FIG. 22 : JOHANNESBURG - MAJOR TRAFFIC ROUTES

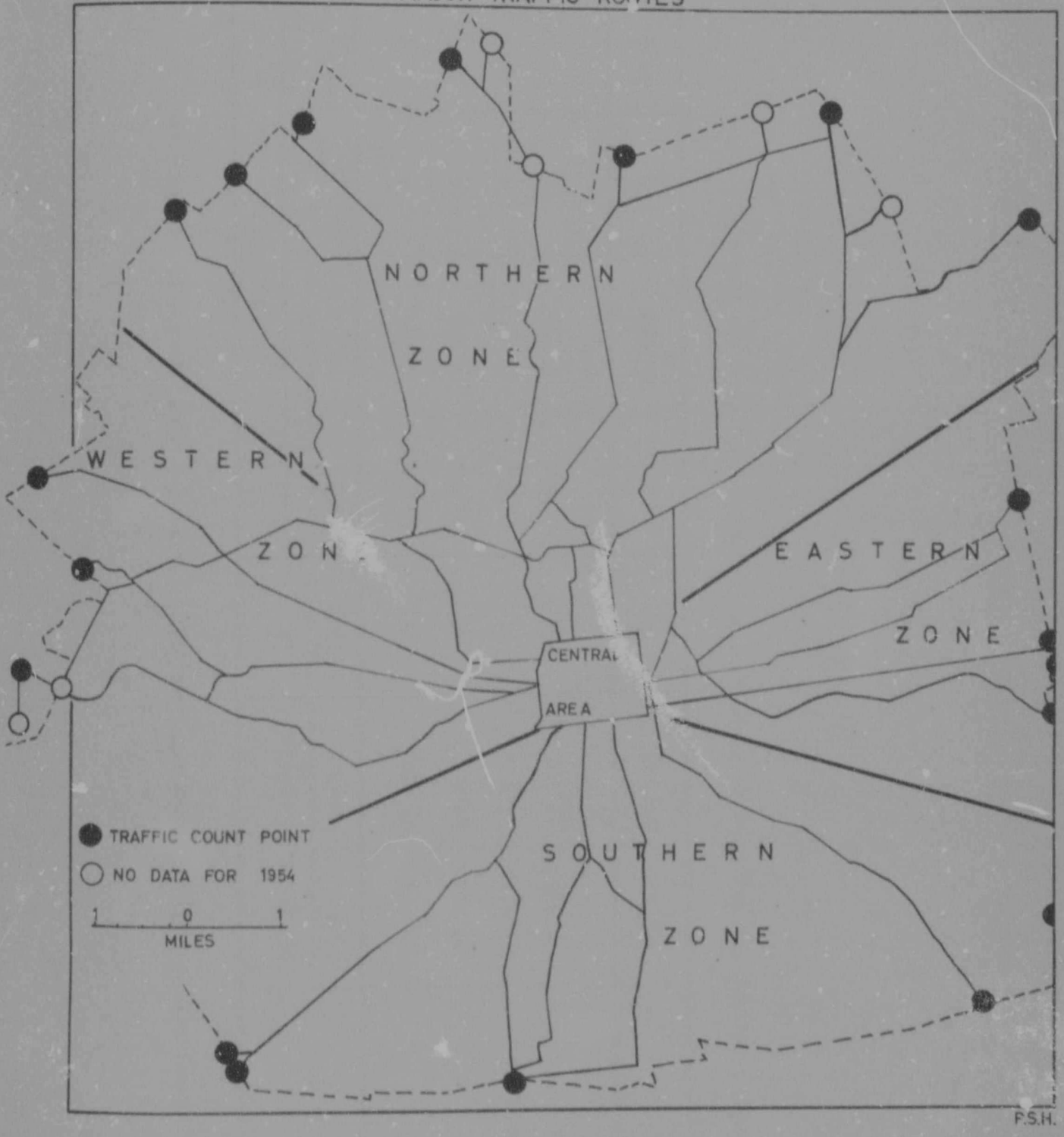


TABLE 20 : Motor Vehicles on Johannesburg's Municipal Perimeter 1954 and 1963. INCREASE.

ZONE	Total No. Vehicles		% Increase 1954-63	Peak Hour (7.45 a.m. - 8.45 a.m.)				
				Totals		% increase 1954-63.	% of Total No. Vehicles.	
	1954	1963		1954	1963		1954	1963
Northern	12,911+	25,084	94	1,996+	4,121	106	16.5	16.5
Eastern	9,799	14,249	45	1,468	2,353	60	15.0	16.5
Southern	7,738	14,601	89	1,057	2,476	134	14.0	17.0
Western	7,095+	10,201	44	1,784+	2,739	48	25.0	27.(
Totals	37,543	64,135	72	6,305	11,689	85	17.0	18.0

+ Estimates (See FIG. 22 for traffic count points for which 1954 data are not available).

the importance of the passenger vehicle especially in the Northern Zone, which has very little industry compared to the concentrations in and near the gold mining belt and in Germiston.

An important aspect of the movement of traffic, is the increase in volume during the peak hours (7.45 a.m. to 8.45 a.m. and 4.40 p.m. to 5.45 p.m.). Although the greatest number of vehicles enter from the north, the relative importance of the peak volume is about the same as in the east and south. The figures also indicate a rise in the volume during the morning peak hour since 1954.

A study of traffic volumes in the municipal area on the C.B.D. perimeter (TABLE 21) shows that in 1954 there was a gain of 34.5% over the municipal perimeter total. This gain increased to not less than 40% in 1963, thus indicating that the increase in traffic volume is not only due to an increase on the municipal perimeter, but to actual residential expansions in the municipal area itself, especially to the north. In fact the increase is mainly due to more vehicles having their origin in the municipal area, with the Northern Zone contributing the most vehicles, then the Southern and Eastern Zones, while the increase of vehicles within the municipal area in the Western Zone is less than the increase on the perimeter.

In 1954 the daily influx of vehicles amounted to more than 108,500 of which about 58,000 (53.5% had as their destination the C.B.D. 57.6% of the latter total were passenger cars, while 57.2% of the more than 50,500 vehicles passing through were lorries. These values changed during the following 7 years to the following: about 145,500 entered the C.B.D. with almost 65,500 (54.9%) vehicles having it as their destination, and 82.1% of the latter were cars. The percentage gain as regards the vehicles entering

.../the

TABLE 21 : Motor Vehicles on Johannesburg's C.B.D. Perimeter.

ZONE	1954				1961					
	Total Entering C.B.D.	C.B.D. Destination	Peak Hour 7.45 a.m. – 8.45 a.m. Total	Peak Hour 7.45 a.m. – 8.45 a.m. % Total Entering C.B.D.	Total Entering C.B.D.	Cars Entering C.B.D.	Trucks Entering C.B.D.	C.B.D. Destination	% Gain Entering C.B.D. 1954-61.	% Gain C.B.D. Destination 1954 - 61.
[illegible]	[illegible]	23,355	8,136	23.5	50,344	30,844	3,450	34,294	45.5	47.0
Eastern	26,400		3,434	13.0	35,094	13,453	4,256	17,709	33.0	± 34.0
Southern	27,000	12,258	2,972	10.0	36.853	12,293	4,008	16,301	36.5	33.0
Western	20,500		2,769	13.5	23,217	8,985	2,580	11,565	13.5	± 13.0
TOTALS	108,573	58,065	17,291	15.0	145,508	65,575	14,294	79,869	34.0	38.0

the C.B.D. was 34.0% for the period 1954 to 1961, while the gain was 38% for the vehicles with the C.B.D. as destination for the same period. The ever increasing role the C.B.D. of Johannesburg is playing is evident from the figures as given above.

The peak hour data on the C.B.D. perimeter are unavailable for 1961, but noting the peak hour values on the municipal perimeter and the general increase in traffic volume we can assume a gain in this respect as well.

So far the discussions have only been concerned with the vehicle, but the vehicle is only the means used by man to get to places. It is thus necessary to get some idea of the actual movement of people. Taking the average number of passengers per vehicle, including lorries, as 1.5 (Green - 1957a) then about 87,100 people had the C.B.D. as their destination in 1954, this figure increased to 119,800 people in 1961. If the number of people passing through the C.B.D. is included then the totals were 162,860 and 218,260 people for the above two years. The number of people having the C.B.D. as their destination is representative of the enormous importance that the centre of the city has as a place of employment and as a market and business centre.

The very intense movement of people and vehicles in the city and its surroundings explains the attempts of authorities to lighten the present critical congestion of the main traffic arteries, especially during the peak hour rushes of the morning and late afternoon. Johannesburg has embarked on a major traffic plan of R54 million (Johannesburg 1960). Of the tendency to use the car in preference to other means of transport, L. Mumford said, "Whereas our cities need to develop every form of transportation, urban planners have been blindly sacrificing the internal activities of our cities to the private car, the most inefficient and the most

... / costly

costly of all forms of mass transportation, whether judged by a technical or financial standard. Yet, by now it should be plain that no city will have the parking space or the possibility of circulation if we continue along the present lines. Either the motor car will drive us all out of the cities, or our cities will have to drive out the motor car, in order to preserve the many other advantages of urban life."

FIG. 23 depicts the movement of traffic in the P.W.V. area. The densest movement taking place within the inner metropolitan zone of Johannesburg. According to the data for Aug. 1961, a total of 36,790 vehicles moved into Johannesburg and left it daily from 7.00 a.m. to 7.00 p.m. Of this total 76.6% were direct intertown traffic, and the remaining 23.4% traffic passing through other towns on their way to Johannesburg. Of the total number of vehicles 72.8% had their origin in the inner metropolitan zone and 12.7% came from the outer metropolitan zone leaving a remainder of 14.5% of the vehicles to come from towns outside the metropolitan region but within the Southern Transvaal.

Green (1957a) found that in 1954 of the 58,065 vehicles with the Johannesburg C.B.D. as destination, 91.5% came from the inner and 5.5% came from the outer metropolitan zone and a further 3% from beyond the metropolitan boundary.

Based on the N.R.D.C. survey of the intertown traffic in the P.W.V. in 1961, TABLE 22 shows the traffic relationships between Johannesburg and the towns of the inner and outer metropolitan zones. There was a high percentage of intertown traffic between Johannesburg and the towns of the inner metropolitan zone, especially within a radius of 10 miles from the city's C.B.D. Beyond this there was a rapid decrease in percentages, notably in the cases of Benoni and Boksburg.

.../TABLE

FIG. 23: SOUTHERN TRANSVAAL - TRAFFIC FOCUSING ON JOHANNESBURG, 1961 (PERCENTAGE)

PERCENTAGE OF TOTAL VEHICLES			
ZONE	METROPOLITAN REGION		OTHER
	INNER	OUTER	
N	-	-	9.2
E	46.3	5.2	-
S	9.4	-	5.3
W	17.1	7.5	-
TOT	72.8	12.7	14.5

DIRECT TRAFFIC : 76.6 %
TRAFFIC THROUGH OTHER TOWNS: 23.4 %

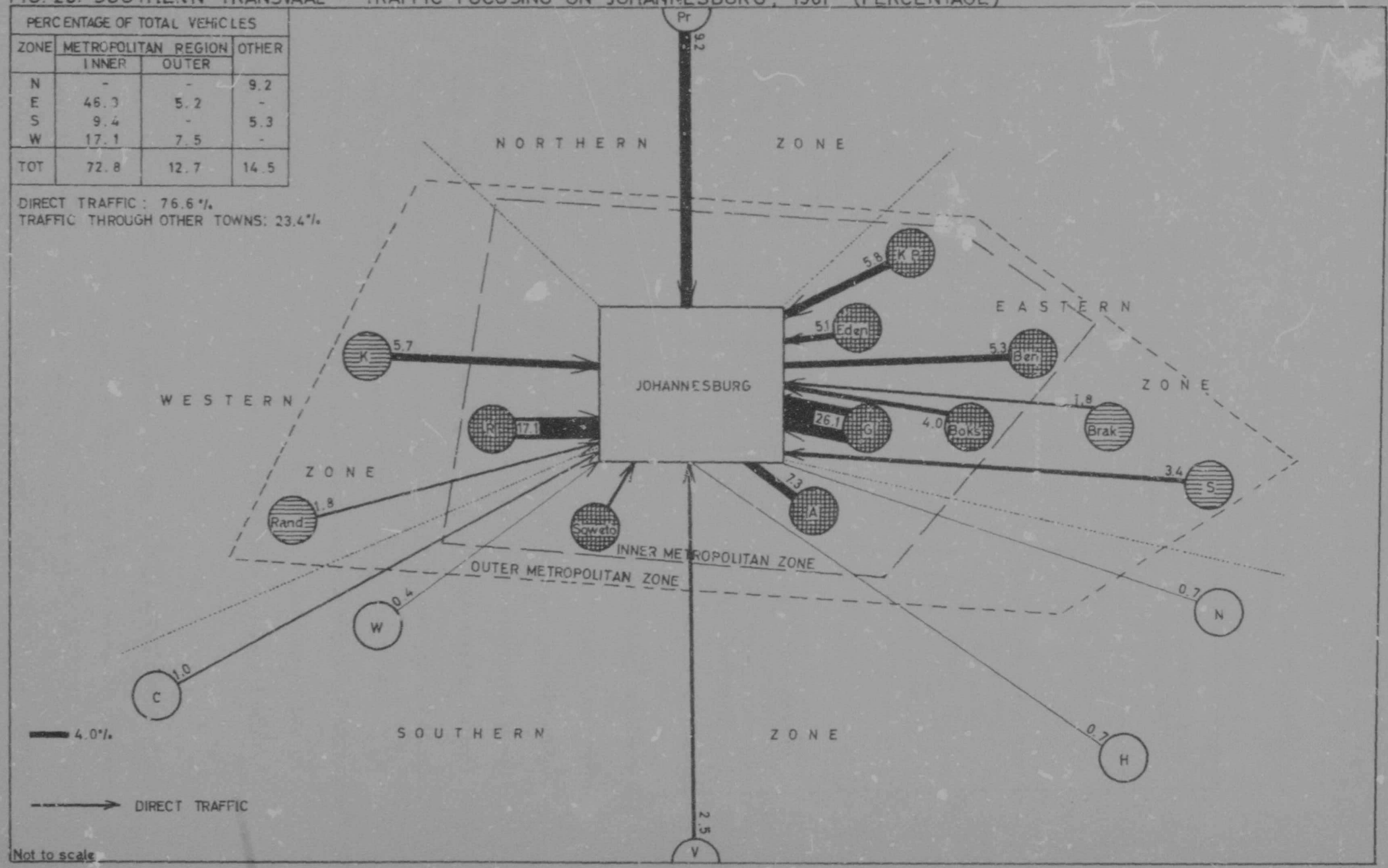


TABLE 22: Intertown Traffic in the Witwatersrand Metropolitan Region - Importance of Johannesburg.

TOWN	Total No. of Inter-town Traffic (vehicles)	Intertown Traffic with Johannesburg		% of Traffic with most Important Rival.
		Vehicles	%	
Inner Metro-politan Zone:				
Roodepoort	8,700	6,300	72.3%	21.8 (Krugersdorp)
Edenvale	2,920	1,870	64.0	20.5 (Germiston)
Alberton	4,720	2,700	57.2	36.4 (Germiston)
Germiston	18,260	9,500	52.0	17.5 (Boksburg)
Kempton Park	5,690	2,130	37.4	22.2 (Germiston)
Benoni	9,720	1,930	19.9	33.5 (Boksburg)
Boksburg	10,120	1,470	14.5	32.2 (Benoni)
Outer Metro-politan Zone:				
Krugersdorp	5,760	2,100	38.2	32.9 (Roodepoort)
Springs	5,970	1,250	21.0	40.2 (Brakpan)
Randfontein	3,370	670	20.0	40.4 (Krugersdorp)
Brakpan	5,760	680	12.0	44.1 (Springs)

In both these cases the movement of traffic to and from Johannesburg was surpassed by the movement between these two Eastern Rand towns. In the outer metropolitan zone it is striking that the percentage of vehicles moving between Krugersdorp and Johannesburg is remarkably high. It is the only town in the outer metropolitan zone where the movement of traffic between it and Johannesburg exceeds the movement between it and another town. From the above, it is obvious that in terms of traffic, Johannesburg's sphere of influence lies mainly to the west. This is due to the dormitory nature of these towns which offer fewer work places than the East Rand.

2. Buses.

Referring to Western Europe, F.H.W. Green (1953) finds that more people use buses than any other single means of conveyance for local transport. Although this is still the case at present, Johannesburg is following the world tendency to use private

... / cars

cars instead of municipal transport or mass transport, despite the fact that the costs involved for the traveller is 2c per mile per bus compared to 9.6c per mile per private car (Johannesburg 1961). The total number of people with the C.B.D. as destination using motor vehicles (cars and trucks) increased from 87,100 in 1954 to 119,800 in 1961, whereas the number of bus passengers coming into the C.B.D. (not necessarily the destination) daily remained about 120,000[1]. These figures are clearly indicative of the preference of the traveller for the private car[2].

TABLE 23: Bus Passenger Survey - July, 1962 (Leggo 1962 p8).

	26th July.	28th July.	26th & 28th July - Average %
Morning Peak (6.45 a.m.- 8.15 a.m.)			
Outgoing	20,058	19,907	16.5
Incoming	44,457	44,639	37.0
Evening Peak (4.15 p.m.- 6.15 p.m.)			
Outgoing	46,244	45,173	36.0
Incoming	11,208	12,180	10.0
Valley Periods (8.15 a.m.- 4.15 p.m.) (6.15 p.m.-11.00 p.m.)			
Outgoing	55,398	62,239	47.5
Incoming	66,615	67,430	53.0

Note: Figures reflect the total numbers of passengers handled on routes in and out of city.

TABLE 23 indicates the in and out flow of passengers using the buses of the City Transport Department, with special reference to the morning and evening peak periods. As may be

... / expected

1. L. Green (1957a) states that 121,631 road transport passengers entered the C.B.D. daily in 1954. Leggo (1962 ,8),basing his findings on TABLE 23 makes the total about 120,000 in 1962 - city transport only.

2. See L. Mumford's statement (p115).

expected the incoming passengers during the morning peak period (1½ hours) isabout the same as the number of outgoing passengers during the evening peak (2 hours). The greater majority of these people are going to work in the C.B.D. and then returning home. However, there is a reasonable difference during the morning outgoing and evening incoming passengers. The valley periods (12¾ hours) is responsible for about half of the incoming and outgoing passengers. The above again illustrates the attraction of the C.B.D. as a place of employment, and the resulting congestion which takes place on the roads used by vehicles and the pavements of the C.B.D. by pedestrians.

TABLE 24 and FIG. 24 show the number of municipal buses[1] entering the C.B.D. daily. The data for the table and map were extracted from the municipal bus timetable (1964). The importance of the Northern Zone as a supplier of daily workers is quite evident from the large number of buses (over 40% of all buses) entering the C.B.D. During the peak period (6.45 a.m. - 8.15 a.m.) about one quarter to one fifth of the total number of bus journeys into town are made. It is also noteworthy that close on 90% of all bus routes begin in the zone which lies from two to six miles from the city centre. However, only about 6% commence the journey outside the municipal area and mostly within the northern peri-urban area.

Although the City Transport Department does cater for Non-Whites as well, the total number of bus journeys amount from 10% to 15% of the services catering for Whites. The transportation of the Non-Whites by bus is undertaken mainly by the Public Utility Transport Corporation (PUTCO). Data on the services provided by PUTCO are not satisfactory since "the majority of our

.... /(PUTCO)

1. The City Council has 450 buses, of which the double-deck buses are used mainly on the heavily patronised routes, usually the shorter ones, and the 68 single-deck buses on the longer routes (Johannesburg 1961).

TABLE 24: Road Transport (City Transport Department) into C.B.D. - Whites only.

Distance in miles from C.B.D.	Northern Zone			Eastern Zone			Southern Zone			Western Zone			Total		
	T	P	F	T	P	F	T	P	F	T	P	F	T	P	F
0 - 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 - 2	116	34	-	22	3	-	-	-	-	-	-	-	138	37	-
2 - 3	297	56	-	49	22	-	24	6	-	173	37	-	543	121	-
3 - 4	15	3	-	225	42	-	398	71	-	135	27	-	773	144	-
4 - 5	307	73	16	153	25	41	71	20	-	10	5	-	531	123	57
5 - 6	136	24	15	-	-	-	-	-	-	108	24	-	244	48	15
6 - 7	14	3	19	-	-	-	-	-	-	-	-	-	14	3	19
7 - 8	18	6	1	-	-	-	-	-	-	-	-	-	18	6	1
8 - 9	56	17	14	-	-	-	-	-	-	-	-	-	59	17	14
9 - 10	-	-	7	-	-	-	-	-	-	-	-	-	-	-	7
Total	962	216	72	449	92	41	493	98	-	416	93	-	2320	499	113

T= Total;
P= Peak (6.45 a.m. - 8.15 a.m.);
F= Feeders (i.e. buses not bound for city but providing links to other services).

(PUTCO) services are operated on an 'as and when required' basis. The reason for this is that most of the areas which we serve are still developing, so that passenger requirements change from time to time" (Correspondence 28/8/1964).

Besides those services operating within Greater Johannesburg, several bus services originate beyond the borders of Greater Johannesburg (FIG. 25). Here again the data is not complete but an indication is given of the extent of bus services centring on Johannesburg.

3. Conclusion.

It has been indicated that Johannesburg acts as a magnet as far as road transport is concerned. A large number of motor vehicles, representative of both individual and mass transport, flow into the Johannesburg Central Business District daily. Five Road Traffic Zones result (FIG. 26).

Zone I incorporates the Johannesburg municipal area and the larger portion of Greater Johannesburg including the South-Western Bantu Townships. The majority of private and public road transport originate in this zone.

Zone II coincides with Green's (1957a) inner metropolitan zone, and extends westwards from Johannesburg to Roodepoort and eastwards to Benoni.

Zone III may be regarded as Green's outer metropolitan zone.

Zone IV extends northwards of Johannesburg along the main transport routes and includes Pretoria. The southern portion adjoins Zone III and incorporates the Vereeniging-Vanderbijlpark complex, as well as Heidelberg and Nigel.

Zone V surrounds the other zones, and though no definite

.../ boundary

FIG. 25 : JOHANNESBURG - DAILY INCOMING BUS TRAFFIC, 1963 / 64

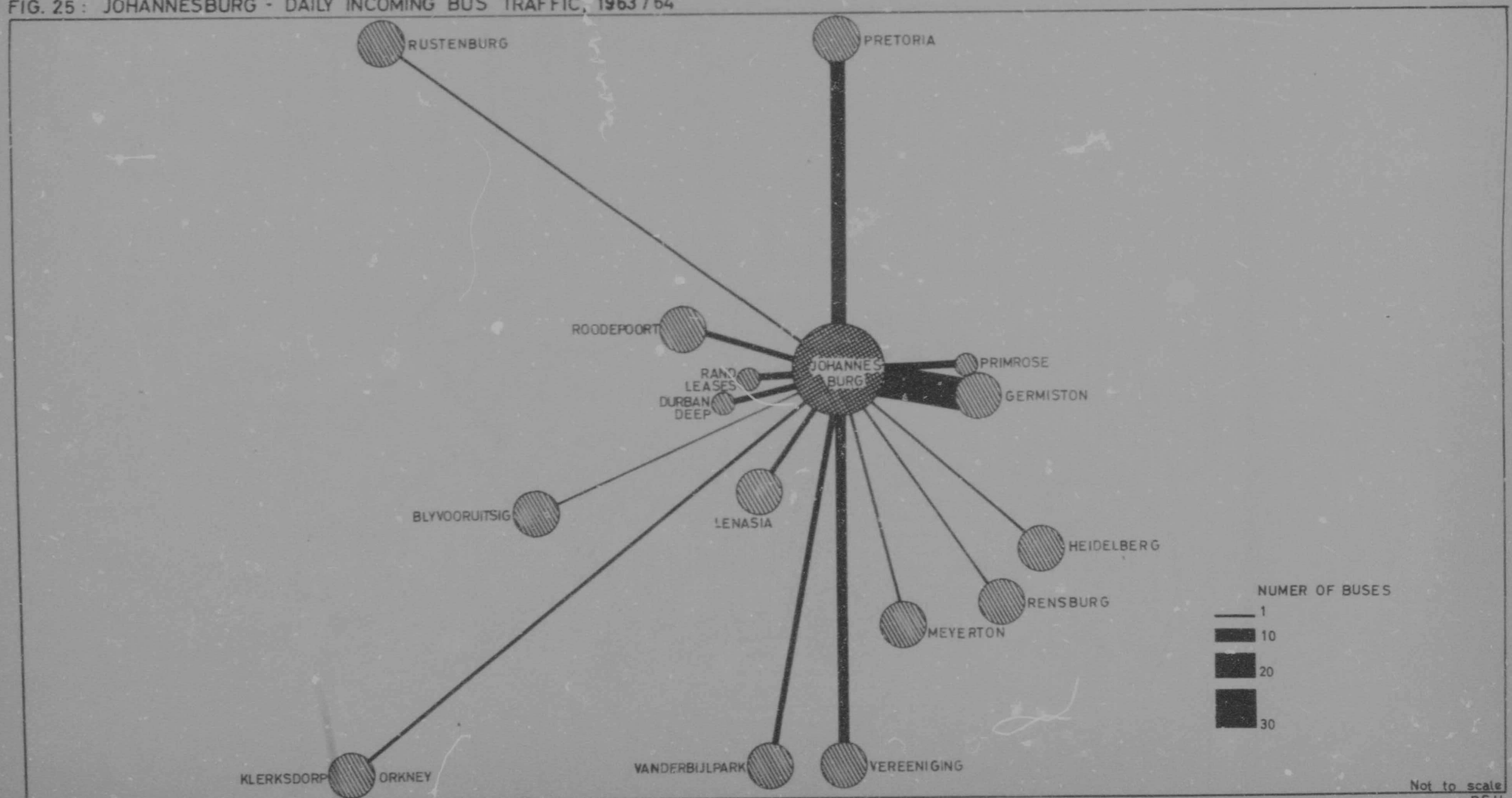
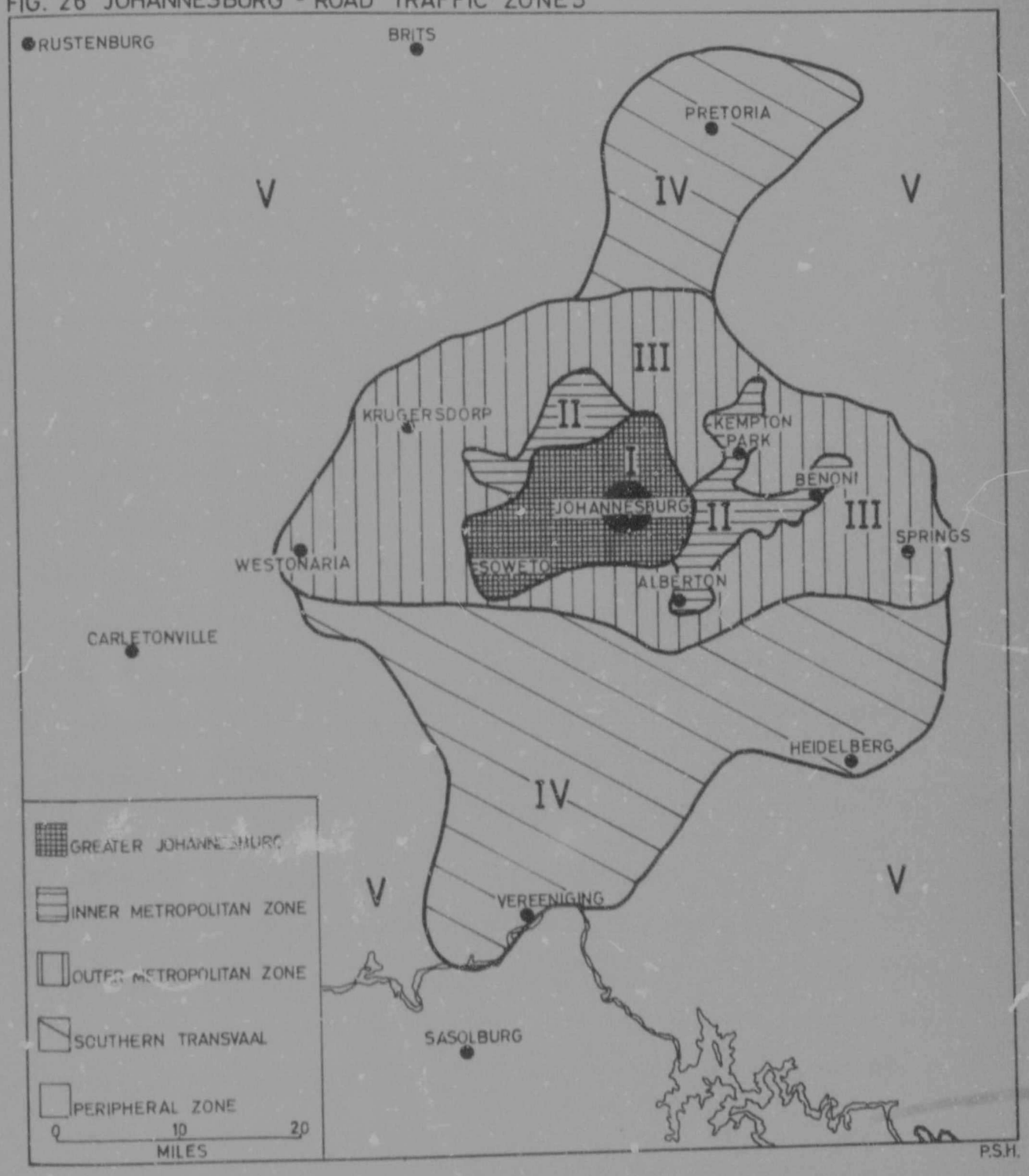


FIG. 26 JOHANNESBURG - ROAD TRAFFIC ZONES



boundary is delimited the zone does not continue indefinitely but does, however, extend to include Rustenburg, Klerksdorp and Parys.

C. RAILWAYS.

1. Introduction.

With the discovery of diamonds in the 1860's at K[illegible]rley, the need for rail linkage between the coast and the inte[illegible] of the country became a necessity. This line from Cape Town, with its link from Port Elizabeth, was completed in 1885. However, with the discovery of gold the following year on the Witwatersrand, Kimberley was replaced as the terminal of the railways from the coasts. Linkage with the Witwatersrand and Pretoria (founded 1855) was accomplished from Cape Town, Lorenco Marques and Durban in 1892, 1894 and 1895 respectively. The junction of these lines took place where the easiest crossing of the watershed was possible, that is, Germiston, thereby giving the centre a permanent nodal significance. For the purpose of supplying coal, discovered on the East Rand in 1887, to the goldfields, a line linking Springs to Krugersdorp was completed in 1891. The present axial pattern of the Southern Transvaal was, thus, already established by 1896.

Of this settlement complex arising in the last fourteen years of the 19th Century, Johannesburg was the major focus as it still is today, and although not the chief junction it is the terminal for long-distance trains and for most long-distance and local passengers.

To measure Johannesburg's sphere as a railway centre three chief information sources, all examined in this study, are available: (a) timetables;

(b) ticket sales, and

(c) passenger counts.

..../ The

The first source provides data pertaining to the number, origin and destination of trains moving to or from and through the hub, and is also useful for the determination of isochrones. The second source, although very useful, loses some of its significance because tickets allow the holder to travel within a specific delimited area i.e. a passenger may travel from a specific station to several other stations on the same ticket. As for passenger counts, detailed data are available only for passengers from the various Non-White Townships and from the Johannesburg area back again. A problem, however, is that the destination of passengers is not stated. This disadvantage may be partly overcome by computation.

2. White and Mixed Trains.

FIG. 27 portrays the daily movement of White and Mixed (White and Non-White) trains travelling in the direction of Johannesburg over a period of 24 hours. These trains do not necessarily reach Johannesburg, e.g., trains from Alberton and Wattles which terminate at Germiston. The striking feature is the great number of trains moving along the east-west axis, with 105 trains from both directions passing into the core (Braamfontein, Johannesburg, Jeppe). The line from Pretoria is far more important than the lines from the south and south-west, namely, the two lines from Vereeniging and the two lines from Bank. These four lines, before entering the metropolitan region contribute only 14 trains compared to the 28 trains from Pretoria.

INSET A of FIG. 27, as seen from the percentage increase, shows that an inner zone of White and mixed train movements exist. The inner zone corresponds closely to the inner metropolitan zone of Green, especially in the south. The boundary of the outer zone, however, includes Pretoria and co-incides with the inner zone's boundary in the south.

.../ 3. Non-White

3. Non-White Trains.

As FIG. 27 indicates, the Non-White trains centre on three distinctly separate foci, (Johannesburg, Germiston, Dunswart) with only a very weak link between them. The dominance of the Johannesburg core (Braamfontein, Johannesburg, Jeppe, Faraday and Westgate) is very clear. From the South-Western Non-White Townships 81 trains have the Braamfontein - Johannesburg - Jeppe core as their destination, while 69 trains terminate at Faraday and Westgate, a total of 150 trains per day.

Into the Germiston core (Germiston, Kutalo, Simpan) a total of 61 trains enter daily, with the trains from Tembisa numbering 19 and Kathlehong 41. Of the total entering, only two trains do not terminate in this core but pass through to Johannesburg.

The third core is just as distinctly defined as the former two with 37 trains from Daveyton, terminating at Dunswart. Only one train does not terminate at Dunswart.

4. Passengers (Not from Bantu-Townships).

FIG. 28 illustrates the boarding of passengers[1] who have Johannesburg as their destination and shows the time taken to Johannesburg. The isochrones are based on the shortest travelling time between stations taking that the train stops at all stations on route. It is, therefore, possible that a train which does not stop at all stations on route may take a shorter time than is indicated by the isochrones. This difference only amounts to a few minutes even at the furthest stations from Johannesburg within the Witwatersrand local train network.

.... / TABLE

1. Passenger totals based on the number of tickets sold at the different stations in the Southern Transvaal (Basic data supplied by N.R.D.C.).

TABLE 25: Origin of Passengers[+] Travelling to Johannesburg[++] 1964.

ISOCHRONES IN MINUTES	ORIGIN WEST %	ORIGIN EAST %	TOTAL %		DAILY %	
0 - 9	3	4	7	INNER ZONE	17	
10 - 19	1	1	2		4	
20 - 29	13	7	20		22	
30 - 39	5	7	12	MIDDLE ZONE	13	
40 - 49	6	11	17		20	
50 - 59	-	5	5		6	
60 - 69	4	1	5	OUTER ZONE	4	
70 - 79	-	4	4		7	
80 +	-	3	3		8	
	32	43	75 (16,180)		100	
			+25 (5,510)		Incl. JHB.	
			100 (21,690)			

[+] Totals computed from daily, weekly and monthly tickets sold at the different stations in April, 1964. (N.R.D.C.)

[++] Excludes Non-Whites (i.e. Bantu Townships).

TABLE 25 illuminates the pattern of passenger movement to Johannesburg as related to the time taken for the journey. Three zones are definable. The first lies between the 0 and 19 minute isochrones. 9% Of the passengers travelling to Johannesburg come from this zone, but the larger portion thereof comes from between the 0 to 9 minute isochrones. The reason for this difference is that six stations lie within the 9 minute isochrone and suburban-residents use the train service as supplementary to bus transport. The very low percentage between the 10 and 19 minute isochrones results from the relatively small stations situated here, and also because the railway line lies close to the periphery of the northern residential areas and the mining belt to the south. In this inner zone the contributions of the west and east to the passenger total are about the same.

The important middle zone, bounded by the 20 and 49 minute isochrones, yields about 50% of the total passengers

... / travelling

travelling daily to Johannesburg. Although the east and west each contribute a half, the west (Maraisburg to Roodepoort) is the main contributor in the zone between the 20 and 29 minute isochrone with 13%, while the east (especially Benoni) is the chief contributor between the 40 and 49 minute isochrones.

The outer zone contributes 18% of the daily travellers with 14% of the passengers coming from the east.

The percentages as stated above, together total 75%. The other 25% is made up of passengers buying their tickets at the Johannesburg station. The origins of these passengers are not available. If these origins, however, were known then all the percentages as given above will probably be raised somewhat.

When looking at the number of passengers travelling to Johannesburg with daily tickets (TABLE 25), then the pattern of the three zones is not really altered, except that there is a marked increase between the 0 and 19 minute isochrones. This points to the zone being an important origin of the traveller who does not make regular daily journeys to Johannesburg.

Although 30 minutes is the most suitable time for the journey to work by car, 50 minutes is more representative of the time the train passenger is prepared to travel, except on the West Rand where the limit is about 35 minutes. The isochrones strengthen the boundaries of Green's inner metropolitan zone and verify the linear extentions along the main rail arteries (FIG.21). About 70% of the passengers travelling daily to the metropolitan hub come from the inner metropolitan region. The 60 minute isochrone on the railroads from the north and south seems to indicate some coincidence with the outer metropolitan region boundary, while the outer boundary on the east-west axis lies somewhere between the 70 and 80 minute isochrones. This absence of a distinct limit stresses the transitional nature of the outer metropolitan boundary.

.../5. Passengers

5. Passengers from the Bantu Townships.

The Bantu are the chief users of rail transport. TABLE 26A shows the very large number of passengers coming from the South Western Bantu Townships (SOWETO), and the remarkable increase, more than 20%, over a three year period. Although the destinations of the passengers are not given, a clear idea is obtained from the data of the passengers returning to the Bantu Townships (TABLE 26B). The latter figures indicate that about 60% of the passengers travel to the Johannesburg core (Braamfontein to Jeppe, Faraday, Westgate), with about 50% destined for stations between Braamfontein and Jeppe. The Johannesburg station is the destination of about 23% of the Bantu passengers coming daily to the industrial and commercial core. No other data are more meaningful in pointing out the tremendous pull exerted by the Johannesburg C.B.D. and its adjacent business and industrial districts on the inhabitants of SOWETO. By far the greatest portion of the Bantu, more than 75%, come from between the 20 and 40 minute isochrones (FIG. 28 and INSET A), a zone which lies within Green's inner metropolitan zone.

The insets to FIG. 28 show the isochrones centred on various nodes as they affect the various Bantu Townships and point to the isolated nature, mentioned previously, of the different cores on which the Bantu train services centre. These townships, although very closely linked with the various secondary nuclei of the Witwatersrand metropolitan region, have very little daily contact with the actual hub, and therefore, lie outside the inner zone.

... / TABLE 26A

TABLE 26 A : Passengers from South-Western Non-White Townships (S.A.R.)

ORIGIN	Sept.'60	March '62	Oct. '62	Oct.'63
Naledi Line	82,640	95,959	97,306	102,046
Pirville-Lenz Line	37,191	40,253	42,510	51,791
TOTAL	119,831	136,212	139,816	153,837
Westbury-Newclare	-	-	-	3,297
GRAND TOTAL	119,831	136,212	139,816	157,134

TABLE 26 B : Passengers to South-Western Non-White Townships (S.A.R.).

ORIGIN	Sept.'60	March '62	Nov. '62	Nov. '63
Westgate	-	20,756	19,075	20,950
Faraday to Crown	-	18,208	19,726	24,147
Cleveland - Croesus	-	133,981	136,053	155,541

The greater importance which is attached to Johannesburg as the major focus is seen when a comparison is drawn between the Bantu passengers coming into it and the total Bantu passengers coming from all the other townships to the various nuclei, namely 156,500 compared to 40,000 (1963).

6. Peak Hours for Bantu Services.

As is the case with the various forms of road transport, a peak period is also experienced, and this explains the need which was felt to have separate lines from the various townships to the nuclei. 57% Of the Bantu travelled on trains leaving SOWETO between 5.30 a.m. and 7.15 a.m., while 55% left for the Bantu Townships between 4.15 p.m. and 6.00 p.m. It was found that during the same times 64% of the daily Bantu passengers left the other townships to the secondary nuclei, while 54% returned.

... / 7. Total

7. Total Suburban Passenger Traffic.

The importance of Johannesburg as a railway focus is indisputable and its importance is further appreciated when of all the suburban areas passenger traffic in South Africa, 54% of the more than 360.4 million (Bureau of Statistics, 1964), journeys were made in the P.W.V. (of which Johannesburg is the focus). In 1945 this figure was only 40%, thus showing the increased importance of Johannesburg as a rail centre in relation to the other centres. Of the total number of local journeys made in S.A. in 1964, it seems, therefore, that not less than 20% was made by Bantu from the South Western Townships.

8. Conclusion.

Three zones of rail traffic are identifiable. Zone I corresponds to Green's inner metropolitan zone. Zone II is similar to Green's outer metropolitan zone, with the exclusion of the Bantu Townships north and south of Germiston and Daveyton, since these townships are not centred on Johannesburg. Zone III, includes Pretoria, Vereeniging and Carletonville.

D. CONCLUSIONS ON ROAD AND RAIL TRAFFIC.

It has been indicated that Johannesburg as major focus for the Witwatersrand and Southern Transvaal, to a very great extent determines the pattern of road and rail traffic in this area. Green (1957a) has shown that about 325,000 people (1954) flowed into the Johannesburg C.B.D. by public and private transport and by rail. Of this total 235,000 had destinations in the C.B.D. of which more than 90% came from the inner metropolitan zone. It would appear that by 1964 the total number of people passing into the C.B.D. was well on the way to 400,000 of which about 70% had destinations in the C.B.D. for commercial, industrial, administrative, shopping and recreational purposes. It is thought that

.../ about

about the same percentage as in 1954 came from the inner metropolitan zone.

In the light of the above, the road and rail transport still makes for an inner and outer metropolitan zone as defined by Green though with the expansion of residential areas in various parts of the Witwatersrand, the inner zone may have increased in size. It is also thought that the links, as reflected by road and rail traffic, which Pretoria, the new gold fields to the west and the Vereeniging-Vanderbijlpark-Sasolburg complex have with Johannesburg, allow for the delimitation of a peripheral zone. This is an indication of the Southern Transvaal developing into a definite urban concentration or "megalopolis", with three foci of which Johannesburg is the major one.

E. AIR TRANSPORT.

1. Introduction.

Johannesburg is served by two airports, namely the Jan Smuts Airport at Kempton Park and the Rand Airport at Germiston. The latter is owned by the Johannesburg City Council and is the busiest airport in South Africa -- more than twice as busy as Jan Smuts - with 44,000 aircraft movements in 1964, an average of more than 120 a day. It is now firmly established as the headquarters for commercial and general aviation in the country. During 1964 more than 800 over-border flights mainly from the Protectorates and Mocambique were executed; 26,000 passengers on scheduled and non-scheduled charter services used the airport. Regular flights are operated between the Rand Airport, Welkom and Phalaborwa.

Although not the busiest airport, Jan Smuts is still the chief international airport in South Africa and most of the Country's international and internal air passengers pass through it. TABLE 27 shows the increase in passengers and freight traffic in

.../international

international air traffic, incoming and outgoing, for South Africa over a period of 12 years. This is an increase of more than 600% and 300% in passenger and freight traffic respectively. Apart from Jan Smuts the only other airport from which the S.A.A. operates international flights is the Louis Botha Airport (Durban), but clearance by customs is still done at the former. The extent to which the latter is overshadowed needs no further comment.

The S.A.A. operates three services from Jan Smuts: International, Regional and Domestic Services.

2. International Services (FIG. 29).

(a) Springbok Service. Six weekly services between Johannesburg and Europe existed as at 31st March, 1964. Prior to the 22nd August, 1963, the route passed over countries in the eastern part of Africa, but consequent to the overflying ban imposed on S.A.A. by certain African States the route was altered to the longer West Coast route. This change led to a decrease of 11% in the 196 /63 total to 48,870 passengers since totals prior to the change over included a large number of passengers travelling only on sectors north and south of Nairobi and not mainly end-to-end travellers as now.

(b) Wallaby Service. This service consists of a fortnightly flight to Perth, Australia and is carried on in partnership with Quantas Empire Airways.

3. Regional Services (FIG. 29).

(a) Southern Rhodesia.[1] This service is carried on in partnership with Central African Airways. 8 Return flights weekly, 3 between Johannesburg and Bulawayo and 5 between Johannesburg and Salisbury existed as on 31st March, 1964. Passenger journeys increased by 11.5% over the previous year's total of 31,479.

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1. Now Rhodesia.

.../(b) Lourenco

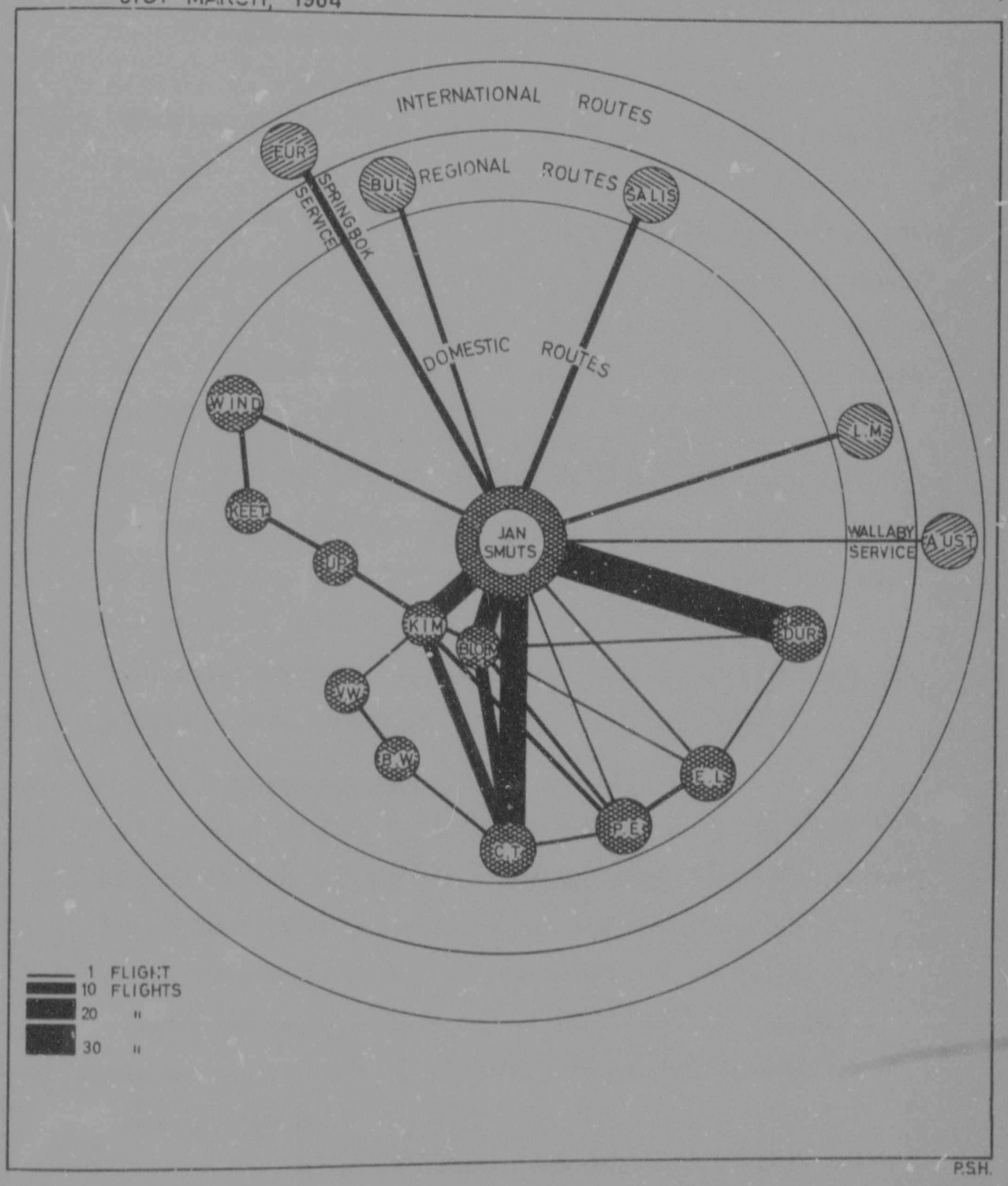
TABLE 27 : International Air Traffic - South African and Foreign Carriers, 1951-63 (Bureau of Statistics 1964).

Year	No. of Passengers Carried	Air Freight (1,000 lbs)	Flights	
			In	Out
	T O T A L			
1951	42,499	2,281	-	-
1952	75,298	4,219	-	-
1953	80,874	4,496	-	-
1954	91,005	4,550	-	-
1955	106,780	5,249	2,390	2,383
1956	121,266	5,446	-	-
1957	135,503	5,548	-	-
1958	136,458	5,330	-	-
1959	139,901	5,534	-	-
1960	172,043	7,093	-	-
1961	189,110	8,501	-	-
1962	200,745	9,292	-	-
1963	299,651	9,314	3,415	3,385
	JAN SMUTS AIRPORT			
1951	42,499	2,281	-	-
1952	75,298	4,219	-	-
1953	80,874	4,496	-	-
1954	86,533	4,518	-	-
1955	100,723	5,208	2,390	2,383
1956	113,180	5,400	-	-
1957	125,521	5,483	-	-
1958	127,223	5,270	-	-
1959	129,620	5,600	-	-
1960	158,842	7,037	-	-
1961	175,621	8,447	-	-
1962	186,373	9,253	-	-
1963	214,677	9,269	3,134	3,103

TABLE 28 : South African Airways - Air Traffic, 1951-63 (Bureau of Statistics 1964).

Year	Passengers	Freight (1,000 lbs)	Flights.
	International Overseas Services.		
1951	15,710	1,278	1,311
1963	56,115	4,580	9,953
	International Regional Services.		
1951	18,950	364	925
1963	38,879	861	1,429
	Internal Services.		
1951	132,967	796	11,662
1963	418,648	7,586	18,305

FIG. 29 : SOUTH AFRICAN AIRWAYS - WEEKLY FLIGHTS TO AND FROM JOHANNESBURG, 31ST MARCH, 1964



(b) Lourenco Marques. 3 Aircraft, in partnership with D.E.T.A. carried out weekly flights. The 1963/64 passenger total of 6,673 proved to be 35% higher than the 1962/63 total.

4. Domestic Services (FIG. 29).

The map is of the internal S.A.A. flights from Johannesburg (return flights are the same) to 4 major termini, with stops en route. 85 Aircraft or 46% of all the internal flights in one direction only, left Jan Smuts Airport weekly, while corresponding figures for Cape Town, second in importance, were 57 and 32% respectively. A total of 315,946 passengers were carried on standard class services and on the Skycoach service the figure was 102,943 in 1963/64.

The relative importance of the three services is seen in TABLE 28. From this table and FIG. 30 South Africa as a whole is the inner zone of air services centred on Johannesburg; since the number of passengers carried on internal services is almost double that carried by all aircraft from Jan Smuts over the South African border, namely 418,648 as to 214,677 in 1963.

5. Overseas Concerns.

Besides the international flights of the South African Airways, several other aircraft concerns execute international flightsthereby increasing the sphere of Johannesburg (through Jan Smuts Airport) to many cities and countries. Because of the frequent changes in scheduled aircraft operations only the names of several of these concerns and the countries of origin are listed:

British Overseas Airways Corporation (BOAC) - Great Britain; SABENA - Belgium; Central African Airways (CAA) - Rhodesia, Malawi, Zambia; DETA - Mocambique; EL AL - Israel; PANAM - United States; Lufthansa - Germany; QUANTAS - Australia;

.../UTA

UTA - France; T.A.P. - Portugal; KLM - Holland.

6. Conclusion.

Whereas road and rail transport define Johannesburg's sphere of influence on a local and regional basis, air transport spreads the cities influence much further and allows for a national sphere which includes the whole of South Africa and South West Africa, and an international sphere which includes Europe and neighbouring African countries.

CHAPTER IX.

POPULATION AND METROPOLITAN STRUCTURE.

A. INTRODUCTION.

If any major urban centre has any influence on its surrounding territory this influence should be observable in the population distribution pattern of this territory, since it is also for people outside the actual urban limits that work, services, goods and other typical urban functions are provided, and in turn, it is these "outside" people who cater for many of the urban requirements, of which the need for foodstuffs is of primary importance. This is also true for Johannesburg.

Practically the only sources for data which will give an indication of the population distribution pattern are the periodic population censuses of the Bureau of Census and Statistics. If the data from several such censuses were employed the changing or stable influence which the focus exerts on its surrounding territory would be seen. This would be an indication of the increasing, declining or constant importance of the focus, and would further indicate changes taking place in the territory "dominated" by the focus, such as the rise or decline of the influence of rival centres. It is these changes in the population distribution pattern which would be investigated if comparisons are made for different periods. Such comparisons, however, are beyond the scope of this study, since the interest here is centred chiefly on the existing pattern of population and the determination of the territory in which the influence of the urban focus is experienced, that is, the determination of Johannesburg's sphere of influence. It is for this reason that only the 1960 population census was used for this study of the population distribution pattern.

.../B.

B. METHOD OF ANALYSIS:

The method employed closely follows that of Bogue (1950). His investigation was based on the study of 67 selected American metropolises ranging in size from 100.000 to over 1,000,000 inhabitants. In South Africa only a few cities qualify to be regarded as metropolises, and of this limited number four were selected to obtain average values which were used to cast more light on the effects of Johannesburg on its surrounding territory. The four centres selected were Johannesburg and its three nearest or adjacent metropolises, namely, Durban, Pretoria and Bloemfontein. They vary in size from 145,000 to over 1,000,000 inhabitants.

The next stage involved the determination of the boundries of the separate metropolitan communities. This was based on the following rule: "A metropolis can dominate all of the area which lies closer to it than to any other similar city, even if the other metropolis is larger. The boundaries of metropolitan areas (i.e. communities), therefore, pass through the points bisecting the airline distance between adjacent metropolitan centres" (Bogue 1950 p17). Initially a metropolitan community boundary is determined geometrically by joining the metropolises and then bisecting these lines. These bisectors include areas closer to the enclosed centre than to any other metropolis this is regarded as the sphere of influence of that centre. However, these geometric boundaries do not coincide with the magisterial district boundaries. To overcome this problem a magisterial district was assigned to the community in which its chief urban centre was located (FIG. 30).

The next step was to determine separately the number of urban and rural people per square mile, i.e., the habitation ratio per magisterial district. The term "habitation ratio" is preferred to "population density" since it is not an indication of urban people on urban land or rural people on rural land, but is rather an indication of the degree of urbanisation or the rurality of a

.../magisterial

magisterial district. The habitation ratio is obtained by dividing the urban and rural populations separately by the area of the district. In the magisterial district of Nigel, for example, the urban habitation ratio is 98, i.e. 36.489 (urban population of five urban centres in the Nigel magisterial district) divided by 371 (the area of the magisterial district), and the rural habitation ratio is 41, i.e., 13,085 (rural population of the magisterial district) divided by 371.

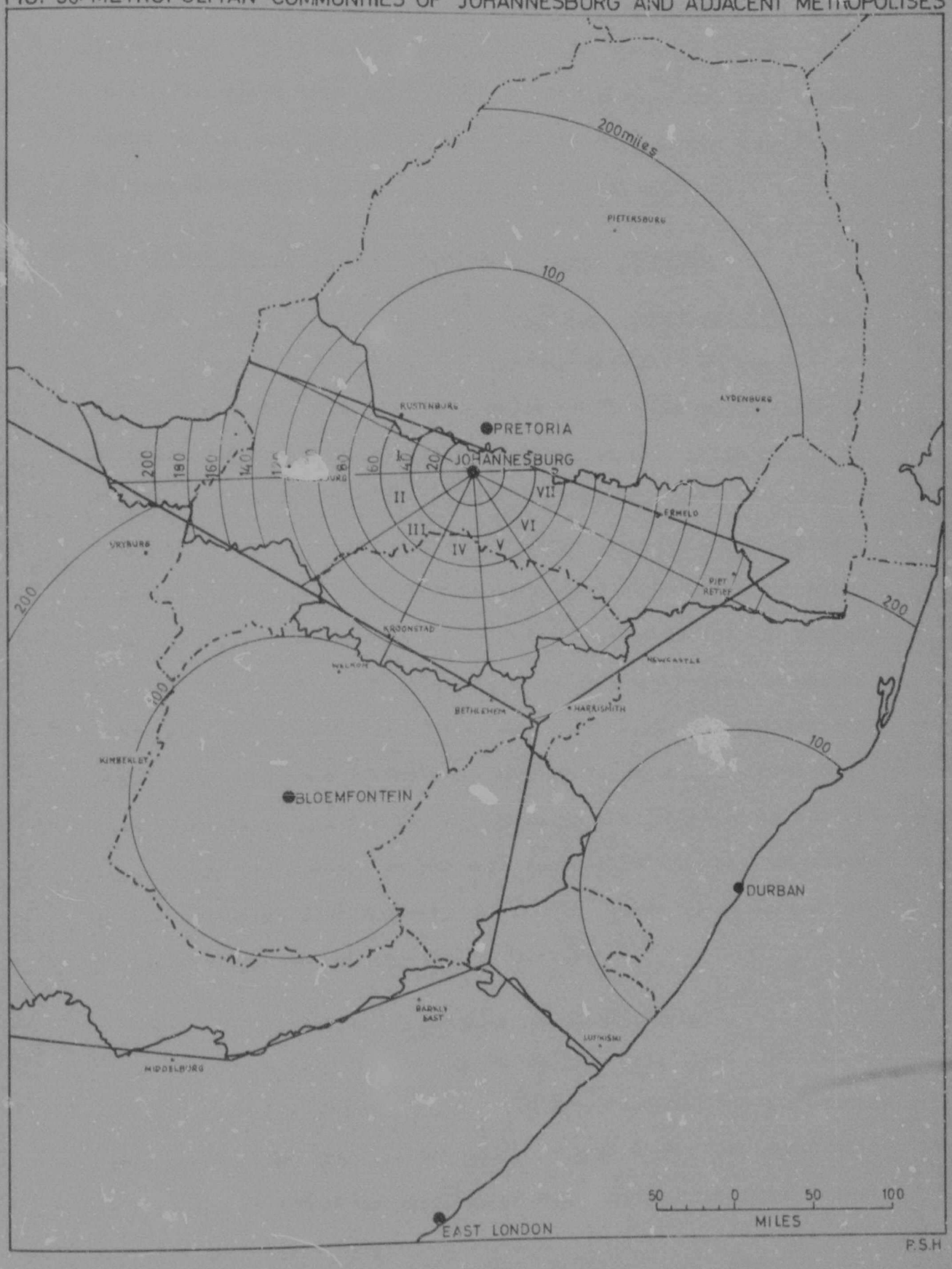
The next stage entailed the division of the metropolitan community into concentric zones of equal width. Twenty-mile zones were selected, for this was the most practical distance to work with on the initial base map (1:3,000,000). FIG. 30 indicates those areas of the separate metropolitan communities which were covered, i.e., areas with a maximum radius of 200 miles from the metropolitan foci of Johannesburg, Pretoria, Durban and Bloemfontein.

The procedure further included the determination of the urban and rural habitation ratios per twenty-mile zone for each of the four metropolitan communities. These values were plotted on semi-logarithmic graph paper with the habitation ratios on the y-axis and the x-axis representing the distance-zones from the metropolis. The graphs (FIGS. 31a and b), therefore, show the curves of the metropolitan community of Johannesburg and the mean curves for the four metropolitan communities.

Because the pattern of population distribution in the surrounding countryside of Johannesburg is not uniform due primarily to mining activities, it was decided to determine the habitation ratios in various sectors centred on Johannesburg. After experimenting with sectors of various angles, 30° sectors provided the best results. Because the metropolitan community

... / boundary

FIG. 30: METROPOLITAN COMMUNITIES OF JOHANNESBURG AND ADJACENT METROPOLISES



boundary passes very close to the north of Johannesburg due to the nearness of Pretoria, sectors could not be projected in that direction. The number of sectors was thus limited to seven (FIG. 30). The habitation ratios in each of these sectors were determined in the same manner as those for the communities and plotted on semi-logarithmic graph paper (FIG. 32a and b).

C. ANALYSIS OF URBAN HABITATION RATIO CURVES:

1. Mean Curve for Four Metropolitan Communities (FIG. 31a):

The habitation ratio increases gradually as the distance from the metropolises decreases, except at 90 miles where there is a slight decrease, the result of the exceptionally high ratios in the Klerksdorp district at 110 miles. However, this irregularity is of no great importance as a mean value, since the mean value is based on the ratios of only four centres. At 70 miles the curve rises rapidly, and over the last 50 miles approximates an exponential curve, that is, a constant rate and not a constant amount of increase[1]. A comparison of the four individual metropolitan community curves shows that the steepness of the mean curve over the last 70 miles is not due to the values in the Johannesburg metropolitan community alone, but may also be ascribed to the high values in the communities of Pretoria and Durban, since their curves increase from 110 and 90 miles respectively.

2. Johannesburg Metropolitan Community Curve:

It is only in the zone beyond 140 miles that the metropolitan community of Johannesburg has lower values than the average curve, indicating that the community is more highly urbanised within a radius of 140 miles than any of the other metropolitan communities considered here.

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1. Constant Rate: 1, 3, 9, 27 (threefold increases).
Constant Amount: 1, 3, 5, 7 (increases by 2).