	17	63	0.79	35.3%
17:45 TO 18:00	403	1752	0.90	4	9	13	64	0.80	30.8%

Table 5: Raw data of Garsfontein and Mante intersection

	FULL INTERSECTION			ACCESS	ACCESS				
				15-Min Flows					
Time	15-min Pk	PHV	PHF	In	Out	In+Out	PHV	PHF	InSplit
AM peak raw data									
06:00 TO 06:15	477			10	3	13			
06:15 TO 06:30	517			9	3	12			
06:30 TO 06:45	775			9	9	18			
06:45 TO 07:00	1202	2971	0.62	19	9	28	71	0.63	67.9%
07:00 TO 07:15	1202	3696	0.77	22	14	36	94	0.65	61.1%
07:15 TO 07:30	1096	4275	0.89	32	35	67	149	0.56	47.8%
07:30 TO 07:45	799	4299	0.89	22	13	35	166	0.62	62.9%
07:45 TO 08:00	1098	4195	0.87	45	12	57	195	0.73	78.9%
08:00 TO 08:15	1047	4040	0.92	41	18	59	218	0.81	69.5%
08:15 TO 08:30	1013	3957	0.90	32	24	56	207	0.88	57.1%
PM peak raw data									
16:00 TO 16:15	1123			62	130	192			
16:15 TO 16:30	879			62	105	167			
16:30 TO 16:45	920			65	97	162			
16:45 TO 17:00	797	3719	0.83	45	85	130	651	0.85	34.6%
17:00 TO 17:15	843	3439	0.93	47	96	143	602	0.90	32.9%
17:15 TO 17:30	757	3317	0.90	48	87	135	570	0.88	35.6%
17:30 TO 17:45	670	3067	0.91	40	72	112	520	0.91	35.7%
17:45 TO 18:00	595	2865	0.85	35	61	96	486	0.85	36.5%

3. RESULTS DISCUSSION AND COMPARISON WITH TRIP RATES CURRENTLY USED IN SOUTH AFRICA

Data was analysed using non-linear regression analysis technique to determine the required peak hour trip generation rates. The trip rates for all five sites are presented in Table 6, and the AM and PM rates are compared with the TMH 17 rates in Figure 2. The directional split, peak hour factor and peak hour volumes are also presented.

Table 6: Summary of trip rates for the five sites

Peak Hour	PHV(Full intersection)	PHF	PHV(Development)	PHF	Split	GLA	Trip rate
Soutpansberg/International Relations– Intersection 1							
AM	2587	0.9	195	0.77	85.7%	42026	0.46
PM	2169	0.83	308	0.92	20.2%	42026	0.73
Lois/Ingersol – Intersection 2							
AM	1305	0.96	370	0.91	71.6%	16510	2.24
PM	1615	0.94	586	0.90	0.7%	16510	3.55
Hotel/Meiring Naude – Intersection 3							
AM	4231	0.92	444	0.83	70.7%	31694	1.40
PM	3655	0.89	482	0.89	20.6%	31694	1.52
Oak/Einstein – Intersection 4							
AM	1863	0.92	100	0.81	64.5%	32807	0.3
PM	2054	0.85	78	0.63	33.3%	32807	0.24
Mante/Garsfontein – Intersection 5							
AM	4299	0.89	166	0.62	62.9%	30000	0.55
PM	3719	0.83	651	0.85	34.6%	30000	2.17

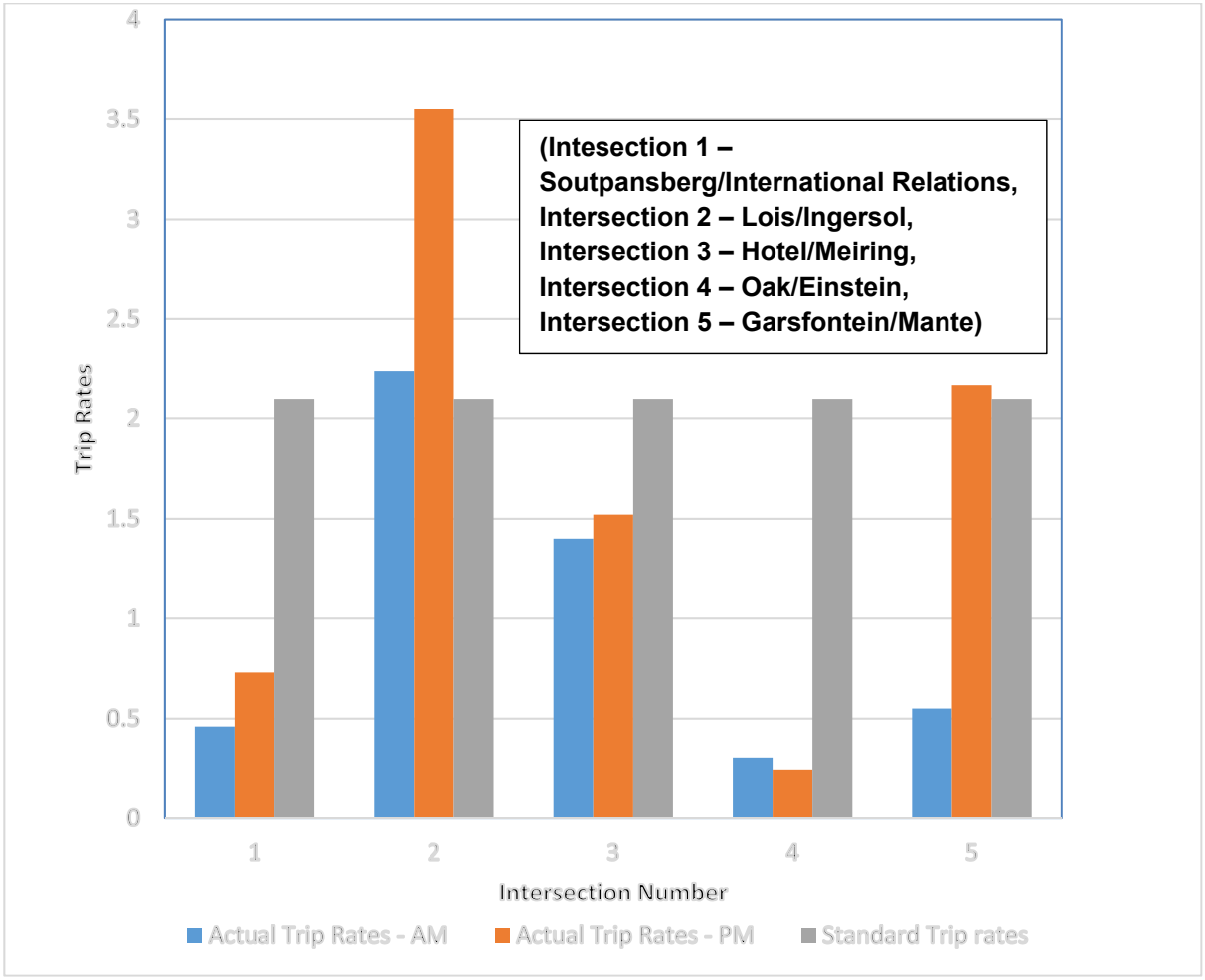

Figure 2: Actual AM and PM peak hour trip rates and standard trip rates

At all intersections with the exception of intersection 2 (Lois/Ingersol) and PM peak hour rate for intersection 5 (Garsfontein/Mante) both AM and PM peak hour rates are lower than the standard rates. These trip rates vary significantly with the trip rates currently used in South Africa. On the other hand, the PM rate at intersection 5 (Garsfontein/Mante) is almost equal/slightly higher than the standard rate. Lois/Ingersol's PM peak hour rate is significantly higher than TMH17 standard rate with the AM peak hour rate slightly higher than the same standard rate. It is important to note that due to the type of offices forming part of the study area, location of the site and minimal use of public transport (identified during visual inspections) by employees and patrons none of the trip adjustment/reduction factors were applied.

Using equation 1 to calculate trip generation using standard trip rates and calculated (developed) trip rates at Soutpansberg/International Relations intersection

$$Generated\ trips\ =\ \frac{Gross\ Leasable\ Area\ (GLA)*Trip\ rate}{100} \qquad (1)$$

$$Where\ GLA\ =\ size\ of\ the\ development\ in\ m^2$$

With GLA = 42026 m^2

Trip generation using standard (existing) rate i.e. (2.1 for both AM and PM peak) = **883 trips** for AM peak and **883 trips** for PM peak

Trip generation using calculated (developed) rate i.e. (0.46 AM peak and 0.73 PM peak = **193 trips** for AM peak and **308 trips** for PM peak

The calculation above indicates the difference between trip generation using the existing rate and the trip generation using the calculated (developed) rate. These numbers play a vital role in determining the impact that a development has on the road network. Road upgrades may be required to emanate the impact of the trips generated and this can have financial implications on either the developer or the Local/Provincial/National Authority.

4. CONCLUSION

Out of the five sites investigated, trip generation rates for Lois/Ingersol intersection and PM peak rate for Garsfontein/Mante are the only ones close to the values presented in TMH 17. Trip rates for four of the five sites are very low in comparison to current standard rates. Although errors in data for parameters factors such as land use, nature of trips, GLA and traffic counts might have an influence on the overall results of the study area, it must be noted that reliable techniques and sources were used to attain data and to carry out the analysis. Having said this it is acknowledged that to make valid conclusions on the study a recommended minimum data set for 10 sites must be used, therefore these results must be considered a base which will be extended at a later stage once resources become available.

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