

# TRAFFIC LOADING ON THE GREATER JOHANNESBURG MUNICIPAL ROAD NETWORK

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The Johannesburg Roads Agency (Pty) Ltd is the roads and stormwater agent for the new City of Johannesburg created in December 2000 as a single municipality with an 9 000 km municipal road network (some 54 000 links). The total (unclassified) traffic per road link varies from less than 100 vehicles per day to 60 000 vehicles per day per direction (over 3 lanes). The accurate, although necessarily generalized traffic loading in 80 kN ( $\approx 8\,165$  kg) Equivalent Standard Axles (E80) per link is essential to determine network performance, maintenance priorities, suitable treatments, and suitable budget or funding levels. The deregulation of freight transport, increased legal axle loads, higher tyre contact pressures and unfortunately ever-laxer law enforcement has resulted in an increased load on the road network.

The damaging effect of an axle has typically been taken to be APPROXIMATELY proportional to the fourth power of axle load although the range could be 2 to 6. The major characteristic of the so-called FOURTH-POWER law is that only the numbers of laden heavy commercial vehicles (H C V) and laden heavy-duty buses are really significant in assessing structural damage to a road. Other loadings and vehicles are less significant. Sophisticated H C V configurations are being widely used and the number of axles per H C V has increased typically to 5, 6 or 7 from the 4 or 5 axles common in the past.

The issues have been addressed and reasonable assessments made of the following problem areas

- Whether a road hierarchy can be used as a surrogate for traffic loading
- Whether national vehicles sales can be used as an analogue for the typical urban fleet
- Distribution of traffic counting stations from traffic loading and law enforcement points of view
- Whether transportation studies are applicable to assessing traffic loading
- The typical long term growth rate in an urban area
- The total traffic in vehicles per day and the corresponding cumulative E80 per road link for a particular analysis period
- The validity of a 1991 study used in the preparation of past road resurfacing programmes.
- Whether an assumption of structural failure is appropriate in the lower order roads

While commercial vehicles are only a small proportion of the national fleet, the traffic loading can easily be under or over estimated by 200% or 300%. The traffic loading has been over estimated on normal suburban streets but under estimated on the primary road network with serious road maintenance cost implications.

## **Problems in assessing pavement wear and some simplifying assumptions**

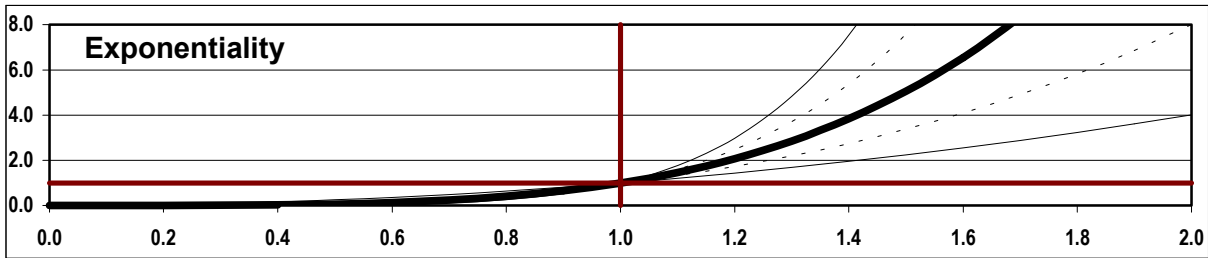
A pavement is 'consumed' by heavy traffic to some terminal state with the rate accelerated by excessive moisture but the damaging effect of the traffic is extremely difficult to quantify. Pavements deteriorate as a result of a variety of factors acting both independently and in combination (**conveniently summarized in 1**). The widely varying loads that a pavement experiences over its life can only be accurately measured in a research environment (even though static weighing of individual axle loads is difficult to relate to low (never mind normal) speed weigh-in-motion, estimated on a dedicated facility or wildly guessed at in a road network. Furthermore accelerated testing with **heavier** than standard loads is fraught with problems over selection of the appropriate damage exponent).

The number of axles per heavy commercial vehicle (H C V) (typically the Gross Vehicle Mass [G V M] or Gross Combination Mass [G C M] exceeds 15 t) has increased while the **National Road Traffic Regulations (2)** permit higher loads to be carried on vehicles. The use of higher tyre inflation pressures as well as 'super singles' instead of dual tyres are other sources of increased road damage. A substantial portion (at least 50%) of freight is transported in closed vehicles or in containers and accurate visual surveys of the loading condition have become very difficult.

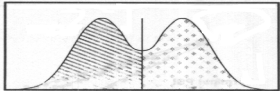
The concept of cumulative equivalent standard (80 kN  $\approx$  8 165 kg  $\approx$  18 000 lbs) single axles (E S As or E80s) was developed to simplify the assessment of the actual traffic loading over the life of the pavement. The standard is the single axle although tandem or tridem axle units probably cause less damage to a flexible pavement than the equivalent single axles (**1**). This 'damage' or 'wear' is EXPONENTIAL (typically proportional to the fourth power of the axle load). The sensitivity of the exponent becomes important when there are axles differing from the 80 kN standard. The type of pavement and its thickness and materials also have an important bearing on load equivalence and the exponent can vary between 2 and 6 especially on pavement structures having what could be regarded as atypical or non-standard materials. Other important issues are load transfer, dynamic loading and tyre contact pressure. The major characteristic of these exponential functions especially with the higher exponents is that only the numbers of laden H C Vs and laden heavy-duty buses are really significant in assessing structural damage to a road. The estimation of past and the prediction of future pavement wear or damage only becomes possible because of these assumptions and this can be made even more simple if a further assumption is made that the typical 'heavy vehicle' generates some characteristic number of E80s per axle with a typical number of axles per vehicle. (**3, 4**).

Only those heavy vehicles with a G V M  $>$  10 t should be considered while the typical medium commercial vehicle (M C V) (6t or 7t G V M) is probably best ignored unless there are demonstrably large volumes. The quantification of the bus loading is best done from transportation studies or using known bus routes.

**Figure 1 : Increase in damage for different exponents**



**Tandems (dual or double axles) & Tridems (triple or tri-axes)**



The **1956-1958 AASHO (now AASHTO) Road Test (5)** showed that tandems (no tridems were tested) caused some 20% less damage than the equivalent number of single axles. The figure is from Uzan and Sidess **(6)**. This was further addressed in **(7)** and **(1)**. However both the 1989 and the current South African regulations **(2)** seem to contradict this. Tandems are taken as 2 singles (ie 16 400kg in 1989 and 18 000kg in 2000), while tridems are restricted (ie 21 000kg in 1989 and 24 000kg in 2000). In Australia the statutory loads (defined as equivalent to a standard axle) are set as follows for use in  $(P/P_s)^4$  **(8)**.

- Single axle (dual tyres)   8.2t    ≈     2.1 ESA (E80)
- Tandem   13.6t ≈     3.1 ESA (E80)
- Tri-axle   18.5t ≈     2.8 ESA (E80)

Hajek & Agarwal **(9)** state not only does the **AASHTO guide (7)** “. . . underestimate the damaging effect of dual and triple axles in comparison with single axles” but “the axle spacing is not defined by the Guide” even though “for large axle spacings, all LEFs (8160kg loads) tend to approach 2.0 for dual axles and 3.0 for triple axles”. They reported further that in Ontario while single axles are limited to 10t, dual axles are limited to 15.4t and triple axles to 19.5t.

Figure 5-1 in **(1)** implies that 16.4t tandems ≈ 1.5 E80 and 18.0t tandems ≈ 2.0 E80 (*cf* the 2.0 E80 and 3.0 E80 implied respectively in the various TRH documents **(10, 11)** which furthermore imply that a 24.0t tridem is ≈ 2.7 E80). It seems obvious that in the case of tandems and tridems the “sum of the parts” ≠ “the sum of the whole”. This is a serious shortfall as the estimation of the E80s generated by theses axle-units are crucial to the assessment of the total load on a road. The values assumed in all the calculations have been reduced by a fudge factor of 0.9 per axle. It is essential to check for new research and to confirm that the conclusions above are in fact still valid but my personal view remains, despite the crucial need for accurate values, that the following are applicable

- 16.4 t tandems   definitely less than 2 E80 per axle unit
- 18.0 t tandems   probably less than 3 E80 per axle unit
- 21.0 t tridems   definitely less than 2 E80 per axle unit
- 24.0 t tandems   definitely less than 3 E80 per axle unit
- 27.0 t tandems   probably about 4 E80 per axle unit

## Summary of assumptions

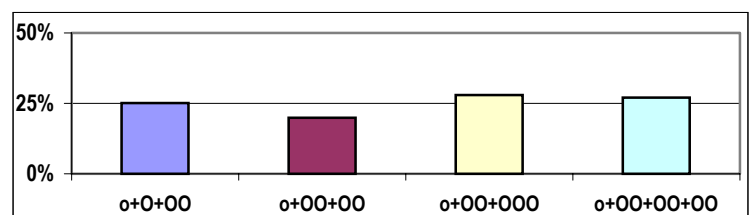
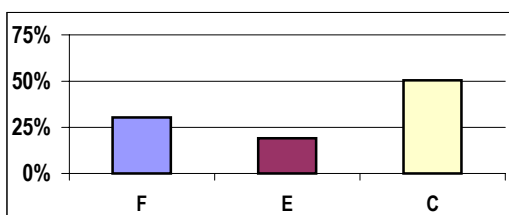
While commercial vehicles are only a small proportion of the national fleet, the traffic loading can **easily be under or over estimated by 200% or 300%** and great care should be taken against using unsuitable factors. The following simplifying assumptions were used but could be inappropriate if good data is available for specific projects and probably should only be used for the optimization of maintenance needs across large urban road networks

- The damaging effect is proportional to the fourth power of the axle load but reduced for tandems and tridemms
- The Johannesburg modal distribution hand counts are unsuitable and should only be used as a last resort.
- The number of axles (and the consequent E80s) per H C V should be based on sample surveys.
- The distribution of “trucks” seems to be restricted to certain, what could almost be called “truck routes” and is probably additionally restricted to roads in most industrial areas.
- There are significant differences between “rural” long haul and “urban” short haul, and the opportunities for high load factors and better vehicle utilization within urban areas are limited.
  - A “fully” loaded commercial vehicle is probably only at 75% of the permissible G V M.
  - Approximately 30% of H C Vs are obviously “fully” loaded, 20% are definitely empty while 50% are closed or the loading condition is not visible.
  - Some commodities such as cement, aggregate, bricks, beverages etc are transported one-way only – ex works to the consumer.
  - This implies that probably only 50% to 60% of the H C Vs are at some 75% of their respective G V Ms or G C Ms.
- The increase in traffic loading as a result of the increased legal load limit is probably about 30% compared with the 45% implied by the fourth-power law.
- There is no obvious use of non-standard tyres.

## Distribution of loading and configuration / composition of the urban fleet

Some form of random windscreen or roadside survey (29) is essential if no loading or only visual data is available. Published data is probably out of date or not applicable or in appropriate. The cost of proper surveys is in fact infinitesimal compared with the implications of an incorrect loading assumed during design. The E80s generated by vehicles with a G V M > 10 t could be as much as 98% of the total. It is essential that these vehicles be adequately quantified with a split between “fully” laden and definitely empty.

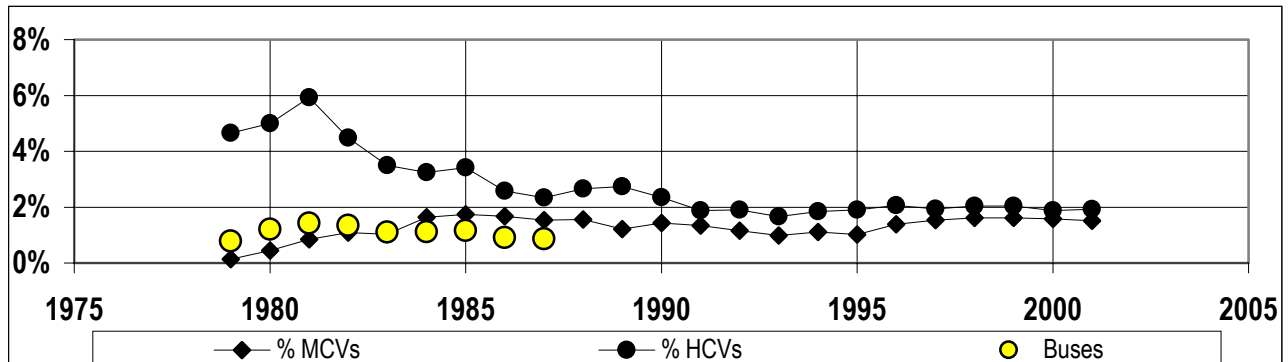
**Figure 2(a) Loading condition and Figure 2 (b) Vehicle configurations**



Based on the sales of new vehicles over the last 10 years the number of H C Vs (G V M > 7.5t) is about 2% of the total sales of new vehicles while sales of M C Vs (G V M typically about 6t or 7t) vary between 1% and 1.5% of the total new sales. There are no up to date

figures for buses. In fact the quantity of buses should be assessed by transportation studies with the identification of bus routes as a priority. These figures are probably too coarse for the determination of E80s and should be replaced by the actual sales of the various bus groups (ie 10t, 12.5t, 15t and 20t) split into rigid and articulated types or preferably surveys.

**Figure 3 : M C Vs and H C Vs as % of national new vehicle sales**



### Traffic classes

The original philosophy of traffic (damage) classes developed in the various editions of TRH 4 and TRH 16 is still appropriate for large road networks. However the cumulative traffic loading is transformed (20 year period, 2% growth rate) into classes of **E80 per day** which are more easily visualized (See table 1)

**Table 1 : Traffic damage classes**

TRH4	Lower limit	Upper limit	TRH22	Upper limit	Proposed	A A D E80	Cumulative
ER	1	50 000			UDE0	5	45 000
E0	50 000	200 000	T0	500	UDE1	20	180 000
E1	200 000	800 000	T1	1 500	UDE2	80	720 000
E2	800 000	3 000 000	T2	4 500	UDE3	320	3 000 000
E3	3 000 000	12 000 000	T3	13 500	UDE4	1 250	12 000 000
E4	12 000 000	50 000 000	T4	40 000	UDE5	5 000	45 000 000
E5	50 000 000	200 000 000	T5	120 000			

### The development of a road hierarchy and use as a surrogate for traffic loading

The development and ongoing use of a road hierarchy as a surrogate to provide default values for the traffic loading on a road network has a long and distinguished history. Although the classic definitions (15, 16 and 17) used in determining the typical road hierarchy from a transportation or design standard point of view are often less than helpful in trying to assess the actual traffic loading in E80, such a hierarchy is an **essential starting point in grouping road links with putatively similar traffic patterns**. This is especially so to complement the intimate knowledge of the traffic patterns (not necessarily actual traffic counts) that network managers and their consulting engineers possess.

Typically bus routes and 'main roads' would be treated differently (See table 2). A comprehensive hierarchy, network knowledge and 'rules-of-thumb' can identify any abnormal maintenance needs resulting from unusual or temporary traffic patterns or directional imbalances. The extensive use of mini-bus taxis in the place of heavy-duty

buses is actually beneficial to the pavement structure as the **E80 per commuter** is substantially reduced (in theory to 0,001 E80 from 0,02 E80).

**Table 2 : The 1992 Johannesburg PMS road categories (28).**

Category	Description
<b>A</b>	Main arterials (excl M1 & M2) ("yellow" routes in map book / numbered routes)
<b>B</b>	Major collectors, CBD roads & streets, industrial areas & major bus routes
<b>C</b>	Minor collectors & residential roads (all other township roads & streets)
<b>D</b>	Cul-de-sacs

The development of the definitions is simple but the real problem comes in applying the definitions to the actual links in the road network. Fortunately the availability of easy to use geographic information systems (G I S) has made possible electronic road centerline maps with easily edited attribute information. The availability of continuous, digital, colour, ortho-photos has made possible the capture and maintenance of road centerlines even where is no up to date cadastral data or where the roads and streets do not follow cadastral boundaries with purpose made inspection sheets being generated for PMS visual assessments. Road hierarchies are now so easily generated and maintained and no longer limited to the network of any road particular authority but can easily incorporate neighboring networks in the same or separate ArcView® shape files.

The road hierarchy proposed for use in Greater Johannesburg map is given in **table 3** below.

**Table 3 : The City of Johannesburg road hierarchy**

Rank	Road type	Owner	Simple description	Preferred
01	Existing / declared national roads	SANRAL	Freeways	<b>01</b>
02	Primary - <b>inter</b> provincial	Gautrans	Freeways	<b>02</b>
05	Primary - <b>intra</b> provincial	Gautrans	Important single/dual roads	<b>03</b>
07	<b>Inter</b> district connectors	Gautrans	Other provincial (paved)	<b>04</b>
09	Major <b>intra</b> district connectors	Gautrans	Other provincial (unpaved)	<b>05</b>
03	Urban freeways	Local	M1 & M2 motorways	<b>10</b>
04	All ramps & loops (only for convenience)	All	Ramps & loops	<b>11</b>
06	Major urban arterials	Local	"Metropolitan roads"	<b>12</b>
08	Minor urban arterials	Local	Other distributor roads	<b>13</b>
10	Major urban collectors / <b>intra</b> district connectors	Local	Secondary roads	<b>20</b>
11	Industrial roads & streets	Local	(Industrial areas)	<b>25</b>
12	Minor <b>intra</b> district connectors	Local	Main tertiary streets	<b>30</b>
13	Minor urban collectors / local access roads	Local	Tertiary streets	<b>31</b>
14	Other public roads (access erven / cul-de-sacs)	Local	Other tertiary streets	<b>32</b>
15	All private roads (remote controlled access)	Private	No public access	<b>40</b>

The separation in the hierarchy, of ramps and loops from the main line is necessary as there is a comprehensive ramp counting programme and also because some of the interchanges are extremely complex. It is also convenient to identify the owner of the various roads (the road and route numbers are held as attributes) as well as their status (paved or unpaved) and roads and streets in industrial areas. The total road and street network within the new City of Johannesburg comprises the national, provincial and municipal networks each of which have as an example **freeways**, but a lightly trafficked rural freeway is not necessarily more or less important than an urban freeway having an A D T say 3 or 4 times greater.

The ongoing connection of **any** formal traffic counting database (**or any other attribute database**) to the road centerline map is facilitated by the ability to add a unique counting station code to the G I S attribute table/s so that traffic data files may be joined to the ArcView® shape file. Normal GIS themes can be generated with legends that facilitate an understanding of traffic patterns across the network, identify gaps in the traffic data, show shortcomings in network coverage, simplify updating of the actual hierarchy and so on. However the retrofitting of traffic counting data held in a separate, standalone, conventional database managed by others, to a G I S attribute table often generates mismatches due to inter-departmental differences over data ownership. This is compounded by the addition of new / or renumbered stations. The need for co-ordinate data ownership is essential.

### **Distribution of traffic counting stations and suitability of typical (transportation) traffic studies**

It has become virtually impossible to manage a very large network using wall maps and lists of data as the walls have become too small and the lists too big. The connection of other attribute data (provided there is a common field) is extremely simple as is the generation of typical GIS themes. The original road centerline map also has wider uses as the backbone for the **Public Transport Record (18)** and for **EMME/2® (19)** network modeling. Backlund and Gruver (20) showed “that a pavement manager must know what heavy trucks are moving over the highway system in order to manage pavements: A pavement manager needs to know

- Past loading history
- Current heavy-vehicle volumes by route
- Future heavy-vehicle volumes by route, and
- ESAL factors by pavement types and vehicle types”

The present traffic counting system was developed from the original 30-year old mainframe system used in old Johannesburg and extended to the then adjacent municipalities as well as portions of the contiguous national and provincial networks. The original stations were intended to serve a radial system of arterial roads but were increased without due consideration of the need to provide full coverage of what is now a large network. The stations covering the old system of cordon and screen line counts as well as the modal split and occupancy counts (on the employment cordons) for transportation planning were also incorporated into the new system. The modal split counts are useful in that while not classifying trucks (as the previous counts had done) there is an indication on the relative numbers of cars, bakkies, trucks, minibus taxis and heavy-duty buses.

There are however a large number of practical issues to be resolved

- Not all of these counts are undertaken each year
- Substantial portions of the existing network were not part of the original JOMET area
- Greater harmony is required between the Comprehensive Traffic Observations and the municipal counting system especially the location and numbering of stations.
- Vehicle classification needs upgrading to be more suited to assessing the traffic loading
  - Distinction between the different mass groups (M C Vs, “light” and “heavy” H C Vs)
  - Some indication of number of axles and the vehicle configuration (rigid, articulated)
  - Some indication of the loading condition (definitely “full”, closed, empty)
  - The counting hours do not cover the problem period between 18:00 and 06:00 when a larger proportion of H C Vs in fact use the network than is obvious during daylight.
- Coverage from road maintenance point and law enforcement points of view is unsatisfactory
  - Identify “truck” routes
  - Systematic counting on roads & streets within industrial areas
- A personal preference would be for the inclusion of at least a further 10 permanent stations into the C T O system covering the M1 and M2 motorways and Main Reef road with some secondary stations on roads and streets being fed by the ring road and other significant load generators.

A further G I S specific issue arising out of the need to show point data (at a counting station) on a line feature, forces the ‘allocation’ of the unique traffic counting station code to a suitable link or group of links if there individual links between interchanges or intersections. The question of direction on dual carriageways is currently addressed (not really satisfactorily) by calculating the ‘per direction’ count and then applying this figure to each carriageway of a dual carriageway.

As always there is the need to simplify data collection and minimize costs so that less than 1 000 counting stations are expected to cover a network of 54 000 links. However the location of counting stations needs to be revisited in a more logical manner using the links of road centerline map (with their unique ID) and the current road hierarchy as a starting point. The existing stations should be retained in such a manner as to access historical data. The original sequential numbering of the counting stations *per local authority* results in duplicates (the concatenation of a unique prefix is then essential but this *still* does not distinguish counts in following years) which contain no inherent intelligence. Historical data is absolutely essential to determine long-term growth patterns so as to make more reasonable estimates of shortfalls in both transportation and structural capacity. Access to historical data remains easy as long as there is a table with the new and old codes in a one-to-one relationship.

It would be convenient for a new counting station reference system to refer to the road hierarchy definitions (**See table 4**). This is not a problem to implement as the road hierarchy is already in place. The original convention of a station being NORTH or EAST of a particular intersection as well as that NORTH-SOUTH routes use **ODD** numbers and EAST-WEST routes use **EVEN** numbers should continue to be implemented. These



conventions require discipline during data capture and provide some form of intelligence so that gross errors may be avoided.

Such locating of additional stations should be done in a logical manner using the road hierarchy from national to provincial to local routes in a route by route fashion so that there is comprehensive coverage of the full network right down to a comprehensive sampling of the most minor township streets. This exercise should take into account the need for comprehensive coverage of the network incorporating classified and both modal and occupancy counts in such a fashion to provide an indication of traffic loading.

**Table 4 : Proposed traffic counting station code system**

Owner	Simple description	Hierarchy	Unique code
SANRAL	Freeways	01	yyyy-01-0xxx-D
Gautrans	Freeways	02	yyyy-02-1xxx-D
Gautrans	Important single/dual roads	03	yyyy-03-2xxx-D
Gautrans	Other provincial (paved)	04	yyyy-04-3xxx-D
Local	M1 & M2 motorways	10	yyyy-10-4xxx-D
All	Ramps & loops	11	yyyy-11-5xxx-D
Local	Primary roads	12	yyyy-12-6xxx-D
Local	Secondary or other arterial roads	20	yyyy-20-7xxx-D
Local	Tertiary streets	30	yyyy-30-8xxx-D

- Note :
- (1) "yyyy" is the year of the count as before
  - (2) A simplified version of the hierarchy is included in the counting station code
  - (3) "D" is the direction of flow corresponding to the direction in the GIS link code

The traffic counting system should be extended to provide full coverage of what is now a large, integrated network incorporating national and provincial routes that now seamlessly function as part of a totally urban road network. This especially applies also to those networks that were never part of the original JOMET area. Likewise the stations covering a comprehensive system of cordon and screen line counts for transportation planning should also be clearly identified. All counts should be taken annually with a special effort made to eliminate gaps in the data.

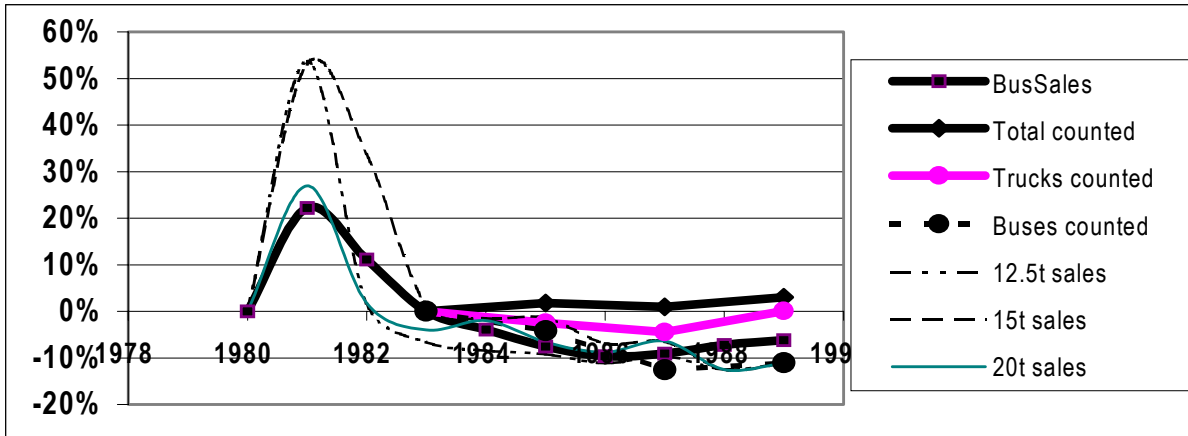
### Urban traffic growth

The use of growth rates in urban traffic is fraught with difficulties. The mathematics are well defined as is the basic principle of the use of a large period (at least 5 years but preferably 10). The actual growth in E80 per day over some design or analysis period is required but unfortunately the difficulties in assessing this value are small in comparison with the long-term fluctuations in heavy traffic as a result of

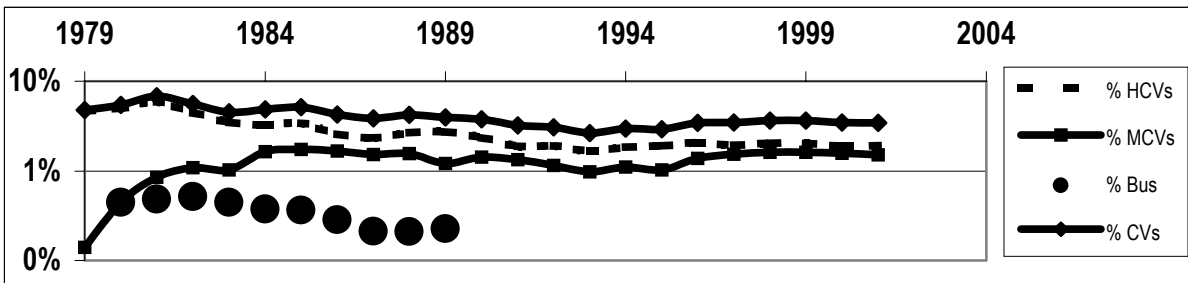
- Economic growth (or the lack thereof) which is often influenced by changes in the fuel price
- There is a long term decline in new vehicle sales but the total fleet is probably increasing as is vehicle utilization
- Changes in land-use which can play havoc with both industrial and construction traffic generation
- Inaccurate statistics or changes in methods (eg new station numbers) or gaps in the base data
- Capacity shortfalls in a network will divert traffic in unpredictable patterns

Analysis of data generated over a period of more than 30 years within the old City of Johannesburg has shown absolutely no consistency even on such well-defined routes as the M1 and M2 motorways. The long-term traffic growth on the **total network** is unlikely to exceed 2% per year with zero growth being more likely except for certain growth areas. Probably the only solution is the use of surrogates such as the registration of vehicles per year or gross fuel sales as even the NAAMSA (21) figures on the sale of new vehicles show negative growth between 1979 and 2000. Individual rehabilitation projects should however be assessed on a per project basis.

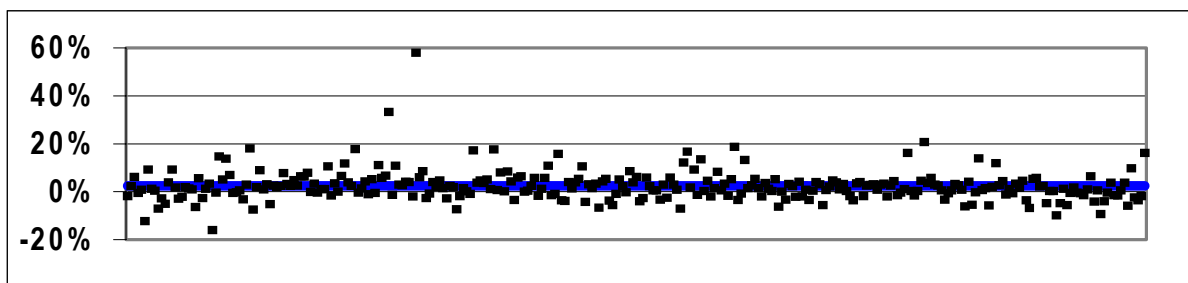
**Figure 4 : Variation in growth rates from screen line counts and NAAMSA new vehicle sales**



**Figure 5 : The long term trend of new vehicle sales (split by type)**



**Figure 6 : Variations in annual traffic growth per station (1994 to 1998) – average = 2.4%**



### **The loading over the life cycle of a pavement**

A weak township street pavement has a variable loading. The **construction traffic** often is a more severe load than the typical ongoing **in-service loading** as a result of the exponential damage **(8, 22)**

### **The actual determination of E80s at a network level**

The factors for the E80 generated per vehicle or per axle as used historically in Johannesburg have their origins in the pioneering work by Lomas, Curren and others **(3, 4)**. These factors have been formalized in the various editions of TRH 4 **(10)** and TRH 16 **(11)** where the current values per vehicle have been substantially reduced. Similar factors are currently used in the Comprehensive Traffic Observations (some have been increased from 1990 to 1999) and where further assumptions are made that “heavy” vehicles have some characteristic length and body height **(12, 13)**.

In 1984 using results from the 1983 classified screen line counts **(23)** and further updated in 1991 **(30)** (using the 1983, 1985, 1987 and 1989 counts), the average traffic loading was estimated first at 60 E80 and later at 20 E80 per 1 000 vpd using the classical factors mentioned above. These factors are unfortunately biased towards major roads. The upgrading of the 1990 Johannesburg pavement management system required cumulative E80 per road link and where no actual traffic counts existed, default values of 1000 vpd, 5000 vpd and 10000 vpd (based on machine counts from 1982 to 1987) for category C, B and A roads and streets **(see table 3)** resulted in default loadings of 20 E80 per day, 100 E80 per day and 200 E80 per day. The treatment algorithms were further adjusted to allow for road category and known bus-routes (defined as > 10 buses per day).

A decade later and after the expenditure of many, many millions on road resurfacing there is still no better information available on a routine basis and the original data shortfalls and system shortcomings still exist and the only real change has been the convenience in working with the data. These problems exist because of different priorities and focus areas

- Accuracy (year-on-year comparisons per station show growth rates from –16% to +58%)
- Only 294 stations have a 1994 record AND a 1999 record
- The coverage of the stations is biased towards the old JOMET transportation needs
- The stations tend to be placed on major roads
- The classified counts quantify commuters crossing certain screen lines and cordons

Notwithstanding the issues above a concerted effort has been made to determine representative default values so that a reasonably accurate assessment of the traffic loading can be made and the optimization of all future road resurfacing programmes will in fact be realistic and accurate. The values that follow are the best values available although intuitively there is a serious concern that the values for roads in industrial areas and other roads having large “truck” volumes, are “light” **(31)** although this may really be as a result of the wide variations in actual counts and/or the small amount of data that is available.

The default values given can probably be used with confidence at a network level in any urban network not having a preponderance of through “truck” routes with large numbers of long haul freight carriers. Such routes should either be treated separately (as are the M1 and M2 motorways in Johannesburg) or totally excluded.

An important issue that should not be forgotten is that as the traffic loading decreases below probably 1 million E80 over the design life, the total number of vehicles per day can be more significant than the E80s.

The aging of the surfacing on the lower order roads in an urban network is a more significant distress than structural damage and care should be taken in broad use across an unfamiliar network (Judd).

These values have been substantially smoothed, averaged, fudged etc to make sense in a holistic fashion across the network taking into account the known characteristics of the network as well as the known problems with the data (accuracy, completeness, coverage, representativity etc) and can be justified.

The importance of suitable values cannot be over-emphasized and as such will be tested in a workshop with all interested parties.

The suggested default values are shown below in **table 5** below.

**Table 5 : The suggested default values**

ROAD CLASS	E80 per 1 000 vpd			Total vehicles per day			Total E80 per day		
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Primary	15	20	30	6 000	25 000	60 000	90	500	1800
Industrial	10	15	25	4 000	10 000	30 000	40	90	200
Secondary	8	10	20	2 000	10 000	30 000	16	100	600
Main tertiary	4	6	8	1 000	5 000	10 000	4	30	80
Tertiary	2	3	4	500	1 000	5 000	1	3	20

ROAD CLASS	Typical cumulative E80			TRH 4 traffic class			Urban daily E80 class		
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Primary	657 058	3 650 324	13 141 168	E1	E3	E4	UDE3	UDE4	UDE5
Industrial	292 026	657 058	1 460 130	E1	E1	E2	UDE2	UDE3	UDE3
Secondary	116 810	730 065	4 380 389	E0	E1	E3	UDE1	UDE3	UDE4
Main tertiary	29 203	219 019	584 502	ER	E1	E1	UDE0	UDE2	UDE3
Tertiary	7 301	21 902	146 013	ER	ER	E0	UDE0	UDE0	UDE1

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# TRAFFIC LOADING ON THE GREATER JOHANNESBURG MUNICIPAL ROAD NETWORK

## C A HOEHLER

Johannesburg Roads Agency (Pty) Ltd, Private Bag x70, Braamfontein. 2017.

### PERSONAL DETAILS

Current employer                      Johannesburg Roads Agency (Pty) Ltd (Jan 2001 to date)  
City of Johannesburg Metropolitan Council (December 2000)  
Greater Johannesburg - S M L C (Technical Services - Roads and Stormwater) (Jan 1997 to Nov 2000)  
G J T M C (Johannesburg Administration - Roads Directorate) (Jan 1996 to Dec 1996)  
Johannesburg City Council (Roads Directorate) (Jul 1992 to Dec 1995)  
Johannesburg City Council (City Engineer's Department) (Oct 1977 to Jun 1992)

Marital status                          Married with two sons (born 1984 and 1981)

### EDUCATIONAL QUALIFICATIONS

Last school attended                  Boksburg High School 1962  
Tertiary Institution attended        Witwatersrand Technikon 1968

### CURRENT POSITION

Present Position                        Manager : Road Surfacing Depot and Asphalt Plant (July 2001)

Main job function                      Function as a contractor to implement of the road-resurfacing programme within the area of jurisdiction of the City of Johannesburg

### BACKGROUND

Design, construction and maintenance of railway lines (1963 to 1977)  
City of Johannesburg (1977 to date)  
Pavement Management Systems  
Maintenance management of a roads and stormwater network  
Road resurfacing (departmental and by contract)  
Utilities management  
Engineering support

- developing, implementing and providing information systems
- internal technical support to line management
- quality control services