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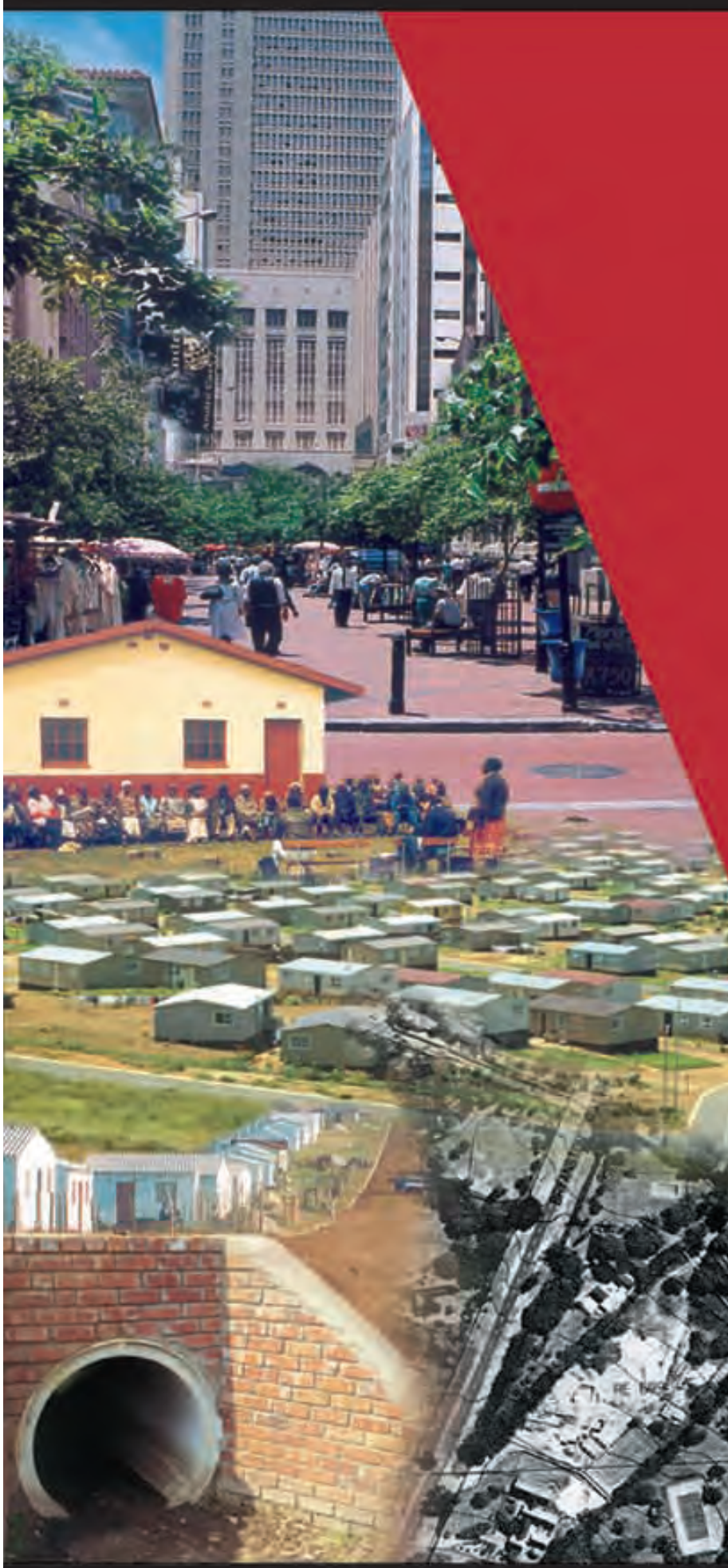

HUMAN SETTLEMENT PLANNING AND DESIGN

VOLUME 1

Compiled under the patronage of the Department of Housing

by CSIR Building and Construction Technology

Compiled under the patronage of the Department of Housing

by CSIR Building and Construction Technology

FOREWORD

The establishment of economically, physically, environmentally and socially integrated and sustainable built environments is one of the most important factors which will contribute to harnessing the full development potential of South Africa and addressing distortions of the past and the future needs of our growing population. This goal cannot be achieved without the active participation of especially local government, the private sector and communities in partnership with one another.

This manual, *Guidelines for Human Settlement Planning and Design*, provides a guiding vision for South African settlement formation, addressing the qualities that should be sought after in our human settlements, and providing guidance on how these can be achieved. The publication has been developed over a period of more than two years through a participative process in which stakeholders and experts from various disciplines were involved.

This book is intended to be a living document and you, the reader, are one of its architects. I therefore encourage you to use it, discuss it and debate the guidelines it contains. Still, this work is not the last word on the subject, and your feedback and comments would be welcome. Your active involvement will be the key to the successful attainment of sustainable, habitable living environments in South Africa.

MS S MTHEMBI-MAHANYELE
MINISTER OF HOUSING

Published by CSIR Building and Construction Technology
P O Box 395, Pretoria, 0001

Boutek Report No. BOU/E2001

Reprint 2005
Capture Press, Pretoria

ISBN 0-7988-5498-7

ACKNOWLEDGEMENTS

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Cover design:

Truter & Truter Design & Advertising (Pty) Ltd

Design and layout:

African Watermark Graphic Design

RECORD OF REVISIONS AND AMENDMENTS

Revisions: Remove existing chapter(s) and substitute with the attached revised chapter(s).

Amendments: Remove existing page(s) and substitute the attached new page(s). A vertical line in the margin shows where a change has been made (there are no amendments to date).

Date	Chapter	Title	Rev No.	Amdt No.	Page number(s)
August 2003	9	Water supply	1	-	All
August 2003	10	Sanitation	1	-	All

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Chapter 1

1

Introduction

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BACKGROUND

This document is the result of a collaborative effort by several government departments under the auspices of the Department of Housing. Mutual concern for the quality of the built environment and the country's natural resources, as well as a common recognition of the role that human settlement planning and the provision of engineering services plays in its protection or destruction, was the catalyst for this multi-departmental cooperation. The process was overseen by a coordinating committee consisting of representatives of the various departments, whose main role was overall guidance, policy direction and financial control. Detailed guidance and control of the written content was provided by various steering committees, each consisting of a number of practitioners acknowledged for their expertise in the particular fields. The work was contracted to the CSIR in accordance with a detailed proposal submitted to the then National Housing Board in August 1995. Overall project management was undertaken by the CSIR's Division of Building and Construction Technology, while other divisions, as well as various external organisations, also provided technical and related expertise.

NEED FOR A REVISED DOCUMENT

This aspect is best explained by a brief summary of, first, the developments leading to the publication of the first edition of the *Red Book* and, second, the workshops that followed this event. These ultimately led to the formulation of a detailed proposal for a complete revision of the document and the multi-departmental initiatives for funding and guiding the process.

Historical perspective

For many years it has been widely recognised that the cost of providing engineering services forms a significant component of the overall cost of housing. Where capital subsidies for housing schemes are involved, the cost of engineering services could consume anything between 50 and 100% of the subsidy, depending on, among other things, site conditions and levels of service provided (Schlotfeldt 1995b). In any development scheme, therefore, layout planning and the concomitant design of engineering services should receive particular care and attention in order to optimise the levels of service within the given financial parameters. Until comparatively recently engineers were seldom presented with the complex task of choosing between a great variety of service options, particularly in the fields of water supply and sanitation. The policies of the various authorities largely dictated the levels of service to be provided in each case, and engineers merely confined themselves to the technical and contractual aspects of design and construction (Austin 1996).

The last two decades, however, have seen the recognition of, first, the effect of layout planning on the cost of providing engineering services and, second, the impact of services on the continually rising cost of housing. They have also seen the appearance of various guideline documents aimed at optimising the provision of services which are not only of sound engineering quality but acceptable (both financially and technologically) to the recipient communities as well. *The Blue Book*, *Green Book* and *Red Book* guidelines prepared by the CSIR take their titles from the colour of their respective ring binders, and represent some of the efforts made over this period to address the issue. This revised document has evolved partly as a natural progression from the previous guidelines, but has also been substantially revised and expanded to present a holistic, integrated approach to settlement planning.

The previous edition of the Red Book, entitled *Guidelines for the provision of engineering services and amenities in residential township development*, was completed in 1992. Due to the political changes taking place in the country at the time, however, the document was not published until 1994. It was furthermore realised that the guidelines were no longer capable of meeting the challenges facing developers in the times of societal change which the country was experiencing. The book was considered to have a number of shortcomings which restricted its usefulness in the drive to produce sustainable and vibrant human settlements, as opposed to mere serviced townships (Austin and Biermann 1998). Some of the perceived shortcomings were: outdated and unwieldy urban-planning principles, insufficient information on various appropriate engineering technologies, and a general lack of an integrated approach to settlement planning. It was therefore decided to gather feedback from users of the book by means of a series of countrywide workshops, where these and other problems could be debated by experienced professionals.

The purpose of this document is not merely to assist professionals in producing efficiently serviced "townships", but rather to create sustainable and vibrant human settlements. This approach is reflected in the new title of the book - *Guidelines for Human Settlement Planning and Design* (Austin and Biermann 1998). In this context, a "human settlement" is regarded as any built environment where people live, work and play, with the provision that only residential areas, and other developments associated therewith, are considered in this book.

A "living document": the Red Book workshops

In terms of its mandate, the Division of Building and Construction Technology has undertaken to maintain the *Red Book* as a continually updated "living document" (Schlotfeldt 1995a). Standards should be seen as a reflection of society's values at any given time; moreover, values and priorities are not inflexible but rather in a constant state of change. Technology also develops and changes and the *Red Book* should reflect this evolution. A series of five workshops were held in February and March 1995 in Bloemfontein, Cape Town, Pretoria, Durban and Port Elizabeth, where users and other interested parties were afforded the opportunity to discuss the applicability of the guidelines and provide constructive criticism with a view to the document's improvement and further development. Other forums, such as conferences and meetings of a number of professional societies, were also used as platforms for discussion and information concerning the book.

The workshops were attended by nearly 700 delegates representing a wide range of interests (e.g. consulting engineers, urban planners, local and regional authorities, provincial and central government departments, universities, technikons, developers, manufacturers, financiers and NGOs). The result of the deliberations was a great number of valuable recommendations and suggestions for improving the guidelines, as well as many requests for additional guidelines on various subjects. All the recommendations received serious consideration and the vast majority have been taken up in this revised document. There was consensus amongst all parties present at the workshops that, in any development, a holistic, integrated planning process is an essential requirement and that planners, engineers and other professionals need to work together right from the conceptual stage of a project to achieve this. It is largely as a result of the input from the planning profession during these and later deliberations that not only was a framework for the redevelopment of the urban planning guidelines produced, but also the guiding philosophy for the entire document.

Investment in infrastructure is crucial to the efficiency and habitability of our urban areas. World Bank research (South Africa 1995) indicates that investment in infrastructure stock has a significant impact on GDP growth, as infrastructure raises general levels of welfare and health. It is also realised, however, that eliminating - or even just reducing - the housing backlog will simply be beyond reach if the highest level of infrastructure (i.e. fully reticulated water and electricity supply, full waterborne sanitation, etc) is regarded as the norm. There needs to be space for incremental approaches to provide sustainable and affordable levels of service while ensuring acceptable and adequate functionality. Creative and varied solutions are thus required, and it is not necessary to confine housing strategies to conventional methods and technologies. A balance between established practices and new ideas and developments is thus required.

PURPOSE AND LEGAL STATUS OF THIS DOCUMENT

Urban planners and engineers are continually confronted with the dichotomy of the needs or aspirations of communities versus their ability to pay for housing and services (Austin 1996). The central government has set limits on its ability to provide grants and subsidies for services. Local governments will therefore be largely responsible for making provision for access to most of the engineering services and amenities by persons residing within their area of jurisdiction. Furthermore, these services and amenities must be rendered in an environmentally sustainable manner and must also be financially and physically practicable. Information is thus required on all available service technologies and complementary spatial settlement planning, so that informed decisions may be made on what is most suited to a particular community and what is sustainable.

The need for this information is not confined to technical professionals only. All those who are required to take decisions on policy at the various levels of government or within non-governmental organisations can benefit substantially by having greater insight into the possibilities and limitations of various available options. Such insights will enable them to interact more effectively with consultants and community structures, and the *Red Book* is also aimed at providing these insights in a manner that is both understandable and useful to non-technical persons.

For sustainable progress, as well as for the general health and well-being of the population, settlements should be coherently planned; there should furthermore be a choice between a range of affordable technologies, particularly in the water-supply and sanitation fields. Service levels should be appropriate, as a high level of service which fails (for whatever reason) may well pose a greater threat to public health and the environment than an inadequate lower level of service. Various factors, for example high population densities or adverse geotechnical conditions, may also dictate that consideration be given to alternative types of service technology. However, only proven designs should be used and, ideally, communities should be able to exercise choice within a range of approved designs. In this context, appropriate technology may be defined as "meeting the needs of a particular community at a particular time".

In order to achieve the above objectives, engineers and urban planners need to be provided with *guidelines*, as opposed to standards. Guidelines are intended to assist decision-making, whereas standards are enforceable absolute limits (Schlotfeldt 1995a). It is recognised that both the rigid application of guidelines as well as the setting of inappropriate standards can have the opposite effect to that intended. The inter-departmental coordinating committee tasked with overall direction of the revision of the *Red Book*, as well as the steering committees involved, were of the opinion that the concept of "guidelines" should continue to prevail, and that the provisions of this document could thus not be legally enforceable. The use of these guidelines by the various disciplines involved in the design, supply and management of serviced land for residential development would be strongly encouraged, however.

It should be noted that only "local" services and planning issues are considered. Bulk services and amenities - for example main water supply pipelines, outfall sewers, treatment works, landfills, freeways and so forth - are considered beyond the scope of this document.

The intention of the new *Red Book* is to provide performance-based guidelines for informed decision-making. The purpose is essentially to indicate the qualities that should be sought in South African settlements, and to provide practical guidance on how these qualities can be achieved. The document is therefore intended to be educative, providing ideas and useful information, and not as a substitute for innovative planning and engineering practice (Behrens 1997).

ROLES AND INTERACTION OF PROFESSIONALS INVOLVED IN THE BUILT ENVIRONMENT

The primary readers of this book will be the range of professional and other persons that contribute to the planning and design of human settlements (i.e. architects, urban designers, town and regional planners, civil, transportation and electrical engineers, energy practitioners, etc) from both the private and public sectors. The document attempts to integrate information that is relevant across different disciplines and, unlike its predecessor, moves away from having separate and exclusive sections on "engineering" and "planning".

The fullest cooperation between the various professionals engaged in human-settlement planning is crucial to achieving sustainability, and thus also replicability (Austin and Biermann 1998). A common strategy is required in order for the development process to be geared towards meeting the particular needs of communities in a manner which is acceptable to them, and not merely acceptable to the planner, designer, financier or local authority. The guidelines represent a balanced and integrated approach to settlement planning and, although unlikely to satisfy everybody, represent the culmination of four years of intensive planning, research, writing, debate, questioning, criticism and rewriting. Engineers, architects, urban planners and academics have worked together and achieved basic agreement on the requirements for housing the nation in a sustainable manner.

This document is the result of input from a wide range of participants. Relevant national and provincial government departments were involved through representation on the coordinating committee. Local government, the private sector, academics and organised professional bodies participated through the various steering committees. Academic and practising experts contributed by authoring sections of the book. Specialist workshops, involving a broader spectrum of expertise, were held at key stages during the process to debate concepts and drafts. Universities, professional engineering and planning bodies, relevant national, provincial and local government departments and bodies, as well as selected practising consultants, all formed part of a beta-testing programme, where the final draft was distributed to a sample of potential users of the book for comment.

HOW TO USE THE DOCUMENT

This document is explicitly not intended to be an administrative "check list" for local authority officials (Behrens 1997). It will instead provide guidance on appropriate practices and technologies. Emphasis is placed on assessing "performance" (in relation to issues like health, safety, recreation, education and trade) as opposed to simply assessing the quantitative dimensions of the plan to ensure some form of compliance with stated norms. Once again it is emphasised that these are *guidelines*, not specifications. The document therefore does not remove professional responsibility from practitioners, and certainly does not replace the need for professional experience and judgement. The contents should therefore not be rigidly applied, but rather perceived as an aid to preparing one's own project plans and specifications.

Various national and provincial government departments, statutory bodies and local authorities may also have their own sets of guidelines for use by planners and engineers. It is not the intention of this document to take the place of these other guidelines. Rather, the *Red Book* should be considered as being supplementary to them, because local conditions and experiences can often dictate what procedure should be followed in specific cases.

STRUCTURE OF THE DOCUMENT

Although significant effort was made to approach the revision process in an integrated manner, the presentation of the material in document form required it to be divided into manageable and readable sections.

Chapter 2 provides a guiding philosophical framework for the entire document and discusses an appropriate context for settlement-making relating to the two central concerns of human- and nature-centred development. Performance qualities are identified, clarifying desirable achievements in settlement formation. The nature and planning of human settlements is described and the importance of structure is emphasised.

Chapter 3 focuses on settlements as systems made up of functionally interrelated elements. The chapter sets out the starting points for achieving positively-performing settlements, the principles that are important in achieving highly functional settlements and provides a synthesis of the principles as well as an application of the principles and the planning guidelines. Chapter 3 can therefore be seen as providing the link between the framework presented in Chapter 2 and the practical guidelines provided from, and including, Chapter 5.

Guidance on the planning method and the participation required is given in Chapter 4, where human-scale development and partnership-based participation are advocated.

Chapter 5 provides qualitative and quantitative guidelines relating to the planned elements of a settlement system. Its sections relate to the following interrelated - and somewhat artificially separated - planned elements of settlement systems: (5.1) movement networks; (5.2) public transport systems; (5.3) hard open spaces; (5.4) soft open spaces; (5.5) public facilities; (5.6) land subdivision; (5.7) public utilities and (5.8) cross-cutting issues. The purpose of presenting the various planned elements of settlement systems separately, is to present useful information relating to settlement systems in an accessible and distinguishable way, rather than to suggest that these elements of the settlement system should be planned in isolation.

Section 5.8 focuses on cross-cutting issues that have relevance across both the planning and engineering spectrums. These include environmental design for safer communities (5.8.1), ecologically sound urban development (5.8.2), and fire safety (5.8.3).

Chapter 6 sets out stormwater management principles in a manner which complements and reinforces the foregoing urban design principles and the following chapters on road design, sanitation and solid waste management. Road layout issues were prepared largely in conjunction with the movement networks guidelines (5.1) with the result that Chapter 7 has been confined largely to detailed engineering issues while the geometric planning component has been incorporated into section 5.1. Chapter 8 provides a comprehensive and modern approach to road pavement design, construction and maintenance, with special emphasis on lower-order roads.

The water supply and sanitation chapters (Chapters 9 and 10) have been thoroughly revised in order to make them more useful and relevant. The previously incorporated section on water treatment has been removed as it is considered to be a bulk service and thus beyond the scope of this book; it is furthermore regarded as a specialised subject, which cannot be given justice in a broad guideline document of this nature. The details on waterborne sewerage design have also been removed, with other design manuals being referred to instead. The guidelines have concentrated, rather, on providing designers with broad background information on the multiplicity of sanitation systems available, to enable them to apply the most appropriate technologies under the specific circumstances, while providing sufficient reference material for their needs.

The solid waste management section (Chapter 11) sketches the legislative background pertaining to waste handling and also sets out the different levels of service in a way which maximises employment and opportunities for entrepreneurship. On-site storage, transfer stations and recycling operations are also described. Landfills are not dealt with as they are regarded as a bulk service. However, broad guidelines pertaining to landfills, in so far as they are required for settlement planning purposes, have been included.

Guidelines on energy (Chapter 12) have been presented in two parts, the first part dealing with conventional grid electricity and the second with alternative and renewable energy sources. The latter section includes details on “clean” technologies such as solar power and other appropriate energy opportunities for poor or small rural communities. Urban planning principles which facilitate the application of alternative energy technologies are also encouraged.

CONCLUSION

The concept of *sustainability* is a philosophy common to all sections of this guideline document. Sustainability should always be the main concern in any type of development. This has the following implications (Miles 1995):

- development projects should contribute to technology transfer and skills development;

- beneficiaries must have effective control of their environment;
- an operational and sustainable product or system must be delivered; and
- systems should be capable of being operated and maintained using local resources.

The emphasis has shifted from merely providing serviced erven in the most cost-effective manner to the creation of sustainable living environments and thriving communities. New demands are being placed on professionals involved with the development of human settlements, from the application of unfamiliar technologies to social science and community organising skills, as well as technology transfer and skills development. It is expected that such professionals will increasingly turn to guideline-type documents in order to obtain the required information. It is thus imperative that the revised *Red Book* remains a living document; constant input by practitioners and researchers will ensure that this goal is achieved. Constructive criticism and comment from users of the document will therefore be welcomed.

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Chapter 2

A framework for settlement-making

2

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INTRODUCTION

The purpose of this chapter is to provide a guiding framework for settlement-making. The chapter provides a brief overview of planning and design in South Africa, which expresses the need for a new framework, before setting out the two central concerns - namely human and nature-centred development - which form the basis of the framework. The starting points to achieve positively performing settlements are provided before performance qualities, clarifying the desired achievements in settlement formation (guided by developments in the planning policy arena) are identified. These are applicable to all the subsequent planning and engineering chapters. Finally, the importance of structure in the planning of human settlements is described.

BACKGROUND

For some fifty years, the planning and design of settlements in South Africa has been dominated by the political ideology of separate development and the planning ideology of modernism.

A central theme of the modernist movement is its basis in functionalist thought, which is dominated by concerns with efficiency and technology. Efficiency is largely defined in technological terms, with urban settlements seen as "machines". Urban life is compartmentalised into broad categories of activity (live, work, play, move), resulting in spatial separation of these activities.

These ideologies have lead to the development of mono-functional settlements, often fragmented and environmentally sterile. These settlements - particularly those created for the disadvantaged members of our society - are characterised by low levels of service and high levels of inconvenience; they generate enormous amounts of movement at great cost in terms of money, time, energy and pollution; they are expensive for inhabitants, and the quality of their public environments is appalling. There is little evidence of a cohesive spatial environment which integrates urban activities and structures.

With the advent of the "new South Africa", it is necessary to reverse the effects of these ideologies. The challenge is to create a framework for settlement-making which will enrich life in settlements and serve as an instrument of urban reconstruction and development. This has already been accepted in policy terms. The government's Urban Development Framework (South Africa 1997) calls for "the physical, social and economic integration of our towns and cities" and stresses the need for higher density, more compact and, in terms of land use, more mixed-use settlements. Similarly, the Development Facilitation Act, No 67 of 1995 (South Africa 1995), inter alia, calls for environments which

- promote the integration of the social, economic, institutional and physical aspects of land development;
- promote integrated land development in rural and urban areas in support of each other;
- promote the availability of residential and employment opportunities in close proximity to or integrated with each other;
- optimise the use of existing resources, including resources relating to agriculture, land, minerals, bulk infrastructure, roads, transportation and social facilities;
- promote a diverse combination of land uses, also at the level of individual erven or sub-divisions of land;
- discourage the phenomenon of "urban sprawl" and contribute to the development of more compact towns and cities;
- contribute to the correction of historically distorted spatial patterns of settlement in the Republic and to the optimum use of existing infrastructure; and
- encourage environmentally sustainable land development practices and processes.

This framework should begin to move us in this direction. It is based on the integration of the human and nature-centred approaches to settlement-making.

CENTRAL CONCERNS

The human-centred approach emphasises that a central purpose of planning is to ensure that the developmental needs and activities of people living in settlements are catered for and, in particular, that opportunities for people to achieve their full potential through their own efforts are maximised. This approach, rather than being purely cost - or technologically-driven, is people-driven and democratic.

The nature-centred approach recognises that natural systems interact in highly synergistic ways, which must be respected if breakdowns in them are to be prevented. Human actions on the landscape, such as settlement-making, must thus be sensitive to ecological processes. Therefore, rather than imposing settlement development on the environment, this approach emphasises design with nature, thereby creating synergy between man-made and ecological systems.

THE STARTING POINTS

There are three starting points for achieving positively performing settlements.

- The first is the importance of pedestrian movement. A fundamental dimension of scale is related to movement on foot. The pedestrian condition describes the reality for the majority of residents in towns and cities in the country. Large numbers of people do not, and will not in the foreseeable future, own private motor vehicles. Obviously, though, settlements cannot be only pedestrian-based.

  Settlement growth brings with it higher order opportunities, services and movement systems. Consistent with the principle of equity, particularly in communities with low levels of car ownership, public transport becomes a necessity once the pedestrian scale is exceeded.

- The second starting point is the importance of thinking spatially. In pedestrian-scaled environments the public spatial environment should be viewed as the highest level of social infrastructure. In these environments a great deal of activity occurs in the public spaces, with the result that the quality of the public-spatial environment profoundly affects the quality of life. Thinking spatially, in this context, requires that all public spaces, particularly streets, be viewed as public space.

- The third starting point is the importance of a *minimalist approach* to settlement-making. This requires that the basic structure and most important actions required to create the preconditions for a positively performing settlement be defined at the outset of the settlement-making process. Over-design of the process reduces spontaneous settlement-making activities.

WHAT WE SHOULD BE TRYING TO ACHIEVE: PERFORMANCE QUALITIES

The integrated approach on which the framework for settlement-making is based, makes it possible to identify performance qualities, which should guide plan-making and against which plans and settlements can be monitored and measured.

Environments reflecting these performance qualities have the following physical characteristics:

- they are scaled to the pedestrian, although commonly neither the pedestrian nor the motor car has absolute dominance;
- they are compact, having relatively high building densities;
- their structural elements are integrated and the composite parts reinforce each other;
- they have a strong spatial feel, with well-defined public spaces; and
- their spatial structures are complex, offering choices in terms of intensity of interaction, privacy of living conditions, lifestyles, housing options and movement systems.

Efficiency of resource use

The development of settlements requires the use of a wide range of resources, including land, money, building materials, manpower, energy and water. As a general principle, it is essential that resources be used as efficiently as possible.

Opportunity generation

People come to settlements to improve their personal welfare. The opportunity to improve one's lot derives from the economic, social, cultural and recreational opportunities resulting from the physical agglomeration of people in settlements. However, the capability of settlements to generate opportunities is not only determined by numbers of people, it is also affected by how settlements are ordered and made.

Of importance to developing countries, such as South Africa, is the need to create opportunities for small-scale economic activity. The reality is that, within the foreseeable future, large numbers of people will not be absorbed in the formal economic sector and will have to generate their own survival activities, via the small-scale - and often the informal - economic sector.

There are a number of ways in which spatial conditions in settlements create opportunities for economic activity.

- The first is *intensification*. This requires the promotion of higher unit densities than is the norm under the current model of settlement development. The case for increasing densities rests on a number of grounds. Higher densities create more opportunities for interaction, a climate in which economic activity - and small-scale economic activity, in particular - can thrive. A further effect of increased densities is an increased local demand for goods and services, promoting increasing specialisation and diversification in the small business sector.

The promotion of economic activity is also affected by the efficiency of movement systems. Efficiency of movement creates higher levels of support for goods, services and social facilities, simultaneously ensuring a wider range of goods and social facilities and increasing the viability of the services provided. In this way higher densities play a crucial role in achieving higher levels of convenience.

Higher densities lead to increased support for public transport systems, improving their viability. Higher densities, by lowering unit costs, can also contribute to the more efficient use of infrastructure.

Finally, higher densities can contribute to the efficient utilisation of land, the counteracting of urban sprawl, a reduction in travelling and a reduction in energy consumption and pollution.

- A second way in which settlements maximise opportunities is by integrating the *different parts of the settlement*, so that they contribute to each other. When a settlement is fragmented into a number of smaller, inwardly orientated parts, each part is largely reliant on its own internally generated resources. Consequently, levels of service and convenience may be low. By contrast, when the parts of a settlement are integrated, each part benefits from a much larger area. New settlements should accordingly not be viewed as ends in themselves only. They should also be viewed as instruments of restructuring, in the sense that they can be used to integrate a fragmented settlement environment.

  The above has implications for our thinking about movement. The challenge is to establish and maximise a continuity of movement systems, tying local living areas together. Movement systems need to be viewed not just as movement channels, but as spatial structuring elements. This line of thought leads to the conclusion that maximising access is as important as maximising mobility.

- A third way of increasing opportunities is by *enabling the evolutionary development of more complex settlements*. When this occurs, a diversity of large- and small-scale activities can find viable locations within the settlement system.

- A fourth way of creating opportunities is by *using the generating power of larger activities to attract smaller activities*, both of which benefit from the movement flows that result from the presence of the other.

Convenience

Good urban environments are, by definition, convenient. They allow inhabitants to conduct daily activities quickly and easily. Inconvenient environments, on the other hand, impose on lifestyles, reduce choices and increase costs.

Access lies at the heart of convenience. In this regard, access needs to be conceived of in terms of movement modes. The first mode is *pedestrian movement*, which is the lowest common denominator of movement and which describes the primary movement mode of large numbers of people in South Africa. The second is *motorised movement* in the form of public and private transport. Not all human activities and interaction opportunities exist within walking range. When this occurs, motorised transport becomes the more convenient movement mode.

For millions of South Africans, who cannot afford a motor car, public transport is crucial to facilitate movement. Although this does not deny the need to accommodate motor vehicles in settlements, the structuring of settlements, particularly for those who cannot afford private transport, should encourage and facilitate pedestrian movement and public transport systems.

Two forms of access are central to promoting convenience.

- The first form is access to the economic, social, cultural and recreational benefits which result from the agglomeration of people. This requires the intensification of settlements, the generation of opportunities for a greater range of activities and choices promoting more complex levels of spatial order and encouraging a greater range of development processes. Movement is the integrating structural element underpinning the above.

- The second is access to nature. Since settlements are, as a rule, places of intense human activity, the opportunity to escape from this intensity and to experience nature is of great importance to people. For many, for reasons of affordability, contact with nature has to be collective contact as it cannot always be provided adequately within private gardens. In addition, the productive capacity of the land can be a vital settlement resource. For many settlement dwellers the opportunity to use the land productively, or to engage in lifestyles which incorporate dimensions of both urban and rural living, is crucial to their survival.

Choice

Settlements which perform well are multifaceted places. They offer a diversity, and thus choice, of places, lifestyles, activities and interaction opportunities.

On the one hand, positively-performing settlements offer opportunities for human contact and interaction. Their activities and events play a major part in shaping the identity of the settlements. Importantly, settlements provide opportunities where people can live on their own but not be alone. They also provide people with choices regarding the extent to which they wish to engage in social activity.

On the other hand, people also require places which are private, particularly in the sense of knowing who "the locals" and who the strangers are.

The degree to which people wish to live in intensive and vibrant environments - or quieter, more private, places - varies from person to person and over the life-cycle of households.

The challenge is to promote environments which provide a *diversity of choices*, so that people do not have "either-or" choices, but rather choices which relate to relative degrees of privacy or exposure. The key to this lies in hierarchies of movement, public spaces and social institutions, and the design of living areas.

Equality of access

It is neither possible nor desirable for all parts of settlements to be the same. The reason for this is that clustering tendencies emerge in the structure of settlements as they grow. Activities requiring public support tend to cluster at the most accessible places. Nevertheless, it is important that all people have reasonably equal access to the opportunities and facilities which support living in settlements.

Spatially, two issues are central to this:

- The first is the recognition that balance is not so much a geographical as a structural concept. The issue is not one of attempting to achieve an even distribution of facilities over the surface of settlements. Rather, it is one of integrating public facilities and events with movement systems, so that access is equalised.

- The second issue is that of creating the access preconditions for more intensive activities to spread in a logical way, consistent with the growth of the settlement.

Quality of place

Quality of place is attained by embracing uniqueness as opposed to standardisation. In terms of the natural environment it requires the identification, a response to and the emphasis of the distinguishing features and characteristics of landscapes. Different natural landscapes suggest different responses. Accordingly, settlement design should respond to nature.

In addition, quality of place can be achieved by site-making actions, including topographical moulding in areas where soil is easily movable, to create greater diversity in the land form; tree planting, to provide areas of shade and recreation; the use of supplementary sources of energy and building materials; wind protection and space definition; the creation of water bodies as recreational features, sites of aqua-culture and visual relief; and creating choices of living condition.

In terms of the human-made environment, quality of place recognises that there are points where elements of settlement structure, particularly the movement system, come together to create places of high accessibility and special significance. These are the meeting places of the settlement. Business and commercial activities, schools, clinics, libraries, community halls and other facilities and activities requiring exposure to large numbers of people are associated with these places. In the best cases, the importance of these places is recognised in that they become the focus of public investment, aimed at making them attractive, user-friendly, and comfortable to experience.

They also become the places that accommodate symbolic statements, such as objects of remembrance. These, then, become the memorable places, which shape lasting impressions of a settlement. Their significance is strengthened by their dominant locations in terms of the movement network and from the significance of the social events or rituals they accommodate.

Sensory qualities

Positively performing environments reflect powerful sensory qualities. They are places which are aesthetically appealing and which add to the quality of peoples' lives.

The quality of the public spatial environment plays a critical role as far as the sensory qualities of settlements are concerned. The public spaces and places are the primary areas within which people engage in, and experience, urban life.

The role of public spaces in the lives of the urban poor is particularly critical. When people are poor, the full range of a household's needs cannot be adequately

met by the individual dwelling. Accordingly, a significant part of their lives is played out in public spaces. If properly made, these spaces can give dignity and a sense of permanence to environments. They are places where many social experiences occur and, in a real sense, they operate as extensions to the private dwelling. The implication is that all public spaces, of which the residential street is one of the important forms, should be viewed and constructed as social spaces.

It is the integrated framework of public spaces that enhances the sensory qualities of settlements.

Sustainability

Sustainability has two main dimensions. The one relates to the relationship between the built environment and the natural landscape. The other is the degree to which the settlement reflects "timeless" qualities .

- Settlements exist as adaptations of natural landscapes and are dependent on resources drawn from a much larger area. Two issues are central to achieving environmental sustainability. The first is the need to work harmoniously with the natural landscape, rather than causing breakdowns in natural systems, such as filling in wetlands to obtain developable land rather than developing higher-lying ground. The second issue is the need to recycle wastes to the greatest possible degree. For example, stormwater runoff can be used for irrigation purposes, and treated sewage as fertiliser.

- The second dimension of sustainability is the degree to which the settlement reflects, in its structure and form, "timeless qualities". Sustainable settlements accommodate growth and change well, and are in turn enriched by processes of change. They have three primary characteristics. They are scaled to the pedestrian. They reflect a structural order, which allows logical reinterpretation by successive generations. They have a strongly spatial feel, with defined and generously made public spaces, spaces not determined only by immediate development needs, but made with the recognition that public space is important in its own right.

PLANNING OF HUMAN SETTLEMENTS: THE ROLE AND IMPORTANCE OF STRUCTURE

The meaning of structure

Spatial structure is a concept used to interpret, design and make human settlements. The spatial structure of a settlement results from an interplay between the formally planned (or programmatic) and the spontaneous (or non-programmatic) dimensions of settlement-making. The planned dimension is essentially quantitative. It requires the identification of the major elements of land use and the development of a land and engineering services budget.

By contrast, the spontaneous, or non-programmatic, spatial structure is essentially qualitative, having at its core a concern with the whole rather than the parts. It reflects how people, over time, have addressed the making of a place to meet their needs and enrich their lives. Spontaneous environments reflect the timeless qualities referred to above. They do not depend on particular levels of technology, or minimum levels of personal means, to operate well.

The term "structure", as used here, refers to the creation of the public environment: that realm which is shared by all inhabitants, as opposed to the private realms of individual households and businesses. In investment terms, this usually equates with public investment in the spatial structure, to which private investment and decision-making responds.

The art of planning and design is to arrange the elements of structure into a system of references that supports the processes of living, and which establishes a spatial logic eliciting responses from the many actors who contribute to settlement-making. Settlement plans should therefore be able to accommodate uncertainty and change, rather than simply accommodate the initial development programme that necessitates the plan in the first place.

The elements of structure

In conventional planning, the elements of structure are described in terms such as circulation networks, public transport systems, open spaces, public facilities, and public utilities (engineering services). However, in the context of spontaneous settlement-making, it is useful to describe the structural elements as connection, space, public institutions and utility services. How each of these elements gives structure to a settlement is outlined below.

Connection

Connection refers to movement of all kinds, including fixed line systems such as roads, light - and heavy - rail systems, underground rail systems,

as well as pedestrian and bicycle routes. As a general principle, movement should be seen as an activity which occurs within space. The movement system, therefore, is the network of spaces through which people move in various ways, from the pedestrian mode to modes specifically conceived for fast movement. It is primarily within this network of movement spaces that the public life of a community takes place. Consequently, its making should be informed not only by technocratic considerations, but also by human and environmental considerations.

The movement system has considerable structural significance as it defines the pattern of accessibility, both within the settlement and between settlements. It is this pattern, in turn, which sends structural signals to individuals, entrepreneurs and place-makers, and which significantly affects the range of choices and opportunities the settlement offers inhabitants.

Space

Space lies at the heart of the non-programmatic approach to settlement-making. It is not just one element of a settlement programme, such as "public open space" (as designated in town planning schemes), but should be approached as part of thinking about the whole.

Settlements are characterised by diversity. They are many-placed places. Some parts are more public, others are more private, while others are more neutral, serving broader, more diverse sets of citizens and urban activities. It is apparent, therefore, that there is a structural order in settlements. This order lies at the heart of the concept of structure.

Public spaces are the meeting places of people in settlements. The public spaces comprise the urban "rooms" and "seams" of connectivity. There also exists a continuum of spaces, which represents a transition from more public to more private living. The order in settlements thus not only relates to access, but also to degrees of publicness and privacy. A similar order of publicness and privacy exists in relation to social institutions and activities, and places of perceived value.

At the heart of settlement-making lies the creation of a continuum, or hierarchy, of public spaces and movement systems, which attract, and give order to, activities, events and elements in accordance with their need for publicness or privacy.

Space becomes particularly significant when one is considering movement at a local scale. At this scale the concept of "road" needs to be replaced by the concept of providing spaces which are comfortable for people to be in, and within which movement can take place. In spaces so conceived, neither the pedestrian nor the vehicle has complete dominance or right of way.

Public institutions

Historically, the institutions which were most valued by society - such as institutions of learning, worship, exchange, markets and universities - served as the key structuring elements of settlements. The siting of these, in turn, formed the basis for the locational choices of other, more private, uses, such as housing. It is considered important to revive this tradition. However, a difficulty is that, in modern times, societies occupying settlements have become increasingly heterogeneous and diversified. As a consequence it has become difficult to identify institutions which have generally recognised value. This does not, however, negate the importance of thinking about settlement structure in this manner. In the absence of certainty about what institutions will be prioritised by communities, the social space itself becomes the highest form of social institution.

The location of institutions in relation to the other elements of structure is also of critical importance. Commonly, institutions occur in central places, are easily accessible in terms of movement patterns, and are announced by public spaces. The institution abutting onto the space gives unique character to the space and often attracts informal activities.

Public utility services

Public utility services refer to those engineering services that are essential to the functioning of settlements. They include water provision, sewage removal, stormwater disposal, solid-waste removal and electricity supply. These services are essential to the maintenance of public health in settlements. They can be provided in various technological forms, all of which have different cost implications and environmental and geometric requirements.

As a general principle, utility services should be provided as efficiently and as cost-effectively as possible, taking due cognisance of the human- and nature-centred approach to settlement-making proposed herein. However, in terms of structuring settlements, utility services should follow, not lead.

An approach to structure: minimalism and complexity

The appropriate approach to settlement-making is *minimalist*. This approach requires that the minimum number of strong actions necessary to give direction to the settlement-making process be clearly defined in the framework plan.

A failure to clearly define the minimum actions required will almost certainly destroy the quality of the whole. Essential public and private sector investments may not materialise, leading to unfavourable and unintended outcomes and failure of the plan.

However, if the plan for settlement-making goes too far, freedom, and thus complexity, will be reduced. A hallmark of positive environments is that they are complex. Complexity, however, cannot be designed. Environmental diversity results from freedom of action and the iterative application of the ingenuity of many decision-makers and actors in meeting their particular requirements, as well as the needs of their fellow human beings.

Spatial structure, in a sense, can be seen as the enabling "constraint" which gives direction, and some predictability, to settlement-making processes, without defining their precise form or outcomes. It is the function of structure to generate a range of opportunities to which individuals and groups can respond, and around which a diversity of human activities can take root.

While growth and development processes take many forms and are not always predictable, an enabling plan should nevertheless be aimed at unlocking the energies, ingenuity and resources of settlement-builders and implementing agencies. These include individuals, groups, communities, small and large developers, utility companies, investors, semi-governmental organisations and a range of governmental institutions and agencies.

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Chapter 3

Spatial and structural principles for settlement-making

3

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LIST OF FIGURES

INTRODUCTION

This chapter focuses on settlements as systems made up of functionally interrelated elements. It builds on Chapter 2 by providing principles important to achieving well-performing settlements, and guidance on how they can be achieved. Chapter 3 can therefore be seen as providing the link between the framework presented in Chapter 2 and the practical guidelines provided in Chapter 5 and those that follow.

NATURE OF THE GUIDELINES

The guidelines are essentially concerned with *principle*, *idea* and *context*.

- "Principle" refers to a set of spatial "rules", which should be applied in the settlement-making process.

- "Idea" refers to the relationships between elements of structure, which best capture the desired performance qualities in the context of a particular problem.

- "Context" has two dimensions.

  - Time: Time impacts on the technologies which can be applied to, or which have to be accommodated in, the challenge of settlement-making.

  - Place: Place refers to the specifics of the natural, socio-economic and cultural environments.

  Context is the catalyst which transforms an idea into design. It makes it possible to develop a variety of different designs, based on the principles and the idea.

In these guidelines *principle* and *idea* are addressed, where necessary, by means of generic diagrams, as these are helpful in defining spatial relationships. They do not, however, represent designs. They are a-contextual. In this document the diagrams use geometric conventions, such as the grid and the pin-wheel, to clarify important relationships. It must be stressed, however, that the principles can be expressed in many different forms. It is the principle which is important, not the geometric form.

PRINCIPLES

The principles which are important in achieving well-performing settlements are of a structural and a spatial nature.

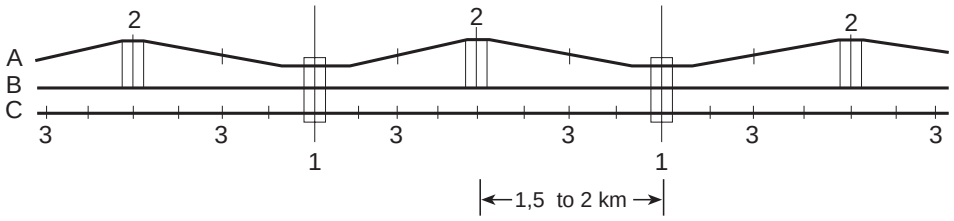
Structural principles

The principle of reinforcement

It is necessary to think structurally about all elements within the settlement. This means that each structural element should reinforce the others. This is illustrated in Figure 3.1.

The figure illustrates how interconnected modes of movement (pedestrian, bicycle, train, tax, bus, car) are brought together into a single corridor, thereby creating a range of structural opportunities. At points of major connectivity, where stopping points for all modes come together (marked 1 on the diagram) the potential exists for the creation of a major place with high-order urban activities, as these will tend to gravitate towards such points.

The integration of the elements increases the potential impact to a far greater extent than if they



LEGEND

A. Road-based public transport and private vehicles on high order limited-access routes: bus, taxi and private vehicles.
B. Heavy rail-based public transport: train.
C. Light rail-based and road-based public transport as well as private vehicles: tram, bus, taxi, private vehicles.
   1. First order centre. All modes of transportation.
   2. Second order centre. Mixed transportation: train, bus, taxi, private vehicle, walk.
   3. Local order centre. Local transportation: taxi, private vehicle, bicycle, walk.

Figure 3.1: Reinforcing modes of movement

were to be considered in isolation. Where two of the non-pedestrian links merge, a major place (marked 2 on the diagram) will also emerge, albeit of lesser intensity than 1. At places of local accessibility (marked 3), however, local order activities, supported mostly by local demand, will cluster.

The principle of continuity

Continuities of green space

Human society functions in a landscape that consists of the original (or primeval) natural landscape, as well as rural and urban landscapes. Access to all elements can be considered a basic need for human beings. As a result, establishing continuities of green space becomes an important element in the settlement-making process. Apart from fulfilling an important human need, this principle also promotes ecological diversity. Ecological systems are complex, with the migration of species and their exposure to different habitats forming integral components of the systems. Natural habitats should thus be continuous to allow for this to occur. At a larger settlement scale, the promotion and protection of such continuous systems become important planning principles. At a smaller scale of settlement, green spaces in new developments should contribute to emerging continuous green systems.

Two additional points can be made about green space:

- Green space within settlements should be productive space. Green space requires maintenance. If maintenance becomes too expensive or, for any other reason, breaks down, the space becomes environmentally negative. In addition, in many areas, urban agriculture has a vital role to play in the support of urban systems. In this role green space is an important supplementary source of nutrition and income for poorer people.

- Green spaces can absorb outputs from settlements. In this regard they can be used for evaporation ponds to remove partially treated wastewater; and as stormwater-retention systems.

Continuities of movement

The movement, or flow, of people, finance, goods and services is the energy network of settlements. Activities requiring the greatest degree of exposure will tend to gravitate towards the most accessible points and links in the energy network. The movement network exhibits its own ordering structure. At the settlement level the energy potential contained in the network is released through stopping, not through movement. Different movement modes have different patterns of stopping. Pedestrians and cars can theoretically stop anywhere along a route, bus stops may be spaced at 500 m to 800 m intervals, and train stations at intervals of 1,5 km to 2 km. Accordingly, these modes establish different rhythms of accessibility. The co-ordination of different modes enables certain points to be strongly reinforced, thus attracting and creating opportunities for the clustering of activities.

By definition, routes which do not allow stopping, such as freeways, have little positive structural impact (as defined in these guidelines) at the local level. They serve as the integrators of space at the inter-settlement level. At the local level of settlement they tend to emphasise points of exit and entry, rather than lines of accessibility. At this level they sever - rather than integrate - space.

The application of the principle of continuity consists of the creation of a complex and diverse pattern of movement and accessibility. This will enable all settlement activities, large and small, formal and informal, to find a place within the structural system. The resultant land-use pattern will be highly synergistic, with each part of the system benefiting - and being benefited by - the other parts.

Continuity of built form

New parcels of development should be integrated with existing development to obtain agglomeration economies. There is, however, a scale dimension to this. At places, the continuity should be consciously broken to ensure convenient access to green space as well as the natural and rural landscapes.

Continuity of public space

As discussed earlier, public spaces should make up a continuous network of space. Achieving a sense of enclosure and definition is important in this regard. Every building, either through the building itself, its walls, or planting, should contribute to defining the public space it abuts.

The principle of discontinuity

In the settlement-making context the principle of discontinuity refers to the promotion of breaks in particular components of the urban system, to achieve particular effects.

Discontinuities of movement

Along higher-order routes, discontinuities can be used to create special places, such as public squares

and parks. The discontinuity principle can also be used to integrate natural and rural areas and existing features into the urban landscape.

Discontinuities of movement on lower-order routes can be used to create qualities of secrecy or privacy, particularly in that through-traffic is discouraged.

Discontinuities of built form

Public space, such as a square or a park, can be used as a device to interrupt built form, thereby creating visual diversity in the built environment.

The principle of externalisation

Social facilities and higher-order urban activities should not be "embedded" within residential precincts, but should be externalised by locating them along more continuous movement routes.

This will ensure that the future of facilities is not entirely dependent upon the fortunes and resources of particular local communities. It will also maximise the potential return on the investment in facilities, by making the facilities accessible to a wider range of people. In addition, it will reinforce the private quality of the residential areas. Lastly, it will contribute to the establishment of symbiotic relationships between different activities and facilities.

The principle of concentration along routes

While intensive activities and facilities should be externalised along continuous routes, it is important to recognise that development along them will not be even. The accessibility of different points along routes is not the same, as there are powerful tendencies for more intensive activities to concentrate at the most accessible points along movement routes. These tendencies are illustrated in Figure 3.2.

The principle of accommodating sameness and diversity

This principle relates to accommodating both homogeneity (sameness) and heterogeneity (diversity) in settlements. It is this principle that accommodates both cultural and economic diversity and expression within settlements. It recognises that in a democratic, multicultured, society all communities, individuals and cultures are to be accorded equivalent respect.

This realisation has significant implications as far as the approach to structure and space in the settlement-making process is concerned.

The connection between space and structure lies in the recognition that different activities, cultures, and lifestyles have their own requirements, which must be met in the settlement-making process. As a result, successful settlements are ones that reflect diversity in terms of areas of sameness, areas of diversity or mixed-use development, areas of cultural homogeneity and areas of cultural diversity.

At a fundamental level, the requirements of sameness and diversity relate to variations in the need for privacy and exposure. Certain institutions and public places are more "owned" by particular groups, communities, lifestyles and cultures and are thus more private, while others are more neutral or public in the sense that they serve broader, more diverse, communities. Thus, for example, commercial activities and sport stadiums, when compared to religious activities, are heterogeneous. A mosque, or church, however, is "owned", by a smaller, more specific set of people.

In the sense that there is an order of homogeneity and heterogeneity in successful settlements, there exists a similar ordering of space, which reflects a transition from more public to more private living.

At the heart of positive settlement-making lies the creation of systems of public spaces which order activities, events and facilities according to their need for exposure or secrecy, and the integration of this system of spaces with the movement system, which, in itself, forms part of the system of public spaces.

In terms of the minimalist approach to planning and design, it is inappropriate to make centralised decisions about everything. Greater freedom, and

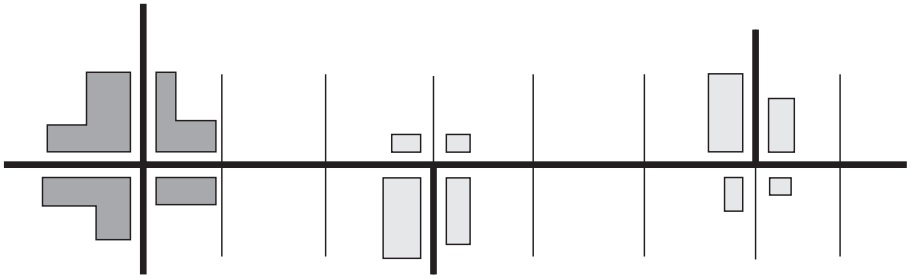


Figure 3.2: Hierarchical concentrations along routes

the more complex process of development which results from this, allow many actors to participate in and contribute to the settlement-making process. The result of this approach is settlement-making and planning in the form of a process, a process enabling and involving a diverse range of delivery agents.

Spatial principles

There are four spatial principles, which are central to creating positive settlements. These are *definition*, *scale, flexibility* and *intensity of space-use.*

Definition

In positive environments the public space is defined by buildings and other space-defining elements, such as walls and planting. This creates a sense of enclosure. The contrast is free-standing elements in a formless sea of space.

Scale

Scale refers to judgement about relationships such as size, distance and height. In settlement terms, reference is usually made to a "human scale", which is the scale that human beings feel comfortable with. Although a quality that can be difficult to define, it is one that should be striven for in modest, as well as bold, settlement-making processes.

Flexibility

Positive environments reflect flexibility in their spatial structures. The principle of flexibility thus refers to the creation of spatial structures which can accommodate the unexpected demands made upon them over time.

Intensity of space use

Land should be used as intensively as possible as this has positive spin-offs for settlement-making. These include:

- the creation of higher levels of support for economic and social goods and services;
- the establishment of an economic climate in which economic activity can thrive;
- the creation of the preconditions for viable public transportation systems;
- the efficient use of infrastructure; and
- the achievement of better utilisation of the land, contributing to compact urban environments, reduced travelling and energy consumption, as well as a reduction in pollution.

Intensification does not imply a standardisation of living conditions, or uniform densities. In the context of the minimalist approach, a choice of living conditions, which is an important objective of settlement-making, is facilitated in a number of ways, such as:

- by encouraging the development of areas of different character throughout the settlement;
- by the presence of contrasts within the structural system, with respect to space that is private and space that is public;
- by the natural development or evolution of a range of urban densities; and
- by an evolution of configurations of plot shapes and sizes, which result in the promotion of different housing types.

A SYNTHESIS OF THE PRINCIPLES

A synthesis of the settlement-making principles, discussed in the preceding sections, is depicted in Figures 3.3 and 3.4. The synthesis indicates how the principles can be integrated, thereby establishing a set of locational responses.

Figure 3.3 depicts an intense, mixed-use, but primarily residential area. The area contains a wide range of uses: housing, education and other social facilities, formal and informal economic activity, small-scale manufacturing and small-scale agriculture.

Economic activity, both formal and informal, is linked with the continuous intra-settlement route. It is backed by a belt of schools. These play an integrative role, since they serve pupils from a much wider area. Pupils can access them via public transport along the main road. The library, which serves a number of schools and the community at large, is located on the main road. The informal play space is associated with the schools but also serves the broader community. In order not to disrupt the continuity of building along streets it is located on the periphery.

Opportunities for urban agriculture are created on the periphery of the site. Stormwater runoff is organised so that this area is irrigated. The agricultural area forms part of the storm-water management system.

A small-scale manufacturing hive forms the western edge of the agricultural belt. This is associated with larger scale manufacturing to the west of the site.

All space is designated as social space. A continuous hierarchical system of public spaces organises the location of educational and other public facilities, all of which are externalised.

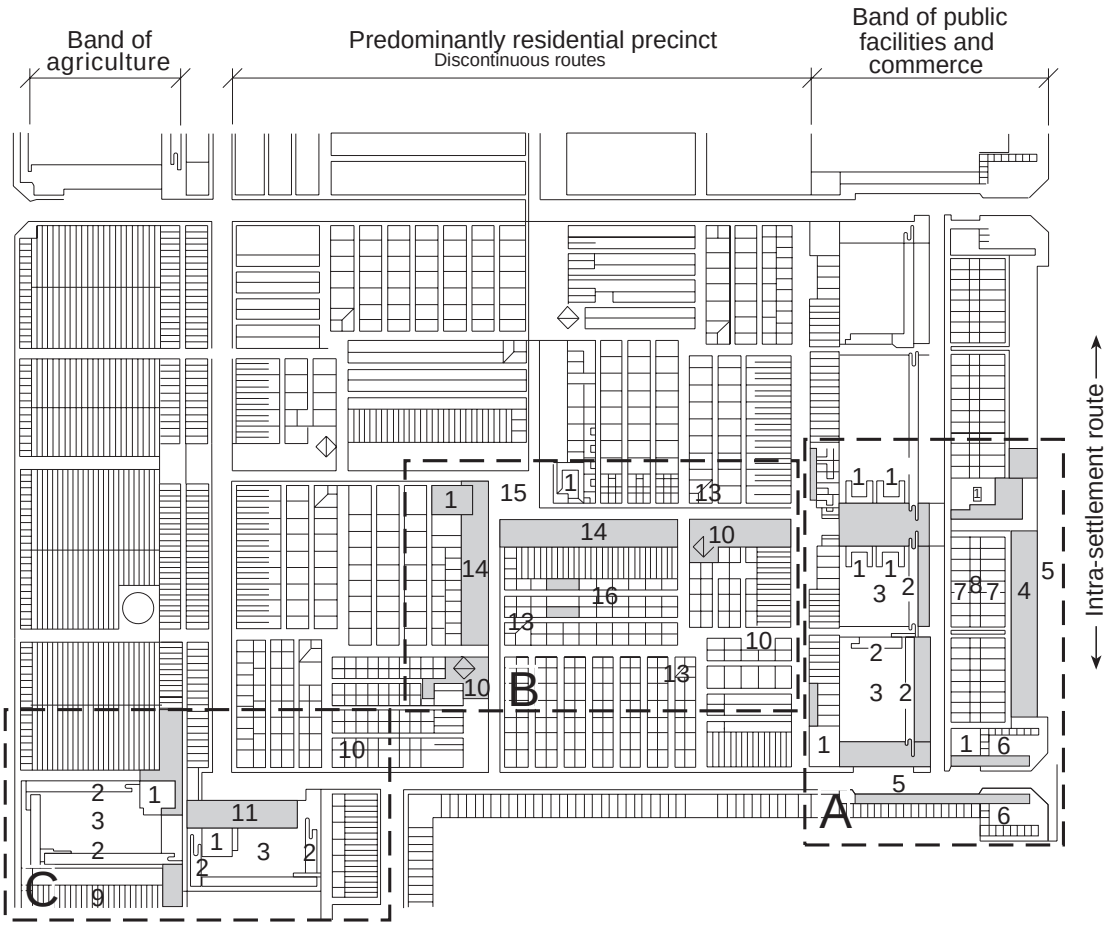


Figure 3.3: A synthesis of principles

The residential precinct is primarily organised around a 400 m by 400 m super-block module. There is no one ideal block size, as this will vary with context. The choice of the block and its internal organisation reflects an attempt to optimise efficiencies in terms of pedestrian and vehicular movement. The organising system is one of nesting blocks. At the larger scale, blocks are approximately 200 m by 200 m (although some variation in size is necessitated by the need for space-making), which is efficient in terms of vehicular use. At the smaller scale, the basic block size is 80 m by 80 m, a comfortable scale for pedestrians and one which is found in many cities of the world. The smallest blocks can also be accessed by car, but are chiefly pedestrian.

A hierarchical system of discontinuous routes create varying levels of privacy: there is a wide range of living conditions in terms of publicness and privacy.

The larger movement channels also serve as linear green spaces. They also accommodate vehicular and pedestrian movement and parking, which function as part of the green system.

The plan also shows how a variety of plot sizes and configurations, and thus house types, can be accommodated and how higher densities can be achieved.

Figure 3.4 shows areas A, B and C (indicated in Figure 3.3) in greater detail. Numbers in parenthesis refer to numbering in Figure 3.4.

- The community facilities are externalised (1). There is a pronounced dimension of order in the system, with the largest and most important facilities associated with the highest-order spaces. It is not necessary to predetermine the form of these facilities. Communities can establish their own priorities.

- The educational facilities comprise urban schools. Where possible, they should be atomised (i.e. broken up into parts), with community facilities such as sports fields, halls, libraries, computer centres and laboratories being shared between schools and between school and community (2, 3).

- Informal play spaces associated with the schools are located on the periphery, to maintain the continuity of the built form along streets (2, 3).

- The planted spaces can be used in many ways, including community events and parking (4).
- The main road is made into a space to accommodate parking (5).
- Main market sites for informal trading occur at highly accessible points (6).
- An intensive mixed-used zone, with flats above shops is promoted (7).
- There is a service zone serving the shops (8).
- There are communal gardens for agricultural activity (9).
- Refuse-sorting points are planned. Their location is determined by the main refuse-removal route (10).
- An important forecourt space is located at the end of a discontinuous route (11).
- There are manufacturing hives (12).
- In low-income, informal housing areas, corner sites may be used as communal bath-houses and laundry points (13).
- Elongated planted spaces are shown. These are social places that operate as social extensions of the houses. They are important play spaces for children (14).

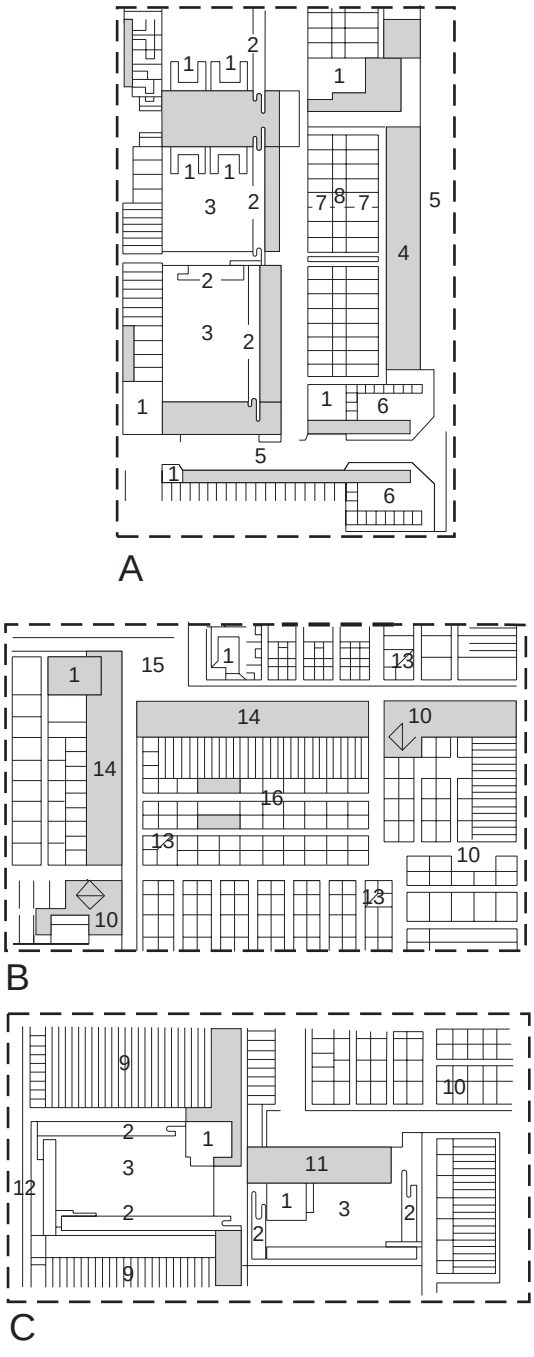


Figure 3.4: The detail of the plan

- An important public space gathers to it community facilities and commercial activity. As with 14, in these spaces neither the car nor the pedestrian dominates (15).

- A fine-grained housing precinct which is effectively pedestrian dominated (16).

APPLICATION OF THE PRINCIPLES

The guidelines for settlement-making have been formulated on the basis of principles. In their application to a site, however, they can obviously be captured in many forms and need to be applied on an integrated basis. Some brief notes in this regard are provided below.

At present there are in essence three generic urban conditions prevailing in South Africa. These are greenfield or undeveloped sites, urban restructuring, and the upgrading of informal settlements. In each of these cases the form is different but the application of the principles should be the same.

Greenfield sites

The generic problem of greenfield developments is to provide a spatial ordering system to guide growth (which may occur relatively quickly) on the site, while integrating it with surrounding urban systems to the greatest degree possible.

The plan for a greenfield site should seek to create an area of settlement which is highly liveable and which has inherent qualities that will promote ongoing processes of consolidation and upgrading over time. It should be informed by the needs of the main affected parties, including existing residents, entrepreneurs and industrialists, as well as new residents. It should be recognised that each of these constituencies has different requirements of, and within, the settlement system, which need to be respected and protected. Existing communities and entrepreneurs need to be part of an environment with which they are familiar, the new settlement needs to be closely tied into broader city-wide systems but at the same time must have its own logic, identity and, over time, sense of community and belonging.

Urban restructuring

At the heart of urban restructuring is increasing investor confidence - for people to invest in the environment, from both an economic and residential point of view. To improve the urban environment over time, they must have confidence that the area is improving and that their investment will be safe. In depressed environments the application of the identified settlement-making principles can play an important role in creating a climate of confidence.

In essence, restructuring involves a number of generic actions:

- establishing a spatial structural logic or order by creating spaces and achieving the greatest possible continuities of movement at different scales - in particular, breaking down the fragmented urban pattern which is characteristic in South African urban settlements;

- improving the quality of the public spatial environment;

- creating new public spaces where they are required;

- intensification, through housing-infill programmes, in order to increase thresholds of support and thus levels of service.

Urban restructuring also requires channelling of new development into existing areas in order to improve them. This can be achieved by using new development, particularly housing, to increase densities in order to improve levels of service (for example, along existing or new transportation corridors), or to make better use of existing investments (for example, in inner city areas, around existing commercial and industrial nodes). This approach is consistent with the principle of reinforcement.

Upgrading informal settlements

A common challenge in terms of South African settlements is that of upgrading informal settlements. In terms of greenfield sites the generic problem is to provide, from the beginning, a public spatial structure to guide new development. In the case of informal settlements, the problem is one of the later provision of a public spatial structure to provide relief from overcrowding, to create public gathering places, to guide public and private investment and to improve movement systems. Whereas, in the greenfield case, housing and economic development is generated by means of infill development in the context of the spatial structure, in the case of upgrading projects the negotiated relocation of residents and economic activities may be necessary to create a spatial structure consistent with settlement-making principles.

KEY PLANNING GUIDELINES

In this section key planning guidelines are established, within the context of the minimalist approach to settlement-making. The guidelines deal specifically with those elements of the settlement-making process over which the planner has relative control.

General observations

- Different communities have different priorities in terms of social facilities. The important thing is not to predetermine the form of all facilities, but rather the positioning of social institutions valued by the community. The precise nature and form of many of these facilities can be determined over time by the community itself.

- The principle of lump-sum funding should be adopted in financing new settlement-formation. Funds should preferably not be allocated in a predetermined manner (for example Rx amount for roads, Ry for community halls) but should be allocated as a lump-sum to allow for negotiated trade-offs within the planning process.

- Community facilities are important place-making elements and they should be deliberately used, in combination with public space, to make memorable places.

- Social facilities are dependent upon public support and play an important integrating function in and between communities. They should therefore be "externalised", by being located in places of high accessibility, and made accessible to the local and surrounding communities. In this way, they bring together people from a number of local areas and are not tied to the fortunes of any one community.

- Realities of resource scarcity demand that public spaces and buildings be used for more than one purpose. This is consistent with the principles of multifunctionality and the sharing of resources between user groups.

The movement network and public transport

- Public transport is essential in areas that are characterised by low levels of car ownership. As far as possible, new development in such areas should support public transport. Higher densities increase the viability of public transport and should be encouraged along public transport routes.

- Coordinating the stopping points and terminals of different movement modes significantly increases the attractive power of the zones in which they are found. These zones are ideal for high intensity, mixed-use development.

- Movement should not be seen as a separate element but as an activity which occurs within social space.

- The degree to which movement dominates space varies from spaces which are entirely pedestrian-dominated to spaces which are entirely vehicle-dominated. As a general principle, however, most spaces within settlements should accommodate both pedestrian and vehicular activity. However, entirely pedestrian routes, which vehicles cannot penetrate, have their place in settlements.

- Movement spaces should be flexible, to allow them to meet other demands - such as markets, meeting places and parking.

- There is a strong ordering dimension to movement. At all scales, it is necessary to maximise continuities of movement, as this promotes choice and integration. Land uses should be able to respond freely to movement patterns as this encourages diversity and a mix of activities.

- While being ordered, rigid approaches to movement hierarchies, such as inflexible stipulations regarding intersection spacing and access should be avoided, as these mitigate against spontaneous settlement-making.

- The most important social spaces are low-order, local streets and these, in particular, must accommodate pedestrian activities.

The open space system

- In the case of large city-wide green space systems, continuity is important to promote ecological diversity.

- Sports facilities form an important part of the green recreation system.

- Formal sports fields, which function as green spaces, should be located to ensure a maximum degree of sharing of space, such as sharing between sports clubs, seasonal sports, schools and communities.

- Passive recreational places where people can walk, picnic or reflect on life are important settlement facilities. Wherever possible, these should take "natural" forms, which do not require maintenance and should be associated with unique natural features such as forests or plantations, hills, rivers and streams.

Urban agriculture

- Land for urban agriculture is particularly important in settlements where people are dependent on their own produce for food and nutrition, or have to supplement their incomes.

- Urban agriculture is an environmental feature that can operate as an area of visual relief, particularly in situations where finance to maintain "public open space" is not available.

- Space for urban agriculture should generally be provided on the edge of the settlement, in order not to disrupt the continuity of the urban fabric.

Public facilities

Education

- The creation of environments which promote learning forms an integral part of the settlement-making process. Learning has both formal and informal dimensions. Schooling relates to the formal dimension of education. Informal learning stems from exposing people to experiences outside the formal learning environment, such as experiencing nature, urban activities and social events. In this respect, the informal part of the learning experience can be enhanced by integrating educational facilities with the broader settlement structure. This can be achieved by locating schools, colleges, technikons, adult-education centres and universities close to places of intensive urban activities.

- The concept of the specialised self-contained school, accommodated on a spatially discrete site and serving only its pupil population, needs a rethink. Schools should be seen as resources serving both pupils and the broader community. In this regard schools can accommodate the school population during the day and, where possible, adult education during the evenings. Similarly, halls and libraries can serve the school population during the day and the broader community during the evening, ensuring 18-hour usage of facilities.

- The need for informal school play space can be supplemented by public space adjacent to which the school is located. Formal sports fields can serve both the school and the broader community.

- In terms of their location, schools should be part of an accessible, city-wide system of education facilities. Accordingly, they should be located close to continuous public transport routes. This will make schools sustainable over a longer period, since they will draw pupils from a larger area, thus becoming less susceptible to fluctuations in the local population.

Health

- Health considerations must inform all dimensions of settlement-making and design. Particularly important is ensuring clean air, potable water, the disposal of human and toxic waste, air circulation, shelter and the prevention of overcrowding.

- Health facilities should be accessible and should be integrated with public transportation. This can be achieved by locating such facilities close to activity areas and regular places of gathering.

- The location of preventively orientated health facilities, such as clinics, in association with primary and pre-primary schools, offers advantages. Preventive functions, such as inoculation and nutritional programmes are best delivered through schools. Where a multipurpose hall serves a number of schools, a clinic may be beneficially located within or adjacent to that hall.

Meeting spaces

- Both open-air public spaces and enclosed spaces such as community halls are important parts of social infrastructure. Halls should be located in association with public spaces as this will allow for events in one to spill over into the other, or provide alternatives in case of weather changes.

- Halls should also be associated with other public facilities, such as schools and markets. Given the limited number of public facilities which can be provided in any one settlement, it makes sense to concentrate these to create a limited number of special places, which become the memorable parts of the settlement.

- The number and location of meeting places cannot simply be numerically derived. Rather, it is necessary to create “forum” places, places which over time assume a symbolic significance outstripping their purely functional role.

<u>Religion</u>

- Religious facilities are “public” in the sense of serving large numbers of people and being of great significance to the communities that they serve. They should, therefore, be accorded equivalent respect, regardless of their denomination.

- They should be located at equivalent, significant places within the settlement. Their symbolic importance can be emphasised by using them to define vistas and by associating them with significant natural landmarks.

Public utilities

Public utility services are engineering services, such as potable water and electricity into settlements, and sewage, refuse, stormwater and wastewater removal from settlements.

As far as possible, it is necessary to work with nature in terms of these "inputs" and "outputs". Thus:

- Water-collection technologies (e.g. roof tanks) should form an important part of the infrastructure in water-scarce areas.
- Woodlots can form important supplementary sources of energy.
- In certain places, solar energy is a viable alternative energy form.
- Stormwater and partially treated wastewater can be used for irrigation by being channelled to playing fields and urban agricultural areas.

Engineering services can be provided through a wide variety of technologies; all these have different cost implications. The choice of appropriate technology should, however, result from an examination of social, environmental and cost issues.

Cross-cutting issues

Crime prevention

It is generally accepted that certain types of crime can be limited if the environment is designed appropriately.

- Ensure surveillance and visibility through multifunctional land uses, rather than monofunctional zoning, to ensure long hours of use; provide inviting and well-defined outdoor spaces conducive to users meeting and communicating; all paths and pedestrian routes should be in areas where there is surveillance, good lighting, controlled vegetation and high levels of activity; small open spaces should be strategically located within the neighbourhood.
- Owners/users should be encouraged to take responsibility for places by avoiding tracts of vacant land without designated users or control; design the public realm to increase people's ability to read the built environment; networks of small neighbourhood parks are preferred to uncontrolled large open spaces.
- Limit easy access and escape routes for criminals by carefully planning the location, size and design of large open spaces; avoid ending roads on vacant/undeveloped land; clearly mark pedestrian routes.

Environmental concerns

The following ecological factors need to be considered when designing human settlements:

- Identify geological conditions and assess risks and costs associated with development on less ideal geological terrain.
- Consider hydrological concerns, especially with regard to stormwater runoff and its direct relationship with urban development (e.g. plot size, type of land use).
- Take note of atmospheric considerations in terms of orientation and layout of erven, the impact of the prevailing wind direction, plus air and noise pollution.
- Consider implications of development on biodiversity.

Emergency services

The main emergency services are ambulance, fire-fighting and police services.

- Fire stations and ambulance depots should be located near the intersection of major continuous urban routes to facilitate rapid access to the movement network. Similarly, police stations should be centrally located relative to the areas they serve.
- At a local scale, it is not necessary to enable access to every housing unit by emergency vehicles. However, in such cases, distances should be short enough for easy stretcher-bearing, and for buildings to be reached by fire hoses.
- The public spatial structure, which includes streets and public spaces, should be deliberately used for fire-breaks. In informal housing areas, which are not served by electricity, provision should be made, as part of the essential public infrastructure, for spaces where fires can be made, as cooking frequently occurs in these spaces.

Economic services

Economic considerations should be taken into account in all the planned elements of a settlement. Some of the related concepts and applications are discussed below.

Employment generation

In South Africa employment generation is one of the highest priorities facing society. The reality is that the majority of potentially economically active people have no option but to generate their own employment, usually in the form of "informal-sector" activity. It follows that a pressing priority in settlement-making is to create opportunities for

people to manufacture, trade and provide services. Settlement plans should ensure that sufficient intensity is generated at points in the settlement structure to generate local markets. A plan should provide an easily readable spatial structure which unambiguously suggests major movement channels and places of gathering, allowing entrepreneurs to respond to the structure created.

As a rule, entrepreneurs will find their own place in the structure and will provide their own infrastructure where necessary. However, given problems of entry capital and urban management in many settlements, it may be necessary to establish urban markets and manufacturing infrastructure by means of deliberate public actions.

Urban markets

Urban markets result from the physical agglomeration of large numbers of traders in public spaces.

There are a number of advantages in promoting markets by means of public actions.

- The creation of urban markets enables small operators to gain access to viable locations.
- The physical concentration of numbers of traders increases their drawing capacity and enables them to compete with larger, formal operators.
- The agglomeration of large numbers of traders establishes the potential for other forms of mutually advantageous co-operation, such as delivery of bulk supplies from wholesalers, the sharing of vehicles, and so on.
- Markets in low-income areas can provide an important service to consumers, in that they offer variety and choice of goods and services to people who are unable to travel large distances.
- From the perspective of urban management, the creation of urban markets contributes to the resolution of problems of hygiene.

Markets should be located at points of maximum accessibility. Particularly, they should seek a close association with public transport and major pedestrian flows. Wherever possible, they should be associated with public transport terminals, such as railway stations and bus and taxi ranks.

The centrality of the market should be reinforced by associating other forms of public infrastructure, such as clinics, halls, community resource centres, pension pay-points and services pay-points, with it.

Engineering services required to maintain adequate levels of hygiene, including water, public toilets, and refuse storage facilities, should also be provided.

Markets need not always be permanent. The use of public spaces, including streets, for periodic markets, at certain times of the day, week or year is also a positive, cost-efficient option.

Manufacturing infrastructure

Most of the arguments associated with the provision of markets also apply to the provision of hives for small-scale manufacturing.

The critical elements of infrastructure are sheltered work spaces, electricity, water and toilet facilities. The use of metered water and electricity enables regulated usage by small-scale operators.

From a locational point of view, small-scale manufacturing needs to be associated with points of movement - in particular pedestrian activity. Because they are frequently single-person operations, it is difficult for operators to separate manufacturing and selling functions. Consequently, they should be associated with urban markets and other forms of trade agglomerations.

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Chapter 4

Planning method and participation

4

TABLE OF CONTENTS

INTRODUCTION

Besides moving into a more democratic planning environment in South Africa, there is a definite move away from the blueprint nature of planning and to a lesser degree, away from procedural planning. At the same time, there is a shift away from non-participation and/or token processes to more inclusive and interactive planning processes. The current trend in planning is largely based on the satisfaction of fundamental human needs, as stated in Chapters 2 and 3. Accordingly, the "human scale development planning method" is advocated. The form of public participation proposed is that of partnerships as a form of citizen empowerment. This chapter takes the following into account as its points of departure:

- That there is current approved planning legislation such as the Development Facilitation Act (No 67 of 1995) which emphasises a planning framework and process based on need, integration and community participation.

- That current and/or new planning legislation does not exclude existing planning legislation and reference to previous legislation such as guide plans, zoning schemes, ordinances, and so on.

- Due to the multi-disciplinary nature of planning it must be accepted that there is a tendency in planning practice for planning and development to be managed by project managers who are not necessarily professional planners. The specific role of the planner in the planning process has shifted from purely technical to that of mainly a technical expert, coordinator, facilitator and advocate.

- While the role of theory in understanding method and participation is very important, context and realistic circumstances prevailing in South Africa must also inform method and participation.

- In the past, communities did not play an important role in planning and development. However, communities have a wealth of local knowledge that they can offer as well as a natural understanding of their needs, requirements, local conditions and relationships. This knowledge is a vitally important part of planning and development.

- There is a place for procedural planning methods, albeit not in the form that it was practiced in the 1970's, but in a more appropriate and relevant form.

APPROPRIATE NATURE OF THE PLANNING METHOD

Human scale development "is focused and based on the satisfaction of fundamental human needs, on the generation of growing levels of self-reliance, and on the construction of organic articulations of people with nature and technology, of global processes with local activity, of the personal with the social, of planning with autonomy and of civil society with the state" (Max-Neef 1991, p 8). These pillars must be sustained on a solid foundation of creating conditions where people are the protagonists in their own future. The focus of planning method and participation should be on the response to basic human needs. Human scale development assumes a direct and participatory democracy that nurtures those conditions that help to transform the conventional, paternalistic role of a state into a role that encourages creative solutions flowing from the bottom up.

APPROPRIATE NATURE OF PARTICIPATION

Governance is a term that encompasses the relationship between civil society and government. It should create an environment in which there is representativeness, legitimacy, accountability and transparency. The achievement of sustainable development within cities is impossible without competent, effective and representative city and local government that works in partnership with citizen groups, business, societies and non-governmental organisations (NGOs) (Global Forum '94 Conference 1994).

One of the fundamental sources of conflict is the competition for scarce resources. Development in South Africa very often introduces scarce resources into resource-starved communities and therefore focuses on the existing power struggles in these communities, because individuals and organisations controlling resources command political allegiance (Hindson and Swilling 1995). Power structures in divided communities are part of reality and means of dealing with them must be incorporated in any development process.

At the one end of the participation spectrum, recipient communities are not involved at all in the decision-making process whereas at the other end of the spectrum, more radical planning processes such as that advocated by the organised homeless in the country, essentially find little need for government and professional input into their planning processes. Rather than any of these two extremes, a partnership approach to planning is advocated in these guidelines.

Partnerships provide the integrated planning framework within which development initiatives occur. Partnerships also ensure cooperation among stakeholders as the parties

"agree to share the planning and decision-making responsibilities through structures such as joint policy boards, planning committees and mechanisms for resolving impasses " (Arnstein 1996).

Partnership-based planning processes provide more than a mechanism for public participation. They mobilise community expertise, commitment, and resources for joint action. It is agreed that there is no single correct way to create a partnership planning process, but trial and error and reviewing success stories offer some useful guidelines.

The focus of participation is on delivery and not on ideologies and/or political power; accordingly, a public participation process is required that is flexible enough to address the realities of the stakeholder participation and community dynamics, while keeping focus.

ROLE-PLAYERS IN THE PLANNING PROCESS

The "role" of each group involved in the *partnership*, being the community, the local authority (or decision-makers/politicians) and the professionals is as follows:

- The *community* has a wealth of local knowledge that it brings to the project as well as a natural understanding of the local conditions and relationships. The community can identify needs and measure improvements. One of the important roles of community representatives is to disseminate information into the broader community. Professionals can also benefit from community representatives, as they collect and bring socio-economic and demographic information and personal experience from the communities, which can be used to inform the planning process and strengthen the community's case during negotiations. When the community is involved, proposals or plans are more likely to be acceptable.

  In a greenfield situation, "the community" includes surrounding stakeholders and/or potential users of a settlement. In most instances, potential users are known, whether they are on a waiting list or waiting to be housed in public housing or private developments. There is always a sense of "the potential users". Other stakeholders include interested and affected parties such as developers, local authorities, etc. In in-situ or renewal situations, "the community" is usually already resident.

- The *decision-maker* (or government organisation) has power by virtue of laws - laws that ensure implementation. The local council can also provide the information centres required by all parties, including staff, financing, and other resources to encourage and improve public-participation programmes.

- The *professionals* have technical expertise and experience in land delivery. They can also fulfil various roles, such as that of facilitator, coordinator, advocate, etc. Included in this group is the developer who could be a private developer or the local authority.

ROLE OF THE PLANNER IN THE PLANNING PROCESS

The traditional role of the planner is that of principal coordinator, project manager and technical professional in the settlement-development process. The planner operates within the realm of legal requirements for township establishment, rezonings and consent uses, and his or her technical role is in motivating the changes in land use. In motivating the land use change, the planner needs to consult widely with other professionals from other disciplines, and the ability to think holistically and integrate various inputs is essential. The traditional role of the planner remains. However, with the involvement of the community in the planning process, additional skills are required. These skills do not necessarily reside within a planner or any other one professional. If the planner does have the necessary additional skills, such as conflict resolution and negotiation, his or her role can be expanded. If not, the additional required skills can be brought in as part of the project team, and the planner co-operates and co-ordinates with all members of the team.

THE PLAN-MAKING PROCESS

Other than the broad directive that the plan-making process should be centered on human needs and driven by a partnership between the community, the professionals and decision-makers, these guidelines are not intended to suggest a step-by-step plan-making process which needs to be strictly adhered to under all circumstances, but rather to outline typical actions necessary in plan-making, which can be adapted, ordered and applied under various conditions and contexts at the discretion of the partnership team. In addition, the dynamics brought to the process by including the community cannot be predicted or stifled and the plan-making process needs almost to unfold as the process progresses, appropriate to that group of participants, at that point in time, and for that particular set of needs and circumstances. Despite this requirement for flexibility in the process, there are a number of common key actions which are typically followed in plan-making. Broadly, the actions stem from two kinds of decision sequences: those concerned with making the plan and those concerned with administering it.

Identification and notification of interested and affected parties and other stakeholders

Partnerships work most effectively where there is an organised power-base in the community to which citizen leaders are accountable (Arnstein 1996). Effective participation can be obtained if representatives, who have been elected through democratic structures, are involved. It is, however, extremely difficult to develop and operate an organisational system that reaches the majority of citizens; therefore one must use existing institutions and their networks to achieve what needs to be done, for example local councils, residents organisations, business organisations, NGOs and civic organisations, etc. As community-based organisations (CBOs) and NGOs are not always well resourced, it is important to build up capacity in the communities one is working with, so as not to put resources solely in the hands of professionals and have the government merely be a facilitator (Schiceka 1994).

The NGOs require particular consideration on the issue of how people need to be represented at local level. The NGOs are recognised as having an important role in initiating, facilitating and sustaining community action. However, while promoting the initial steps in democracy and participation, they can also be counter-productive if they become self-serving and compete for resources themselves. Communities should both value and capitalise on the inputs from NGOs. Representatives of communities should be elected democratically to prevent misrepresentation; however, the initiative should come from the communities.

The means of notifying stakeholders is through
- press releases;
- scheduled meetings with representative bodies;
- pamphlets/photos;
- telephone calls; and
- mail drop.

Negotiation of a participation strategy

Once the groups have been identified, the public participation requirements or strategy need to be negotiated with all parties including communities. One must not merely inform the community of its role in a specific project. It is very important to set ground rules for participation where all the roles, responsibilities, participation limits and rights, as well as the process, are understood and agreed upon up-front.

Careful consideration should be given to the design of the consultation process, as the players could change and then the only "fixed" issue is the agreed-upon participation process. As there are various levels of participation, active and passive, the interested and affected parties should not necessarily be the focus but rather the proposed participation process. There should never be a barrier to participants' joining at any stage during the participation process, but the rules for joining should be specified in the participation strategy.

Once the participation strategy has been agreed upon, it should be documented and signed as a partnership agreement which can be referred to at any stage in the participation process. The fundamental purpose of the partnership agreement is to facilitate the process of bringing together all stakeholders, for them to agree on the details of the type of development to take place and establish what each party has to offer the development. Stakeholders should enter into a partnership agreement to establish a decision-making forum directed at creating an environment of cooperation, in addition to obtaining the commitment of all. A partnership agreement should also be a dynamic agreement, which should permit additional stakeholders to become signatories at any point during the process. It is the document that formally records the content and terms of this agreement. Thereafter projects should be implemented, monitored and evaluated in terms of the abovementioned agreement so that the objectives of this agreement are met.

Local councils and decision-makers should have strategies that outline their commitment to working in partnership with communities. Such strategies should be defined and have measurable objectives, promoting an interdisciplinary culture that values community participation. Examples exist in the Local Agenda 21 programme. Depending on the way institutions are structured, their interactions will either facilitate or obstruct participation and partnership. It is vitally important for members of communities to be able to meet members of government, the decision-makers, in order to facilitate participation. Institutions may need to alter their structures and modes of operation in order to promote appropriate interactions.

Mediation skills and mechanisms need to be built into planning and reconstruction because the possibility exists at almost every stage of the development process that negotiations will break down. The approach to development is therefore the formulation of partnership agreements as a framework for conflict resolution. In order to reduce conflict it is important for the client to attend public meetings in the plan-preparation process, in order to be exposed to communities' needs and perceptions.

A forum or steering committee should be established by the partners to ensure that adequate and appropriate planning occurs, that a process of participation is established, and that a mechanism for management of the project is created, as well as to ensure the implementation, monitoring and evaluation of the project in terms of the negotiated agreement.

Needs identification and prioritisation

The identification and prioritisation of needs is best informed by the people whose needs are to be fulfilled. This action can be coordinated and facilitated by a planner, a project manager or any other person with facilitation skills. The community needs to be the main role-player and take the lead where possible and necessary. Essential tasks in this action involve the following:

Capacity-building and empowerment

If required, capacity-building must happen prior to setting goals, objectives, etc, for the project. The community needs to be aware of its minimum rights, responsibilities, technical considerations and the options available to it. In addition it needs to be aware of the operations and decision-making processes of the client (local authority, government or a major developer).

Sustainable development cannot be achieved unless problems and issues are addressed in a cooperative and interdisciplinary way. Structures and channels of communication that promote this should therefore be created (Global Forum '94 Conference 1994). The degree to which citizens are actually placated depends on two factors: the quality of technical assistance they have in articulating their needs and priorities, and the extent to which the community has been organised to press for those priorities (Arnstein 1996).

Disseminating information

Successful sustainable development programmes depend to a large extent on the ability to make wise decisions on options and actions. Wise decisions can be made only if good quality information is available. It is thus very important that such an information system be put in place. Such a system could include resource and information centres, with appropriate technological and human-resource back-up (Global Forum '94 Conference 1994).

Choice of living conditions

The best settlements are created when people have a wide range of choices in relation to living conditions. Each new development should therefore contribute to broadening the range of choices. A basic decision is whether the range of choices is created on-site, or whether development on the site provides one option in a range of choices over a larger area. As a general principle, the larger the site, the greater the choice of living conditions becomes an issue.

Site assessment

In this action, the planner takes the lead as coordinator and facilitator. Assistance from communities is encouraged. Other professionals (such as engineers, environmental planners, etc) will gather the data necessary to undertake their specialist tasks. All relevant information necessary to undertake a detailed site assessment or analysis of context needs to be acquired. The site assessment needs to occur within the context of the identified needs, from a number of perspectives.

Site potential and relationships

Each land parcel has unique relationships with other land parcels, each with their different structuring elements and relationships. The potential of each parcel in terms of these relationships, and uses which could be accommodated on it, need to be discovered.

Site integration and/or discontinuity

It is essential to integrate the site with other land parcels. The principles of achieving continuities and discontinuities are central to the integration process.

The natural system

Each land parcel is unique in terms of the natural system (geology, soils, topography, hydrology, climate, flora and fauna) which gives it its character. These features need to be carefully understood to determine the following:

- The presence of important ecological systems, which should be protected to ensure their continued functioning.
- The appropriate approach to development. There are two basic approaches. The first relies on a strong, imposed geometry to create place. The other, which is a more organic approach, gives less direct direction and is usually more responsive to the natural landscape. The chosen approach is usually a combination of these basic approaches.
- The orientation. This is informed by aspects such as views, wind protection, the need to optimise light and shade, shelter from the elements, and so on.
- The engineering constraints. Natural conditions can play an important role in determining which engineering technologies should be used.
- The availability of resources. Sites may contain resources, such as building materials, which can

be used in a development and which contribute to a unique sense of place.

- The potential of natural place-making features. Water bodies can, for example, be used as place-making elements.

See also Sub-chapter 5.8.2 for further elaboration regarding ecological considerations.

The higher-order planning system

The site must be contextualised in terms of higher-level existing requirements of integrated development plans (IDPs)/local development objectives (LDOs)/spatial development frameworks, integrated transport plans, local economic development and environmental plans applicable in the area.

Setting of goals and objectives

This phase requires the translation of needs into goals and objectives that are realistic, given the nature and conditions of the site, parameters of the brief and financial and time constraints. It is important for the planner to introduce and debate the performance qualities to be achieved in the development of settlements, and for technical professionals to ensure that stakeholders understand all aspects of the site assessment. The participation process should focus on

- enabling interested and affected parties and authorities to bring to the attention of the project team their concerns, attitudes and perceptions about the project and related investigations; and

- ensuring that the interested and affected parties' concerns, attitudes and perceptions are addressed by the project team.

Establishment of a crude land allocation budget

Having assessed the site and needs and set broad goals and objectives, it is useful to calculate a coarse land-allocation budget, which includes

- a determination of what activities and land uses should be accommodated on the site; and

- a determination of the approximate land areas required for the various components of the settlement.

Although the land budget cannot be calculated precisely, it is useful in that it establishes a general sense of scale and it identifies the public and institutional elements that are appropriate to the site, over which the planner has relative control.

Preparation of a conceptual plan

This action involves the formulation of a conceptual spatial ordering system for the settlement. It requires the articulation of the main *principles* and *ideas* informing the plan. The conceptual plan, which is an abstract device, has the following purposes:

- it ensures clarity by enabling the idea to be questioned and taking plan-making out of the realm of simple intuition;

- it enables continuity by ensuring that the relationships between ideas are addressed;

- it serves as a management tool by providing the framework to which plan-makers can refer in searching for solutions to particular problems and in the making of the formal plan itself; and

- it provides the basis for discussion and incorporation of stakeholders views and inputs.

Preparation of a framework plan

The framework plan is made by refining the conceptual plan. This is the design stage of plan-making, and consists of a number of components:

- The first involves working with nature. The specific site conditions will mould the plan and suggest new possibilities and options for the settlement-making process.

- The second component requires the refinement of the "land budget" and identifying those parts of the framework plan about which there is some certainty, such as the investment of public resources.

- A third component is closely related to the above and requires the inputs of a range of experts involved in the settlement-making process. This includes a range of fields including engineering, urban design, ecology, demography, economics, finance, and so on.

- The fourth component is involving stakeholders in the plan refinement process. In some instances, trade-offs will need to be made and this must be discussed and workshopped closely with stakeholders.

- The last component consists of obtaining the required approval of the local authority and relevant government agencies before proceeding with the implementation plan.

Costing and budgeting

The cost of implementing the framework plan needs to be determined. An important part of this is determining who pays for different elements of the structure envisaged in the plan. At this stage, the financial viability of the plan is tested by considering the availability of resources and by comparing expenditure with the expected return on investment. This process may result in further refinements and adaptations of the plan.

Preparation of an implementation process plan

The "Process Plan" is an action or implementation plan and is concerned with ensuring an efficient implementation process. If the site is relatively large, an important part of the settlement-making process is ensuring that a wide range of implementing agents, including local and provincial authorities, individuals, communities, housing utility companies, small and large developers, etc., is involved in the settlement-building process. Where appropriate, local labour needs to be identified and invited to work on development. Tender documents need to be simplified to make them understandable by local entrepreneurs. The process plan should incorporate a land-release programme, a detailed management framework (incorporating institutional arrangements), and a financial plan.

Applications for land use changes and amendments to higher order plans such as IDPs, LDOs or spatial development frameworks, need to be made if and where necessary.

The management framework should incorporate land-use management recommendations, concerned with the definition and application of appropriate rules to the settlement-making process, including

- land use or zoning restrictions, specifying the types of activities permitted on the land;
- coverage, height, density, floor area and access restrictions for specific sites; and
- site layout and landscaping requirements.

Land-use controls need to be applied cautiously, as they are by nature cumbersome. The pre-determination of land uses often reduces flexibility, thus mitigating against spontaneous settlement-making. The primary form of land-use control - at least during the initial stages of development - should be the logic of the framework plan itself. Land uses will commonly respond in a predictable way if the settlement structure is clear and easy to read.

In the South African situation, particularly where rapid settlement-making occurs, consideration should be given to a system where land uses acquire post hoc rights; that is, legal rights are established after the particular use is developed, and subsequent changes in land uses are handled on the basis of impact and nuisance.

Implementation

A dynamic project manager plays the leading role in the implementation phase. The project manager plays a key coordinating function. The planner's role becomes one of monitoring, along with the other stakeholders. Other key players include training and development facilitators and administrators. Implementation includes the following actions:

- Preparing tenders;
- Awarding tenders;
- Site plans and preparation;
- Building plans;
- Beginning construction and development;
- Managing and coordinating construction and development;
- Financial management;
- Landscaping; and
- Provision of movement networks, engineering services, public facilities and utilities, and open space.

Administering the plan

It is the primary responsibility of the local authority to ensure that the desired performance qualities of the plan have been met but it is recommended that when people become resident on the site, a sub-committee should be formed in conjunction with representatives from relevant authorities to monitor and evaluate development progress, performance and sustainability of the local area and fulfillment of basic needs.

Since there is no one ideal form of plan, the administration process must be a reactive one. Ideally, the process should be creative and interactive, allowing for adaptation of the plan as and when circumstances may require, and where community support for such changes exists.

ADAPTING THE METHOD AND THE PARTICIPATION PROCESS

The proposed methodology was specifically designed for the planning and development of greenfields areas but is applicable to all development situations with certain minor adaptations and changes in emphasis at certain points in the process. While the methodology and generic guidelines are similar for in-situ upgrading and renewal circumstances, some differences do exist, particularly relating to the process of participation, site-assessment, and implementation.

In the case of upgrading and renewal, the stakeholder-identification step is easier, as the primary stakeholders are physically resident in the area. The actual participation process is likely to be more complex, however, due to the fact that the specific community already has a history at that location, together with existing problems, issues and politics. The design and implementation of the participation strategy and the setting of ground rules is of particular importance to ensure that focus on the pertinent issues is maintained, and that only the relevant issues and problems are considered.

The degree of participation will vary according to specific circumstances and particularly according to the willingness and desire of the particular community to become involved. Existing provincial town planning ordinances, in terms of which many land-use changes are still applied for, have specific requirements regarding advertising and informing the public of the proposed development. These and other applicable provincial legislation, should be regarded as the minimum requirements. The recently promulgated environmental legislation, requires a greater degree of stakeholder identification and involvement. The methodology proposed in this chapter accommodates the entire range of degrees of participation, but it is in the hands of the practising planner to decide, in terms of prevailing legislation and specific circumstances, what degree of participation is appropriate to each situation.

Regarding site-assessment differences, in the case of greenfields development the emphasis will be on the natural and physical characteristics of the site, whereas with upgrading and renewal the emphasis will be on social aspects and the limitations and opportunities provided by the already built physical environment. A socio-economic survey is likely to be an important component of upgrading and renewal developments (Behrens and Watson 1996).

The implementation process for renewal and upgrading is also more complex than for greenfields developments as it may be necessary for people to temporarily move out of the area, be accommodated elsewhere, and then move back into the area once the upgrading has been completed. The logistics of managing this process are significantly more difficult than in the greenfields situation.

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Chapter 5

Planning guidelines

5

Movement networks

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INTRODUCTION

"Movement networks" are defined broadly as public right-of-way networks, accommodating land-based movement by a range of movement modes. Earlier guidelines have referred to "movement networks" as "road layouts".

While the guidelines presented in the previous version of the "Red Book" (1994) were intended for application in both high- and low-income residential development, its guidelines on road layout planning were drawn directly from the initial "Blue Book" (1983). It was acknowledged in the subsequent "Green Book" (1988) that the "Blue Book" had been prepared for "developed communities" or "municipal townships", not "developing communities". In the review of the previous "Red Book" (in 1995), its road layout planning guidelines were criticised for being car-oriented and for largely ignoring the movement needs of those sectors of the South African population without access to private motor cars.

The intention of this sub-chapter is therefore to provide guidance on the design of local area movement networks in both higher and lower income areas that are primarily convenient for pedestrians and public transport users, while at the same time restrictive of unwanted and potentially dangerous fast-moving through-traffic. The guidelines have been prepared for application in predominantly residential, but also mixed, land-use developments that seek to be consistent with current housing, transport and land-development policy objectives.

A different approach to those of past guideline documents has been adopted in that

- public right-of-way networks (as opposed to road layouts) are the focus of planning and design;
- reference to conventional road classifications such as "access roads", "collectors", "local distributors" or "arterials" is avoided to prevent preconceptions regarding the functions and cross-section of any particular public right-of-way; and
- continuous, pedestrian-friendly, public right-of-way networks are promoted ahead of conventional discontinuous suburban road layouts.

These differences are consistent with recent shifts in international practice - which have included site layout design as one of a series of "travel demand management" (TDM) strategies - often referred to as "transit-oriented" or "(neo)traditional" design. These design ideas have emerged largely in response to growing automobile dependency and associated efficiency and equity problems, and to the prospect of global warming as a result of increasing greenhouse gas emissions (to which vehicle tailpipe emissions are a significant contributor). Government authorities and professional institutions in various parts of the world have begun either replacing or supplementing their design codes to take account of these ideas. The list of key literature at the end of this sub-chapter provides references to some examples of these design codes.

The sub-chapter is divided into five sections. The first section clarifies what is meant by the term "movement network". The second discusses the role movement networks play in human settlements, and the qualities they should have. The third section provides guidance on how these qualities can be achieved in the configuration of movement networks in general. The fourth section provides guidance on the contextual factors that should inform the configuration of a movement network on a particular site. The final section provides guidance on the adaptation and conversion of movement networks to accommodate changing patterns of movement demand and right-of-way functions.

These guidelines should be read in conjunction with Chapter 7 on geometric design, as well as the Department of Transport's "Transport planning guidelines" (TPGs) - particularly TPGs 1, 5, 9, 12 and 14 on "integrated transport plans", "spatial planning", "travel demand management", "transport systems management", and "traffic calming" respectively. Further guidelines on road design, which adopt an approach similar to that of the earlier Blue Book, can be found in the former Committee of Urban Transport Authorities' (now replaced by the Committee of Land Transport Officials) "Urban transport guidelines" (UTGs) - particularly UTGs 1, 5, 7 and 10 on "urban arterial roads", "urban collector roads", "local residential streets", and "commercial and industrial local streets", respectively.

ELEMENTS OF MOVEMENT NETWORKS

Local movement networks are made up of (a) links and (b) junctions of public rights-of-way or reserves. These links and junctions contain overlaid systems of "ways" for different movement modes - including footways, roadways, pathways, cycleways, and sometimes railways (see Figure 5.1.1). Viewing a movement network as a network of public rights-of-way, as opposed to simply as a network of roads, is central to the planning approach presented in this sub-chapter; it is argued to be essential to the design of local movement systems that move away from being car-oriented.

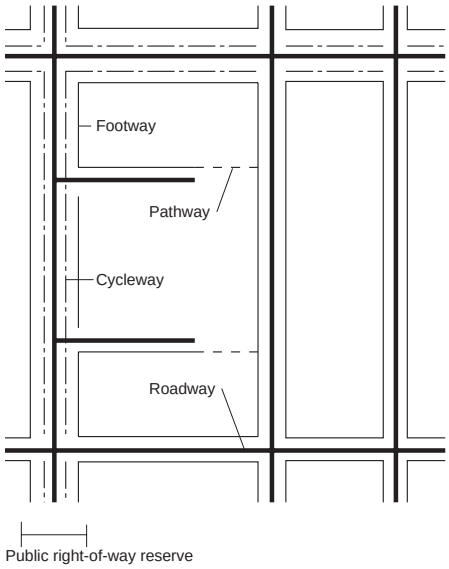

Figure 5.1.1: Diagram illustrating a movement network as a series of overlaying "ways"

Links

This network of public rights-of-way within a local mixed land use development has numerous functions - including the facilitation of movement by different modes, accommodating utility services, providing commercial activities with exposure to potential consumers, and so on. The configuration of movement networks and the functional differentiation of links therefore needs to be informed by a variety of socio-economic factors (e.g. the accommodation of street trading, child play and social interaction), as well as movement factors. Movement networks, based on a functional road hierarchy that is tiered solely on the basis of traffic distribution, do not take into consideration - and often cannot accommodate - all the functions the network needs to perform.

In order to avoid overlooking or excluding some of the functions they perform, public right-of-way links are broadly categorised below on the basis of the users they accommodate. More detailed functional differentiation should occur on a context-specific basis.

- There are links within a movement network where the needs of longer distance vehicular traffic predominate over those of other users and functions, and these links therefore need to be designed to accommodate motorised modes only. These *vehicle-only links*, corresponding with major arterial roads or freeways, should be designed to provide uninterrupted vehicular channels which accommodate the needs and requirements of fast-moving inter- and intra-settlement traffic. The need for uniform operating conditions and high levels of safety requires, inter alia, control over direct frontage access and intersection spacing, and frequently grade separation at intersections.

- On the bulk of the remainder of links within a network it is necessary to achieve a balance between the variety of social, recreational, economic and movement functions the link performs. These *mixed-mode links*, which may be collector or local roads, should therefore be planned to reconcile the diverse requirements of a multiplicity of users, with the recognition that inevitably no one function will operate with optimum efficiency. In terms of vehicular traffic circulation, different mixed-mode links perform a variety of access, collection, and even shorter distance mobility functions. Higher order mixed-mode links would be those designed to accommodate the shorter distance distribution and stopping of relatively large volumes of mixed traffic (often referred to as "activity" or "main" streets). Middle order mixed mode links would be those designed to collect traffic onto vehicle-only distributors. Lower order mixed-mode links would be those designed to provide access to individual properties - some of which would be designed primarily for pedestrians, and vehicle behaviour would essentially be determined by a set of pedestrian rules (e.g. *woonerven*). Conventional hierarchical road classification systems therefore fall within this categorisation of higher, middle and lower order mixed-mode links - arterial roads fall within the category of higher order mixed-mode links, collectors fall into the category of middle order mixed mode links, and local streets (also known as "access roads") fall into the category of lower order mixed-mode links.

- As some routes accommodate only motorised modes, other routes accommodate only non-motorised modes (e.g. pedestrians and cyclists). The entrances to such *pedestrian-only links* are typically designed to prevent access by vehicles. The links themselves are, however, often designed to enable the movement of occasional emergency or service vehicles. The functions of pedestrian-only links can vary significantly, from those links abutting and accommodating intensive commercial activities (e.g. "pedestrianised" streets in city centres), to links performing a primarily pedestrian- or bicycle-access function within "superblocks" or across soft public open spaces.

An understanding of the potential range of functions that each link within a movement network may be expected to perform enables the appropriate number of lanes, the pavement structure, the footway width, the on-street parking provisions, and the intersection configurations and spacings, etc, to be selected. Contextual factors that inform the derivation of mixed-mode link functions include:

- the existing and expected composition, volume and destinations of motorised and non-motorised traffic on the "external" movement network

surrounding the site, the degree to which this traffic may wish to pass through the site, and the routes they select;

- the number of consumers that may wish to pass through the site, and the exposure of local entrepreneurs to potential non-local consumers along the routes they may select;
- the composition, volume and destinations of motorised and non-motorised traffic that is likely to be generated and attracted by the expected land use pattern on the site, and the routes they may select; and
- the alignment of existing and anticipated "external" road-based public transport services, how these services may be integrated into and through the site, and points at which modal interchange is likely to occur.

Junctions

Junctions, as in the case of links, perform a variety of movement and non-movement functions. With regard to movement functions, the carrying capacity of an urban roadway network is determined by intersection capacity, not by route capacity, and it is therefore intersection performance that often determines the operational efficiency of the roadway network as a whole. The non-movement functions of junctions relate primarily to economic activity. Each quadrant of a junction is exposed to two adjacent movement routes, and consequently is the site of maximum potential consumer exposure in the immediate area.

THE ROLE OF MOVEMENT NETWORKS IN HUMAN SETTLEMENTS AND THE QUALITIES THEY SHOULD HAVE

The role of a movement network in the process of settlement-making is essentially to provide the basic spatial framework within which a number of urban processes that involve the physical movement or reticulation of people, goods and services, find spatial form. A measure of the performance of a movement network should therefore be the degree to which the network can effectively accommodate a variety of changing urban processes.

The role of a movement network in the daily operation of a settlement system is essentially to enable the convenient, efficient, affordable and safe movement of people, goods and services and, in doing so, to satisfy the needs of a variety of users and facilitate the effective operation of local space economies. A further measure of the performance of a movement network should therefore be the degree to which the network minimises the demand for movement, and hence the degree to which ease of access is increased. Movement should not be seen as an end in itself, but as a means through which needs can be satisfied.

In performing these roles, a local settlement movement network should have the following basic qualities:

- A movement network should prioritise the needs of non-motorised modes most sensitive to distance, as well as the needs of public transport services depended upon by those sectors of society without access to private motor cars.
- A movement network should be able to maintain convenience, safety and multiple-use patterns over time, as the nature of movement demand and network use inevitably changes.
- As mentioned earlier, apart from a limited number of links that accommodate the requirements of fast, longer distance vehicular traffic, a movement network should accommodate a range of movement demands and socio-economic functions.

GUIDELINES ON THE CONFIGURATION OF MOVEMENT NETWORKS (IN GENERAL) TO ACHIEVE THESE QUALITIES

In order for movement networks to perform these roles and have these qualities:

- certain basic relationships need to be created between vehicle-only, mixed-mode, and pedestrian-only links; and
- public right-of-way networks need to be configured in particular generic ways.

The relationship between vehicle-only, mixed-mode, and pedestrian-only links

The purpose of interconnections between vehicle-only and mixed-mode links is essentially to provide higher-speed route alternatives. They enable longer distance, higher-speed traffic to avoid mixed-mode links (or portions of mixed-mode links) that experience relatively high, but lower speed (i.e. "stop-start"), vehicular traffic volumes. In practice, lower levels-of-service (i.e. slower and denser vehicular traffic) will be acceptable on links that have a higher capacity route alternative. Wherever possible (Figure 5.1.2):

- Higher order mixed-mode links should therefore run parallel to high-capacity vehicle-only links. This enables through-traffic to "opt-in" or "opt-out" of travelling along the higher order mixed-mode link, depending on the range of urban activities to which access is required.

- The higher order mixed-mode link and the vehicle-only link should ideally be close enough to make it relatively easy for vehicles to move between the two routes, yet ensure that the fragmentary impact of the higher order facility, particularly if it is a freeway, does not prevent commercial and public facility activities from locating on either side of the mixed-mode link.

- Access interchanges between vehicle-only links and higher order mixed-mode links, as well as system interchanges between vehicle-only links themselves, should be designed to facilitate safe and uniform operating conditions. These interchanges perform a "mobility" function, which precludes locating any activities that require direct frontage access adjacent to the intersection. The spacing of interchanges along vehicle-only freeways should be determined by the need to prevent joining traffic streams from disrupting traffic flow and reducing traffic speed, creating unsafe operating conditions.

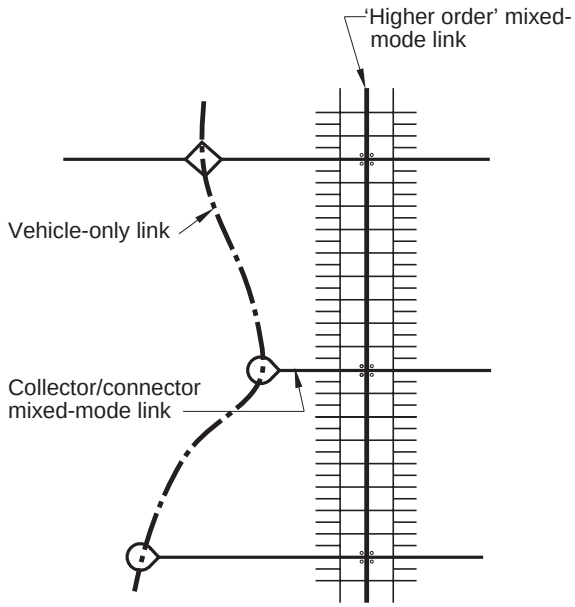

Figure 5.1.2: Diagram illustrating the relationship between vehicle-only and mixed-mode links

On mixed-mode links that accommodate higher traffic volumes, the following should be noted:

- The spacing of intersections should be greater than on links carrying lower traffic loads. In order to avoid excessive disruptions to the traffic stream, greater intersection spacings can be achieved by aligning blocks parallel to - as opposed to perpendicular to - higher order links (and, where required, providing pedestrian-only access through the middle of these blocks).

- Intersections between two mixed-mode links that accommodate larger volumes of traffic are points of greatest accessibility, and are therefore points where commercial opportunities are often largest. The relative accessibility of a particular intersection is determined not only by the type and nature of passing traffic, but by the ability of traffic to stop. Consequently, in order to create trading opportunities, vehicles (including public transport vehicles) should be able to stop and park or offload passengers within a reasonable walking distance from the intersection, and buildings should not be prevented from fronting onto the intersection.

- Taking vehicular access close to the intersection, however, increases the potential for conflict and should be avoided. The volume of traffic on many of these intersections necessitates some form of intersection control which, in turn, through eliminating potential conflict points, enables greater use of four-legged junctions.

On mixed-mode links that accommodate lower traffic volumes, the following should be noted (Figure 5.1.3):

- Intersection spacing should be influenced more by, inter alia, pedestrian circulation, block subdivision and internal utility service reticulation considerations than by traffic circulation considerations. By limiting straight, unbroken stretches of roadway in which vehicles are able to pick up speed, network configurations can be used as traffic calming mechanisms, which enhance the ability of pedestrians to use streets for social and recreational purposes.

- Low traffic volumes do not usually justify investment in intersection control, in the form of traffic signalisation. T-junctions can therefore be used as a way of breaking long stretches of roadway.

- Intersections between two mixed-mode links that accommodate smaller volumes of traffic, are less accessible and therefore provide opportunities for less intensive trade and collective servicing points. Activities should not therefore be prevented from locating close to the intersection.

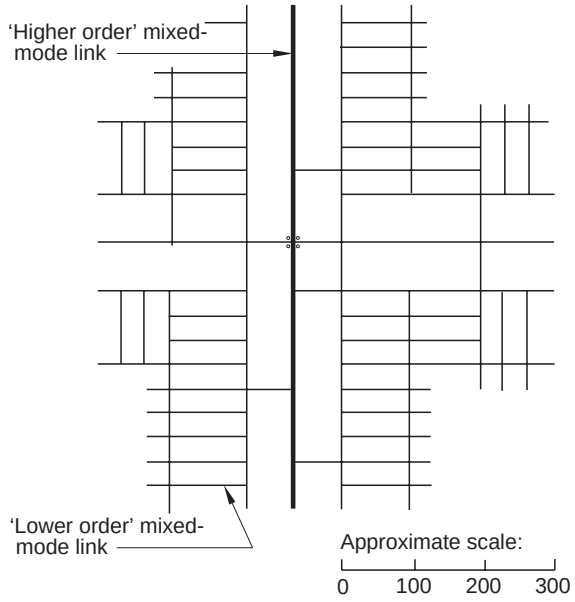

Figure 5.1.3: Diagram illustrating the relationship between higher and lower order mixed-mode links

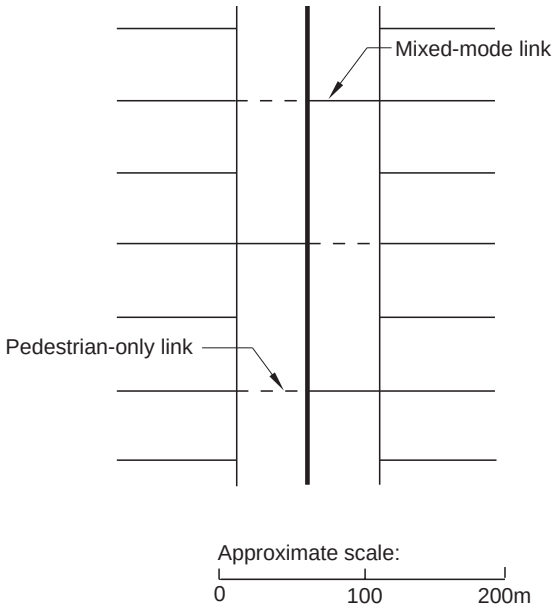

Figure 5.1.4: Diagram illustrating the relationship between pedestrian-only and mixed-mode links

Note: The diagram illustrates public right-of-way links, not roadways. The junction of two right-of-way links does not therefore necessarily imply the intersection of two roadways. See Figures 5.1.8 and 5.1.9 for illustrations of roadway systems that prevent or manage through-traffic on lower order mixed-mode links.

The purpose of interconnections between mixed-mode and pedestrian-only links is essentially to maintain easy multi-directional pedestrian and bicycle access, in situations where the roadway network is discontinuous to prevent large quantities of vehicular through-traffic from using certain routes (Figure 5.1.4). The network of pedestrian footways, crossings, pathways and cycleways should always remain convenient and direct. Intersections between mixed-mode and pedestrian-only routes typically take the form of footways joining with short pathways that run through longer blocks or open spaces.

The configuration of links and junctions into networks

A continuum of basic network-configuration options can be identified on the basis of network connectivity (Figure 5.1.5). On either end of the continuum are closed and open networks. A closed network consists of a hierarchy of links, within which links intersect only with other links equal to - or one below or above - it in the hierarchy. This system establishes clearly defined movement routes between any two points, but offers no equidistant alternatives. An "open" network on the other hand, consists of a system of links of differing hierarchical importance intersecting freely with one another. This system offers a choice of alternative equidistant routes between any two points within the network.

Studies of the impact of open and closed networks on travel behaviour and residents' quality of life, have indicated that different configurations have both advantages and disadvantages. On the one hand, studies have shown that while open networks (in

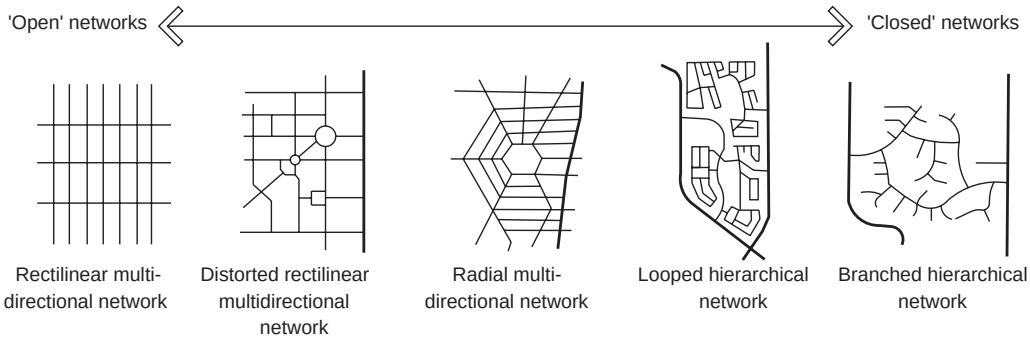

Figure 5.1.5: Generic network configurations

conjunction with mixed land-uses) improve levels of accessibility to local destinations, reduce total vehicle kilometres travelled and increase the walking and public-transport share of the modal split; they can also result in numerous problems associated with the intrusion of fast-moving through-traffic (e.g. safety and noise). On the other hand, studies have shown that, while closed networks manage through-traffic effectively, they can also isolate neighbourhoods and reduce the viability of smaller neighbourhood commercial activities, as well as increase trip lengths for non-motorised modes and necessitate road-based service vehicles to either back-track or frequently accord priority to other vehicles.

Central to the planning approach presented in this sub-chapter is the argument that the configuration of public rights-of-way into networks that are multidirectional, enables different way systems within the movement network to either incorporate or avoid the above-mentioned advantages and disadvantages. It is possible, for instance, for a *multidirectional* movement network to maintain easy and direct pedestrian and bicycle circulation in all directions (through the design of the footway, pathway and cycleway component of the network as an open system), while preventing or limiting the safety and intrusion problems associated with extraneous vehicular traffic (through the design of the roadway component of the network as a closed system - see Figure 5.1.6).

A multidirectional configuration (and the associated patterns of public and private land ownership) further enables the various "way" systems within the movement network to be adapted to become more open or closed as modal split and dynamic land-use development processes alter the nature and pattern of movement demand and the functions of particular links. Network configurations, to a large extent, determine the pattern of land sub-division, which in turn forms the basis for title registration and the allocation of development rights. Given that large-scale expropriation and compensation is required in order to significantly alter patterns of land ownership and development rights, discontinuous or "dendritic" public right-of-way networks are extremely difficult to adapt and are inflexible. A multidirectional movement network is thus able to prioritise the needs of non-motorised modes and public transport users, as well as maintain convenience, safety and multi-use when conditions and movement needs change. It is important to note that a multidirectional movement network is not necessarily an orthogonal grid.

Figures 5.1.7, 5.1.8 and 5.1.9 provide an example of how the individual "way" systems within a hypothetical multidirectional movement network (see Figure 5.1.7) can be configured to manage motorised traffic on lower order mixed-mode links through either volume management measures (see d, e and f of Figure 5.1.8), or speed reduction measures (see Figure 5.1.9), while maintaining direct pedestrian and bicycle circulation in all cases (see a, b and c of Figure 5.1.8). It should be noted that the management of traffic volume and traffic speed is interrelated, and it is not the

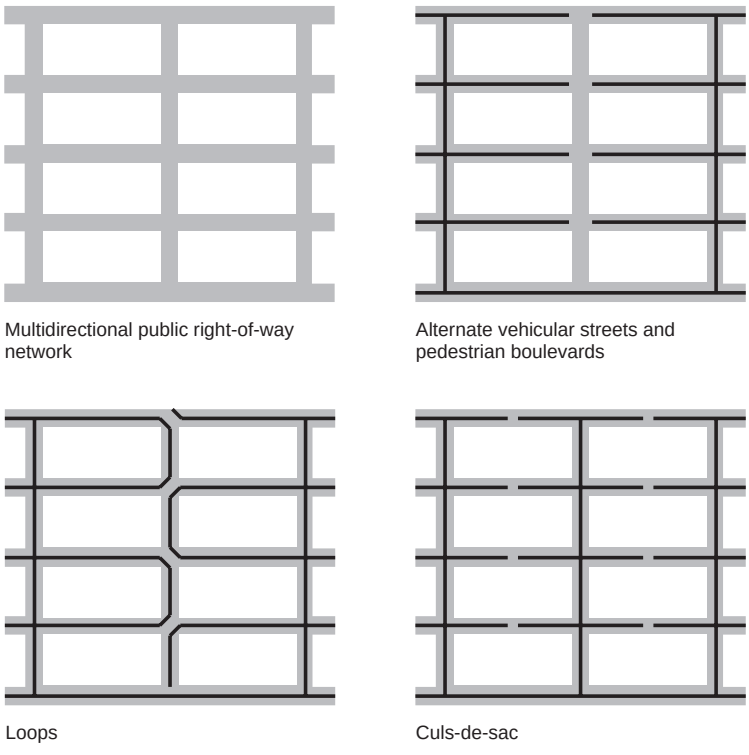

Figure 5.1.6: Conceptual examples of closed roadway system options within a multidirectional public right-of-way network

intention of the figures to suggest that they should be considered independently. Studies on the impact of traffic volume and speed management measures have shown that speed reduction on particular links almost inevitably leads to volume reduction as well. The use of roadway closures and diverters which restrict through-traffic are therefore not regarded as mutually exclusive from the use of measures that reduce speed (e.g. tables, pinch points and chicanes), and vice versa.

It should also be noted that in all the different configurations represented in Figures 5.1.8 and 5.1.9, a continuous footway and pathway network with 18 pedestrian entrance/exit points is maintained. The pathways are also all relatively short and straight, and surrounding properties overlook them. The public transport route is direct, and pedestrian access to the public transport stop is unhindered. In the case of roadway systems, the minimum spacing between T-intersections involving minor arterials and service/collector routes is ± 100 m, the minimum spacing between T-intersections involving collector and local access routes is ± 25 m, and the minimum spacing between cross-intersections involving collector and local access routes is ± 50 m.

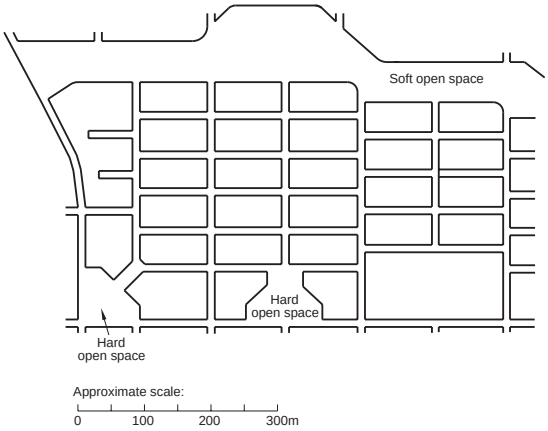

Figure 5.1.7: Hypothetical example of a multi-directional public right-of-way network

The exact configuration of a multidirectional movement network is dependent on context-specific factors like topography, the distribution of traffic-generating activities in surrounding areas, car-ownership levels, and the modal split of the population on the site as well as the surrounding population - these contextual factors are discussed in the following section.

GUIDELINES ON THE CONTEXTUAL FACTORS THAT INFORM THE CONFIGURATION OF A PARTICULAR MOVEMENT NETWORK

An analysis of the pattern and mix of existing and anticipated land-use activity surrounding the particular site, as well as the pattern and mix of higher order land-use development that is to be encouraged within the site, will indicate spatial patterns of movement demand (known as “desire lines”) across, into and from the site. In order to identify movement-demand desire lines, it may be useful to establish a map which indicates possible future patterns of movement demand (both motorised and non-motorised) between existing and anticipated areas of land-use activity. This desire-line map essentially consists of bands which represent the major movement flows between appropriately scaled zones - delimited on the basis of a simple grid, or on the basis of clusters of dominant land-use activity. The beginning and end points of the band indicate the origin zone and the destination zone, and the width of the band indicates the relative magnitude of the anticipated movement demand. Such movement desire-line maps can be prepared for different times of the day or week, in order to indicate temporal fluctuations in movement demand. An indication of the nature of these patterns of movement demand can be used to inform

- the need for, and alignment of, higher order movement routes across the site; and
- the need for, and alignment of public transport connections across the site.

An analysis of the pattern and mix of existing and anticipated land use within the site, the demographic and income profile of the existing and “target” population on the site, as well as the biophysical features of the site, will indicate, inter alia, land-access requirements, the nature of movement demands, and topographical constraints on network configuration. In the case of in-situ upgrade projects, the existing pattern of informal movement channels will be a major internal informant of movement-network configuration. An indication of these requirements and constraints can be used to inform

- the modes of movement that will need to receive priority in the configuration of the network;
- local economic development considerations in the configuration of the movement network;
- the land-access requirements associated with the pattern of land subdivision;
- place-making considerations in network configuration; and

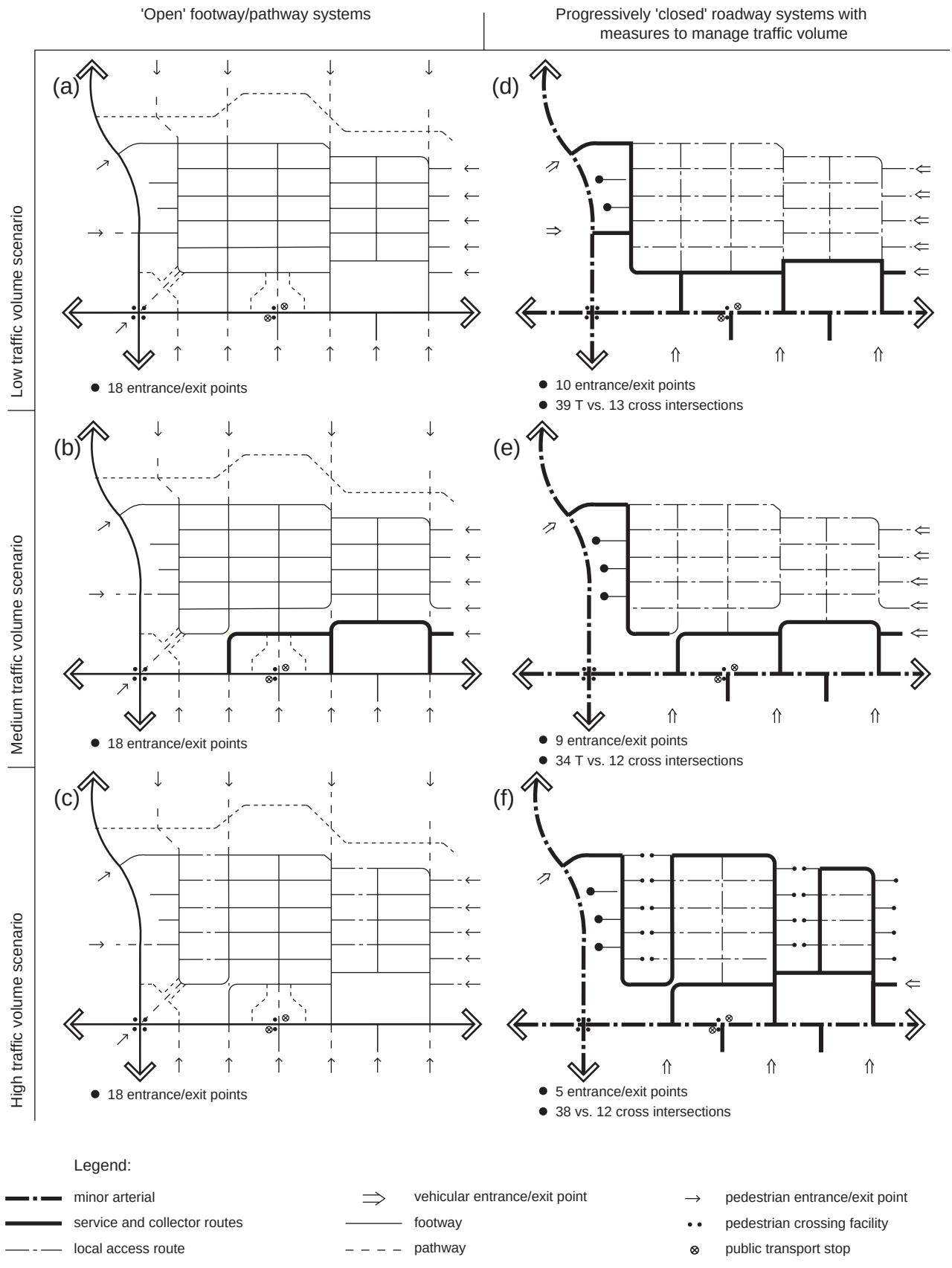

Figure 5.1.8: Possible configurations of foot/pathway and roadway systems within a public right-of-way network that respond to different traffic volume situations

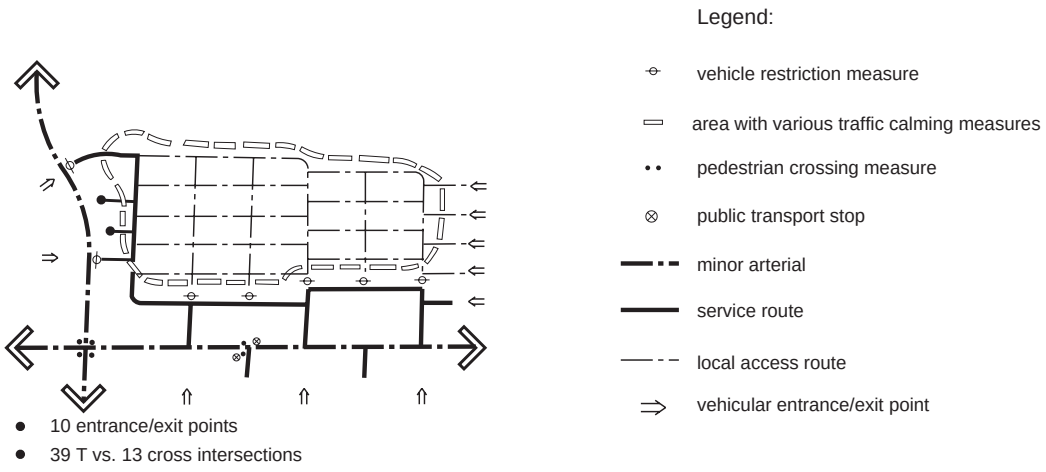

Figure 5.1.9: Possible use of measures in a public right-of-way network's roadway system to manage traffic speed

- the network configuration requirements of internal services reticulation, particularly gravity-based wastewater and stormwater drainage.

Higher order movement route connections

Higher order movement routes, in the form of vehicle-only links or mixed-mode links carrying greater volumes and densities of vehicular traffic, which lead to, across, and out of the site, facilitate longer distance intra-settlement connections. In many cases the need for, and the alignment of, these higher order movement routes across the site will already have been identified in metropolitan or sub-metropolitan plans. In these cases, the proposed higher order routes need to be accommodated within the site, and the planning and design of the local movement network needs to be done in relation to these dedicated alignments. Of particular importance, is the fact that when these higher order routes take the form of vehicle-only links, the opt-in-opt-out relationship between vehicle-only and higher order mixed-mode links, discussed earlier, needs to be considered.

Public transport service connections

Public transport service connections that lead to, across, and out of the site represent an important way of integrating the local environment with the surrounding movement system and land-use pattern. The planning and design of the local network should provide opportunities for increased coverage and penetration of road-based public transport operations, through extending these into and across the site. In order to identify the need for increased public transport coverage and penetration, it may be useful to establish a map which indicates areas that are served and not served. The area served by public transport is delimited on the map as that which is within convenient walking distance of public transport stops. A convenient walking distance is often interpreted as maximum walking time of 5-10 minutes, and a maximum walking distance of that involving 400-500 metres. Such a map illustrates the area of coverage, and suggests where additional service routes and stops might be placed.

Network configuration requirements of vulnerable modes

- Public policies relating to desirable modal split, as well as the existing or anticipated level of car ownership among the site's population (and associated dependence on walking or public transport services), will provide an indication of the relative importance that different modes will need to assume in movement-network design within particular contexts. In order to design networks that are capable of prioritising particular - while effectively accommodating all - modes, it is useful to consider the specific network-configuration requirements of dominant modes (i.e. motor cars, walking, public transport vehicles).

- Motor cars are the most flexible of all movement modes, able to undertake any length of door-to-door trip. It is argued therefore that the configuration of local movement networks should be informed by the needs of more vulnerable, gradient - and distance-sensitive modes, particularly pedestrians.

- Walking trips can only cover relatively short distances (i.e. 1-2 kms), and are often associated with the beginning and end portions of public transport trips. Pedestrian movement is accommodated primarily within footways, pathways and roadways. In order to facilitate efficient pedestrian movement, these "ways" should be configured in the following manner:

  - Footways should be configured into multi-directional networks which enable pedestrians to choose relatively direct and equidistant trip routings, that either avoid or select roads that accommodate greater traffic flows and greater commercial land-use activity, and to orientate

themselves within settlements they do not know well.

- Blocks, within multidirectional network configurations, should be short to medium in length, to enable more intersections where cars must stop and pedestrians can cross, and more direct routing of walking trips. For ease of pedestrian circulation, block lengths should be in the region of 100 m.

- When block lengths are significantly longer than 100 m (in the region of 200-300 m) because of land use or traffic management considerations, short and direct pathways through the centre of the block (known as "pass-throughs") should be provided, in order to maintain the ease of pedestrian circulation.

- When culs-de-sac (or road closures) are incorporated within the movement network because of traffic management considerations, pathways should be provided which connect the end of the cul-de-sac with the nearest foot/roadway, in order to maintain multi-directional pedestrian circulation.

- On mixed-mode links where roadways and footways are separated by kerbs, footways should be provided on both sides of the roadway, and should connect with pathways that cut across large soft open spaces, to facilitate continuous and multidirectional pedestrian circulation.

- Pedestrians tend to choose travel lines of least resistance - cutting corners and keeping their routes as direct as possible. Pedestrian pathways within soft open spaces (that accommodate non-recreational trip functions) should therefore be as direct and short as possible.

- On roadways experiencing relatively high traffic flows, pedestrian crossings should be provided at regular intervals, and should be located at points where pedestrian desire lines cross the roadway, in order to maintain adequate levels of pedestrian safety.

• Public transport vehicle trips typically take the form of shorter feeder, and longer line-haul or express trips. The number and spacing of stops establishes the line-haul or express nature of the public transport service. The network configuration requirements of express public transport vehicles are similar to the requirements of motor cars undertaking longer distance trips. Public transport vehicles are accommodated within roadways and railways. In order to facilitate efficient public transport movement, these "ways" should be configured in the following manner:

- Effective line-haul public transport service operations are quick, frequent and predictable. Roadways carrying road-based bus and light rail services should therefore be as direct as possible, to avoid the delays associated with continuous backtracking, and frequent turning movements where giving priority to other vehicles needs to be accorded. Direct road alignments also make the introduction of dedicated public transport lanes less complex than on circuitous roads, and enable numerous service operations to be routed along the same road for portions of their service length - thus enhancing the frequency of services along the route.

- Parallel road-based feeder public transport service routes should be spaced at maximum intervals of 800 - 1 000 m, to maintain a maximum convenient walking distance to these services of 400 - 500 m.

- At bus service terminals, vehicles may stand for some time and need to turn around. It is preferable to provide a turning area off the roadway, unless there is a suitable nearby roundabout which can be used.

- Where rail lines are an integral part of the movement network, or where a site is being developed adjacent to an existing railway station, every opportunity should be taken to structure a set of road-based public transport routes to interchange or end at the railway station, in order to facilitate inter-modal transfer.

Network configuration impacts on local economic development processes

The spatial organisation of local economies is influenced by a number of complex socio-economic, financial, security and development control factors. It is important that the configuration of the movement network maximises opportunities for small entrepreneurs, and does not disadvantage, or preclude, certain types of entrepreneurs and spatial patterns of economic activity from occurring. Movement networks define the spatial pattern of exposure and access to passing consumers, and therefore influence spatial patterns of economic opportunity (i.e. points of greatest commercial viability that are largely, but not exclusively, dictated by relative levels of exposure and access to passing consumers). Movement networks that create a cellular settlement structure and channel all through-movements onto arterials along which fronting access and on-street parking is not allowed, for instance, tend to create a nodal (as opposed to linear, or randomly scattered) pattern of economic opportunity. Given the limited number of such nodes within a local area, this pattern of economic opportunity frequently

results in commercial activities organising themselves into shopping centres. Small independent entrepreneurs with limited capital are typically unable to meet the relatively high overhead costs associated with trading within shopping centres, and are therefore denied access to most of the viable trading locations created by the network configuration. In order to put in place one of the spatial preconditions necessary to create opportunities for small independent entrepreneurs, movement networks should be configured in the following way:

- The local movement network should be integrated into the surrounding movement system and land-use pattern, so that flexible and complex patterns of intra - and inter-district shopping can develop which enable consumers to move directly and conveniently into, and out of, the local area - thus avoiding monopolistic and oligopolistic trading conditions in which local retailers are able to charge inflated prices to a relatively captive market. Local multidirectional road networks should therefore be stitched into, and form an integral part of, the system of movement in the larger area, and should not be regarded as an independent sub-system.

- The network configuration should incorporate links that enable shorter distance through-traffic to move through local areas, and at the same time ensure that, where necessary, through-traffic has the option of travelling along high-speed vehicle-only routes. Shorter distance through-traffic and local traffic should be concentrated onto continuous integrating main streets that accommodate road-based public transport services, in order to create the passing consumer thresholds that are necessary to support viable, fronting, small-scale commercial activities. Vehicular and pedestrian traffic can be concentrated onto main streets through the alignment of different public transport modes and services along shared routes for a portion of their service length, and the location of movement generators like major public facilities and public transport modal interchanges along the route. While not necessarily dictating the spatial pattern of economic activity within a local area, this network configuration creates a more dispersed, linear pattern of economic opportunity that can accommodate a range of types and sizes of entrepreneurs and commercial investment patterns.

Land-access requirements

A central informant of the planning and design of the site's movement network is the need to ensure that there is adequate access to all erven within the site - typically in the form of a passing roadway and footway to which private pathways and driveways (or private roads, in the case of estates) can connect. What constitutes "adequate" access is subject to debate, however. Conventionally, all erven are provided with vehicular access but, in some instances, due to steep topography or low levels of car ownership (especially in in-situ upgrade developments), "adequate" is interpreted as being a relatively short public pedestrian pathway leading from a public road. The expected nature and mix of land-use activity on the site will, through an iterative process, indicate the width, and in some instances the length, of blocks that need to be incorporated in the network. To facilitate the efficient subdivision and utilisation of land, movement networks should be configured in the following way:

- In the absence of topographical or other constraints (e.g. infrastructure servitudes), local movement networks should be broadly rectangular, to yield the greatest possible number of erven from blocks. Sharply curving road alignments, which result in curved blocks, make the efficient subdivision of land difficult.

- Blocks defined by the configuration of the local roadway network should, wherever possible, be modular in order to enable larger blocks to fit into a pattern of smaller pedestrian-scaled blocks. Land-use activities like schools, shops and parks consume relatively large parcels of land that often do not fit into pedestrian-scaled blocks.

Place-making considerations

The way in which a site's movement network is configured can contribute to the creation of a "sense of place". The concept of a sense of place is complex, crudely referring to the images and feelings associated with the uniqueness of a particular part of a settlement, an entire settlement, or even a collection of settlements, that are embedded in collective memory, and to the way in which individuals respond psychologically, to the way public spaces within settlements are made. It follows therefore that the attainment of a sense of place cannot be achieved through standardised planning and design. Place-making essentially involves recognising the natural and cultural uniqueness of a particular environment and its population, and incorporating - and enhancing - this uniqueness in planning proposals. More specifically, in order to contribute to the creation of a sense of place in settlements, movement networks can be configured in the following way:

- Straight tree-lined avenues or boulevards can be aligned towards, and terminate at, important cultural or symbolic public buildings, public art displays or objects of public remembrance, in order to create vistas (i.e. visual axes) and enhance gateways to public spaces. Road alignments that create vistas can therefore help establish a series of landmarks that make a settlement memorable. By

giving important objects visual dominance in the settlement, they become reference points - thereby reinforcing their symbolic importance.

- Road alignments can, where appropriate, respond to the natural features of the site, and incorporate it visually into the settlement. The alignment of roads can be used as a means to create vistas to natural features like established trees, *koppies*, or distant mountain peaks, and to retain existing landscape features.

Network configuration impacts on internal utility service reticulations

Reticulated utility services, in the form of water supply, sewerage, stormwater drainage, electricity supply and telecommunications are conventionally - either entirely or partially (in the case of mid-block reticulation) - accommodated in road reserves. The configuration of the movement network therefore has an impact on the reticulation of these channels, pipes and cables. The aspects of movement-network configuration that have the greatest impact on efficient service reticulation are: (1) road curvature, and (2) road gradient.

The curvature (or horizontal alignment) of the road reserve has the greatest impact on piped gravity-based services (i.e. sewerage and stormwater drainage), and above-ground electricity and telecommunications cabling. In order to facilitate the efficient reticulation of these services, movements networks should be configured in the following way:

- Notwithstanding the need to follow contours, road reserves accommodating below-ground pipes and above-ground cables, or dictating the pattern of reticulation in the middle of blocks, should generally be as straight as possible to facilitate the shortest relative service line lengths per erf, for straight trenches, and to minimise manhole and poling requirements. Curving road reserves require more sewer and stormwater manholes to provide access to pipes for cleaning (see discussion below), and necessitate extra poles in above-ground public lighting and electricity-supply systems, to ensure cables do not hang over the roadway.

- Notwithstanding the need for larger blocks to accommodate a range of non-residential land uses, blocks should generally be ± 100 m long, to minimise the number of sewer and stormwater manholes. The primary function of sewer or stormwater manholes is to provide access to pipes so as to clear blockages. It is conventional practice to provide manhole access to a gravity pipe at horizontal and vertical changes of direction, junctions between main and branch pipes (but not at junctions with erf connections in the case of sewerage), the head of a reticulation system, and at intervals on straight stretches of pipe. Manhole spacing on straight stretches of pipe is normally restricted to the length of hand-operated cleaning rods (typically 50 m), which are pushed along the pipe. Rods can bend to negotiate curves in a pipe but, if the curve is too tight (with a curve radius of less than 30 m), the rods tend to damage the wall of the pipe. The maximum spacing of manholes on straight stretches of road reserve, where pipes are cleaned with hand-operated rods, is therefore ± 100 m. When blocks are ± 100 m long, manhole access would be required at 100 m or so intervals to accommodate the junctions between main and branch pipes anyway. Limiting the length of blocks to ± 100 m therefore reduces the necessity for manholes on straight stretches of pipe.

The gradient (or vertical alignment) of the road reserve also has a great impact on gravity-based services (i.e. sewerage and stormwater pipes and channels). In order to facilitate the efficient reticulation of these services, movements networks should be configured in the following way:

- T-junctions or culs-de-sac at the down-stream end of steep roads should be avoided, in order to maintain “positive drainage” and avoid flooding.

- Very steep or completely flat road gradients present problems relating to the circulation of larger service vehicles (in the form of congestion), and the self-cleansing flow velocities of gravity-based services (in the form of clogging and road scour). Maximum grades are set by vehicle manoeuvrability requirements (provided the surface runoff velocity that results from the grade is less than 3 m/s), while minimum grades are set by drainage requirements. Maximum grades vary according to the volumes and speed of traffic and the nature of the terrain - generally grades should not exceed 5-6% (or 1:20-1:16) in flat terrain, 10-12% (or 1:10-1:8) in hilly terrain and 12-15% (or 1:8-1:7) in mountainous terrain. Minimum grades of road reserves accommodating pipes should generally not be below 0,4% (or 1:250). In hilly and mountainous terrain, in order to achieve these grades, and avoid deep cuts and high fills, blocks and their associated fronting road reserves should follow contour lines, and traversing roads should intersect roads above and below them at an angle sufficient to maintain an acceptable maximum grade. When blocks are aligned with contours, provided toilets are located close enough to the rear of the erf, mid-block sewer trenches can be dug to ensure that both lines of erven within the block are served by the same sewer.

GUIDELINES ON THE ADAPTATION AND CONVERSION OF MOVEMENT NETWORKS TO ACCOMMODATE CHANGE

As indicated in the previous section, a range of contextual features will inform the configuration of a site's movement network. In particular, with regard to the roadway component of the movement network, the actual and desirable level of car use and associated modal split of the site's (and surrounding) population will inform the degree to which the system is open or closed to through-traffic. This section discusses the anticipation of patterns of movement demand to inform the configuration of roadway systems and the adaptation and conversion of roadway systems to accommodate changing modal split, and changing movement patterns associated with dynamic spatial patterns of land-use activity.

The anticipation of patterns of movement demand within sub-metropolitan and local movement networks

The pattern of movement demand within a sub-metropolitan or local area is directly affected by the nature and form of the movement network. In the case of a closed hierarchical roadway system, it is possible to predict the volume and pattern of traffic (associated with a static spatial pattern of land use and modal split) that will use each road in the system with some degree of certainty, as the system presents no choice of potentially equidistant routes between any two points. While it is not possible, in the case of a more open system, to predict the volume and pattern of traffic with any degree of certainty - due to a greater choice of local and through routes - a more open system is more flexible and integrates the site into its surrounding environment better. There is however a trade-off between flexibility, integration and cost. The ability of more numerous links within a movement network to accommodate a dynamic range of social, recreational, economic and movement functions over time, has capital cost implications - and in many instances greater road reserve width and stronger roadway pavement structure will be required. Every link in a network cannot therefore be designed to accommodate large increases in traffic volumes.

To avoid the excessive road construction costs associated with total flexibility and greater integration, it is necessary, within limits, to predict the possible range of movement demand conditions (or scenarios) a more open road network proposal may be expected to accommodate. More specifically, the need is to identify those links expected, in the short term at least, to accommodate a wider range of functions and greater traffic volumes. Without a reasoned estimate of the traffic load a particular link or intersection will be required to accommodate, it is not possible to make informed decisions relating to the design of appropriate roadway cross-sections and pavements, or the selection of appropriate intersection-control systems. The direction, volume and mode of movement generated and attracted by a proposed development will be influenced by variables like household size and composition, areas of employment, levels of car ownership, and use of public transport services. It is important that an understanding is gained of the extent of change which is realistically possible within these variables, so that the network can be designed to accommodate such changes.

Patterns of movement demand on vehicle-only links, as well as mixed-mode links expected to accommodate larger volumes of traffic, can be predicted through a four-step modelling process, in which future traffic load, at a point in time (typically 15-20 years into the future), is assessed on the basis of a desirable, as well as the existing, land-use pattern. It is important to note that the modelling of future patterns of movement demand is sensitive to transport and land-use policy. Extrapolations of current patterns of movement demand should therefore be tempered by the settlement qualities to be created in a particular environment, and assumptions relating to the ability of the public sector to manage transport-related market forces. The conventional "four-step" modelling process is dealt with in detail in the Department of Transport's TPG 7 and can be broadly summarised as follows:

- estimating the number of trips that will be generated or attracted by each zone (often on the basis of the anticipated population of the zone multiplied by an average trip rate),

- estimating the number of trips that will occur between different zones (often represented in the form of an origin-destination matrix, and a desire-line map),

- estimating the relative proportion of modes through which trips between zones will occur, and assigning the trips moving between different zones, by different modes, to particular routes.

Patterns of movement demand within a particular site can be crudely predicted through the following five-step simulation:

- estimating the number of trips that will be generated or attracted by each erf within the site (often on the basis of assumptions relating to average number of workers per household and per business unit, and the average number of schoolchildren per household);

- estimating how many of these trips are local trips, and how many are into, and out of, the site;

- establishing trip directions on the basis of the location of major movement attractors (e.g. schools, employment and commercial centres) within the site and in the surrounding area;

- estimating the relative proportion of modes through which trips in different directions will occur; and

- assigning the trips moving in different directions, by different modes, to particular routes.

This simulation process can be conducted for peak and off-peak conditions, to establish temporal variations in the nature and pattern of movement demand. The patterns of movement demand identified can then be used to establish link volumes and turning movements.

Given the uncertainty of future predictions of future land-use development patterns and associated movement demand, and the need for movement networks to perform more than simply movement functions, it is important that the modelling processes described above be used to test the likely consequences of movement-network proposals, and not used as the basis for formulating proposals (beyond minor adjustments to network configuration). Demand-driven approaches to movement-network planning and design, based on the traffic load forecast, run the danger of either entrenching existing inefficiencies and inequalities, or of simply basing proposals solely on potentially erroneous predictions of future development patterns.

The management of changing patterns of movement demand within sub-metropolitan and local movement networks

The uncertainty of future predictions of movement-demand patterns also makes it important to monitor change (in terms of variables like traffic volumes, speeds and accidents) over time and, where necessary, to adapt or convert movement networks to accommodate this change. It is important that initial movement-network designs consider and facilitate possible future adaptations. Such adaptations or conversions are essentially aimed (a) at managing or "calming" the increased volumes and speeds of vehicular traffic associated with changing patterns of movement demand - more specifically to prevent large volumes of high-speed, longer distance traffic from cutting through quieter, predominantly residential areas, and to slow traffic on roads that experience a high mix of pedestrian and vehicular traffic, and in doing so, (b) at maintaining the ability of links to accommodate a range of movement and non-movement functions. As mentioned earlier, an advantage of multidirectional movement networks is that a variety of traffic calming interventions can be applied to convert the roadway network into a closed or speed restricted system which controls through-traffic, while maintaining an open footway and cycleway network, and which still enables the roadway network to be converted back to an open system should this be required. The achievement of greater flexibility therefore has implications for the operational capacity of local authorities, in terms of being able to monitor change, as well as for the configuration of movement infrastructure, and cost.

Within local movement networks the ongoing traffic-management objective is essentially to keep the speed of appropriate volumes of traffic low and, in doing so, to make the road as safe as possible for pedestrians. Traffic management, or calming, therefore takes two basic forms. The first is the reduction of speed through adaptations to the cross-section and horizontal and vertical alignment of the roadway. The second is the reduction of traffic volumes on certain roads through converting roadway network connectivity. It is important to note, however, that roadway adaptations can also reduce traffic volumes by making the route less attractive to through-traffic, and connectivity conversions can similarly reduce traffic speed.

The introduction of these traffic management measures are warranted when the monitoring of patterns of movement indicates that certain traffic speeds or volumes along certain routes have increased to levels that are not compatible with the range of social and economic functions the route is required to perform (see TPG 14 on "traffic calming"). Internationally, speed reduction measures on local roads are typically deemed necessary when maximum speeds exceed ± 30 km/h, and on mixed-mode arterials when maximum speeds exceed ± 55 km/h. Typically, volume-reduction measures are deemed necessary on local roads when traffic volumes exceed ± 600 vehicles/h. At slower speeds, drivers have greater opportunity to perceive and react to a situation, thus helping to reduce the number and severity of collisions. Roadway systems can be adapted to manage traffic speed, through the introduction of traffic-calming measures as illustrated in Figure 5.1.10.

Roadway systems can be converted to manage traffic volume, through the introduction of traffic calming measures as illustrated in Figure 5.1.11.

Empirical studies on the effectiveness of traffic management measures indicate that legal speed limits (in the form of "speed zones") have little effect on driver behaviour, and that it is rather the physical or operational characteristics of the road that determine driver behaviour. Traffic management measures should therefore be self-enforcing. Studies suggest that different self-enforcing measures have variable impacts on traffic volume and speed - apart from speed humps and speed tables, "adaptation" measures tend to have a greater impact on traffic speed, than on traffic volume, and "conversion" measures have a significant impact on both speed and volume.

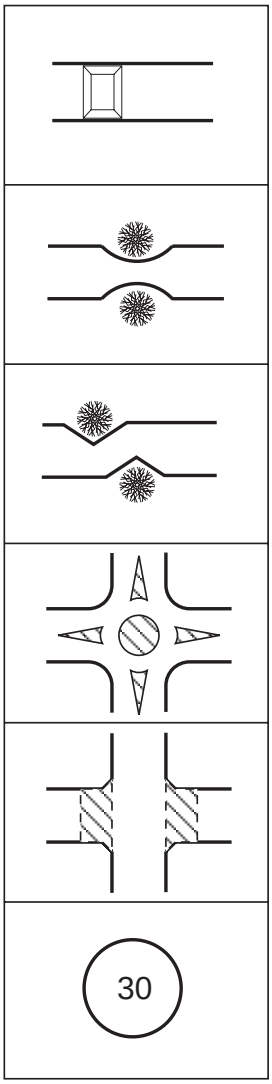

Figure 5.1.10: Roadway adaptations to manage traffic speed.

* The partial of full closure of roadways at the end or middle of the road

* The restriction of traffic movement to selected directions only, in the form of diverters (also known as diagonal road closures) and median closures

* The conversion of two-way roads into one-way roads

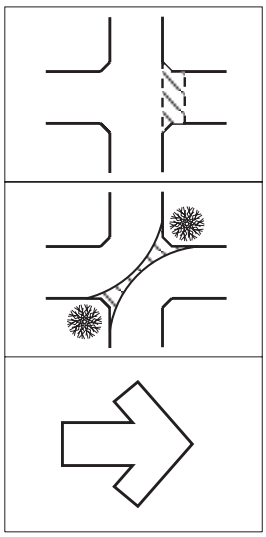

Figure 5.1.11: Roadway adaptations to manage traffic volumes.

The introduction of adaptation and conversion measures requires careful consideration, however. If local area traffic management measures, particularly conversion measures that alter network connectivity, are introduced on an ad hoc or area-specific basis, they can have a negative effect on the performance of the movement network as a whole. For instance, the closure of roadways that accommodate slower speeds, and shorter distance through-movements, increases trip lengths, and can lead to congestion on vehicle-only routes, and can reduce the viability of abutting formal and informal economic activities that depend on exposure to passing non-local consumers. The adaptation of individual roads can simply divert problems to nearby parallel routes, and the introduction of speed humps can have a negative impact on the operation of road-based public transport services and emergency service vehicles. Traffic management measures therefore need to be monitored and applied on an area-wide basis.

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Public transport

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INTRODUCTION

Public transport policy, strategy, planning, operations and management are all currently in a state of flux in South Africa. In the recent past, in most urban areas the focus of public transport bodies was largely the provision of basic services for low-income communities, whose travel choices do not extend to walking, cycling or driving to their destinations. In most medium- to high-income areas, only rudimentary services exist which can barely be considered an alternative to the motor car. Accordingly, public transport services in South Africa have been designed to serve the perceived need to assemble labour from distant suburbs and satellite low-income dormitories, at centralised workplaces. There were, and still are, very few off-peak services. Public transport to serve non-work trip purposes has also been neglected. In recent years, public transport has come to be dominated by minibus taxis, which do not run to schedule and which have tended to follow the line of least resistance through the townships and settlements, in order to give operators the opportunity of maximising the number of journeys, and thus their profits. Service to customers has not been of primary concern.

The foregoing is the public transport context within which the planners of new settlements will be operating in the short to medium term (the next five to ten years). Settlement planners[1] will, however, be challenged to assist transport authorities[2] in changing direction and building cities and towns which facilitate public transport, and make it more accessible, viable and sustainable. It is, therefore, essential that the planners of settlements in urban areas should understand the current and evolving public transport policies so that they can assist in facilitating settlement which is supportive of public transport. This guide does not deal with settlements in rural areas, although many of the principles and standards are applicable.

The next section provides a summary of relevant documentation about public transport, and gives an indication of the likely directions of change in the coming ten years, to provide settlement planners with an understanding of the context within which settlement planning will be undertaken.

EVOLVING PUBLIC TRANSPORT POLICY AND ITS IMPLICATIONS FOR SETTLEMENT-PLANNING

White Paper on national transport policy

The strategic objectives of the White Paper which are relevant to settlement-planning and which should be incorporated in future settlements are summarised below:

- Public transport travel distances and times for work trips should be limited to about 40 km, or one hour in each direction. This means that new settlements should be located no further than 40 km from the major work destinations. Further, as a general guideline, settlements should rather be located as close as possible to places of work and other urban activities so as to facilitate trips by bicycle or on foot. Where this is not possible, settlements should be located close enough to work destinations to enable public transport vehicles to make two or more trips from the settlement to the work place or school in peak-hour periods.

- An objective has been set to promote the use of public transport over private car travel with an ambitious 4:5 ratio of public to private transport being set as a target. To assist in the achievement of this objective, settlement plans should have circulation systems or movement layouts which make all dwellings accessible to public transport (see Sub-chapter 5.1).

- Within the strategic objectives for improving accessibility, a target has been set of reducing walking distances to public-transport facilities to less than about one kilometre. Most people take about 15 minutes to walk one kilometre, so this objective should be regarded as a minimum. A far more desirable target for settlement-planning will be to place every dwelling within about seven minutes of a public transport boarding point (around 400-500 m).

- A final strategic objective which should be taken into account in settlement-planning is the object of promoting and planning for the use of non-motorised transport. Accordingly, settlements should be planned as places with a variety of urban activities, containing workplaces, schools, shops, recreational and community facilities, and dwellings. They should also have movement networks which permit direct pedestrian access to activities and public transport facilities (see Sub-chapter 5.1).

1 This applies to all professions involved in the planning and design of settlements.

2 Transport authorities are provincial or municipal governments responsible for pubic transport and roads in terms of schedule 4 of the constitution of the Republic of South Africa Act of 1996.

The White Paper also contains a number of policy statements that should be taken into account in settlement planning. These include the following:

- Land-development proposals (which include settlement plans) should be subject to a spatial policy framework within an agreed development-planning process. This means that the settlement plan must be approved in terms of an integrated development plan (IDP), part of which is an integrated transport plan (ITP)[3]. Accordingly, settlement planners will, at the outset, need to consult transport authorities to ensure that the planned settlement will be complementary to the integrated transport plan (ITP), which includes public transport strategies and operations.

- Land-use development at local level (settlements) will be subject to development approval in conformity with integrated development plans.

- The settlement plan should be cognisant of the designated public transport corridors and nodes contained in regional, metropolitan or urban IDPs. Thus, it will be necessary to contextualise the settlement within such a spatial plan. Every new settlement will be either adjacent to, or distant from, a major line-haul public transport corridor (in rare cases the public transport corridor may even bisect a settlement). The form of the settlement should be strongly influenced by its spatial relationship to line-haul public transport corridors, modal interchanges and feeder corridors; in this regard, specific guidelines on planning principles and design standards will be provided in later sections. At this juncture, it is sufficient to note that in terms of the White Paper, settlement plans will need to give effect to the policy of locating employment activities within (or close to) the public transport corridors and nodes (interchanges). Likewise, the settlement plan should facilitate the provision of higher density and mixed land uses adjacent to public transport facilities.

- A high density of development is important for public transport, in that it supports differentiated public-transport provision and enhances operating efficiency.

Legislation

Local government and transport legislation is in the course of preparation and will establish institutions and planning processes and procedures that will give effect to the White Paper's objectives and policies relating to both urban settlement and public transport. It can be expected, however, that local government, land development and land transport legislation will seek to promote integrated planning. This means that settlement plans will be subject to policies set out in integrated development and transport plans, as indicated earlier. Accordingly, in the short term, settlement planners can be guided by the objectives and policies set out in the White Paper which will, in due course, be given effect through the Land Transport Act. An important component of the Act will be the establishment of transport authorities, who will be responsible for planning for public transport. Settlement planners must consult transport authorities as an essential part of the planning process.

Moving South Africa

Moving South Africa (MSA) (South Africa, Department of Transport 1998) was a project of the National Department of Transport, completed in September 1998, which aimed to develop a long-term transport strategy for South Africa. The strategies identified in MSA entitled "Towards a transport strategy for 2020", will impact on settlement-planning. Appendix C to this sub-chapter contains a summary of these strategies. The following are the main features of MSA which are significant to settlement-planning:

- Line-haul, mass public transport will be concentrated into relatively few public transport corridors to provide conditions that will attract high-density mixed land uses. It is expected that most new urban employment activities will be encouraged to locate within such corridors.

- The quality of public transport and the extent of social support for the services will depend on the market segments served in each of the corridors. Settlement planners should thus be aware of the customer segmentation in the settlement, as this will provide an indication of the type of service that can be expected.

- Moving South Africa has developed a broad set of guidelines for determining the type of public transport infrastructure which will be appropriate to each corridor. These are only guidelines because, in due course, transport authorities will examine corridors on their own merits and determine their particular public transport policies. The guidelines will, however, influence settlement-planning. They are as follows:

    - High passenger-volume (also referred to as "ridership") corridors with more than 40 000 passengers per direction per day will probably support a rail - or dedicated public transport road - infrastructure in congested areas. Public transport nodes (stations and interchanges) in these high-ridership corridors will be supported by feeder services rendered by buses or minibus taxis.

[3] An Integrated Transport Plan is defined in guidelines prepared by the Committee of Land Transport Officials (COLTO).

- Moderate-ridership corridors with 10 000 to 40 000 passengers per day per direction are likely to be served by a road infrastructure, with priority or dedicated lanes for public transport over parts of the corridor. The line-haul services in these corridors will largely be provided by buses, supplemented by both buses and taxis at nodal public transport interchanges.

- Low-ridership corridors will characteristically have fewer than about 10 000 passengers per day per direction, and are likely to have some road-based priority schemes. Many of these low-ridership corridors will be feeder corridors. All the roads can be expected to be paved and the line-haul function or feeder function will fall primarily to taxis or small road-based vehicles.

Settlement planners will need to ascertain where the existing public transport corridors are located, relative to the proposed settlement. In planning the settlement it will be necessary to ascertain the type of corridor that will serve the settlement. This means negotiating with transport authorities to identify whether there will be extensions to nearby line-haul services, or whether the settlement will be served by a feeder service. In the case of the latter, the location of existing nodal points and modal interchanges will be an important consideration in the alignment of the low-ridership feeder corridor serving the settlement. Likewise, the location of the corridor or feeder facility within the settlement will need to give cognisance to the accessibility standards discussed earlier.

Figure 5.2.1 shows the urban densification options considered by MSA. MSA notes that high central-city densities will enhance public transport use and sustainability, but in South Africa this solution is problematic due to historic land tenure patterns.

MSA notes that the tendency towards continuing decentralisation of workplace locations is complicating the task of creating "compact cities". While it is argued that some compaction may be achievable as a means of increasing density in some cities, and is not ruled out, it is suggested that the predominant pattern in South Africa should be the "corridor city". MSA argues that the corridor approach fits more easily with existing South African urban land-tenure patterns. The appropriateness of the corridor approach is driven not only by the already decentralised distant townships and the low density of inner-ring suburbs, but also by recognition of the decline in central business district (CBD) vitality and the dispersion of development to satellite nodes. The favoured corridor option recognises the existing vacant land between townships and suburban areas which should be taken into account in settlement planning. These areas, if developed, can build on existing flows on major current corridors.

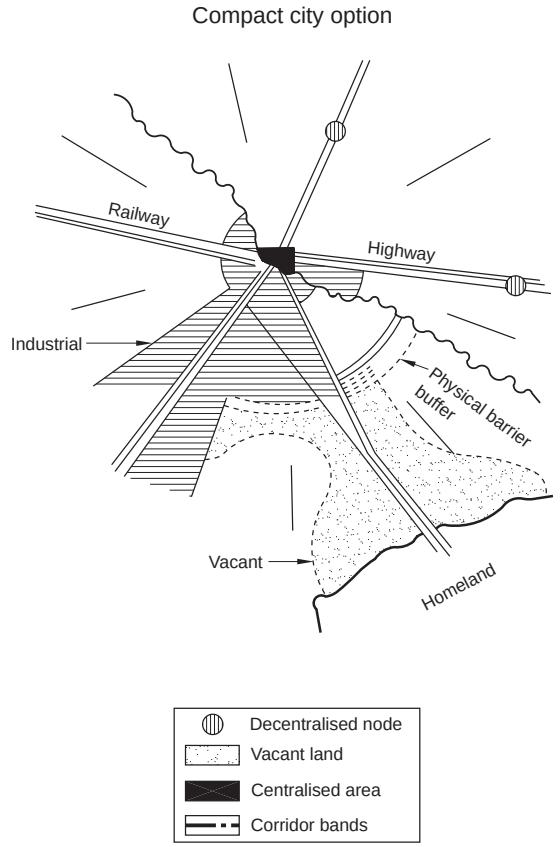


Figure 5.2.1: Urban densification options
Source: South Africa, Department of Transport (1998)

MSA states that corridors already exist to some extent in South African cities and, accordingly, their strategy focuses on densification of existing corridors and the creation of new corridors for future urban settlement-planning. The short-term focus should be on reigning in the centrifugal tendencies in South African cities to

prevent the future dispersion of development. MSA will be looking for strategies to attract decentralising activity towards public transport corridors. This approach should have a strong influence on settlement-planning.

PRINCIPLES TO ACHIEVE THE FUNDAMENTAL RESTRUCTURING OF PUBLIC TRANSPORT

The Department of Transport, through the CSIR, is currently assessing the processes and actions necessary to achieve a fundamental restructuring of urban public transport and create sustainable high-priority public transport systems.

Settlement planners may take it as given that the objectives, policies and strategies outlined in the preceding sections will be pursued through transport policy implementation, which should begin to shape ITPs as part of the process of urban development. The ideal of an interconnected network which serves a variety of destinations and is fully integrated will require a number of interventionist strategies and a supportive land-use structure. Evidence from cities such as Curitiba (Brazil) and Singapore suggests that this can be achieved only through strict adherence to principle and through an approach based on a committed spatial and network form.

The principles for fundamental restructuring are the following:

- *Problem-solving approaches and programmes for restructuring public transport should be incremental, practical and focused on the long-term vision (the corridor form of urban development)*

  Within this principle there are two aspects with a land-use or settlement dimension:

  – Public transport efficiency criteria are the key to the development of land-use. In time to come, transport planning and travel-demand management will impact on spatial patterns in South African cities, helping to make the urban land market more responsive to public transport as a locational determinate.

  – The high-priority public transport network will form the structural component for focused spatial development initiatives. Decentralised, retail and industrial developments and their relation to new settlements should be viewed as key elements in support of bidirectional public transport flows. This will require a review of decentralisation node location, as future design will be geared towards compact decentralisation nodes.

  A public-transport priority network should be developed (a few lines with frequent service are preferable to many lines with infrequent service). This will mean that settlement planners should note that, in most instances, the public transport component of new settlements will be feeder services and transfer nodes, except where the settlement falls within one of the higher-density corridors.

- *Appropriate nodes and technology should be selected to provide cost-effective services at predefined service levels, based on principles of efficiency*

  The public transport corridor and modal hierarchy will be assessed in terms of the length of the corridor, the convergence of routes and the relationship to the surrounding routes. For this reason it will be necessary for settlement planners to consider more than just the nearest point of access to public transport for the settlement. It will be necessary to understand the entire transport network or system when plugging a new settlement into any urban area.

  Settlement planners must be aware that public transport routes may be upgraded from feeder or low-priority routes to high-intensity lines or routes over time, as the urban area grows. Accordingly, the settlement must be designed with some flexibility to facilitate the application of different technologies as the demand at particular nodes and along the corridor grows. Where public transport routes are planned as part of the settlement plan, the demand implications of nodes and the potential for concentrations of land use along the corridor length, should be given attention during the planning of the layout.

- *The potential for transfer between routes should be maximised*

  Modal transfer centres will serve as the focus for the high-priority public transport network. Where such points lie within - or at the edge of - a settlement, they should serve as focal points for the movement network in the settlement. Pedestrian, cycle and public transport feeder roads should converge radially on central transfer points, which should be designed as pedestrian-friendly. To ensure that these points do not become clogged by standing and waiting buses and minibus taxis, separate holding areas should be provided in the settlement. Care must be taken to design the holding areas so that they do not cause unsightly impediments to movement within the settlement. The nodal transfer centres, whether stations or road-based interchanges, should be planned and managed as mixed-use centres, containing retail

facilities, offices, community services, and even some residential activities.

- *Seamless services that contribute to the concept of a centrally operated and controlled public transport system should be developed*

  Seamless services have a uniform and shared fare and ticket system applied to all modes, and customers can transfer between travel modes with a minimum of delay and discomfort. This principle can be supported by settlement planners if they ensure that a public-transport network, or potential network, is provided which is direct and which is physically conducive to comfortable and convenient transfer. In the design of the transport network, every effort should be made to make the route and facilities associated with it highly visible and accessible to the community.

- *Commercial, retail and industrial development activities should be located at appropriate nodes (convergence points on the public transport network), preferably within the priority corridor structure*

  These spatial components of the fundamental restructuring of public transport are illustrated in Figure 5.2.2, which highlights the principles that should be applied to achieve fundamental restructuring of public transport. Settlement planners should be cognisant of the need for public transport nodes to be prioritised in terms of their location relative to the high-priority network, and should be based on meeting certain minimum thresholds of demand. A clearly defined approach to settlement land-use planning is necessary for the support of an efficient, structured public-transport system. Nodes which fall short of the threshold of demand necessary to support a high-frequency public transport service should have further development discouraged within them, both by zoning regulation and the use of incentives and disincentives. This means that settlement planners need to understand at the outset what the public transport thresholds are, and should obtain this information by consulting transport authorities about their standards for public transport in the vicinity.

  Existing townships, particularly dormitory townships, provide a special case in terms of nodal structure. It is important that settlement planners who will be responsible for extensions of townships and infilling should understand that these types of settlement generally lack any kind of economic or activity node. They are, however, powerful

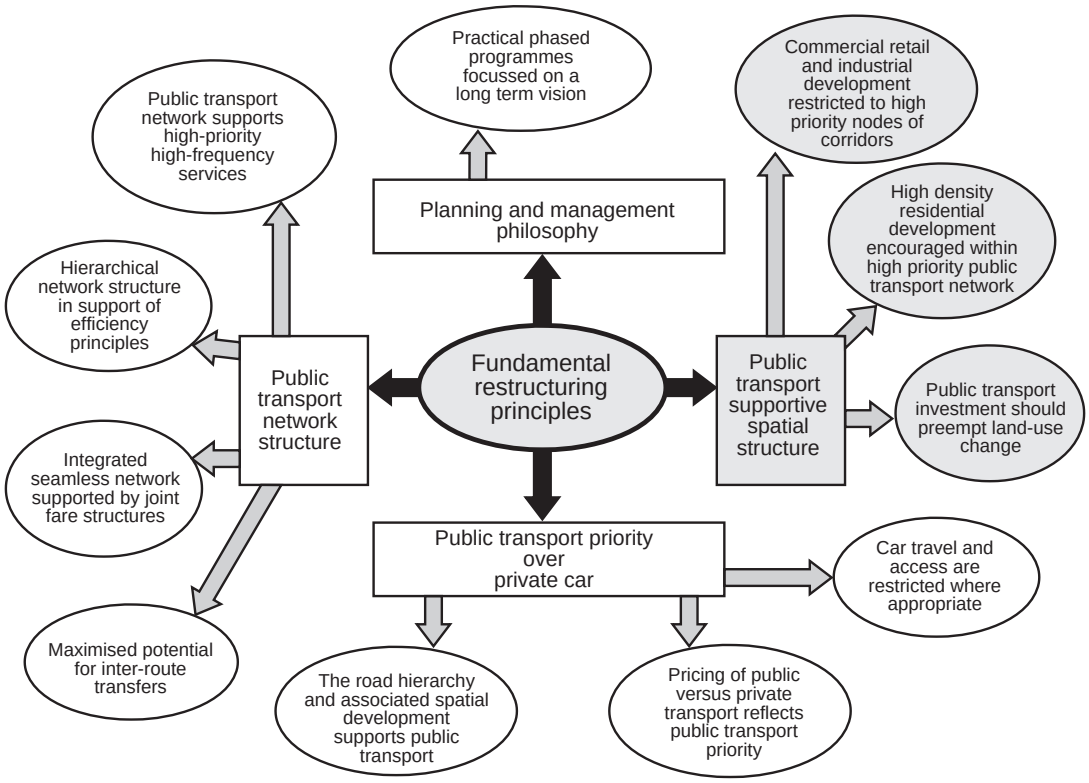


Figure 5.2.2: Principles to achieve the public transport supportive structure necessary for fundamental restructuring
Source: Shaw (1998)

generators of demand for public transport. For this reason it is suggested that potential nodes[4] be identified within or immediately adjacent to township areas. Under ideal circumstances, employment and amenity-related growth should be located at these potential nodes. It must, however, be recognised that developers may be resistant to considering investing in such nodes, thereby constraining the ability to develop efficient bidirectional ridership patterns. The settlement plan should make space available for the relevant nodes to develop, even though there may be resistance to invest at the outset.

- *High-density residential development should be encouraged within the priority high-frequency public transport corridor structure*

  Settlement planners need to understand that higher-density residential development should be encouraged on unused or under-utilised land within the corridor structure of the high-priority public transport network. While it is recognised that the current South African housing delivery process does not encourage high-density development, one of the most significant future challenges to settlement planners will be to find delivery mechanisms and design solutions that promote higher-density residential development as a support mechanism for more efficient public transport. This should apply particularly to the areas adjacent to high-frequency public transport corridors and to nodes within all types of public transport corridor.

- *Public transport priority and infrastructure investment should pre-empt initiatives with respect to land-use*

  In the urban areas of the future, as the primary and feeder public transport route network is developed there will be a need for flexibility in the network within settlements to enable lesser traffic routes to be upgraded as demand increases. This is not to say that large reserves need to be set aside to accommodate possible future public transport, but that the internal circulation or movement system should be designed so that ultimately road-based services can be provided with stops at 800 to 1000 m intervals, with each of the stops having nodality and good access to the surrounding settlement for pedestrians.

- *The road hierarchy, and the association between this hierarchy and spatial development, should support public transport*

  Settlement planners should be cognisant of the negative aspects of creating car-orientated "closed" road networks which are designed to inhibit through-traffic. Provision must be made for the penetration of neighbourhoods by public transport. The road hierarchy should promote direct public transport routing and, where necessary, public transport priority, and encourage suitable pedestrian access to surrounding land uses. Small residential cells may be designed as "closed" networks, providing that cycle and pedestrian through-movement is facilitated (for details see Sub-chapter 5.1).

  In considering the public transport routes through or adjacent to a settlement, settlement planners are reminded to give consideration to the current and proposed future function of the route, whether a primary public transport corridor or a feeder corridor. There is a need to separate the primary public transport route from the private car-based arterial road network, and vice versa. Public transport priority and a public transport supportive road hierarchy are essential to the success of the promotion of high levels of service for public transport. Unfortunately, attempts to give priority to public transport over a considerable portion of the road network are unworkable because of the extensive coverage which would be needed. It would only be possible where there was really significant demand for public transport. However, areas of the network offering the highest accessibility need to be transferred from mixed-traffic conditions to dedicated rights-of-way for public transport.

  If there is to be a priority node and/or corridor within a settlement, the planner should note the need to make a distinction between the core and the frame of the high-priority node. The core should be identified as the area of the greatest pedestrian activity. Parking should be omitted from the core in favour of dedicated pedestrian activities. Parking facilities may be provided within the frame of a node.

  One of the most significant components of settlement planning in support of public transport in the future will be decentralised nodes. The planners of new settlements need to ensure that nodes with large commercial floor space should not be provided in areas not served by public transport.

[4] A potential node is a point in a public transport network where the public transport movement is concentrated and transfers from one travel mode to another take place, providing conditions conducive for local economic development, based on the traffic at the node.

Thus a settlement unconnected to the primary or feeder network through nodes should not be developed as a decentralised activity centre.

- *The pricing of public versus private transport should reflect public transport priority*

  Settlement planners need to recognise that a targeted approach towards the management of both accessibility and the associated form of the public transport is needed. A key element in the future management of accessibility in building South African cities will be to move away from an approach in which infrastructure improvements are commissioned to relieve congestion, irrespective of location. In future, infrastructure improvements should be based on the enhancement of accessibility, particularly by public transport.

- *Restrict car travel and access under appropriate circumstances*

  Settlement planners should restrict motor vehicle access within CBDs and other nodes. Along high-priority public transport routes the access of pedestrians to fronting properties should be promoted, whereas vehicle access should restricted.

The Phase One report of the Department of Transport's fundamental restructuring project contains an assessment of four alternative city forms with associated public transport network structures. The results, highlighted in Figure 5.2.3 provide settlement planners with an overview of the impact of different city forms on passenger-volume conditions, average transfers per trip, trips per capita and the directional mix of traffic. Settlement planners should, therefore, take pains to understand the network to which the settlement is to be attached.

PUBLIC TRANSPORT OBJECTIVES

The following objectives should be applied to give effect to the principles outlined in the preceding section, and to ensure that the settlement is conducive to the provision of efficient and convenient public transport:

- providing for an urban structure of walkable neighbourhoods clustered together to form towns and cities of compatibly mixed uses, in order to reduce car dependence for access to activities;

- ensuring that walkable neighbourhoods and access

Example of four public transport network concepts

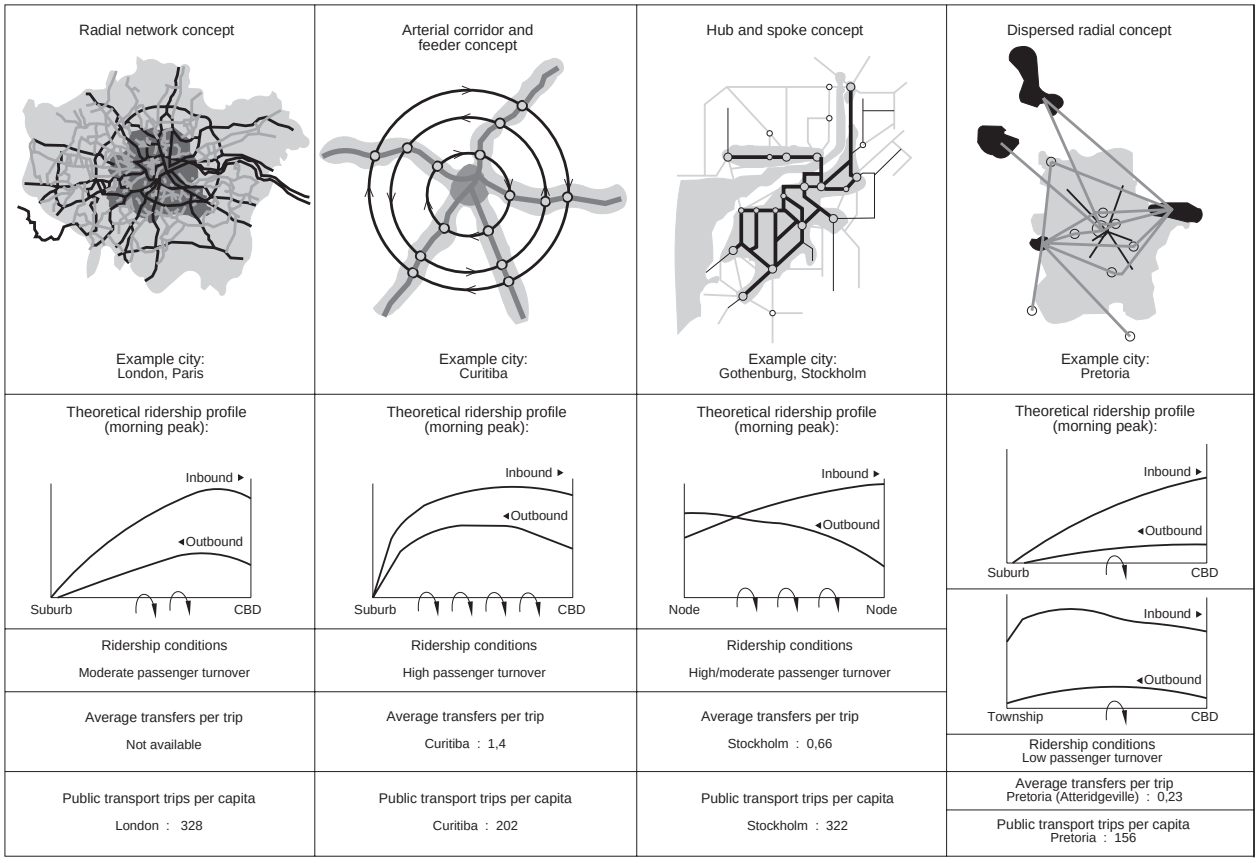


Figure 5.2.3: Example of four public transport network concepts
Source: Shaw (1998)

to services and facilities are designed for all users, including those with disabilities;

- facilitating development that supports the efficiency of public transport systems, with safe and direct access; and

- providing a variety of plot sizes and housing types to cater for the diverse housing needs of urban dwellers at densities that can support the provision of viable public transport.

The design and layout of a settlement can have a profound influence on its sustainability. A number of objectives need to be pursued which will contribute towards creating living environments that are more affordable for residents. The design should

- reduce dependence on cars by encouraging walking, cycling and the use of public transport; and

- give access to facilities for all users of the environment, and provide opportunities for locally based business and employment.

As a global phenomenon, recent neighbourhood design concepts have been given titles such as "transit-oriented design" (TOD), "traditional neighbourhood design" (TND), "green-house neighbourhoods" and "urban villages". In each case the underlying objective is to create neighbourhoods which reduce dependency on private vehicles and are more energy-efficient.

GUIDELINES FOR PUBLIC TRANSPORT SUPPORTIVE SETTLEMENTS

Planning settlements that are accessible to public transport

The process of planning for public transport includes site and contextual analysis, right down to the details of street alignment and form, plot sizes and shapes. The "coat-hanger" around which the settlement should develop is the public transport network. This should be supported by a movement network which should, as a priority, facilitate multi-directional pedestrian movement, focused on a highly accessible public transport system.

In respect of the public transport component of settlement-planning, the planning should take account of and address the following questions:

- How big is the settlement, how will it be developed and at what density?

- Where is the settlement, relative to the main activities in the urban area in which it is situated?

- Where is the settlement located relative to existing public transport, either rail- or road-based?

- How will the settlement be connected to the existing public transport network, whether road or rail or both?

- Will the settlement be sufficiently large for the main public transport line-haul system to be extended through it, or will it be located to one side of the major public transport route, or at some distance from the corridor, requiring a feeder public transport service?

- What will be the likely demand for public transport generated by the settlement?

- Where will the main access to public transport be within the settlement?

- What will be the spacing of public transport stops in the settlement?

- How can the settlement be planned so that the movement system provides the maximum access to public transport?

- What is the relationship between the movement system for the settlement and the proposed public transport services?

Obviously, these and other questions will inform the planner with regard to the integration of the movement and public transport networks. Specific guidelines on the site and contextual analysis, as they relate specifically to public transport, are provided in the following section.

Contextualisation and connection

This should be undertaken at an early stage to identify opportunities and constraints presented by the site. The processes take into account all constraints - such as open space, topography and servitudes - and include an analysis of the regional structure and neighbourhood form in existing surrounding areas. Of relevance to the public transport planning is the following:

On a map (as exemplified in Figure 5.2.4), and where relevant, quantify the following information:

- existing and planned neighbourhoods, towns and regional centres;

- other significant features such as regional parks;

- freeways, arterial roads, public transport routes, bus stops and rail stations; and

- the location of rail stations.

Map, describe and where relevant, analyse, the following information:

- servitudes and street reserves;
- linkage to and from the site;
- distance and direction to public transport infrastructure; and
- distance and direction to local shops and schools.

The foregoing context and site analysis applies only to public transport. Obviously there are other contextual and site-analysis factors which need to be taken into account by settlement planners, including topography, drainage, vegetation, etc.

Figure 5.2.4 exemplifies the concepts of contextualisation and connection. It shows the site and the spatial relationship between the site and existing urban development, indicating the location of the main transport infrastructure, existing and future roads and road reserves and future developments of

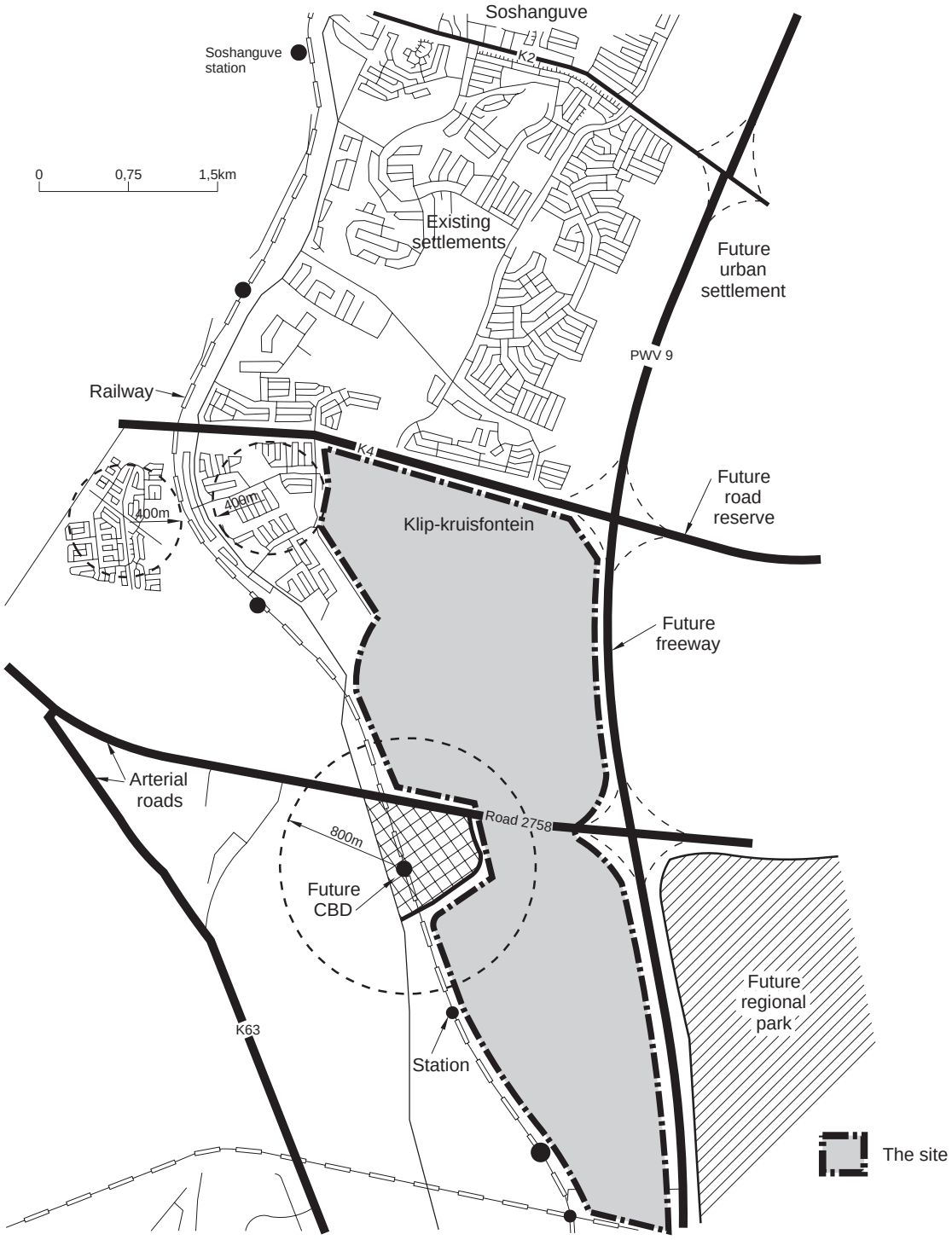


Figure 5.2.4: Context and site analysis map

regional significance, such as a future CBD and rail station and a future regional park. This example is superimposed on an actual settlement, but the elements (such as the proposed future regional park) are hypothetical. The figure illustrates some of the site conditions that will influence the movement and public transport network. Topography and the influence of slope are not shown, but the planner is cautioned to note the importance of topography to the public transport movement system (see Sub-chapter 5.1). It is obvious from this context and site analysis how the site needs to be developed to tie in with the existing settlement and infrastructure. The freeway shown in the figure represents a constraint on the development of the site. This constraint would require settlement planners to negotiate with road and/or transport authorities, to provide measures to eliminate severance and to help minimise the environmental impact of the freeway on the development of the settlement. In this instance, settlement planners should persuade road authorities to provide freeway bridges or underpasses to link the communities on either side of the freeway. In the situation depicted in the figure, the entire layout and settlement plan will be influenced by the number and type of movement connections which the road authority may be willing to provide. Different circumstances will prevail, and there may be cases where the local authority or transport authority will require the site developer to pay for providing linkages. This decision usually hinges on the stage of the planning of the future freeway.

Public transport framework

Planning information requirements should address - but not be limited to - the following matters:

- the contents of the Integrated Transport Plan, including policy statements on the public transport network, rail concessions, bus contracts, minibus initiatives and public transport infrastructure;
- public transport demand (the origins and destinations of trips) the placement of bus routes, proposed bus stop locations (including calculations of walkable catchments served within a 400 metre radius);
- all existing/proposed rail station locations (including calculations of walkable catchments served within an 800 m radius;
- provision for pedestrians and the disabled;
- an actual or potential cycle network plan;
- layouts to facilitate effective traffic management around schools and to facilitate safe access to schools;
- traffic management in and around proposed activity centres;
- measures to control traffic speed; and
- proposed intersection controls, including priority systems signalled by the use of a clear movement hierarchy.

Guidance on the technique to use walkable catchments as the basis for accessibility planning and calculating catchments is listed in Appendix A. Examples of processes for restructuring public transport demand for different settlement types and market segments are provided in Appendix B.

An example of the recommended process for the development of settlements supportive of public transport is illustrated in Figure 5.2.5.

In consulting with transport authorities to ascertain future proposals in respect of road and rail infrastructure, as well as public transport services, the planner is cautioned to note that, in some cases, the settlement should influence and modify planned transport facilities. Some hard-nosed negotiation may be necessary. A hypothetical public transport framework is illustrated in Figure 5.2.5.

It will be noted from Figure 5.2.5 that the main public transport corridor is to be found to the west of the settlement and comprises a commuter railway line, which provides for long distance movement, and a "road-based" activity spine within the corridor, to provide for regional movement between stations and between different districts of the urban area. In this case, the location of the road-based activity spine may be questioned because it duplicates and competes with the rail service. An alternative location further to the east and bisecting the settlement may be preferable, to provide a viable threshold for the road-based public transport service. The regional, road-based "activity spine" needs to be well connected to the rail at interchanges and stations. The figure depicts a future station at the centre of a proposed future central business area. Such a station should be served by feeder road-based public transport in which case there will be a need to plan for a public transport, interchange to facilitate this process. Although not part of the settlement plan, the station and the public transport interchange will exert a strong influence over the road alignments in the settlement, as depicted in the figure. The technique of using 800 m catchments around stations, and 400 m catchments around bus stops, has been used to provide the structuring elements or transport framework for the settlement. The figure shows the activity nodes in the centre of the public transport catchments, which are the focal points on the feeder routes and should be spaced at 800 m intervals. Such a design will provide for flexibility, even if feeder routes are not initially

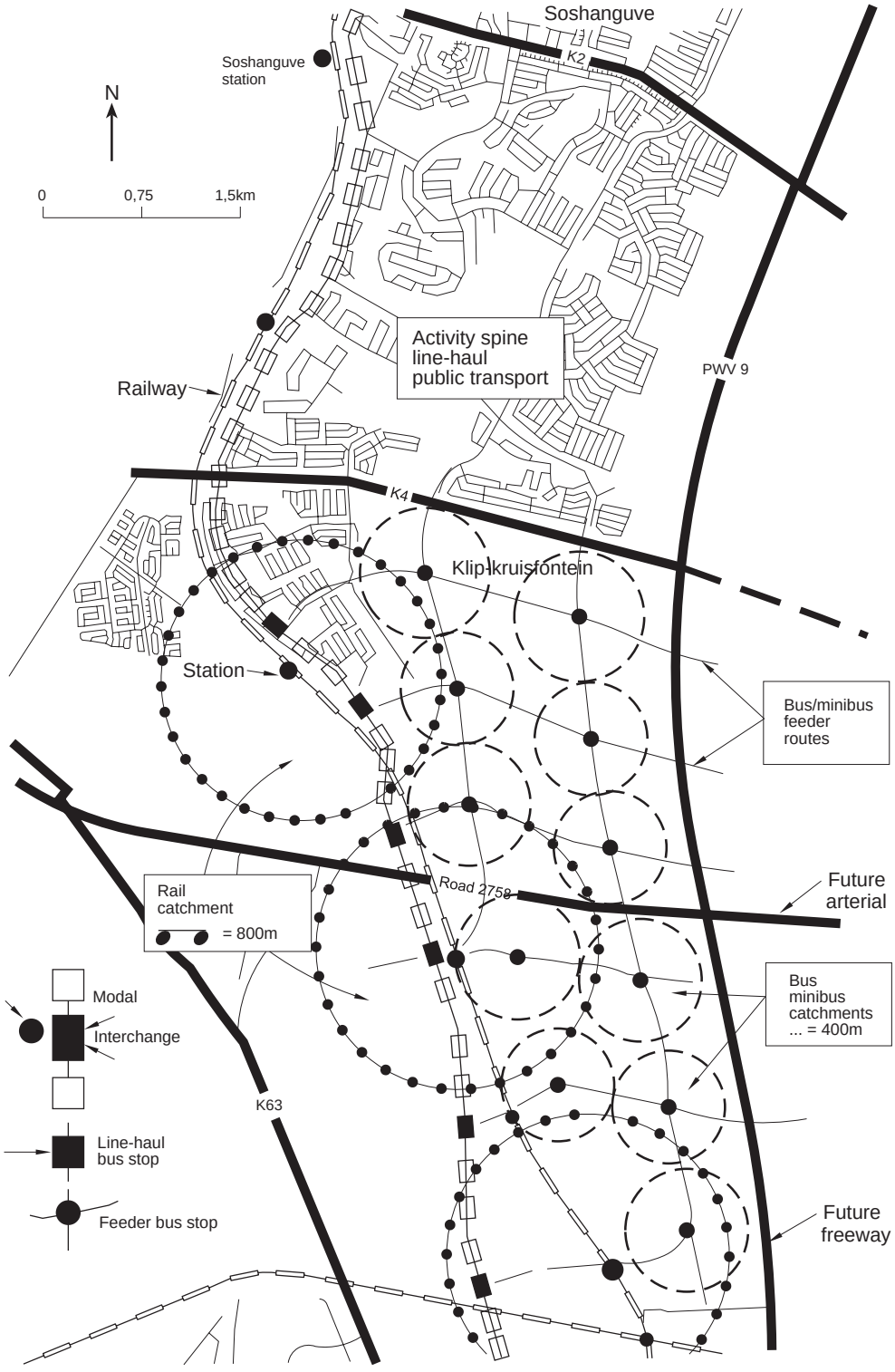


Figure 5.2.5: A transport framework for settlement planning

provided in both directions. For example, the bus stop spacing could initially be lower on the activity spine, with all feeder routes from the settlement feeding into the public transport interchanges, associated with rail stations rather than into stops at 800 m intervals on the activity spine as indicated in the figure.

It is important that flexibility should be provided in the design. It will be noted that the transport framework has made provision for the freeway to be crossed at around one kilometre intervals. This is an important principle and standard which should be adhered to in urban areas in order to minimise severance and the environmental impact of freeways.

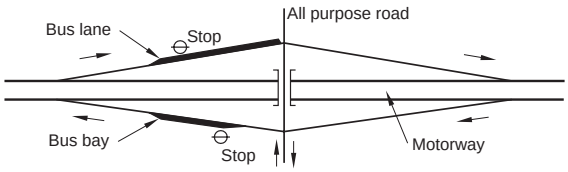
Integration of public transport and movement networks

When designing a movement network in support of the public transport network, the different patterns of movement of buses, freight vehicles, cars, bicycles and pedestrians should be borne in mind (the reader should refer to Sub-chapter 5.1 for guidance on movement networks). Typically, cars and goods vehicles seek to make direct journeys at the highest possible speed. The aim should therefore be to get these vehicles from a neighbourhood to a through-route as quickly as possible. Buses and minibuses, on the other hand, are required to serve passengers and to offer an attractive and convenient alternative to car travel. Buses should be able to proceed directly through the centre of neighbourhoods, picking up and setting down passengers as close as possible to their origins and destinations.

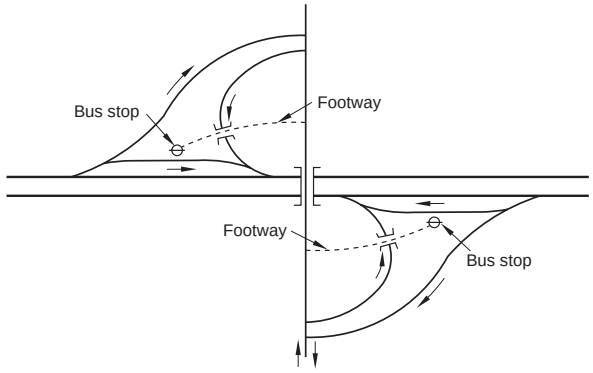
Buses and minibuses normally travel along public roads shared with other traffic. Such roads are usually classified by traffic engineers within a functional road hierarchy. Bus operations can be expected to be found on many of the strata. Accordingly, settlement planners should provide public transport networks on roads on which the traffic functions and characteristics of the road are harmonised with the moderate speed, mixed-traffic and pedestrian-crossing requirements of such a facility. Guidance on public transport in relation to the road hierarchy is provided below:

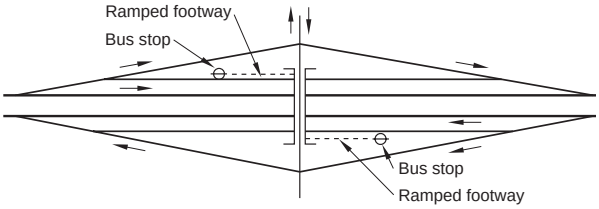
- *Major arterials*. The arterial network in intended to accommodate major traffic movements and to link the major districts of towns and cities. "mobility" routes, which have a limited number of interchanges or intersections and a large degree of access control to fronting properties. Major arterial roads such as urban freeways and dual carriageways are not suitable for bus services and should only be used for limited-stop and express services. In the case of limited stop and express services operating on freeways, stopping places may be provided as indicated in Figure 5.2.6.

- *Minor arterials*. Minor arterials feed traffic from the major arterials into and from the main urban districts and provide the linkage between them. These are generally the ideal roads for line-haul bus and minibus taxi movement. While there are usually some restrictions on frontage access and restraints on street parking on this type of road, particularly during peak hours, the standard of intersection spacing tends to be lower and there is considerable cross-traffic and pedestrian movement, and there are many pedestrian footways at the roadside. The amount of interaction and cross-traffic produces a reduced speed differential between buses and other traffic, meaning that buses can stop at the kerb without causing undue delay or danger for other road users. Bus lay-bys should, however, be provided, and in congested areas on this type of roadway priority lanes should be provided for road-based public transport.

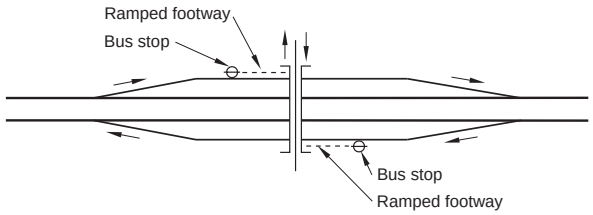


(1) Bus stops on interchange slip roads (for services entering or leaving an urban motorway)





(2) Bus stops for through services at an interchange



(3) Bus slip roads and stops at points between interchange

Figure 5.2.6: Location of bus stops on major arterial roads of freeway standard
Source: Greater Glasgow PTE (1973)

- *Collectors*. Collector roads are the link between the urban main road system (arterials) and neighbourhoods. These should penetrate the neighbourhoods and, together with minor arterials, are the appropriate level in the road hierarchy upon which public transport services, particularly feeder services, should be provided.

  The majority of stopping bus and minibus feeder services will be found along the collector type of

road, which should preferably be at least 7,3 m wide. Widths in excess of this tend to encourage higher speeds which are not desirable on mixed-traffic facilities.

- *Activity streets.* Hitherto, such streets have not formed part of the urban road hierarchy and have not been planned, but have evolved. They are streets that experience mixed traffic and intense fronting land use activity. Many activity streets start life as high-mobility arterials but, because of their high accessibility, become congested and attract commercial land use. Access-seeking traffic begins to predominate over through-traffic. Activity streets are the ideal locus of road-based public transport services. Settlement planners should provide layouts and land-use plans which facilitate the emergence of "activity streets" as the basis of public transport corridors. The scale, geometric characteristics and dimensions of an "activity street" cannot be specified prescriptively. An activity street could vary from collector-road scale, with a narrow cross-section, typical of a European village "high street" to a minor arterial in a generous cross-section. Typically, there should be interaction between one side of the street and the other, with much pedestrian crossing, so the scale of the street should be modest.

- *Local (access) streets.* Public transport should be precluded from using this type of street, which should be designed to facilitate mixed traffic within neighbourhoods in safety and at low speed.

The specifics of the design and layout of the road and movement networks are dealt with in section 5.1.

The following section provides some additional guidelines in respect of the local road and movement networks in relation to public transport. Figure 5.2.7 shows a public transport feeder route bisecting a neighbourhood unit with a radius of 400 m. The centre, or point of highest accessibility, is the point at which public transport services will be provided. It is evident from the layout that, because of the open road network, public transport is highly accessible along the public transport route. The figure also indicates that, ideally, higher-density mixed land-use should be provided adjacent to the route. It also shows that service roads can be provided for access to fronting shops.

Figure 5.2.8 shows a variation of the same network to illustrate the point that intensive neighbourhood activity should be located at the centre or most accessible part of the neighbourhood, whereas more extensive activity, some of which may have an inter-neighbourhood function, may be located further away at the periphery, but will still be accessible on foot, to residents in the neighbourhood. An example of the latter is a primary school.

Figure 5.2.9 shows a "closed" street network which is characteristic of residential networks provided in the recent past. This type of network is a "car-oriented network" in that pedestrian movement is channelled along the streets and the only access to the central

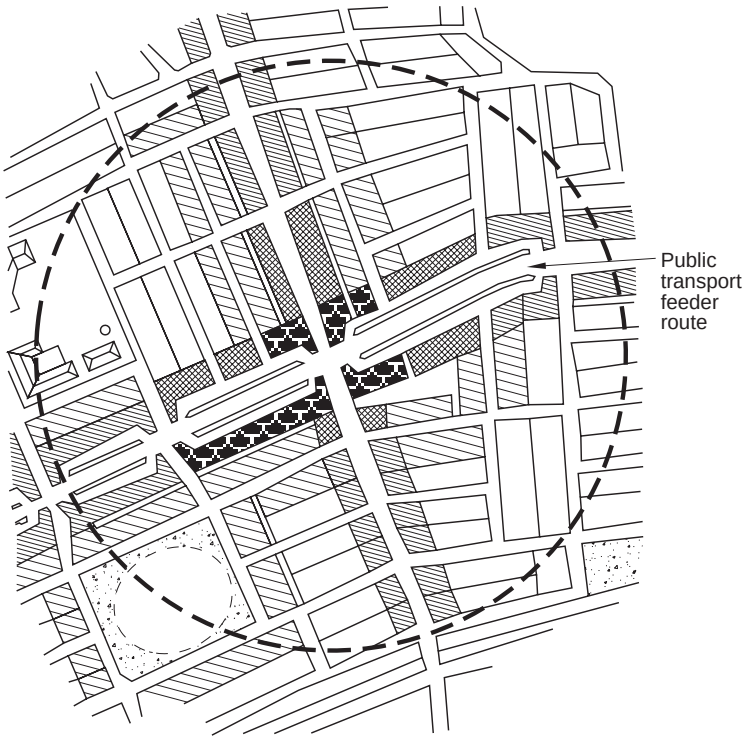


Figure 5.2.7: A public transport feeder route in an open network
Source: WAPC (1997)

"public transport road" is the intersection at the centre of the figure. It is evident that such a layout will be inconvenient to pedestrians, particularly those trying to access the central road from the closed loops.

The "closed" network depicted in Figure 5.2.9 can be modified to facilitate pedestrian access to the central public transport feeder routes at appropriate points, while retaining the closed road network which precludes through traffic (see Figure 5.2.10). This is by means of mid-block pedestrian or cycle gates placed at strategic locations on the facility. The figure also shows bus lay-bys provided in a widened reserve at the most accessible point. Such "closed" street networks may be desired by some communities as an impediment to vehicle-based through traffic, and to preserve the security and or environmental benefits of closed networks. Settlement planners should, however, bear in mind that open networks designed with appropriately scaled reserves and narrow roads tend to inhibit through movement and have greater flexibility. Through traffic tends to be curtailed where space for parking is limited and the streets are designed to facilitate pedestrian movement, street parking and slow vehicle movement.

The foregoing examples provide some guidance as to how the public transport framework interfaces with the neighbourhood movement and street networks.

Figure 5.2.8: A public transport feeder route in relation to neighbourhood activities
Source: WAPC (1997)

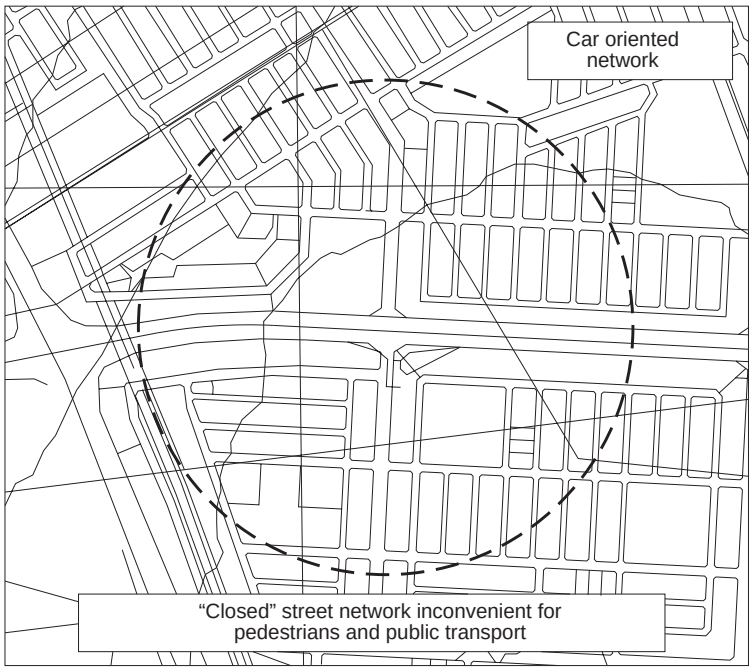


Figure 5.2.9: Car-oriented network

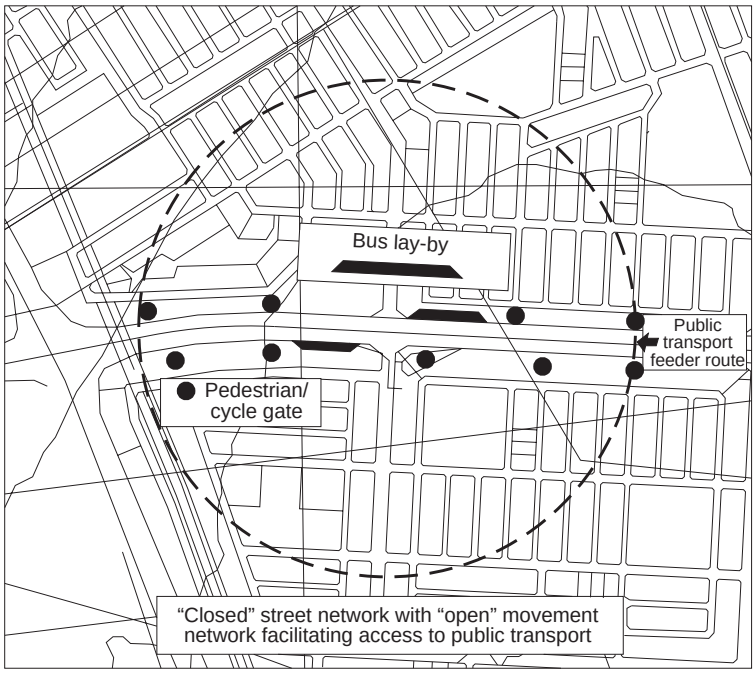


Figure 5.2.10: Modification of a closed road network to provide an open movement network

Integration of land use and public transport

Land-use elements

To attract customers to public transport, planners need to understand the influence of land use and urban design on travel behaviour. As indicated in the previous section, better integration of land use and public transport is possible when public transport considerations are included in settlement planning. Municipalities have the legal authority and regulatory instruments to enforce urban development that is supportive of public transport. In terms of integrated development plans, it is important that development proposals should be reviewed in the light of traffic generation, potential public transport ridership, and ease of operation for public transport. This section of the guidelines describes what public transport-oriented land development means in terms of urban structure, road networks and design standards which are favourable to public transport. Changes to by-laws and regulations governing land development should be contemplated by all municipalities as part of their integrated development plans.

Figure 5.2.11 shows some typical land-use proposals which would be supportive of public transport. At the centre of the public transport catchments are cross-roads on the public transport network. These roads may be mixed-traffic minor arterials and/or collector roads linked to the arterial road system. They are focused on accessible activity nodes at the centre of the neighbourhoods, based on a 400 m walking distance for residents. The activity nodes will largely attract neighbourhood retail and community facilities but will also be the location of bus stops. The figure also shows that, particularly on the most significant public transport route leading to the proposed future central business district, mixed high-density land uses may be planned to support public transport, and in some circumstances, trading activity may be encouraged. The figure shows how the feeder routes converge on the major nodes. The central node should combine central place activity, retail, office and service functions, as well as a modal interchange. It is evident that the central area should be highly accessible by road-based public transport.

It should be noted that the street network within the major public transport corridor is an existing street network, which may be incompatible with the principles being propounded in this guideline. It is inevitable that, as major public transport corridors evolve in urban areas, there may be a need for redevelopment to encourage higher intensity land uses in support of the activity in the corridor. Activity nodes are likely to develop at accessible points in the corridor, as indicated in the figure.

Factors contributing to viable and sustainable public transport

There has been extensive research to demonstrate that the features of public transport-friendly urban design include development density, the land-use mix, the configuration of the urban road network and the design of movement or circulation systems which accommodate both pedestrians and public transport vehicles. Throughout this guide reference has been made to settlement planners, but it is increasingly realised that urban settlements should be the product of multi-disciplinary work involving landscape architects, architects, urban planners and designers as well as traffic and transport engineers. Greater effort is required to design streets from a holistic perspective, as advocated in this guideline, taking account of all forms of movement, including bicycles, pedestrians, cars, and public transport.

It is important to remember that the use of public transport involves pedestrian movements at either end of the public transport trip. An unpleasant pedestrian experience will inhibit growth in public transport patronage. Accordingly, very important factors in promoting public transport are perceived proximity to the boarding point of public transport, walking distance to the final destination, the overall street and site designs, pedestrian facilities, and amenities on the sidewalks.

Development density

The two aspects of settlement density which are important to public transport are the location of dense or less dense settlements, relative to public transport services, and continuous density along a public transport route.

In general, as residential and employment densities increase, so do the number of passengers per kilometre along the route also increase, justifying more frequent or higher levels of public transport service. This helps to make public transport much more attractive.

At metropolitan or city-wide scale, it is important that settlements should be continuous; that is, they should not be permitted to “leap-frog” agricultural land or parkland, as was formerly the case with the lower-income dormitory settlements in South Africa. Municipalities affected by discontinuous developments will experience higher costs per capita for infrastructure such as roads and sewers. This will also apply to public transport services. In settlement planning, the costs of new public

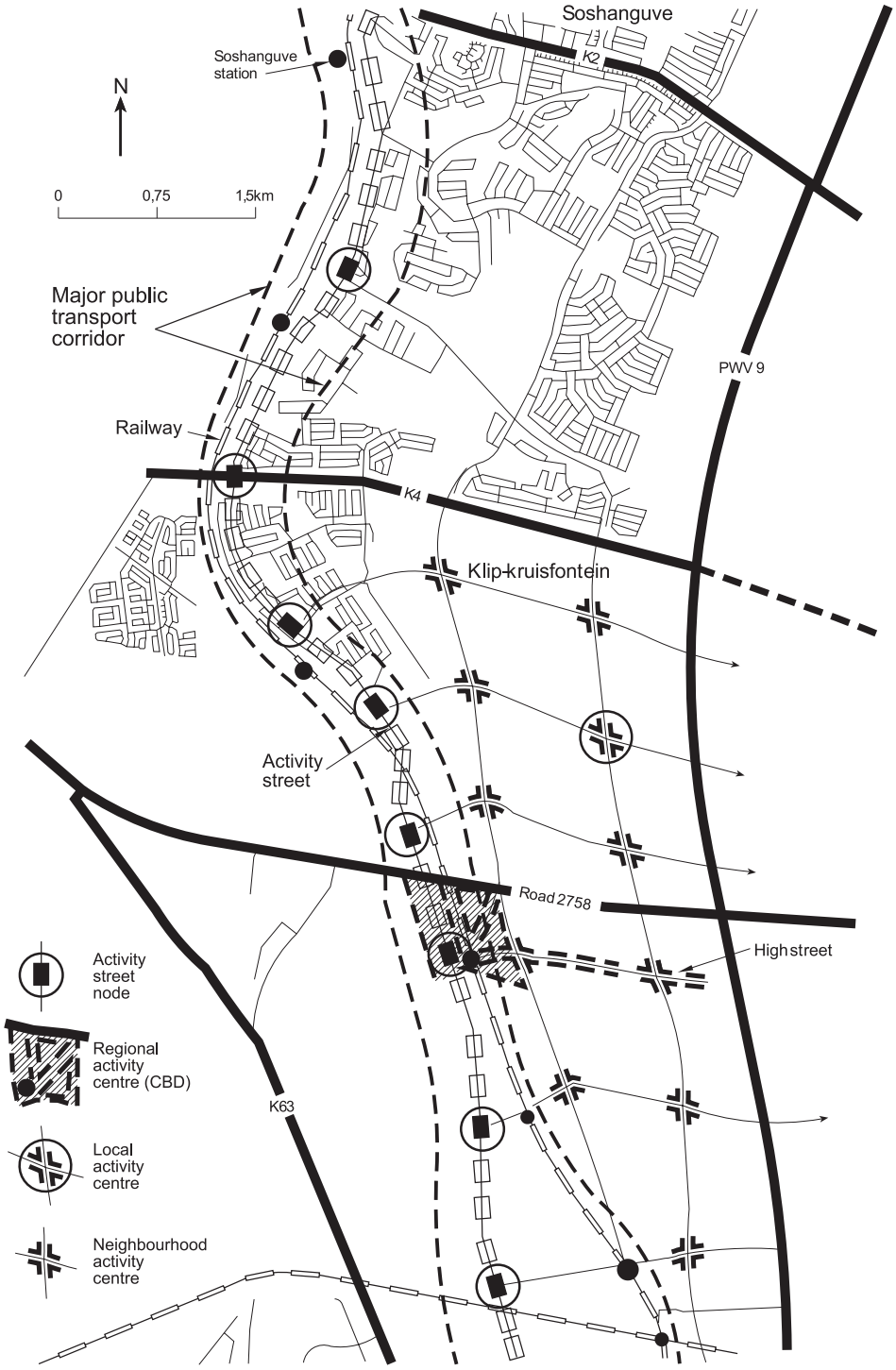


Figure 5.2.11: Land-use elements in relation to the transport framework

transport services should also be factored into the assessment of the municipal infrastructure required for the settlement.

Relationship between density and the location of employment

Future settlement planning should take cognisance of the need to develop balanced communities containing employment activities within the community. The settlement should seek to cluster businesses and employment activities into a few areas of significant development, to help create the critical mass which public transport requires to serve areas cost-effectively. Scattered travel patterns should be avoided so that public transport reflects movement towards a single centre. Empirical research has found that public transport ridership increases markedly when a threshold of one employer per 100 m^2, in a centre with more than 10 000 jobs, is attained. Public transport is therefore heavily influenced by the critical mass of employees, but also by the availability of free parking. Where parking is restricted, public

transport ridership is also enhanced. One of the most serious impediments to the use of public transport in urban areas is the decentralised suburban "business park". Settlement planners must be cognisant of the detrimental effects of such land uses on public transport, and ensure that employment is centred within public transport corridors.

There are two factors that discourage the use of public transport in office or business parks; namely, there is little incentive for employees to consider using public transport when there is free parking, and office parks are usually located some distance from existing public transport services.

Relationship between public transport and residential density

For public transport to be feasible a minimum threshold population is necessary. However, because of the variety of residential market segments in South Africa and the relationship between residential and employment activities, it has not been easy to establish minimum thresholds for residential density. In lieu of clear thresholds and guidelines it is advisable for settlement planners to take note of relationships established abroad. For example, Table 5.2.1 shows public transport services related to residential density as a result of empirical studies in North America. According to Pushkarev and Zupan (1997) the desired threshold for dwelling densities per hectare is around 10 for hourly local bus services, rising to around 40 dwellings per hectare for very frequent public transport services at intervals of less than 10 minutes.

Mixed land use and public transport

Mixing land uses means combining commercial and other uses of various types - for example permitting personal services and restaurants to be located near industry or commerce. Residential settlements should include convenient services within walking distance. The opportunity to walk to and from bus stops and accomplish errands conveniently is a further motivation to use public transport rather than to drive. The central or focal points within any neighbourhood which form part of a settlement should comprise the non-residential land uses such as convenience stores, retail shops, parks, schools and other amenities. The mix of land uses in close proximity to a neighbourhood centre will enable people to accomplish several trip purposes, often by walking. Current zoning often requires strict land-use segregation, resulting in large distances between different activities, increasing single-purpose trips. This can be discouraged by settlement planners who provide conditions conductive to the use of public transport.

Providing for buses, minibuses and bus stops

Alignment of public transport routes

Public transport routes should be planned to follow a reasonably fast and direct itinerary passing as close as possible to the centres of neighbourhoods served by the route. Circular routes should be avoided. Streets used as bus/minibus routes should have a maximum gradient of 1 in 15 (6,7%). Where warranted by demand for public transport, parallel bus routes outside town centres should not be less than about 800 m apart, in order to provide each route with a reasonable catchment area.

Planning to facilitate bus services in new settlements

Settlement planners should take into consideration the fact that areas of intense

Table 5.2.1: The relationship between public transport services and residential density

TYPE OF PUBLIC TRANSPORT SERVICE	GROSS RESIDENTIAL DENSITY (DWELLINGS/ha)
Frequent Service (5-10 minute service intervals)	37
Frequent bus service with some express routes (15 minute intervals)	22
Local bus (daytime 30 minute intervals and extended services at 60 minute intervals)	17
Local bus (daytime 60 minutes intervals)	10

Source: Pushkarev and Zupan (1977)

pedestrian activity such as health clinics, old age homes, schools and bus centres are best located with ready access to the public transport services. As noted elsewhere in this guide, the walking distance to the nearest bus stop should not be more than 400 m from the furthest house. High-density housing developments should be situated closer to the roads along which buses will operate. Development to a depth of at least 200 m on both sides of bus routes is desirable.

Settlement planners should ensure that proper facilities for buses and minibuses are provided from the outset. The following principles need to be borne in mind:

- roads, which may be used as bus or minibus routes, should connect activity centres directly and be suitable as regards width, alignment and construction;
- corner radii should take into account the fact that buses have a large swept turning circle (in the order of 20 to 25 m in diameter);
- bus bays and turning areas should be provided as appropriate (see Figure 5.2.12);
- the minimum width of road for bus operations in new developments should be 7,3 m, or 9 m where there are more than 30 buses per hour using the road; and
- where possible, bus services should have balanced traffic in both directions at peak time. This can be achieved by having employment areas concentrated at nodes along the main bus corridors.

Figure 5.2.13 shows different road layouts, reflecting the history of planning practice. The grid network found in townships that developed before 1950 provided direct pedestrian access to services, shops and public transport.

Sub-divisions over the last 30 years have tended to focus on the internal neighbourhood structure, with roadways designed to reduce travel speeds and discourage through traffic. This type of layout tended to discourage the use of public transport.

This current guide seeks to provide a compromise or a combination that provides the best of both worlds - namely a movement network that caters for direct pedestrian movement in all directions and a road network which inhibits through traffic. These variations are depicted in Figure 5.2.13.

Factors that encourage pedestrian activity and have a direct impact on the attractiveness of walking to bus stops and waiting for buses include

- barrier-free routes, with crosswalks, overpasses and ramps;

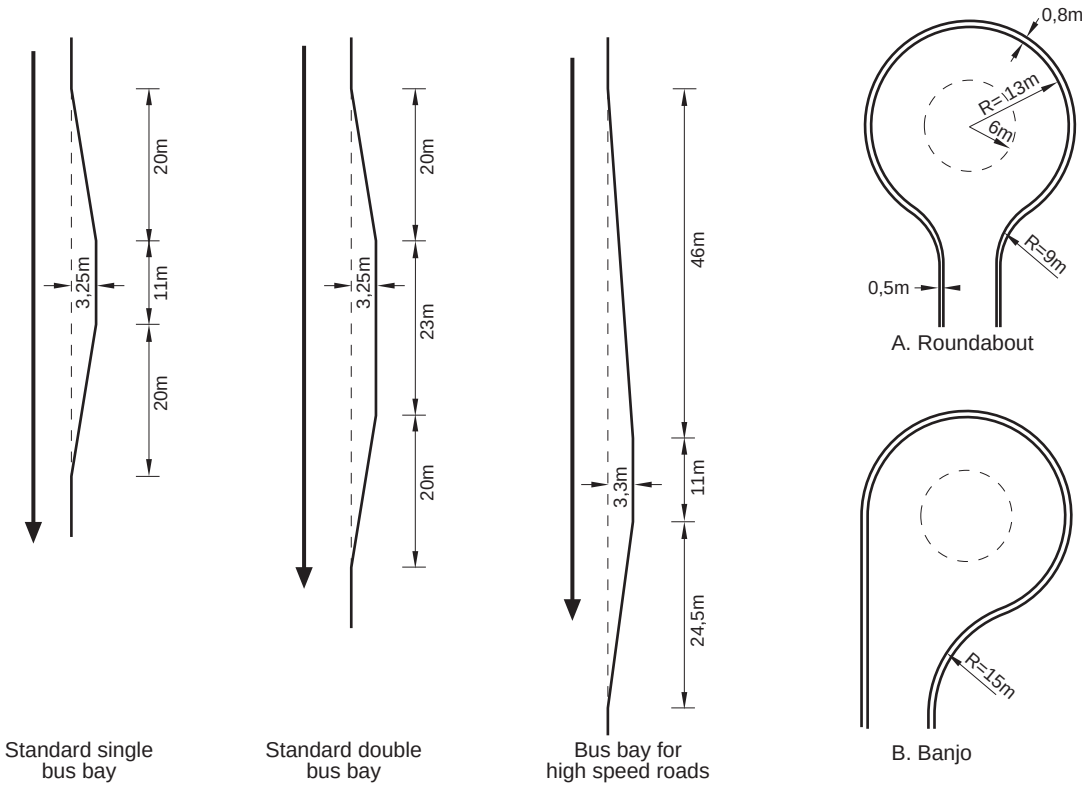


Figure 5.2.12: Dimensions of bus bays and bus turning circles
Source: Greater Glasgow PTE (1973)

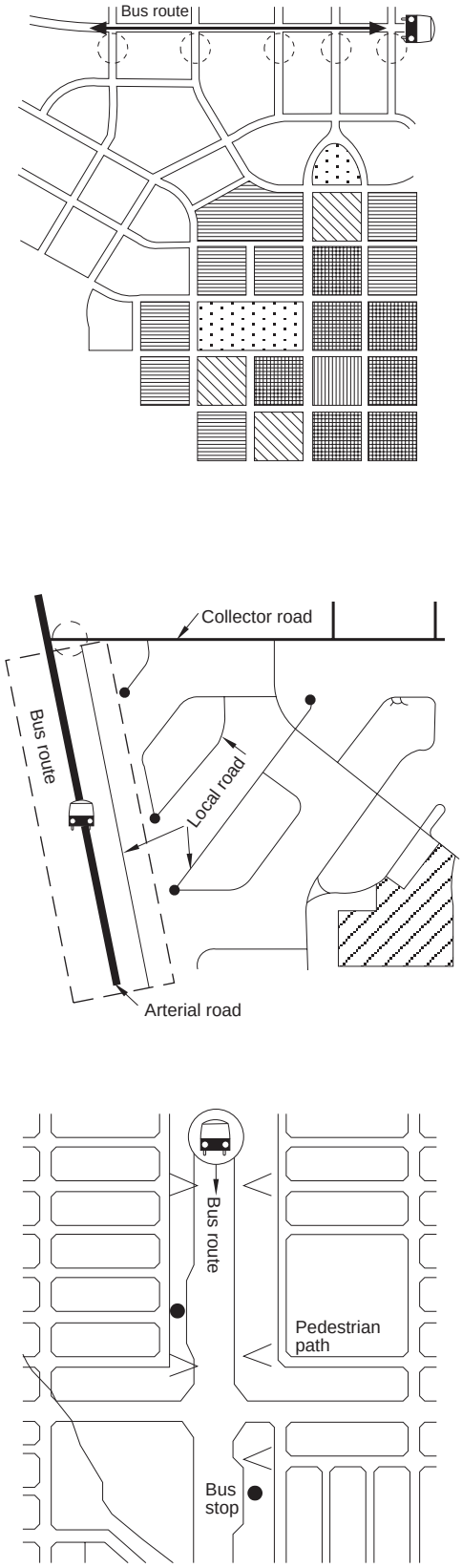


Figure 5.2.13: Road layouts reflecting evolving planning practice
Source: BC Transit (1995)

- good lighting and an environment which is perceived to be safe, because it is overlooked by human activity;
- sidewalks, seating and shelters; and
- pleasant views and other attractions, including landscaping and plantings.

The convenient location of bus stops is significant, and they should be placed relative to building entrances. This aspect is as important to public transport customers as convenient parking is to car users.

Modal choice and relative cost efficiencies for infrastructure and operations

Although this subject is beyond the scope of settlement planners, they should be aware that layout of the movement network and the spatial arrangement of land uses can impact both positively and negatively on public transport. Where modal choice is a consideration, pains should be taken to avoid duplication of public transport infrastructure such as stops and terminals.

The relationship between public transport and commercial sites

Commercial sites in settlements which are supportive of public transport usually face the street and provide easy access for customers approaching by foot rather than by car.

Design features which encourage pedestrian flow include continuous sidewalks, trees and benches, and street furniture that provides a buffer between circulating traffic and the sidewalk. Figure 5.2.14 shows the ideal relationship between a commercial activity site and public transport.

Bus stops

The information that follows applies to both buses and minibuses. The location of bus stops must be planned as part of the movement network at the outset, to achieve the best arrangement. The spacing of bus stops needs to be a compromise between the achievement of as high an operating speed for buses as possible and the placement of stops within an acceptable walking distance of traffic generators, attractors and transfer points. Bus-stop spacing depends on the density of roadside development. Where development is not intense, such as in residential suburbs, stops should be around 800 m apart. In nodal activity centres where there is a high concentration of trip ends, stops should be closer together, with an average separation of around 300 m. If there is more than

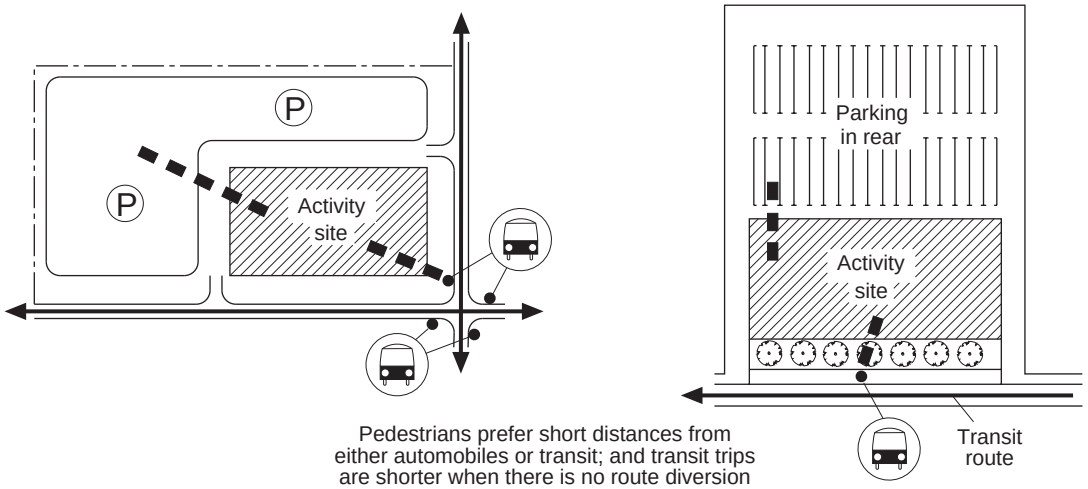


Figure 5.2.14: Relationship between bus stops and a commercial site
Source: BC Transit (1995)

one bus service along a road, transfer is facilitated if all the services use the same stop, providing congestion is avoided.

Bus stops close to railway stations should be arranged to provide the minimum walking distance for transferring passengers. At business centres stops should be sited so that buses deposit passengers at the main frontage of the centres.

For reasons of road safety, bus stops on opposite sides of a single two-way carriageway should be staggered by a least 45 m, so that buses stop tail-to-tail. This dimension may be reduced where lay-bys are provided.

For the convenience of passengers, stops near intersections or junctions should be located as close as possible to the junction consistent with safety. Generally, bus stops should be located at the far side of the junction to minimise interference with left-turning traffic and to maintain traffic-signal efficiency. If public transport is to be promoted, facilities should be provided at bus stops. These include shelters. In siting shelters, care must be taken to maintain adequate sight distance for drivers emerging from side roads. Recommended minimum distances are as follows:

SPEED LIMIT (km/h)	MINIMUM DISTANCE AFTER LEFT TURN (m)
50	23
65	31
80	38

CONCLUSION

If settlement planners are to succeed in providing an environment which is conductive to the use of public transport, the greatest attention to detail should be provided in respect of the development itself and its relationship with surrounding areas. The greatest attention should be provided for pedestrian amenity. Site design features that make public transport more attractive are required but, given the pressures on the road system, it is time to de-emphasise land-use design for the convenience of car users, and refocus towards pedestrian movement and public transport. Public transport-friendly designs can be achieved without detrimental results for car users.

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APPENDIX A

PUBLIC TRANSPORT CATCHMENTS AS THE BASIS FOR NEIGHBOURHOOD PLANNING
Source: Western Australian Planning Commission (1997)

Walkable catchments, when depicted on maps, show the actual area within a five minute walking distance from any centre or bus stop, or ten minutes from any major transport interchange, such as a railway station. The centre should ideally be an activity node for either a neighbourhood or a local community served by public transport. The walkable catchment helps in planning a settlement in such a way that it is easy to evaluate the ability to move through the urban area to access centres.

Walkable catchment calculations are expressed as the actual area within five minutes walking distance, as a percentage of the theoretical area within a five minute walking distance. The theoretical five minute walking distance is shown as a circle with a radius of about 400 metres around a focal points, such as a crossroad. This provides an area of 50 hectares. When calculating a ten minute walking distance, the radius used is about 800 metres, resulting in a circle with an area of 200 hectares (see diagram below). The higher the percentage of actual to theoretical five minute or ten minute walk, the better the "walkability". A good target for a walkable catchment is to have 60 per cent of the area within the stipulated walking distance.

Process for calculating walkable catchments.

1. On the settlement site map draw circles of 400 metre radius around desired focal points, and 800 metre radius circles around rail stations which are either existing or planned.

2. Starting from the centre, measure along the centre line of all planned streets to a distance of 400 metres.

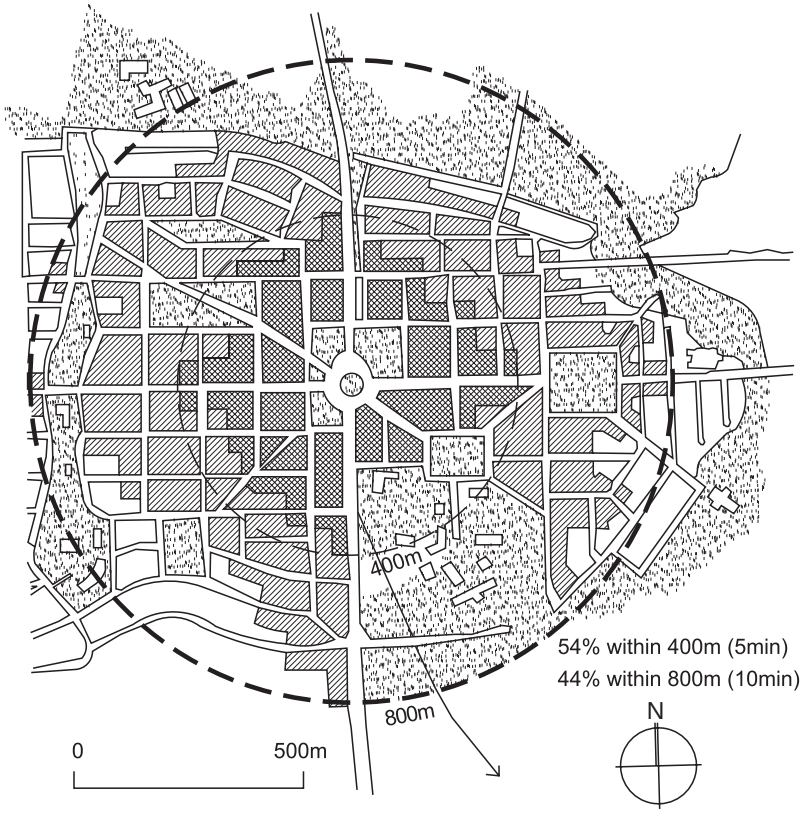
3. Estimate the boundary of the plots within a 400 metre walk. This will provide the actual area from which the centre can be accessed along the planned streets within a five minutes walk.

4. In the case of stations the same exercise may be completed for a ten minute walking distance using 800 metres as the distance measure. On each circle the result will be a map showing the actual distance within both the five minute walk and the ten minute walk from rail stations.

5. Using a grid of scale hectares, calculate the approximate area and hectares and the land accessible within a five or ten minute walk and express this as a percentage of either the 50 or 200 hectare circles. The percentage will indicate the efficiency of the layout.

Note that the walkable catchment should always count the area of land used for dwellings, but not include public open space contained in the accessible area.

It should be noted that in fine-tuning the calculations, there are practical influences, such as short-cuts through parks or along pedestrian paths. These should only be included where there is a high degree of surveillance from adjoining development and where there is good lighting. Similarly, the walkable catchment may need to be reduced where there is poor surveillance and routes may ultimately be perceived as unsafe.



APPENDIX B

GUIDELINES FOR ESTIMATING PUBLIC TRANSPORT DEMAND AND ASSOCIATED PUBLIC TRANSPORT SYSTEMS IN SETTLEMENTS
Source: South Africa, Department of Transport (1998)

The demand for public transport in any settlement is related to car ownership (affected by household incomes), the form of development (density, proximity to services, etc) and the quality of the services. Settlement planners need to understand public transport demand, in order to size facilities appropriately. In short, in planning a settlement, it is necessary to understand whether the public transport component is scaled to mini-bus taxis or buses or trains. The following examples may be helpful. They are based on differing combinations of the 400 metre radius of "walkable" neighbourhoods.

Conditions

1. A "walkable" public transport catchment of 400 m radius, encircling an area of 50 ha.

2. A "walkable" public transport catchment of 800 m radius for rail, encircling an area of 200 ha.

3. In the dwelling density range which is common in South Africa, of between 5 and 30 dwellings per hectare, around 60 per cent of a neighbourhood can be expected to be developed for residences. Thus in a 50 ha neighbourhood the following may be expected:

   plot sizes of 200 m^2 = 30 du/ha = 1 500 units
   plot sizes of 600 m^2 = 10 du/ha = 500 units
   plot sizes of 1 000 m^2 = 6 du/ha = 300 units

4. Plot sizes usually approximate car ownership and household income, with the smaller plot sizes being associated with lower income and car ownership.

Assumptions

The following assumptions may be applied to public transport demand estimation for a low income settlement based on parameters observed in Cape Town in the current "Moving Ahead" transport study:

1. Size of settlement = 50 ha (400 m walking radius).

2. Income of residents = < R40 000/household/year.

3. Non-residential development
   = 2 ha office/retail
   = 4 ha industrial
   = 4 ha schools and parks
   = 10 ha roads and public spaces.

4. Residential modal split = 85 per cent public transport.

5. Office and retail modal split = 60 per cent public transport.

6. Work trip generation rates for households earning < R40 000 per annum = 1,6 trips to work/day.

7. Average trip length = 14 km/trip.

8. Directional split = 70 per cent from neighbourhood to city centre; 30 per cent from neighbourhood to outer node.

Calculations

Public transport trip productions for a settlement of 30 du/ha (gross):

1. Total number of households = 10 000 m^2 /ha x 0,6 = 1 500 du (200 m^2 stands).

2. Commuter trip generation (TOTAL)
   Residential generation = 1,6 x 1 500 = 2 400
   Office/retail attraction = 2,0 x 250 = 500
   Industrial attraction = 4,0 x 100 = 400 .

3. Commuter trip generation (PUBLIC TRANSPORT)
   Residential generation = 2 400 x 0,85 = 2 040
   Non-residential = 900 x 0,6 = 540.

4. Total trips to work = 2 580.

Deductions

1. In the above example the demand for movement out of the settlement in peak work commuter periods amounts to around 1 500 to 1 700 passenger trips (2 040 trips generated, with some having local and others external destinations). There are 540 total neighbourhood trip attractions).

2. Around 1 600 peak period (x 3 hour) commuter trips would approximate a maximum peak hour demand of about 1000 trips per hour.

3. With a road-based public transport supply policy of 5 minute intervals for bus services in the peak, this would translate to a demand of about 12 buses per hour.

4. In a transport corridor comprising five such neighbourhoods on a single route, the capacity to meet such demand (5 000 passenger trips) would amount to 50 buses per hour.

5. In such conditions, a transport authority would need to consider higher capacity public transport options, each of which would impact on traffic movement in the corridor. Such options might include:

   - articulated buses;
   - bus priority and traffic management schemes; and
   - alternative transport nodes modes such as light or heavy rail.

6. In the foregoing circumstances the transport planning authority should be involved in planning the settlement to ensure that conditions on the ground facilitate effective public transport.

7. The above example represents an extreme case of a neighbourhood where residents would be heavily dependent upon public transport.

Forecast

It is not advisable for settlement planners to make long-term forecasts of demand for public transport. As a cross-check, however, the calculations outlined in this Appendix can be used as a consistency check to determine when critical thresholds are likely to be reached in respect of public transport. At that stage, the necessary infrastructure adjustments can be made.

APPENDIX C

THE MOVING SOUTH AFRICA (MSA) STRATEGY WITH REFERENCE TO LAND USE AND LAND MANAGEMENT ISSUES
Source: South African, Department of Transport (1998)

Urban transport focuses on three categories of strategic action:

The first action is the densification of transport corridors. This requires the substantial reversal of apartheid land use planning to halt dispersion, but it is essential to achieve needed economies of scale in the transport system. The strategy will need an aggressive mix of controls and incentives, and will require appropriately integrated coordination of the many institutions with a stake in the urban arena.

Land use patterns are the single greatest driver of the poor performance of the urban transport system in meeting customer needs, and so any solution will require either altering land tenure or working within its existing context. Distance, density, and employment location are all facets of land use that affect the layout of South African cities and, subsequently, the economics and service levels of public transport.

Corridorisation lowers overall system costs - not only for transport but for other infrastructure, too - and also enables lower subsidies, raises travel speeds, and improves frequencies.

Today there is still a tendency towards continuing decentralisation, especially of workplace locations, which further complicates the task of creating compact cities. Some degree of compact city may be achievable in some areas of some cities, and the MSA strategy does not rule out the option in some circumstances. However, the predominant pattern should be the corridor city. The corridor approach fits more easily with the existing South African urban land tenure patterns. Its appropriateness is driven not only by the decentralised distant townships and the low density inner-ring suburbs, but also by a recognition of the decline in CBD vitality and the dispersion of development to satellite nodes. This pattern recognises the existing vacant land occupying the space between most townships and suburban areas, and also builds on existing flows along major current corridors.

Corridors already exist to some extent in South African cities. Therefore, the strategy focuses on densification of existing corridors and creation of new corridors for major new developments. It is essential to prevent the further dispersion of development, and to create incentives for any decentralisation away from the CBD to occur within the corridor context. The major trade-off against the corridor densification strategy is the higher cost of land for new housing projects closer to the CBD. Analysis shows that transport and other utilities generate savings over time which compensate for the increased cost of land.

Housing targets are driving the need to build on cheap, available land, which is causing dispersion. Transport and other utilities have to be provided to serve these dispersed housing developments, bearing increased long-term costs.

Because of the uniquely local nature of land use decisions, the most challenging part of implementing the corridor vision will be the co-ordination across and within government to overcome the obstacles. Some national policies, as in housing, encourage continued dispersion, based on the economics of land acquisition. These policies will need to be harmonised to fit into a paradigm that encompasses the systems cost of all community infrastructure, not just one component like housing or electricity.

The MSA strategy recognises many other obstacles exist to corridor densification, and overcoming these potential pitfalls will require strong co-operation across government. In particular four different public entities will need to act in close co-operation and co-ordination:

- National Government must provide the overall strategic vision for urban development, including transport. It must also create a framework for absorbing systems costs and aligning the incentives for different national departments to follow the framework. Out of this activity will come guidelines for internalising systems costs within land developments.

- Provincial Government must create broad provincial land use strategies that account for full systems cost, within the context of the national government framework. In addition, they will need to orient the subsidy policy to support the corridors, and are responsible for urban roads.

- The Roads Agency will need to align investments in national roads in urban areas with the local corridor strategies developed by local entities.

- Local Government and Metropolitan Transport Authorities will be responsible for developing land use and transport plans, and will now need to be integrated into planning for major commercial and residential developments. The subsidy allocation procedure must be linked into the corridor densification strategy.

The second action works to optimise modal economics and the service mix. Investment in corridors is primarily roads-based, because densities of new corridors are unlikely to support new rail lines. The strategy is one of regulated competition, with integration of modes facilitated. Optimising modal economics requires addressing the use of road space, and the strategy proposes tough road space management to prioritise public transport. A principal lever of the recommended strategy is that of subsidies, which will be targeted and providing affordable access to the stranded and subsidising the most economic mode on each corridor.

The third strategic action entails improving firm-level performance, a task which predominantly falls to private firms. The strategy requires effective regulation of all modes, especially minibus-taxis and the enforcement thereof. It emphasises tendering for subsidised routes and other forms of contract management, with built-in incentives for productivity innovation and reinvestment.

Implementing the strategy will require overcoming some significant obstacles. Changing the nature of land-use planning, road space management, planning and regulation, and subsidy targeting will need agreement on the objectives and strong political will.

Hard open spaces

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INTRODUCTION

Public space includes almost all land that does not belong to private institutions or individuals. Soft open space (addressed in Sub-chapter 5.4) is the unbuilt or "green space" flowing almost in natural lines through the settlement. Hard open space, on the other hand, is accessible and built public space within the built environment and can be viewed as either semi-public or public hard open space.

Within existing developments, open spaces are usually the result of space-left-over-after-planning. They should, however, be effectively designed from the outset in order to serve as purposeful public spaces. A greenfields development thus poses the opportunity for hard open space to be designed with a purpose in itself. Purposeful spaces should respond to user need, be carefully accommodated and sensitively designed. Then only can they be sustainable spaces that can be effectively used by future generations.

With the renewal or upgrading of existing areas, hard open spaces should be redesigned to better fulfil the public's demand for a quality environment with aesthetic appeal and a functional purpose. During the renewal/upgrading process, existing left-over-spaces between buildings can be redesigned to serve as effective public spaces that only serve as walkthroughs. Through renewal programmes these spaces and their directly linked areas could be given a new lease on life.

AIM OF THIS CHAPTER

In encouraging the effective functioning and urbanity of cities and thus also hard open space, it is important to provide guidelines for development, which is the aim of this chapter. These guidelines illustrate how certain generic forms of public space should be planned to avoid being merely meaningless leftover space.

In using these guidelines it is important to note that the specifics of a situation (the contextual determinants, such as context, site, climate, function and cultural determinants, and the symbolic aspects, such as culture, identity of place, user characteristics) should be considered in the planning and design process. Even though this chapter focuses on a neighbourhood/sub-metropolitan level, the guidelines have to be applied in a broader context within a hierarchy of hard open spaces. Through the interpretation of contextual and cultural determinants, certain distinctive elements of hard open spaces can be derived, evolving towards a unique relationship between the place and the contextual environment in which it functions. It is vital for the reader to bear in mind that the guidelines should merely serve as tools. They provide a means to an end and, to produce successful hard open spaces, they should be combined with the designer's own creativity and ingenuity.

THE ROLE OF HARD OPEN SPACE

In terms of settlement systems, hard open spaces fulfil a crucial role in providing continuity through various other elements of settlements. The public space (hard and soft) between buildings is the heart of the built environment and one of the fundamental form-giving elements of settlements. Through the integration of both the soft and hard open space systems with the built environment, a certain urban structure is created. The quality of public spaces is the result of the planning and development of a settlement. Densification and the reduction in the size of private space make the availability and quality of the public space system of utmost importance to the public realm.

A vital relationship exists between movement networks and hard open space, as the movement network is mostly encompassed by, or accommodated within, public hard open spaces.

According to Rapoport (1977) the relationship between different spaces is as important as the space itself. This relationship is twofold as, on the one hand, it has to do with the continuity and flow of space between different scales or levels of spaces and, on the other, it has to do with flow of space from private to public domains.

This continuity between hard open spaces and soft open spaces is very necessary if the different settings for social, economic and environmental development are to be integrated.

FUNCTIONS OF HARD OPEN SPACE

In order to effectively derive and utilise guidelines for the planning and design of hard open spaces, the point of departure should be the functions taking place, or which ought to be taking place, within hard open spaces. Function should altogether relate to the ability of the open space to foster healthy public living. It has to promote activities as diverse as possible in a multifunctional manner, in order to produce a vibrant environment for people.

In terms of structure there exists a continuum of hard open spaces with different degrees of publicness. These vary from semi-public hard open spaces to public hard open spaces. Based on the degree of publicness, function will vary between these spaces.

For discussion purposes the functions of hard open spaces can be broadly classified on the basis of either active or passive use, encompassing social functions, movement functions, economic functions and political or symbolic functions.

Social functions

- Social functions include activities such as play, sport and recreation. Open spaces are especially used by children for play and recreation. A possibility which has not been adequately capitalised on, yet, is the conversion of open spaces to hard surface playgrounds for games like basketball, etc.

- Cultural entertainment (Moughtin 1992, p 89), such as performing musicians and artists, also forms part of social functions taking place on hard open spaces.

- Another important social activity of hard open spaces is lingering or resting. Public places should function as magnets which draw people to themselves or to the associated public facilities. With the correct mix of surrounding land uses these spaces could become attractions and visitors' destinations.

- Hard open spaces, due to their locality between private spaces and public spaces, are very functional meeting and socialising places (Moughtin 1992, p 89) for business people, shoppers, the unemployed, friends and the elderly during the day, and largely for the young at night. The spaces are particularly important to the least mobile sections of the population as very visible places to meet and enjoy conversation with others.

Economic functions

- The function of street vendors (trading) is an economic activity taking place on hard open spaces that has become a vital part of the South African urban experience. Street vendors are dependent on open spaces such as streets or public transport facilities where there is a flow of pedestrians, and they are in direct contact with their customers.

- Hard open spaces also cater for outdoor markets in designated areas, as well as through the multifunctional and temporary use of parking areas, streets and sidewalks (Rapoport 1977, p 100).

- Hard open spaces are the ideal setting for gatherings like festivals or market places (Moughtin 1992, p 89), which function in parallel with the space as an agent for social interaction.

- Access to facilities such as public services, civic buildings (clinics, libraries, etc.) and shopping spaces are an important function of hard open space (Moughtin 1992, p 89).

Movement functions

- Hard open spaces provide access to public facilities and transport, not only via walkways and sidewalks, but also to places for waiting and intermodal transfer at stops or stations.

- In terms of movement or access, hard open spaces are usually located at points of relatively high accessibility.

- Hard open spaces also encompass spaces such as intersections and traffic junctions.

- Parking is an important activity that takes place in hard open space.

Political or symbolic functions

- Hard open space can provide a venue for ceremonial occasions and parades.

- An important symbolic function of hard open spaces is the provision of suitable, identifiable and accessible settings for civic buildings.

DIFFERENT GENERIC FORMS OF HARD OPEN SPACES

Most of these briefly discussed generic forms of hard open space can and should be used and managed as multifunctionally as possible.

Mixed-mode streets

Mixed-mode streets are streets that contain a mix of motorised and non-motorised users. Although these streets are in part dominated by vehicular movement, they include the hard open space components of sidewalks, bicycle paths and space for the provision of engineering services. Variations and uses of sidewalks and road reserves can be exploited. Road reserves can, for example, be applied to better locate informal traders by making sidewalks wider and catering for sidewalk parking.

Pedestrian-orientated streets

Pedestrian-orientated streets can be regarded as streets set out for the main purpose of pedestrian use, such as the "woonerf" concept and arcades. Variations on use and function are available, including play streets, streets closed (temporarily or permanently) and alleys used for trading, markets, recreation and entertainment.

Squares/plazas

Various forms and uses for squares and plazas exist. The most common uses are as atriums, courtyards, intimate inner-city parks, markets, meeting places, and spaces for entertainment, sport and recreation.

Markets

It is impossible to distinguish between permanent and informal markets, such as informal trading on sidewalks or markets in parking areas or streets. Retailing forms an important part of hard open spaces, and includes convenience and specialist markets.

Parking areas

Parking areas are also considered hard open spaces, but their present use leaves much to be desired. Parking in the street and in front of shopping centres, office blocks, churches and public buildings is most common. Opportunities exist for a variety of uses; especially with regard to different times of night and day and different days of the week.

Public transport stops and stations

Various forms of hard open space relate to stops and stations for public transport, such as bus stops, taxi ranks and bus depots. These spaces can also be used multifunctionally for informal markets and meeting places.

THE INFLUENCE OF USER GROUPS ON THE PLANNING AND DESIGN OF HARD OPEN SPACE

In order to identify various user groups, a hierarchy of activities could be set out (Van Zyl 1997). The first of these sets of activities is "necessary activities". These activities include those that are more or less essential aspects of living - shopping, waiting for a person, running errands. A second category of activities is "optional activities". These are activities participated in if there is opportunity and if time and place make it possible.

Users can be identified by the level of their participation in necessary or voluntary functions, whether static or dynamic. Users can also be identified in terms of their demographic characteristics (age, gender, race, income group, culture, ethnic group, children, teenagers) or in terms of their location-specific activity, in which case activity equals the user, such as the selling of vegetables.

Some of the various user groups that need special mention and attention in the design of hard open spaces, as well as some of their specific needs, are:

- children need formal and informal play areas, and safety;
- elderly people need convenient access, seating, safety and shelter;
- youth need space for activity, safety, multifunctional uses, socialising and lingering;
- disabled people need adequate ramps and access as well as safety;
- traders need public facilities, shelter and public amenities;
- shoppers need public facilities, convenience and access;
- higher income groups need hard open space that provides the setting for private space; and
- lower income groups need to utilise hard open spaces, such as streets, as part of the urban room; incorporating socialising and playing space.

It should, however, be borne in mind that the time at which activities take place can vary between day and night, as well as between weekdays and weekends, and this will influence the user group involved. So a specific hard open space can cater for different groups at different times or simultaneously.

Various cultural and income groups also use hard open spaces differently and have different perceptions regarding open space, urban qualities, environmental quality and cognitive domains of space (Rapoport 1977, pp 24-5).

GUIDELINES FOR THE PLANNING AND DESIGN OF CERTAIN GENERIC FORMS OF HARD OPEN SPACE

General guidelines applicable to hard open space in general are set out first. These are followed by guidelines specific to the following generic forms of hard open space:

- mixed-mode streets;
- pedestrian-orientated streets;
- squares;
- markets;
- parking areas; and
- public transport stops and stations.

For both general and specific categories, qualitative guidelines are defined first, after which quantitative guidelines for each generic form follow. In the case of the specific category, qualitative guidelines refer to:

- location and typologies;
- vertical edges;
- horizontal surfaces;
- public furniture; and
- signage.

Quantitative guidelines for the specific category refer to:

- ratios and thresholds; and
- dimensions and distances.

The guidelines are provided in tabular form and, where applicable, illustrated diagrammatically.

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General qualitative guidelines

Table 5.3.1: Integrated hard open space system

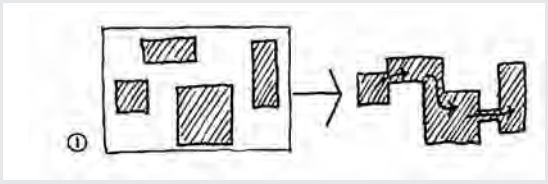
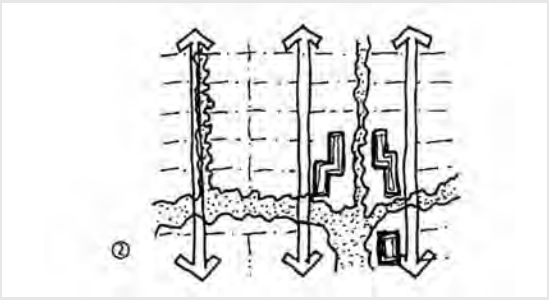
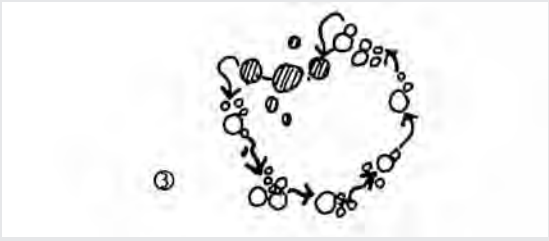
Create an effective hard open space system that integrates the different elements of a settlement to contribute to a meaningful urban structure.	• Provide physical, visible and perceptual connectivity between cluster and linear open spaces. Establish strong and legible linkages between various hard open spaces. [1] • Align the hard open space system and soft open space system with main public buildings, such as community centres or places of worship. [2] • Ensure quality of contextual linkages through the continuation of special activities or functions.[3] • Enhance structural similarity of the street through associational symbolism (personal experience) and cultural symbolism (common areas of understanding in culture) to ensure that as many people as possible can relate to the space. [4]	 ①  ②  ③  ④

Table 5.3.2: Public facilities

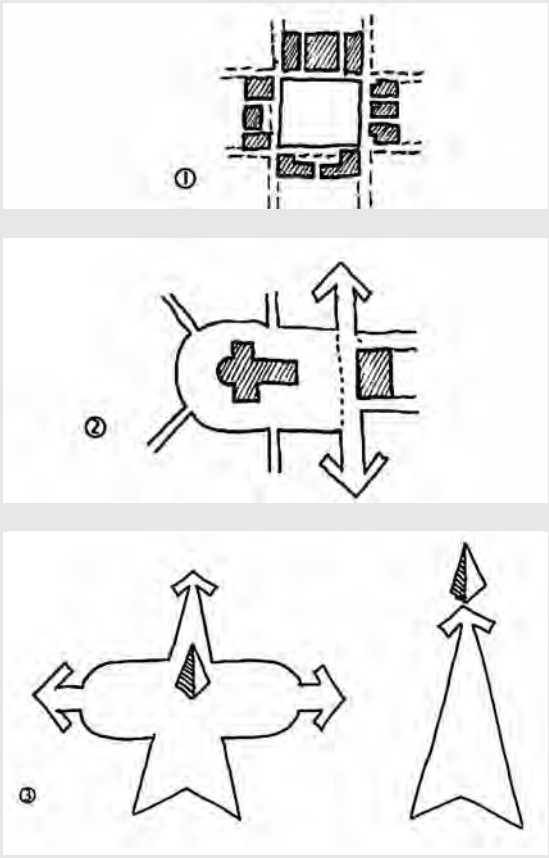
For a meaningful urban structure, link symbolic elements or public facilities to certain hard open spaces in relation to their importance and character.	• Create special public places, as public spaces and public institutions are the focal point of community life. Public furniture should support the desired character of the space. • Concentrate buildings with public facilities, amenities and collective service points adjacent to public spaces. [1] • Locate public buildings in relation to formal public spaces and important movement routes. Hard open space should announce the buildings and accommodate informal activities that respond to these buildings. [2] • Balance the composition of building groups, and place the focal point near the middle of the group (Moughtin 1992, pp 56-7). [3] • Locate symbolic and/or focal points in the middle of a cluster space or at the termination points of a linear space.	

Table 5.3.3: Private and public domains

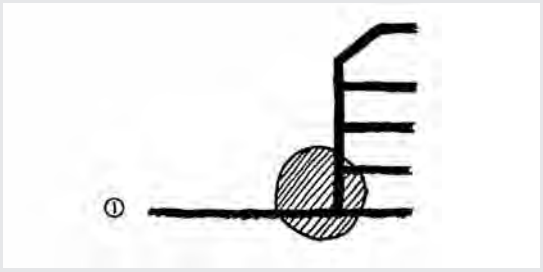
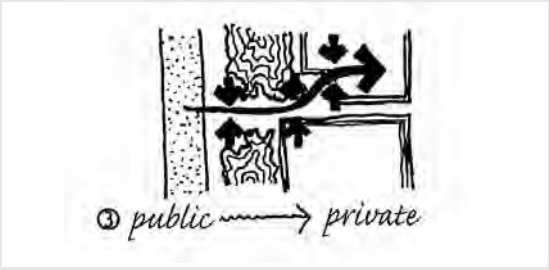
Ensure definition of the public space through effective design of an interface between public and private domains.	• Thresholds should act as shared environments (meeting places) or transitional space between public and private space. [1] • Visual permeability through an interface can enrich the public domain and will affect the way private space is used. It becomes a controlling and enabling constraint. [2] • Enhance the visibility and legibility of the relationship and the transition between private and public domains (Rapoport 1977, p 23). [3]	  

Table 5.3.4: Enclosure

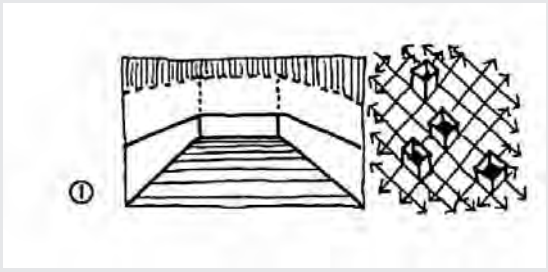
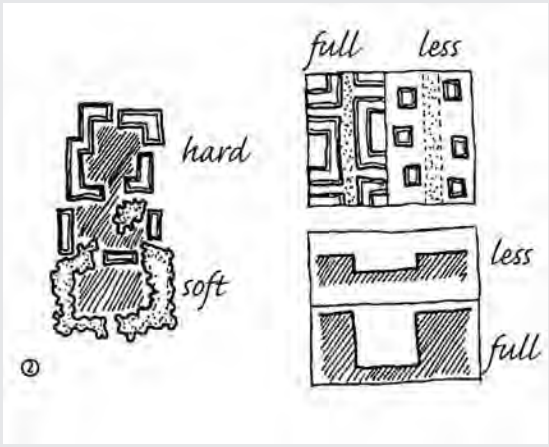
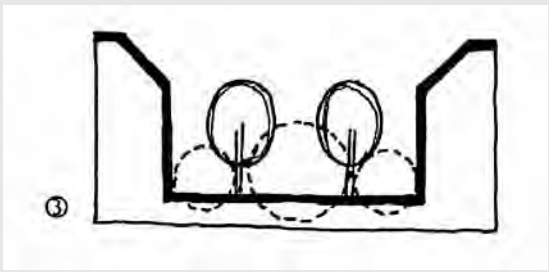
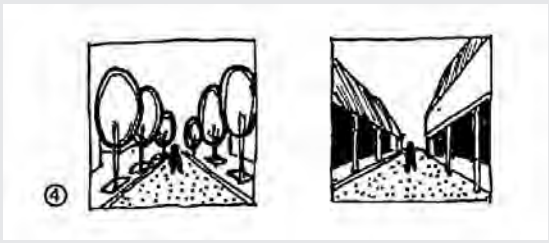
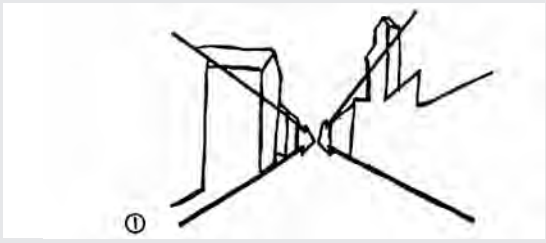
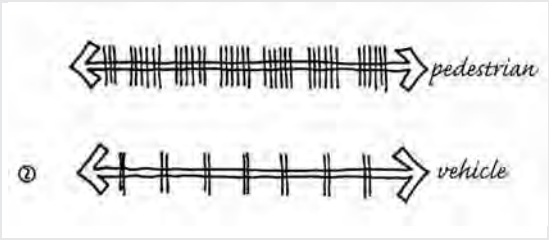
Ensure appropriate sense of enclosure that is on a human scale and fits into the context within which the space is situated.	• Enclosure is needed for the public space to act as an urban room. [1] • The degree of enclosure and nature of enclosing elements determine the character of the space. [2] • Proportion should not be vehicle dominated. Use trees as enclosing elements and to create a human scale. [3] • Define the boundary of the space by means of a unified wall or a series of pavilions linked with landscaping. [4]	   

Table 5.3.5: Continuity and rhythm

Continuity and rhythm of and within spaces should enhance legibility and interest.	• Create rhythmic and spatial progression along a space through the composition of activities or change in land uses (Moughtin 1992, p 58). [1] • Establish a continuation of special activities or functions that exist in the node, within the linkages towards the node. • Perception of hard open spaces is related to the concepts of speed and complexity. Movement relates to complexity and the number of changes that take place within a specific unit of time (Rapoport 1977, p 241), Due to the relative slow movement of pedestrians, a greater degree of complexity and a large number of changes are needed. Faster vehicle movement requires more simplicity and less changes per unit of time. This holds implications for the richness of detail to be provided on buildings. [2]	 ①  ②

General quantitative guidelines

Table 5.3.6: Scale and proportion

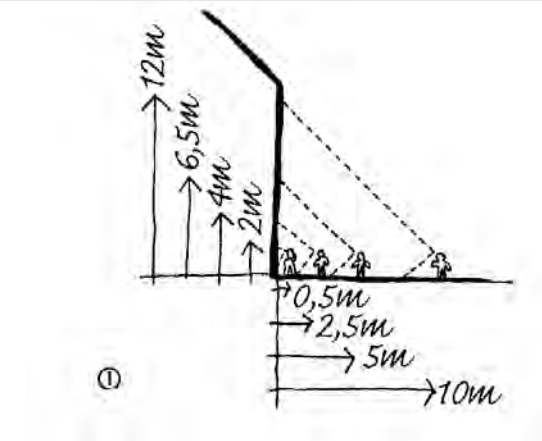
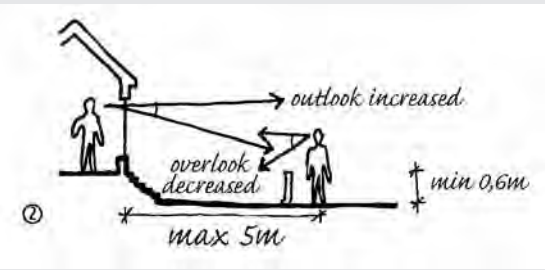
Visual recognition and surveillance.	• Height of detail on buildings that could be appreciated from certain distances away from the facade: - Up to 2 m high to be appreciated from 0,5 m away. - Up to 4 m high to be appreciated from 2,5 m away. - Up to 6,5 m high to be appreciated from 5 m away. - Up to 12 m high to be appreciated from 10 m away. [1] • To maintain contact for safety between pedestrians on street level and people in adjacent buildings, a maximum of 5 m is required. To ensure privacy for inhabitants of buildings at this distance, the street should be at minimum 0,6 m lower than the ground level of the building.[2] • To maintain privacy, a clear distance of at minimum 11 m is needed, otherwise visual obstructing elements, such as trees, should be provided. [3]	  

Table 5.3.6: Scale and proportion (continued)

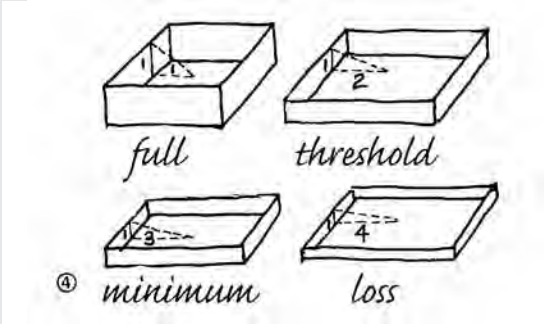
Visual recognition and surveillance (continued).	• Human scale: - Intimate human scale: 12 m (maximum distance to see facial expression); - Normal human scale: 21 to 24 m (25 m at maximum to recognise a face); - Public human scale: 140 m (135 m at maximum to distinguish a human); - Monumental scale: 1 500 m (maximum distance for vista).	
Enclosure.	• Buildings should be seen as a whole from a distance that is twice its height at a 27° angle. • Relationship between radius and height to ensure enclosure (Moughtin 1992, pp 100-1); - Full degree of enclosure is 1:11; - Threshold for enclosure is 1:2 (beyond this proportion space leaks out); - Minimum enclosure is 1:3 (prominent objects are perceived beyond the space); and - Loss of enclosure is >1:3 (space loses its containing function). [4]	

Table 5.3.7: Environmental factors

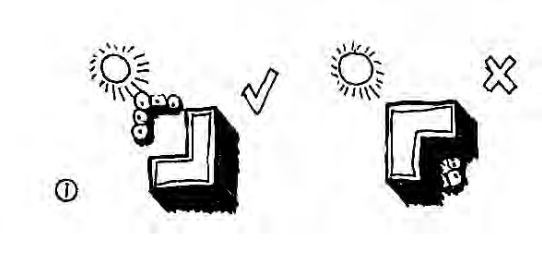
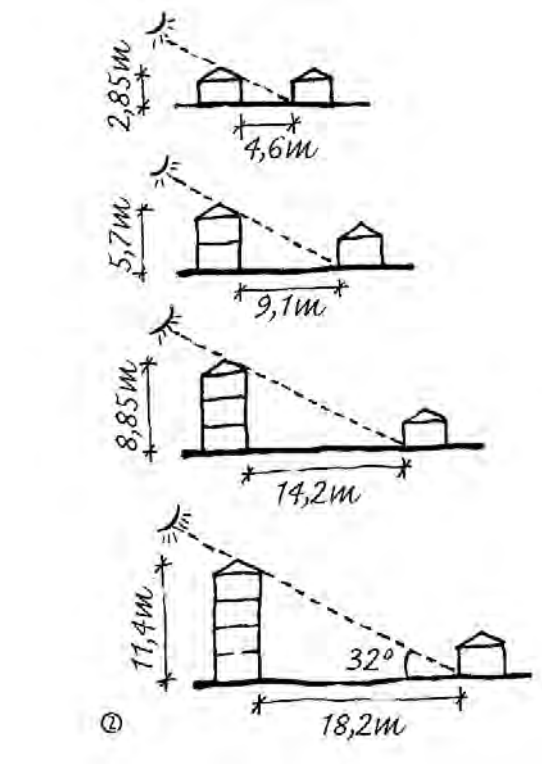
Solar access.	• Locate highest buildings to the southern side of the open space, with lower buildings or trees (as enclosing elements) on the northern side. [1] • To provide adequate solar access to a building, the distance between two buildings should be determined with the following: tan (latitude of the area +10˚) divided by the height of the adjacent building to the north. For example, at Midrand (with a latitude of 22˚) the following is applicable: - If the adjacent building is 2,85 m high (one storey), the distance between the two buildings should be 4,6 m. - If the adjacent building is 5,7 m high (two storeys), the distance between the two buildings should be 9,1 m. - If the adjacent building is 8,85 m high (three storeys), the distance between the two buildings should be 14,2 m.[2]	 

Table 5.3.7: Environmental factors (continued)		
Wind protection.	• An obstruction such as trees can provide the necessary protection against wind. The ground area protected, is generally 10 times the height of the obstruction. [3]	

Specific qualitative guidelines

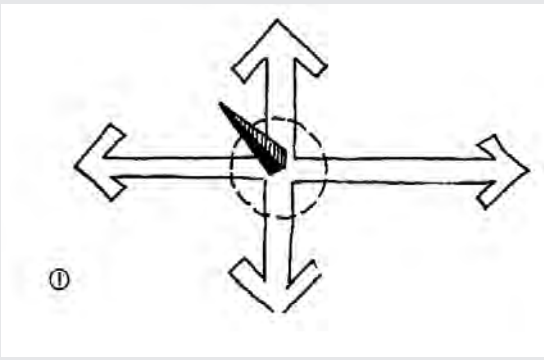
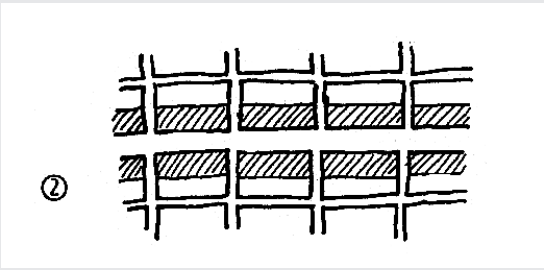
Table 5.3.8: Location and typologies		
Mixed-mode streets		
Ensure a meaningful location in terms of the movement network and urban structure.	• Design the road network to accommodate various and diverse functions. • Meeting of special streets should result in squares and focal points (Moughtin 1992, p 80). [1] • Concentrate intensive activities along continuous vehicle-orientated and public-transport routes. Locate majority of public buildings also along these routes. [2] • Locate buildings close to the street to increase pedestrian activity, reduce resident isolation, and foster pedestrian services such as retail outlets along streets connecting higher density developments.	 

Table 5.3.8: Location and typologies (continued)		
Mixed-mode streets (continued)		
Increase intensity and diversity in the street reserve.	• High information routes are experienced as short, but remembered as long. Ensure complexity and interest along roads and in space along routes (Rapoport 1977, pp 217-220). • Create rhythmic and spatial progression along an axis/street, via composition of activities or change in land uses (Moughtin 1992, p 59). • Block lengths influence access and economic thresholds. Design optimal block lengths to foster diverse activity and economic viability.	

Table 5.3.8: Location and typologies (continued)

Mixed-mode streets (continued)

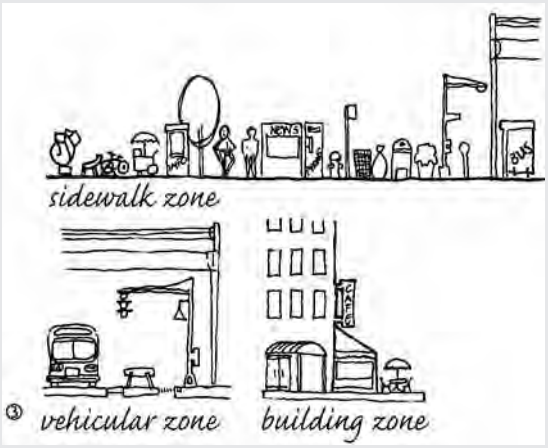
Increase intensity and diversity in the street reserve.	• Effectively design the whole reserve, including the spaces between the road surface and the building entrances. Design for and make a distinction between the following: - building zone (arcades, canopies, commercial signs, enclosed cafes and sidewalk cafes); - sidewalk zone (sewers, gratings, kerbs, urban art, benches, bicycle racks, hawker stalls, information kiosks, trees, cycle areas, pedestrian areas, newspaper stands, telephone booths, fire hydrants, traffic signs, refuse bins, mail boxes, planters, street lighting, parking meters and bus shelters); and - vehicular zone (banners, manholes, traffic signals, on-street parking, decorative lighting and telephone poles).[3]	

Table 5.3.8: Location and typologies (continued)

Mixed-mode streets (continued)

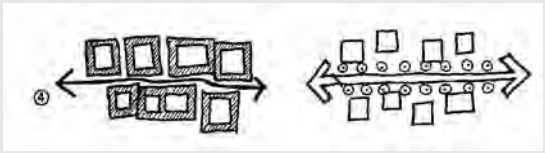
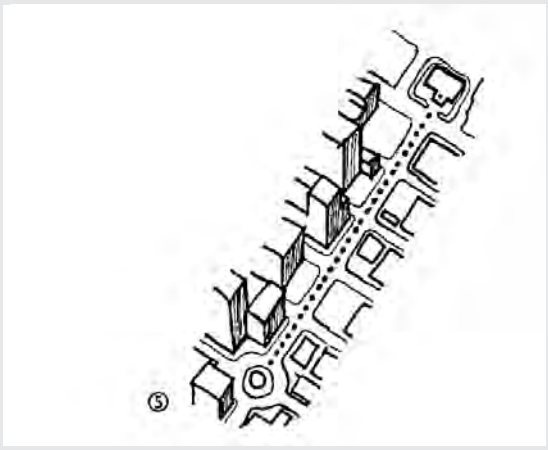
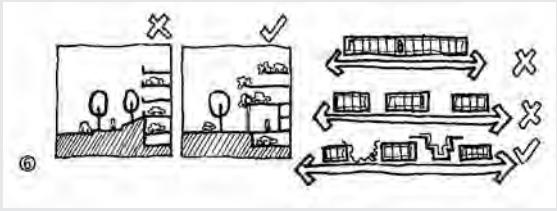
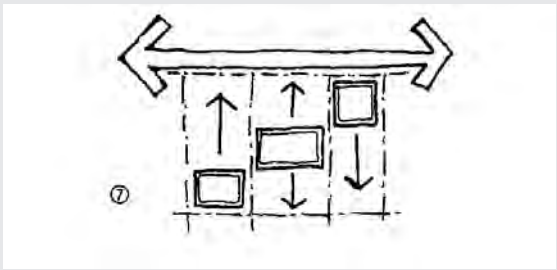
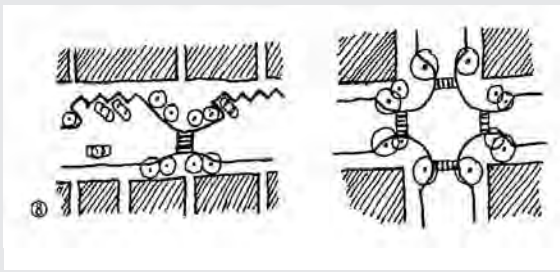
Define the street as a safe and unique public space.	• The general pattern of buildings should help to define the street. [4]	
	• In pavilion-type buildings, use trees to define the street. The streetscape design should incorporate a consistent theme, strengthening the association of unrelated buildings. When a street is not strongly defined at its edges, focal points - at the ends or at regular intervals - could provide a sense of place. [5]	
	• Land uses should enliven the street and ensure surveillance of it. Parking structures should not dominate street frontages. [6]	
	• Distinguish between so-called front-and-back uses and definition, which take place within the street realm, but which differ for various urban users and cultures. [7]	
	• Intersections and road crossings should be designed to be safe for pedestrians and vehicles. This includes the design of sidewalks and crosswalks, traffic signals and other intersection treatment. [8]	

Table 5.3.8: Location and typologies (continued)

Mixed-mode streets (continued)

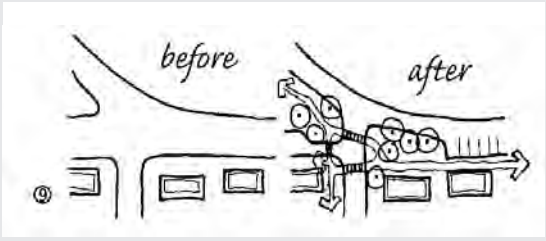
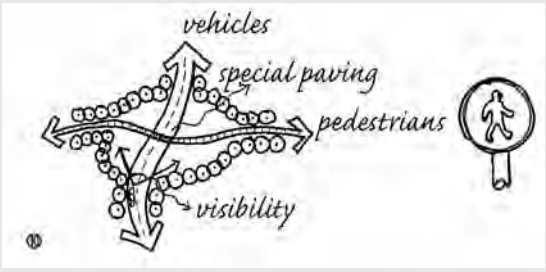
Define the street as a safe and unique public space (continued).	• Modify existing leftover space to accommodate easy pedestrian crossing of streets. [9] • Where pedestrian routes cross streets, ensure visibility through landscaping and signage. [10] • To enhance safety for pedestrians on sidewalks (Untermann 1984, pp 25-28): - minimise conflict with cars; - cater for the disabled; - provide sidewalks; - provide parking, between road and pedestrian; - the busier the street, the broader the sidewalk should be; - place kerb between sidewalk and street; and - design road to discourage speeding.	 

Table 5.3.8: Location and typologies (continued)		
Mixed-mode streets (continued)		
Accommodate a variety of users in the street.	• The effective separation of pedestrian and vehicular movement should be at a scale which encourages activity and pedestrian comfort. • For movement, the street should include a surface for cars, together with bicycle and pedestrian lanes. • Other facilities to be accommodated are those for informal traders, small-scale businesses (such as decorative kiosks for flowers), landscaped strips and spaces of relief and relaxation in bustling areas.	
Pedestrian-orientated streets		
Ensure a meaningful location in terms of the movement network and urban structure.	• Create a symbolic location for a special street through its relative location within a geographical area.	
Increase intensity and diversity in the street.	• In pedestrian arcades, provide spaces of relief and relaxation in bustling areas. • In pedestrian-dominated streets related to residential uses, such as the woonerf street, provision should be made for other uses, such as recreation and socialisation, which are related to the main residential use. • Visitor parking can be provided in the street.	

Table 5.3.8: Location and typologies (continued)		
Pedestrian-orientated streets (continued)		
Define the street as a safe and unique public space.	• Design detail to discourage traffic through the area, and speeding. • Design soft mounds and plant trees separating footpaths and buildings from the road. • Footpaths should preferably be designed adjacent to buildings that overlook them, as opposed to blank walls (Cartwright 1980, p 32).	
Accommodate a variety of users in the street.	• Concentrate public facilities according to functional relationship, to facilitate sharing of resources (halls, playing fields, equipment). • The street as communal area can provide the setting for the integration of collective services in lower-income residential areas.	

Table 5.3.8: Location and typologies (continued)		
Squares		
Ensure a meaningful location in terms of the movement network and urban structure.	• Locate largest and most important buildings in association with largest and most important squares. • Create symbolic location by relative location within a geographical area. • Enhance legibility of the structure (Rapoport 1977, p 116; Lynch and Hack 1984) via the locality of squares at movement-decision points. • Give important squares, dominance in the settlement (Moughtin 1992, pp 56-7) - for example, by letting buildings that surround them, occupy high ground or dominate the skyline. • Provide contrasting hard open spaces with greater or less activity.	
Increase intensity and diversity in the square.	• Integrate indoor and outdoor spaces to make them more useful. Plan spaces to be small and informal in character and quality, so as to be inviting, comfortable and non-oppressive. • Use of the square and activities in the square depend on the activities at the edge, especially on the ground floor. Develop restaurants, small shops and retail stores around the square; exclude large banks, travel agents and offices that attract few pedestrians.	

Table 5.3.8: Location and typologies (continued)		
Squares (continued)		
Increase intensity and diversity in the square (continued).	• Urban squares could be used as markets, with either the central area of the square or the edges as demarcated space for trading.	
Define the square as a safe and unique public space.	• Design identifiable gateways as legible entrance points to the square (Rapoport 1977, p 95). Entry points should be highly visible and linked to major contextual routes (Rapoport 1977, p 383). • Ensure surveillance of the square through its visibility from adjacent buildings. • From a central point one should be able to appreciate all sides of the square.[1] • To enhance memorability, buildings that are simple in geometric shape should be placed together (Moughtin 1992, p 72). One prominent building should dominate the group.	

Table 5.3.8: Location and typologies (continued)

Squares (continued)

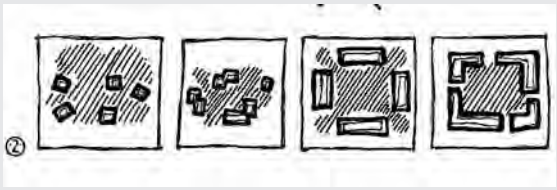
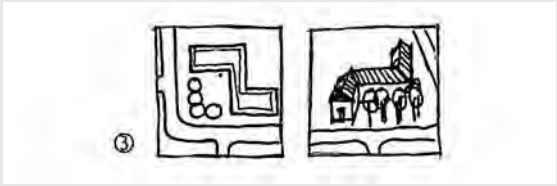
Define the square as a safe and unique public space (continued).	• To contextualise the square and design the correct proportion within the context, take the typology of surrounding buildings into account. Give attention to size, height, unifying elements, theme, shape of space and roof lines. Continuity in height of buildings around a square enhances enclosure. Enclosure is reduced with the degree of difference in building height. • Design for a sense of permanence, through robustness of buildings, which are compatible for a diversity of uses. • Enclosure depends on the way buildings are grouped. Create a sense of enclosure, especially on corners, otherwise space gets fragmented.[2] • One or two sides of a square should be enclosed with buildings. The other sides could be enclosed by something else, such as trees.[3] • If the physical sense of enclosure is less, the sense of place/activity/meaning should be higher.	 ②  ③

Table 5.3.8: Location and typologies (continued)		
Squares (continued)		
Accommodate a variety of users in the square.	• Enhance the symbolic meaning of city squares. Accommodate symbolic elements and places (statues, objects of remembrance and memorable places) that reflect shared community values and events. • Encourage the use of bandstands, public display areas, outdoor dining space, roller-skating and other features that attract crowds. • Encourage recreational facilities such as theatres, restaurants, cafes, movie houses, and libraries with late-night hours, hotels, and teenage meeting rooms, extending the usage of the square to night-time.	
Markets		
Ensure a meaningful location in terms of the movement network and urban structure.	• Incorporate markets at points of greatest access in the urban structure, such as at modal interchanges and intersections. • Ensure the permeability of, and short cuts through, the market.	

Table 5.3.8: Location and typologies (continued)

Markets (continued)		
Increase intensity and diversity in the market.	• Plan the market to convey a sense of permanence. This should be achieved with compatible buildings that can accommodate changing uses over time. • Create opportunity for formal commercial and informal trading activities. The concentration of activities will encourage interaction and generate economic expansion. • The size of the market will change over time. Expansion and contraction of the market can occur over short periods. The market should, however, be planned in such a way as to retain its intensity at all times. As phased growth takes place, the market should operate as a totality at each stage of its development.	

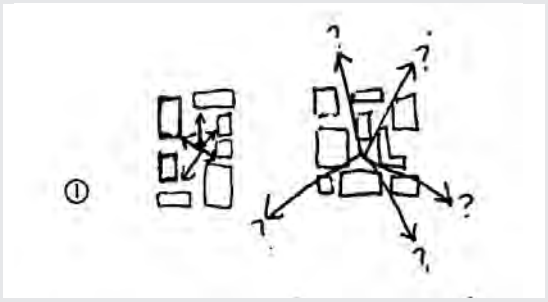
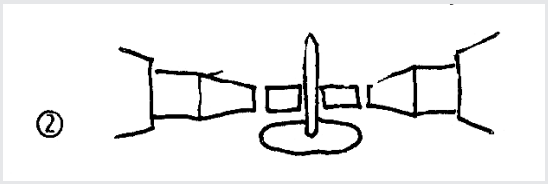
Table 5.3.8: Location and typologies (continued)		
Markets (continued)		
Define the market as a safe and unique public space.	• The gateways to the market place should convey a friendly invitation, where a sense of belonging could be experienced by users. • The market should have an acceptable sense of place that should be defined by means of a primary space, supported by secondary spaces. [1] • The primary space should form the major communal space around which market stalls should be positioned. A vertical element should preferably be placed at its centre. This should form a reference point that will enhance legibility of the market. [2]	 
Accommodate a variety of users in the market.	• Markets with small-scale activities require less formal market infrastructure. Market activity may be intermittent and could take on different forms. The spaces should thus be designed to be as multi-functional as possible.	

Table 5.3.8: Location and typologies (continued)

Parking areas

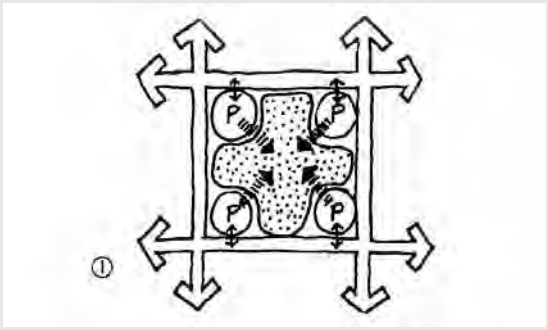
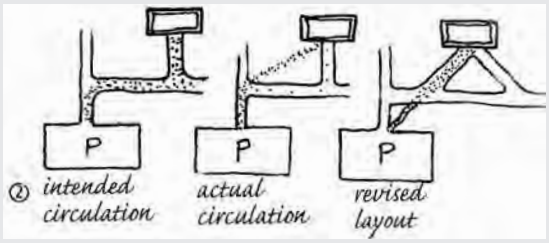
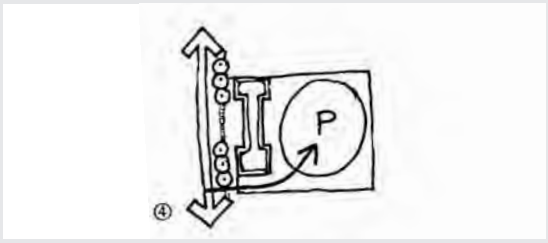
Ensure a meaningful location in terms of the movement network and urban structure.	• Organise parking in small lots around the perimeter of the core of activities and movement. Parking lots should lead to the core and should provide pedestrian access to all streets. [1] • Integrate a parking area with the surrounding area through linking it to natural movement routes and accommodating short cuts. [2] • Parking should be located in smaller areas closer to destinations, especially in higher density development and at local shops. [3] • Parking should preferably be located away from the street at the back of buildings. If parking is provided at the front, a maximum of two rows of parking should be provided. Parking structures should not dominate street frontages. [4]	   

Table 5.3.8: Location and typologies (continued)

Parking areas (continued)

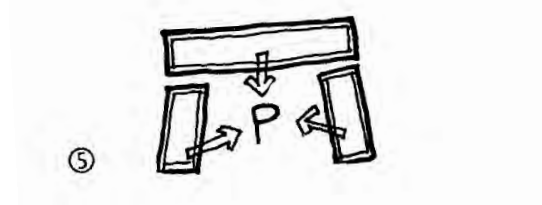
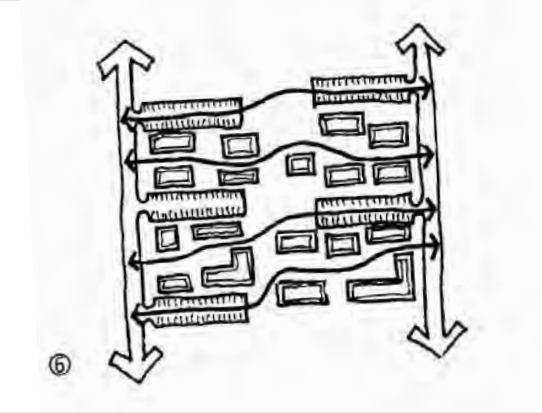
Increase intensity and diversity in the parking area.	• Manage activities in parking areas for various uses and effective utilisation of space through different times of the day, such as the closing of parking areas to act as markets in the evening or play areas on weekends. • Type and intensity of uses can vary over time as the demand for parking increases or decreases (differences between day and night, times of the day, days of the week or month). • Accommodate different uses that increase latency and allow for social change without physical change.	
Define the parking area as a safe and unique public space.	• The way buildings are arranged around the parking area should ensure adequate surveillance. [5]	
Accommodate a variety of users in the parking area.	• Allow for informal traders to trade within the parking area in an organised way. • Accommodate multifunctional use of elements within the parking area, such as trees. • Accommodate pedestrian routes through the parking area. [6]	

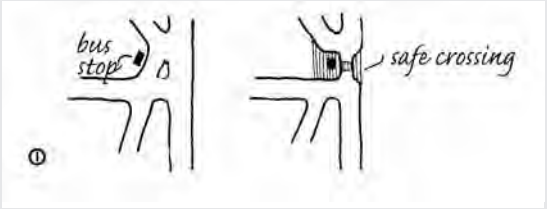
Table 5.3.8: Location and typologies (continued)		
Public transport stops and stations		
Ensure a meaningful location in terms of the movement network and urban structure.	• Locate public transport stops and stations on convenient routes between different land-use activities. • Locate stops or stations at points of highest accessibility. Integrated intermodal transport nodes and change-overs should be promoted to ensure sustainable physical development. • Incorporate stations within their surroundings by means of the effective utilisation and design of existing leftover space. [1] • Stations and stops should be located at more frequent intervals and closer to destinations in higher-density and mixed-use developments.	
Increase intensity and diversity at the stops and stations.	• Organise informal trading around the stop and within the station.	
Define the stops and stations as safe and unique public spaces.	• Attend to the quality of the stops in terms of safety, shelter, character or image and visibility.	
Accommodate a variety of users at the stops and stations.	• Provide adequate space and facilities for informal traders at stops and stations.	

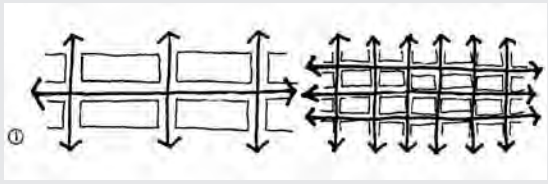
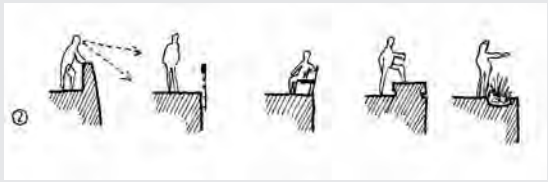
Table 5.3.9: Vertical edges		
Mixed-mode streets		
Create easy access to and from the street.	• Permeability of public space can be enhanced through the provision of maximum alternative routes (Bentley et al 1987, p 10). Small blocks give more choice of routes than large blocks. [1] • Enhance permeability by not absolutely segregating pedestrian and vehicular movement. • Design for permeability and access to occur at visible entrances. • Provide shortcuts to intermediate distance substitutes, such as bus, bicycle and taxi.	
Establish appropriate interfaces.	• The building facade should be linked to human activities along the route to ensure visibility of pedestrians and thus surveillance of the street. Surveillance of the street should also be facilitated from upper storeys. The way this edge is made will also determine the feeling of the upper-storey space. [2] • Arcades provide a defined human space between the building and the street. Arcades should also provide shelter against bad weather.	

Table 5.3.9: Vertical edges (continued)

Mixed-mode streets (continued)

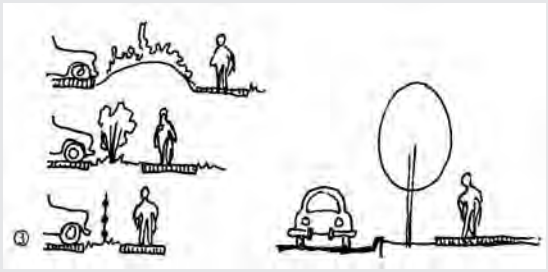
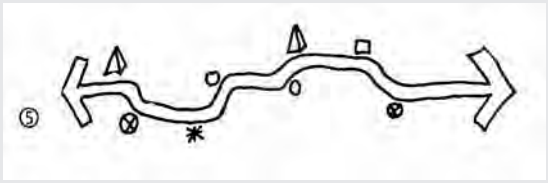
Establish appropriate interfaces (continued).	• Interfaces can ensure coherence and interest, and will provide a visual stimulus to passers-by. Colonnades as interface could provide a coherent simple rhythm on the outside (which relates to fast-moving vehicles) and complexity on the inside (which relates to pedestrians). • Interface between pedestrians and cars should be defined through a row of on-street parking or through landscaping (Untermann 1984, pp 25-28). [3] • Garbage receptacles or unsightly equipment should be screened, especially from pedestrian-movement routes.	
Ensure a unified and interesting edge surface design.	• Unify street design and street frontages of buildings to create a special street with an identifiable character. New buildings should fit into the existing context and attention should be given to similar elements such as roof lines, bay windows and window proportion (Moughtin 1992, p 2, 143). [4] • A number of distinctly identifiable elements along routes should be provided, with continuity of shop fronts (Moughtin 1992, pp 56-57). [5]	 

Table 5.3.9: Vertical edges (continued)

Pedestrian-orientated streets

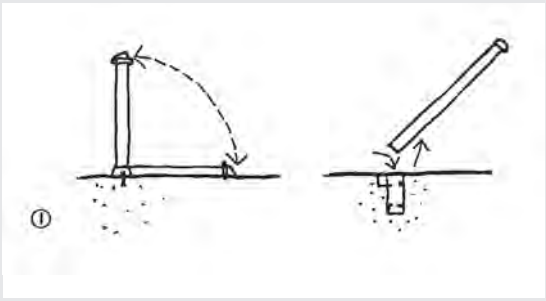
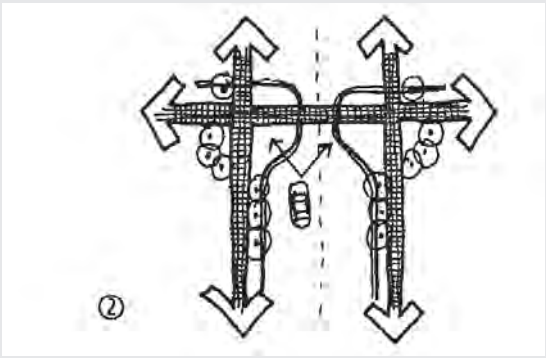
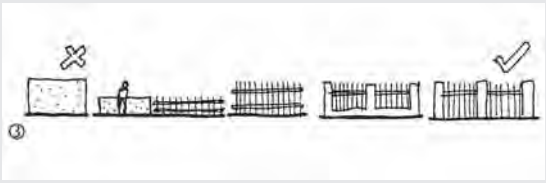
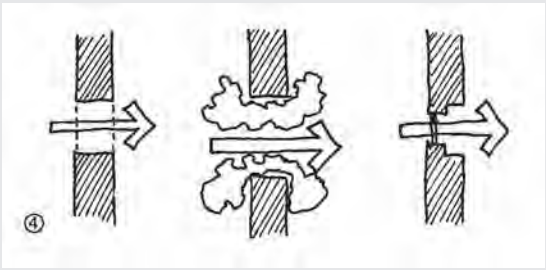
Create easy access to and from the street.	• Access for pedestrians and bicycles should be made easy, while access for vehicles should be more difficult and controlled. Use lockable bollards where applicable. [1] • Access for vehicles must be made difficult. [2]	 
Establish appropriate interfaces.	• In residential developments, it is preferable not to have any fences or walls on the street boundary. However, should fences be put up, it is proposed that palisade fencing that provide maximum visibility, be erected. This should ensure surveillance of the street. [3] • Transition from public to private space should be appropriately made through the provision of perceptual locks. This will contribute to the clear distinction between and definition of public and private spaces. [4]	 

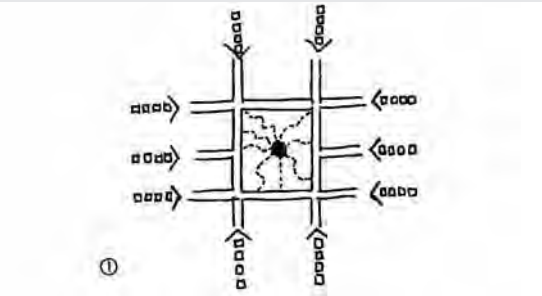
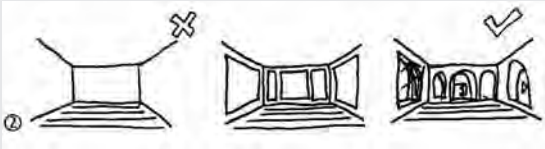
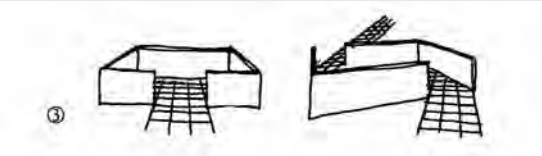
Table 5.3.9: Vertical edges (continued)		
Pedestrian-orientated streets (continued)		
Ensure a unified and interesting edge surface design.	• To organise a unified character, it is proposed that the interface be designed as a single entity.	
Squares		
Create easy access to and from the square.	• Provide direct access to and continued routes through the square.[1] • Design for permeability with as many shortcut routes through the square as possible.[1] • Link the square to major contextual routes.[1]	
Establish appropriate interfaces.	• Establish a boundary which can be a wall, windowed façade or natural features such as trees. Do not design large expanses of blank walls.[2] • The interface should address issues of human comfort, such as shelter from sun, wind and rain and a choice between sun and shade and public lighting.[2]	
Ensure a unified and interesting edge surface design.	• Enhance the sense of enclosure with unity in walls and similar architectural treatment of buildings (Moughtin 1992, p 72). Local styles and materials should be used consistently.[3] • Squares should create discontinuity or interruption in the built form in order to prevent boredom. When approached at an angle, the effect can be dynamic.[3]	

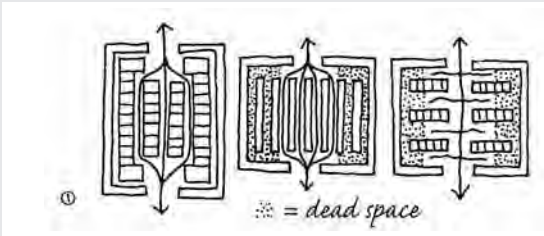
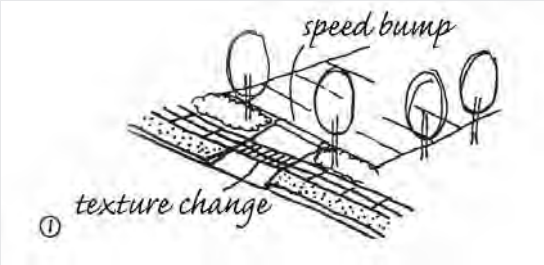
Table 5.3.9: Vertical edges (continued)		
Markets		
Create easy access to and from the market.	• Edges of markets should provide maximum permeability for easy access to and from market activities. [1]	
Parking areas		
Create easy access to and from the parking area.	• Provide adequate stacking space for vehicles waiting to turn into the parking area. • Provide ample dedicated pedestrian routes where pedestrians can access the parking area. • Conflict between pedestrians and automobiles should be reduced through location and design of vehicular and pedestrian access to parking facilities. [1]	
Establish appropriate interfaces.	• Design boundaries as meeting places between different domains. The boundary should act as interface between public space and private space or between inside space and outside space. • Design edges to be used for shelter against wind or rain.	
Ensure a unified and interesting edge surface design.	• Plant shade trees in the parking strip to continue the trees found in surroundings.	

Table 5.3.9: Vertical edges (continued)		
Public transport stops and stations		
Create easy access to and from the stop or station.	• Enhance convenience and safety through provision of the most direct pedestrian access to and from public transport facilities. • Reduce the walk length with short cuts to intensify activity, and to support intermediate distance substitutes, such as bus, bicycle and taxi.	
Establish appropriate interfaces.	• Integrate bus or taxi stops for shelter and safety in the design of the interface of the adjacent building. • Interfaces such as overhangs can provide shelter to informal traders or people waiting for transport.	
Ensure a unified and interesting edge surface design.	• Provide a landscaped setback for ranks, depots and stations from the street.	

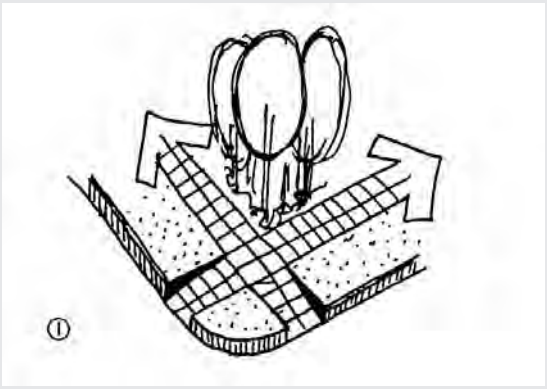
Table 5.3.10: Horizontal surfaces		
Mixed-mode streets		
Ensure accessibility and convenience for different user groups.	• Paving materials should provide safe walking surfaces. • Provide clear markings for pedestrian crossings at intersections. [1] • Walking routes should be provided as level as possible, avoiding unnecessary changes in elevation that can cause accidents.	

Table 5.3.10: Horizontal surfaces (continued)

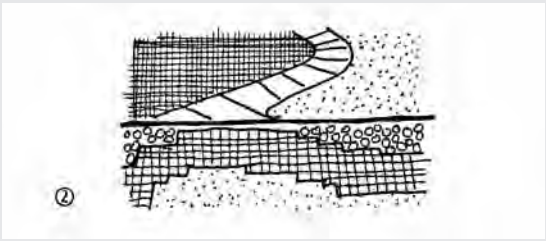
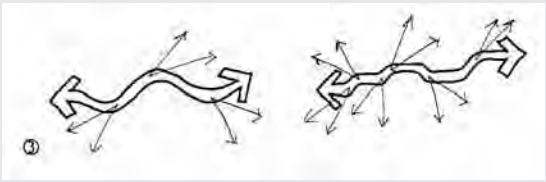
Mixed-mode streets		
Create diversity and interest.	• Pedestrian activity areas should receive special pavement treatment with coordinating materials and patterns to create a specific character for the precinct. [2] • Design simple continuous routes with complex views especially for pedestrian movement (Rapoport 1997, pp 217-8). [3] • Planting and pavement treatment in pedestrian streets should be related to activities and uses in adjacent buildings. • Street landscaping, in particular, should be selected and designed according to a special theme for a given area, providing a sense of place in addition to its other amenities.	 ②  ③
Consider specific conditions of surfaces.	• Functionality of surfaces in terms of kinaesthetic elements such as change of level, curves with implications for speed of movement and tactile elements such as texture under foot, should be taken into account. • Climatic elements such as air movement and extreme temperatures should be considered. Sun exposure should be considered for early morning and late afternoon.	

Table 5.3.10: Horizontal surfaces (continued)		
Pedestrian-orientated streets		
Ensure accessibility and convenience for different user groups.	• Adequate provision should, for example, be made for paraplegics, elders who want to sit down and youths who want to play.	
Create diversity and interest.	• A combination of soft and hard surfaces should be provided, with certain surfaces being dedicated for a main use such as the carrying of vehicles. However, secondary uses should be promoted and designed for.	
Consider specific conditions of surfaces.	• A variety of surfaces (hard and soft) should be provided to increase maximum choice of use. • Surfaces should be as maintenance-free as possible. • Be aware of the influence of climatic conditions on chosen surfaces. Attention should, for example, be given to stormwater runoff and excessive heating.	

Table 5.3.10: Horizontal surfaces (continued)		
Squares		
Ensure accessibility and convenience for different user groups.	• Avoid sunken squares with difficult access, which make people feel uncomfortable. Keep squares level or just slightly below sidewalk grade. • Ensure easy access for paraplegics to all facilities around the square. • Choose surfaces that will most likely accommodate sports activities such as roller-skating.	
Create diversity and interest.	• Movement spaces as well as resting places should form part of the route. The different kinds of spaces should be reflected in the paving pattern. [1]	
Consider specific conditions of surfaces.	• Sunlight and drainage must be evaluated and appropriately addressed as limitations or potential assets in design.	
Markets		
Ensure accessibility and convenience for different user groups.	• Traders with trolleys should be able to get easy access to the market.	
Create diversity and interest.	• Demarcate position of stalls through different paving patterns.	
Consider specific conditions of surfaces.	• Design surfaces for easy cleaning.	

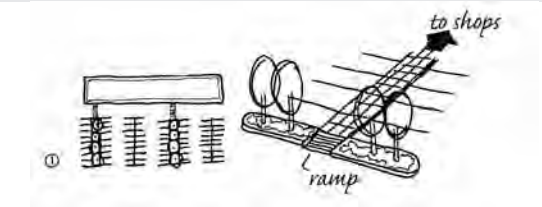
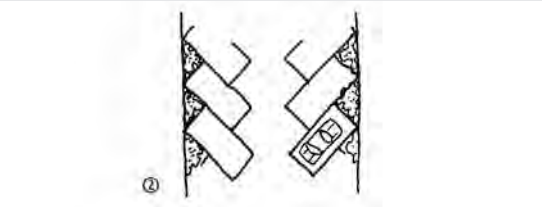
Table 5.3.10: Horizontal surfaces (continued)		
Parking areas		
Ensure accessibility and convenience for different user groups.	• Provide dedicated pedestrian walkways separate from the parking surface, between the building and the parking area. [1]	
Create diversity and interest.	• For 30°, 45° and 60° parking, the triangle in front of each parking bay should be landscaped. [2] • Brick paving, as opposed to concrete blocks or asphalt, should be considered to provide a more interesting surface texture and pattern.	
Consider specific conditions of surfaces.	• Use landscaping and trees to reduce the impact of large areas of asphalt. • Where appropriate, parking surfaces could consist of grass blocks to give a softer, parklike image.	
Public transport stops and stations		
Ensure accessibility and convenience for different user groups.	• Provide for use of stops and stations by wheelchairs and disabled people. • Pedestrian crossings at stops should have clear markings. Take road conditions, traffic intensity and speed into account in the detail design.	
Create diversity and interest.	• The paving pattern should assist in defining the public transport stop as a unique public space.	

Table 5.3.10: Horizontal surfaces (continued)		
Public transport stops and stations (continued)		
Consider specific conditions of surfaces.	• When it rains, surfaces should not gather water or be muddy in order for people not to wait in these conditions and then board public transport.	

Table 5.3.11: Public furniture and signage		
Mixed-mode streets		
Provide functional and aesthetically pleasing public furniture.	• Provide adequate bicycle racks near entries of buildings to prevent vandalism or theft. • Provide adequate seating space. Planters as part of the landscaping can also be designed for this purpose.	
Coordinate signage.	• Street signs and other information signs should be uniform to provide a unique precinct character. • Signs should clearly convey their message but should be located and sized not to block views to and from adjoining buildings. They should also not be excessive in size and number.	

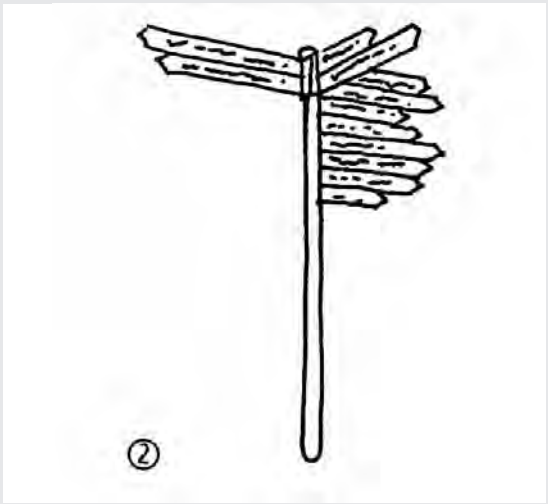
Table 5.3.11: Public furniture and signage (continued)		
Pedestrian-orientated streets		
Provide functional and aesthetically pleasing public furniture.	• Furniture should support the envisaged character of the street. • Furniture could include fountains, litter bins, bus shelters, benches, lighting or basketball rings, depending on the context within which the street is situated.	
Coordinate signage.	• Signage should support the creation of a unified character for the street and convey information to local residents. A notice board could be used for this purpose. [1] • Within a woonerf type of street, signage should mainly convey the message to vehicles that they should drive slowly, due to a number of other users occupying the street for different reasons. • Within an arcade, signage will mainly be geared to pedestrians, indicating where what can be found. [2]	 ①  ②

Table 5.3.11: Public furniture and signage (continued)

Squares

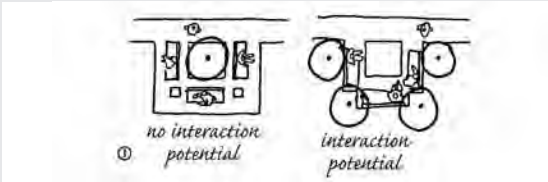
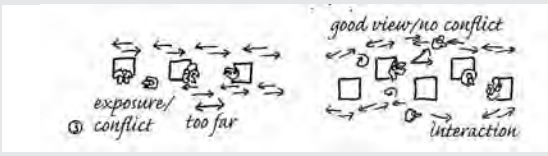
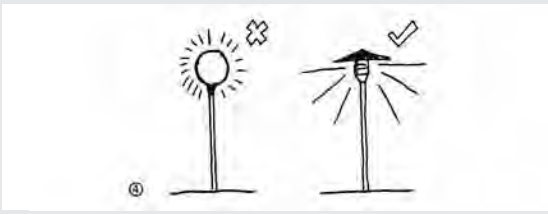
Provide functional and aesthetically pleasing public furniture.	• Some permanent benches should be arranged in order for groups of people to talk to one another.[1] • A choice of seating should be considered, such as movable furniture. Movable chairs make ideal seating because each user can determine the direction he or she wants to face, and move it to gain privacy, sit in or out of the sun or have a better view.[2] • Provide seating in passive areas next to active areas, to encourage people to look towards either side. Design for interaction among people sitting down, and avoid conflict between people walking and sitting.[3] • Appropriate levels of lighting should be used to enhance safety and accent and highlight landscaping. Accent lighting, directed upwards into trees, provides low intensity, but often dramatic illumination of nearby pedestrian areas.[4] • Use sustainable lighting features where light energy is not dispersed into the air. • Regular intervals of lights should be maintained and incorporated into streetscape improvements.	   

Table 5.3.11: Public furniture and signage (continued)		
Squares (continued)		
Provide functional and aesthetically pleasing public furniture (continued).	• Light poles and fixtures should fit into and preserve the historical character of the streetscape.	
Coordinate signage.	• Provide information through signage that is colourful, interesting and theme-based.	
Markets		
Provide functional and aesthetically pleasing public furniture.	• Market facilities and services should be spread evenly in clusters over the market area, to be accessible for all. • Secondary spaces should provide the settings for the location of these clusters of communal services. • Communal services to be provided are standpipes, solid waste bins, public telephones, public toilets, and metered electricity dispensers. These should be integrated. • Electricity will be needed for lighting or manufactured appliances. Water will be needed to clean the market area, also where animals are slaughtered. Water is also needed for laundry or vegetable areas, washing basins, cooking, and general hygiene.	

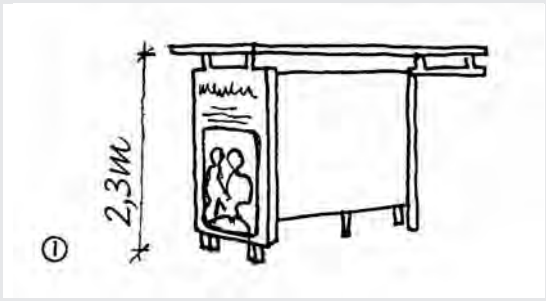
Table 5.3.11: Public furniture and signage (continued)		
Markets (continued)		
Provide functional and aesthetically pleasing public furniture (continued).	• Any extensive public investment in market infrastructure should respond to market development, rather than precede it (Behrens and Watson 1996, p 217).	
Parking areas		
Provide functional and aesthetically pleasing public furniture.	• Where parking areas abut the sidewalk, a landscaped setback should be provided, with adequate furniture such as benches.	
Coordinate signage.	• Signage to parking areas should be coordinated with signage of the building or the street, depending on its direct relationship.	
Public transport stops and stations		
Provide functional and aesthetically pleasing public furniture.	• Provide adequate shelters against rain, sun and wind, if possible. [1] • Provide places for waiting where change in transportation modes take place and at intersections. • Provide space for resting, eating or drinking while waiting for transportation. • Provide benches at bus stops or shelters. Comfortable design and location of street furniture should adhere to the needs of potential users.	

Table 5.3.11: Public furniture and signage (continued)		
Public transport stops and stations (continued)		
Provide functional and aesthetically pleasing public furniture (continued).	• Provide adequate lighting to improve safety. • Provide enough and appropriate litter bins.	
Integrate and coordinate signage.	• Integrate signage with shelters at public transport stops. [2]	

Specific quantitative guidelines

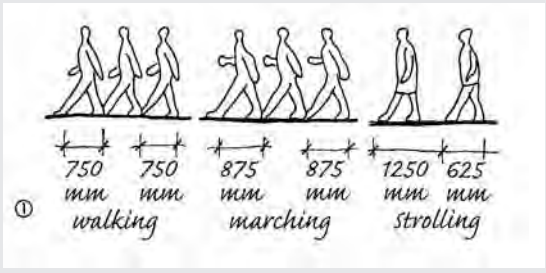
Table 5.3.12: Ratios and thresholds		
Mixed-mode streets		
On-street parking.	• In areas of high car ownership, two visitors' parking spaces should be provided onsite, in addition to on-street parking. • In areas of low car ownership, on-street parking may be sufficient.	
Pedestrian movement.	• 4,5 m per person allows a clear view of the ground ahead, for comfortable adjustment to meet changing conditions. This serves a capacity of 1 000 pedestrians per hour (Untermann 1984, p 54). However, different contexts would allow for different walking spaces. [1] • Stairs reduce walking speed to about one third the speed of level conditions and constrict traffic flows.	

Table 5.3.12: Ratios and thresholds (continued)

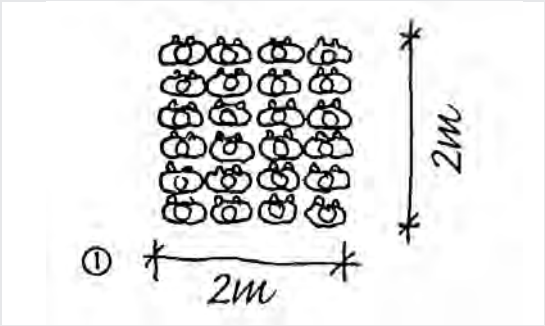
Squares		
Walking space.	• Walking on sidewalks and squares differ. On squares, the crucial spatial dimension is square metres; the more space available to adjust one's route, the faster a pedestrian can walk. Less than 1 m^2 per person can force a pedestrian to stop and less than 0,5 m^2 is totally unacceptable. The greatest density possible per m^2 is 6 people. [1]	
Markets		
Market size.	• Markets that are designed to be small, with no capacity to expand, very often fail as they are too small to attract customers. Markets should accommodate at least 70 operators to be economically viable (Behrens and Watson 1996, p 217).	
Parking areas		
Parking ratio per land use.	• Dwelling unit of 1 habitable room: 1,0 space/unit. • Dwelling unit of 2 habitable rooms: 1,0 space per unit. • Dwelling unit of 3 habitable rooms: 1,25 spaces per unit. • Dwelling unit of 4 habitable rooms: 1,5 spaces per unit. • Visitors: 0,5 space per unit. • Hotels and motels: 1 space per habitable room + 10 spaces per 100 m^2.	

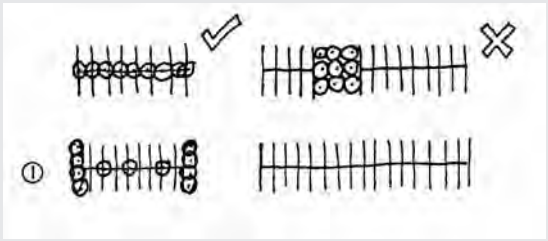
Table 5.3.12: Ratios and thresholds (continued)		
Parking areas (continued)		
Parking ratio per land use (continued).	• Residential hotels, boarding houses, etc: 0,6 spaces per habitable room. • Old-age homes, orphanages, etc: 0,3 spaces per habitable room.	
Landscaping.	• Minimise the impact of parking areas on the living environment through the provision of at least 1 shade tree per 3 parking bays. [1] • 10% of the parking area should be landscaped.	

Table 5.3.13: Dimensions and distances		
Mixed-mode streets		
Travelling distances.	• Design short and narrow residential blocks of ± 100 m x 30 m to ensure permeability and easy pedestrian access. • Shoppers carrying packages or tending to children are more aware of time and distance than people who linger. Keep walking distance and maximum length of a walkway up to a maximum of 140 m. • 20% - 25% of personal trips are under 1,6 km in length. 20% are 1,6 to 3,2 km, with only 12% - 15% being 3,2 to 4,8 km. Thus, almost one half of all urban trips are less than four kilometres long. This has implications for the intensity of information to be provided.	

Table 5.3.13: Dimensions and distances		
Mixed-mode streets (continued)		
Travelling distances.	• Human scale is lost with a linkage longer than 1 500 m (maximum distance to establish vista).	
Ramps and stairs.	• Clear space of ramps should not be narrower than 1,2 m, allowing a person in a wheelchair to pass another person. Ramps should have continuous handrails and should form an integral part of the design of the building, not merely be an add-on.[1] • Ramps can have a slope of between 5% (1:20) and 8% (1:12). • For continuous walkways, cross-slopes of 1:12 should be avoided, with a preferred slope of 1:16. • Stairs should be avoided where large volumes of foot traffic must be accommodated. On stairs, a railing should be provided on at least one side with a height of at least 450 mm (Untermann 1984, pp 29, 41).	

Table 5.3.13: Dimensions and distances (continued)

Mixed-mode streets (continued)

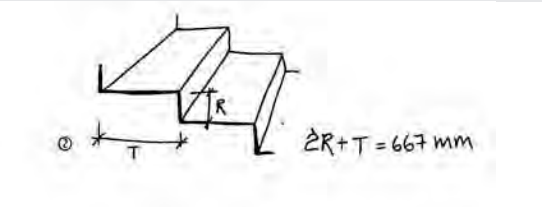
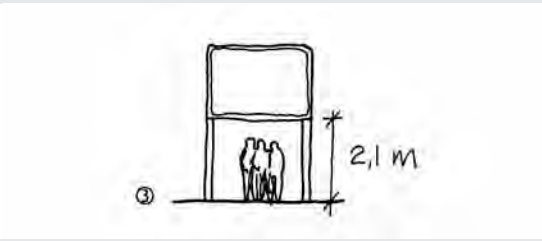
Ramps and stairs (continued).	• On stairways, the rise in height should not exceed 165 mm. 1,1 m is recommended as a minimum stairway width to allow passing in the opposite direction. The ideal proportions for outside steps are determined by the indicated formula. [2] For long slopes, a level rest-platform should be installed at a maximum distance of every 20 treads. This platform should be long enough for a person to walk three paces, which is approximately 1,8 m.	
Sidewalk widths.	• With walking on sidewalks, the width is a crucial dimension, since passing is possible only when there is enough width to pass easily (Untermann 1984, pp 25-28). Recommended width for sidewalks in mixed use development is 3,5 m to 4,5 m, clear of any street furniture (Cartwright 1980, p 42).	
Public furniture and landscaping.	• The minimum height for signs over pavements should be no less than 2,1 m (Cartwright 1980, p 99).[3] • Planters, kerbs, rails and other raised surfaces can be used for seating. Any height up to 600 mm will work, with 400 mm being the best. A width of at least 160 mm is appropriate.	

Table 5.3.13: Dimensions and distances (continued)

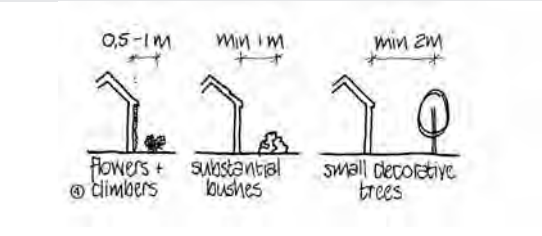
Mixed-mode streets (continued)		
Public furniture and landscaping (continued).	• Appropriate distances of plants to be placed from the facade of buildings are the following: - Flowers and climbers: 0,5 m to 1 m away; - Substantial bushes: minimum 1 m away; and - Small decorative trees: minimum 2 m away. • The bigger the ground surface of the plants, the wider the sidewalk should be to ensure safety and ease of movement for pedestrians. [4]	
Pedestrian-orientated streets		
Widths and slopes.	• The maximum gradient of bicycle tracks should be 5% (1:20), with a maximum cross-fall of 2,5% (1:40). • The maximum gradient of footpaths should be 1:12 and the minimum gradient should be 1:200 (for stormwater), with a minimum cross-fall of 1:30 (3,3%). • The minimum width of dedicated pedestrian walkways in these streets is 0,8 m. • When planting slopes with grass, bear in mind that maximum slopes for mowing machines should not exceed 1:1.5, while for tractors they should not exceed 1:3 (Cartright 1980, p 13).	

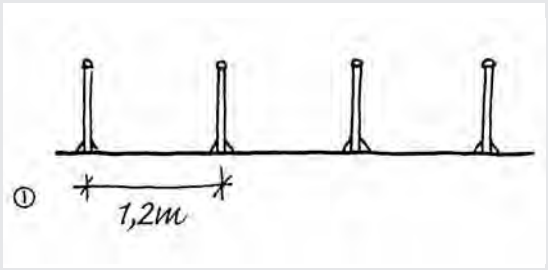
Table 5.3.13: Dimensions and distances (continued)		
Pedestrian-orientated streets		
Widths and slopes (continued).	• The minimum width of a one-way bicycle track is 2,75 m and for a two-way track it is 3,6 m (Cartwright 1980, p 43). • The maximum width for a dedicated pedestrian walkway is 12 m.	
Distances.	• To maintain coherence and safety, the maximum length of a pedestrian-orientated street should be 140 m, which is the maximum distance for discerning action.	
Public furniture.	• Bollards should not be higher than 800 mm to avoid interference with motorists' sight lines (Cartwright 1980, p 67). • A distance of 1,20 m between bollards will bar any car from access (Cartwright 1980, p 67). [1]	

Table 5.3.13: Dimensions and distances (continued)

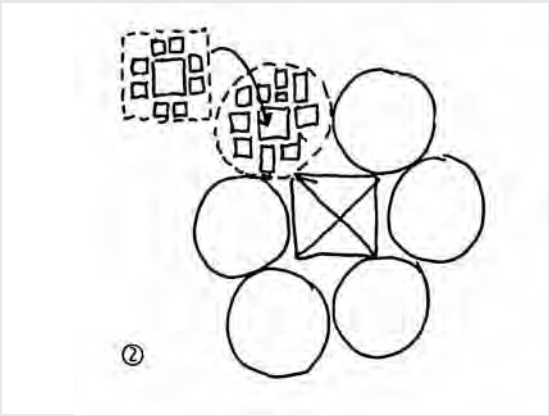
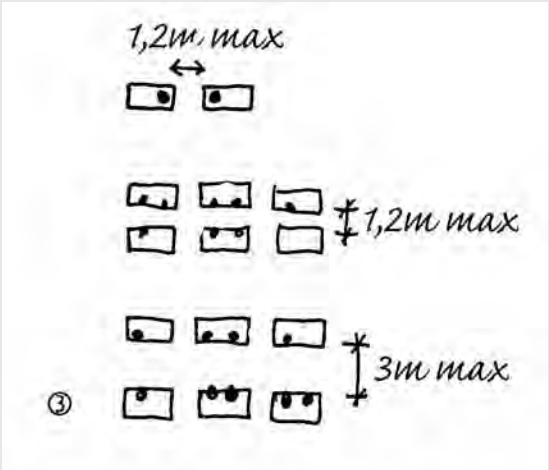
Squares		
Scale and proportions.	• Hard open space with a certain sense of enclosure: below the threshold of 18˚ the space loses its sense of enclosure as one can see beyond its edges (Moughtin 1992, p 99). • Limit plaza size to create small, human-scaled spaces. A maximum size of 235 m^2 is appropriate with several small plazas better than one large one. • To maintain a sense of enclosure, the angle between two buildings, attached or detached, should not exceed 135°. [1] • Scale of squares (Moughtin 1992, p 42): Large plazas: 21-24 m Town or village square: 57 m x 143 m City quarter: 800 m radius. [2]	 
Landscaping and furniture.	• Provide one linear metre of seating for every m^2 of square area (Paumier 1990, p 33). • To enable communication, benches should be a maximum of 1,2 m apart. The minimum distance for normal conversation is 0,6 m. To ensure that no interaction takes place, benches should be a minimum of 3 m apart (Bentley 1987, p 74). [3]	

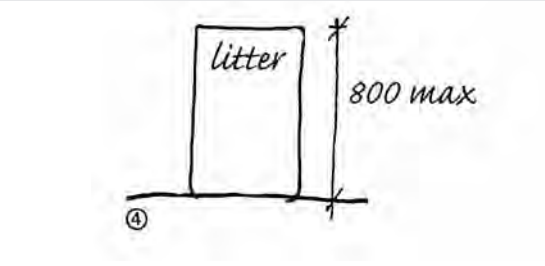
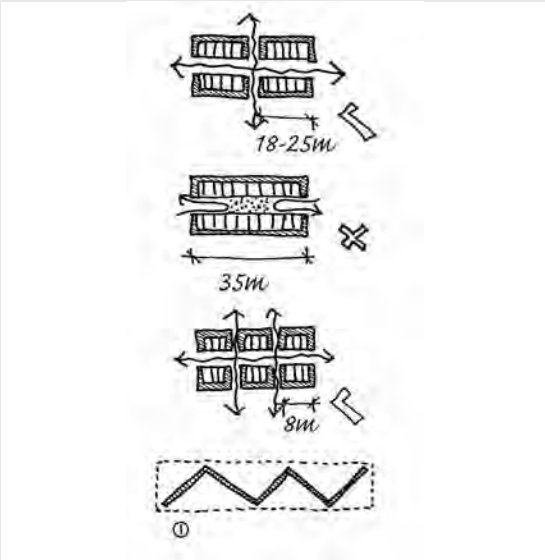
Table 5.3.13: Dimensions and distances (continued)		
Squares (continued)		
Landscaping and furniture (continued).	• Bollards with the dimensions of 500 mm (height) and a minimum of 300 mm (width) can also double as seating (Cartwright 1980, p 67). • Design litter bins preferably not higher that 800 mm. Should they be any higher, there would be seating constraints on the bins and children would have difficulty in dumping their rubbish (Cartwright 1980, p 111). [4] • Plan for at least 20% of the square to be landscaped.	
Markets		
Travelling distance.	• Distances from public transport facilities, home and work influence the positioning of markets and economic thresholds. - Driving threshold of 5-minute drive @ 60 km/h: market can be located 3,2 km away (Untermann 1984). - Walking threshold of 5 minute walk @ 6,4 km/h: market can be located at 0,5 km away (Untermann 1984).	

Table 5.3.13: Dimensions and distances (continued)

Markets (continued)		
Market layout.	• Dead spaces and stall facades longer than 35 m, should be avoided. Shorter blocks between 18 and 25 m are more appropriate (Behrens and Watson 1996, p 215), with 8 m being the optimum length for functionality and permeability. A zig-zag layout can effectively facilitate movement on both sides. [1]	
Public transport stops and stations		
Walking distances.	• In some cases people cannot walk long distances. Pedestrians carrying packages or tending to children are more aware of time and distance and may be willing to walk an absolute maximum of 300 m (Untermann 1984). • Increase the number of formal public transport stops, as this may decrease the appearance of ad hoc stops, especially by minibus taxis. Shorten the walk length to a maximum of 150 m in high density and mixed-use areas. In lower densities, stops can be located further (up to 400 m apart).	

Management guidelines to promote multifunctional use of hard open spaces

Critical issues are currently facing many cities alike. If we want to secure the liveability and vitality of urban settlements, the preservation of public spaces and the transformation of hard open spaces to serve new purposes and accommodate multifunctional uses, is crucial. However, these spaces have to be effectively managed in order not to become neglected and consequently vulnerable to the many pressures of contemporary urban development.

Despite limited local authority powers and resources, local authorities have to practise sound judgement and good management in terms of monitoring the success of hard open spaces and responding to consumer needs. A positive and integrated approach to planning, designing and managing space is essential. It is essential to prioritise key issues and concentrate efforts where they will produce tangible results.

Through involvement and commitment, communities, the private sector (developers, banks, investors) and local governments can and have to play an active role in initiatives to protect and manage hard open spaces.

URBED (1994, p 151) proposes the following to be included in local authorities' planning processes with regard to open spaces:

- Form multidisciplinary management groups for all open spaces, integrating all relevant departments (planning, economic development, engineering, parks and recreation, cultural services).
- Periodically review the situation in a representative forum.
- Do profile and performance analysis on usage, pedestrian flows, attractions, access, and the amenities within hard open spaces.
- Promote research and study tours on the city's public spaces.
- Publish promotional material and encourage tourism and multifunctional usage.

There is thus a very important strategic planning component involved in giving care and attention to hard open spaces. This should be coupled with a strong marketing campaign to attract investment.

Apart from planning and design, the following managerial aspects should be considered:

- Who is responsible for factors that affect the function and appearance of hard open spaces?
- Who is responsible for activity and time management?
- Who is responsible for funding (maintenance, management)?

It should be borne in mind that the use of hard open space could change over time due to changes in user groups and land uses. Multifunctional use can thus more easily be accommodated and managed within a space with a sense of permanence (well defined within urban structure) and robustness (compatible buildings). Spaces should be able to accommodate changing use over time, diverse activities and temporary diversity with a change in intensity.

In addressing the crucial issues of effective management, it is believed that hard open spaces can play a vital role in ensuring vibrant and sustainable urban settlements.

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Chapter 5.4

Soft open spaces

5.4

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INTRODUCTION

Soft open spaces are open, or unbuilt, spaces within a settlement, with a predominantly vegetated or porous surface. Access into soft open spaces ranges from their being totally unrestricted, to temporarily or user-restricted, to entirely private. This sub-chapter is concerned with local and sub-metropolitan public and semi-public soft open space, and to a lesser extent with larger private soft open spaces that are functionally and aesthetically related to public soft open space.

THE ROLE OF SOFT OPEN SPACES

The role of soft open space in settlement systems is essentially to (a) enable ecological processes to continue to occur sustainably and safely within environments significantly altered by human action, and (b) accommodate a variety of socio-economic community needs, and to a lesser extent to provide barriers that contain and manage settlement growth. These roles are not necessarily exclusive to particular spaces as, ideally, outdoor spaces should perform as many roles as possible.

Soft open space needs of settlement ecosystems

The elements that are common to all ecosystems include flows of energy and the cycling of materials, self-regulatory mechanisms with positive and negative feedbacks, and linked subsystems. These flows, feedbacks and linkages within, and between settlements and their surrounding biophysical environment can be conceptualised as a settlement metabolism, made up of a variety of "extractive" and "absorptive" demands.

"Extractive" demands are inputs of renewable and non-renewable resources, extracted from the biophysical environment. They can take the form of, inter alia, daily inputs of clean water, air, food, fibre, and energy which are required to satisfy the settlement metabolism. Once resources are extracted, they are either consumed, stored or transformed into exportable products or wastes.

"Absorptive" demands take the form of the breakdown, processing and recycling of solid, liquid and gaseous wastes and heat that inevitably arise as the by-products of urban metabolic processes, which are absorbed by the biophysical environment. They can take the form of, inter alia, daily outputs of sewage, garbage and smoke. The release of these outputs often requires the installation of a system of utility services, particularly to deal with liquid and solid waste. Since these waste products cannot generally be exported to other regions, they usually have to be absorbed and recycled within the immediate biophysical environment.

Soft open spaces play a key role in enabling these "extractive" and "absorptive" processes to function sustainably within settlements. In terms of extraction, they facilitate the renewal of resources through the recycling of biodegradable wastes, and the production of food, fibre and fuel. In terms of absorption, they facilitate the purification of wastes through the cleansing and regulating of water, and the filtering of air. In order for these ecological processes to function within settlements, soft open spaces should be (a) appropriately located, (b) sufficiently large, (c) sufficiently interconnected, and (d) appropriately vegetated.

- In terms of location, soft open spaces should incorporate particularly sensitive natural environments, like wetlands, rivers, coastlines and remnant patches of indigenous flora, which are necessary to maintain the diversity of indigenous flora and fauna habitats within a settlement.

- In terms of quantity, soft open spaces should be sufficiently large, to maintain the seed banks and breeding stocks necessary to preserve the flora and fauna, and to enable the biophysical environment to renew resources and absorb and recycle liquid and solid waste. In other words, a balance needs to exist between the natural and built environment so as not to overload the system and exceed the capacity of the soft open space system to perform its life-enhancing and regenerative role.

- In terms of connection, soft open spaces should be sufficiently interconnected to enable local fauna to move and breed. Settlement formation fragments previously intact natural habitats, and can lead to the isolation of indigenous species within a settlement.

- In terms of vegetation, the surfacing of soft open spaces should be suited to its ecological location. The choice of vegetation within a soft open space determines the variety of habitats for animal life, and hence the diversity of flora and fauna.

Soft open space needs of identifiable user groups

In planning soft open spaces that can perform their other role of accommodating a variety of human needs, an understanding of the range of current and anticipated end-user needs within and surrounding a site is necessary. In order to achieve this understanding it is useful to consider needs in terms of individual user groups. It is important to note, however, that no one soft open space has, or should have, one identifiable user group - a central argument to be made is that better soft open spaces accommodate the greatest possible number of user groups and needs.

Empirical studies of the needs of different user groups clearly illustrate that need is both diverse and dynamic. User needs typically vary considerably according to such factors as age, gender, culture, income and levels of mobility and, consequently, the needs of an individual, as well as the composite needs of a particular geographical community, change over time. There are nevertheless many needs that are common to all users:

- All users require a degree of comfort from the natural elements, and the choice of a shady or a sunny place to rest.

- All users need to feel safe. Feelings of safety and security relate both to protection from fast-moving vehicular traffic, and to the avoidance of hidden places of refuge where potential muggers or rapists may lurk.

- All users require opportunities for active engagement with other people and with spaces. In other words, people need accessible and well-known public places in which to wait for, and make arrangements to meet, their friends, as well as spaces in which games and sports can be played.

- All users require opportunities for passive engagement with other people. In other words, people need accessible and well-known public places where they do not have to be alone, where they know something will always be happening, and where they can engage in "people watching" and maybe even establish social encounters.

- All users also require opportunities to escape from intense concentrations of people and activity.

A problem with the literature available on soft open space is the limited availability of empirical studies specific to South Africa. The available literature deals typically with different age, gender and income groups - there is comparatively little empirical work that discusses how needs vary across cultural and socio-economic groups. Table 5.4.1 summarises the needs of user groups as dealt with in the literature.

Table 5.4.1: The soft open space needs of identifiable user groups

2-5 YEAR-OLD CHILDREN	
Psychological needs	**Physical needs**
• To feel secure - young children often have difficulty tolerating visual separation from their parents or minders. Visual separation is in fact often the main source of anxiety. • To play - young children tend to play inventive, or imitation, games by themselves, and usually focus their attention on a fairly small play space. • Visual, aural and tactile stimuli, to explore and experience new sensations.	• Play spaces located close to benches or embankments that survey the space. • Stimulating (but safe, in terms of height and water risks) play objects that can expand their growing sense of spatial relations, and around which they can invent games. Spaces and objects should be scaled to their size and strength. • Soft play surfaces to prevent injury. • Protection from fast-moving vehicular traffic.

Table 5.4.1: The soft open space needs of identifiable user groups (continued)

Appropriate soft open spaces	Frequency and access needs
The psychological and physical open space needs of 2-5 year olds can be met in relatively small play spaces (± 60 m^2). Children can play virtually anywhere and everywhere. Appropriate play spaces can therefore take the form of parts of other open spaces like widened footways on roads experiencing light traffic volumes, or squares. The implication of this is that child play should be a consideration in the planning and design of all public open spaces.	2-5 year olds tend to play on a daily basis. Attempts should therefore be made to locate public open spaces that address the needs of pre-school children, within ± 500 m of spatial concentrations of these users (e.g. créches).
6-12 YEAR-OLD CHILDREN	
Psychological needs	**Physical needs**
• To play: 6-12 year olds tend to play in groups, and therefore focus their attention on a larger play space. • A sense of adventure (i.e. unpredictability in the way certain spaces are designed, e.g. hedge mazes): 6-12 year olds need to be able to discover, and be stimulated by, new spaces and objects, and be inventive in developing games. A sense of adventure is especially important for younger children, as physical and creative play develops motor skills and innovation, which are necessary for physical as well as intellectual development. • To be challenged by the space (e.g. crossing rivers on stepping stones or logs, without falling in and getting wet).	• Challenging play objects, and discovery spaces - there is less pretence in the play of 6-12 year olds than in younger age groups. More objects and play equipment are therefore required, and play spaces (sometimes needing game markings) need to be larger to accommodate contact games (150 -1 000 m^2) and ball games (300 -1 500 m^2). Spaces and objects should be scaled to their size and strength. • Soft play surfaces to prevent injury when falling or wrestling. • Protection from fast-moving vehicular traffic.
Appropriate soft open spaces	**Frequency and access needs**
The psychological and physical open space needs of 6-12 year olds can be met in relatively larger play spaces, which enable a clear flow of movement and enable "big play" activity (150 - 1 500 m^2). The most obvious examples of such spaces would be "adventure" playgrounds, parks or linear parkways with streams, and playspaces in schools. Like 2-5 year olds, they can, however, play virtually anywhere.	Children aged 6-12 years tend to play on a daily or weekly basis. Attempts should therefore be made to locate public open spaces that address the needs of 6-12 year olds within ± 500 m of spatial concentrations of these users (e.g. primary schools or homes).

Table 5.4.1: The soft open space needs of identifiable user groups (continued)

13-19 YEAR OLD TEENAGERS AND YOUNG ADULTS	
Psychological needs	**Physical needs**
• Passive engagement with people - older children and young adults are also more likely to go to public places on their own to seek chance encounters with other children or young adults (i.e. to "hang out"). • Active engagement with people - as children grow older their need for space, expansive team games, and sports practice, increases. • To be challenged by the space.	• Play surfaces, sometimes with game markings (300 - 1 500 m^2). With older children, play equipment increasingly becomes less important than uninterrupted play space. • Visible and busy places in which to socialise, which are comfortable to sit in and talk. • Challenging and stimulating spaces and objects.
Appropriate soft open spaces	**Frequency and access needs**
The psychological and physical open-space needs of older children and young adults can be met in a diverse range of soft open spaces. Parks, linear parkways and sportsfields can meet more active engagement needs, while pocket parks in more central locations can meet more passive engagement needs.	Older children and young adults tend to meet and play on a daily or weekly basis. Attempts should therefore be made to locate public open spaces that address the needs of older children and young adults, within ± 500 m of spatial concentrations of these users (e.g. secondary schools, homes). Specialised or less frequently used spaces (e.g. sportsfields used for relatively less frequent competitive sports events) can often be located further away, and accessed by bicycle or public transport.
ELDERLY PEOPLE	
Psychological needs	**Physical needs**
• Passive engagement with other people - retired people tend to use public spaces in a frequent, routine manner, mainly in the morning and early afternoon, when there is sunshine and least competition for seating with teenagers and children. • To be visually stimulated by aesthetically pleasing environments.	• Seating around the perimeters and near the entrances of spaces, as it is here that there is often a greater feeling of safety provided by passers-by, and friends are more likely to be spotted. Maximum comfortable walking distances also tend to be shorter for elderly people than for younger user groups, so seating close to entrances is more convenient. • Seating in sheltered areas that offers choice between shade and sun, and protection from the wind. • Stimulating public art, and game markings (e.g. chess, shuffleboards). • Flat or gently sloping pathways.

Table 5.4.1: The soft open space needs of identifiable user groups (continued)

ELDERLY PEOPLE (continued)

Appropriate soft open spaces	Frequency and access needs
The psychological and physical open space needs of elderly people can be met in all public open spaces, but to a lesser extent in active recreation spaces like sportsfields.	Elderly people tend to use open spaces on a daily and weekly basis, and tend to tire more rapidly from walking than younger groups. Attempts should therefore be made to locate public open spaces that address the needs of elderly people within ± 400 m of spatial concentrations of these users (e.g. old-age homes, or neighbourhoods accommodating many elderly people).

WOMEN

Psychological needs	Physical needs
• To feel safe - the specific needs of women in public open spaces focus primarily on the issue of crime and safety. Very often, as a result of the incidence of sexual assault and harassment, women are afraid or reluctant to use public open space on their own. Women need to feel a sense of control in public spaces, in terms of being able to orientate themselves easily and leave the space quickly, and see who else is in the space.	• Spaces that do not contain hidden refuges or corners, and have dimensions that enable women to identify potential dangers easily. • Spaces with numerous possible exit points, which are overlooked by surrounding activities. • Comfortable places, close to play spaces, in which to sit and mind small children in the case of child-minding parents. • Hardened pathways for pushing prams, in the case of child-rearing parents.

WHEELCHAIR USERS

Physical needs (detailed guidelines are provided in SABS Code of Practice 0246:1993)

- Hardened (but not slippery) pathways along the thoroughfares of spaces, as well as to more secluded spaces.
- Flat or gently sloping pathways that do not exceed a gradient of 1:12, and have a cross-sectional camber (or banking) that does not exceed 1:60.
- Pathways that are sufficiently wide to accommodate wheelchairs. As wheelchairs are typically 70 cm wide, the minimum width should be in the region of 90 cm.

VAGRANTS

Physical needs

- Seating, and soft surfaces on which to lie, as open spaces are inevitably used by vagrants as a place to live during the day. In addition, public open spaces are sometimes used as places to sleep during the night, when night shelters are either unused or unavailable. The permanent presence of large numbers of vagrants, however, often discourages other user groups from using the space, and compromises often need to be sought.
- Protection from the sun, wind and rain.
- Water points and, where applicable, ablution points.

Table 5.4.1: The soft open space needs of identifiable user groups (continued)	
WORKERS	
Psychological needs	**Physical needs**
• Relief from intense commercial, business and industrial activity. Workers mainly use public open spaces for active and passive engagement during tea and lunch breaks, as a stimulating and pleasing place to meet, relax and eat.	• Spaces that are easily accessible from places of work. • Sheltered spaces that provide a choice between shade and sun, wind protection, seating and soft surfaces to lie on. • Stimulating public art.
Frequency and access needs	
• Workers take lunch breaks on a daily basis. Attempts should therefore be made to locate public open spaces, that address the needs of workers, within ± 300 m of spatial concentrations of these users (e.g. office blocks, industrial parks).	

The roles relating to ecological and human need have the following implications for the way soft open spaces within settlement systems should be planned and designed (Figure 5.4.1):

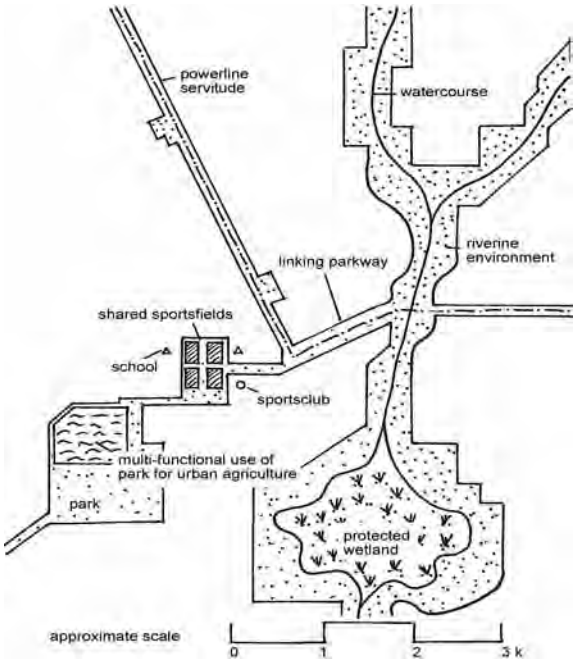


Figure 5.4.1: Spacial diagram illustrating multi-functionality and flexibility, protection and linkage

- Soft open spaces should perform a variety of human and ecological functions, and the configuration of these spaces should be able to accommodate changing functions over time. The soft open space system therefore needs to accommodate a diversity of open space forms, that can be shared by a diversity of user groups. Multi-functionality has two dimensions - a single soft open space should be able to perform different functions, and a space performing a particular function should serve a variety of different users.

- In order for vital ecological processes - like drainage, groundwater recharge, or air and water purification - to continue functioning within human settlements, and for flora and fauna species diversity to be maintained, key natural areas need to be protected from development, and incorporated into a settlement's soft open space system. Understanding the qualities of the natural environment in each place, integrating it in the design of settlements, and respecting the functioning of its dynamic systems, are all critical in making human settlements both sustainable and unique.

- Larger soft open spaces and remnants of natural landscapes need to be linked by corridors of soft open space. These linkages facilitate a range of continuous recreational opportunities, and act as conduits for indigenous species, potentially facilitating the movement of pollinators and the dispersal of seed from one space to another. This movement of pollinators and seed enables natural systems to be protected far more effectively than in the case of unconnected natural remnants.

Despite the need for multifunctionality, the diversity of ecological and human needs discussed above necessitates that not all spaces are the same. Networks of soft open space can be made up of the following typical forms: pristine areas, parkways, parks, sportsfields, servitudes, and urban agriculture. The following two sections provide, respectively, guidance on the planning and design of networks of soft open space, and guidance on the planning and design of individual forms of soft open space.

GUIDELINES FOR THE PLANNING AND DESIGN OF NETWORKS OF SOFT OPEN SPACE

Important considerations in the planning and design of networks of soft open space are: (a) location, (b) quantity (i.e. how much space there should be relative to other land uses), (c) connection (i.e. how individual spaces should connect with each other), and (d) vegetation (i.e. the nature of surfaces, and the balance between "pristine" and "artificial" landscapes).

Table 5.4.2: Guidelines for the planning and design of networks of soft open space

LOCATION	
Sustaining ecological processes	**Accommodating user needs**
The location of networks should incorporate remnant patches of representative indigenous flora, and sensitive natural areas like wetlands, slopes, rivers and coastlines that are critical to the continued operation of natural systems.	Empirical studies indicate that the needs of frequent space users can be accommodated in most forms of space. The question of how far users should have to walk or travel in order to gain access to soft open space amenities therefore relates more to access to a network of space, than access to individual generic space forms. A distance of 500 m is recommended as the maximum a person should have to walk to gain access to the network. When determining the pedestrian catchment area of a public soft open space network in accordance with a maximum 500 m walking distance, it is important to avoid simply measuring off the relevant walking distance on a compass and drawing a perfect circle around the space. Barriers like water courses, railways lines and limited access freeways often inhibit pedestrian movement, making a circle around the space an unrealistic reflection of the potential pedestrian catchment area.
QUANTITY	
Sustaining ecological processes	**Accommodating user needs**
Networks of pristine or natural open space should be sufficiently large, to maintain the seed banks necessary to preserve the flora and the breeding stocks necessary to preserve fauna species, and to enable the biophysical environment to renew resources and absorb and recycle liquid and solid wastes. This is a contextual issue, depending on the nature of the resources or wastes in question, and the diversity of habitats for indigenous flora and fauna.	Networks should be sufficiently large to accommodate the amount and frequency of need, yet sufficiently small to avoid reducing gross residential densities to levels that do not provide the necessary thresholds of support. Quantity relates more to the total amount of space within a settlement and the access that users have to this space than to the size and dimensions of individual forms of space. Appropriate quantities of space are a contextual issue, with geographical location and residential density being important considerations. Decisions relating to quantity cannot therefore be made purely on the basis of formulas or on cumulative totals resulting from the mechanistic application of standards for individual space types. International comparisons indicate that open space should typically account for between 10% and 17% of land in a development - depending on factors such as population density and proximity to natural open space.

Table 5.4.2: Guidelines for the planning and design of networks of soft open space (continued)

QUANTITY (continued)	
Sustaining ecological processes	**Accommodating user needs (continued)**
	An important way of reducing the land required to accommodate user and ecological soft open space needs, is the sharing of amenities by different users, and the multifunctional use of the space. South African society can no longer afford the luxury, within an urbanising area, of having certain spaces set aside for single open space use. Wherever possible, different but compatible uses should be accommodated on the same open space. In essence, a shift in concern from quantity to quality is required.
CONNECTION	
Sustaining ecological processes	**Accommodating user needs**
Networks of soft open space should be sufficiently interconnected to enable the movement of pollinators and the dispersal of seed from habitat to habitat. These connections are necessary at a range of scales. At the larger scale they connect natural features such as mountains, coastlines and rivers. At the smaller scale they connect remnant patches of indigenous habitats.	Networks of soft open space should be connected to create continuous recreational walking, jogging, and cycling opportunities, not possible in spatially isolated spaces.
VEGETATION	
Sustaining ecological processes	**Accommodating user needs**
The vegetation covering those portions of a network of soft open space that primarily accommodate ecological need should obviously be as pristine or natural as possible, and when these portions of the network have been significantly degraded, they need to be rehabilitated. The advantages of locally indigenous vegetation relate primarily to maintenance costs, pollution avoidance, the enhancement of uniqueness in settlement formation, and biodiversity. Indigenous vegetation typically requires less irrigation and fertiliser than exotic species.	The vegetation covering of those portions of a network that primarily accommodate human need essentially need to incorporate areas of shade and wind protection, soft durable surfaces for playing games, and hardened durable pathways for frequent pedestrian, bicycle and wheelchair movements. When possible, local indigenous plant species that have these characteristics should be used in landscaping. In situations where indigenous plant species are not suited to the requirements and functions of the open space, exotic species that are suited to the climate of the region, and which do not present an invasive danger to pristine environments, should be used. Whenever possible, established trees should be incorporated into landscape designs.

GUIDELINES FOR THE PLANNING AND DESIGN OF GENERIC FORMS OF SOFT OPEN SPACE

Important considerations in the planning and design of generic forms of soft open space are:

- location - where different forms of soft open space should be located within human settlements;
- access - the maximum distance users should have to travel in order to use different forms of soft open space;
- size and dimensions - the area, width and length of different forms of soft open space;
- use capacities and thresholds - the number and frequency of users a space can accommodate before the space begins to degrade, and the number and frequency of users that are required for efficient utilisation;
- edges - the boundaries and definition of different forms of soft open space;
- surfaces - the appropriate horizontal covering of different forms of soft open space; and
- public furniture - the physical objects in different forms of soft open space.

Table 5.4.3: Guidelines for the planning and design of generic forms of soft open space

	LOCATION
Parkways	• Parkways can be located along water courses, adjacent to floodplains determined by the 1:50 year floodline, in order to act as part of the major stormwater management system. • Parkways can be located as links between larger spaces, and can incorporate buffer areas around incompatible or unsafe land uses.
Parks	• Larger parks should be located in areas with no or limited access to natural amenities (in the form of mountains or coastlines). They should be fairly evenly distributed throughout a settlement, and where possible, connected by parkways. • Larger parks can be juxtaposed to, and incorporate, urban agriculture, fuelwood planting, solid waste disposal and nature conservation sites, in order to enhance multifunctionality and visual interest. • Smaller parks can be located within easy walking distance (i.e. ± 300 m) of workers situated within busy commercial and industrial centres in order to create contrasting spaces of relief within predominantly residential areas, so as to create easily surveilled child-play spaces, and within school clusters, which create safe, shared playtime spaces.
Sportsfields	• Larger competitive sportsfields should be located within clusters of schools and close to private sports clubs, in order to facilitate the sharing of amenities between different user groups and to avoid under-utilisation. Schools can have allocated times of use during the day, while sports clubs can use the amenities mainly during the evening. • Competitive sportsfields should be located close to public transport services, in order to facilitate the access of visiting teams. • Sportsfields can be located on low-lying land adjacent to water courses and incorporated into parkways, in order to act as part of the major stormwater management system in the event of severe storms.

Table 5.4.3: Guidelines for the planning and design of generic forms of soft open space (continued)

LOCATION (continued)	
Playspaces	• Wherever possible, playspaces should be incorporated with other public open spaces (for reasons of multifunctionality). • Playspaces can be located within clusters of primary schools and close to pre-school and day-care facilities, in order to facilitate the shared use of these amenities as safe and stimulating play-time areas. • Playspaces can be located within parks, relatively close to entrance points (but away from busy perimeter roads) and traversing pathways, so that they are areas of greatest public surveillance and safety.
Urban agriculture	• Urban agriculture can be practised on land located next to sources of irrigation water, in the form of rivers and stormwater retention ponds. • In instances where lower-income farmers need to walk to the cultivated lands on a daily basis, urban agriculture should be located close to residential areas. • Where appropriate, urban agriculture should be located close to markets. • Urban argriculture is a useful way of productively utilising residual under-utilised land such as servitudes.
ACCESS	
Parks	• As larger parks serve sub-metropolitan as well as local users, maximum distances will sometimes be greater than maximum walking distances (i.e. ± 500 m or 10 min). The implication of this is that parks will often need to be accessed by bicycles or public transport. • As smaller parks are likely to be used on a daily basis by children, elderly people and workers, and are accessed by foot, they should be located within 300 m to 700 m of users. The maximum time spent walking to a smaller park should therefore be approximately 10 min.
Sportsfields	• School sportsfields should be located within easy walking distance (i.e. ± 300 m) of school buildings - with primary schools requiring closer locations than secondary schools, and should be located within 500 m to 1 500 m of other user groups (e.g. sports clubs).
Playspaces	• Playspaces should be located within easy walking distance (i.e. ± 300 m) of primary school buildings and créches, and should be located within 500 m to 1 500 m of other users. As playspaces sometimes serve children from surroundings areas, maximum distances will occasionally be greater than maximum walking distances (i.e. ± 500 m or 10 min.).

Table 5.4.3: Guidelines for the planning design of generic forms of soft open space (continued)

	SIZE AND DIMENSIONS
Pristine areas	• It is not possible to generalise about the ideal size for pristine areas, or the width of effective corridors, as these will vary between flora and fauna communities. Where appropriate, land preserved as a pristine area should be nodal, as opposed to linear, in order to minimise exposure to human activity. • In the case of wetlands and drainage courses, setbacks which protect development from flood waters should ensure that development is restricted to at least above the 1:50 year floodline. The setback also makes provision for a vegetated strip which protects water courses from pollutants, prevents bank erosion, secures habitat for birds and other wildlife, and provides recreational opportunities through trails. The required width of such a strip depends on soil and water-travel characteristics, slope, climate, vegetation type, and the scale and density of proposed development (Figure 5.4.2).
Parkways	• The length, and therefore size, of a linear parkway depends on the particular context. Widths should, for surveillance and safety reasons, not exceed ± 300 m, with a width of 25-50 m making it easier for more vulnerable users to identify and avoid potential dangers.
Parks	• The area and dimensions of a park vary according to the functions the park is intended to perform, and to proximity to the natural environment. Larger parks should be able to accommodate a variety of collective events like carnivals, fairs and concerts. Parks that are between 6 ha and 10 ha in size, with widths of between 200 m and 300 m, and lengths of between 300 m and 500 m, are generally flexible enough to accommodate these events. • The area and dimensions of smaller parks also vary according to the functions they are intended to perform. Smaller parks should, however, be small enough to maintain a sense of intimacy, and enable easy visibility and recognition (i.e. ± 25 m maximum). Such parks should therefore be between 450 m^2 and 1 000 m^2 in size, with widths of between 15 m and 25 m, and lengths of between 30 m and 40 m.
Sportsfields	• The area and dimensions of a sportsfield cluster vary according to the quantity and range of sports to accommodated, their respective field dimensions, and the degree to which field markings can be overlaid to reduce space requirements. The specific field dimensions of common outdoor sports are illustrated in Figure 5.4.3. It should be noted that the dimensions of larger field sports like cricket, rugby and soccer can vary considerably, and that only competitive matches need the specified field dimension and marking. Non-representative team games, social league games and other informal sporting activities do not necessarily require the specified field dimensions. • soccer: 65 m X 105 m (6 825 m^2) • rugby: 69 m X 125 m (8 625 m^2) • cricket oval: 128 m X 128 m (16 384 m^2) • hockey: 50 m X 87 m (4 350 m^2) • volley ball: 9 m X 18 m (162 m^2) • basketball: 14 m X 26 m (364 m^2) • netball: 15 m X 30 m (450 m^2).

Table 5.4.3: Guidelines for the planning and design of generic forms of soft open space (continued)

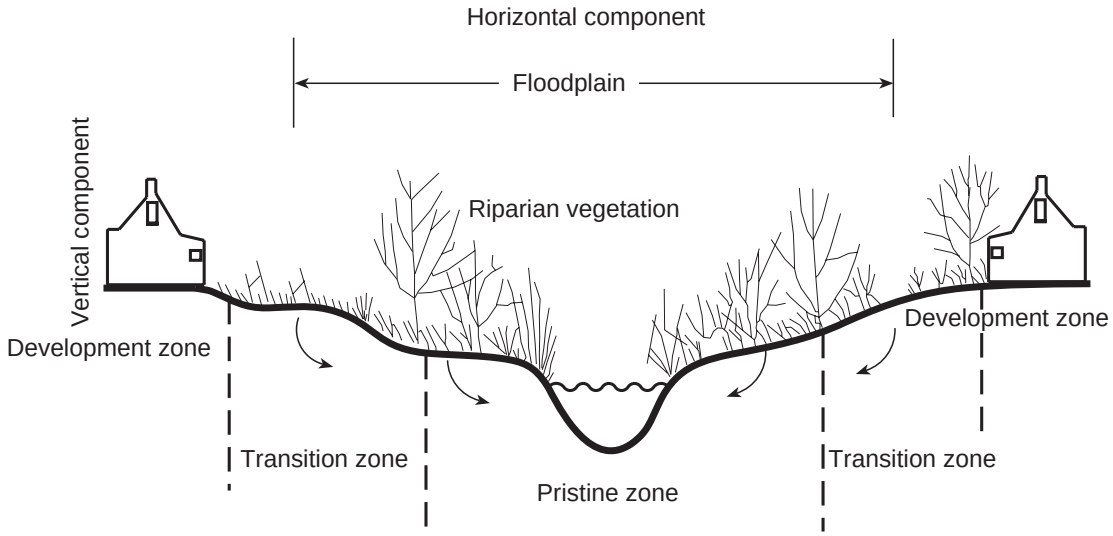
SIZE AND DIMENSIONS (continued)	
Playspaces	• The area and dimensions of a playspace vary according to the nature of the play equipment (e.g. whether or not small animals are kept within the space), and whether or not the playspace is part of a larger soft open space. Playspaces should however be small enough to enable easy supervision and recognition (i.e. ± 25 m maximum). Playspaces should therefore be between 450 m^2 and 1 000 m^2 in size, with widths of between 15 m and 25 m, and lengths of between 30 m and 40 m. • It should be kept in mind that the size and surface of playspaces could have an impact on their use, especially in areas where sufficient resources are not available to keep them in a state conducive to play activities. The result could be that smaller play spaces are used for rubbish dumping, parking, etc. It might prove to be more suitable in some instances to develop these as hard open spaces to allow for various games requiring a hard surface.
USE CAPACITIES AND THRESHOLDS	
Pristine areas	• It is important that the frequency and the volume of users do not reach a point where they compromise the environment and interfere with the natural functioning of the ecosystem - this varies according to context.
Sportsfields	• The use threshold of sportsfield clusters depends on the size of the cluster, the number of schools and sports clubs that share the amenity, the capacity of the fields, the surface of the fields and the levels of use that are required to maintain efficiency. • Different surfaces have different capacities. When considering the sharing of sportsfields, it is necessary to establish whether certain levels of sharing are feasible from a surface capacity point of view. In Cape Town, for example, a (kikuyu) grass playing field can typically accommodate only six matches or practices per week, before the surface begins to degrade.
Playspaces	• Playspaces primarily serve the open-space needs of children. The use threshold of playgrounds depends on the demographic characteristics of the local community, and whether or not schools and créches make formal use of these amenities.
EDGES	
Parks and parkways	• Parks and parkways should be defined by perimeter roads and fronting buildings, in order to improve surveillance and safety. Visual access or visibility is important in order for people to feel free to enter a space. • Parks and parkways with direct road access should be protected by traffic barriers (e.g. trees, bollards or railing), in order to prevent cars from parking in the space, and prevent small children from running into busy streets. Trees, in particular, provide a definite visible line of transition between built areas and open spaces, and provide shade and windbreaks. • The fencing of parks facilitates collective events where entrance fees are charged (e.g. fairs, open-air theatre). It is important that only a few parks in a settlement are fenced off, to minimise restrictions on public access, and that entrance points relate to approaches from public transport stops and major pedestrian desire lines.

Table 5.4.3: Guidelines for the planning and design of generic forms of soft open space (continued)	
EDGES (continued)	
Sportsfields	• Sportsfield clusters should be defined by perimeter roads and fronting buildings, in order to provide surveillance and safety. Depending on the nature of the amenity-sharing, fencing to limit public access to specific user groups may be required. In these instances surrounding properties can back onto the space directly without adversely affecting safety.
Playspaces	• Free-standing playgrounds should be defined by fronting buildings, in order to provide shelter from the wind and sun, and enable adults to survey the space from surrounding houses. • Free-standing, unfenced playgrounds with direct road access should be protected by traffic barriers (e.g. trees, bollards or railing), in order to prevent cars from parking in the space, and prevent small children from running into busy streets.
Urban agriculture	• In most instances urban agriculture needs to be fenced in order to prevent theft and vandalism, and protection from stray animals.
SURFACES	
Pristine areas	• Surfaces should be left in a natural (i.e. locally indigenous) state, and river banks should be vegetated with riparian vegetation to decrease and slow water runoff.
Parks and parkways	• Surfaces should match the frequency with which the space is used. Heavily utilised spaces should be paved or gravelled, while less utilised spaces can have a soft surface. • Surfaces should include hardened, tractive pathways of ± 90 cm with gradients not exceeding 1:12, in order to facilitate the easy movement of wheelchair users, pedestrians and cyclists. Pathways should run through and across the space, in order to create continuous walks and limit any fragmentation of urban areas as a result of the space, and should also lead to more secluded viewing sites. • Portions of larger parks (± 50 m x ± 50 m) should be left unplanted and open, in order to accommodate informal ball games and other forms of play that require free space (e.g. kite-flying). • Retention and retarding stormwater ponds should be incorporated as water features, in order to improve the landscaping and recreational interest of the space, and for the dual purpose of stormwater attenuation. Paths crossing water courses, in the form of bridges or stepping stones, should be made into challenging child-play objects. • Plant and tree landscaping should avoid the creation of hidden places of refuge, in order to reduce opportunities to commit crimes in the space.

Table 5.4.3: Guidelines for the planning and design of generic forms of soft open space (continued)

SURFACES (continued)	
Sportsfields	• Surfaces should be appropriate to the range of sports to be accommodated. The use of an indigenous grass is preferable for ecological reasons. While the cost of establishing indigenous grasses, like buffalo, is often significantly higher, maintenance is cheaper. In some cases, an artificial surface (e.g. astroturf) could be appropriate. Astroturf can be used 24 hours a day, but the capital cost is high. It does not, however, need regular maintenance or reinstatement. • There should be a differentiation between playing fields. In some instances (e.g. climatic conditions), less important, non-competitive fields can be surfaced with earth. The advantage of earth surfaces is that there is no limit to use, and maintenance costs are reduced. • Where possible and appropriate, field markings should be overlaid in different colours, to enable the same space to be used for a number of different sports. • If parking space is provided within the sportsfield cluster, hard surface field markings (e.g. basketball, netball) can be overlaid onto the space so that the parking area can also be used as a sports facility when demand for parking is low.
Playspaces	• Areas of intense play and heavy use, requiring high durability, should have a hardened surface, while areas where children are likely to fall and hurt themselves should have a soft surface. • Surfaces should demarcate playspaces for children of different age groups. Small soft spaces suit young children of pre-school age in their predominantly passive engagement activities, while larger soft spaces suit the more robust contact games of older children.
Servitudes	• To reduce maintenance costs, and increase habitats for indigenous flora and fauna, servitudes should be surfaced with indigenous vegetation.
PUBLIC FURNITURE	
Parkways	• Public furniture can include benches and waste bins at viewing sites.
Parks	• Public furniture in larger parks can include benches and waste bins close to entrances and play areas for less mobile elderly people and minding parents, child play equipment away from busy perimeter roads, and ablution blocks where required. • Public furniture in smaller parks can include children's play equipment, public art or a stimulating water feature to add to the uniqueness and character of the space, benches and tables (for lunch eaters, newspaper readers, board games, etc.), and game markings (e.g. hop-scotch).
Sportsfields	• Public furniture can include benches and stands for spectators. In the case of public fields shared with sports clubs, adults who work during the day can only play sport at night, and therefore often need lighting as well. • Depending on the size of the sportsfield cluster, and the range of user groups, collective service points in the form of changing-rooms with toilets and taps can be provided.

Table 5.4.3: Guidelines for the planning and design of generic forms of soft open space (continued)	
PUBLIC FURNITURE (continued)	
Playspaces	• Public furniture can include interactive and challenging play objects (e.g. wooden building blocks, stepping stones), play equipment (e.g. slides), and benches overlooking play areas. • Free-standing playgrounds with formalised use arrangements may require water points for drinking and toilet facilities.
Urban agriculture	• Appropriate public objects in spaces used for urban agriculture are likely to relate to water irrigation systems and storage facilities for farming implements.



Pristine zone: An undisturbed natural environment with locally indigenous riparian vegetation and natural habitats for flora and founa

Transition zone: A porous vegetated strip which enables water infiltration, further protects the water course from pollutants, prevents soil erosion, and provides altered habitats for flora and fauna - the zone contains 'soft' land-use activities like sport and recreational amenities, and organic plant cultivation

Approximate scale:

0 100 200m

Figure 5.4.2: Spatial diagram illustrating the basic cross-sectional components of a riverine environment

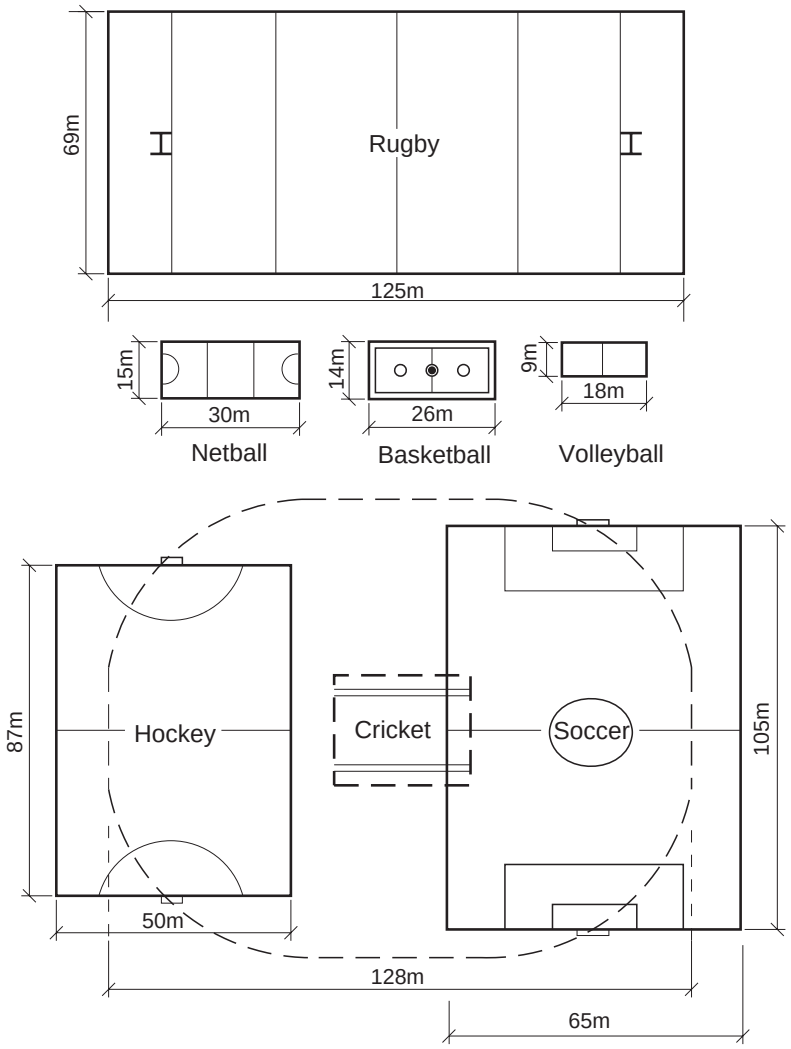


Figure 5.4.3: Sportsfield markings and dimensions

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Chapter 5.5

Public facilities

5.5

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THE ROLE AND FUNCTION OF PUBLIC FACILITIES

This sub-chapter gives guidance on the planning of public facilities within residential settlements. Public facilities are defined as those basic services which cannot be supplied directly to the individual dwelling unit and as a result are utilised away from the individual residential dwelling unit within the public environment. Public facilities satisfy specific individual or community needs - including safety and security, communication, recreation, sport, education, health, public administration, religious, cultural and social.

Public facilities, as the name implies, are generally regarded as the responsibility of government, whether central, regional or local, and more often than not are provided by government institutions. However, public facilities are also provided privately, when the government-provided services are perceived to be inadequate.

TYPES OF PUBLIC FACILITY

Public facilities can be classed as higher-order, middle-order, lower-order and mobile, depending on the size of the area that they serve.

- Higher-order public facilities:
  These facilities generally serve the entire region, metropolitan area or city (e.g. hospitals, universities) and are not provided for in the layout planning process for single residential settlements. The location of these public facilities is determined by analysing the most suitable and accessible location for the greatest number of people. Essentially, these facilities are planned in terms of an overall development framework.

- Middle-order public facilities:
  These are facilities which serve a number of diverse and different communities (e.g. high schools, clinics). These facilities are essential to individual residential settlements, but the facilities serve a threshold population which exceeds an individual settlement, and therefore are supported by a number of settlements.

- Lower-order public facilities:
  These are facilities which are utilised by a single or a limited number of residential communities (e.g. a créche or pre-primary school) and which are generally provided for in the design and layout of residential settlements.

- Mobile public facilities:
  These are facilities which move from one location to another, serving a large number of communities. Many problems with regard to the spatial location of public facilities are increasingly being solved (especially in less mobile communities) through the use of mobile public facilities - such as clinics, post offices and public telephones. Through mobile facilities the ideal of allocating scarce resources, whilst at the same time serving the greatest number of people, can be achieved.

Functional categories of public facilities

Public facilities can also be defined in terms of the function that they serve (i.e. education, health, recreation, culture and administration). Table 5.5.1 illustrates the hierarchical categories and also indicates whether the facilities are publicly or privately provided, and the order of the facility.

Table 5.5.1: Functional categories of public facilities		
FUNCTIONAL CATEGORY OF PUBLIC FACILITY	NATURE OF FACILITY	PROVISION: PUBLIC OR PRIVATE
Educational facilities		
Créche/nursery school	Local/middle order	Generally privately provided
Primary school	Local/middle order	Generally public provided, but may be private
Secondary school	Middle order	Generally public provided, but may be private
Tertiary facilities (colleges, technikons and universities)	Higher order	Generally publicly provided
Adult learning centres	Middle order	Generally public provided, but may be communal
Health facilities		
Mobile clinics	Mobile	Publicly provided
Clinics	Middle order	Publicly and privately provided
Hospitals	Higher order	Publicly and privately provided
Recreational facilities		
Playgrounds	Lower/middle order	Publicly provided
Sports fields	Middle order	Publicly provided
Sports clubs	Middle order	Usually privately provided
Sports stadiums	Higher order	Publicly provided
Cultural facilities		
Libraries	Middle order	Publicly provided
Community centres	Lower/middle order	Publicly provided
Religious centres (churches, synagogues, mosques, etc.)	Lower/middle order	Privately provided
Administrative facilities		
Cemeteries	Middle order	Publicly provided
Magistrate's court	Higher order	Publicly provided

Table 5.5.1: Functional categories of public facilities (continued)		
FUNCTIONAL CATEGORY OF PUBLIC FACILITY	NATURE OF FACILITY	PROVISION: PUBLIC OR PRIVATE
Administrative facilities (continued)		
Municipal offices/pay points	Middle order	Publicly provided
Post offices	Middle order	Publicly provided
Police stations	Middle order	Publicly provided
Fire stations	Middle/higher order	Publicly provided
Old age homes	Middle order	Publicly provided
Children's home	Higher order	Publicly provided
Information centres	Middle order	Publicly provided

Relationships between public facilities

Table 5.5.2 is a compatibility matrix which attempts to identify the degree of compatibility between various public facilities when related to one another. The degrees of compatibility are defined below.

- Compatible: There are interrelationships or linkages between the facilities and they can be located close to, or clustered with, one another.
- Neutral: There are no obvious linkages or interrelationships between facilities; their location together would have no benefits or disadvantages.
- Incompatible: The facilities are unsuitable to be located in close proximity or adjoining one another as their uses are contradictory.

Complex and intricate patterns and relationships exist between various public facilities. An example of relationships and interrelationships between various public facilities is given in Figure 5.5.1.

The relationships depicted in the example refer to

- *individual facilities* (e.g. individual school buildings with their own individual playing or exercise areas); and
- shared facilities, including
  - specialised facilities (e.g. main hall, main library), and
  - sport facilities (e.g. swimming pools, tennis courts).

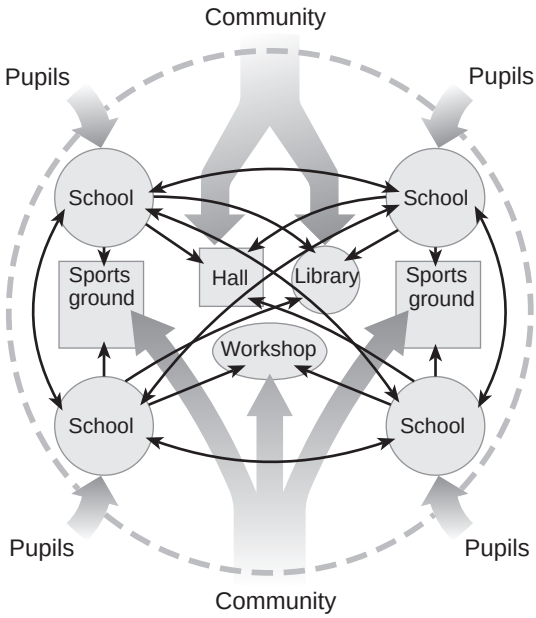
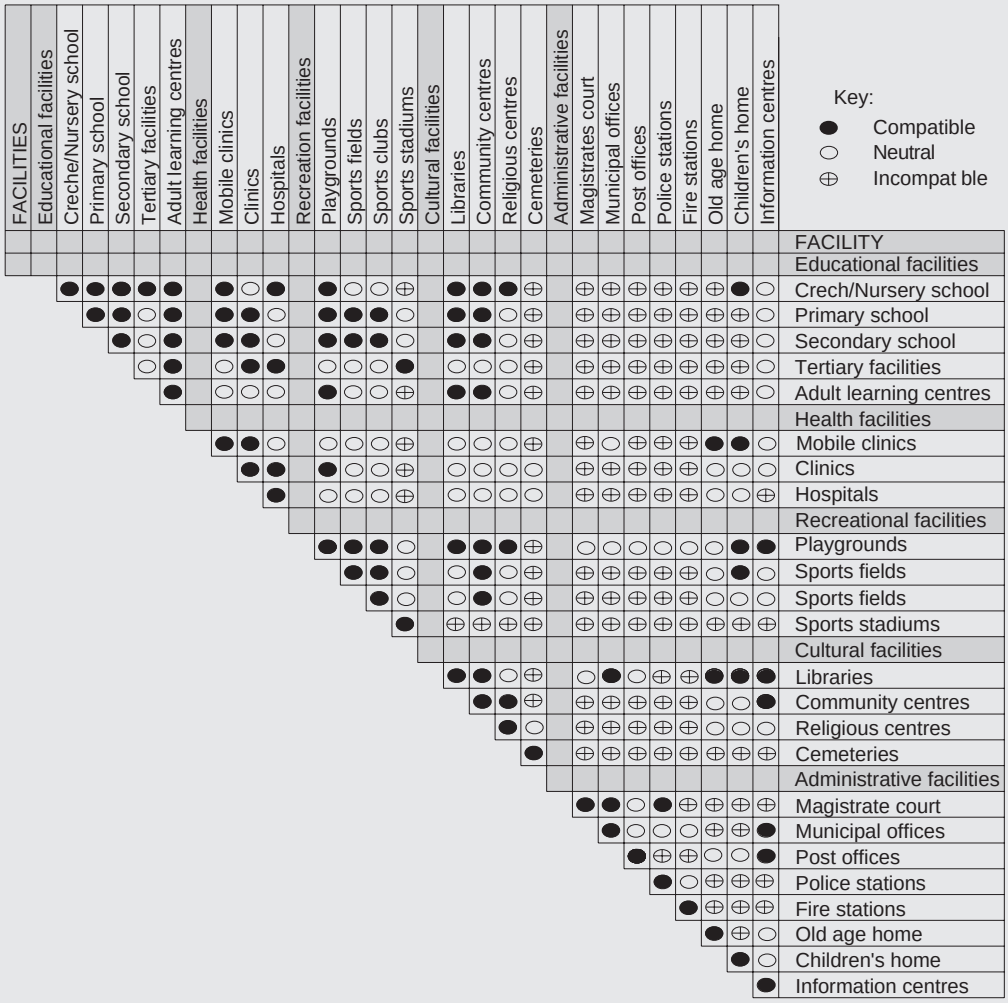


Figure 5.5.1: Relationships between public facilities (Smit and Hennessy 1995)

The shared facilities will not exclusively serve the schools but also be accessible to the public.

It is these interrelationships that present the opportunity for the clustering of facilities. Essentially there are two types of facility cluster:

Table 5.5.2: Compatibility matrix



Multipurpose facility clusters

A multipurpose facility cluster is a multifaceted facility under one roof or more, which offers a range of services such as social services, recreation, health, economic activity, in one location. Multipurpose facility clusters are generally located together with one or the other structural elements of urban settlements (at a transport stop/interchange, urban square, market, sports field, etc).

The multipurpose facility cluster concept provides for a flexible grouping of facilities at an accessible location. Each cluster is essentially a social hub and the size and number of services provided will depend on the demand and needs of surrounding living environments.

Multipurpose facility clusters can range from metropolitan development nodes to local clusters of telephones, bus stops and post boxes.

The specific composition of a single facility cluster is dependent upon:

- its location relative to the transport network;
- its location within the metropolitan area;
- the size of the community/(ies) from which it draws support;
- community-identified needs; and
- the size of service area for facilities.

The advantages of establishing multipurpose facility clusters are outlined below:

- convenience, as all services are located in one centre and people can accomplish a number of tasks within a single journey, which equates to savings in terms of money, time and effort and has the net effect of improving quality of life;
- a reduction in the cost of providing public facilities through the sharing of resources, equipment and land;
- exposure for public facilities and encouragement

of their use;

- integration of different communities;
- a reduction of inequalities in the provision of facilities;
- the provision of greater security; and
- the offsetting of transport costs.

Functional clusters

Another concept which is becoming increasingly popular in terms of public facility provision is the creation of functional clusters of facilities. The concept applies to all functional categories of public facilities; however, most research has focused on educational and related facilities. As a result, the proposals detailed below refer specifically to education. They could, however, be applied to other functional categories of public facilities.

Current thinking proposes to externalise the provision of educational facilities from within local areas and cluster them together around a hub of shared specialised facilities. In terms of this concept a number of educational buildings are loosely clustered together with residential and commercial facilities, around a hub of specialised facilities. The hub is easily accessible in terms of public transport. The specialised hub is a communal facility that can be used by the entire community. The school playgrounds and fields are shared among the schools and are also available for use by the community after hours and on weekends.

Individual schools within the education cluster can be enclosed separately if so desired, but the shared facilities should be easily accessible to the public and should be integrated into the built environment. These shared facilities need not be physically attached to individual schools but should always be easily accessible - not more than a few minutes' walk.

The functional cluster concept is illustrated in Figure 5.5.2.

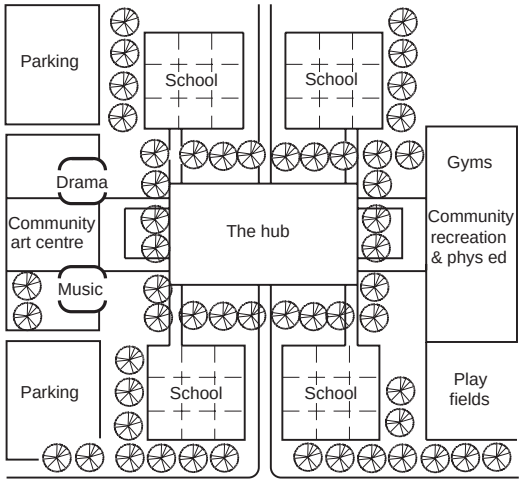


Figure 5.5.2: Educational facility cluster (after Leggett et al 1977)

The advantages of clustering functional facilities are summarised as follows:

- convenience, as all services are located in one centre;
- the sharing of high-cost elements can reduce costs considerably (e.g. specialised facilities like laboratories and space-extensive facilities like libraries) ;
- exposure for public facilities and the encouragement of their use;
- the integration of different communities;
- a reduction in inequalities in the provision of facilities;
- the offsetting of transport costs;
- a cutting down on the amount of land required;
- the promotion of full use of buildings;
- lower building costs;
- lower running costs;
- minimum maintenance costs;
- a large catchment area, less susceptible to localised demographic changes.

QUALITATIVE GUIDELINES

This section involves an elaboration of the principles of reinforcement, continuity, discontinuity, externalisation, concentration and hierarchical association, as outlined in Chapter 3. These principles form the basis of urban structuring and have vast implications for the organisation of public facilities.

The principle of reinforcement

- Public facilities should be located adjacent to public spaces. The net effect of the association of these two structural elements is that the urban form is strengthened and defined creating a logical pattern within the urban settlement which is easily recognised by its inhabitants. As a general rule the most important and largest of public facilities should be associated with the largest and most important open spaces.

- Public facilities can be used to define hard open public spaces and create a sense of definition and enclosure, as well as to improve the security of the public open space by providing surveillance from the public-facility buildings.

- Higher- and middle-order public facilities should be located in dominant positions relative to open space and movement systems - especially those that cater for public transport. This has the effect of strengthening their importance and significance for the community as they become symbolic focal points within settlements. This can be achieved by aligning roads to key public facilities (i.e. community centres and religious facilities) to create vistas and enable the associated informal activities to spill out into the adjoining open spaces.

- Through the reinforcement of these structural elements, convenience, choice and efficiency in resource use are achieved.

- The clustering of a number of public facilities together can lead to intensive utilisation by a large number of people, and, through the creation of "load centres" can generate the largest demand for utility services. Clusters of public facilities can therefore be used to "pull" service mains economically through a settlement, with the facilities - and the public spaces they abut - accommodating a range of services often not supplied to single residential erven.

The principle of continuity

- Soft open spaces should be linked together throughout settlement systems in order to form a continuous web of recreation space leading through the built environment. Public facilities can be clustered adjacent to these open spaces, which can then be accessed by defined pedestrian paths leading through the open space system. In addition, the open space can serve a dual purpose in that it can provide recreational playgrounds and sportsfields for clusters of schools and the community.

- A diverse and continuous network of multifunctional open and flexible movement routes should weave through settlement systems and connect public facilities. The placement of public facilities at regular and convenient intervals along these routes will ensure that they are easily accessible by all modes of movement.

- Those public facilities which serve numerous communities or the region as a whole will need to be located along major transport routes, which form part of the public transport systems and which are punctuated by public transport stops at frequent intervals. This will ensure that public facilities are easily accessible to all sectors of the population. The location of public facilities along these routes will provide exposure of the facilities to the greatest number of people, thereby encouraging their use.

The principle of discontinuity

- Higher-order and middle-order public facilities should be located on stop-start activity streets, in order to create thresholds high enough to support facilities and also ensure that the people can gain direct and easy access to facilities.

- Public spaces (public facilities and open spaces) can be used as mechanisms to create areas of intense activity and tranquil settings, thereby creating a range of spaces from very public through to very private. These provide for variation within the urban fabric and add interest and diversity to settlements.

The principle of externalisation

- Public facilities should be placed in positions of maximum exposure along major transportation routes. The exposure of these facilities enables complex patterns of facility use between different neighbourhoods and serves to integrate rather than isolate residential neighbourhoods.

- The clustering and sharing of facilities is not only more efficient but can also have a positive impact on development and result in increasing private investment, as it creates potential sites for local business and generates more concentrated activity and travel patterns.

- Public facilities that are functionally related can be located in clusters outside predominantly residential areas, to allow for resource-sharing and

the multifunctional use of buildings and space, thereby creating efficiency in layout plans by reducing the amount of space required for the facilities - reducing costs and reducing the number of trips required to access certain public facilities.

- If facility provision is integrated with public transport, and several facilities are located together in one place which is easily reached by car or foot, this will:
  - provide convenience as the number of trips is reduced;
  - save resources as different services can share space;
  - transmit signals for future investment;
  - provide advantages in terms of the efficient provision and operation of public transport; and
  - provide advantages for utility-services reticulation.

The principle of hierarchical concentration along major routes

Public facilities serve different purposes and therefore the location of a public facility will depend on the specific function that it performs. One needs to evaluate what purpose and function the facility will serve and then decide on the best location. Behrens and Watson (1996) define the following five categories of public facility on the basis of locational requirement:

- Public facilities that distribute emergency vehicles (ambulances, fire engines, etc) should be located on higher-order multifunctional routes that intersect with regional or primary distributors.
- Public facilities that need to be visible and accessible to the greatest number of people require easy access to public transport stops and interchanges and high levels of exposure to more intense activity routes (i.e. libraries, community centres, post offices etc).
- Public facilities that need to be visible and accessible to the greatest number of people, but located in a safe, quiet environment require easy access to public transportation stops and interchanges, but should be locate a block or two back from intense activity routes (i.e. primary and secondary schools, day-hospitals and clinics).
- Public facilities that need to be accessible to pedestrians and that need safe and quiet surroundings should be located within the residential area within walking distance of the residents homes (i.e. créches and churches).
- Public facilities that need to be as visible and as accessible to pedestrians as possible should be located within walking distance of the user household on busier road intersections.

The principle of hierarchical association of public space and public facilities

- The main focusing elements of integrated land-use environments are public facilities, as they are the collective communal gathering places for the surrounding population.
- Public facilities that are provided for in settlements can be divided into two categories - those that serve a single group or community (homogeneous facilities) and those that serve multiple communities (heterogeneous facilities):
  - Homogeneous facilities are very local in nature and are generally found within residential settlements and serve a particular community (i.e. a church or créche);
  - Heterogeneous facilities, on the other hand, serve a variety of different groups and are more public in nature. These tend to be found in locations that are accessible to the greatest number of people. The location of these public facilities should be closely linked to the transport system (especially public transport).
- The clustering of public facilities will result in the formation of facility clusters, ranging from metropolitan development nodes to local clusters. The hierarchy of such centres is closely liked to their location and accessibility, with the higher-order centres being located at points of maximum accessibility (i.e. intersection of major transport routes).

PROCEDURAL GUIDELINES

When planning for public facilities for residential settlements it is necessary to analyse the site and target population in order to determine the type of public facilities required for a specific development.

The following procedures should be undertaken in order to determine what facilities are required.

Determine the nature of the residential settlement

Before any planning is done, one needs to determine what type of development is being planned and in this regard it is important to distinguish between “greenfield” sites and “infill” sites.

- Greenfield sites are large vacant tracts of land and usually involve the provision of a large number of new housing units; as a result these sites will require a number of new public facilities to serve the needs of the future residents.

- Infill sites generally involve filling up the vacant land in and around existing settlements; in these cases there are usually facilities in close proximity and the development tends to be small in nature.

Therefore the planning of public facilities for different forms of settlement will vary.

Prepare an inventory of existing public facilities

In order to determine what facilities are required by the target community, one needs to evaluate what facilities exist in the surrounding areas, whether these facilities are operating at full capacity, and whether they will be adequate to serve the needs of the proposed new living environment.

One will need to create a public facilities plan showing the existing and proposed public facilities in the area. This will give an indication of what is available and what is over- and underutilised, by providing an indication of what is required within the new living environment.

The creation of an inventory applies not only to the lower and middle-order facilities, but also to the higher-order and mobile facilities as, if they provide a good service and are easily accessible (especially by public transportation), these will be utilised by communities.

Prepare a profile of the target population

It is necessary to have a complete profile of the population for which the public facilities are intended, in order to determine what facilities that community requires. An incomplete population profile can result in facilities which are inappropriate (i.e. the provision of a créche in an area where the population is ageing).

One needs to determine the following:

- Age and gender profile (gender ratios, household age structure and size).
  One needs to determine what age group and gender one will be serving, in order to determine what types of facility will be required (i.e. an ageing population will require access to health facilities, as opposed to educational facilities).

- Income profile (household expenditure and income).
  The income and various areas of income expenditure of the target group for which the public facility is intended need to be determined in order to establish whether the community can afford the public facility and whether it is appropriate.

- The level of public facility provided.
  This needs to accord with what the community can afford and must be prioritised by the community itself, in order to ensure that limited financial resources are converted into services that are required and which will be well utilised by the community.

- Cultural profile.
  The mix of population in a given area is likely to determine what public facilities are required. The social structure will ultimately shape the demand for public facilities, eliminating the need for some, and placing greater emphasis on the need for others.

- Discuss community priorities.
  In some instances the target community has already been identified and their needs and wants in terms of public facilities can be determined through public participation and survey. This will give a clear idea of what a particular community requires in terms of public facilities. Where a target community does not exist, one can analyse similar surrounding communities in order to determine what types of public facilities are needed.

QUANTITATIVE GUIDELINES

In the past, public facilities were provided through the application of a set of standards relating to the provision of different types of public facility. These tended to be rigid and inflexible and, as a result, it was decided instead to provide a set of guidelines for the provision of public facilities (see Table 5.5.3 - 5.5.7). As the name implies, these are meant to guide the planning of public facilities and cannot be applied uniformly across the board. The context must be evaluated and the guidelines adapted to suit the specific situation at hand.

International comparisons indicate that public facilities and amenities should together generally take up between 15% and 25% of land in a development (Behrens and Watson 1996). Of this combined amount, ± 33% should be taken up by public facilities, and ± 66% taken up by public open spaces. An ideal breakdown of private (i.e. housing, commerce and industry), and semi-public (i.e. roadways and footways) use of land is in the region of 50-60% private, 15-25% semi-public and 15-20% public. The following tables provide guidelines in respect of location, access, size and dimensions and thresholds.

Table 5.5.3: Quantitative guidelines - Educational facilities

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Créche/nursery school	These are community-specific facilities which should be within walking distance of residential units. Facilities can be clustered with pre-primary schools, primary schools, community centres, etc. (This does, however, result in the externalisation of facilities beyond individual residential settlements).	Should be accessible by pedestrian pathways without having to cross major streets. Where streets are crossed these should be minor streets. Maximum travel time: 10 minutes (whether by foot or vehicle). A maximum walking distance of 750 m.	Minimum size for facility: 130 m^2 • 50 m^2 per 45 children served. • Minimum area per playlot: 20 - 30 m^2. • One third of the total area should be used for circulation, administrative and ancillary uses.	Estimated minimum population: 5 000.

Table 5.5.3: Quantitative guidelines - Educational facilities (continued)

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Primary school	Should be located within easy reach of the local areas which it is intended to serve. As a result it needs to be located close to, but not necessarily along, a public transport route. Primary schools can be combined with a number of other facilities to form a cluster (i.e. a high school, community hall, playground, park, etc).	Should ideally be accessible by foot, bicycle and vehicle. Maximum travel time: 20 minutes (whether by foot, bicycle or by vehicle). Maximum walking distance: 1,5 km.	Buildings and recreational space are the two components of a school which physically occupy the site. The minimum size of a primary school site is estimated at 2,4 ha and is made up as follows: Buildings: 1,4 ha Recreational space: 1 ha. If exact numbers are known, one can do a calculation based on the following: • 40 pupils per classroom and 50 m^2 per classroom. • One third of the area for circulation, administrative and ancillary uses. • Recreational area: 1 ha (playing fields).	Estimated minimum population: 3 000 - 4 000.

Table 5.5.3: Quantitative guidelines - Educational facilities (continued)

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
High school	School should be situated on a major transport route with public transport stops.	Maximum travel time: 30 minutes. Maximum walking distance: 2,25 km.	The minimum size of a high school is estimated at 4,6 ha and is made up as follows: Buildings: 2,6 ha Recreational space: 2 ha. If exact numbers are known then one can do a calculation based on the following: • 40 pupils per classroom and 50 m^2 per classroom. • One third of the area for circulation, administrative and ancillary uses. • The recreational area can be calculated according to the type of sports to be offered - refer Sub-chapter 5.5, Table 5.4.3, for the dimensions of sportsfields.	Estimated minimum population: 6 000 - 10 000.
Tertiary facilities	Regional facilities located along major transport routes with public transport stops.	Regional scale of facility means that it would be planned for in terms of a development framework and not when designing specific living environments.		

Table 5.5.3: Quantitative guidelines - Educational facilities (continued)

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Adult learning centres	Adult learning centres are not usually provided as stand-alone facilities and generally "double up" with some other form of facility (i.e. a community centre, hall, school etc). No figures have therefore been given as the most efficient provision is through doubling up where existing space is adapted for adult learning classes.			

Table 5.5.4: Quantitative guidelines - Health facilities

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Mobile clinic	Mobile facilities which move from community to community - therefore there is no fixed location.	Must be accessible by foot. Maximum walking distance: 1 km.	These are self-contained units. Space is, however, required to park and operate the clinic: this can be done from a local park, community centre, church, etc.	A mobile facility will serve a population of about 5 000 people.

Table 5.5.4: Quantitative guidelines - Health facilities (continued)

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Clinic	Clinics should be accessible to the greatest number of people and as such should be located close to public transport stops. The facility need not be located along a major route and can be located a block or two back, in quieter surroundings.	Maximum walking distance: 2 km. Where it is not possible for the facility to be placed within walking distance, it must be easily reached via public transport, with a maximum walk of 5 minutes from the public transport stop to the facility. Maximum travel time of 30 minutes to reach the facility.	The size of the clinic will vary according to the number of people the clinic will serve - the more people the greater number of services required, and as a result the larger the facility. The following guidelines are suggested: • 0,1 ha per 5 000 people • 0,2 ha per 10 000 people • 0,5 ha per 20 000 people • 1 ha per 40 000 people • 1,5 ha per 60 - 80 000 people.	An estimated minimum of 5 000 people.
Hospitals	These are regional facilities, which must be located along major transport routes in close proximity to public transport stops.	Regional scale of facility means that they would be planned for in terms of a development framework and not when designing specific living environments.		

Table 5.5.5: Quantitative guidelines - Recreational facilities

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Playgrounds	See Sub-chapter 5.4 Table 5.4.3			
Sportsfields				
Sports clubs	These are generally privately provided and therefore fall beyond the scope of this document.			
Sports stadiums	Regional facilities, located along major transportation routes in close proximity to public transportation stops.	Regional scale of facility means that they would be planned for in terms of a development framework and not when designing specific living environments.		

Table 5.5.6: Quantitative guidelines - Cultural facilities

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Libraries	Should be easily accessible, preferably on main thoroughfare convenient to main traffic and transportation routes. Libraries can be combined with a number of other facilities to form a convenient cluster i.e. schools, community centres, etc.	Libraries should be within walking distance of the communities they are to serve. Walking distance: 1,5 km - 2,25 km. Where it is not possible to provide the facility within walking distance, it should be within 5 minutes walking distance of a public transport stop. Maximum travel time: 20 - 30 minutes.	Libraries require a minimum of two books per capita and the size of the library will depend upon the population being served. The suggested minimum size is 130 m^2.	Libraries can serve populations of 5 000 - 50 000.

Table 5.5.6: Quantitative guidelines - Cultural facilities (continued)

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Community centres	A community centre provides a variety of services to a number of residential communities and, as such, it should be easily accessible to these communities, preferably on a main thoroughfare in close proximity to public transport stops.	Where possible, community centres should be within walking distance. The suggested distance is 1,5 km - 2,25 km. Where it is not possible to provide the facility within walking distance it should be within 5 minutes walking distance of a public transport stop. A maximum travel time of 20 - 30 minutes is recommended.	The estimated minimum size is 5 000 m^2. This may vary according to the amount of sharing undertaken with other public facilities such as parks, libraries, playgrounds, and schools.	A minimum population of about 10 000 people.
Religious centres (churches, synagogues, mosques, etc)	The location will generally depend on the community being served and the existing facilities in the area surrounding the site. Churches can be clustered with other public facilities such as playgrounds, community centres, halls, etc, in order to promote multifunctionality.	Churches are generally community facilities and should be located within walking distance for members. Maximum walking distance: 1,5 km. The maximum travel time by foot or public transport or vehicle: 20 minutes.	There is no common uniform agreement as to the adequate size of a church site. The size will depend on the facilities provided (i.e. if there is a religious school attached, the site will be much larger). A site can therefore range from 150 m^2 - 3 000 m^2.	It is estimated that approximately 2 000 people are required to support a single church.
Cemeteries	Cemeteries are generally not considered as a land use which is compatible with residential land use and, as a result, they are not dealt with in this document.			

Table 5.5.7: Quantitative guidelines - Administrative facilities

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Magistrates court	This is a provincial facility and courts are planned and provided for by the provincial administration.			
Municipal offices/pay points	These facilities require high levels of exposure and must be easily accessible by public transport.	Should be accessible by public transport. Maximum travel time: 30 minutes.	The minimum size for municipal offices is 3 000 m^2.	A minimum population of 50 000 people.
Post offices	Post offices generally serve a number of communities and, as a result, need to be visible and accessible to the surrounding population. As such, they should be located along activity routes within easy walking distance of public transport stops.	Where possible, communities should be able to access the post office on foot - the maximum walking distance is 2 km. The maximum travel time per foot/vehicle: 30 - 40 minutes.	These have generally moved into commercial shopping nodes and, as such, the rental will be a determining factor when deciding on a minimum size. The minimum recommended size is 500 m^2.	Estimated minimum population: 11 000 people.
Police stations	Community police stations should be located central to all the communities which they are required to serve and should be on a main thoroughfare - so that emergency vehicles can be easily dispatched to adjoining communities.	Where possible, people should be able to access their community police station on foot - a walking distance of 1,5 km is recommended. Maximum travel time: 20 minutes.	Varies between 0,1 ha - 1 ha, depending on the type of facility provided.	Estimated minimum population: 25 000.

Table 5.5.7: Quantitative guidelines - Administrative facilities (continued)

Facility	Location	Access	Size and dimensions	Use capacities and thresholds
Fire stations	Fire stations distribute emergency vehicles to the area and as a result, they should be located on higher-order multifunctional routes that intersect with primary or regional distributors.	Fire stations are a higher-order facility - not generally planned for within a residential community nor one that residents would require access to on a regular basis.	Average erf size: 1,2 ha.	Estimated minimum population: 60 000 people.
Old age home	Old age homes are generally provided by the private sector, based on need and demand, and are therefore not dealt with in this guideline.			
Children's home	This is a regional facility and would be provided in terms of a development framework based on statistics regarding homeless children.	Not applicable to the planning of residential settlements.	Average erf size: 2 ha.	One children's home is required per 200 000 people.
Community information centres	These are aimed at providing information to communities on the various services and activities available to them. They should be easily accessible, and visible to as many people as possible. They would be located on busier road intersections.	They should be within 1 km walking distance of residents or easily accessible by some means of public transport with a maximum journey time of 15 minutes.	The size of the facility will depend upon funds available but the building need not be bigger than 100 m^2.	Estimated minimum population: 22 000 people.

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Chapter 5.6

Land subdivision

5.6

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INTRODUCTION

One of the most basic design decisions facing settlement planners, is how the land will be divided and used to provide for new development. Factors that influence this decision include the physical conditions of the site, market forces, surrounding patterns of development, and regulatory limitations. The size of the site also often influences development options; large parcels of several hectares can offer many opportunities for creative and diverse land plans, while small sites usually offer a more limited number of possibilities.

More formally, a subdivision could be defined as the division of any improved or unimproved land for the purposes of sale, lease, or financing. For this reason legal processes have been established to ensure the following:

- proper registration and title for individual parcels of land;
- accurate identification of land by way of survey;
- establishment of rights to tenure and occupation;
- security for financing/cost recovery;
- identification of boundaries for development;
- a formal procedure of conducting subdivision; and
- allowance for taxation.

The abovementioned are achieved through application of various forms of legislation such as the Provincial Ordinances, Deeds Registry Act, Land Survey Act, and more recently the Development Facilitation Act.

In simplified terms, the role of subdivision in this context is as follows:

- to identify public versus private land;

- to create portions of land (erven) which suit the purposes for which they are intended (i.e. industrial versus residential versus open space versus undeveloped land etc);

- to establish a vehicle for implementation of policy or overall planning philosophy; and

- to identify land which is unusable for settlement purposes either as a result of physical or topographic limitations.

QUALITATIVE GUIDELINES FOR LAND SUBDIVISION

Allow for density and diversity

- Encourage higher densities at strategic points (like public transport stops and adjacent to higher amenity areas such as parks), and along significant public transport routes. The higher densities would provide the economies of scale to support the facilities and/or transport service. This could be achieved by providing for smaller lots, and lots capable of supporting higher density development at these positions and along these routes in the settlement.

- Larger land uses like sport stadiums, large “green” spaces, industrial and large commercial sites should occur at the edges of districts where they do not disrupt the fine-grain mix of uses. There, they can be “shared” by a number of districts.

- A diversity of stand sizes should be provided to accommodate a range of activities but the following points should be kept in mind:

    - the need for business and home-based enterprises to locate in close proximity to concentrations of economic activities (taking advantage of agglomeration economics) and along arterial routes (to ensure optimal access and exposure);

    - the ability of land-uses and building forms to act as noise buffers to external noise sources such as major roads, railways or industries;

    - the capacity of potential mixed-use lots, initially developed for housing, to efficiently convert to or add a business use; and

    - opportunities to allocate highly accessible strategic sites on transport routes to larger scale industrial or distribution uses.

It is therefore necessary to try to attain the highest residential densities and greater mix of land use along major connection streets and in close proximity to commercial concentrations.

Consider the range of housing types required

South Africa's human settlements portray a range of delivery systems and a variety of ways in which communities participate in the housing process. The culmination of these lead to a wide variety of housing types. Housing types differ in terms of materials, permanence, design, internal and external finishes, size and density, layout on the site and in relation to each other, number of stories and functions. There are also certain house types geared specifically towards the rental market and others which are for private ownership. The determination of house type is dependent on:

- residents or households, understood within their societal context and described in terms of such qualities as age, gender, opinions, beliefs and skills of members;
- the dwelling and how it is used by household members;
- existential context or setting of the household which includes relations with various social groupings, including family groups, neighbourhood groupings, labour associations; wider political and economic conditions of the society; and a household's material conditions, including qualities of site and climate and the households access to resources; and
- the individual dwelling within the broader settlement, with qualities of form, substance, function, meaning and locality.
- It is therefore necessary to provide a range of residential lot sizes to suit the variety of dwelling and household types within the area, and dimensions that meet user requirements. A variety of both lot sizes and housing types throughout settlements facilitate housing diversity and choice and meet the projected requirements of people with different housing needs. Figure 5.6.1 is a representation of a layout that achieves a diversity of lot sizes and shapes.

Figure 5.6.1: Diversity created by different lot sizes and shapes

Consider the site context

It is important to keep in mind that land subdivision does not occur in a vacuum but is largely influenced by the surrounding natural features as well as the existing adjacent settlement structure. The success of a site's subdivision in achieving a distinct identity and "sense of place" can be measured in terms of how well the design relates to the specific site and its wider urban context. The context and site analysis are therefore crucial means through which the design will achieve these outcomes, and will also identify any features that will add value to a development by accentuating its "uniqueness" or "character".

The purpose of context analysis is to ensure that new subdivision and development is connected to, and integrated with, surrounding natural and developed areas, including planned and committed development for adjacent sites. The site analysis will ensure that site features (natural and cultural assets) and constraints (including noise, soil erosion, poor drainage, saline soils and fire risk) inform the layout decisions to enhance local identity.

Natural features

The land form and its features on which a settlement is developed, are the foremost determinants of that settlement's form. In considering the landscape, we are seeking its character. The prominent features of the landscape (ranges of hills on the horizon, plateaus) can be employed actively as sites or passively as vistas. They can be used as major vista objectives from points within the city or as special sites for buildings. Some are better left in their natural state.

Topography

Land subdivision should aim to accentuate diversity in land form, and the topography of the site is the most important structural element to start with. Topography is a major determinant of a site plan because topography influences the type and cost of development, controls the direction and rate of water runoff, adds variety to the landscape, influences the weather and climate, and affects the type of vegetation and wildlife. High costs relating to grading and site improvements are associated with hillside sites. From an environmental perspective, as the slope increases, erf sizes should also increase to prevent excessive run-off. Where the cost of improving lots needs to be kept to a minimum, gently rolling, well-drained land is most desirable. Very flat sites present problems of sewer and storm drainage that can raise costs of improvement. Flat sites must be sculptured into contours and elevations that create variety in the siting of the houses as well as a functioning infrastructure system (ULI 1990).

Soil conditions

If the soil conditions are good for cultivation there is a reason for large private plots, allotments or other areas the residents can use for food production. Heaving clays or collapsible sands often require costly foundation solutions. In order to cover these costs and make the development in lower income areas more viable, erf sizes need to be decreased to provide more cost effective solutions.

Streams and flood plains

Stream patterns need to be taken into account in the subdivision of a site in order to ensure that the subdivided land drains effectively. No subdivision may take place within the 50-year flood plain of streams and rivers, which often results in this land being set aside for open space.

Plant cover

It is important to retain as much of the existing plant cover as possible during the subdivision process. Established foliage (mature trees) gives an "established" feel to a new development and could be preserved in most cases in a land subdivision, with minimal cost implications.

Frontage

Whenever possible within the subdivision layout, residential erven should be orientated to maximise the northern aspect. In the case of block subdivision of smaller erven, it is preferable to orientate the blocks to run east-west rather than north-south as fairly narrow dwelling units within a north-south block configuration tend to over-shadow one another. However, in some instances (e.g. KwaZulu-Natal) it is not always possible or necessary to have erven subdivided in order to maximise the northern aspect.

Wind

Changes in wind direction during the various seasons can be utilised within subdivision layout to assist, to a limited degree, with creating a more desirable micro-climate within the settlement. It is often to the overall settlement advantage if block subdivision can be orientated to allow cool summer breezes to move through the settlement while winter winds are diverted. The influence of winds on the settlement pattern can be seen to be particularly important in the coastal regions which tend to be more susceptible to wind patterns. Micro-climates should also be taken into account with particular reference to land sea breezes and anabatic and katabatic winds which could influence the micro-climate.

Noise

A site constraint that has a profound impact on the quality of place of a settlement and which can be rectified by layout and land-use planning is noise pollution. Effective noise buffering can be achieved where settlements - abutting external noise-sources such as arterial routes, railways or industries - provide lots capable of accommodating:

- non-residential uses which provide a shield to residential uses behind;
- home-business uses with the workplace providing the buffer; and/or
- dwelling layouts which locate the more noise-sensitive rooms away and protected from the noise source (see also *Ecologically sound urban development*, Sub-chapter 5.8.2).

Cultural features

No population group or community is completely homogeneous, but different people have varying needs, preferences, aspirations, tastes and expectations. The relevant characteristics, needs and constraints of the community or anticipated target market are crucial informants that should guide land subdivision - especially with regard to levels of affordability (income profile) and community and individual preferences (e.g. it should be determined whether provision must be made for agricultural activities, whether there will be need for large communal stands, etc). A further

example could be if the community tends to live within an extended family structure, larger erven would need to be created to allow for the incremental development of the dwelling unit. Whether the community is highly mobile or not is an additional feature which would result in alternative subdivision layout patterns.

An aspect that needs consideration in this regard is that of social networks. These networks should be reflected in the planning layout in order to increase the complexity and enrich the physical plan. The subdivision of an area into blocks, streets, courtyards and houses, should be coordinated with the size and organisation of communities, street committees and other groups with common interests. A strong connection between such groups and the plan could encourage residents' own initiatives and influence them to take more responsibility for their living environment (Hifab 1998).

Accommodate change

For settlements to be flexible over time, the layout must be able to accommodate mixed and changing land uses. It is therefore important to ensure that a reasonable variety of house types is attainable, in order to ensure adaptability over time. It is also necessary to plan for future/expected developments that will impact on the settlement like a major urban centre or railway station. In these cases, lot dimensions and development should be designed to facilitate future intensification.

When undertaking land subdivision one needs to provide a certain number of larger erven to accommodate various public facilities. In the past these facilities were usually located in a centralised position within the residential precincts. These facilities, due to their location, are unable to cater for changing community needs as they serve a limited range of users. If those users' needs change, the facility could become obsolete. If, however, the erven that are to accommodate community facilities are located along routes of high accessibility, the facilities' catchment area increases and is also more diverse, and the chances of its sustainability over time therefore increases.

Enhance the effective use of resources

To enhance the land and energy resource efficiency of a layout the following design factors should be considered:

- maximise the number of solar-oriented lots;
- maximise the number of lots;
- minimise the slope of roadways and lots; and
- minimise total costs for on-site infrastructure.

QUANTITATIVE GUIDELINES

Block size

The geometry of the block and the size and relationship between blocks is a basic determinant of urban form. While it does have inherent flexibility of arrangement and use, it is also the source of great difficulty where urban accent is needed. A block can be too long or too short - too long to provide rhythmic relief and lateral access, and too short to allow substantial development. The size of blocks will be influenced by the expected nature and mix of land-use activity on the site and the attempt to optimise efficiencies in terms of pedestrian and vehicular movement.

The subdivision of settlements into a specific block type has an impact on the movement and circulation systems within the settlement. The large scale production of motor vehicles has also resulted in the development of superblocks which allowed for a reduction in the number of intersections to facilitate optimum traffic movement along the length of the blocks, while at the same time reducing traffic flows through the residential precincts. The standard application of the superblock layout to the majority of residential settlement layouts has proven problematic in areas of low car ownership, as the superblock has been found to constrain pedestrian movement.

In areas of low car ownership, fairly short blocks of approximately 100 m in length are most appropriate. As the block length decreases, the number of through connection increase for pedestrian movement. On the other hand, shorter block lengths imply that more street area needs to be constructed, which in turn increases the costs and also results in fewer erven being provided with a resultant loss in gross density.

Block widths have not been found to exhibit the same problems as block lengths, as the maximum widths of blocks usually does not exceed 60 m in length. A consideration in establishing appropriate block widths is safe road intersection spacings. It has, however, been identified that intervals of between 30 to 40 m are necessary, in order to provide for adequate driver visibility and safe clearance (Behrens and Watson 1996).

The scaling down of large blocks could be beneficial in creating a sense of belonging, especially for children. In a low-income development like Joe Slovo Village in Port Elizabeth (Hifab 1998), micro-community units of 10 to 20 people make their own plot cluster layouts. The bigger the group, the larger the combined resources which can be used for the common activities. Smaller groups might work more easily together. In Joe Slovo Village, 12 families are found to be a suitable number to form a micro-community around a common space. The group decides on the layout and how to

use the central space, e.g. as a park, a playground, or for gardening, etc.

Land utilisation

In order to assess the efficiency of land utilisation within the proposed block subdivision, Behrens and Watson (1996) have identified the following methods to access layout efficiency:

- Network length: area ratio
  This ratio measures the length of road network in relation to the area served. In general, the lower the value of the ratio the more efficient the network. A suggested target value is 150 - 230 m/ha.

- Network length: dwelling unit ratio
  This ratio measures the length of road network relative to the number of dwellings within a given area. In general, the lower the value of the ratio the more efficient the network. The area and dwelling unit ratios need to be considered in conjunction, because narrower erven in a two erf-deep block, implies a longer road network for the same erf area. A suggested target value is 5 - 10 m/du.

- Frontage: depth ratio
  This ratio measures the width of an erf relative to length. In general, the greater the ratio (i.e. the shorter the erf frontage) the more efficient the layout. Narrowing erf frontages and reducing plot sizes effectively reduces the network length per erf and increases erf densities. A suggested target value is between 1:5 and 1:3.

- Residential density
  Density measures have two interrelated components. The first is the density of residential dwellings. Gross residential density expresses the number of dwelling units divided by total site area, and net residential density expresses the number of dwelling units divided by that part of the site taken up by residential use only. The second is the density of population, expressed as the number of people divided by the site area. Appropriate densities are specific to a range of social, economic and environmental factors - with a gross density of over 50 du/ha likely to be appropriate in most developing urban areas of South Africa.

- Land utilisation index
  The index, or land use budget, identifies the proportional use of land. Land uses are conventionally broken down into residential, commercial, industrial, public facilities, public amenities and movement. Appropriate proportions of land uses, particularly commercial, industrial and public amenity uses, are context specific. However, as a rule of thumb, at the local area layout scale, residential, commercial and industrial uses should take up approximately 55% of land, public facilities and amenities approximately 25%, and movement less than 20%.

These tools of evaluation may be used to assess the benefit of the use of various block designs in a proposed subdivision layout. It should, however, be cautioned that these indicators should only be used as a guide. The context of the site which is to be subdivided, as well as both the physical and cultural context of the site, may result in one form of subdivision being preferable to another. This is despite the land efficiency index indicating that an alternative subdivision is preferable from a technical efficiency perspective.

Erven size and arrangements

The housing type or land use which is to occupy the erf generally determines the dimensions and the extent of the required erf. Single detached and semi-detached dwellings usually should have a minimum erf width of 8 m while the minimum width of erven for row housing is identified by Behrens and Watson (1996) as being not less than 5 m to ensure that acceptable sized rooms can be created. Multi-unit developments such as cluster housing and blocks of flats, offices or shops, have much wider and larger erven and can even occupy an entire block.

According to Chakrabarty (1987) an erf dimension with a frontage: depth ratio of 1:2 is generally acceptable. Behrens and Watson (1996) identify that ratios of between 1:5 and 1:3 are also acceptable. It is however important that the erf is of suitable dimensions for the structure being accommodated on it.

In order to achieve higher densities the size of subdivided land can be reduced. According to Dewar and Uytenbogaardt (1995) erf sizes of 60-100 m^2 are entirely adequate for habitable purposes. By encouraging vertical expansion into 2, 3 and 4-storey walk-up forms, the density of an area can be increased. The increase in density should go hand-in-hand with the provision of effective public and recreational spaces and streets to counter the lack of space on the smaller stands. When planning for erf sizes of these proportions, specific attention needs to be given to detail such as privacy, ventilation, roof slopes etc. For example, when making use of shared walls between dwelling units (party walls) due to the cost and space advantages, sound privacy could be a problem and proper care must be taken to minimise this.

As smaller stands reduce the potential for on-site agricultural activities, providing extra rooms for sub-letting, running a small business from home etc., larger stands that provide the opportunity to use the available area for these types of income-generating activities also need to be provided. This should,

however, not be seen as a reason why all stands should be big enough to accommodate this kind of activity since not all of them will be used for that purpose.

The impact of residential density on the cost of service provision is different for each service. The total cost of water and sewerage provision, for example, increases as density increases, with larger and more expensive piping requirements. On the other hand, because costs are shared by more users, the net cost is lower. The cost of other services such as street lighting remains fairly constant irrespective of density (Behrens and Watson 1996). It is also found that certain services only become viable at a certain density, such as public transport, for example, which requires densities in the region of 50 to 100 dwelling units per hectare to be viable.

As density increases, so servicing costs of a particular land subdivision would increase. Increased densities result in an increase in the number of service connections which have to be installed and possibly a higher standard of services to cope with the increased demand. Bulk service contribution payments which are usually made to the local authority for the construction of the bulk services network to deliver services to the proposed subdivided site, are based on the proposed density of the development on the site and consequently the increased demand. The exact formulae which local authorities use to determine bulk services vary between local authorities and also vary according to the service which is being provided.

Generic block subdivision options

Grid layout

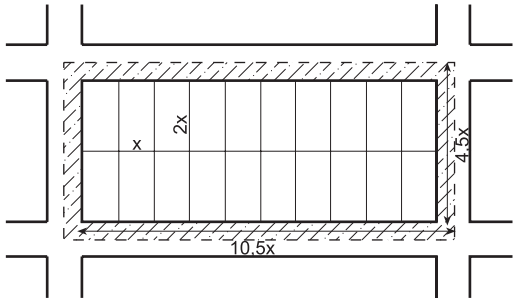

Figure 5.6.2: Conceptual diagram depicting the grid layout

Positive aspects

- The grid layout is possibly seen as the most permeable form of settlement layout, as traffic and pedestrians are able to penetrate and circulate indiscriminately within the settlement area.
- The grid subdivision pattern does not necessarily have to fit a rigid rectilinear pattern, but could also follow a more curvilinear arrangement.
- By virtue of its accessibility, the grid subdivision pattern tends to allow for the stimulation of greater economic opportunities, especially at the intersections of the grid.
- Grids may be aggregated or disaggregated into coarser or finer levels of resolution.

Negative aspects

The high degree of accessibility within the grid layout tends to have negative cost implications in relation to other block subdivision patterns. It is difficult to achieve the same network length: area ratios, network length: dwelling unit ratios, and residential densities of alternative subdivision patterns.

Aspects to ensure optimal design

- Short block lengths tend to increase the servicing costs, at the same time they also result in a high number of cross streets increasing traffic hazards and travel time through the area.

- The longer the block becomes the smaller the network length per dwelling unit becomes, the smaller the average road length, and the lower the costs of road development and service reticulation. The length of the block is, however, a trade-off with pedestrian movement within the settlement. Blocks cannot be excessive in length as pedestrian movement through the overall grid system decreases as blocks increase in length.

- Crosswalks through long blocks may be provided especially where a nearby shopping centre, school or park is located in order to prevent a larger number of residents of a neighbourhood being forced into circuitous routes in order to reach their destinations. It is, however, important that if crosswalks are utilised, they are clearly identifiable and well maintained.

- By reducing the width of the erven while keeping the erf size constant, it is also found that a more economic grid block subdivision can be created. It should, however, also be cautioned that the width of the erven cannot be narrowed without taking into account the functionality of the erf and the proposed housing type to be located on the erf.

- In order to further increase the width of the block in relation to its length, the introduction of pan-handle stands to produce a 4-stand deep block can be seen as an alternative.

Loop subdivision layout

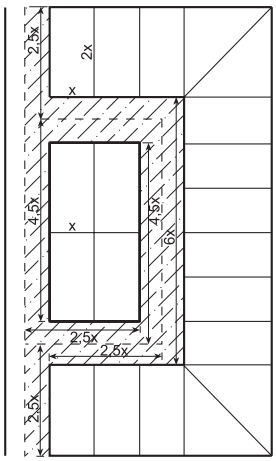

Figure 5.6.3: Conceptual diagram depicting the loop subdivision layout

Positive aspects

- Loop layouts can be seen as a common form of access street.

- The loop type layout provides greater efficiency in terms of network length : area ratios, network length : dwelling unit ratios, and residential densities, than the grid subdivision pattern.

- In high-mobility areas the loop subdivision pattern reduces vehicular movement through the residential environment.

Negative aspects

- The loop subdivision pattern is usually associated with the creation of superblocks, which tend to constrain pedestrian movement.

- Loops have been found to increase the number of intersections on distributor roads.

Aspects to ensure optimal design

- As in the case with the grid subdivision layout, the loop subdivision layout can also be made more economical by narrowing the width of erven and increasing the block length within the loop.

- In order to lessen the number of intersections which loops may make with the surrounding distributor road, the shape of the loop may be altered to the “P-loop” design which effectively reduces the number of intersections by half.

Cul-de-sac subdivision layout

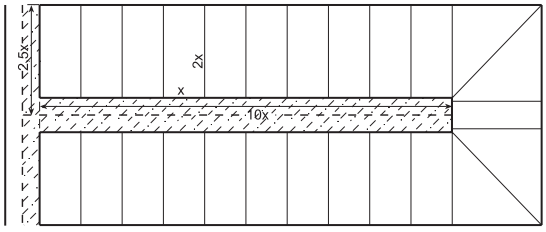

Figure 5.6.4: Conceptual diagram depicting the cul-de-sac subdivision layout

Positive aspects

- The length of the cul-de-sac can be seen to have little impact on cost efficiency, as the entire length of the road is fully utilised.

- The cul-de-sac type layout also assists in the separation of traffic and pedestrian movement in close proximity to the houses.

- In certain cases the cul-de-sac can also be utilised as an activity or play area, reducing the amount of additional open space required in the overall layout, which in turn would impact on the overall land budget.

- Servicing costs can be reduced as the erven surrounding the cul-de-sac are serviced by way of an extension of the main service line.

Negative aspects

- Where culs-de-sac are relatively short, local authorities tend be hesitant in taking over the maintenance of such small areas of road.

- Refuse removal is also a concern of the local authority, as waste removal trucks are too large to enter the cul-de-sac if no turning circles are provided. In these cases the residents may be required to place their waste on the access road at the entrance to the cul-de-sac.

- It is also important that stormwater be carefully considered within this type of design in order to ensure that it can drain out of the cul-de-sac.

- Problems have also been identified in terms of circulation within culs-de-sac in that access to the interior erven can be impeded by a blockage at the open end, and that traffic at the open end can become undesirably high if the streets are too long and access to a large number of homes are provided.

- Culs-de-sac can be highly negative when utilised in the design for subdivisions in communities which rely heavily on pedestrian circulation, in that they tend to constrain the free movement pedestrians through the settlement.

Aspects to ensure optimal design

- The only significant efficiency aspect which can be identified is, as in the previous examples, to reduce the width of the stand while maintaining the size of the erf.

- The restrictions which culs-de-sac exhibit to the movement of pedestrians through the settlement can be alleviated to some degree if pedestrian crosswalks are provided between the heads of two adjacent culs-de-sac.

Woonerf subdivision layout

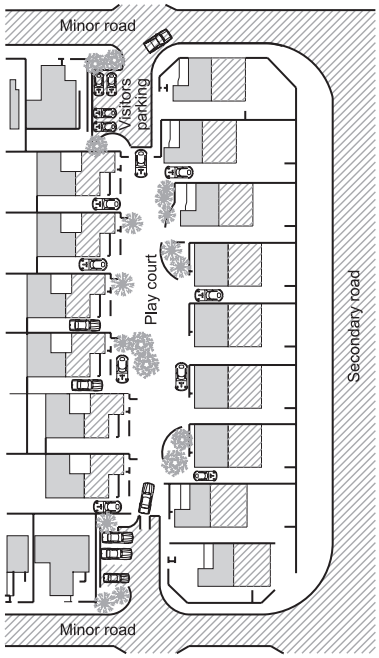

Figure 5.6.5: Conceptual diagram depicting the woonerf subdivision layout

Positive aspects

- This type of sub-division is characterised by fairly small stands usually of approximately 150 m^2 in extent. Therefore fairly high net densities of up to 62 dwelling units per ha can be achieved according to Kitchin (1989).

- Houses are usually attached or semi-detached, facing onto a paved court. Although vehicles are allowed to move along the street, their progress is restricted by the street design which is orientated more towards pedestrian movement and other activities.

- The accommodation of play areas within the road reserve should impact positively on the land-use budget, as less land will need to be set aside for open space.

Negative aspects

- As with the cul-de-sac design it has been found that stormwater runoff needs to be carefully considered, as large built and paved areas result in increased runoff.

- The different boundary setbacks of the housing units as well as the paving and landscape design of the play court areas can result in an increase in the total layout cost.

Cluster

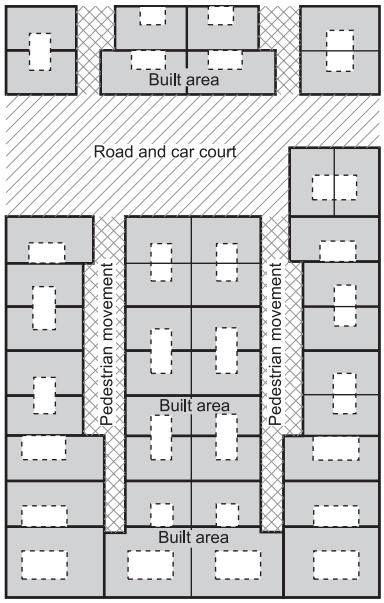

Figure 5.6.6: Conceptual diagram depicting the cluster subdivision layout

Positive aspects

- Where physical characteristics of the site to be subdivided, such as slope or dolomitic constraints, prevent the creation of the standard subdivision layout, alternative pedestrian-based layouts may have to be considered.
- In order to ensure that stable foundations are created in these cases at affordable cost levels, dwelling units have to be accommodated in a row-housing type of configuration.
- It has been identified by GAPP Architects (1997) that densities of over 55 dwelling unit per gross hectare can be achieved using this type of subdivision design.
- Access to the individual units is by way of pedestrian walkways, with a centralised parking court provided for residents who may own a car. It is seen as sufficient access for communities who rely predominantly on pedestrian mobility.

Negative aspects

- The consequence of the site constraints (for example dolomitic risk zone requires suitable structural base and standard of services) would be that the individual erven would be on average between 60m^2 to 90m^2 in extent.
- Due to the density and coverage of the site, mainly hard spaces are created which would have to be designed carefully.

Services

The subdivision and block layout have very tangible implications on the cost and maintenance of services (Figure 5.6.7). Not only the size of stands, but also the shape thereof has an influence on the layout and cost of services. The overall cost for infrastructure provided

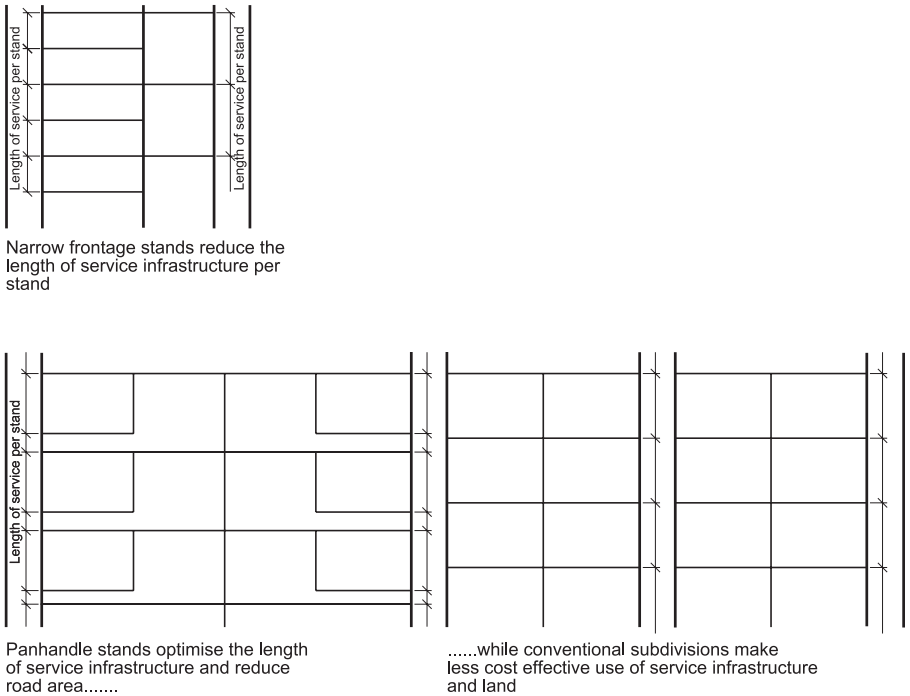

Figure 5.6.7: Optimising service infrastructure through erf layout

along any given street stays more or less the same regardless of the number of stands serviced along the street. Therefore, the narrower the street frontage of the stands, the more dwelling units share in the cost of the services and the lower the infrastructure cost per dwelling unit. It is therefore usually better to provide narrow, deep stands.

It is generally accepted that manholes are required at approximately 100 m interval for the maintenance and repair of services such as sewerage as well as optimising the cost for the installation of such services. It is also necessary that block lengths are kept as straight as possible as any changes in direction of the services requires an additional manhole to be added (see sub-chapter 5.1).

Service reticulation can also be seen to influence the more detailed subdivision of the block into individual erven. Services can either be reticulated in the middle of the block or running within the road reserve. The mid-block reticulation of sewerage, water supply, electrification and telecommunication cables is often favoured in lower income areas for cost reasons. By not having to contend with traffic loads and other services in the road reserve, services located at mid-block can be laid at shallower depths.

Apart from these advantages there are some hitches associated with mid-block reticulation, resulting from its location. Gaining access to the services in the mid-block is often found to be problematic with owners refusing access to council workers purely due to owners being at work during the day. Illegal second dwelling units which are constructed to the rear of stands are often over the mid-block services, which results not only in additional inaccessibility but the weight of the structure on the services may also result in damage.

When erven are smaller than 10 m in length, it becomes inefficient to design conventional two-erf deep blocks, as the block widths of 20 m have proved to be dangerous from a vehicular perspective. Numerous subdivision patterns, like pan-handle erven or blocks with pedestrian-only routes, can increase the number of erven between road reserves. The latter assumes that erven within the centre of the block will never require private vehicular access. Four-erf deep subdivision patterns offer servicing advantages, as more erven can be serviced from a single service running in the road reserve. It should be noted however, that households often prefer erven with street frontages because of the trading opportunities they offer, better security by being in the public view and the awkward toilet locations that can result on inner erven.

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Chapter 5.7

Public utilities

5.7

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PUBLIC UTILITIES

The purpose of this sub-chapter is to describe guidelines for the planning of public utilities. Utilities are, for the purposes of this sub-chapter, defined as engineering services including water, sanitation, roads, stormwater drainage, energy supply, solid-waste removal, communications in the form of telephones, and postal collection and delivery.

Collective utilities and residential utilities are defined as follows:

- Collective services (utilities) are those services consumed off-site, to satisfy either community or domestic service needs. Community service needs relate to movement, drainage, public safety, outdoor manufacturing, market trading and social interaction. In the case of domestic needs, the service is transported to the household site for consumption within the dwelling or on the site. In the case of community needs the service is used within the public environment. Collective services include water supply in the form of public standpipes, sanitation in the form of public toilets, roads and stormwater drainage, energy supply in the form of metered electricity dispensers in public markets, the lighting of public places (including street lighting), solid waste removal in the form of rubbish collection points, and communications in the form of public telephones and post-collection points.

- Residential services (utilities) are those services consumed on-site, to satisfy domestic household service needs. The service is used either in the individual dwelling, or on the site. Residential services include water supply in the form of house or yard taps, sanitation in the form of in-house or out-house toilets, energy supply in the form of electricity or gas, solid waste removal in the form of kerbside rubbish collection, and communications in the form of private telephones and postal delivery (Behrens and Watson 1996, p 81).

Many forms of collective utilities are described in the available literature. But, invariably, these are designed and built for single utilities, e.g. as water points, communal ablution blocks, or as post-delivery points. The purpose of this sub-chapter is to go beyond these single-utility views, and show how multi-utility collective points can provide convenience, be attractive in their own right, and go a long way to resolving the health threats presented by the litter, poor drainage and physical danger so prevalent in communities, especially where large numbers of people gather every day (e.g. taxi ranks and informal markets).

FOCUS AREAS

The sub-chapter has four focus areas, as follows:

- Utilities in settlements are only a means to an end.

- The provision of utilities cannot be divorced from site-specific and community-specific characteristics.

- Link and internal infrastructure (utility) provision, the process of settlement formation, and the planning and design of collective utility systems.

- The processes of planning and design, construction, operation and maintenance, and the upgrading and eventual replacement of utility systems.

Utilities: A means to an end

Utilities in settlements, whether collective or to households, are only a means to an end. The "end" can be variously defined but it certainly includes, for the households living in that settlement, greater health and safety and greater access to income-earning opportunities and amenities. Understanding of this is essential in

- addressing the end by the most appropriate means (which may not be an engineering service, but education, or institutional change);

- integrating the utility with other means to the same end; and

- selecting levels of service and standards.

The decision to provide utilities in a settlement, and what utilities, how and when, must be part of an integrated decision-making and (particularly) prioritisation process; then the investment in a utility must be part of a package of interventions.

Site- and community-specific characteristics

The provision of utilities, whether collective or to households, cannot be divorced from site-specific characteristics (e.g. topography) or from community-specific characteristics (e.g. institutional structure, affordability). For example, one community may have no need for collective utilities, whereas another may be unable to afford (in the financial sense) anything but collective services.

No one should have difficulty with the concept that site-specific characteristics such as topography are fundamental to the provision of utilities. It may, however, be of value to consider why and how community-specific characteristics would affect the provision of utilities. For example, the assumption

that certain health- and safety-related ends will be achieved if certain levels of service of utility infrastructure are provided, and that, if complementary services are also provided, it will constitute a sufficient holistic package of health and safety, might be true for more affluent South Africans.

The assumptions are, however, probably not true for the less affluent. In a total public sector budget for health and safety services, for example, too much emphasis on only one aspect (say, water and sanitation) could - for the less affluent - reduce the resources available for other services. There is an evident need for a holistic view of the range of urban services (including utilities) before decisions are made on basic need levels, and before investments are made.

Linkages

This focus is on the relationship between link and internal infrastructure (utility) provision on the one hand and the process of settlement formation on the other, as well as on the planning and design of collective public utility systems.

These links, together with the fourth focus area, lie at the heart of this sub-chapter. These two foci lead directly to the development of appropriate guidelines on: (1) the integration of issues relating to the provision of utility infrastructure, and issues relating to land-use planning and settlement formation; and (2) the planning and design of collective public utility systems - indicating key functional interrelationships with other planned elements.

Process

The focus concerns the process of planning and design, the construction, operation and maintenance process, and the upgrading and eventual replacement of utility systems, whether collective or to households.

It must be noted that selection of utilities and their levels of service, and the planning and design of the selected utilities, are, wittingly or (often) unwittingly, made in the context of a set of planning, design, construction, operation, maintenance and upgrading assumptions. These assumptions relate to the following questions:

- How will the utility, its level of service, and the chosen technology suit conditions expected in practice? Examples of these conditions are
  - geotechnical and groundwater conditions;
  - type of housing and its density; and
  - frequency of use of the utility (for example: how many persons per utility, and how much of each day are they using the utility?).
- How will the utility be constructed (i.e. workmanship)?
- How will the utility be operated and maintained?
  - by the individual users; or
  - by the corporate agency (community, NGO, private company, local government)?
- Other elements upon which the success of alternatives is dependent (principally, assumptions as to institutional capacity, enforcement of regulation, monitoring of use, adequacy of funding for operation and maintenance, and so on).
- What complementary services are required? For example, if a collective water service is provided, will sanitation also be provided, or at least a means of dealing with sullage, and vice versa?

It must further be noted that the (majority) reported experience of operation of collective utilities in South Africa is that incorrect use of these facilities, abuse and vandalism are widespread; also that maintenance often ranges from insufficient to non-existent. This should heavily influence design and construction decisions, and should also require that the process of collective utility provision, including that of utility management, be done with greater care.

QUALITATIVE GUIDELINES

Hierarchy of collective utility points

A hierarchy of collective utility points ranges over a continuum from

- lower-order collective utility points within primarily residential areas, mostly used on single-purpose trips from the house to the utility point and back; to
- higher-order collective utility points at public gathering points such as at modal interchanges, public markets or community centres, often used on the way to or from home or to (in addition to patronising the utility point) work, school, recreation, shopping or some other destination(s).

In practice, it is found that the following differ greatly from the one end of the hierarchy to the other:

- thresholds and catchments;
- space standards;
- numbers of users at any one time;
- distribution of use through the day and through the week; and

- the type of utility needed, and the combinations of these with each other and with other facilities.

As an example, consider the lowest-order end of the hierarchy. The great majority of the usership of a facility in a residential area is often that resident within a catchment defined by a walking distance within (depending on the facility) a number of minutes of the facility. If the population within that walking distance is large enough (i.e. above the threshold), the facility is potentially sustainable. However, the usership of a facility at a public gathering point - for example a modal interchange - is less dependent on the walking distance to that facility, and thus on its catchment, than it is dependent on the numbers of people who change modes at that interchange, the attractiveness of other facilities (e.g. the market) there, and so on. An example at the higher-order end of the hierarchy would be a modal interchange at a major road intersection at the edge of an urban area - few people have their homes close by, but many people spend time there waiting for transport - and thus need and would probably make use of the utilities there.

A significant implication of Chapters 2 and 3 is that, as new settlements are planned and existing settlements are grown in terms of these concepts of settlement formation, land uses will mix to a far greater degree than at present. Given that, there will be more public gathering points at lower levels and thus more need for collective utility points that serve both residences and public gathering.

Where a full range of residential utilities cannot for various reasons (of which affordability is often one) be supplied to each residential site, it may be worthwhile to supply some of these at an accessible, collective point. If these utilities could also satisfy the collective needs of a taxi rank or a market, that would be more efficient - but such a situation would be the exception. However, it is very likely that, at even a lower-order collective utility point, a couple of small entrepreneurs will set up - selling food, or providing a repair service, for example. This emphasises both the hierarchical nature of the demand for utilities and the need to provide a hierarchy of collective utility points.

The design of any collective utility point will be simplified by an assessment of the design demand separately by the extent to which it concerns both lower-order and higher-order collective utility demand, and then by their aggregation. This distinction is important in terms of design elements such as the location and utility mix of the collective point. Thus the following section deals primarily with lower-order collective public utility points, and the section after that with higher-order collective utility points.

Planning of utilities to optimise fulfilment of entrepreneurial, social, recreation and other needs

In Chapter 3, the planning of settlements to create favourable spatial conditions for entrepreneurs has been laid down as a primary determinant of settlement-planning. In addition, how collective utility points can be located to reinforce these entrepreneurial conditions and maximise their access to users has been specified as a very significant contribution that this sub-chapter can make to successful settlement-planning. However, how collective utility points can be located to support and enhance social, recreation, education, safety and other needs in a settlement, is of equal importance.

Several mutually reinforcing means are described whereby conditions can be optimised to fulfil entrepreneurial, social, recreation, education, safety and other needs. Principally these are

(1) concentrate local through-movement on stop-start activity routes;

(2) provide accessible public spaces which create opportunities for collective activity;

(3) incorporate public markets as an element of essential public infrastructure;

(4) cluster facilities (including utilities) to enable resource-sharing;

(5) integrate open spaces with utility services; and

(6) align trunk utilities to important routes.

(1) - (4) Location of collective utility points to maximise their access to users

Collective utility points (e.g. public standpipes, public telephones, post collection points, solid-waste collection points, metered electricity dispensers, and public toilets) should be clustered around public markets and hard open spaces, to create favourable small-scale manufacturing and trading conditions. Also, in cases where these utilities perform residential functions as well, they enable local residents to satisfy several needs in a single trip. The clustering of utility points provides the utilities necessary for small trading operations, and attracts potential consumers to specific points in space.

Public facilities are intensively used by large numbers of people, and, through the creation of “load centres”, can generate a large demand for utilities. As a result they can be used to “pull” service mains economically through a settlement, with facilities and the public spaces they abut,

accommodating a range of utilities often not supplied to individual residential erven (e.g. telecommunications, solid-waste collection, postal delivery).

Settlement layouts should locate public markets and squares, and their associated collective utility points, to ensure that all households have convenient pedestrian as well as motorist access and that a single trip can satisfy a number of needs - entrepreneurial, social, recreation, education, safety and other needs. In order to achieve this, planners and engineers require an understanding of the range and threshold requirements of, and functional relationships between, the different collective utilities.

(5) Integrate open spaces with utilities

The design of public open space networks should be integrated with the design of utility infrastructure networks. In particular, interconnected soft open space systems should be integrated with major stormwater management systems (i.e. open stormwater channels, retention and retarding ponds, etc.). Open spaces and clusters of playing fields, should take up low-lying land subject to periodic flooding, acting as overflow facilities in the event of severe storms, while stormwater outfall and storage facilities should be used as landscaping features within the amenity network (See Sub-chapter 5.4 on Soft Open Spaces).

(6) Align trunk utilities to important routes

Where possible, trunk utility lines should be aligned to more intensive movement routes which link public facilities and non-residential land uses, and electricity sub-stations (which transform high-voltage current into low-voltage current for the purpose of residential reticulation) should be located close to public facility clusters (i.e. "load centres").

In this way, full water, sewerage, electricity, public lighting and telecommunication connections can, from the beginning of the infrastructure-provision process, be made to commercial services, small-scale manufacturers, and public facilities like schools and health clinics. Similarly, in cases where adequate road surfacing is not affordable on all roads, public facilities should be connected by a network of surfaced roads to ensure the effective provision of regular road-based services.

In situations where water reticulation to residential areas is not designed for additional fire fighting flows, water supply ring mains with greatest capacity and pressure should, where possible, be aligned to intensive activity routes. This will ensure that, at the very least, public facilities like schools and community centres are adequately covered by fire hydrants and associated fire-fighting services (See Sub-chapter 5.8.3 on Fire Considerations).

Figure 5.7.1 and Figure 5.7.2 illustrate the above.

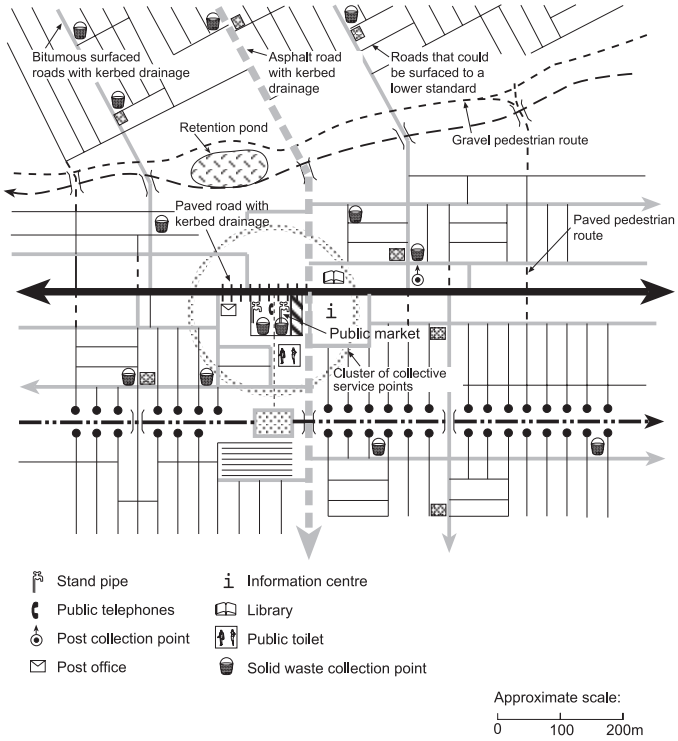

Figure 5.7.1 Conceptual diagram of key spatial relationships relating to collective utilities within greenfield projects

Source: Behrens and Watson 1996, p 103

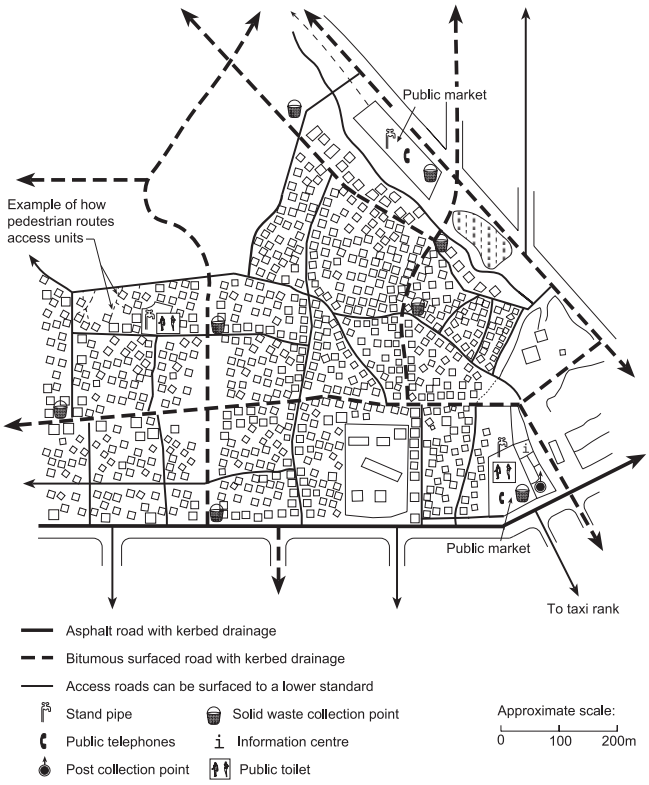

Figure 5.7.2 Conceptual diagram of key spatial relationships relating to collective utilities within upgrade projects
Source: Behrens and Watson 1996, p 111

They indicate the spatial relationships of utilities within, respectively, a "greenfield" and an "upgrade" project.

QUANTITATIVE GUIDELINES

Collective utility points primarily serving lower-order collective public utility points

Densities, alternatives and hierarchies

The effect of two contextual factors needs to be made clear in respect of any standards for lower-order collective public utility points.

The density of the area

For example, in densely populated areas, 15-25 dwelling units per standpipe (a rough guide of the threshhold for a standpipe) can be achieved by placing a standpipe at the end of each street, and at a maximum distance of 100 m. In more sparsely populated areas, a walking distance greater than the Redistribution and Development Programme standard of 250 m should not be exceeded, almost irrespective of the threshhold. The walking distance will probably prevail over threshhold criteria.

The availability of residential utilities

For example, in an area which (say) lacks a door-to-door postal service and solid-waste collection service, but where residential sites each have a toilet and a standpipe, the need for collective toilets and standpipes will be much lower than where these are not provided on residential sites. However, at a residential area collective utility point where say solid waste, postal and telephone facilities are provided, collective toilets and standpipes will nevertheless have to be provided for the users of the telephones, nearby entrepreneurs and their customers, and passers-by.

Table 5.7.1 provides only a rough guideline, and the context of the specific area being served must be investigated, particularly with respect to densities and alternative options to the collective utility.

In addition, the place on the hierarchy of the collective points being designed must be borne in mind. For example, if a lowest-order point, to serve 20 dwelling units, includes one water standpipe, a second-order point centred around solid-waste collection, public telephones and post boxes could adequately also have only one standpipe. Although the other utilities here may be serving 200 or more dwelling units, the standpipe is not also serving 200 dwelling units,

but is the standpipe for only its immediate area of 20 dwelling units - and for passers-by, etc, as described above.

Thresholds and time and distance standards

Design decisions regarding public utilities relate mainly to (i) the population catchments they serve (conversely the thresholds that they require in order to be sustainable), and hence the numbers of each facility required in any given area, and (ii) the distance that user households have to travel to gain access to them.

The specific demographic and socio-economic profile of each community should be used to plan and provide its public utilities, as indeed it should be used for any other public facilities, especially those serving primarily residential areas. For example, it is possible that a greater proportion of investment would be required for pre-school facilities within the first five years of a new settlement than for secondary and tertiary education.

Behrens and Watson (1996) point out that standards for individual facilities and amenities are conventionally assessed by considering their "optimal" spatial requirements in isolation of each other. This leads to a number of problems. For example, formulating space standards in isolation restricts the potential of resource sharing and multi-functional use to reduce land requirements. In conditions of resource scarcity this is essential - in cases where neither the local authority nor the relevant government department can afford to develop the planned facilities or maintain public open spaces, land remains vacant and unattended.

Planning, space and engineering considerations

In the absence of detailed information regarding utility performance standards, Table 5.7.1 provides rough guidelines on location, time and distance, size and dimensions and user threshold standards. When used in conjunction with user threshold standards, the set of time and distance standards can act as benchmarks to check the accessibility of utility locations. For these utility points, which are accessed primarily by pedestrians, the standards assume an average walking speed of 3 km/h, or 50 m/min.

Depending on the supporting threshold population, some facilities should be sited in locations accessible to pedestrians, while others should be sited in locations accessible to public-transport users, as well as to a limited number of pedestrians in the local area. Time and distance standards are therefore more applicable to lower-order, pedestrian-orientated facilities - the locations of higher order facilities are determined more by the public transport system, or by other reasons for the public to gather, than by time and distance ranges.

Upgrades, operation and maintenance, links, and detailed design

Provision for upgrading

- The assumption up to now is that public water standpipes (for example) are needed because the residential stands do not have their own standpipes, or that these are over-used (e.g. several families on each stand, sharing one tap). In another example, there has been the assumption that postal delivery boxes are needed because there is no door-to-door delivery service. This situation may change if the services are upgraded - the need for collective utility points would reduce to the extent that each household now received a service at its door or to its site. The design guidelines for these higher levels of service may be found in Chapter 6 onwards (the postal service is not addressed).

- The conversion of collective to on-site household services should take place through incremental in-situ upgrading projects as the community circumstances improve. The need for communal toilets, ablution facilities, laundry centres and standpipes placed at walkable distances from houses would fall away as on-site (residential) services are provided. The public spaces on which these stand could then be rezoned for residential, business or institutional purposes. The prevailing circumstances would dictate.

- With respect to piped services, the design of the link mains, trunk mains and the pipe network for formal townships should allow for upgrading to individual site connections, leading directly to greatly increased water demand in the future. This design philosophy, together with the phased construction/provision of water mains and pipelines only along important movement routes and to collective water utility points, will provide ample capacity to satisfy the peak demand at the public standpipes.

- The design approach of pipe networks for informal settlements should take cognisance of the permanent or temporary nature of the settlement, and the final layout if the settlement is to be upgraded. If a settlement is temporary, the pipe network should be designed to satisfy the minimum (RDP 1994) levels for walking distances and consumption.

Table 5.7.1: Quantitative guidelines for lower-order public collective utility points

UTILITY	LOCATION	ACCESS	SIZE AND DIMENSIONS	USE CAPACITIES AND THRESHOLDS
Collective water standpipes	• Collective standpipes are planned at positions in residential areas to satisfy the minimum service levels, but should also be informed by community needs. • For maintenance considerations it might be preferable to place collective standpipes on private residential sites (maintenance responsibility on owner - see Chapter 9). • Alternatively, the standpipes could be constructed on public open space adjacent to a residential site whose owner would take on the maintenance task.	• In densely populated areas a maximum distance of 100 m and a walking time of two minutes are preferable. • In more sparsely populated areas, a walking distance of 250 m (DWAF 1994, p 15) should not be exceeded.	• Water standpipe and structure should be customised to suit the community needs. • Considerations include acceptable lifting heights, animal watering, whether containers are washed at standpipes, whether hosepipes are used to fill narrow-mouthed containers, need for bulk filling, etc.. • Consider provision of seating or at least an area for queuing or waiting (the area around the standpipes is often used for socialising).	• In densely populated areas a norm of 15-25 dwelling units per standpipe is acceptable.

Table 5.7.1: Quantitative guidelines for lower-order public collective utility points (continued)

UTILITY	LOCATION	ACCESS	SIZE AND DIMENSIONS	USE CAPACITIES AND THRESHOLDS
Communal bath houses	• Sites should primarily be chosen for convenience of access to their catchment area in terms of potential users. • Siting should take account of adaptation and re-use, and whether improved utilities should be provided to residential sites (e.g. conversion to change rooms for sportsfields). • Security considerations are extremely important (see Sub-chapter 5.8.1 on Environmental Design For Safer Communities).	• Walking distance and time of 200 m and four minutes respectively.	• Bath houses require sites with areas in the order of 200-300 m^2. • Public bath houses could have showers and laundry facilities, and also toilets. The laundry basins could be provided inside or outside. • These can be built as part of the same structure as, but with a separate entrance from, other public buildings, so as to share supervisory staff. • A waiting area can be provided under a lean-to outside rather than inside the building.	• One communal bath house could service a maximum of 50 dwelling units or 280 people.

Table 5.7.1: Quantitative guidelines for lower-order public collective utility points (continued)

UTILITY	LOCATION	ACCESS	SIZE AND DIMENSIONS	USE CAPACITIES AND THRESHOLDS
Communal toilets	• Sites should primarily be chosen for convenience of access to their catchment area in terms of potential users. • Sites on which communal toilets are placed could be converted to residential or business sites when upgrading of utilities takes place. • Where possible they should be located next to facilities like schools, clinics and libraries, so that when (if) individualised sanitation is provided, they can simply be incorporated into the public facilities. In this way redundant service provision can be avoided.	• Walking distance and time of 75 m and 1,5 minutes respectively.	• Various sanitation technologies are described in Chapter 10. The factors which influence the choice of each of the particular sanitation systems are detailed. • Subject to the constraints influencing the choice, most, if not all, of these sanitation systems can be used for communal toilets.	• If residential sites do not have their own toilets, it is proposed that a reasonable level of convenience for the users of public toilets can be attained if the ratio is a maximum of two households (12 people) per toilet. • If the communal toilets are supplementary to toilets on residential sites, their number can be reduced accordingly.

Table 5.7.1: Quantitative guidelines for lower-order public collective utility points (continued)

UTILITY	LOCATION	ACCESS	SIZE AND DIMENSIONS	USE CAPACITIES AND THRESHOLDS
Solid-waste collection points	• Sites should primarily be chosen for convenience of access to their catchment area in terms of potential users. • Small containers can be placed on sidewalks, whereas larger skips require larger sites. (See also Chapter 11)	• Walking distance and time of 100 m and two minutes respectively (skip).	• Hard-standing areas need ± 24 m^2 for the trucks loading and off-loading the containers. • Size of containers vary from 85 ℓ to 6 m^3 capacity • Smaller containers (up to 210 ℓ container) are mounted on an axle/pivot shaft mounted on two supporting pillars to prevent dogs overturning them.	• A maximum of 100-150 dwelling units should be serviced by one solid-waste collection point (skip). • Average solid waste generated by low-income urban households is 0,2 m^3/capita/ year at an average density of 300 kg/m^3 - and for middle-income households 0,75 m^3/ capita/ year with density of 215 kg/m^3. • Example: If low-income households (average of 5,6 persons/ household) generate 22 ℓ per week (1,12 m^3/year), the number of households served by a container serviced weekly would be: - 4 per 85 ℓ container - 9 per 210 ℓ container - 270 per 6 m^3 container (skip). (See also Chapter 11)

Table 5.7.1: Quantitative guidelines for lower-order public collective utility points (continued)

UTILITY	LOCATION	ACCESS	SIZE AND DIMENSIONS	USE CAPACITIES AND THRESHOLDS
Postal collection and delivery points	• Preferable to have smaller postal collection and delivery points evenly spaced throughout the residential area. • Need to be highly visible and accessible to the population serviced. • Should be located along activity routes within easy walking distance.	• Walking distance and time of respectively 250 m and five minutes.	• Appropriate dimension of a 50 box structure is 0,6 m wide x 0,9 m long on plan. • Pillar-type post boxes are usually provided for posting letters, but parcels, insured mail, etc, need to be handed in a post offices (see Sub-chapter 5.5, Table 5.5.7).	• One post collection point (one collection/ delivery box per subscriber) could serve 200-1000 dwelling units.
Public telephones	• Need to be highly visible and accessible to the population served. • Should be located along activity routes within easy walking distance.	• Walking distance of 200 m.	• Telkom SA provides public telephones after a needs analysis and projected future demand exercise has been done to confirm the viability of the specific installation.	

Sources of information: WHO 1979; CSIR 1994; Behrens and Watson 1996; Kerr 1989; Kerr 1990; Ninham Shand 1997; various person communications)

- The opportunities for upgrading the technology of sanitation, in the form of descriptions of each of the sanitation alternatives, are dealt with in Chapter 10. Should the upgrade be to toilets on each residential site, the need for public toilets will fall away and the site on which these have been erected can be transferred to private ownership.

- As informal areas are upgraded and developed into formal settlements, the transportable post box structures can "move" with the users and can be made a permanent structure.

- The upgrading of refuse collection services, to collection from the sidewalk outside individual sites, would make redundant the facilities provided at solid-waste collection points. These could either be relocated to other areas still in need of such facilities, or removed, and the service would cease.

Operation and maintenance

Correct operation and maintenance, to enable the utility to provide at all times at least a minimum level of the intended service, is extremely important. However, the operation and maintenance of the collective utility point can often be a problem.

To reduce the incidence of utilities being out of action, and hence reduce construction, operation and maintenance costs, as well as inconvenience to users, public participation should attempt to ensure "ownership" and identified responsibility of individuals or households for the operation, maintenance and cleaning of the utility that they will directly depend upon. The likely effectiveness will be increased if training of local inhabitants in the operation and maintenance of the utility accompanies the infrastructure development. Conversely, design of the utility should take cognisance of the capacity and resources of local inhabitants to facilitate this local operation and maintenance. With respect to operation and maintenance, there are thus two issues:

- it must be established who is to be responsible; and

- design the components for easy operation and maintenance.

Even more important than training in maintenance of the collective utility point, because it must involve all users, must be training in the use of the area. It must be inculcated that good operational practices and maintenance are the responsibility of everyone who comes to the utility point. Thus everybody must see it as their duty to (for example):

- turn taps off after use;

- clean up the area - remove rubbish;

- remove sediment from the standpipe apron, and ensure that the outlet to the soakaway is unblocked at all times; and

- notice when taps are dripping even after having been turned off, and to notify (and to know whom to notify) those responsible for routine maintenance, so that they can replace the washer or other faulty component.

Despite all precautions, however, problems frequently arise in practice. A periodically out-of-order collective utility can lead to the users calling for its replacement by an on-site service, whether this option is affordable or not, or undesirable for any other reason. This is despite there being nothing intrinsically unacceptable about the level of service provided by the collective point, but its operational record has given it (and, often, other collective utilities) a bad reputation.

Personal safety is an important issue in respect of some collective utility points, especially bath houses and communal toilets. There are many reported instances of users feeling unsafe at the utility point and/or on the walk there and back. It is because users have been attacked (the bath houses even became the hiding places of criminals) that some of the few bath houses of the past were demolished (Huchzermeyer 1996, pp 26, 27) (See Sub-chapter 5.8.3).

Link infrastructure

For load capacities of link infrastructure, the appropriate chapters from Chapter 6 onwards should be referred to.

Detailed design

The detailed design of collective utility points is beyond the scope of these guidelines. (Refer, for example, to Ninham Shand (1997), for a recent discussion of more detailed issues on collective water points.)

Collective utility points primarily serving higher-order collective utility points

Design considerations

Opportunities for trading, small-scale manufacturing, repairs and servicing, and other economic activities exist at places where large numbers of people

gather or through which large numbers of pedestrians move.

Reference in this section is thus to guidelines for collective utility points primarily serving public gathering places such as at modal interchanges, bus and taxi ranks, areas of high-volume pedestrian traffic (inner city), major vehicle-entry points to residential areas, along major pedestrian routes to railway stations, etc, public markets or community centres. These utility points are, often, also used on the way to or from home or to (in addition to patronising the utility point) work, school, recreation, shopping or other destination(s).

Design decisions regarding these relate mainly to

- planning considerations, particularly the location of one component relative to another (e.g. high-use utilities at a rail station should be as close as possible to the main pedestrian route between the platform exit and the taxi rank);
- space standards, particularly related to the numbers of users at any one time, and the distribution of use through the day and through the week;
- engineering considerations;
- provision for upgrading;
- operation and maintenance; and
- link infrastructure.

Whereas the guidelines of the previous sections would obviously not be of value in determining the location of collective utility points at public gathering places, they are of value in determining the number of each at the various gathering places.

The forms and functions of public gathering places will vary enormously from one location to another, and each resultant physical form of the collective facility must vary accordingly.

In the planning of new local mixed-use areas, provision should be made for space for sites for trading, but nothing should be designed and built until trading has begun on the site and potential shoppers are living in the vicinity.

With respect to the planning of space for and the design of utilities, there are major differences between public gathering places, including trading centres, in outlying settlements and those in the more established parts of the city, including the inner city. The inner city collective utility need is mostly for management of what is already there, and its upgrading, whereas in outlying settlements the need is to facilitate economic development.

Engineering considerations for the inner city and outlying areas are also different. The extensive presence of underground services below sidewalks, which calls for care in the excavation of foundations for stalls, is one example. The outlying areas, on the other hand, are often without engineering services. There is often thus a need to bring utilities to the outlying market areas but in such a way that these also cater for local residents. In another example, there are space constraints in the inner city - thus it might not be acceptable to place a refuse skip on a sidewalk in the inner city.

The planning of the market areas, taxi and bus ranks, public toilets, access for service and emergency vehicles, pedestrian routes and circulation areas lies within the field of urban design and architectural disciplines. In existing trading areas, railway stations, bus and taxi ranks, information can be gathered by means of vehicle and pedestrian movement counts, which will assist in the planning process.

Planning, space and engineering considerations

Utilities for the public gathering places must be designed in accordance with the engineering guidelines contained in Chapter 6 onwards. To take public toilets in modal interchanges areas as an example, provision of these should be linked to the number of people passing through, gathering or trading, etc. Thus large pedestrian stands require more utilities. For information on determining the numbers of toilets, SABS 400:1990 is of value.

Small-scale manufacturing, repair services and cooking activities require electricity (or other alternative energy sources). Electricity supply can be provided through pre-paid card or code-operated dispensers, which are mounted under cover in lock-up stalls hired by the entrepreneurs.

In other respects, the comments in Table 5.7.1 apply here as well.

Provision for upgrading, operation and maintenance, links, and detailed design

Certain facilities/services fulfil a need of the community even as the opportunities for improvement present themselves. Markets would always be a need, if the locality generates income for the beneficiaries. Similarly, sanitation facilities at public open spaces or taxi ranks would not necessarily fall into disuse were there upgrading or improved circumstances for the community.

In other respects, the comments of the previous section under the same heading apply here as well.

THE GUIDELINES - A CAUTIONARY REMARK

Much of the preceding, it has to be admitted, is to some or other extent "unproven". With few exceptions, each provision of collective utility points in South Africa has tended to share one or more of the following characteristics:

- provision as an ad hoc reaction by the authorities to a land invasion, or gradual overcrowding of a settlement (and overloading of existing services) - as a stopgap which is not improved upon until the next health scare, bout of political unrest, or population influx;

- as a single-utility provision (e.g. collective water in one place, collective sanitation elsewhere, and postal delivery in a third place), with no attempt being made to co-ordinate provision for the greater convenience of the users; and

- a few years after construction, the utility is poorly maintained, vandalised, and/or abused - and often as a consequence avoided by those who, it had been planned, would use the utility.

The last couple of years has seen a dramatic increase in the number of attempts to provide collective utilities in the manner described in this sub-chapter, and in the effort and skill devoted to these attempts. This is especially in respect of those places where large numbers of people gather every day (the modal interchange with informal market, for example). Every situation is so very different from any other that design guidelines must necessarily be broad. These situational differences arise in terms of size, in-town or suburban or outlying area location, type and intensity of activity, history, socio-economic groups using the place, presence (or absence) and state of existing utilities, and juxtaposition of magnets (the markets, public transport boarding points, office or shop destinations, etc).

It should, however, be noted that, understandably in the current situation of financially-strapped local authorities (who are usually the developers of these collective utilities), the available resources have had to be given to the worst situations, which usually has meant those affecting the largest numbers of users. Thus the projects available for study, whether projects being planned or already built, are generally at places where large numbers of people gather each day

- to break their commuting journey (i.e. interchange between some combination of walk-taxi-bus-train (less frequently, car or truck; even less frequently, cycle));

- to shop; or

- (often) to do both.

Even in respect of these public-gathering types of use, the available effort is thus going mostly into situations with the largest concentrations of people, rather than into the planning and design of collective utility points to serve smaller-scale taxi stops or trading areas.

Very little of the current effort is going into higher-order collective utility points designed for use by residents of the immediate vicinity. Even the Manenberg bath house, built to cater for a development where the houses were initially not fitted with hot water cylinders, is one of the few exceptions (and it is more than ten years old).

Thus many of the collective utility points presently being designed (certainly, almost all of those above the lowest order) are for the upgrading of already planned situations. Already planned in this context includes

- existing situations where pressure of users, and often the congested and polluted circumstances that have arisen, have to be addressed urgently; and

- situations in townships already built and settled, which may not yet have become problems, but are in an early stage of growth and obviously need to have collective utilities provided before unhygienic or otherwise undesirable circumstances arise.

CONCLUSION

Extensive enquiries failed to find in a single example in South Africa the application of most, let alone all, of the principles set out in these guidelines - which is not in the least surprising. One of the purposes of this document is to modify key aspects of the planning philosophy that has governed the development of our cities - especially to free them from rigid adherence to concepts of the inward-looking neighbourhood unit and from a road hierarchy that is unfriendly to public transport.

Thus no suitable examples were found of planning layouts that specifically allowed for collective utility points, accommodating multiple utilities in a designed relationship with public transport (especially taxis), informal marketing and the nearby residential area. Such forms of development have never before been advocated by the authorities - and, if they have been

built at all, have not been built and operated for long enough for lessons to be learnt. All stakeholders are unfamiliar with the concept - land-owners, residents, taxi associations, informal traders and professionals alike. If there are existing situations that are now being replanned with some of this sub-chapter's principles in mind, they are each unique experiments not just in planning and engineering design, but also in processes of social understanding, small business development, negotiation and, not least, political dynamics.

Even the examples found of collective utility points within residential areas are inadequate in that none were designed as multi-utility clusters. All are primarily single-purpose, with some other uses perhaps added as an afterthought. Their locations are often not satisfactory, even for that single purpose. Their integration into the needs of the community they serve, and especially their surveillance by that community (let alone their operation and maintenance - if any - by that community) have not been thought through.

Nevertheless, despite the untried nature of much of the planning and engineering philosophy underlying this sub-chapter, the shortage of touchable case studies, and the fact that the jury is still out on nearly all of them, it is believed that this sub-chapter is a significant step forward in a desirable planning direction, to the great advantage of the users (residents, taxi drivers and passengers, traders and others) that will have the convenience of collective utilities.

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Chapter 5.8.1

5.8.1

Environmental design for safer communities

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THE ROLE OF ENVIRONMENTAL DESIGN IN PREVENTING CRIME IN SOUTH AFRICAN CITIES AND TOWNS

Preventing crime has become a key challenge to government in post-apartheid South Africa. However, a review conducted for the National Crime Prevention Strategy (NCPS) in 1997, of the extent to which environmental design for crime prevention is being implemented, suggests that there is little experience to draw from in South Africa. Design professionals also rarely use crime pattern analysis in the design process. Therefore, a careful regard of the extent to which environmental design is being utilised to prevent crime is crucial if environmental design changes are to address the real problems.

In this regard, government's core policy document, the NCPS, places environmental design firmly on the agenda. In addition, the White Paper on Local Government expects local authorities to play a key role in implementing two of the four focus areas of the NCPS, namely environmental design and promoting public values and education.

Apart from government legislation, the public is also pressurising local government to respond to the crime issue. Communities participating in workshops to develop Land Development Objectives (LDOs), required by the Development Facilitation Act, have in many cases prioritised the need for greater safety above all other needs. Local and international business interests have also highlighted the impact of crime on tourism and foreign investment. With this in mind, a focus on crime prevention through environmental design is indeed warranted.

Crime in South Africa affects different people and parts of the city in different ways. This has important implications for planning and the prioritisation of design interventions. Crime patterns and trends in poorer areas such as townships and informal settlements differ from those in wealthier suburbs, which in turn differ from those in inner city areas.

The poorer inhabitants of the city are generally most vulnerable to violent crime, but they do experience a significant proportion of property crime. Suburban residents are more likely to be the victims of property crime, and they experience comparatively low levels of violence. In inner city areas, violent crimes targeting property predominate. Environmental design can make an impact on some types of crime in each of these settings, as well as alleviate the fear of crime.

Given this present situation, the next section will shortly define the concept of crime prevention through environmental design. This will be followed by the fundamental principles of environmental design to prevent crime, accompanied by some of the important recommendations to be considered when applying these principles to settlement planning. Finally, the application of these principles will be highlighted.

THE CONCEPT OF CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN

The notion of adapting and exploiting the environment, particularly the built environment, to assist with crime prevention is not new. Take, for example, the defensive walls that were built around medieval towns to protect the inhabitants from intruders. This was, in effect, using environmental design as part of a strategy to prevent crime.

During this century numerous studies have been conducted and many documents written on the relationship between environmental design and crime. Over the past 30 to 35 years, a number of schools of thought have emerged around the idea of crime prevention through environmental design. The international literature and the main components of recent thinking on the subject are outlined in the following South African publications, namely, *Safer by Design* (Kruger et al 1997), *Environmental Design for Safer Communities in South Africa* (Napier et al 1998) and *The History of Crime Prevention through Environmental Design: A Comparative Study* (Meyer and Qhobela 1998).

Today, it is generally accepted that certain types of crime can be limited if the environment is designed appropriately. Design initiatives form an integral part of crime prevention strategies in countries like Canada, the United Kingdom, the United States of America and The Netherlands. A great deal of research on the topic has been done internationally and numerous publications are available. However, little research has been done as yet in South Africa.

Environmental design as currently practised is often indistinguishable from target-hardening (for example, building higher walls and securing property against crime). Target-hardening is, however, only one component of environmental design to prevent crime.

Crime prevention through environmental design can be defined as the implementation of measures to reduce the causes of, and the opportunities for, criminal events, and to address the fear of crime through the application of sound design and management principles to built environments.

Understanding crime is critical to its prevention. Whether or not a crime occurs depends on the interaction of several elements. These elements include the physical and social environment in which a crime occurs, the presence of active or passive forms of surveillance, the perpetrator, and the target or victim

of a crime. The form of the built environment can influence these elements and several design principles are fundamental in designing to reduce crime.

PRINCIPLES OF CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN

A number of basic principles emerge as fundamental in designing to reduce crime. While these principles are universal in the design of safer environments, they have been adapted to suit the characteristics and dynamics of South African cities. Most of these cities were shaped by apartheid planning principles, which contribute to the crime problems. With this in mind, crime prevention through environmental design becomes an even greater challenge.

The backdrop for these principles is, therefore, the South African city. This is the typical physical and social setting within which designers and decision makers are working, and fundamental restructuring is crucial if equitable and safer cities are to be achieved.

These basic principles are

- *surveillance and visibility;*
- *territoriality and defensible space;*
- *access and escape routes;*
- *image and aesthetics; and*
- *target hardening.*

These principles are applied through recommendations for crime prevention at three levels: city, neighbourhood and site. The following section will highlight only a few of the recommendations for the city and neighbourhood levels, since these are directly relevant to settlement-making. A more complete set of recommendations can be found in the publication: Environmental Design for Safer Communities in South Africa (Napier et al 1998).

Surveillance and visibility

Passive surveillance is the casual observance of public and private areas by users or residents in the course of their normal activities. It can also be referred to as the presence of "protective eyes". *The extent of visual contact people have with a space and whether their presence is visible determine whether they can intervene and whether users feel safe.*

Passive surveillance depends on a range of factors including the placing of windows, doors and other openings, the distances between buildings, the sizes of public spaces, vacancy rates and degrees and types of use. The zoning of city areas and the functionality of buildings are key elements in determining whether protective eyes are present day and night, or not. Multifunctional land uses, rather than monofunctional zoning are required to ensure long hours of use.

Active surveillance refers to surveillance by police or other agents whose express function is to patrol an area.

Surveillance is improved if there is good visibility. *Visibility* is the degree to which an environment is made visible by elements such as lighting and uninterrupted lines of sight. Dark or twisting streets, alleys, entrances and doorways can act as havens for potential offenders and increase residents' and visitors' fear of crime. The way in which lighting is designed and positioned, and the way roads and paths are laid out can obviate many of these problems and render environments and users visible to anyone in the environment.

The following are a number of the ways to ensure surveillance.

- *Design and zone streets and squares to allow long hours of use and so act as organising elements for the location of varieties of facilities.*

Figure 5.8.1.1 Increase opportunities for passive surveillance

These facilities can then ensure the presence of protective eyes, both in the day and at night.

- *Design neighbourhoods so that people are encouraged to intervene quickly and effectively to modulate crime.*

This can be promoted in a number of ways - for example, through the proximity of buildings to each other; the number of people accommodated there; the orientation of the buildings and how this impacts on surveillance; the design of shared entrances and access routes; the human scale of the area; and the provision of inviting and well-defined outdoor spaces which are conducive to users meeting and communicating (see Hard Open Spaces (Sub-chapter 5.3), specifically, functions of hard open space and user groups).

- *Ensure sufficient and adequate lighting is provided along streets to improve surveillance.*

Figure 5.8.1.2 Importance of sufficient and adequate lighting

The lighting of public spaces improves surveillance and visibility, allowing users to see and anticipate possible danger. Lighting can also be used to guide people along safer routes. Therefore, the pools of light from streetlights should overlap to form a continuous band of light along pedestrian routes and in front of entrances. The position of streetlights should also coincide with bus stops or, ideally, there should be higher levels of lighting at such places.

- *Encourage pedestrian traffic and direct people along certain routes as this optimises passive surveillance.*

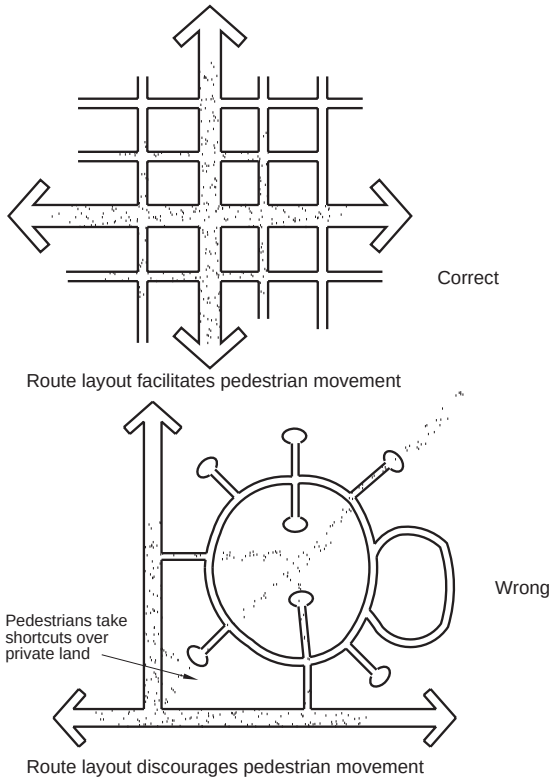

Figure 5.8.1.3 Route layout and pedestrian movement

The more the street is used, the greater the potential for passive surveillance. Surveillance by pedestrians is more effective than surveillance from passing cars. All paths and pedestrian routes should be in areas where there is surveillance, good lighting, controlled vegetation and high levels of activity (see Movement Networks (Sub-chapter 5.1), specifically, mixed pedestrian-vehicle routes).

- *Locate small neighbourhood parks and other public open spaces so that they can be overlooked by buildings and/or well-used streets.*

Figure 5.8.1.4 Location of small open spaces

In order to optimise passive surveillance, the location of small open spaces is important. As they serve a neighbourhood cohesion function, these spaces should be strategically located within the neighbourhood (see Soft Open Spaces (Sub-chapter 5.4), specifically, the location, size and dimension of parks).

- *Ensure high levels of visibility when landscaping parks, public squares or pedestrian routes.*

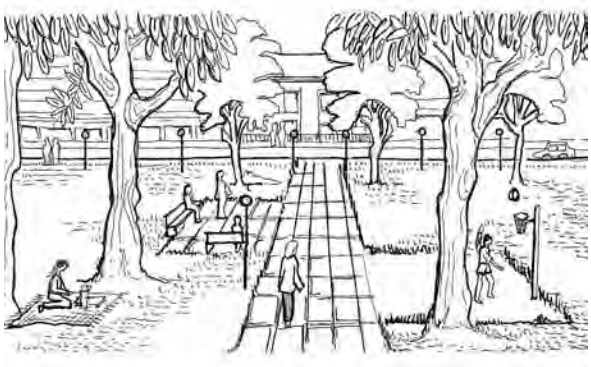

Figure 5.8.1.5 Landscaping and visibility

Where possible, the entirety of an open space should be visible to users of such a space and to passers-by. Trees, bushes and other landscape features can obstruct sight lines and provide cover for potential offenders and criminal activities, but if selected and maintained properly, can ensure visibility.

Territoriality and defensible space

The comment has been made that residents of South African cities should be encouraged to again assume ownership of their neighbourhoods. This is essentially a case of territoriality. Territoriality is a sense of ownership of one's living or working environments. Places can be designed and managed in ways that encourage owners/users to take responsibility for them through a concept such as "defensible space". Spaces are defensible if people are able to exercise control over them.

The benefits of increased territoriality include avoiding wasted or "dead" space through the use of areas for explicit purposes, and the greater likelihood of intervention by passive observers because they feel responsible for their environments. The design of building edges and the delineation of boundaries to mark private, semi-public and public spaces make the use of spaces unmistakable to people frequenting the city and increase the chances that they will be owned and maintained by their users.

Territoriality and defensible space can be encouraged in a number of ways.

- *Avoid tracts of vacant land without designated uses or control. All spaces should have an explicit purpose and be the clear responsibility of some individual or group.*

Open spaces without designated uses, which present themselves as vacant or abandoned land, are likely to become sites for crime. Land is one of the most valuable assets a city has. It should have value added to it through its development rather than be allowed to become a drain on the city's resources. Buffer strips used to separate land uses, racial or income groups, degenerate into vacant land and should not be encouraged. Since this land does not "belong" to anyone, it is likely that no sense of ownership will develop, and no one will take any responsibility for it.

- *Design the public realm so as to increase people's ability to read the built environment. Create an identifiable neighbourhood character through the layout, architecture, street furniture, landscaping, as well as consistency in the approaches utilised.*

When people understand the language of the built environment, their relationship to it improves. This reduces the fear of crime because people are able to locate themselves in the neighbourhood, even if there for the first time. The built environment also plays a major role in establishing an identity. Better identification with the surrounding environment will increase the sense of involvement and responsibility people feel towards each other and, therefore, what happens within this environment.

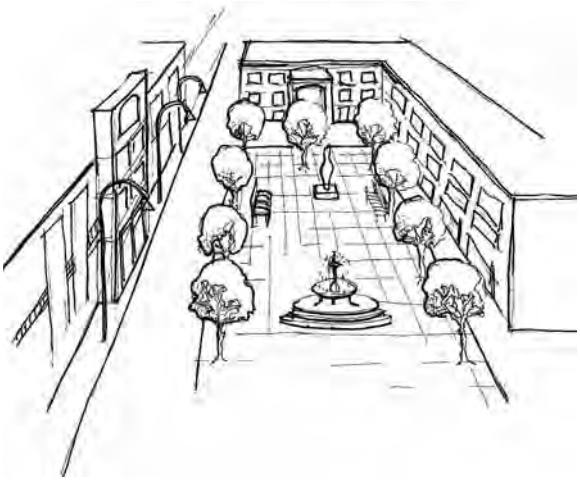

Figure 5.8.1.6 Identifiable neighbourhood character

- *Design a network of small neighbourhood parks rather than open spaces which are too large to be effectively controlled by residents.*

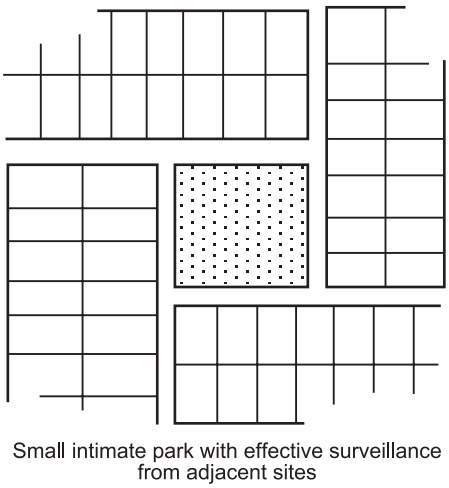

Figure 5.8.1.7 Network of small neighbourhood parks

The size of public open spaces impacts both on visibility and the community's ability to manage and "control" them. Large open spaces do not lend themselves to a feeling of safety unless they can attract sufficient numbers of people and promote a convivial atmosphere. Smaller open spaces or small

parks linked through the street network allow people to pass through, stop and chat. Therefore, encourage the establishment of more small open spaces rather than a few large but unmanageable ones. The surrounding communities should also be encouraged to take responsibility for these smaller public spaces through community committees which can be facilitated by local authorities.

- *The edges of public open spaces and private properties should be clearly defined so that both residents and passers-by can readily recognise boundaries between public, semi-public and private spaces.*

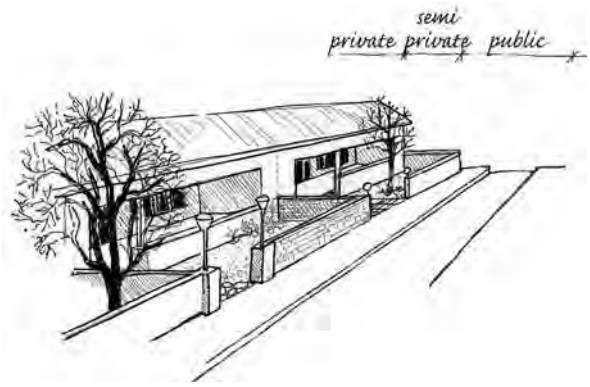

Figure 5.8.1.8 Clearly definable edges

The definition of boundaries improves the potential for ownership to be understood and exercised over different spaces (see *Soft Open Spaces* (Sub-chapter 5.4), specifically, edges of parks and play spaces). There are a number of ways to define edges:

- through planting;
- with a low wall or fence;
- through lighting;
- by changing the surface level;
- by using different surface materials; and
- through the use of street furniture or other prominent landmarks.

Access and escape routes

Access and escape routes are available to both the offender and the victim. Areas of safety that have high levels of passive surveillance and public visibility can act as safe spaces for potential victims.

The sites of certain types of criminal events are often deliberately chosen by the offender, before the act, for access to escape routes. Car highjackings are also often planned to allow quick escape. The layout of transport routes and the juxtaposition of different types of space influence the ease of access and escape. Areas of refuge (e.g. vacant land where people can hide) which have clear routes of escape from a crime are obvious havens for offenders. An example would be tracts of open or agricultural land near a neighbourhood, where stolen goods from thefts can be hidden.

There are a number of ways to limit easy access and escape routes for criminals and promote escape routes for victims through environmental design.

- *Carefully plan the location, size and design of large open spaces such as large parks and golf courses so as to avoid their becoming areas of refuge and escape for offenders.*

Open spaces that are not visible in their entirety and do not lend themselves to constant surveillance can present a problem. Crime statistics suggest a correlation between the location of incidents of housebreaking and access to large open spaces. Both the size and location of these areas are important factors to consider.

- *Avoid ending roads on vacant or undeveloped land. Rather ensure that these end at property edges, at controlled open spaces or in recognised pedestrian paths.*

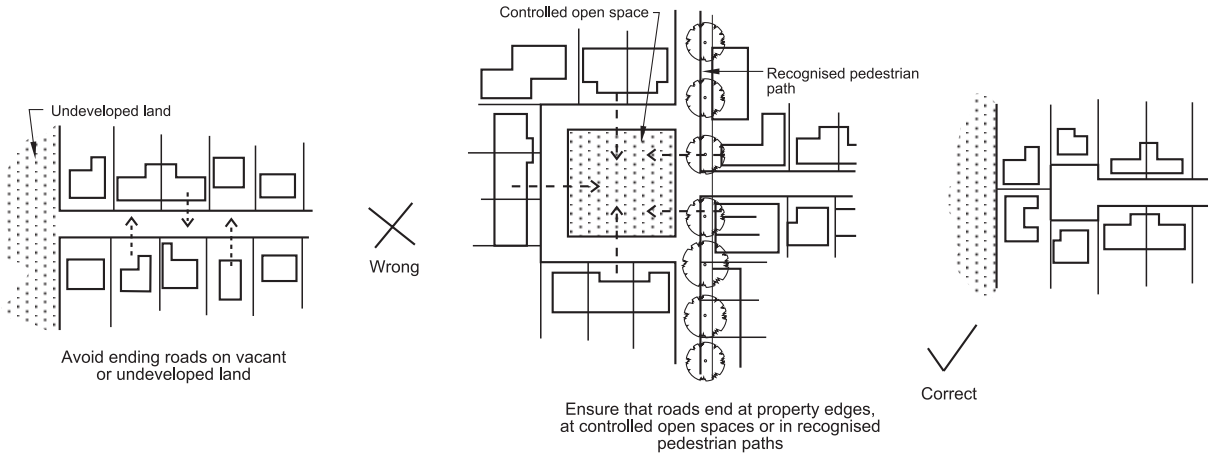

Figure 5.8.1.9 Avoid ending roads on vacant or undeveloped land

Culs-de-sac leading to and ending on vacant land provide escape routes and should be avoided where possible. If there is control over dead ends by the immediate residents, a degree of responsibility can be exercised over the public space.

- *Provide clearly marked and logical pedestrian routes at transport interchanges, to exits, entrances and other functions to avoid confusion and people wandering into unsafe areas. Also incorporate informal traders into any crime prevention strategy.*

The entire modal interchange should be designed to provide safe pedestrian routes. Opportunistic crime depends largely on making use of a target's vulnerability. Struggling to find one's way without directions and wandering around aimlessly can increase vulnerability. If routes are clearly marked, a potential victim can locate a route of escape more easily. Informal trading can also cause congestion and bottlenecks on pavements. This congestion increases the chances of crimes, such as pick-pocketing and bag-snatching, being committed. To circumvent this congestion, pedestrians have to walk in the road, resulting in increased danger and vulnerability. If informal traders are incorporated into hawkers associations and awarded designated areas at, for example, transport interchanges, they can become valuable contributors to the passive policing of the public realm.

Image and aesthetics

The image projected by buildings or public areas in the city has been clearly linked to levels of crime and particularly to the fear of crime. This link is often referred to as "crime and grime". Urban decay and the resultant degradation make people using these areas feel unsafe.

The design and the management of spaces in the city are both important if precincts are not to become actual or perceived "hot spots" for crime. Vacant land, especially if not maintained, and unoccupied buildings particularly, contribute to decay as do uncleared litter and the breakdown of services.

The image of spaces can be improved by ensuring human scale in design, using attractive colours or materials, providing adequate lighting, and designing for high levels of activity.

The following, are some recommendations that address the issues of image and aesthetics.

- *Ensure effective maintenance if environmental design interventions are to be successful in reducing crime.*

The functioning and maintenance of streetlights and roads, as well as cleaning of the roads and care of the landscape, all have major implications for crime prevention. Maintenance directly impacts on visibility and access, as well as preventing places from becoming locations for criminal activity.

- *Toilet blocks in parks should be clearly visible from all sides, designed as an attractive feature, well maintained and preferably near busy areas of the open space.*

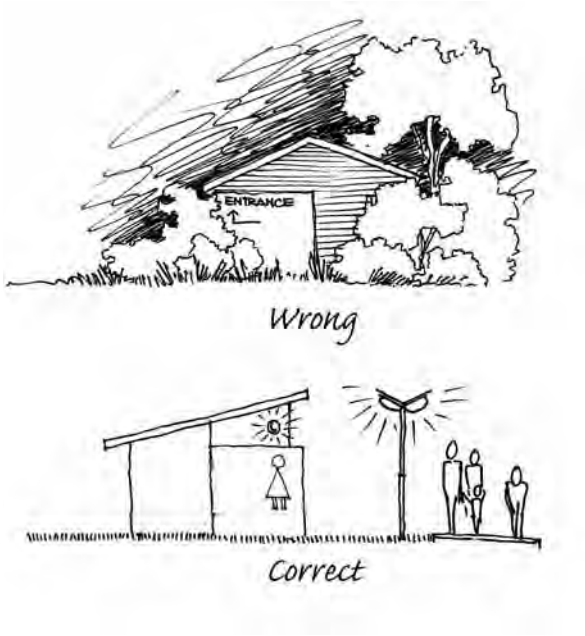

Figure 5.8.1.10 Ensure visibility of ablution facilities

The first impulse of designers is to hide ablution facilities and to design them as purely utilitarian structures. Users then become vulnerable to attack. Features like walls or hedges around the facilities obstruct vision and provide hiding places for potential offenders and criminal activities.

- *When designing buildings or hard open spaces, take into account their public image, as well as the durability and ease of maintenance of the materials.*

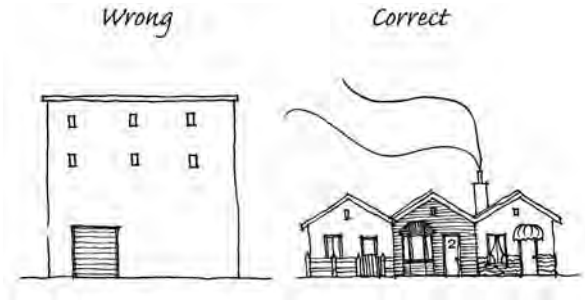

Figure 5.8.1.11 The image of the building

The positioning of buildings in relation to the street and the choice of materials create an image that contributes to, or detracts from, the character of the street and ultimately the character of the area. A more friendly face projected towards the street or city square (hard open spaces) can encourage a sense of safety for pedestrians and, therefore, promote more activity in the street, square or other public open space in front of it. It can also create a more human scale and contribute to a specific environmental character. Together, these aspects can then increase a sense of belonging and security in users.

- *Design and manage buildings and public spaces so that they can be easily maintained and kept "grime free".*

International research has shown that the appearance of a public place affects perceptions of safety. Areas which are badly maintained and dirty increase the fear of crime. They may also encourage criminal activity, because such places show no clear ownership and a disinterested management unlikely to provide surveillance or security. The slogan "no grime, no crime" refers to the positive impact of a clean environment.

Target-hardening

Target-hardening is the physical strengthening of building facades or boundary walls to reduce the attractiveness or vulnerability of potential targets. Walls around houses and burglar bars on windows are the most common examples.

Target hardening is often the first solution that occurs to residents and designers because it physically reduces opportunities for crime. However, the common mistake is to violate other principles in the process. If target-hardening in buildings obstructs lines of sight or provides unsurveyed havens, the hardening is unlikely to be an effective crime prevention strategy in the long term.

A positive way to promote target-hardening is through the application of appropriate barriers and fences.

- *Barriers such as garden fences and security walls should allow for surveillance and be visually attractive to reduce opportunities for, and alleviate the fear of, crime.*

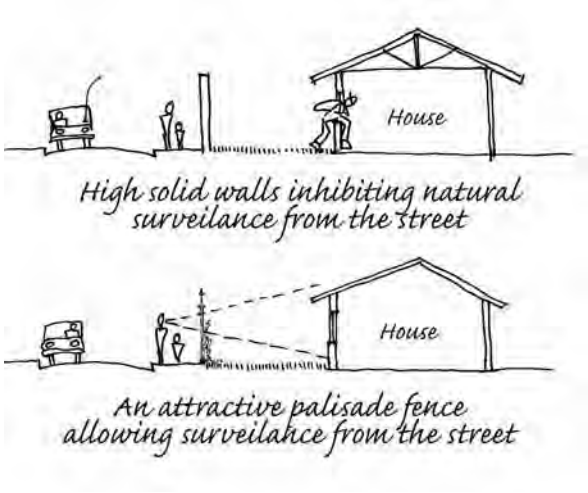

Figure 5.8.1.12 Plan for surveillance

High garden walls are not necessarily safe. On the one hand they make the street unsafe by reducing opportunities for passive surveillance from the building behind. On the other hand, they make the building or entire building complex unsafe as they remove the possibility for passive surveillance by casual passers-by or police patrols. Considering this, it is better to replace high walls with a more transparent fence or barrier. Setbacks and recesses in property walls can also become ideal places for potential offenders to hide and wait. This is especially pertinent in South Africa with the number of vehicle highjackings occurring. Therefore, existing recesses should be well lit at night and not contain shrubs that can provide cover.

THE APPLICATION OF THE PRINCIPLES OF CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN

The most important point is that, in any given situation, these principles all need to work together to be effective as crime-preventive measures. At the same time they need to be working along with other planning principles for the planning of well-functioning settlements.

It is unrealistic, however, to expect to be able to prevent all types of crime using the same methods, or that crime prevention through environmental design alone can solve all types of crime. Therefore, a sound understanding of the crime patterns in a locality is essential in that particular types of crime can be addressed through particular design responses. Given that crime patterns differ, interventions should not only take into account the ease of implementation, but also consider which problems are more conducive to resolution through design measures and, thus, where the impact is likely to be greatest.

Furthermore, an integrated planning approach is necessary. A coordinated layout of roads, sites and buildings will offer a greater chance for the achievement of a safer design.

Crime prevention through environmental design can be proactive or reactive. In other words, design principles can be applied at the initial design stage, anticipating potential problems, or implemented reactively as retrofit design changes once a problem has developed. It is suggested that the preventive approach is more cost-effective.

Related to this are the potential areas of application. As mentioned in Chapter 2, there are at present three generic urban conditions prevailing. These are greenfield or undeveloped sites, urban restructuring and the upgrading of informal settlements. The opportunity to incorporate crime prevention principles should be utilised when planning developments for these conditions.

Recent crime studies have identified three major areas for intervention in terms of crime prevention and these coincide with the three prevailing urban conditions in need of attention. They are

- preventive action (proactive crime preventive development) on undeveloped sites or areas;
- inner city restructuring as part of overall urban restructuring; and
- the upgrading of informal settlements incorporating crime-preventive principles.

In the past, interventions have largely focused on the wealthier parts of the city, where they are easier to implement, rather than those areas with the greatest need or where the most impact is likely. Identifying appropriate areas and crime problems for environmental design to target requires detailed case studies and the analysis of crime patterns in particular localities.

Those areas with the highest levels of crime in South Africa - townships and informal settlements - could benefit most from focused environmental design interventions as part of broader development and local crime prevention strategies. State interventions in the built environment should prioritise those areas where planning has been lacking, or where existing features are conducive to criminal victimisation.

In contrast to townships and informal settlements, areas like the inner city, often considered the natural targets of design interventions, have comparatively low levels of certain crimes. But the crimes that are prevalent in these public places (for example mugging and robbery) are particularly likely to raise citizens' fear of crime. This impacts on the way the city is used and, by implication, its growth and development.

It must, however, be emphasised that crime prevention measures are likely to have the greatest effect when applied in the initial stages of new developments. Development programmes aimed at an improved quality of life should be supported as the most effective way of addressing both the causes of crime and the opportunities for crime. For example, adequately spacious housing with privacy for the residents and appropriate communal spaces for community socialisation, would go further in addressing crime than attempts to intervene at a later stage.

In South African cities some opportunities exist for the creation of whole new precincts. Here the full range of urban design measures for safer places can be brought to bear by planners and developers with the added benefit of contributing to safer environments.

The above recommendations dealing with crime prevention are in most cases no different from basic design principles for well-functioning urban environments. It is surprising then, that - when analysing city precincts in the country - many of the principles have been ignored to the detriment of the city's residents. What seems to be lacking is an awareness that cities, neighbourhoods, buildings and open spaces can be designed to be safer.

Communities are demanding safer living environments and local government is expected to deliver. Within this climate everyone involved should make a deliberate attempt to focus on incorporating crime prevention strategies into current and future development plans.

Safety and security is not a luxury; it is a necessity. Safer environments for the few are not good enough. Therefore, the greatest challenge is to achieve safe cities and towns for all their residents and, along with them viable and sustainable communities. For this to happen social crime prevention and safer design must become an integral part of the culture of all people interested in a better tomorrow and a safer lifestyle.

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Chapter 5.8.2

Ecologically sound urban development

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INTRODUCTION

This sub-chapter highlights some of the environmental concerns that need to be taken into consideration during layout planning for local areas. This sub-chapter should, due to its cross-cutting nature, be read in conjunction with all other chapters. Urban management strategies and technological solutions are not addressed, and the guidelines are confined to mitigation through local layout planning. The aim is to provide generic guidelines to create a general awareness of environmental issues in local layout planning.

The overall aim of ecologically sound urban development is to minimise the negative impact of development on the environment, thus limiting the ecological footprint of development while moving towards greater sustainability over the longer term. The generic guidelines relate to the reciprocal relationship between the natural environment and human settlement activities.

CONCEPTS UNDERLYING ECOLOGICALLY SOUND URBAN DEVELOPMENT

Carrying capacity

Despite technological sophistication, humankind remains in a state of "obligate dependence" on the productivity and life-support services of the ecosphere. It is thus important for any development to take cognisance of the environment's carrying capacity which is defined as *its maximum persistently supportable load.*

The fundamental question for resource economics is whether the physical output of remaining species and biophysical processes, and the waste-assimilation capacity of the ecosphere, are adequate to sustain the anticipated load of human economy into the next century, while maintaining the general life-support functions of the ecosphere.

The impact of human settlements extends beyond their geographic locations. The true *ecological footprint* of a city is the corresponding area of productive land and aquatic ecosystems required to produce the resources used, and to assimilate the wastes produced by a defined population at a specified material standard of living, wherever on earth that land may be.

Cumulative impact

It is important to assess the natural environment using a systems approach that will consider the cumulative impact of various actions. Cumulative impact refers to the impact on the environment which results from the incremental impact of the actions when added to other past, present and reasonably foreseeable future actions regardless of what agency or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period.

Sustainability

Sustainable development implies the adoption of a holistic view of the interdependent relationship between human society and the natural environment. It acknowledges the links between the impact of human activities (particularly economic activities) on the functioning of physical and social environments, and vice versa. Sustainable development is also concerned with "development" - that is, the meeting of essential human needs and improvements in the quality of life. Sustainable development has been presented, therefore, as the means for providing an integrating framework for the reconciliation of human economic and social needs with the capacity of the environment to meet such needs in the long term.

The most commonly quoted definition of sustainable development is attributed to the Brutland Report: "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1990).

Perhaps the most succinct description is provided by Holland (1992, p 242), who states that sustainable development: "is about recognising that this is the only planet we've got. It requires that we give consideration to the rights of future generations to make a living on the planet, and also to the rights of other species to share the world".

Fowke and Prasad (1996, p 62) identified a number of principles at the core of the sustainable development concept. The principles include the following:

- *intergenerational and intragenerational equity* - involves accepting that the current generation should not leave a degraded environment for the next generation, and recognition that equity within the present generation is a legitimate and necessary goal;

- *integration of economy and environment* - acknowledging the linkages between the health of both the economy and the natural environment;

- *dealing cautiously with risk, uncertainty and*

irreversibility - adoption of the precautionary principle and an anticipatory approach to potential development impacts;

- *conservation of biological diversity* - maintaining the variety of life forms and ecological integrity; and

- *recognition of the global dimension* - accepting that the impact of national, state and local policies and activities is not spatially or temporally confined.

No one of these principles can be given priority over the others: such is the nature of their interdependence.

Sustainable development is not a straightforward concept. It does not, therefore, provide us with simple list of do's and don'ts regarding human activities and the environment. Moreover, it places the responsibility back on society as a whole, rather than on science or some other "rational" decision-making medium, to make choices about how we live today, what kind of life future generations will lead and how environmental quality (upon which human society is so fragilely dependent) will be maintained. It is increasingly being recognised that local decisions hold the key to the quality of life in the urban environment and that linkages between urban and global sustainability are growing in importance.

Sustainable cities

It is becoming increasingly obvious that the future of the world will be an urban one. But cities and urban areas are also becoming the places where environmental problems are concentrated.

Expanding cities cause an ever-increasing loss in agricultural and bush land, introducing more and more pollution into waterways and the atmosphere. Biodiversity and native vegetation are lost due to urban and agricultural expansion. Cities in the developed world experience environmental problems such as pollution and congestion stemming from wealth and over-consumption, while the urban populace in the developing world is prone to environmental problems associated with extreme poverty and a lack of infrastructure. A poor quality environment leads to apathy and ultimately to acceptance of crime.

Despite it's many flaws it also needs to be recognised that the city in itself is a valuable resource. The city sustains economic, social and cultural life as we know it, and is a centre for innovation, economic growth, education and civilisation.

ECOLOGICAL GUIDELINES FOR SETTLEMENT-MAKING

The following section provides guidelines for considering ecological factors when designing local living areas to ensure the most suitable location of different land uses in a specific area.

Geological considerations

Undertake a detailed geological survey of the area

In approaching this task it is recommended that the document *Guidelines for urban engineering geological investigations* (1997), published jointly by the South African Institute of Engineering and Environmental Geologists (SAIEG) and the South African Institute of Civil Engineering (SAICE), be referred to.

An understanding of the geological characteristics of a terrain is essential for settlement establishment, for the following reasons:

- there are different structural requirements for foundations on different soil types (e.g. collapsible soil, clay, undermined areas);

- the cost of development, suitable land uses and density of development differ for various soil types;

- the geological features of the site determine the drainage features and patterns and the location of aquifers;

- slope and soil type indicate susceptibility to erosion; and

- areas of seismic activity and radioactivity need to be identified.

Van der Merwe (1997, p 6) describes the *most suitable terrain conditions* for urban development as having a smooth surface gradient with slope less than 12 degrees. This costs less to develop and can be developed at higher densities with less effect on erosion. Accessibility should not be restricted by topography (plateau areas). Suitable terrains should also have:

- no potential for slope instability features (land slides, mud flows);

- easy excavation for foundations and installation of services (normal depth of 1,5 m required);

- foundations above the ground water level or perched water table, with adequate permeability;

- development above the 1:50-year floodline;
- adequate surface and subsurface drainage conditions, with minimal erosion potential;
- no problematic soils (for example heaving clays, compressible clays, sand with some collapse potential, or dispersive soils) that will require expensive remedial measures, as well as no damaging differential subsidence or movement (less than 5 mm total movement at the surface allowed);
- no potential for surface subsidence due to the presence of dolomite (sinkholes) or undermining; and
- an area large enough to accommodate the projected population growth.

All these conditions need to be identified beforehand, as they impact on the suitability (Table 5.8.2.1) and development cost (Table 5.8.2.2) of the area.

Table 5.8.2.1: Geotechnical classification for urban development

CONSTRAINT		MOST FAVOURABLE	INTERMEDIATE	LEAST FAVOURABLE
A	Collapsible soil	Any collapsible horizon or consecutive horizons less than 750 mm in depth.*	Any collapsible horizon or consecutive horizons more than 750 mm in depth.	A least favourable situation for this constraint does not occur.
B	Seepage	Permanent or perched water table more than 1,5 m below ground surface.	Permanent or perched water table less than 1,5 m below ground surface.	Swamps and marshes.
C	Active soil	Low predicted soil-heave potential.*	Moderate predicted soil heave potential.	High predicted soil-heave potential.
D	Highly compressible soil	Low expected soil compressibility.*	Moderate expected soil compressibility.	High expected soil compressibility.
E	Erodability of soil	Low.	Intermediate.	High.
F	Difficulty of excavation to 1,5 m depth	Scattered or occasional boulders less than 10% of the total volume.	Rock or hardpan pedocretes between 10 and 40% of the total volume.	Rock or hardpan pedocretes more than 40% of the total volume.
G	Undermined ground	Undermining at a depth greater than 100 m below the surface (except where total extraction mining has not occurred).	Old undermined areas to a depth of 100 m below the surface where slope closure has ceased.	Mining within 100 m of surface or where total extraction mining has taken place.
H	Instability in areas of soluble rock	Possibly unstable.	Probably unstable.	Known sinkholes and dolines.

Table 5.8.2.1: Geotechnical classification for urban development (continued)

CONSTRAINT		MOST FAVOURABLE	INTERMEDIATE	LEAST FAVOURABLE
I	Steep slopes	Between 2 and 6 degrees (all regions).	Slopes between 6 and 18 degrees and less than 2 degrees (Natal and Western Cape). Slopes between 6 and 12 degrees and less than 2 degrees (all other regions).	More than 18 degrees (Natal and Western Cape). More than 12 degrees (all other regions).
J	Areas of unstable natural slope	Low risk.	Intermediate risk.	High risk (especially in areas subject to seismic activity).
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s^2 within 50 years.	Mining-induced seismic activity more 100 cm/s^2.	Natural seismic activity more than 100 cm/s^2.
L	Areas subject to flooding	A "most favourable" situation for this constraint does not occur.	Areas adjacent to a known drainage channel or floodplain with slope less than 1%.	Areas within a known drainage channel or floodplain.

* These areas are designated as 1A, 1C, 1D, or 1F areas where localised occurrences of the constraint may arise.
Source: SAIEG (1997)

Table 5.8.2.2: Additional development costs due to geotechnical parameters

PARAMETER		CLASS 2	CLASS 3
A	Collapsible soil	+ 10% on infrastructure + 10% on building development	+ 20% on Infrastructure + 20% on building development
B	Seepage	+ R7 000 per hectare under (4) Reclamation	+ R20 000 per hectare under (4) Reclamation
C	Active soil	+ 10% on infrastructure + 10% on building development	+ 20% on infrastructure + 20% on building development
D	Highly compressible soil	+ 10% on infrastructure + 10% on building development	+ 20% on infrastructure + 20% on building development
E	Erodability of soil	+ 5% on roads and streets + 5% on drainage	+ 5% on roads and streets + 5% on drainage
F	Difficulty of excavation to 1,5 m	+ 12,5% on water supply + 12,5% on sanitation	+ 12,5% on water supply + 12,5% on sanitation
G	Undermined ground	+ 10 - 20% on infrastructure + 10 - 20% on building development	+ 30 - 40% on infrastructure + 30 - 40% on building development

Table 5.8.2.2: Additional development costs due to geotechnical parameters (continued)

PARAMETER		CLASS 2	CLASS 3
H	Instability on soluble rocks	+ 30 - 40% on infrastructure + 30 - 40% on building development	Not feasible - life threatening
I	Steep slopes	+ 25% on infrastructure + 5% on building development	+ 50% on infrastructure + 15% on building development
J	Areas of unstable natural slopes	+ 25% on infrastructure + 5% on building development	+ 50% on infrastructure + 15% on building development
K	Areas subject to seismic activity	+ 10% on building development	+ 20% on building development
L	Areas subject to flooding	+ 5% on total development	+ 10% on total development

Source: Williams (1993)

Identify geological materials with economic value

Identify, describe and quantify geological materials with economic value (ecological resources) such as construction materials, through an engineering geological investigation. Sand (calcareous) can be used as building sand and general fill material. Sand (silica) is used for glass-making, foundry sand, metallurgical uses, sand-blasting, filter sand, paint and filler manufacture, tile manufacture, adhesives, and standard sands for use in laboratories. Calcrete is used in cement manufacturing and as a road aggregate.

For low-income developments, assess the potential and appropriateness of the local geological materials for their use in unsealed roads

Through the assessment of the geological structure of local materials, their stage of weathering, the local hydrological conditions and climate, an engineering geologist would be able to select appropriate materials for use in unsealed roads. Unsealed roads, being dynamic systems, are affected far more by traffic, environmental and material conditions than sealed roads. The material is probably the principal component of the total system affecting performance and behaviour.

The requirements of durable coarse materials have been identified as follows (Paige-Green 1997):

- an ability to provide an acceptably smooth and safe road surface without excessive maintenance (i.e. freedom from corrugation, potholes, ruts and oversize material);
- stability in terms of resistance to deformation under both wet and dry conditions (i.e. essentially resistance to ruts and shearing);
- an ability to shed water without excessive scouring;
- resistance to the abrasive action of traffic and erosion by wind and water;
- freedom from excessive dust;
- freedom from excessive slipperiness in wet weather without causing excessive tyre wear; and
- low cost and ease of maintenance.

To fulfil these requirements, durable coarse materials must have

- suitable particle-size distribution;
- appropriate cohesion;
- adequate material strength; and
- adequate aggregate hardness.

Assess the risk of developing on shallow dolomite

A geological survey should be undertaken to assess the risk of development on high risk shallow dolomite. Shallow dolomite is a particular cause for concern where the absence of a protective overburden blanket and the presence of joints and dykes leave an area highly vulnerable to sinkhole formation. The geological hazard in shallow dolomite conditions appears to be broadly related to

- the depth of dolomitic bedrock;
- the nature of overlying material; and
- the nature of the joints and dykes in the dolomitic bedrock.

There are moral and financial implications to various parties if development proceeds on dolomite. Chapter 6 provides a list of general precautions for such developments.

Identify areas with potential subsidence due to undermining or reworked ground

The development potential (height of buildings) can be restricted on undermined areas. Alternatively, additional development costs could be incurred due to the additional reinforcement required in foundations.

Assess the erosion potential of an area by assessing the local rainfall pattern, prevailing wind direction, vegetation and soil type

Areas with a high erosion potential should be developed at lower densities, with more permeable surfaces. The removal of vegetation and topsoil by construction vehicles accelerates natural processes such as runoff, streamflow and erosive siltation (sedimentation) downstream, resulting in higher flooding potential and the decreased ecological functioning of streams. Slope, soil type and vegetation are the main factors controlling overland flow. The interaction between these factors should be assessed before development takes place (Figure 5.8.2.1).

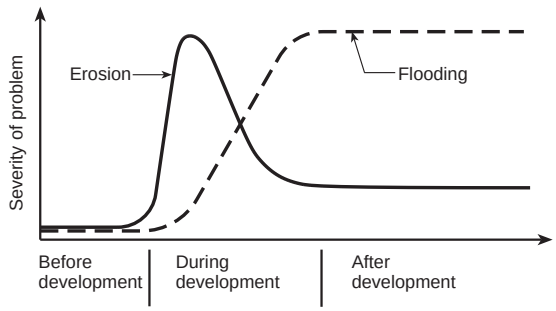

Figure 5.8.2.1: The sequential nature of erosion, sedimentation and flooding

Source: Walesh (1989)

Hydrological considerations

This section is complementary to Chapter 6, in which the detailed design and management of the stormwater system are described.

Identify groundwater recharge zones

Groundwater recharge zones (wetlands and aquifers) should preferably not be developed, or they should at least be appropriately developed (at lower densities with appropriate land uses) to allow for the infiltration of water.

The following activities can pollute the groundwater and special precautionary measures should be taken with regard to their location:

- landfills discharge leachate that may contain organic compounds like methane and benzene (residential garbage) or trace elements like zinc, chromium and lead (industrial landfills);
- some urban stormwater runoff infiltrates the water table and contaminates the groundwater;
- failures in septic tank systems release sewage effluent into the surrounding soil, and the groundwater downslope of such systems is therefore vulnerable to contamination;
- spills and leakages of petroleum products (petrol and diesel storage tanks) are known sources of groundwater and soil pollution;
- mining operations interfere with the groundwater and often degrade its quality; and
- the use of pesticides in agricultural activities poses a water-pollution threat.

Identify the 1:50-year floodline and floodplains around rivers

No development should be allowed in the 1:50-year floodline determined by an engineer, mainly for safety reasons and the protection of property.

The requirements laid down by the National Building Regulations and Building Standards Act (Act 103 of 1977) in terms of development within the 1:50-year floodline area are based only on safety considerations without proper consideration and understanding of the underlying natural streamflow processes. The Town Planning and Townships Ordinance (Ordinance 15 of 1986) also makes provision in Regulation 44(3) for the extension of floodline areas up to 32 m from the centre of a stream in instances where the 1:50-year floodline is less than 62 m wide in total. In order to

improve this situation and to prevent backfilling and encroachment, additional measures will have to be implemented. These measures and guidelines could include the following:

- The 1:50-year floodline restriction should be seen as a minimum requirement for safety reasons only.

- Buffer zones with a minimum width of 10 m should be provided between the 1:50-year floodline area (32 m) and any proposed development, to ensure that no development has a direct impact on the natural flow of rivers and streams. No earthworks should be allowed within the buffer zone of any development.

- Where the 1:50-year floodline (32 m) and the 10 m buffer strip is not sufficient to cover areas frequently inundated by streamflow, additional land should be excluded from development to ensure that the stream and its natural processes are not directly impacted upon by a single development, to the detriment of all other developments upstream or downstream.

- In principle, properties that are severely impacted upon by floodlines, buffer zones and wetland areas should not be modified to increase the development area. Increased rights to the remaining area that could be developed should be investigated.

- Stormwater management on site should become the norm rather than the exception throughout the entire catchment basins of urban streams, as development on every site contributes to urban stormwater runoff. The sites adjacent to streams are usually the ones most affected by a lack of stormwater management throughout the drainage basin.

- The floodplain has the potential to be utilised for urban agriculture, if carefully managed (See Chapter 2).

No backfilling should be allowed in the 1:50-year floodline. No concrete channelling of rivers should be permitted

Land adjacent to streams is usually sought after by developers for high-density developments or business developments. In order to gain more valuable land for development it is common practice to modify the 1:50-year floodplain by filling it up, thereby creating artificially steep stream banks of highly erodable material (Figure 5.8.2.2). The cumulative impact of these practices and the total disregard for geomorphological and hydrological processes have disastrous effects during flooding. Further engineering efforts to reduce flooding - such as levees, concrete channels, damming and piping further destroy stream beds and habitats like ponds and wetlands.

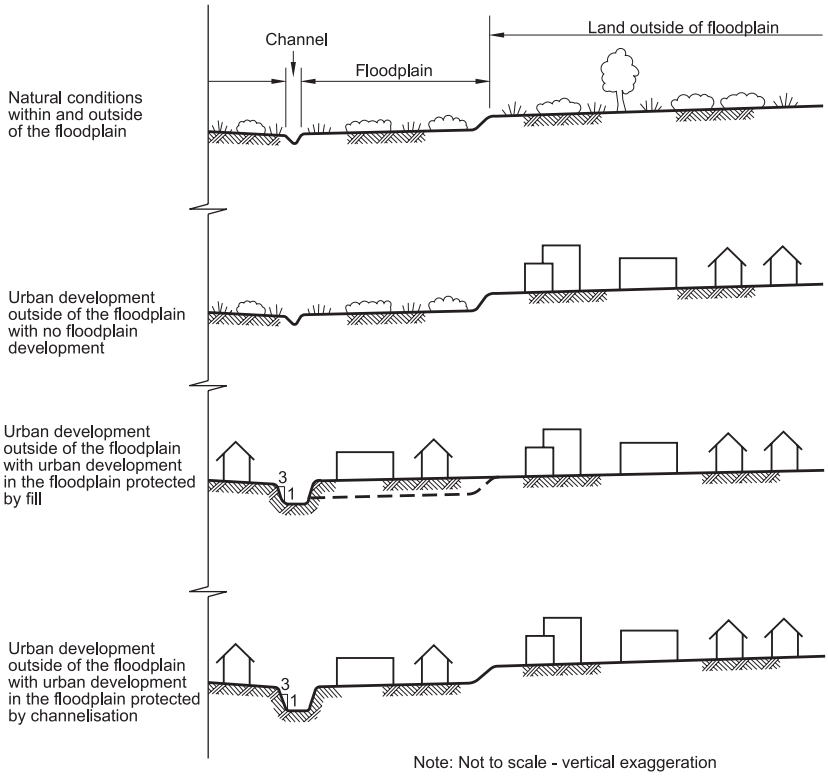

Figure 5.8.2.2: Encroachment into floodplains
Source: Walesh (1989)

The volume of water that runs down these streams will at least be constant or increase, due to development within its catchment area. Modification to the floodline on one side of the stream will have a direct effect on the position of the floodline on the opposite side of the stream. Consecutive backfilling and 1:50-year floodline modifications usually result in very narrow, steep artificial stormwater sewers replacing urban streams and their associated ponding areas such as wetlands, which cater for storm events and bank-overtopping. This type of modification is especially evident on commercial and business sites with stream frontage and it is usually required that more land for development must be provided and that parking requirements are adhered to.

Reduce imperbeable surface cover

New towns and suburbs are usually established on vacant land or natural veld on the outskirts of existing urban areas. In terms of hydrology, these vacant areas have not been extensively modified in terms of permeability, vegetation cover, and soil compactness, and the runoff from these sites can be accommodated by the existing stream channels and floodplains. Water loss through runoff is minimal in natural areas, compared to developed areas.

The development of single units on large erven, results in an increase in stormwater runoff due to the change from largely pervious surfaces on site to impervious surfaces.

Land subdivision causes increased densities and increased impervious surface coverages, resulting in higher stormwater runoff from the site. As intensity of land use increases, so the amount of impervious surface tends to increase (Figure 5.8.2.3).

Due to the variety of residential types, town-planning schemes differentiate between residential use mainly in terms of the number of units (density) per erf or hectare. Use is controlled by factors such as the height, coverage and floor area ratio applicable to the site.

The introduction of paving on residential sites is not covered by the "coverage" definition and is therefore totally ignored. Paved driveways, parking areas, hard landscaping, pools and tennis courts all add to the list of impervious surface areas on residential sites that are not at present taken into consideration in assessing applications for residential development. In theory, these paved areas could increase the impermeability of a site to 100%, especially in areas of high-density townhouse or cluster developments with restricted space for gardening.

Roads (including street surfaces, sidewalks and driveways) are a major contributor to impervious surfaces in residential areas - 63% and 65% respectively for high density and multifamily developments (Real Estate Research Corporation 1974, p 174).

Increased impermeability is not only directly related to increased runoff, it has also been shown to have a direct relationship with the pollutant loading of stormwater. The pollutant loading of stormwater increases with the percentage of impervious cover (Marsh 1991, p 161).

Different land-uses, residential densities and

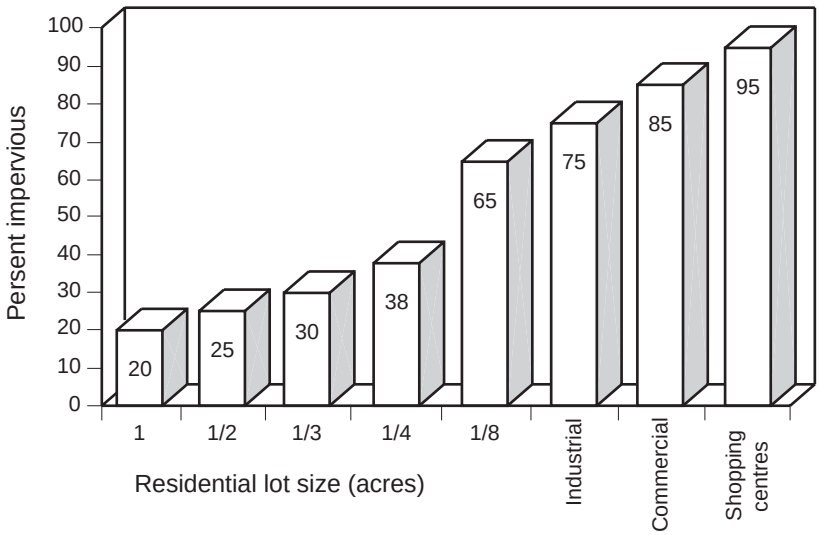

Figure 5.8.2.3: Average percentage of impervious coverage by land use

percentage of impermeable cover all result in different pollution loadings. (Table 5.8.2.3).

Limit stormwater runoff from parking sites

It is accepted that provision will have to be made for private vehicle parking, even in areas where public transport services are provided and where the design and locality of business areas encourage pedestrian use. The design of these parking areas could be improved, especially in terms of drainage and water pollution. Parking areas are designed and constructed as sealed surfaces in order to drain stormwater effectively to the nearest stormwater sewer or culvert and from there to the nearest stream. Polluted stormwater from these parking areas finds its way into the nearest stream, where it decreases water quality and increases erosion and flooding downstream.

Various methods are presently being used to solve the problem of impermeable parking lots. These methods range from permeable grass paving to bioswales and porous parking surfaces, such as gravel (Thompson 1996, p 60).

Bioswales have been used successfully in minimising the effect of stormwater runoff from parking areas as well as for filtering pollution elements. In essence, bioswales refer to a series of linear retention basins that move the runoff from parking lots as slowly as possible, along a gentle incline planted with indigenous vegetation. The vegetation, as well as check-dams at intervals, causes the runoff to pond and infiltrate through the topsoil and plant roots into the water table. This process prevents rapid runoff and also filters out certain pollutions. It has been estimated that these bioswales could draw off about 21 mm of rainfall over a 24-hour period, and that 60-70% of the suspended solids that cause water pollution could be captured by this system (Thompson 1996, p 62).

Porous parking surfaces such as gravel could also be used to improve the infiltration of rainwater, especially in conjunction with asphalt driving lanes. The parking areas or stalls consist of gravel while the lanes in between are constructed of normal asphalt or other hard-wearing, impermeable material.

The potential impact of parking areas associated with large-scale business and commercial developments should be minimised by reducing the number of bays required, secondly by taking into account that multiple-storey parking garages are more desirable and thirdly, by using various designs and materials such as described above to further minimise the effects of parking lots on runoff and pollution.

More detailed design guidelines for parking spaces can be found in Sub-chapter 5.3, which deals with hard open spaces.

Chapter 6 provides a more detailed description of land uses that have the potential to pollute water resources.

Table 5.8.2.3: Stormwater pollution for selected urban uses

LAND USE	DENSITY[a]	NITROGEN[b]	PHOSPHORUS[b]	LEAD[b]	ZINC[b]
Residential, large lot (1 acre)	12%	3,0	0,3	0,06	0,20
Residential, small lot (0,25 acre)	25%	8,8	1,1	0,40	0,32
Townhouse apartment	40%	12,1	1,5	0,88	0,50
High rise apartment	60%	10,3	1,2	1,42	0,71
Shopping centre	90%	13,2	1,2	2,58	2,06
Central business district	95%	24,6	2,7	5,42	2,71

a Based on percentage of the land covered by impervious (hard surface) material.
b Pounds per acre of land per year.

Source: Marsh (1991)

The layout plan should make provision for an appropriate level of sanitation services

It is only when services such as access roads, water, electricity, sewer, stormwater management and solid-waste removal are available that a particular land-use can reach its full potential.

Many studies indicate that high-density residential development without adequate services (informal settlements) is a major threat both to human health and ecosystem functioning. Contamination of stormwater runoff by high levels of nutrient and faecal bacterial loads and litter, mainly from informal settlements, create a more serious threat to water quality than the discharge from a sewage works.

The adequate provision of services during the construction and development of residential areas is, however, not the end of the process. Continuous monitoring and maintenance of these systems is of the utmost importance.

Developed areas with acceptable levels of modern sanitation can also contribute significantly to runoff pollution. This is primarily a consequence of poor maintenance, which results in leaking sewers, especially during dry weather, when these leaking sewers contribute to the maintenance of flow in streams. During rain events poor construction and maintenance of sewers and manholes result in stormwater runoff infiltrating the sewer system. This overloads the sewer system, with resultant overflow of sewerage effluent onto the land surface and potential "flooding" of the wastewater treatment works by excessive inflow (Jagals 1997, p 33).

Both a lack of services and poorly maintained services pose or cause risk to human and animal life. The following measures can help reduce the cost of services, and improve their performance:

- design layouts to reduce the length and therefore the cost of providing services;
- inform and educate the residents about the function and use of urban services;
- provide services that are cost-effective, both in terms of installation and maintenance;
- provide a level of service that is affordable to the residents and acceptable to the local authority; and
- incorporate stormwater design in the residential layout design, which should be designed in harmony with the topography and natural features.

Refer to Chapter 10 for options for - and the implications of - alternative sanitation systems.

Atmospheric considerations

The orientation and layout of erven should provide for north-facing housing units

Topographic aspects such as the slope and orientation of the site play a role in the solar energy gain or loss enjoyed in houses. A development on a steep south-facing slope will be colder than a similar development on the other side of the hill because it receives less solar radiation (see also Chapter 12.2).

Reduce the abundance of concrete and asphalt, and increase the amount of vegetation and open water

This will create higher volumetric heat capacities and greater rates of latent heat flux, thereby lowering air temperatures. Urbanisation can cause significant changes in atmospheric conditions near the ground. In heavily built-up areas of larger cities, these changes extend hundreds of meters above the ground, producing a distinct climate variant - the urban climate. Generally speaking, the urban climate is warmer, less well lighted, less windy, foggier, more polluted and often rainier than the regionwide climate. The desirable climatic effects of vegetated areas provide the rationale for the inclusion of parks and greenbelts in the urban area.

Determine the prevailing wind direction of the area and orientate erven and movement networks accordingly

Wind exposure promotes heat loss in winter, but can be used for ventilation and cooling in warmer climates. In addition, the prevailing wind direction has an influence on the dispersion of dust, noise and odour. Avoid creating windtunnels and provide windbreaks in the form of trees in areas with high winds.

Consider the location of industrial areas upwind of the living area

Most industrial emissions of air pollutants are referred to as point sources, which means that they come from a localised source. The ambient or "surrounding" levels of air pollutants from point sources depend on:

- the distance from the plant;
- the properties of the chemicals involved;
- the local topography; and
- the atmospheric conditions.

Promote the use of public transport (see also Sub-chapter 5.2)

The incomplete combustion of fossil fuels by motor vehicle emissions are a major source of air pollution associated with urban development. Significant emissions of greenhouse gases and respiratory irritants are emitted by diesel and petrol vehicles. Traffic-dense urban areas with high hydrocarbon and nitrogen oxide emissions lead to the formation of ozone and photochemical smog.

The amount of air pollution generated will usually depend on the frequency of private vehicle travel, the distances travelled and the congestion experienced during a trip. The most serious air pollution from motor vehicles typically occurs during morning rush hour, due to substantial congestion, increased pollution caused by cold engines and the more static nature of cold morning air.

At local level, traffic control should aim to provide an even traffic flow to reduce the air pollution caused by vehicles stopping and pulling away. This can be done by having fewer stop signs and by synchronising traffic lights on major roads.

Higher-density areas with sufficient public facilities within walking distance could result in increased pedestrianisation and a decline in private vehicle use.

Parking requirements should be investigated in detail to evaluate their contribution to people's inclination to travel by car rather than use other modes of transport. Where no fee is charged for parking at major business and commercial nodes, this encourages private vehicle movement.

Consider noise sources taking into account temperature, prevailing wind direction and local topography

Although excessive noise levels could be generated during construction it should be recognised that business/commercial nodes could also generate noise on a continuous basis during normal operation. Vehicle movement, especially heavy delivery vehicles after hours, could create noise nuisance. Promotions at shopping centres including loud music and or restaurants open till late could be the cause of complaints from surrounding residents.

- The screening of walls and thick vegetation could reduce/contain the impact of noise to a certain extent.

- Noise impact assessments might become mandatory for all major shopping centre and entertainment complexes.

- Additional measures, such as the soundproofing of venues, might become standard procedure, especially for entertainment venues.

- Time limits could be placed on the duration of concerts.

Consider the provision of buffer zones around land uses that generate excessive levels of noise, dust or odour

Buffer zones around industries, to limit the impact of emissions ranging from gases and odours to noise and light spill, are seldom used in South Africa and are poorly developed. Buffer zones are usually required where residential and industrial land-uses are located side by side. It is generally accepted that levels of emissions decrease, or are diluted, with increasing distance from a source. A safe distance could in theory be determined for a particular industry type, where emission levels on its boundary would be considered acceptable in residential areas.

Such buffer zones are commonly associated with wastewater treatment plants in South Africa. A buffer distance of 1 000 m from the building that generates the emissions is the norm in Greater Johannesburg at present. Offensive odours are usually the reason for the establishment of these buffer zones around wastewater treatment plants.

Apart from buffer zones surrounding mine-tailing dams (1 000 m), and buffer zones around nuclear facilities (up to 18 km for Koeberg), no buffer distance guidelines for a range of industries causing off-site impacts exist to assist urban managers in South Africa. Careful thought has to be given to the design and management of buffer zones to prevent their becoming hideouts or escape routes for criminals and scenes of criminal activity (see Sub-chapter 5.8.1).

Biodiversity considerations

Areas with a high degree of biodiversity should be developed as open spaces or low-density residential areas

The impact of residential development on soil, vegetation and wildlife is mostly associated with the large areas of vacant land, usually at the edge of urban areas, that are required for residential development.

Natural vegetation (veld) is also heavily impacted upon by expanding urban areas - a process known as "urban creep". Residential development is less sensitive to steep gradients, rock, and various soil

types. It is therefore found on land which is not suitable for most other urban land-use. The development of vacant land (veld) for residential use results in the destruction of the habitats of various kinds of wildlife. Gardens and lawns may attract a variety of wildlife, but are seldom a replacement for the species that once inhabited the area.

The negative effects of development on biodiversity can, however, be limited by appropriate densities, careful site planning and design.

The development of sites near urban rivers and streams, or the incorporation of these streams in landscape proposals, is a further cause for concern. Natural systems such as streams have been formed and have evolved over thousands of years in direct relationship to the surrounding topography, soil type and vegetation cover. Extensive vegetation clearing and levelling usually changes the immediate topography to such an extent that the natural watercourses may cease to exist. Extensive landscaping of urban streams to "fit in" with the proposed development usually results in the creation of a dam or large enough water feature to create the very popular "waterfront" type of development. The mere construction of a dam in a free-flowing stream has an impact on aquatic life, water temperature, stream velocity, sediment load and water quality.

Sites containing streams, rocky outcrops and indigenous vegetation of note should be carefully considered and, if possible, incorporated successfully and sensitively into the settlement.

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General qualitative guidelines

Table 5.3.1: Integrated hard open space system

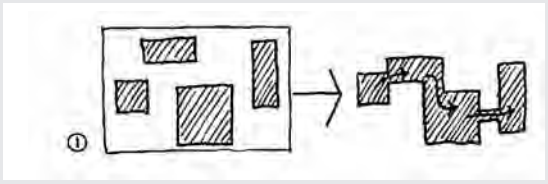
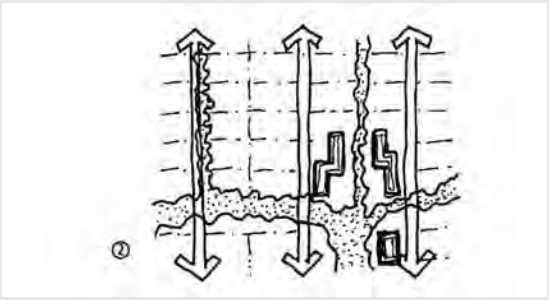
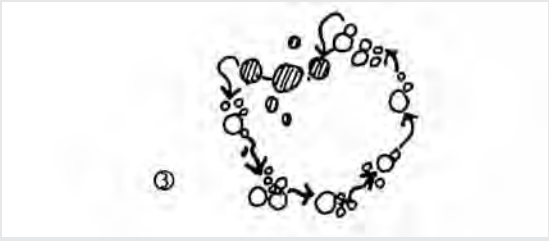
Create an effective hard open space system that integrates the different elements of a settlement to contribute to a meaningful urban structure.	• Provide physical, visible and perceptual connectivity between cluster and linear open spaces. Establish strong and legible linkages between various hard open spaces. [1] • Align the hard open space system and soft open space system with main public buildings, such as community centres or places of worship. [2] • Ensure quality of contextual linkages through the continuation of special activities or functions.[3] • Enhance structural similarity of the street through associational symbolism (personal experience) and cultural symbolism (common areas of understanding in culture) to ensure that as many people as possible can relate to the space. [4]	 ①  ②  ③  ④

Table 5.3.2: Public facilities

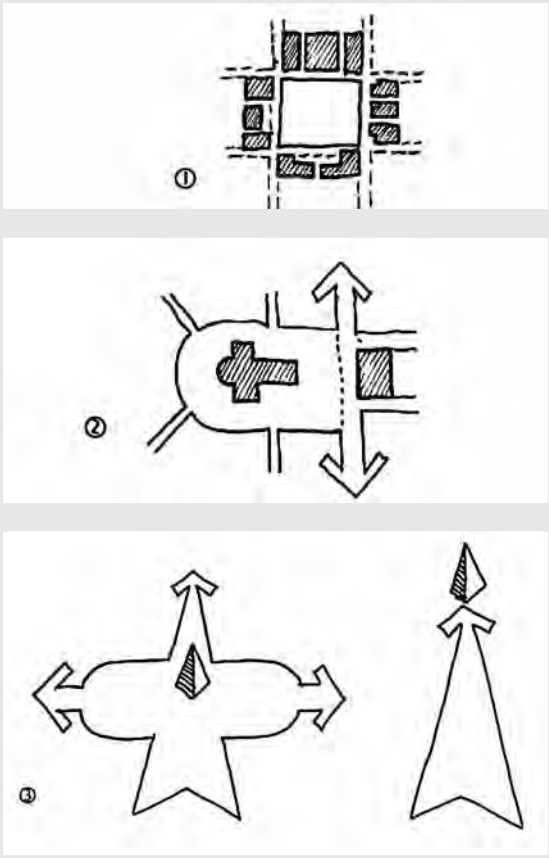
For a meaningful urban structure, link symbolic elements or public facilities to certain hard open spaces in relation to their importance and character.	• Create special public places, as public spaces and public institutions are the focal point of community life. Public furniture should support the desired character of the space. • Concentrate buildings with public facilities, amenities and collective service points adjacent to public spaces. [1] • Locate public buildings in relation to formal public spaces and important movement routes. Hard open space should announce the buildings and accommodate informal activities that respond to these buildings. [2] • Balance the composition of building groups, and place the focal point near the middle of the group (Moughtin 1992, pp 56-7). [3] • Locate symbolic and/or focal points in the middle of a cluster space or at the termination points of a linear space.	

Table 5.3.3: Private and public domains

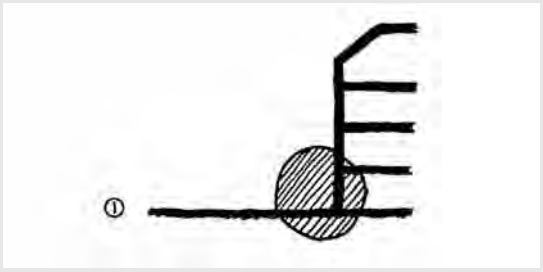
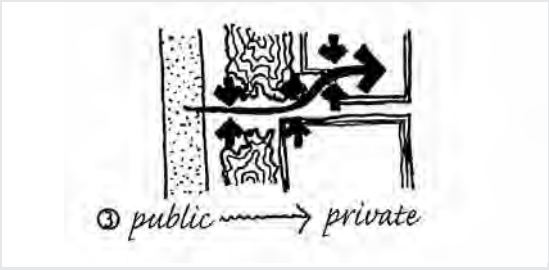
Ensure definition of the public space through effective design of an interface between public and private domains.	• Thresholds should act as shared environments (meeting places) or transitional space between public and private space. [1] • Visual permeability through an interface can enrich the public domain and will affect the way private space is used. It becomes a controlling and enabling constraint. [2] • Enhance the visibility and legibility of the relationship and the transition between private and public domains (Rapoport 1977, p 23). [3]	  

Table 5.3.4: Enclosure

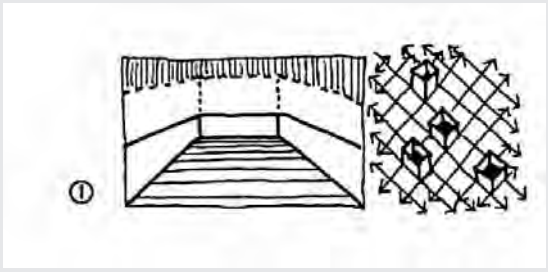
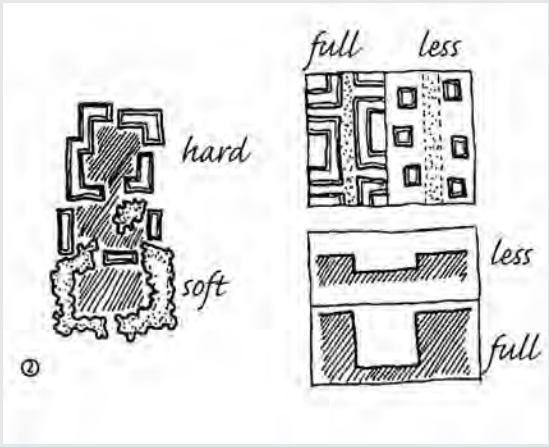
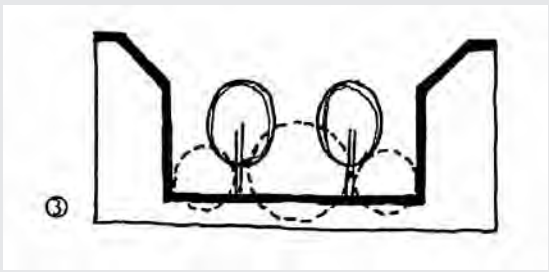
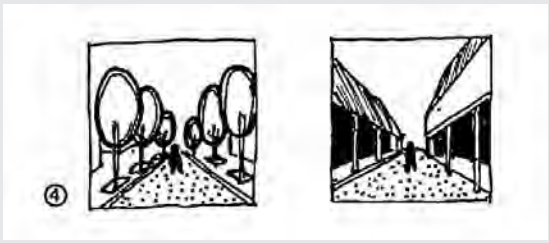
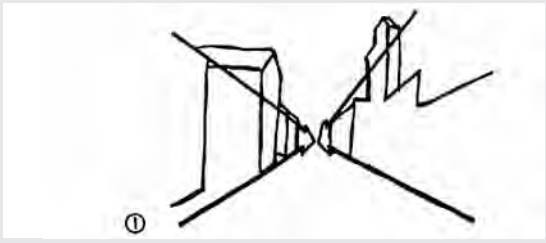
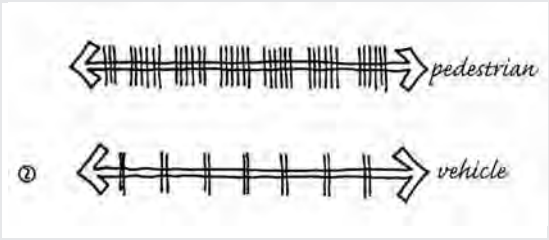
Ensure appropriate sense of enclosure that is on a human scale and fits into the context within which the space is situated.	• Enclosure is needed for the public space to act as an urban room. [1] • The degree of enclosure and nature of enclosing elements determine the character of the space. [2] • Proportion should not be vehicle dominated. Use trees as enclosing elements and to create a human scale. [3] • Define the boundary of the space by means of a unified wall or a series of pavilions linked with landscaping. [4]	   

Table 5.3.5: Continuity and rhythm

Continuity and rhythm of and within spaces should enhance legibility and interest.	• Create rhythmic and spatial progression along a space through the composition of activities or change in land uses (Moughtin 1992, p 58). [1] • Establish a continuation of special activities or functions that exist in the node, within the linkages towards the node. • Perception of hard open spaces is related to the concepts of speed and complexity. Movement relates to complexity and the number of changes that take place within a specific unit of time (Rapoport 1977, p 241), Due to the relative slow movement of pedestrians, a greater degree of complexity and a large number of changes are needed. Faster vehicle movement requires more simplicity and less changes per unit of time. This holds implications for the richness of detail to be provided on buildings. [2]	 ①  ②

General quantitative guidelines

Table 5.3.6: Scale and proportion

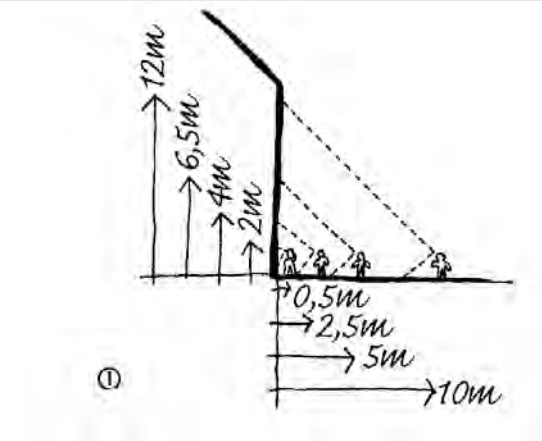
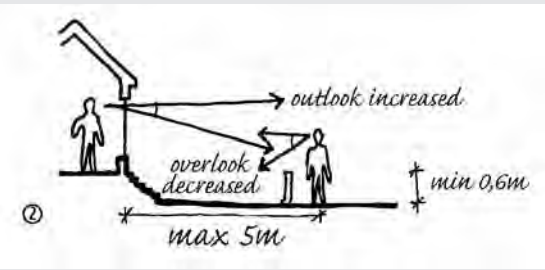
Visual recognition and surveillance.	• Height of detail on buildings that could be appreciated from certain distances away from the facade: - Up to 2 m high to be appreciated from 0,5 m away. - Up to 4 m high to be appreciated from 2,5 m away. - Up to 6,5 m high to be appreciated from 5 m away. - Up to 12 m high to be appreciated from 10 m away. [1] • To maintain contact for safety between pedestrians on street level and people in adjacent buildings, a maximum of 5 m is required. To ensure privacy for inhabitants of buildings at this distance, the street should be at minimum 0,6 m lower than the ground level of the building.[2] • To maintain privacy, a clear distance of at minimum 11 m is needed, otherwise visual obstructing elements, such as trees, should be provided. [3]	  

Table 5.3.6: Scale and proportion (continued)

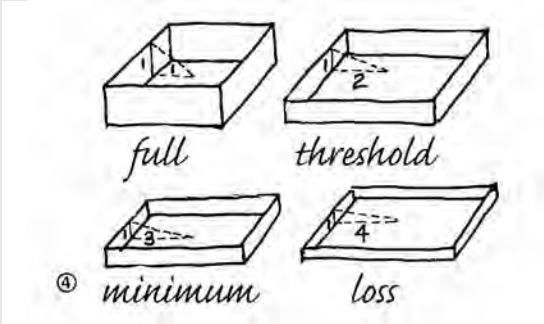
Visual recognition and surveillance (continued).	• Human scale: - Intimate human scale: 12 m (maximum distance to see facial expression); - Normal human scale: 21 to 24 m (25 m at maximum to recognise a face); - Public human scale: 140 m (135 m at maximum to distinguish a human); - Monumental scale: 1 500 m (maximum distance for vista).	
Enclosure.	• Buildings should be seen as a whole from a distance that is twice its height at a 27° angle. • Relationship between radius and height to ensure enclosure (Moughtin 1992, pp 100-1); - Full degree of enclosure is 1:11; - Threshold for enclosure is 1:2 (beyond this proportion space leaks out); - Minimum enclosure is 1:3 (prominent objects are perceived beyond the space); and - Loss of enclosure is >1:3 (space loses its containing function). [4]	

Table 5.3.7: Environmental factors

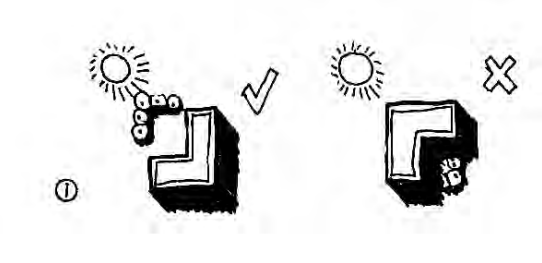
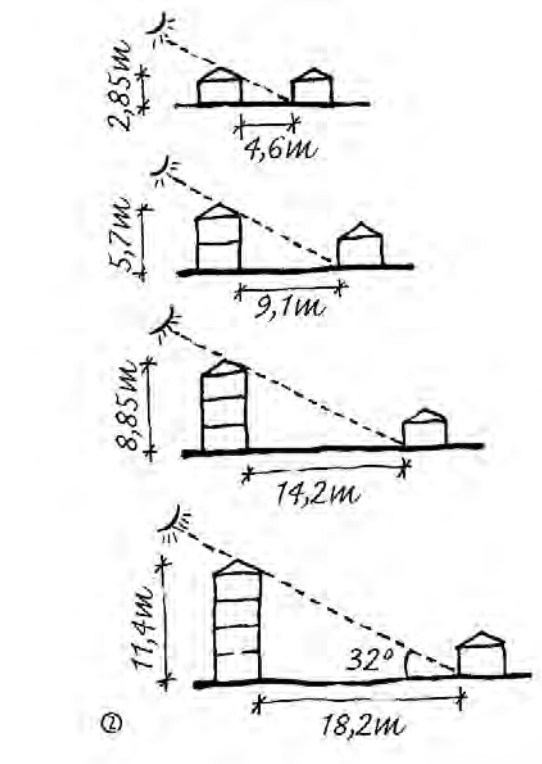
Solar access.	• Locate highest buildings to the southern side of the open space, with lower buildings or trees (as enclosing elements) on the northern side. [1] • To provide adequate solar access to a building, the distance between two buildings should be determined with the following: tan (latitude of the area +10˚) divided by the height of the adjacent building to the north. For example, at Midrand (with a latitude of 22˚) the following is applicable: - If the adjacent building is 2,85 m high (one storey), the distance between the two buildings should be 4,6 m. - If the adjacent building is 5,7 m high (two storeys), the distance between the two buildings should be 9,1 m. - If the adjacent building is 8,85 m high (three storeys), the distance between the two buildings should be 14,2 m.[2]	 

Table 5.3.7: Environmental factors (continued)		
Wind protection.	• An obstruction such as trees can provide the necessary protection against wind. The ground area protected, is generally 10 times the height of the obstruction. [3]	

Specific qualitative guidelines

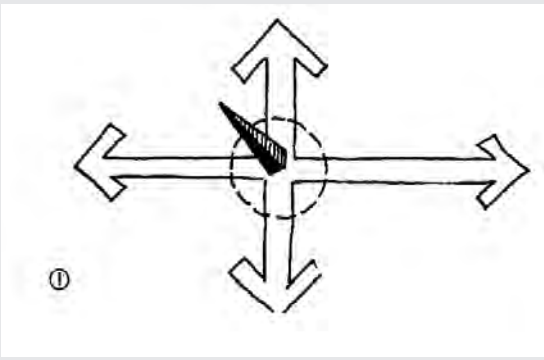
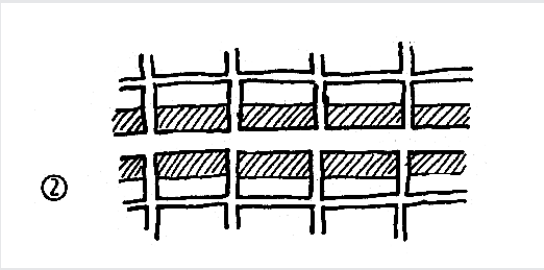
Table 5.3.8: Location and typologies		
Mixed-mode streets		
Ensure a meaningful location in terms of the movement network and urban structure.	• Design the road network to accommodate various and diverse functions. • Meeting of special streets should result in squares and focal points (Moughtin 1992, p 80). [1] • Concentrate intensive activities along continuous vehicle-orientated and public-transport routes. Locate majority of public buildings also along these routes. [2] • Locate buildings close to the street to increase pedestrian activity, reduce resident isolation, and foster pedestrian services such as retail outlets along streets connecting higher density developments.	 

Table 5.3.8: Location and typologies (continued)		
Mixed-mode streets (continued)		
Increase intensity and diversity in the street reserve.	• High information routes are experienced as short, but remembered as long. Ensure complexity and interest along roads and in space along routes (Rapoport 1977, pp 217-220). • Create rhythmic and spatial progression along an axis/street, via composition of activities or change in land uses (Moughtin 1992, p 59). • Block lengths influence access and economic thresholds. Design optimal block lengths to foster diverse activity and economic viability.	

Table 5.3.8: Location and typologies (continued)

Mixed-mode streets (continued)

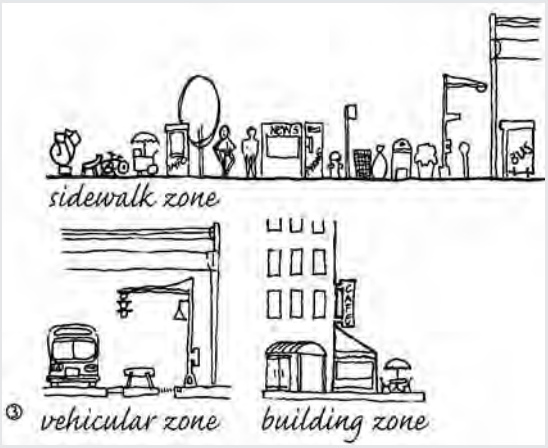
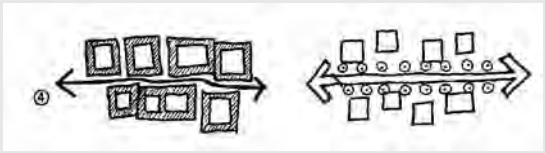
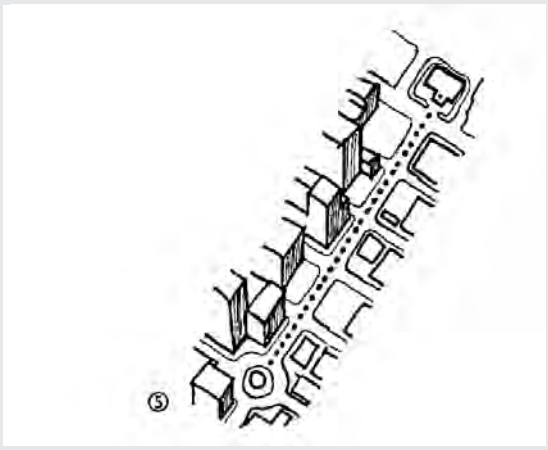
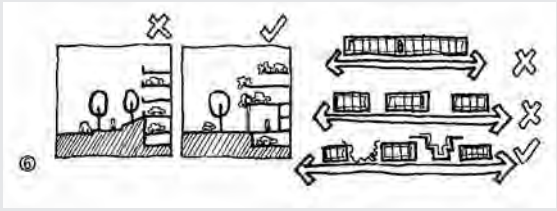
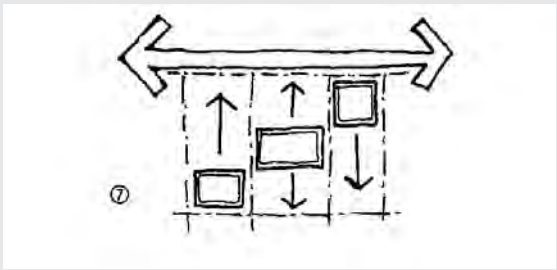
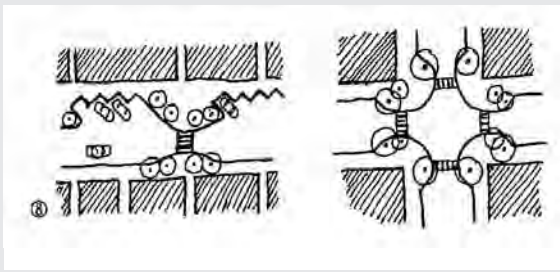
Increase intensity and diversity in the street reserve.	• Effectively design the whole reserve, including the spaces between the road surface and the building entrances. Design for and make a distinction between the following: - building zone (arcades, canopies, commercial signs, enclosed cafes and sidewalk cafes); - sidewalk zone (sewers, gratings, kerbs, urban art, benches, bicycle racks, hawker stalls, information kiosks, trees, cycle areas, pedestrian areas, newspaper stands, telephone booths, fire hydrants, traffic signs, refuse bins, mail boxes, planters, street lighting, parking meters and bus shelters); and - vehicular zone (banners, manholes, traffic signals, on-street parking, decorative lighting and telephone poles).[3]	

Table 5.3.8: Location and typologies (continued)

Mixed-mode streets (continued)

Define the street as a safe and unique public space.	• The general pattern of buildings should help to define the street. [4]	
	• In pavilion-type buildings, use trees to define the street. The streetscape design should incorporate a consistent theme, strengthening the association of unrelated buildings. When a street is not strongly defined at its edges, focal points - at the ends or at regular intervals - could provide a sense of place. [5]	
	• Land uses should enliven the street and ensure surveillance of it. Parking structures should not dominate street frontages. [6]	
	• Distinguish between so-called front-and-back uses and definition, which take place within the street realm, but which differ for various urban users and cultures. [7]	
	• Intersections and road crossings should be designed to be safe for pedestrians and vehicles. This includes the design of sidewalks and crosswalks, traffic signals and other intersection treatment. [8]	

Chapter 5.8.3

Fire safety

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INTRODUCTION

As more and more people congregate closer and closer together in settlements as urbanisation increases, risks associated with fire increase. In the case of more formal settlements, the National Building Regulations, SABS 0400-1990 Part T, first published in 1987, control fire safety in buildings, considerably limiting the incidence and spread of fires in formal areas, as well as the damage caused by fires. It is in the case of more informal settlements, where fires have more recently had devastating effects on life, shelter, livelihood and possessions. By their very nature, informal settlements are more susceptible to fire hazard due to:

- high building and occupancy densities with limited open areas between units;
- a lack of - or limited - electricity services (necessitating the use of flammable fuels and open-flame cooking and lighting);
- the use of combustible building materials;
- poor structural stability;
- poor road surfaces unable to carry fire-fighting equipment;
- the lack of sufficient on-site water; and
- often, the settlements' location in flat, wind-swept areas.

During the two-year period from 1 September 1994 to 30 September 1996, a public media search by the Institute for Contemporary History at the University of the Orange Free State, revealed a total of 39 fires having occurred in informal settlements throughout South Africa, causing 31 deaths, destroying almost 4 000 informal dwellings and leaving nearly 20 000 people homeless (CSIR, 1996). Of the fires, 45% had been deliberately started, 8% were accidental and in the remaining 35%, the cause was undetermined. Weather conditions, particularly dry and windy conditions, played a role in 40% of the fires. From the limited statistics available, it is obvious that fire safety should be a crucial element of settlement planning and design. Fires, whether accidental or malicious, will always be a factor with which any community has to contend. The focus of the guidelines is therefore on how to limit their extent and impact on the community by means of layout planning and design.

PURPOSE OF THIS SUB-CHAPTER

Although layout planning and design is only one of a number of measures which can be taken to contribute to fire safety in settlements, the purpose of this section is to bring about an awareness of fire safety in settlement planning and design, and to make explicit the settlement layout considerations that can reduce the incidence, spread and damaging consequences of fires. Fire-safety issues are inherent to other parts of the guidelines. Specific aspects pertaining to fire safety in terms of emergency balancing requirements are included in Chapter 8 (water supply). Many of the specific guidelines relating to the provision of hard and soft open spaces (5.3 and 5.4), movement networks (5.1), subdivision (stand size) (5.6), and the location of public facilities and utilities (5.5 and 5.7) implicitly support and enhance fire safety in settlements. This fire safety section attempts to introduce fire safety as a cross-cutting issue, worthy of receiving pertinent attention in a range of settlement dimensions in its own right.

THE PROBLEM

The problem of fire in human settlements can be disaggregated into:

- cause of the fire;
- spread of the fire;
- escape from the fire; and
- fire-fighting.

Fire in human settlements is caused predominantly accidentally, usually in relation to the use of various fuel types for open-flame cooking, lighting and heating, but also deliberately as public violence and arson. Fire-safety education and law and order can be the major factors in reducing the causes of fires. Settlement planning and design would not play a major role in limiting the incidence of fires other than in introducing fire safety as an issue in the participation process.

Once a fire has begun, its spread is influenced by natural factors such as wind and topography. In hilly areas, settlements tend to be more dispersed, reducing the spread of fire, but high wind speeds can exacerbate its spread. Building density (in relation to the distances between buildings and groups of buildings), the use of combustible building materials for wall and roofs, and structural instability, all have a considerable influence on the spread of fire and one's ability to escape.

The ability to fight the fire depends on access to sufficient water, and access routes for fire-fighting equipment and vehicles.

Settlement planning and design has limited influence on reducing the incidence of fire, but can significantly affect its subsequent spread, one's ability to escape from the fire, and the fighting of the fire.

PRINCIPLES OF FIRE SAFETY

The aims of implementing measures to limit the incidence and spread of fires are:

- to ensure the safety of people, minimising loss of life and injury;
- to minimise loss of - and damage to - property and possessions; and
- to minimise the negative impact on the environment.

EXISTING REQUIREMENTS

Existing formal requirements in terms of laws and guidelines relate predominantly to buildings, and include requirements of buildings in relation to each other. This has implications for layout planning and design. Also, principles applicable at the building level can be applied and adapted to the layout level. Where appropriate, existing requirements are incorporated into the guidelines presented below.

Requirements in terms of SABS 0400:1990 formal legislation for buildings

All buildings erected within the boundaries of the RSA, from a fire safety point of view, should comply with Part T, Fire Protection, of SABS 0400:1990 - The application of the National Building Regulations. The following requirements from sub-paragraph (1) of the general requirements of Regulation T1 are appropriate to, and can be adapted for, settlement planning and design:

- Any building shall be so designed, constructed and equipped that in case of fire:
  - the protection of occupants or users therein is ensured and that provision is made for the safe evacuation of such occupants or users;
  - the spread and intensity of such fire within such building and the spread of fire to any other building will be minimised; and
  - adequate means of access, and equipment for detecting, fighting, controlling and extinguishing such fire, are provided.

Agrément Certification and MANTAG

The minimum fire safety requirements for a building in terms of **Agrément Certification** conform to the requirements stipulated in Regulation T1, SABS 0400, and are intended mainly for more formal developments. MANTAG (Minimum Agrément Norms Technical Advisory Guide 1993) guidelines, on the other hand, are mainly intended for informal developments to establish some degree of fire safety. The MANTAG guidelines appropriate to settlement planning and design relate to minimum safety distances between any building and the lateral or rear boundary of the site or, where there are two or more buildings on a site, the distance between each building and a notional boundary line between them. Minimum safety distances are determined according to the following:

- The fire resistance of walls: If a wall has a fire resistance of at least 30 minutes, with no openings, there are no requirements for safety distance. Fire resistance is measured in terms of structural stability, structural integrity and insulation. Stability refers to the ability to remain standing without collapse. Integrity refers to the ability to remain intact and not move and buckle to create openings through which flames can escape. Insulation relates to the ability to either contain the fire within the building and not to ignite any material outside, or to insulate what is inside the building from being ignited by a fire outside.
- The combustibility of wall and roof material: The higher the combustibility of the material, the greater the safety distance required.
- The area of openings in the wall facing a particular boundary: As the area of wall covered by openings increases, so the safety distance requirements increase.
- The wall area facing a particular boundary: A wall area of less than 7,5 m^2, with no openings, has no distance safety requirements.
- The size of groups of dwellings - if dwellings are in groups of 20 or less, this effectively means that the spread of the fire is limited to 20 units at a time, and the safety distance between the buildings can be reduced.

GUIDELINES FOR FIRE SAFETY

Create awareness of fire safety during the stakeholder participation process

- Provide education regarding fire safety in the use of open flames for cooking and lighting.
- Promote the choice of electricity within limits of affordability during trade-off debates in the participation process.

- Introduce the concept of watch towers for early warning, which could be operated by the community and could simultaneously fulfil a number of other uses, such as crime prevention.

Ensure adequate space between groups of buildings to limit the spread of fire, to provide escape and to provide access for fire-fighting equipment

- Ensure that there are fire breaks between groups of units, which can correspond to hard or soft open spaces or movement networks. The amount of space is dependant on local weather and the topography - in windswept, flat areas, more space is required and open spaces should be downwind of the prevailing wind direction.

- Heavy fire-fighting tanker vehicles can move only along paved surfaces, but usually have fire-fighting teams capable of handling 90 m of hose, whereas smaller-terrain vehicles carry less water and have 30 m hoses, but can negotiate unpaved surfaces (gravel roads or well-maintained and clear hard or soft open spaces, including servitudes). Where regularly spaced fire hydrants are not provided, each building should be within

  - 30 m of a gravel road or a maintained open space network which is linked to the road network at some point; or

  - 90 m of a paved road.

Ensure adequate space between individual buildings to reduce the spread of fire

- Decisions regarding stand size and arrangement, and the relationship between stand size, coverage and housing type should take into consideration minimum safety distance guidelines.

- Minimum safety distance guidelines based on MANTAG requirements, but applicable to all development types, are as follows:

  - In the case of both non-combustible and combustible externally cladded walls with a fire resistance where at least the stability and integrity are greater than 30 minutes, the minimum safety distance is according to the size of the opening (Table 5.8.3.1). In the case of combustible walls, the entire wall area is considered as an "opening" and the recommended safety distance can be read off Table 5.8.3.1 accordingly.

Table 5.8.3.1: Safety distance recommendations for combustible and non-combustible walls in relation to size of wall opening

FIRE RESISTANCE OF WALL	AREA (m^2) OF WALL "OPENING"	MINIMUM BOUNDARY DISTANCE (m)	MINIMUM DISTANCE BETWEEN BUILDINGS (m)
High (stability and integrity at least or > 30 minutes)	No opening, but with wall area of > 7,5 m^2	No requirement	No requirement
	No opening, but with wall area of < 7,5 m^2	0,5	1,0
	< 5	1,0	2,0
	5	1,5	3,0
	7,5	2,0	4,0
	10	2,4	4,8
	30	3,8	7,6
	50+	4,5	9,0
Low (stability and integrity either or both < 30 minutes)	Not relevant	4,5	9,0
Low, but where units are in groups of less than 20	Not relevant	2,0	4,0
High or low, but with combustible roof (e.g. thatch)	Not relevant	4,5	9,0

- In the case of both non-combustible walls, combustible walls with external cladding, and combustible roofs (e.g. thatch), even if walls are non-combustible, where fire resistance is low (i.e. either integrity or stability or both are less than 30 minutes), the minimum safety distance from wall (or roof edge in the case of combustible roofs) to boundary must be 4,5 m, or there should be 9 m between buildings (Table 5.8.3.1).

The maximum safety distance of 4,5 m from wall to boundary or 9 m between buildings can be reduced to 2 m from wall to boundary or 4 m between buildings, where dwellings units are in groups of less than 20 units.

- Where space is at a premium, an option is that walls, possibly containing internal services, with a fire resistance of at least 60 minutes, could be erected as a common wall on the boundaries, which would mean that no safety distance between buildings would be required. Higher densities could thus be facilitated without compromising fire safety, although there are cost implications.

Land-use arrangements

- Consider the location of watch towers at strategic places in the settlement. These would involve

  - an early warning system to alert inhabitants of the occurrence to facilitate escape and rescue of possessions; and

  - an early warning system to alert fire-fighters.

- Locate "valuable" community facilities along major movement networks so that the areas can be easily accessed by heavy fire-fighting equipment. As a minimum, provide water utilities along these routes.

Adequate water provision

Refer to the relevant provisions of Chapter 8.

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