LIGHT RAIL TRANSIT AND ITS LAND USE IMPLICATIONS

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Koste-effektiewe publieke vervoerstelsels wat nie oormatige negatiewe invloede op die omgewing uitoefen nie, word benodig in Suid-Afrika. Ligte spoorvervoer is 'n modus wat nog nie in Suid-Afrika voorkom nie, maar wat hierdie moontlikhede bied.

Die konsep van ligte spoor word kortliks aangeraak deur 'n bespreking van die voertuig, sy spoorreserwe en haltes. Die invloed van ligte spoor op grondgebruike word hierna behandel. Die Vancouver-ondervinding word bespreek om die invloed van ligte spoor op metropolitaanse vlak aan te dui, en San Diego word behandel as 'n voorbeeld van hierdie vervoermodus se invloed op plaaslike grondgebruike.

Die struktuurplan vir Atlantis ('n nuwe stad met 'n beplande bevolking van 500 000 wat 45 km ten noorde van Kaapstad ontwikkel word) word hierna bespreek. 'n Vervoerstudie het gedui op ligte spoor as 'n gepaste publieke vervoer stelsel vir hierdie projek. Die vervoerstudie word kortliks bespreek, waarna die invloed wat die konsep van ligte spoor op die beplande stadsvorm en fassering van die ontwikkeling gehad het, verduidelik word.

1. INTRODUCTION

Many cities have tried to satisfy their transportation needs by building more and more freeways. Los Angeles and Houston are prime examples of cities which built eight-lane motorways, yet today they still face serious traffic congestion. The problem basically is one of space not being used economically. Private cars take up too much space per passenger, causing congestion both in transit on the freeways, and in storage in city centres.

South African cities generally are still smaller than their North American and European counterparts, but our high rate of population growth and of urbanisation have as a result that we are rapidly approaching the levels of congestion experienced overseas. This trend, as well as the low car ownership amongst certain population groups, requires more attention to be given to the provision of good public transport. Light rail transit is a public transportation option, but one which still needs to be introduced in South Africa. This article serves as an introduction to the concept of light rail transit and explains its impact on the urban environment.

2. THE LIGHT RAIL CONCEPT

2.1 General

Light Rail Transit (LRT) is a concept which evolved from the electric tramways that were found in many of the larger cities some 50 years ago. Increasing conflict with motor traffic however, resulted in such low levels of service that these systems had either to be phased out or upgraded. Unlike the South African experience, many European cities started to provide exclusive rights of way for their trams, mostly retaining the at-grade intersections, and in the process developed what has become known as light rail transit.

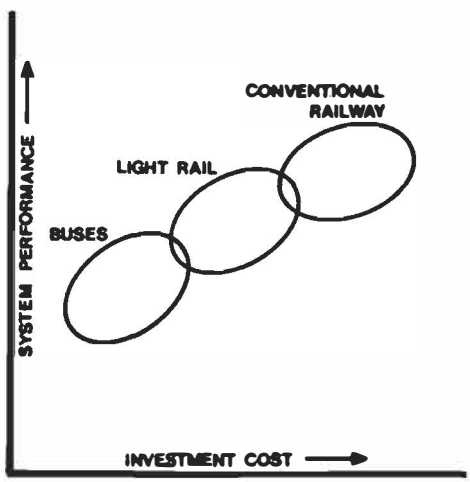


Fig. 1. Level of service

LRT systems can therefore be described as electrically powered, steel wheel articulated vehicles or multiple-unit trains of up to 4 cars which operate substantially on exclusive rights of way. These rights of way are sometimes grade separated and control can be either by visual means or signalised. Volumes of between 6 000 and 20 000 passengers per hour per track are catered for.

LRT does not compete with other modes of public transportation but, taking into account investment cost, provides a level of service which is aimed at a position somewhere between that of buses and conventional railways. (See Figure 1.)

2.2 The Vehicle

As a certain percentage of the light rail route is usually shared with other modes of transport, operating conditions in the street restrict the width of the vehicle to approximately 2,5 m. The articulated vehicles usually range in length from 20 m to 30 m, allowing them to carry up to 250 passengers, half of whom may be seated. The length is constrained by sharp curves which may occur along the route, especially in the older central areas. The vehicle is not constructed to resist the same force of impact which the conventional railway vehicle can with-

stand and can therefore be produced at a lower cost. (See Figure 2.)

An important characteristic of the LRT vehicle is its powerful magnetic brake system which ensures compatibility with other traffic. Speeds of up to 100 km/h can be reached, but operating speeds are typically between 18 and 40 km/h. (Vuchic, 1981.)

2.3 The Right of Way (ROW)

One of the most important characteristics which distinguishes LRT from the tram is the exclusive ROW which LRT enjoys for up to 90% of its length. The ROW is seldom uniform over the total distance and can consist of a combination of the following categories. (Vuchic, 1981.)

- Category A, which is a fully controlled, exclusive ROW with grade separated crossings, as is used for conventional rail.
- Category B, which includes routes that are longitudinally and physically separated from other traffic by means of curbs, barriers etc., but with at-grade crossings for vehicles and pedestrians. This category is most frequently used for LRT.
- Category C, which represents surface streets with mixed traffic where transit vehicles may have preferential treatment such as reserved lanes separated by painted lines, or travel mixed with other traffic. This category is usually used for tram systems.

The fact that up to 90% of the LRT route is within a category B right of way does affect its level of service, but at the same time it eliminates the necessity for costly road over rail bridges. The LRT right of way usually does not exceed gradients of 6 to 10% and is normally located in the median of roads along high density corridors. A lateral asymmetric ROW adjacent to a roadway, is also possible in cases where direct property access across the LRT tracks can be prohibited. (See Figure 3.)

2.4 Light Rail Stops

Light rail stops may consist of a paved area, a shelter, and amenities such as information displays, benches, telephones and news-stands. Raised platforms increase loading rates and passengers also feel safer on them, but the provision of these depend on the vehicles used and the space available. Modern vehicles however, often have movable steps, allowing stops at platforms of different heights.

Stops are usually located before or after road intersections and a light signal, switched by the train, stops motor traffic to allow passengers to reach the sidewalk from the median. In recent years a number of LRT stations have also been located in shopping malls and other pedestrian areas. Stops are located 350 to 800 m apart (Vuchic, 1981), with stations spaced further apart in the suburbs than in the central business district. (See Figure 4.)

3. LAND USE IMPLICATIONS

3.1 General

Legislation in many American states requires environmental impact studies to be carried out before any project is undertaken by a governmental agency. These studies would include the effect the system would have on the physical environment, its socio-economic influence and also what the *growth inducing impacts* of the project would be.

The growth inducing impact can be regarded as a component of the impact on land use, and this element usually has a positive connotation, as opposed to the other impacts which are usually studied to determine any possible negative effects they may have. The positive environmental impact of the introduction of a new public transportation system is mostly ignored in South Africa, but this impact can become a powerful tool in stimulating the development of new shopping and employment centres within metropolitan regions, and even in financing new transit interchange facilities.

3.2 Growth inducing impacts: Coordinating land use and Transportation Planning

3.2.1 The advantages

The combination of office and retail developments which followed new investment in quality transportation facilities in cities such as Toronto, has

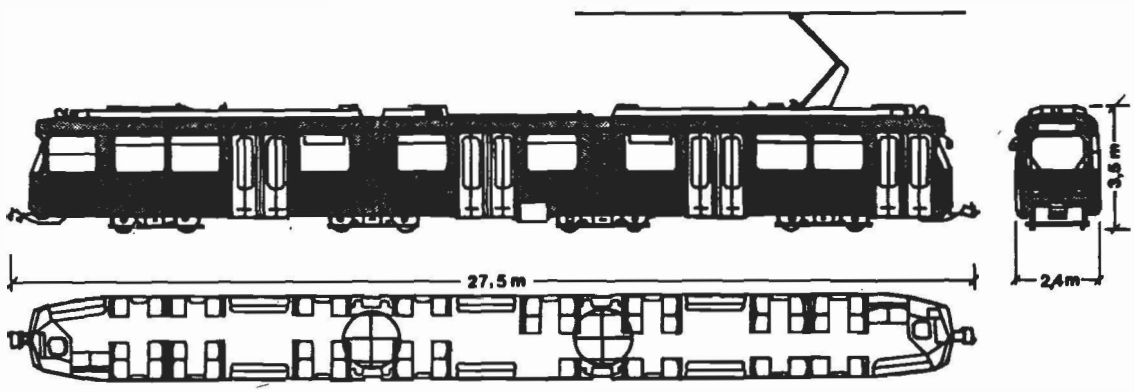


Fig. 2. A typical LRT vehicle

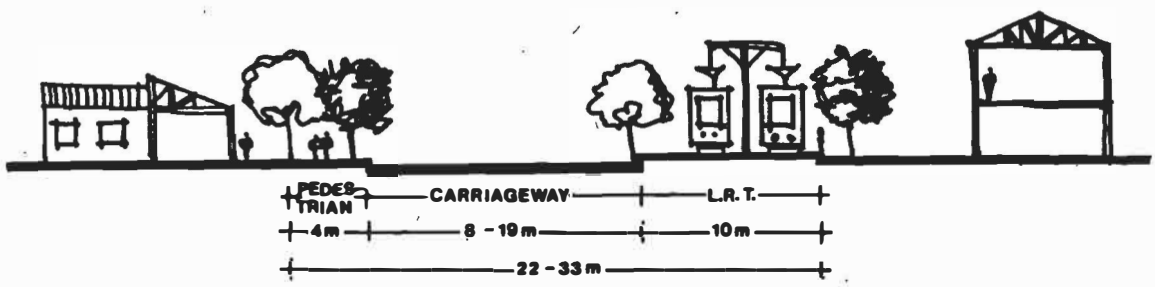


Fig. 3. A lateral asymmetric ROW

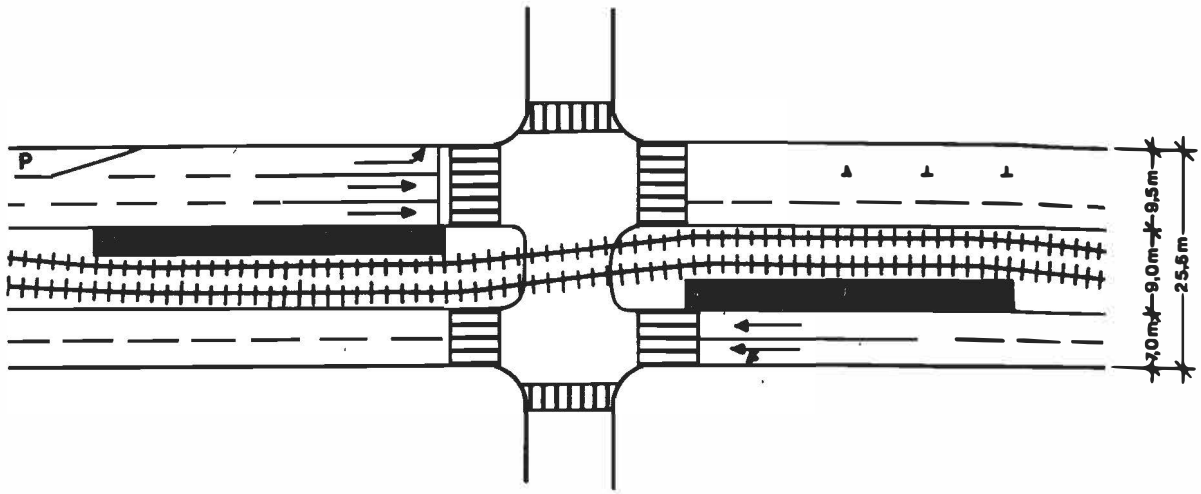


Fig. 4. A typical LRT stop

resulted in the spatial concentration of transit demand, as well as in spreading the demand over time, thus contributing towards a more cost-effective service. The proper coordination of land use and transportation planning will therefore not only result in the development of new employment and shopping centres at selected stops, but also encourage more people to use the system in both directions, both in peak and off-peak periods.

These new nodal points usually interest private enterprise whose expertise and capital can be utilised to develop and finance the interchange facilities, thus lessening the burden on the taxpayer. This principle is already applied in overseas countries. In Vancouver for example, one land owner actually paid the transit authority to use part of his land for a new light rapid transit station, as this would increase the viability of the hotel and shopping centre he planned for the site (Porteous).

3.2.2 Regional impact: The Vancouver experience

- *The City:*
  Greater Vancouver is Canada's major port on the Pacific Coast. It has 15 municipalities, a regional authority and a population of approximately 1,2 million. Its central business district is situated on the coast and in many ways the city is not unlike Greater Cape Town. (See Figure 5.)

During the 1960s and 1970s Greater Vancouver developed a concentration of job opportunities in central Vancouver, and rapid labour force growth in the outer lying suburbs. The result was an increase in the number of long distance commuters, traffic congestion and a demand for costly transportation facilities (Kellas, 1983).

- *The Strategy:*
  To overcome this imbalance, the authorities developed a strategy to decentralise job opportunities by encouraging the growth of four regional town centres within the metropolitan region. This strategy was implemented by the construction of 22 km of a new light rapid transit system which linked the proposed regional centres with central Vancouver. Local buses provide a feeder service to these centres which serve as transit interchange facilities and thus became highly accessible nodes in the region. A new commuter service was therefore planned not only to provide commuters with an efficient public transportation system, but also to change the region's land use pattern.
  The Greater Vancouver strategy is based on four basic objectives (Greater Vancouver Regional District, 1983). ***Firstly***, the highly accessible regional town centres were planned to provide attractive locations for office and shopping development as alternatives to central Vancouver. This would increase suburban job opportunities and increase central Vancouver's potential for additional housing. ***Secondly***, the regional centres will increase both the level and variety of services in the suburban areas. ***Thirdly***, major suburban concentrations facilitate improvements to the public transportation system by increasing the number of transit commuter trips and by encouraging travel in both directions. ***Finally***, this policy will result in a more equitable distribution throughout the region of the costs and benefits of higher density development.

3.2.3 Local Impact: Utilising increased land values

3.2.3.1 General

An increase in land values around new stations is a common phenomenon, especially if the local authority is prepared to rezone the land to permit more intensive land use. Consequently, a public investment results in an increase in land values accruing to the land owner. A number of mechanisms can be used to recover a portion of these benefits to finance elements of the transit system; as fixed guideway transit systems very rarely pay for themselves:

- An enhancement levy may be charged. This system is presently in use in the Cape Province where 50% of the increase in land value in cases of re-

zoning must be paid to the local authority.

- The authorities may engage in land banking, whereby land in the vicinity of stations is bought up before property prices increase. This system has been practised in Toronto and has the added advantage that it may facilitate the implementation of master and site plans prepared for the area in question.
- The authorities may develop the area jointly with private enterprise. This system normally is viewed as a means to get the private sector to contribute to station embellishment. This practice is widely used in Europe and has now also become an accepted practice in North America.

3.2.3.2 The San Diego example

- *The City:*
  San Diego is situated on the American West Coast, just north of the Mexican border. The region contains 14 cities, the largest of which is San Diego, with a regional population of approximately 1,8 million. The LRT system runs from the San Diego central business district southwards over a distance of approximately 25 km to the Mexican border. There are a total of 18 stops, with 11 outside the central areas at an average spacing of 2 km. The service was established on an existing goods line which still carries goods traffic at night.
- *The Strategy:*
  A study (Harmon, 1978) was undertaken for the San Diego Metropolitan Transit Development Board to determine the impact a new LRT line would have on land use in the vicinity of stations. The long term economic outlook for general residential and commericial development (the most obvious land uses in the vicinity of new stations) within the region was firstly established; thereafter different development stategies were investigated. These ranged from corridor policy decisions such as the development of a comprehensive long term land use plan, to the available fiscal tools such as density bonuses and tax incentives, which could be applied in the development of station areas.

  A detailed investigation of each station area was undertaken and recommendations regarding the joint development potential of each were made. One of the most important recommendations was that the authorities themselves should develop at least two of the five station sites with high short term development potential. "This approach would ensure that the joint development stimulus of the proposed light rail system is demonstrated to the private sector during the early phases of system implementation".

  The study was concluded with the statement that it expected the development influence of the LRT line from San Diego to the Mexican border, to be in the order of $30 million in private sector joint development investments outside the CBD, during the system's first five years of operation. The level of subsequent long term investments would be equal or even greater in value. In addition, the land in the vicinity of one station which was designated a "town centre", could be assembled by the authorities, rezoned and leased on a long term basis to a private developer. It was calculated that the annual public sector lease returns from this project could be equal to the annual "net" operating costs of the first phase of the LRT system.

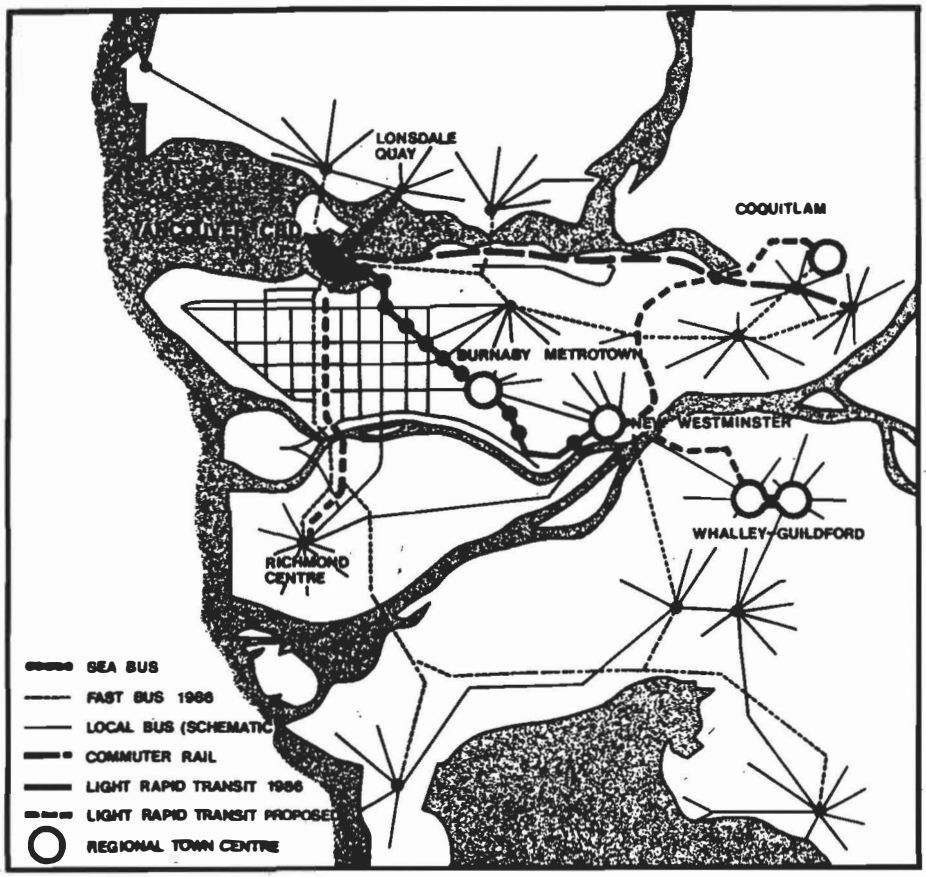


Fig. 5. Greater Vancouver

4. ATLANTIS: A SOUTH AFRICAN APPLICATION OF LRT

4.1 General

Atlantis is a new city being planned for 500 000 people approximately 45 km north of Cape Town. The area has been proclaimed as a growth point with the aim of deconcentrating housing and employment from the Cape Metropolitan area, and is being developed by the Cape Divisional Council with funds provided by the Central Government. Since work started in 1974, a total of

5 392 dwelling units and 142 factories (employing 9 220 people) has been completed. A conventional railway line linking Atlantis with Cape Town has also been completed.

4.2 The Structure Plan

Various planning reports for the Atlantis project have been completed, but the two most relevant ones are a transportation study (Scott, 1982) completed in 1982 and a revised structure plan report completed in 1984. (Plan Associates, 1984.) The transportation study concerned itself primarily with aspects such as the distribution of land uses on a "city wide" scale, and the transportation system which will best serve it. The structure plan report on the other hand, focused more on aspects such as urban form and how the transportation system can best be integrated at the local level.

Bearing this in mind, and also taking into account the principles established by the Driessen Commission, it was decided that a desirable transportation objective for Atlantis would be the provision of an attractive public transportation system, carrying up to 50% of internal commuters. A public road system will ensure that the remainder can use their cars in reasonable comfort.

- *Transportation alternatives*

The physiography of the project area is such that the land available for urban development measures approximately 19 km by 5 km. This configuration can best be served by a transportation network of a linear form with longitudinal spinal routes and crossroads completing the grid. Four alternative urban structures were developed along these lines and tested through a transportation modelling technique. Each network was tested for two modal splits where respectively 50% and 34% of the commuters used public transportation for internal trips. The models tested also included a number of alternative land use strategies. This helped to coordinate the land use and transportation systems and resulted in a balanced distribution of employment centres and in better trip distribution.

Basic to the final proposals is the concept of routes dedicated to the exclusive use of public transportation. These corridors are fundamental to achieving an efficient public transportation system and have been designed to ultimately accommodate LRT. (See Figure 6.)

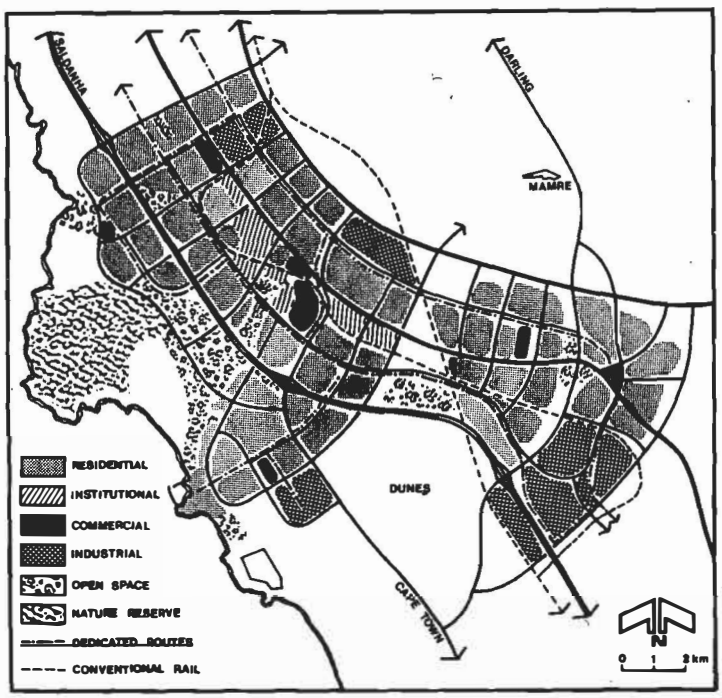


Fig. 6. Atlantis Structure Plan

4.2.1 The transportation study

- *Premise*

Travel patterns over the last 30 years have changed in favour of the private car. The cost of new freeways and the impact that these road networks have had on the environment (without solving the transportation needs, especially those of the lower income groups) have however, forced transportation planners to plan better balanced transportation systems for the future.

4.2.2 Urban form

- *Environmental areas*

Within the overall framework, Atlantis will consist of a number of environmental areas not traversed by through traffic. Each environmental area will contain approximately 2 000 dwelling units supporting 3 primary schools and 1 high school, as well as a commercial element and community services. The environmental area constitutes a functional unit and has been utilised as a useful planning tool.

Unlike the traditional neighbourhood unit which locates shopping and community facilities at the centre of the unit, the concept for Atlantis provides for the grouping together of environmental areas and shopping centres. Two environmental areas are grouped around a single district centre which is located on an activity spine. Concentrating activities and higher residential densities along this spine will improve the viability of the public transportation system and the spine is therefore designed to accommodate a dedicated public transport route. (See Figure 7.)

The advantages of this concept are that the viability of the shopping centres can be improved because they are accessible to larger numbers of people, but the environmental areas remain sufficiently compact to preserve a human scale. The larger catchment area of the shopping centre will support a wider range of shops and services and the viability of the public transportation system is improved. A small local shopping centre with some community facilities will be located within each environmental area to cater for the daily needs of its inhabitants.

- *Dedicated routes*

The dedicated public transport routes adopted for Atlantis are planned to connect residential areas with the employment zones, town centres and central business district. Light rail

stops are located so that the maximum walking distance from a house or factory is no more than one kilometre. These stops will become concentrations of activity as people congregate to embark or disembark, and are therefore located as far as possible at shopping and community centres. The road system will cross the dedicated routes only at controlled intersections and the number of these crossings are confined to a minimum.

4.2.3 Implementation

Although the transportation system has been designed for an ultimate population of 500 000 by the year 2020, public transportation will be required long before that date. Interim urban development should therefore be of such a nature as would encourage the use of public transportation. Linear development with attractions at both ends and activity nodes along it, usually facilitate the introduction of an efficient public transportation system, and it was therefore decided to develop the first phases of the city along these lines.

The implementation strategy for Atlantis is therefore aimed at staging interim development to grow into a linear form by developing adjacent environmental areas on both sides of an activity spine. This interim development will consist of three industrial areas, the central business district and three town centres along it, and accommodate approximately 270 000 residents. It could exist as an entity and has the added advantage of having the potential to be further extended according to the provisions of the structure plan. (See Figure 8.)

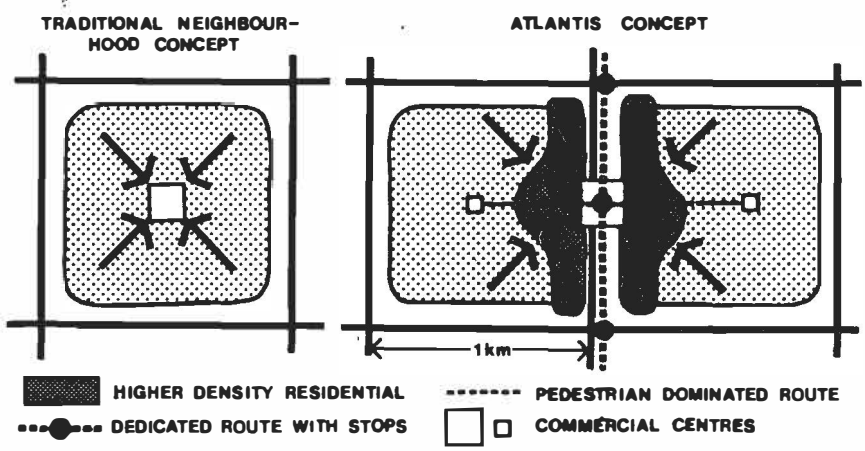
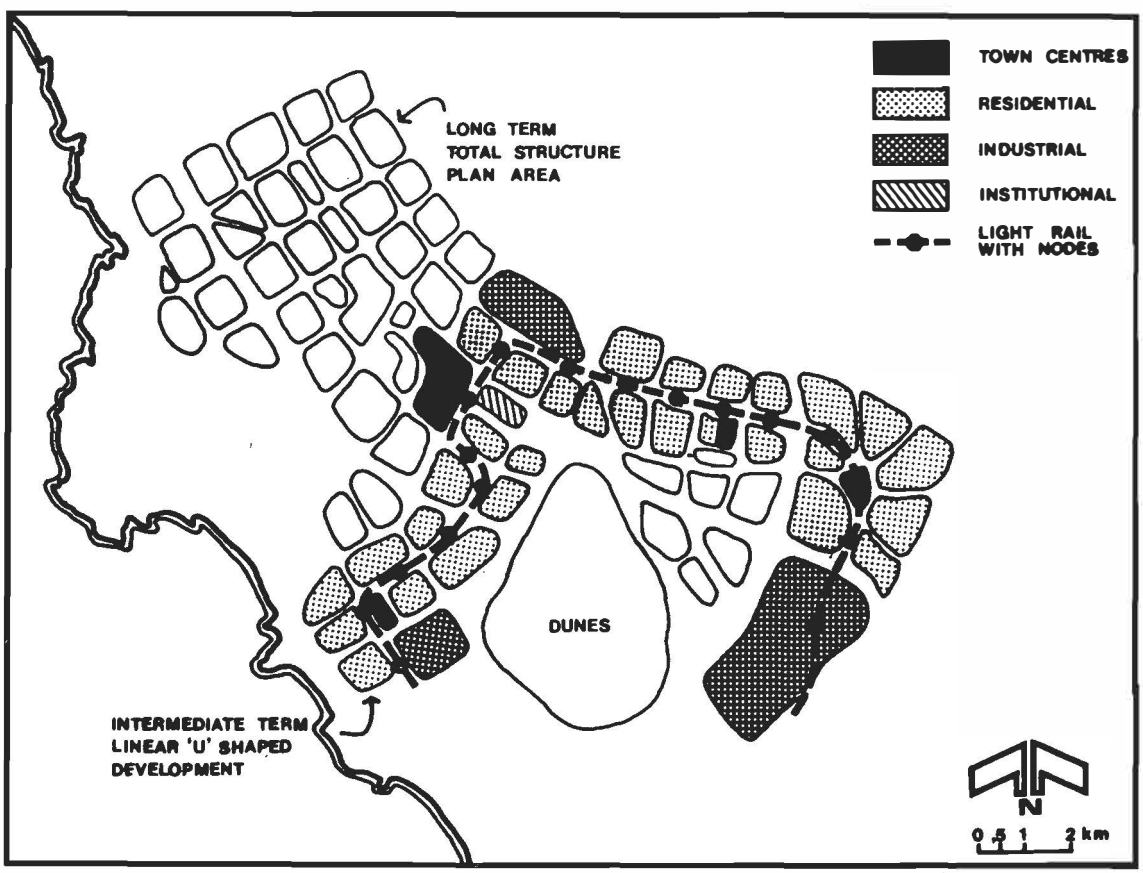


Fig. 7. Environmental areas

During the interim stages buses will share a district distributor road on the activity spine along with other traffic. When required, an LRT line can then be constructed within the adjacent dedicated reserve without disrupting established land use patterns. At that stage buses may serve to feed the LRT system. (See Figure 9.)



5. CONCLUSION

LRT represents a mode of transport which can no longer be ignored in South Africa. Not only is it a relatively cheap form of public transportation with a high capacity, but it also offers both strategic and socio-economic advantages. The strategic advantages stem from the fact that its power source, electricity, can be produced economically in South Africa. Its socio-economic advantages are obvious when its capital cost is compared with that of heavy rail and new freeways in urban areas, and if one bears in mind that it would provide greater mobility to especially the lower income groups.

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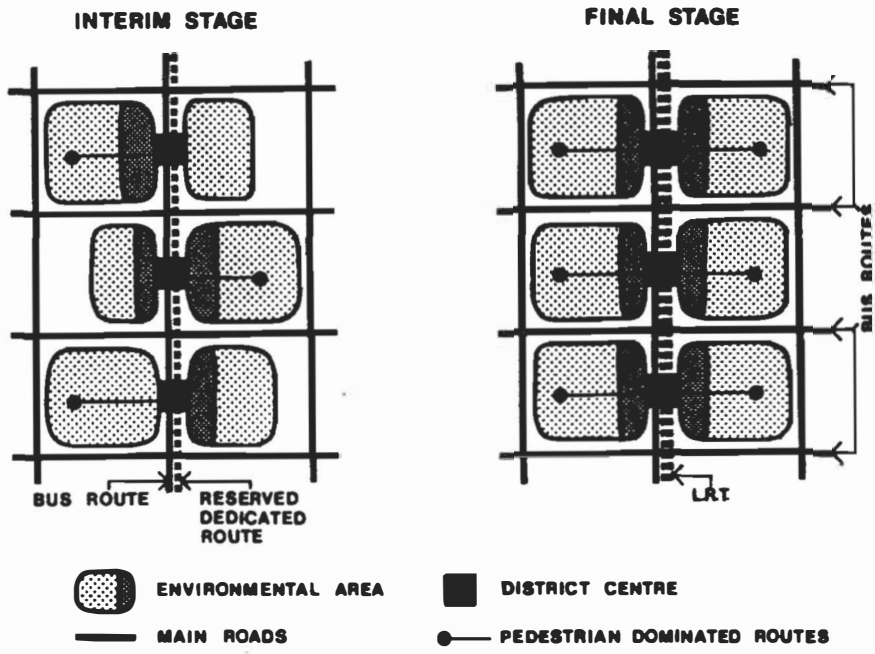

Fig. 9. Phasing