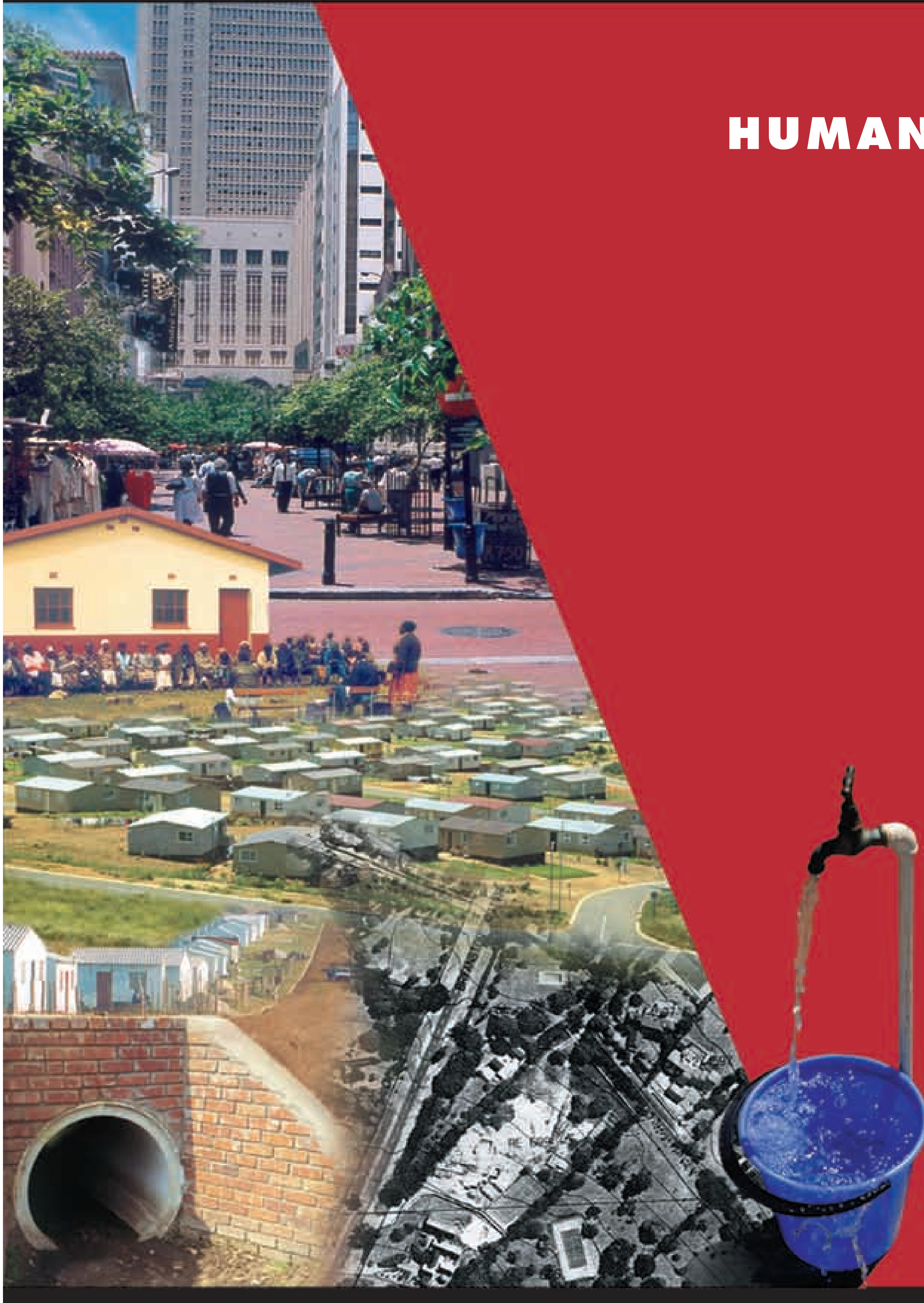
Guidelines for

HUMAN SETTLEMENT PLANNING AND DESIGN

VOLUME 1



Compiled under the patronage of the Department of Housing

by CSIR Building and Construction Technology

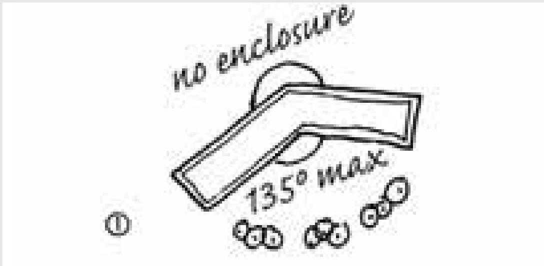
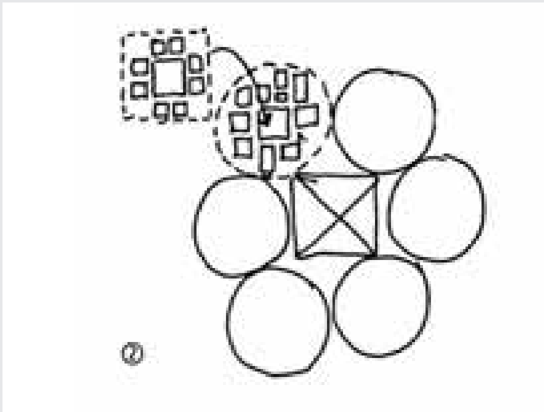
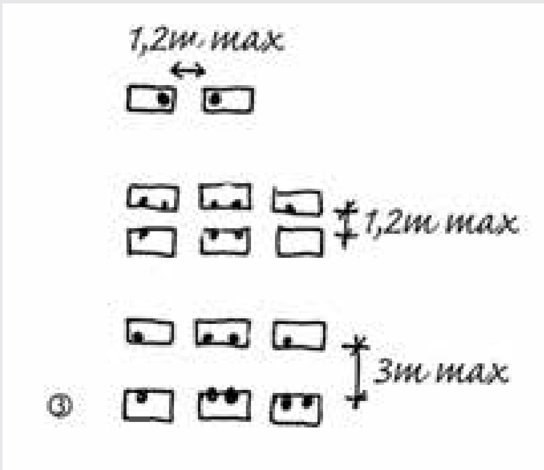
Table 5.3.13: Dimensions and distances (continued)		
Squares		
Scale and proportions.	• Hard open space with a certain sense of enclosure: below the threshold of 18˚ the space loses its sense of enclosure as one can see beyond its edges (Moughtin 1992, p 99). • Limit plaza size to create small, human-scaled 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 135º. [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]	

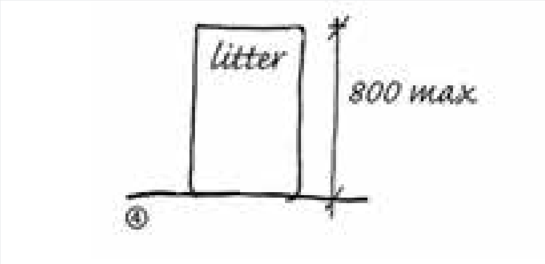
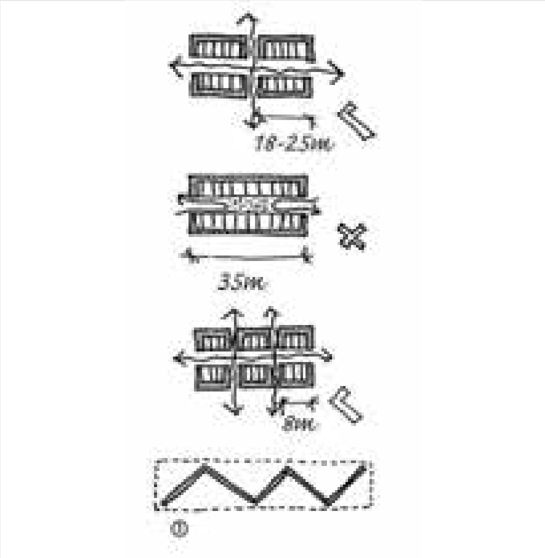
Table 5.3.13: Dimensions and distances (continued)		
Squares (continued)		
Landscaping and furniture (continued).	• Bollards with the dimensions of 500 mm (height) and a minimum of 300 mm (width) can also double as seating (Cartwright 1980, p 67). • Design litter bins preferably not higher that 800 mm. 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.

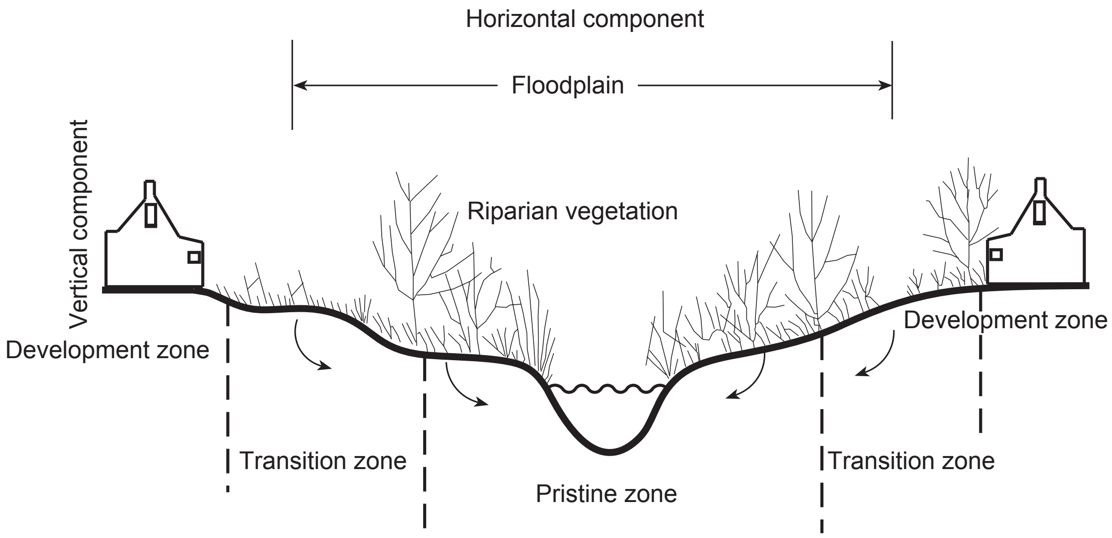
Table 5.4.3: Guidelines for the planning and design of generic forms of soft open space (continued)	
EDGES (continued)	
Sportsfields	• Sportsfield clusters should be defined by perimeter roads and fronting buildings, in order to provide surveillance and safety. Depending on the nature of the amenity-sharing, 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

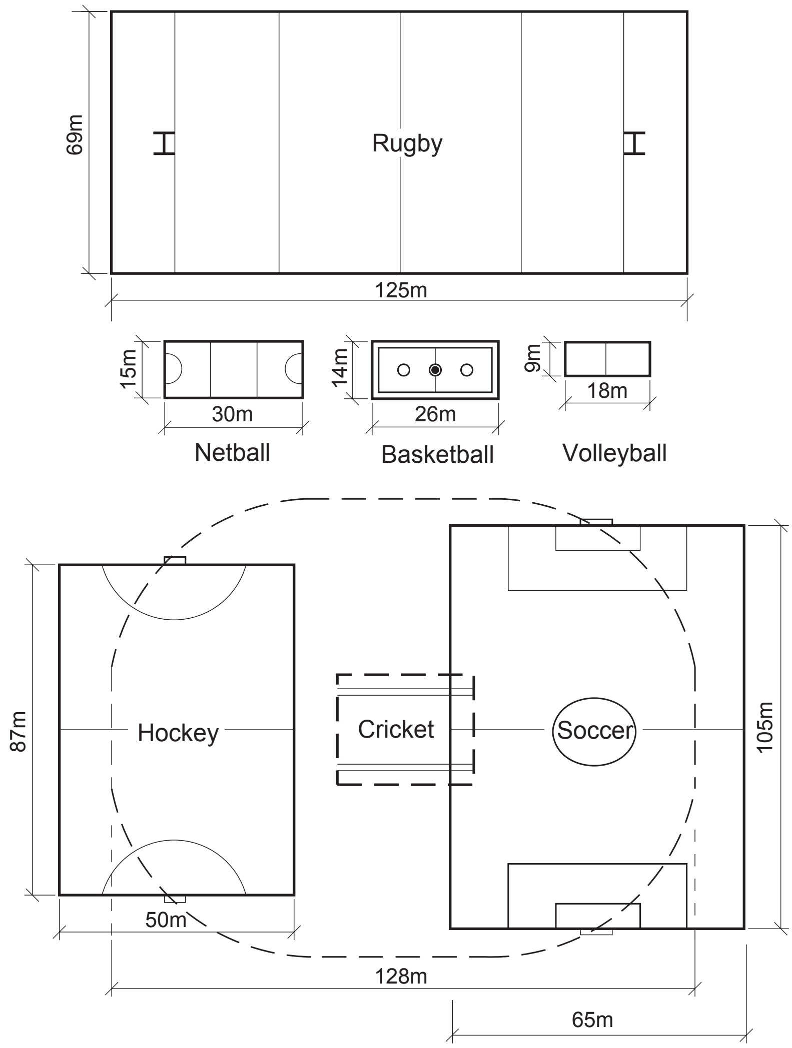


Figure 5.4.3: Sportsfield markings and dimensions

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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).

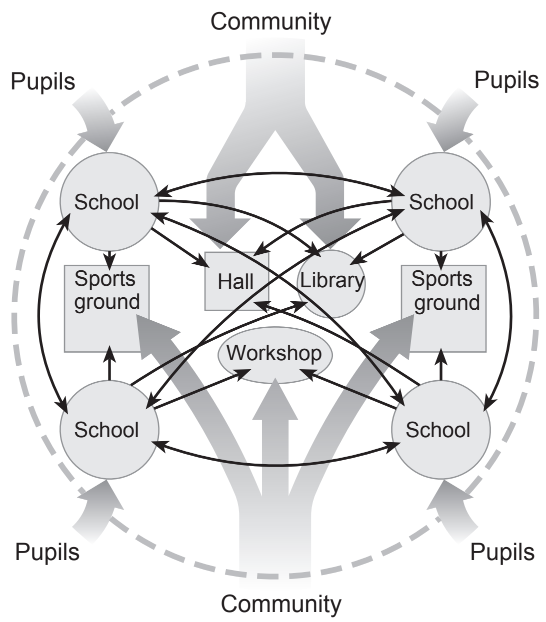

Figure 5.5.1: Relationships between public facilities (Smit and Hennessy 1995)

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

FACILITY	FACILITIES	Educational facilities	Creche/Nursery school	Primary school	Secondary school	Tertiary facilities	Adult learning centres	Health facilities	Mobile clinics	Clinics	Hospitals	Recreation facilities	Playgrounds	Sports fields	Sports clubs	Sports stadiums	Cultural facilities	Libraries	Community centres	Religious centres	Cemeteries	Administrative facilities	Magistrates court	Municipal offices	Post offices	Police stations	Fire stations	Old age home	Children's home	Information centres
Educational facilities																														
Crech/Nursery school			●	●	●	●	●		●	○	●		●	○	○	⊕		●	●	●	⊕		⊕	⊕	⊕	⊕	⊕	⊕	●	○
Primary school				●	●	○	●		●	●	○		●	●	●	○		●	●	○	⊕		⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Secondary school					●	○	●		●	●	○		●	●	●	○		●	●	○	⊕		⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Tertiary facilities						○	●		○	●	●		○	○	○	●		○	○	○	⊕		⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Adult learning centres							●		○	○	○		●	○	○	⊕		●	●	○	⊕		⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Health facilities																														
Mobile clinics									●	●	○		○	○	○	⊕		○	○	○	⊕		⊕	○	⊕	⊕	⊕	●	●	○
Clinics										●	●		●	○	○	⊕		○	○	○	○		⊕	⊕	⊕	⊕	⊕	○	○	○
Hospitals											●		○	○	○	⊕		○	○	○	○		⊕	⊕	⊕	⊕	⊕	○	○	⊕
Recreational facilities																														
Playgrounds													●	●	●	○		●	●	●	⊕		○	○	○	○	○	○	●	●
Sports fields														●	●	○		○	●	○	⊕		⊕	⊕	⊕	⊕	⊕	○	●	○
Sports fields															●	○		○	●	○	⊕		⊕	⊕	⊕	⊕	⊕	○	○	○
Sports stadiums																●		⊕	⊕	⊕	⊕		⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Cultural facilities																														
Libraries																		●	●	○	⊕		○	●	○	⊕	⊕	●	●	●
Community centres																			●	●	⊕		⊕	⊕	⊕	⊕	⊕	○	○	●
Religious centres																				●	○		⊕	⊕	⊕	⊕	⊕	○	○	○
Cemeteries																					●		⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Administrative facilities																														
Magistrate court																							●	●	○	●	⊕	⊕	⊕	⊕
Municipal offices																								●	○	○	○	⊕	⊕	●
Post offices																									●	⊕	⊕	○	○	●
Police stations																										●	○	⊕	⊕	⊕
Fire stations																											●	⊕	⊕	⊕
Old age home																												●	⊕	○
Children's home																													●	○
Information centres																														●

Key:
● Compatible
○ Neutral
⊕ Incompatible

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.

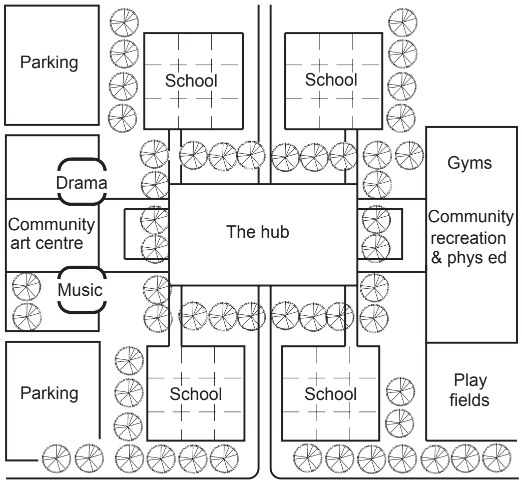

Figure 5.5.2: Educational facility cluster (after Leggett et al 1977)

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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Land subdivision

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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

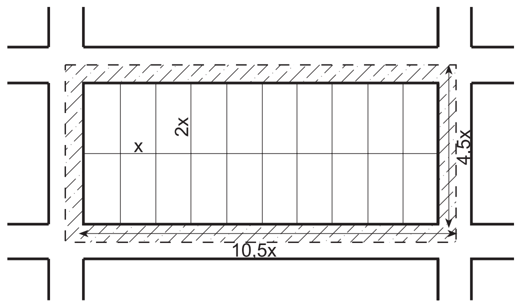

Figure 5.6.2: Conceptual diagram depicting the grid layout

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

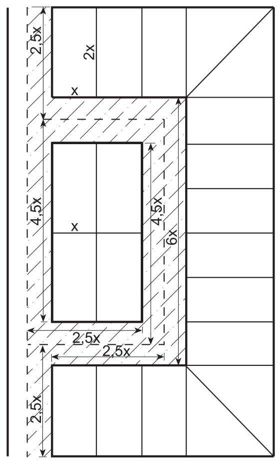

Figure 5.6.3: Conceptual diagram depicting the loop subdivision layout

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

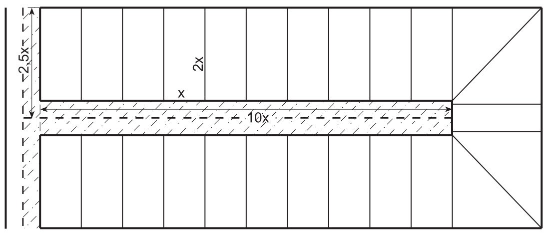

Figure 5.6.4: Conceptual diagram depicting the cul-de-sac subdivision layout

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

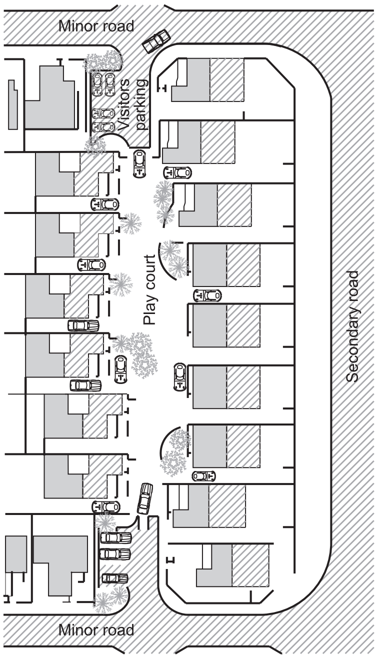

Figure 5.6.5: Conceptual diagram depicting the woonerf subdivision layout

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

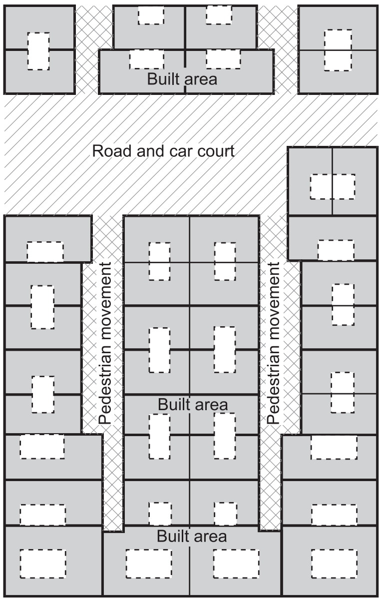

Figure 5.6.6: Conceptual diagram depicting the cluster subdivision layout

<u>Positive aspects</u>

- 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.

<u>Negative aspects</u>

- 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

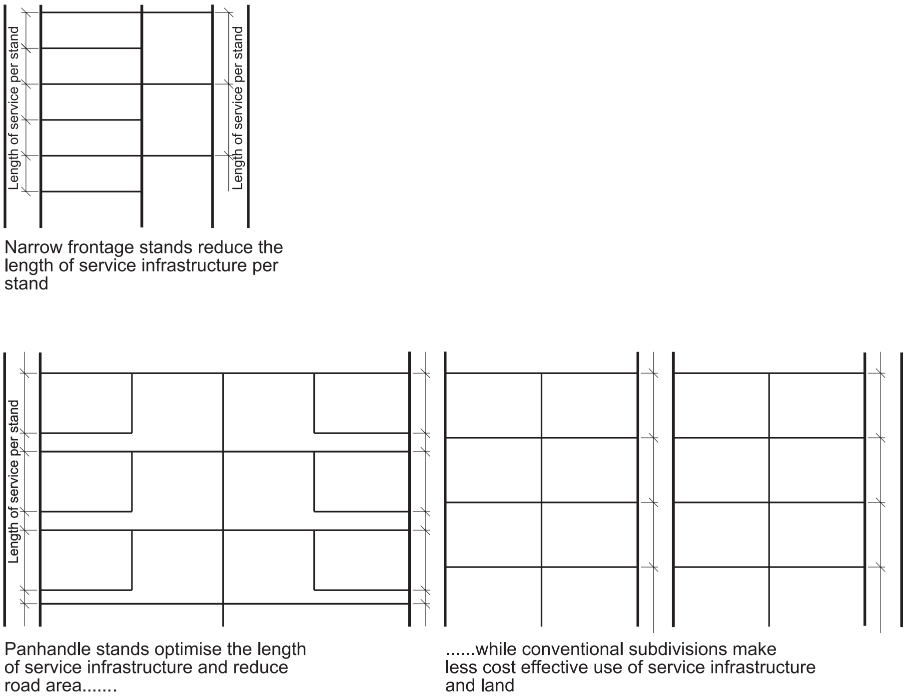

Figure 5.6.7: Optimising service infrastructure through erf layout

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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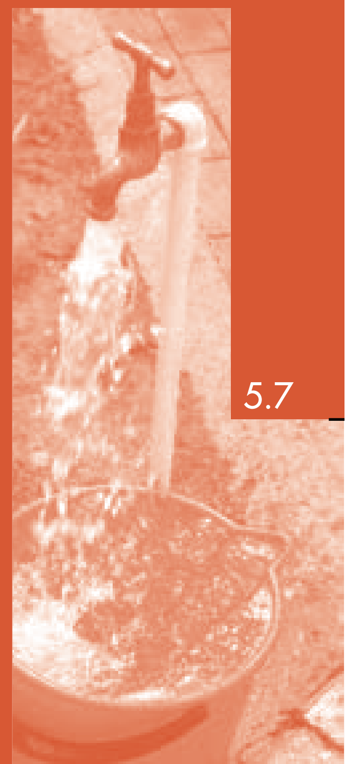
Chapter 5.7

Public utilities



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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.

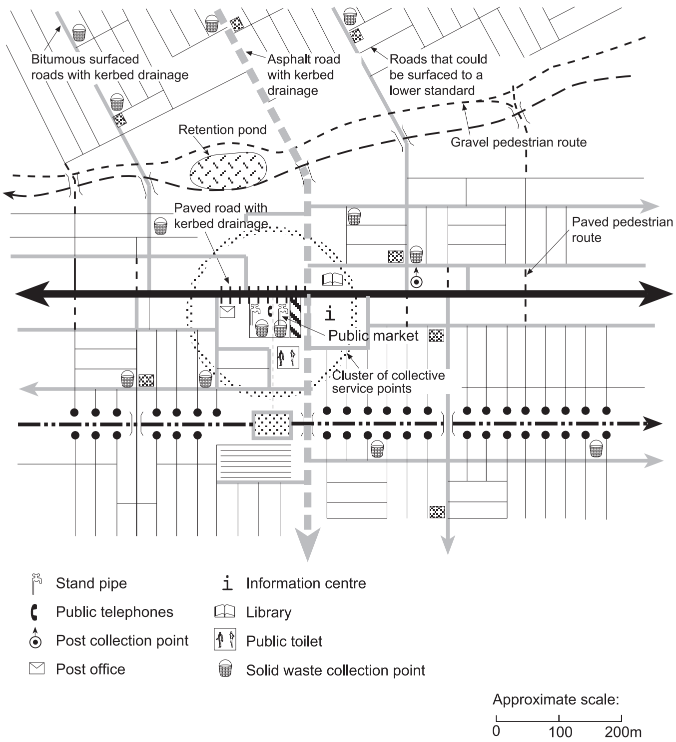

Figure 5.7.1 Conceptual diagram of key spatial relationships relating to collective utilities within greenfield projects

Source: Behrens and Watson 1996, p 103

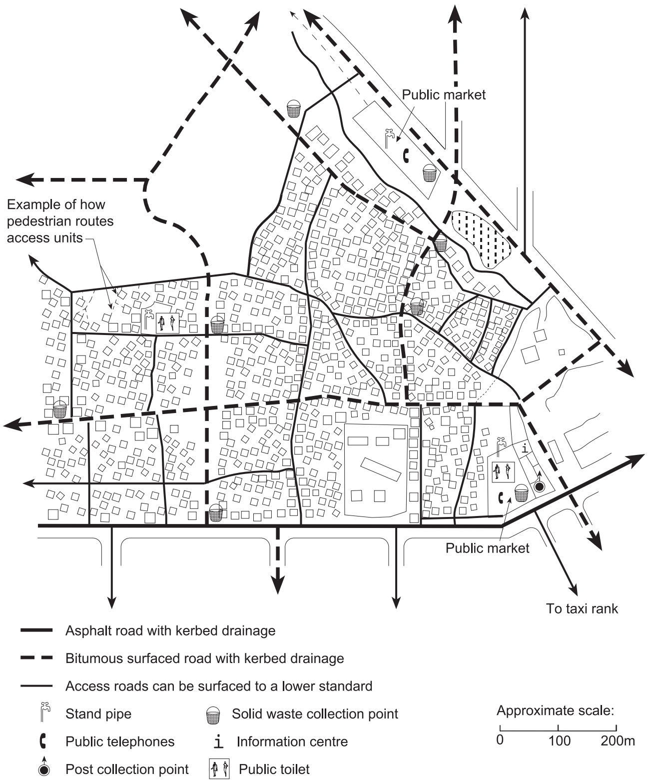

Figure 5.7.2 Conceptual diagram of key spatial relationships relating to collective utilities within upgrade projects
Source: Behrens and Watson 1996, p 111

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

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.*

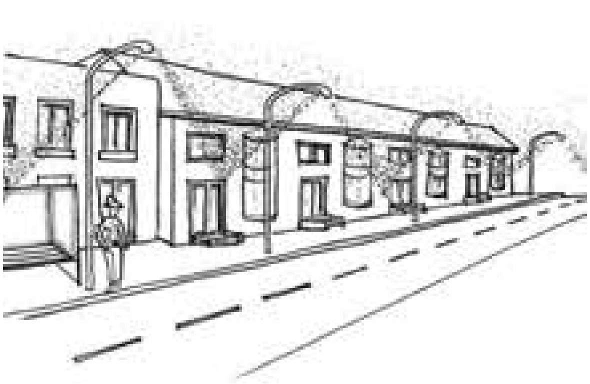

Figure 5.8.1.2 Importance of sufficient and adequate lighting

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.*

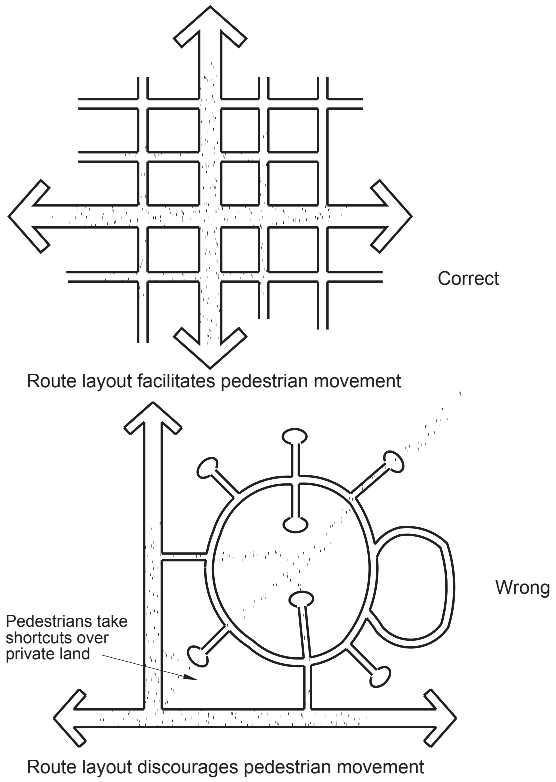

Figure 5.8.1.3 Route layout and pedestrian movement

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.*

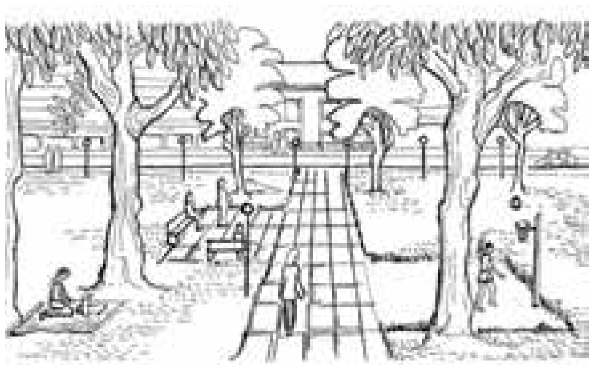

Figure 5.8.1.5 Landscaping and visibility

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.

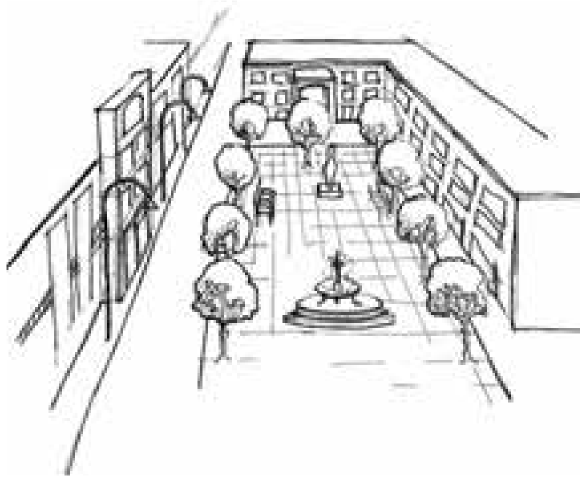

Figure 5.8.1.6 Identifiable neighbourhood character

- *Design a network of small neighbourhood parks rather than open spaces which are too large to be effectively controlled by residents.*

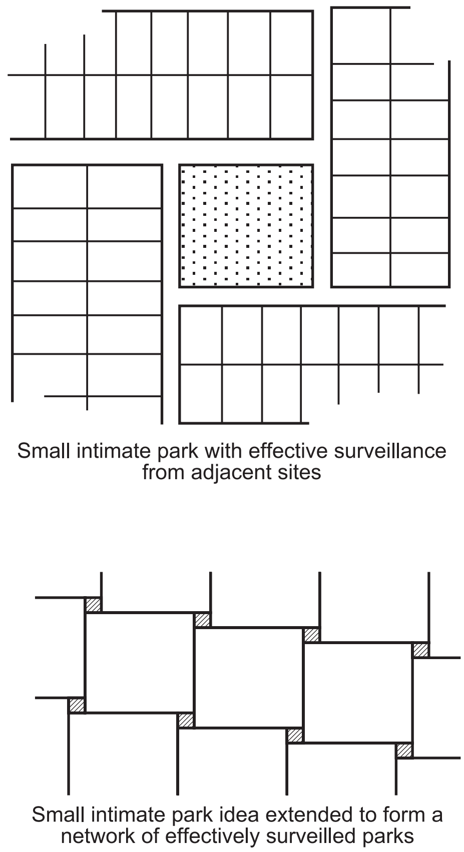

Figure 5.8.1.7 Network of small neighbourhood parks

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.*

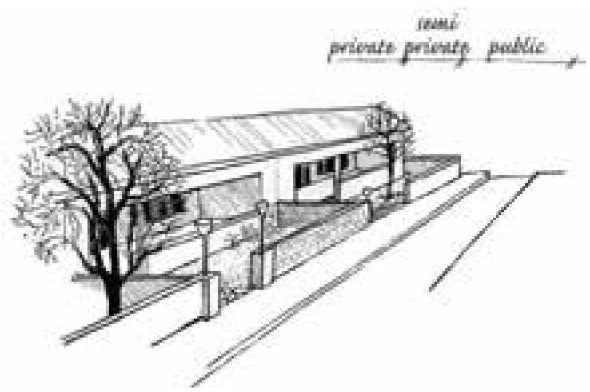

Figure 5.8.1.8 Clearly definable edges

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.*

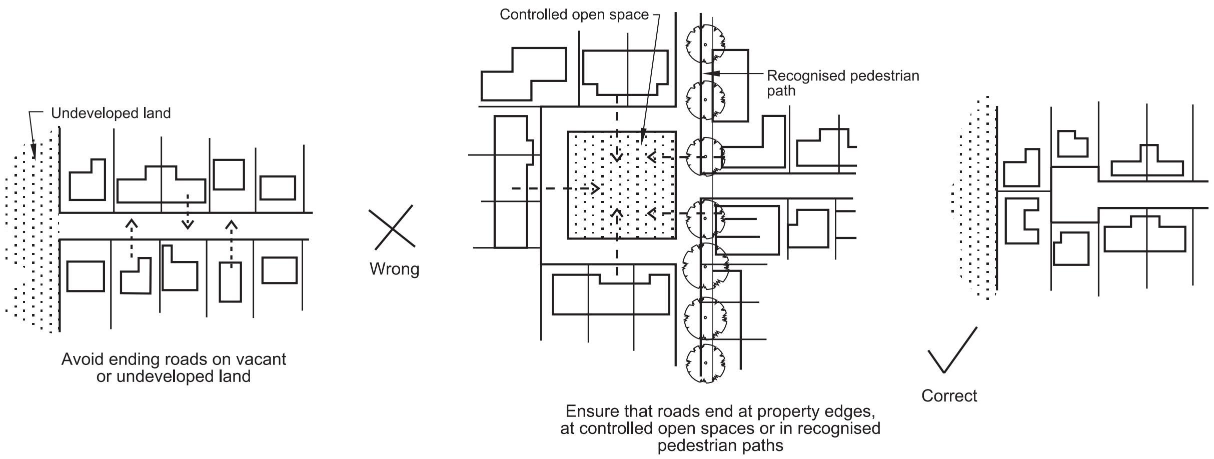

Figure 5.8.1.9 Avoid ending roads on vacant or undeveloped land

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.*

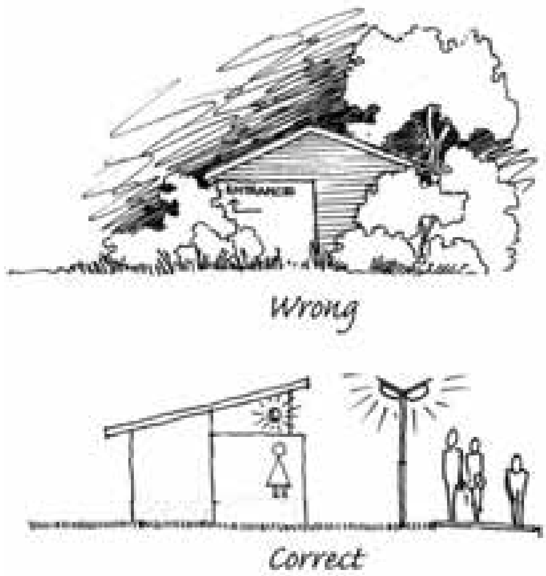

Figure 5.8.1.10 Ensure visibility of ablution facilities

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.*

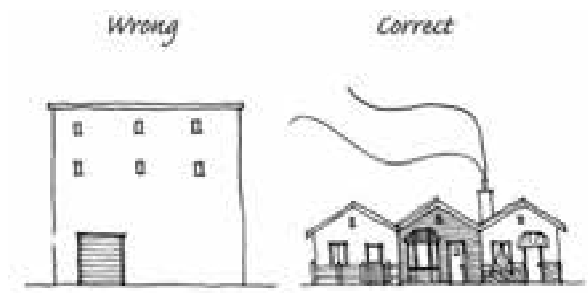

Figure 5.8.1.11 The image of the building

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).

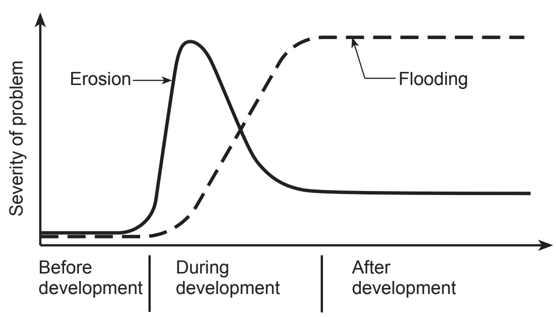

Figure 5.8.2.1: The sequential nature of erosion, sedimentation and flooding

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.

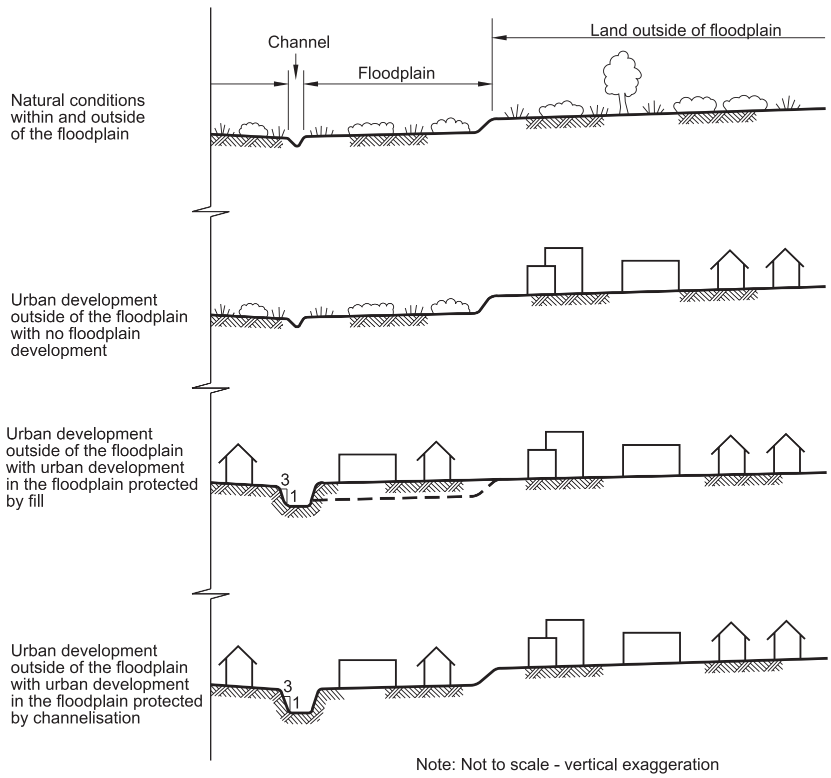

Figure 5.8.2.2: Encroachment into floodplains
Source: Walesh (1989)

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

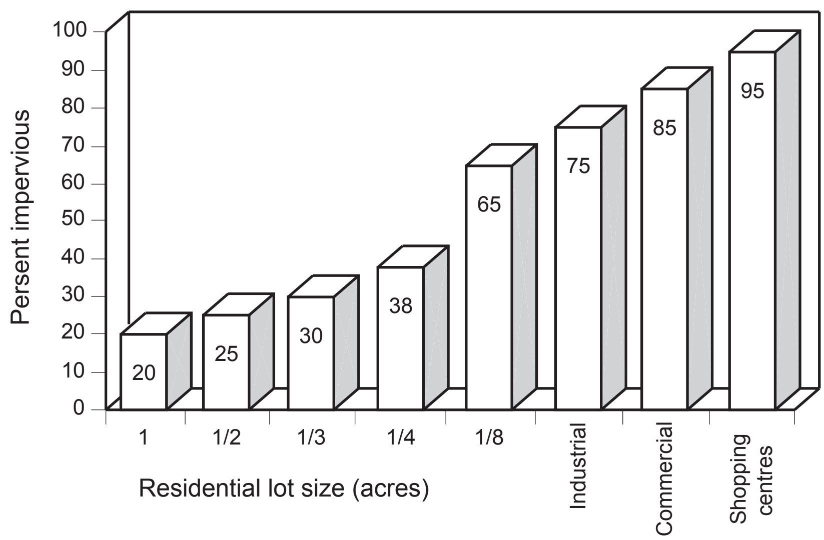

Figure 5.8.2.3: Average percentage of impervious coverage by land use

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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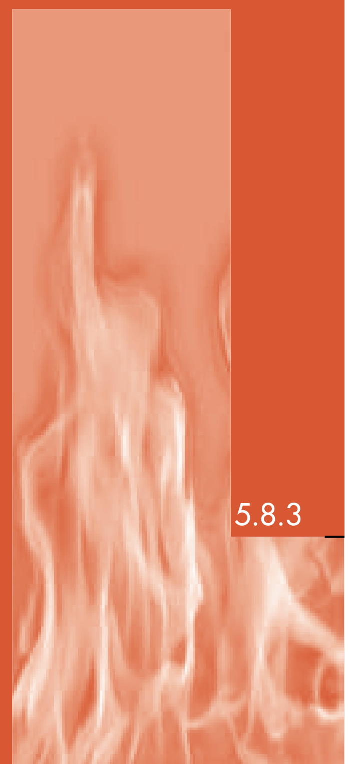
Chapter 5.8.3

Fire safety



5.8.3

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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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