TOOLKIT **EDITION 1** 2018

CITIES' **INFRASTRUCTURE DELIVERY** AND **MANAGEMENT** SYSTEM **CIDMS**

MODULE 1

National requirements for the delivery and management of infrastructure

national treasury
Department:
National Treasury
REPUBLIC OF SOUTH AFRICA

cITIEs SUPPORT PROGRAMME

IUDF
INTEGRATED URBAN DEVELOPMENT FRAMEWORK

2030 NDP

MODULE PURPOSE

This module presents an analysis of urban challenges and expectations for cities and their pivotal role in the economic and social development of South Africa, through considered infrastructure delivery and management in the context of the spatial reform agenda. It also describes the unique value that this toolkit offers in supporting cities to meet these challenges, using the Cities Infrastructure Delivery and Management System (CIDMS) that is founded on best practice and tailored for unique application in the South African urban environment.

WHY

1. Infrastructure investments, the delivery of infrastructure and the management of infrastructure assets and services need to support national policy and strategy relating to the development of the country. This module summarises key urban built environment strategies and highlights strategic objectives for urban infrastructure.
2. The strategic objectives for urban infrastructure serve as outcome areas that define the parameters for decision-making in city asset management systems, dealt with in Module 2 of this Toolkit.

OUTPUTS OF MODULE 1:

1. Identification of standards and best practices considered in the development of the CIDMS system.
2. Articulation of the key urban built environment challenges facing cities and identification of key national policy imperatives with emphasis on infrastructure – this provides the broad legislative and physical context (as part of an environmental analysis) informing the design of a city asset management system* responsive to its environment.
3. Identification of national expectations for urban infrastructure as outcomes to be achieved by cities – these outcomes become the policy principles stipulated in a city's asset management policy.

** Module 2 defines the asset management system.*

KEY RELEVANT NATIONAL REGULATIONS, POLICIES AND STRATEGIES:

1. Spatial Planning and Land Use Management Act, No 16 of 2013
2. National Development Plan - 2030
3. Urban Networks Strategy
4. Integrated Urban Development Framework
5. National Infrastructure Maintenance Strategy

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1.1 INTRODUCTION

1.1.1 Purpose and scope of this toolkit

Cities hold the key to unlocking the full economic growth potential of South Africa, and forging resilient social structures that build a unified, inclusive nation of people who enjoy the full benefits of advanced health care, education, the arts, many recreation activities and that special "buzz" that some successful cities offer (consider **Figures 1.1 – 1.3** depicting South Africa's three largest cities).

By 2011 the majority of South Africa's population resided in the eight metropolitan cities. A large conglomeration of people in fairly small city spaces (compared to rural settings) creates economy of scale and opportunities for interaction, collaboration, specialisation and innovation. Size allows cities to develop the complex, specialised economic systems that are necessary for economic growth and employment creation at scale. Size also enables cities to provide both a wide range and richness of social life, such as universities, advanced health care and access to the arts. Collectively, these benefits are called the "urban dividend". Despite occupying less than 2 per cent of the land mass of South Africa, cities generate in the order of 60 per cent of the country's Gross Domestic Product (GDP) and account for 60 per cent of the population by 2013. Cities stand central in Government's plans for the economic and social development of South Africa.

"Cities stand central in Government's plans for the economic and social development of South Africa."

No city can function without the availability and reliable functioning of complex urban infrastructure support systems. Municipal infrastructure provides households, businesses, institutions and other customers with energy and potable water. It enables movement through roads, bridges, sidewalks and transportation infrastructure. Municipal infrastructure also protects cities from the dangers of flooding through stormwater infrastructure, from fire and other emergencies through infrastructure such as fire hydrants and emergency response facilities, and enables a healthy environment for human, animal and plant life through the safe removal, treatment and disposal of wastes. Municipal parks, open space and recreation facilities enable the citizenry to enjoy varied social activities and provide opportunities for social advancement and cohesion. Cities have over decades invested heavily in infrastructure systems: over 50 per cent of the total replacement value of R1.16 trillion of all municipal infrastructure in the country is vested in cities. This toolkit has been developed to support cities to sustainably increase both the level and quality of investment in infrastructure in order to meet the economic and social aspirations of South Africa as a developing nation.

FIGURE 1.1: Cape Town

Cape Town, the Mother City. Considered one of the most beautiful cities on the planet, it boasts the famous Table Mountain. After Johannesburg it is South Africa's most populous city and its second main economic centre. This city has won many accolades in recent years, including the World Design Capital for 2014 by the International Council of Societies of Industrial Design. In the same year the New York Times named Cape Town as the best place in the world to visit. ***Source:*** Picked from internet.

FIGURE 1.2: Durban

Aerial view of Durban (eThekwini) featuring the Moses Madiba stadium, extensive transport infrastructure, skyscrapers, beachfronts and green open space. The city has the busiest container port in Africa and is the second most important manufacturing hub in South Africa. With its subtropical climate, beaches and attractions such as the uShaka Marine World, it is a major tourist destination. Durban is well known for its diverse cultures and experiences. ***Source:*** Picked from internet.

FIGURE 1.3: Johannesburg

Johannesburg, the financial powerhouse of South Africa, and indeed, of the continent of Africa. Johannesburg is home to South Africa's tallest buildings, two major universities, the country's mining houses and is also the location of the headquarters of most major South African banks. Johannesburg also hosts the Constitutional Court, the ultimate guardian of South Africa's progressive Constitution. Johannesburg also boasts a vibrant night life and is a mecca for the arts. ***Source:*** www.ohphoto.co.za

In particular, this toolkit provides principles, methodologies, processes, techniques and case studies to assist infrastructure planners and decision makers to:

Plan comprehensively for urban infrastructure

Make infrastructure investment choices designed to future-proof cities

Accelerate the delivery of infrastructure

Establish systems and mechanisms that will ensure that infrastructure is optimally managed

These processes, in a nutshell, include:

01 CITY-LEVEL ASSET MANAGEMENT STRATEGY AND POLICY

This includes the establishment and improvement upon resilient city-level asset management strategy and policy to guide infrastructure planning, decision making and activities. These will ensure that the city invests in and cares for assets supportive of smart and inclusive growth in such a way that risks and costs associated with infrastructure are minimised, and that optimum value is derived from infrastructure.

02 ASSET KNOWLEDGE

Develop, maintain, update and improve knowledge on the city's existing infrastructure assets and amenities – service capacities and reach, failure mode status and trends, risk profiles and life cycle requirements.

03 DECIDE SERVICE PACKAGES AND PROFILE THE STATE OF SERVICES PROVIDED

Articulate and measure levels and standards of service, assemble infrastructure service profiles, determine whether service backlogs exist in the present time, and formulate plans to address backlogs and service improvement needs.

04 FORECAST AND MANAGE DEMAND

Estimate the demand for infrastructure services, apply demand management techniques to curb excessive resource consumption and unnecessary investment, and calculate net demand to be serviced. Servicing will be done through infrastructure expansion and upgrading, and other tailored life cycle solutions, as well as recurrent expenditure in the form of operations and maintenance to serve changes in demand.

05 LIFE CYCLE PLANNING FOR ASSET PORTFOLIOS

Develop life cycle plans for asset portfolios and cost life cycle activities. This includes the formulation of programmes and projects in the short to medium term, preparation of life cycle funding estimates in the longer term, and scheduling and optimisation of life cycle activities at asset portfolio level.

06 FINANCIAL APPRAISAL AND BUDGET DEVELOPMENT

Undertake portfolio-level life cycle financial feasibility assessment and budget development. This involves:

- the preparation of revenue and expenditure forecasts
- matching of funding sources
- determining tariff impacts and customer affordability where appropriate and
- assessing financial outcomes of investment on the city's financial position and performance over the longer term

Capital and operating budget submissions are then prepared and included in the city's Medium-Term Revenue and Expenditure Framework (MTREF).

07 PORTFOLIO, PROGRAMME AND PROJECT MANAGEMENT (PPPM)

Review of the portfolio-level consolidated city infrastructure plan and budget (developed in **Sections 5 and 6** above) into a programme and project level implementation plan including overall, integrated scheduling, package preparation and definition. The implementation plan includes the detailed and scheduled aspect of land assembly and development controls. This is followed by the preparation of the procurement plan and strategy and then by detailed project level plans, including detailed designs and specifications.

08 INFRASTRUCTURE PROCUREMENT MANAGEMENT (IPM)

The procurement management process starts with the procurement plan and strategy developed in **Section 7**. Thereafter specialised infrastructure procurement management processes commence with solicitation or tender preparation and invitations, followed by the tender evaluation, and finally the award of the tender.

09 CONTRACT ADMINISTRATION AND ASSET HANDOVER

This stage involves contract administration (administration, compliance assurance, contract data capture and the approval of contract variations), and site activities, including the management of the works and asset handover. It then concludes with the contract close-out stage including the capturing of the asset register data, and package completion or the payment of the final account.

1.1.2 Best practice

This toolkit adopts an asset management approach to the planning and management of infrastructure. Asset management is the process of decision making, planning and control over the acquisition, use, safeguarding and disposal of assets to maximise their service-delivery potential and benefits, and to minimise their related risks and costs over their entire life.

The methodologies and techniques presented in this toolkit are consistent with international and local best practice and standards, inclusive of:

- Relevant standards of Generally Recognised Accounting Practice, with specific reference to GRAP 17: Property, Plant and Equipment.
- *SABS: South African National Standard 55000: 2015. Asset management – Overview, principles and terminology.*
- *SABS: South African National Standard 55001: 2015. Asset management – Management systems – Requirements.*
- *SABS: South African National Standard 55002: 2015. Asset management – Management systems – Guidelines for the application of SANS 55001*
- NAMS and IPWEA' s *International Infrastructure Management Manual* 2011.

As the focus in this first edition of the toolkit is on sound infrastructure investment decision making and acceleration of the delivery of infrastructure, some elements of asset management practice relating to the ongoing management of infrastructure portfolios are not dealt with in this toolkit.

Practices relating to infrastructure delivery meet the requirements of the Standard for Infrastructure Procurement and Delivery Management (SIPDM), which in turn is based on the following standards:

- *SABS: South African National Standard 10845-1: 2015. Construction procurement – Part 1: Processes, methods and procedures.*
- *SABS: South African National Standard 10845-2: 2015. Construction procurement – Part 2: Formatting and compilation of procurement documentation.*
- *SABS: South African National Standard 10845-3: 2015. Construction procurement – Part 3: Standard conditions of tender.*
- *SABS: South African National Standard 10845-4: 2015. Construction procurement – Part 4: Standard conditions for the calling for expressions of interest.*
- *SABS: South African National Standard 10845-5: 2015. Construction procurement – Part 5: Participation of targeted enterprises in contracts.*
- *SABS: South African National Standard 10845-6: 2015. Construction procurement – Part 6: Participation of targeted partners in joint ventures in contracts.*
- *SABS: South African National Standard 10845-7: 2015 Construction procurement – Part 7: Participation of local enterprises and labour in contracts.*
- *International Standards Organisation 6701-1: 2014. Building and civil engineering works – vocabulary – Part 1: General Terms.*

CITIES' **INFRASTRUCTURE DELIVERY AND MANAGEMENT** SYSTEM **CIDMS** **1.6**

1.1.3 Unique value of this toolkit

This toolkit does not aim to replace any of the standards, manuals and guidelines noted in the preceding section. So what does this toolkit offer? Cities will benefit from the implementation of this toolkit in the following ways:

01 SYNTHESIS AND TAILORING FOR URBAN APPLICATION

The urban infrastructure management value chain requires an approach involving multiple disciplines, including engineering, urban planning, economics, finance, accounting and the social sciences. These disciplines have over time developed dictionaries, guiding principles, best practice models, guidelines and standards. Though representative of best practice in the general sense in their respective fields, they in many instances have not been developed for particular application in the South African local government environment generally, and cities specifically. In other words, they require modification to respond to the particular conditions and dynamics of South African cities, the prevailing legislative framework, the emerging urban policy of the country and the desired city strategic outcomes as established in the National Development Plan.

This toolkit collates, interprets, synthesises and tailors these discipline-specific standards, methodologies and techniques for specific application in the South African city space. But the toolkit is also much more than a synthesised compendium of good practice from elsewhere. It showcases emerging home-grown urban best practice. It moves beyond sound principles and descriptions of best practice and offers practical advice and case studies of real-world application of best practices in South African cities.

02 STANDARDISATION

Standardisation holds many benefits. It limits costly investments in practice development, enables easy replication of systems, practices and methods between cities, and allows structured training, sharing and transfer of capable built environment practitioners in and between cities. Standardised methods for analysis, planning and reporting should lead to consistent outputs over time and comparable data and results between cities. This allows for benchmarking and for objective assessment of status quo, progress and needs.

Since the toolkit also synthesises and standardises across the infrastructure management value chain, it allows standardisation within a city. As a case in point, several cities at present prepare, maintain and update two asset registers: one for compliance and financial reporting purposes and another for infrastructure planning and management purposes. This toolkit offers one data model that allows the production of one asset register which complies with the requirements of the Generally Recognised Accounting Practice (GRAP) standards applicable to infrastructure and amenities, and also supports infrastructure planning and management through infrastructure risk profiling, renewals scenario modelling, asset care budgeting and more.

03 FLEXIBILITY

Many of the urban infrastructure challenges apply to all cities with metropolitan authority. But cities differ greatly in population and economic size, growth prospects, spatial configurations and footprints, infrastructure capacities and supply arrangements, and financial, administrative and technical capacity. This toolkit accommodates unique conditions and varying city capacities by offering various levels of practice, from emerging to competent, expert and ultimately, leading practice. This allows cities with limited capacity, either generally or in a particular field, such as demand management, to adopt a level of practice suited to its resources, abilities and challenges. Cities with advanced practices, significant resources and an appetite for innovation have the flexibility to opt for higher levels of practice and to contribute towards advancements in practice that can be replicated across cities.

> ***"Cities with advanced practices, significant resources and an appetite for innovation have the flexibility to opt for higher levels of practice and to contribute towards advancements in practice that can be replicated across cities."***

04 SPATIAL DIMENSION

Urban infrastructure systems are distributed and linked across space, serving many different customers at multiple points across the city. This toolkit blends innovative spatial techniques with accepted infrastructure asset management practice to properly profile customers and access to services; to determine and manage the demand for infrastructure and limit unnecessary resource consumption; to identify critical infrastructure and risks; to analyse revenue and the potential for revenue optimisation; to limit construction costs and to support spatially-based infrastructure investment planning and decision making. It equips cities with the tools necessary to implement the provisions of the Spatial Planning and Land Use Management Act (SPLUMA).

05 OPTIMISATION

The toolkit offers practices for vertical and horizontal alignment across projects, programmes, asset portfolios and ultimately, the organisation as a whole.

06 NUANCED LEVELS AND STANDARDS OF SERVICE FOR CITIES

This toolkit recognises that levels and standards for cities should differ from those accepted in other environments and should in fact even differ within the internal structure of a city, depending on factors such as land use, density and the purpose of a particular area.

07 EMPHASIS ON MULTIPLE DIMENSIONS OF VALUE-FOR-MONEY DESIGN AND APPRAISAL OF INFRASTRUCTURE INTERVENTIONS FOR CITIES

Cities must be financially resilient. They must therefore ensure that on balance their investments in infrastructure will contribute towards a productive asset base and towards positive financial performance results. Unfortunately not all investments, infrastructure and services have revenue-generating potential, and not all citizens have the ability to fully contribute towards paying for services rendered. It is, however, in the interests of the city as a whole, including all of its residents and customers, that inclusive growth is achieved which benefits all in the city in a manner that is financially sustainable.

This requires not only the application of robust investment appraisal techniques to ensure that the municipality remains financially resilient, but also an assessment of economic, social and environmental benefits and costs (including risks) for the municipality and for the wider community. This toolkit provides cities with the necessary decision-making framework and techniques for multidimensional appraisal of municipal investment proposals.

1.2 URBAN DEVELOPMENT AND INFRASTRUCTURE CHALLENGES

Cities are the target of strong critique, despite the many benefits that they confer on their citizens and the country at large. They are generally considered to be fragmented spaces which place limits on social inclusion and prevent the optimum economic functioning of urban spaces. The National Planning Commission (2012: 168) notes that cities are not sufficiently productive and do not produce enough jobs. The general view is that cities are carbon-intensive, and consume resources at unsustainable levels. Infrastructure capacities in many instances limit economic growth, and infrastructure coverage does not extend to all urban customers. Lastly, in relation to urban infrastructure, there is increasing concern about the ability of cities to care for the infrastructure under their control, with the attendant risks of infrastructure failure, service-delivery interruptions, loss of income and increased expenditure to return the service potential of assets.

1.2.1 Fragmented cities

City blueprints suffer from past apartheid practices that led to separate development for various races, the result of which is multiple settlements often disconnected from the functional structures of the core city and its primary nodes. This situation was aggravated over the past twenty years by rapid urban expansion outpacing the roll-out of public transportation coverage (Burdett and Surjic, 2011: 292), and indeed of municipal infrastructure services as a whole in many instances.

Several factors drove this rapid urban expansion, some of which include the degeneration of inner cities and the preference for living in security estates. But the largest driver of urban expansion was the well-intended need to develop large-scale low-income housing settlements for the poor on the urban periphery. Reasons for the choice of location include: the nature of the low-income housing subsidy which requires a single detached dwelling on its own stand of defined size; the availability of large tracts of inexpensive land at the periphery and administrative preference for larger developments (Boshoff, 2014).

FIGURE 1.4: *Sterile low-income housing development*

Example of a sterile low-income housing development, designed for residential accommodation. Note the absence of public open space, amenities, movement infrastructure or other land use such as retail.

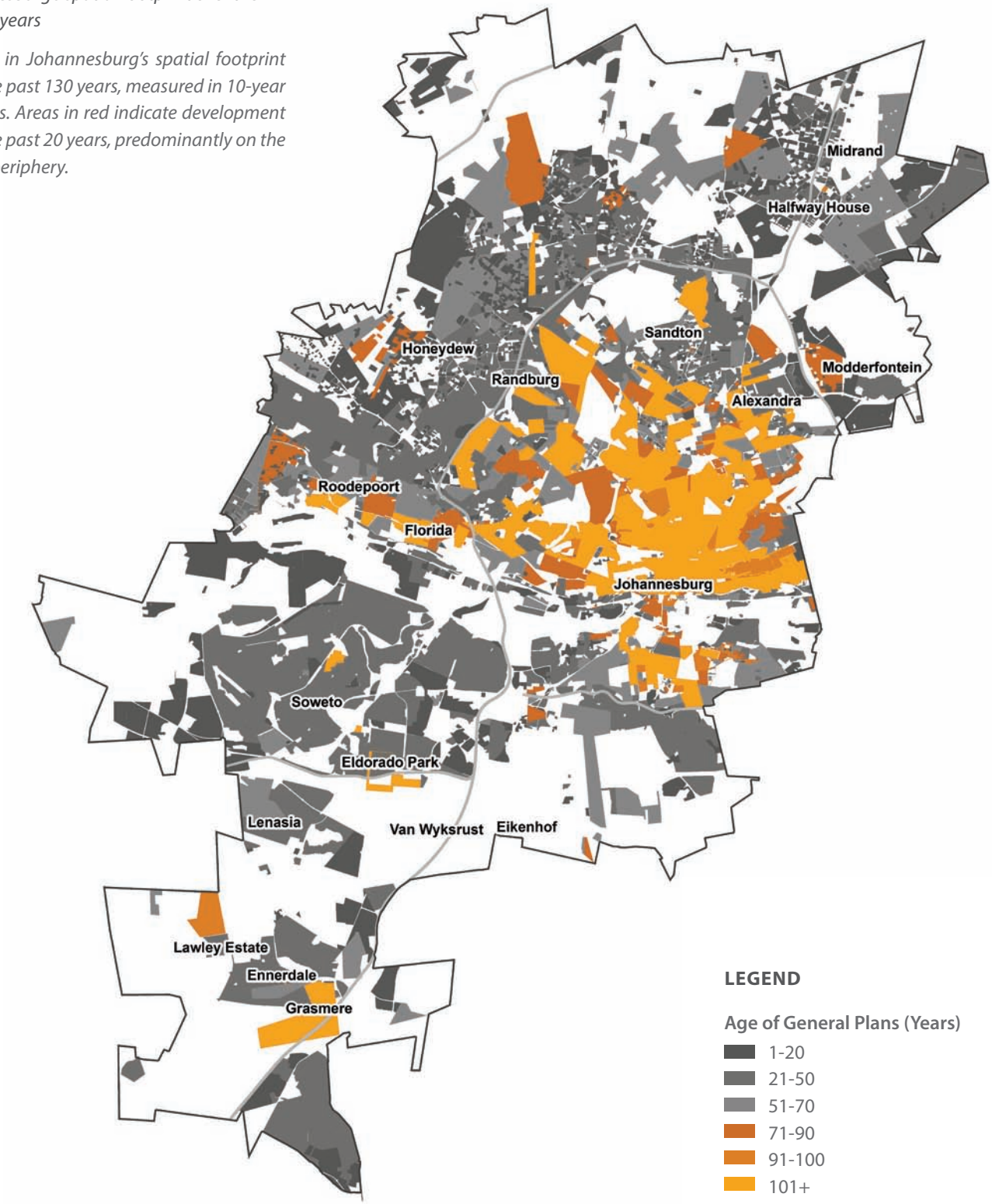
This often resulted in the development of sterile housing projects lacking the key ingredients for sustainable human settlements. Large distances from places of employment opportunities place strain on the finances of the poor who have to spend disproportionate amounts of their time and income on transportation. As a case in point Johannesburg over the past twenty years, like most of the larger metropolitan areas in South Africa, expanded its spatial footprint far beyond the requirements of natural population and economic growth. In its first 120 years (up to the advent of democracy in South Africa) the city grew its footprint to 737 045 955 m^2. In the 20 years since, the city expanded its footprint by 181 864 944 m^2. In short, it grew by 20 per cent, as shown in **Figure 1.5.**

The rapid expansion of city footprints also contributes to low density. Gross density, measured in households per hectare, ranges from as low as 0.37 in Mangaung to 8.27 in Johannesburg. Though Johannesburg has the highest density of any South African city, it is low compared to most European cities or cities in the global south (cities in the developing world). Low-density urban sprawl requires massive investment in expanding municipal civil and electrical networks, rather than increasing the intensity of use of existing networks. Such development forces the implementation of public transportation systems as the poor do not have access to employment and other social opportunities within reasonable distance.

Perversely, though, low densities translate into low ridership on public transportation systems which limits the financial viability of such systems. The Integrated Urban Development Framework (IUDF) notes that providing public transport infrastructure will remain very expensive due to the fragmented spatial structure and low densities that translate into low ridership and therefore higher operating costs per passenger.

FIGURE 1.5: *Rapid growth in Johannesburg's spatial footprint over the past 20 years*

Growth in Johannesburg's spatial footprint over the past 130 years, measured in 10-year intervals. Areas in red indicate development over the past 20 years, predominantly on the urban periphery.



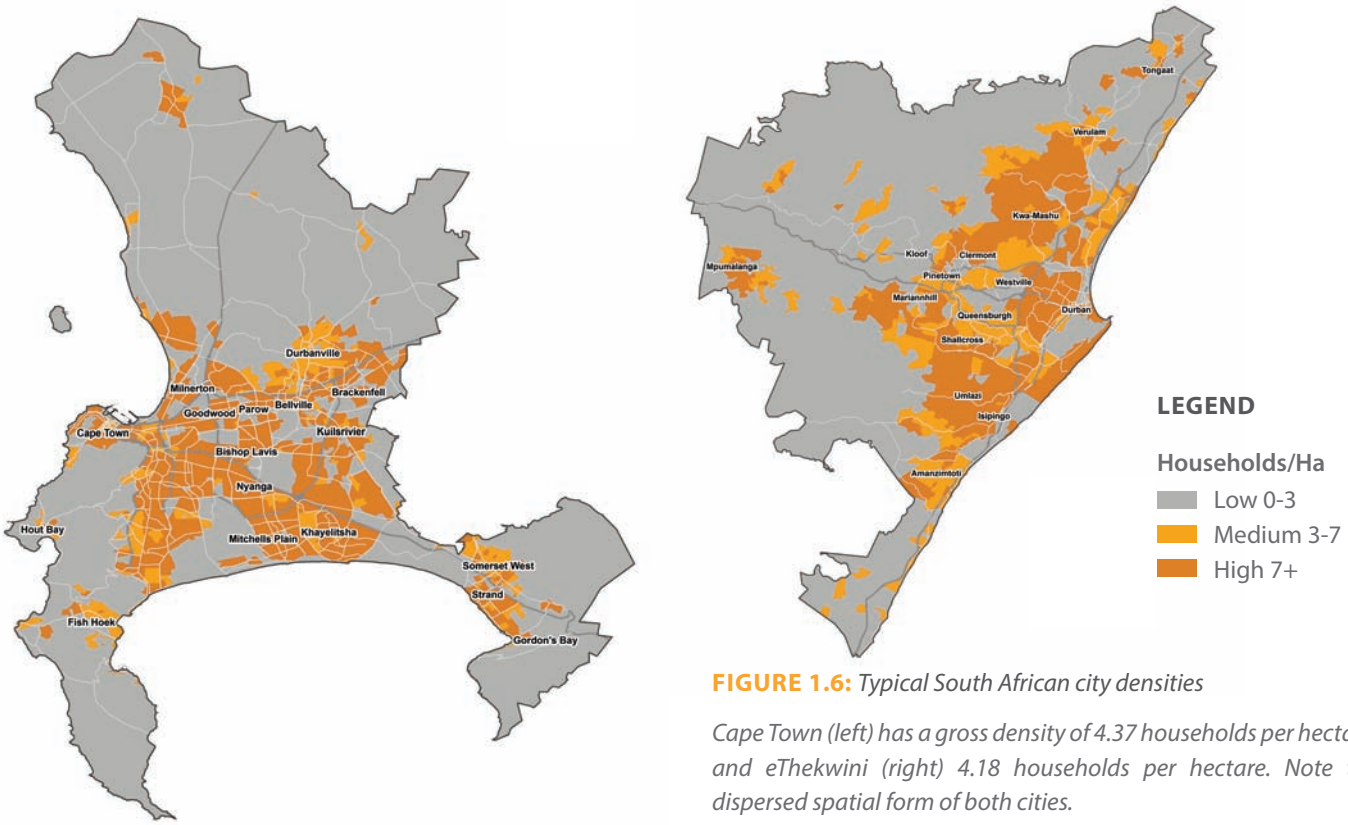


FIGURE 1.6: *Typical South African city densities*

Cape Town (left) has a gross density of 4.37 households per hectare, and eThekwini (right) 4.18 households per hectare. Note the dispersed spatial form of both cities.

1.2.2 Carbon-intensive, resource-consumptive cities

South African cities tend to be characterised by low-density, dispersed growth where control over land use takes preference over urban form. The transportation system is dominated by an automobile-orientated, hierarchical network, with limited provision for pedestrian sidewalks and cycle lanes.

Cities globally account for over 80 per cent of global resource consumption and pollution. The South African Cities Network (2013: 192) notes that South African cities record per capita co^2 emissions of between 3.7 and 7.5 energy-related tons, waste production of about 1 000kg per person per annum, and high mean water consumption of 223 litres per person per day. Despite these high levels of resource consumption and carbon production, cities are not very efficient. The Gini coefficient ranges between 0.67 and 0.75 for cities, indicating high levels of inequality. Cities also struggle to create employment at the rates necessary to move the country forward in a meaningful way.

Cities have over time generally shifted towards complex, centralised conventional high carbon (CHC) infrastructure systems. Such systems tend to rely on non-renewable resources, and they directly or indirectly produce waste or harmful by-products. Potable water supply systems, for example, deliver water through engineered hydrological and hydraulic components. The water purification plants and pump stations in these systems are generally energy intensive. The common approach is to increase supply volumes to meet expanding demand – this applies not only to water, but electricity as well. Indeed, water and electricity are categorised as trading services in the municipal environment, and cities rely on the sale of these commodities to generate a significant portion of operating income.

1.2.3 *Insufficient investment in infrastructure for growth*

For the past decade or so, cities in general focused their capital budgets on eradicating service access backlogs. This was, and remains, an important objective. But service access backlogs have largely been eradicated, and cities also need to invest in infrastructure for growth. This includes natural population growth and economic growth. In the medium-to-long term, investment in infrastructure for economic growth creates the scope for job creation and progressive eradication of poverty, which in turn alleviates the pressure on cities to support the urban poor. In the meantime, infrastructure capacities remain strained. There are many reported incidences where development applications by large industries, offering both employment opportunities and steady municipal revenues, were delayed due to bulk capacity constraints to the point that such investors decided to locate elsewhere instead. The UIDF notes that capacity constraints on electricity will limit economic growth to three per cent per annum, and that funding for stormwater infrastructure is woefully insufficient. The World Bank (2009: 22) estimated that the 27 largest municipalities would require some R271 billion in capital investment over a ten-year period, 91 per cent of which should be invested in infrastructure for growth and for renewal of infrastructure. The South African Cities Network (2013: 101) estimated higher levels of investment needs still, but its findings echo those of the World Bank. Cities need to increase capital spending on a sustained basis, and the lion's share of investment needs are for growth and renewal of infrastructure.

Investment in conventional infrastructure systems and public amenities such as electricity distribution, landfill sites and libraries, though very necessary, is not sufficient anymore. South African cities now compete in the global arena for scarce skills, fixed capital investment, and a share of economic activity. This requires strategic investments in non-traditional assets, services and activities, examples of which include Wi-Fi zones, the development of aerotropolis precincts, public rapid transport systems, development of complete streets in compact urban spaces along desired lines, convention centres, more attractive, inclusive, safe and connected open space, notable urban art, and more.

FIGURE 1.8: Cape Town International Convention Centre
The Cape Town International Convention Centre, an example of a city strategic investment. Source: www.cticc.co.za

FIGURE 1.9: BRT station
Johannesburg bus rapid transport passenger station. Source: Rea Vaya

FIGURE 1.7: An example of a complete street
An artist's impression of a complete street, allowing for the safe, simultaneous use of the street by pedestrians, motorists and cyclists. Also notice the combination of hard and soft landscaping elements, the use of colour in paving choices, clear signage and road markings, and attractive and functional street furniture. Source: blog.aarp.org

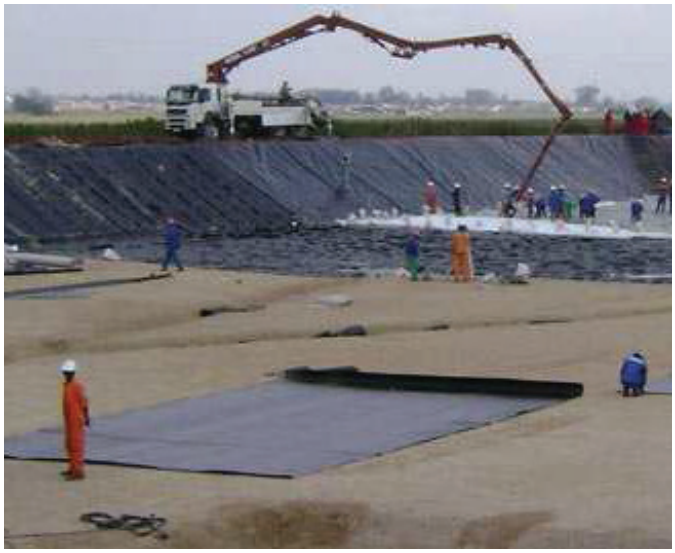
Investment for growth is, for purposes of this toolkit, classified into four categories, namely:

01 NEW DEVELOPMENT

Generally referred to as "greenfields" development. Such development is unconstrained by existing fixed structures. Large-scale low-income housing projects, such as the one depicted in **Figure 1.4**, are typical examples of greenfields development. From an asset management life cycle point of view new development is seen as asset creation if the resulting assets will be under the control of the city.

FIGURE 1.10: Example of an urban renewal project

Presidential urban renewal project: Mitchells Plain CBD transport interchange in Cape Town. Source: City of Cape Town



02 REDEVELOPMENT

Or "brownfields" development. There are two types of redevelopment projects, namely urban redevelopment projects and upgrading of infrastructure systems to increase capacity. Urban redevelopment projects, also referred to as urban renewal projects, entail the rehabilitation of city areas, typically at the scale of a precinct, by renovating or replacing dilapidated buildings with new housing, public buildings, parks and roadways, generally in accordance with an urban design plan. Upgrading or augmentation of infrastructure capacities follows on initial infrastructure installation, the capacity of which must now be upgraded to meet the increased demand for infrastructure following an intensification of land use. Examples of infrastructure upgrades include the widening of roads and increasing water distribution pipe sizes.

Brownfields development is constrained by the existence of fixed structures on the site chosen for development, causing additional costs to demolish current structures prior to commencing with the proposed development. Redevelopment tends to be costly. In addition to the costs of demolition and removal of rubble, such investment activities are often located in developed areas where limited space is available for on-site storage of construction materials, causing higher transportation costs. Where construction takes place in the road reserve or on building fronts adjacent to sidewalks, it may be necessary to institute measures to protect pedestrians from the potential dangers of falling building rubble and tools, and to limit the spread of dust. It may also be necessary to implement traffic calming measures around the site. Inner city redevelopment or projects involving the formalisation and upgrading of identified urban nodes often involves the temporary relocation of residents which further adds to the cost of the project.

Redevelopment is generally seen as asset replacement within the context of asset life cycle management, if the purpose of the redevelopment is fundamentally the same as that of the structure(s) it replaces.

FIGURE 1.11: Example of upgrading of infrastructure works

Upgrading of Johannesburg Water's Olifantsvlei Wastewater Treatment Works to treat residential and industrial effluent more efficiently. Source: City of Johannesburg

03 RETROFITTING

A form of capital investment which adds new features or technology to existing structures or systems to increase efficiency or to add new capability. Adding bus rapid transport (BRT) lanes and stations, or cycles lanes to existing roads are typical examples of retrofitting. Other examples are replacing existing standard windows in a building to double-glazed windows to conserve energy, or fitting solar panels to robots in the roads networks after initial installation to switch to renewable energy rather than to continue relying on coal-based energy. From an asset management point of view, the construction of BRT stations will be seen as new asset creation, the portion of the road's capacity consumed for installation of the BRT station as decreasing the capacity of the existing road and efficiency retrofits as increasing the capacity of existing infrastructure or buildings.

04 RENEWAL OF INFRASTRUCTURE

Renewal is capital expenditure on an existing asset which returns the service potential of the asset or expected useful life of the asset to that which it had originally.

1.2.4 Insufficient asset care and the need for investment in asset renewal

While cities need to increase spending on infrastructure, there are strong indications that they are increasingly unable to sustain investments in existing infrastructure. Infrastructure assets in the main are characterised by longevity – their life spans are generally measured in decades. Yet they age, and their condition deteriorates. This is inevitable, and will happen even when a city applies robust maintenance management practices. This is because the purpose of maintenance is to ensure that assets reach their intended design lives and are able to produce at defined performance standards. But maintenance can at best slow the effects of ageing. Moreover, many long-life civil infrastructure assets have parabolic condition deterioration curves.

This means that the rate of deterioration in condition is very slow, and that assets tend to perform according to expectations for most of their lives without any significant service-delivery scares along the way. This tends to create a false sense of security that assets are in good working order, and will remain so. Then, towards the end of their lives, the deterioration in condition accelerates. At this point it becomes necessary to reinvest in infrastructure to return the service potential or expected life of the asset to that which it had originally. Of course, many condition-related events can cause early impairment or failure of infrastructure assets before the end of their expected useful lives. Examples include flood damage, operator error, vandalism, substandard construction and overloading. Once infrastructure deteriorates beyond a certain point maintenance becomes insufficient and asset renewal becomes necessary.

The National Treasury, the World Bank, the Financial and Fiscal Commission, the South African Cities Network and others have in recent years expressed concern about the state of municipal infrastructure and about the insufficiency of asset care, both in asset maintenance and investment in renewal.

The Cities Network (2013: 98–102) reports that on aggregate 48 per cent of the service potential or economic benefit of city infrastructure has been consumed, deferred maintenance for 2012 amounted to R4,277 million and that asset renewal needs exceeded the total of capital subsidies received by R6,404 million. A sizable renewals backlog is mounting.

Why is this of concern? The citizenry of South Africa has over successive generations invested in the development of municipal and social amenities. These assets contribute to the fixed capital wealth of the country, underpin economic activity and enable the delivery of social goods. In fact, all economic outputs of cities are dependent in one way or another on the ongoing availability of this infrastructure. And as city infrastructures deteriorate, service-delivery interruptions increase, causing loss of both investor and business confidence as well as loss of trust by the citizenry that government is capable of providing reliable services. Furthermore, infrastructure in poor condition impairs city revenues and often leads to increased expenditures, such as in the form of increases in water losses and higher-than-normal repair expenses.

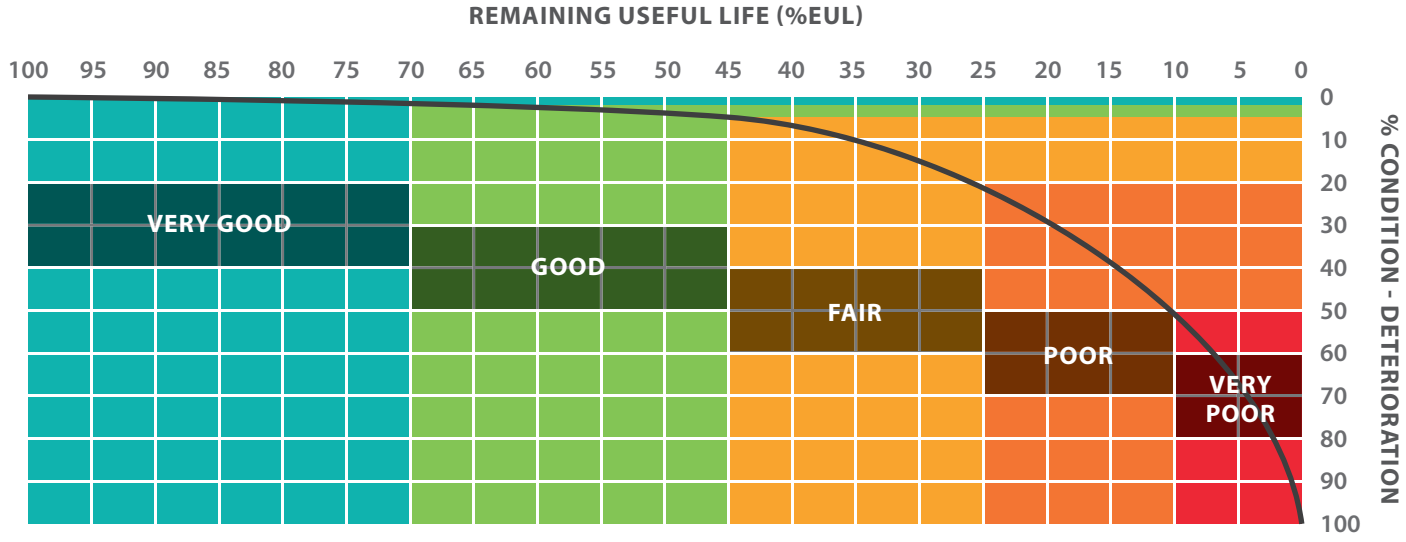


FIGURE 1.12: *Typical parabolic condition deterioration curve of civil infrastructure*

> *"Poor asset care and deteriorating infrastructure not only threatens our current way of life, it also limits our growth aspirations."*

Poor asset care and deteriorating infrastructure not only threatens our current way of life, it also limits our growth aspirations. Reliable infrastructure networks are a precondition for growth, as new infrastructure created will generally need to be connected to existing bulk and distribution infrastructure. Any city administration and its residents wish for fiscal stability. When infrastructure deteriorates beyond a certain point, the cost of addressing the mounting renewals backlog can be so large that it threatens the fiscal stability of a city. This in turn may necessitate significant increases in rates and tariffs to finance renewal programmes, which have severe short-to-medium term impacts on especially poor households and small business owners.

TOO MUCH OR TOO LITTLE INFRASTRUCTURE?

This toolkit highlights the need to invest in infrastructure to eradicate service access backlogs, to support population and economic growth, and to create better functioning cities in general. The discussion on asset care suggests otherwise: it seems cities control asset portfolios of extents beyond their capacity to maintain and renew. So is there too much, or too little infrastructure? The answer is both: cities need to continuously assess their asset portfolios for rationalisation, expansion and optimisation to achieve the desired balance between investments in infrastructure that: enables economic growth; yields sufficient municipal revenue and supports social upliftment. Some infrastructure and social amenities become redundant over time due to factors such as technological obsolescence, system reconfiguration, evolving city structures and changes in land-use patterns, and changes in community behaviour and expectations. This creates scope for asset rationalisation and optimisation, rather than simply continuing to care for assets no longer needed. Cities will need to continue to invest in new infrastructure and the upgrading of current systems if they desire to remain competitive, attractive spaces for investment, settlement and economic activity.

CASE STUDY 1:

The need for asset renewal – just how badly can infrastructure failure affect us?

LOAD SHEDDING

Following years of deferred maintenance and renewal on its power stations, the national grid was experiencing serious strain by early 2015.

It has been estimated that capacity constraints and load shedding has cost the country some R300 billion since 2008, and resulted in 1 million lost jobs.

By late 2014 the power utility was rocked by the silo collapse at the Majuba Power Station, and at the start of 2015 many units in Eskom's 27 power stations experienced technical faults which required unplanned maintenance. This forced the utility to announce a three-month-long period of planned load shedding while it tended to urgent maintenance.

At some points it became necessary for Eskom to implement Stage 3 load shedding while units were taken out of service for maintenance. Stage 3 load shedding involved up to nine hours of power cuts in two blocks per day to prevent a total collapse of the system. The impact of this was felt throughout the nation. National economic output was affected, and economic growth and employment constrained. It affected people in all of their activities, from being subjected to increased traffic congestion due to non-functioning signalling systems to their preparations for supper at night.

But all of these emergency repairs were just that – a multiyear programme of asset renewal requiring large investment is necessary to move the national grid from beyond fire-fighting mode into a position of reliable long-term supply.

Collapsed silo at the Majuba Power Station.
Source: Andriesvanheerden.wordpress.com

WATER SHEDDING

In 2014 the Rand Water pump station at Eikenhof stopped pumping water due to an electricity outage.

This electricity outage was caused by a faulty substation. This caused major water outages in the southern and western parts of Johannesburg, Krugersdorp and the south-western parts of Tshwane. There was a backup substation, but it had been out of service since 2012.

As the system was recovering from the Eikenhof outage, alleged cable theft led to electricity outage at the Rand Water Palmiet pump station that supplies water to Ekurhuleni. The water crises took weeks to resolve and affected dozens of suburbs in all three metros in Gauteng. Major hospitals, schools, factories, businesses and households were affected.

HEADLINE MESSAGES:

- Poor maintenance and failure to invest in asset renewal can adversely affect society at scale.
- There are generally no quick fixes for large failures of strategic infrastructure – sound analysis of infrastructure failure modes and risks and proactive asset life cycle planning culminating in sustained and planned investment in asset renewal is a precondition to our desired way of life.

CITIES' **INFRASTRUCTURE DELIVERY** AND **MANAGEMENT** SYSTEM **CIDMS** **1.18**

1.3 EMERGING SOUTH AFRICAN URBAN POLICY

There is increasing recognition that the future prosperity of the nation lies in cities, and cities have now become the focus of several national strategies. The following strategies provide direction and principles to be pursued in planning for, and the delivery of, infrastructure in urban spaces. The Spatial Planning and Land Use Management Act (SPLUMA) also provides clear principles for infrastructure planning. Hence it is included in the policy analysis.

1.3.1 Spatial Planning and Land Use Management Act

SPLUMA provides a comprehensive system for spatial planning and land use management, a key objective of which is to guide land development. The Act provides the following principles in relation to urban infrastructure planning and delivery, which require:

01 SPATIAL JUSTICE

Specific attention must be given to ensure inclusion of persons and areas previously excluded, with a particular emphasis on informal areas, which must be incrementally upgraded.

02 SPATIAL SUSTAINABILITY

Land development must be undertaken within the fiscal, institutional and administrative means of cities, and must result in viable communities. Land development must be promoted in locations that are sustainable, and urban sprawl must be limited. This includes consideration of all current and future costs to all parties for the provision of infrastructure and community services.

03 EFFICIENCY

Land development must optimise the use of existing infrastructure, and decision-making processes must minimise negative financial, social, economic or environmental impact.

In support of the above principles, SPLUMA requires: the profiling of engineering infrastructure and services in relation to existing needs; the preparation of population forecasts and the identification, quantification and location of infrastructure requirements for future needs. Importantly, the Act also requires a municipality to determine a spatially-based capital expenditure framework for its development programmes.

1.3.2 National Development Plan (NDP)

The National Planning Commission articulates in the NDP a vision of urban compaction and densification (2012:285) to be achieved through affordable, well-located, large-scale, high-density housing development in inner cities. Non-sustainable townships, typically historically black townships and informal settlements, should be retrofitted with public infrastructure to pursue sustainability, land value capture and attract private sector investment. Informal settlements should be upgraded and economic hubs supporting a range of economic activity should be developed where sufficient market size exists, or arrangements should be made to integrate townships with the wider urban economic network. Public transport and connecting corridors of development should be prioritised for investment to spatially link large concentrations of urban poor into the city mainstream life. Applying internationally accepted principles of transit oriented development, new urban development and infrastructure investment should be concentrated around corridors of mass transit (between poor townships and primary nodes) and around current and emerging economic nodes.

The National Planning Commission recognises that spatial transformation is an initiative that will require massive investment in fixed assets by the public and private sectors over decades, but believes that with strong policy, political will and consistent implementation a change in direction is possible within five years.

1.3.3 Integrated Urban Development Framework (IUDF)

The IUDF, still in draft form and taking its cue from the NDP, offers a new take on urban investment by the developmental state (September 2014: 6). It requires the shaping of new spatial forms in settlement and movement characterised by urban spaces that promote spatial equality, integration and multifunctionality, where transport is integrated and people can easily access varied economic and social opportunities, and sustainable infrastructure systems that offer access to all and that facilitate inclusionary economic growth.

Public transport modes should be strengthened non-motorised transport advanced and modal and spatial integration pursued, which will require investments in infrastructure, ICT technology and operational capacity. Nodal-corridor improvements should be pursued through public sector investment and settlement densification along priority nodes and corridors, in pursuit of transport-orientated development, and new growth should be accommodated in these areas. Importantly, the IUDF recognises the following three concerns:

A lack of know-how on how to achieve nodal-corridor improvements and associated land value capture. It therefore calls for an action research programme to develop such knowledge.

Providing public transport infrastructure will remain very expensive due to the fragmented spatial structure and low densities that translate into low ridership and therefore higher operating costs per passenger. Hence public transport subsidisation needs to be debated nationally.

In addition to the high cost of planned densification and mobilisation, there is currently insufficient funding for capital investment and maintenance of urban infrastructure.

According to the Financial and Fiscal Commission (2013: 136) an additional R8 billion is required per annum to recapitalise water, sanitation and electricity systems to perform adequately. The UIDF also notes that funding for stormwater infrastructure is woefully insufficient, and that capacity constraints in electricity will limit economic growth to 3 per cent per annum.

1.3.4 The Urban Network Strategy (UNS)

The UNS has been designed based on the concept of hierarchical connectedness. The strategy intends to strengthen disadvantaged townships and link them into the functional structure of the city in which they are located. This is done through the creation or strengthening of capital webs in neighbourhood or urban hubs through public sector investment via the Neighbourhood Development Partnership Grant (NDPG). A capital web, in this context, is a demarcated area of focused public sector fixed capital investment that leads to the emergence or strengthening of an urban hub which serves as a town centre for the surrounding residential areas.

An urban hub will typically accommodate mixed land use, and offer high-density accommodation, varied services, attractive public spaces and an intermodal public transport facility. It will function as a gateway precinct that will link the secondary urban network (the residential areas surrounding the urban hub) with the established primary urban network (main city network). It is dependent on the existence of public transportation systems linking these areas to primary nodes and also advocates investments along corridors and movement lines.

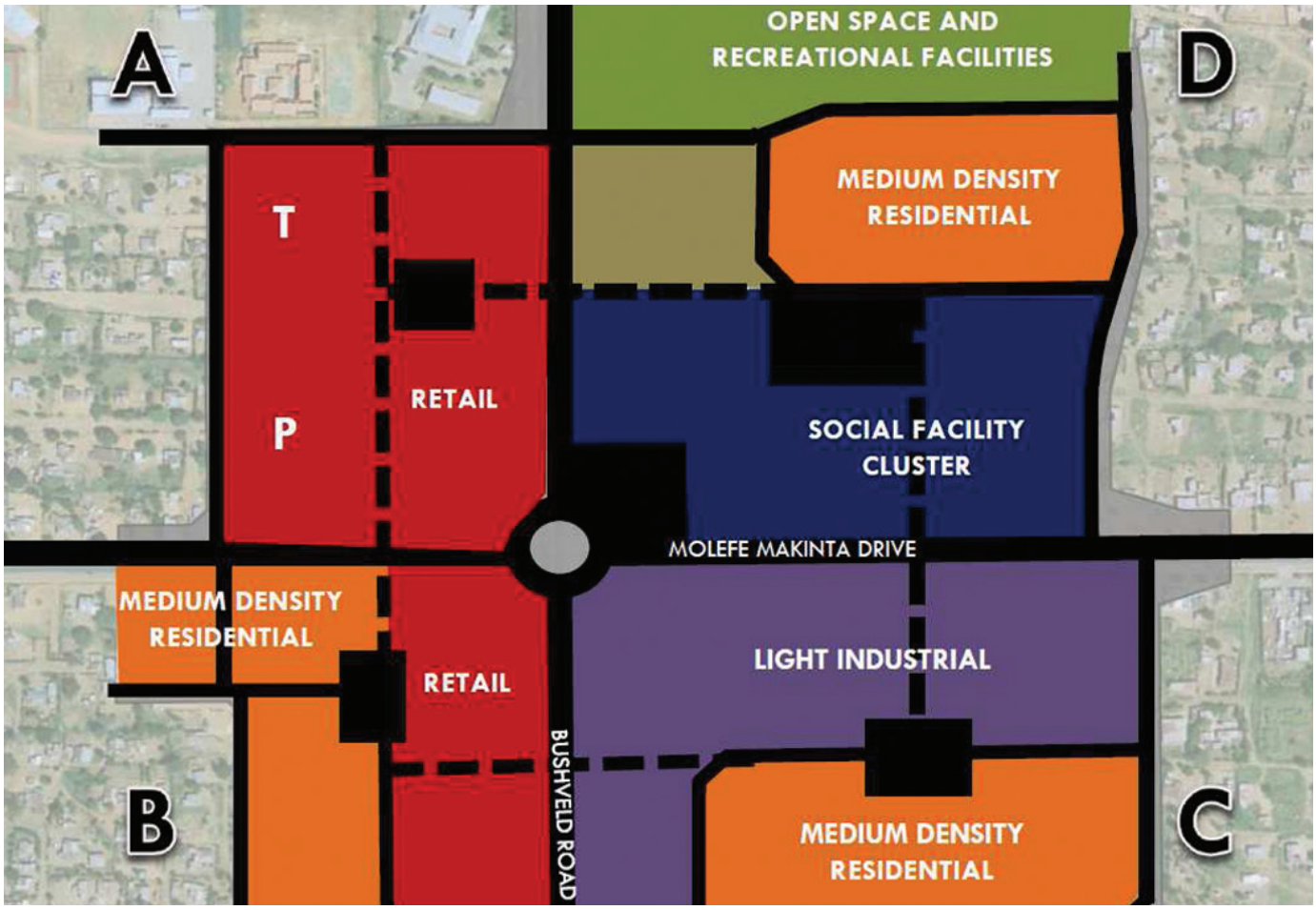


FIGURE 1.13: Example of an urban hub with concentrated public sector fixed capital investment

Urban design framework for Winterveld, a disadvantaged township in the Tshwane metropolitan area. Note the structured, multifunctional design incorporating a variety of land uses including social facilities (e.g. clinic and library), retail, and housing. The design is concentrated at the intersection of two major roads to ensure optimum connectivity.

The UNS offers a methodology for the identification of urban hubs at various geographic scales and lists qualifying criteria for urban hubs to be recipients of funding from the NDPG. For priority townships, these include being located within 7.5 km of the CBD or other primary node, linking to such through some public transport movement line and featuring a minimum population threshold of between 125 000–200 000 people.

1.4 EMERGING URBAN POLICY AND IMPLICATIONS FOR INFRASTRUCTURE PLANNING AND DELIVERY

1.4.1 Spatial form and structure of cities: More compact cities

The spatial form of cities is to be contained, and the pace of urban sprawl must be slackened, resulting in higher-density, compact urban forms. Land development should support transport-orientated development which concentrates housing development around large public transport points in sufficient densities to ensure the viability of public transport systems. Large-scale low-income development beyond the urban edge does not meet this requirement and instead the focus should be on infill development and construction of low-income housing units in inner cities, at or around railway and BRT passenger stations.

This vision has several implications for the planning and delivery of housing, infrastructure and social amenities, including:

- A consideration of appropriate low-income housing products for more dense settlements and the costs associated with them
- Since the ideal location for low-income housing units is within the urban edge, in inner cities and around transport interfaces where plot sizes are generally smaller than at the urban edge or beyond, it is likely that more housing development projects will need to be implemented than is currently the case – unless urban high-rise solutions are implemented which, at scale, may be cost prohibitive
- The costs of infrastructure creation and/or upgrading for low-income housing projects are likely to increase as development will increasingly be undertaken in brownfields or dense inner city environments – this requires cities to revisit cost assumptions, to factor these into infrastructure investment models, and to provide for such in budget estimates and grant applications
- Levels of service choices for infrastructure and social amenities for low-income housing will have to be appropriate for dense, viable settlements. This generally means the adoption of higher levels of service.

> *"Urban compaction offers many benefits. A key perceived benefit of compaction is cost efficiency: it is widely assumed that infrastructure can be provided more cost efficiently to dense or compact spatial forms."*

A word of caution on urban compaction and assumed cost efficiencies. Urban compaction offers many benefits. A key perceived benefit of compaction is cost efficiency: it is widely assumed that infrastructure can be provided more cost efficiently to dense or compact spatial forms. This is, however, not necessarily true in all places and instances. The UN Habitat (2009: 160) notes that research on this topic highlights that the relationship between cost efficiency and compact form is much more complex, and that studies of actual developments indicate highly variable unit costs between types of infrastructure, topography, geotechnical conditions, available capacity and service thresholds.

Case Study 2 indicates the differences in the capital cost basket for infrastructure and social services to low-income households at various densities in greenfield, brownfield and inner city developments in Ekurhuleni. In all instances it is less expensive to develop at lower densities in a greenfields environment. There are also other factors that drive up the costs of high-density low-income developments in city environments. These include higher land costs, higher costs of housing products appropriate for dense development, possible lower future financial benefits for the municipality from lower property rates income and possible lower economic returns from land that could have been applied for more productive purposes. On the other hand, increased densities also contribute towards more viable public transport systems, and if people are placed in locations where they more readily have access to economic opportunities, dependency on the state for financial support is likely to reduce over time. Hopefully, in time, indigents with access to real economic opportunities will be converted into ratepayers, expanding the revenue base of cities. Cities also need to be realistic in planning for infrastructure, transport and social amenities on the basis of desired densities. **High density cities in existence generally formed as a result of:**

Lack of transportation systems and continued population growth over centuries

Highly authoritative government systems

Countries with big populations coupled with rapid industrialisation

None of these conditions exist in South African cities. Our cities are fairly young, our legislation does not allow for highly authoritative, central planning, the majority of the population is already urbanised, the pace of urbanisation has relaxed and city population growth rates have declined.

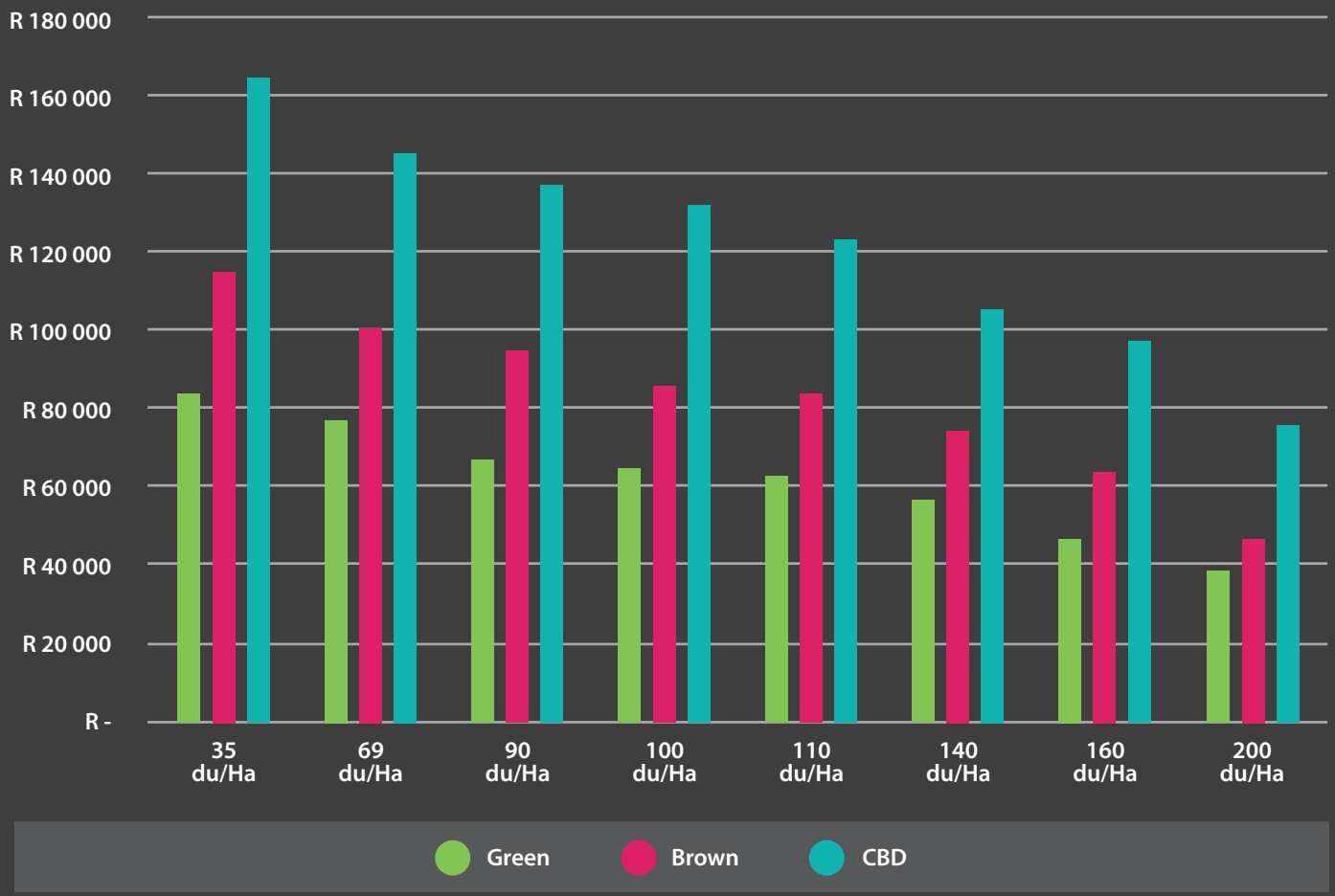
CASE STUDY 2:

Capital cost development at various levels of density

The Ekurhuleni Metropolitan Municipality in 2011 estimated the capital cost basket of providing infrastructure and social amenities at various levels of density in order to test the viability of spatial proposals.

At low densities of 35 dwelling units per hectare (du/ha) the capital cost basket of inner city development, at over R160 000, is double that of greenfields development. This is partly because higher levels of service options must be selected for dense, inner city environments, and partly because of higher construction costs in inner city spaces. Construction activity in inner city spaces often also requires traffic-calming measures. Limited space for the onsite storage of construction materials requires more deliveries and higher transport costs, and since construction activity takes place in active spaces, additional measures are required to make sites safe for pedestrians. Construction in inner city spaces also often involves demolition and the removal of building rubble prior to construction of the desired structures. These and other factors drive up construction costs in inner city environments.

The capital cost basket of all forms of development, whether greenfields, brownfields or dense inner city environments, declines at higher densities. But at no point does brownfields (or inner city development) become less costly than greenfields development. However, from 110 du/ha upward, the capital cost basket of brownfields development costs less than greenfields development at 35 du/ha. The equivalent threshold for inner city development is from 200 du/ha.



None of the comments in the preceding paragraphs of 1.4.1 should be interpreted as an argument to discourage urban densification or compaction. Urban and infrastructure planners are simply alerted to cost dynamics. These should therefore be factored into investment planning models and budget requests, having also considered realistic densities that can be pursued over various planning horizons given population size, growth rates and land availability within the urban edge.

1.4.2 Increasing the level and quality of investment in infrastructure and social amenities

The level of investment in infrastructure and social amenities will need to be increased and sustained at levels sufficient to: eradicate service access backlogs; accommodate the economic growth potential of cities; provide for population growth; retain the capital wealth vested in city assets and respond to changing social and environmental needs. This requires a shift away from the limited focus of providing basic services to ongoing capital investment in new asset creation, upgrading and reconfiguration of informal settlements and infrastructure system capacities, and renewal – both infrastructure systems renewal and urban renewal.

Not only do cities need to raise the level of infrastructure investment and sustain it, they need to improve the quality of capital investments. Capital is always limited, and investment choices should seek the greatest possible benefit package, in line with the desires of a city's growth and development strategy. The "quality" of an infrastructure investment is determined by the desired outcomes of a city's strategy. The South African Cities Network identifies four outcome areas for city growth and development strategies, these being (SACN, nd):

01 PRODUCTIVE CITIES

Job and wealth creation and fighting poverty form part of the scope of this outcome. Specific focus areas relating to this outcome include economic development and transport. It also requires cities to invest in economic infrastructure.

02 INCLUSIVE CITIES

This outcome seeks quality of life for all urban dwellers, including access to employment and economic opportunities, infrastructure services and social amenities. The environment should be safe and secure allowing access to, and participation in, the broad range of social benefits that cities offer. This outcome is concerned with social inclusivity and includes multiple focus areas, some of which are transport, infrastructure services, housing and human settlements and land use planning and management.

> *"The environment should be safe and secure allowing access to, and participation in, the broad range of social benefits that cities offer."*

03 WELL-GOVERNED CITIES

Well-governed and managed cities are desired, and focus areas include public infrastructure investment and asset management.

04 SUSTAINABLE CITIES

City development strategies must recognise and respond to the reality of finite resources, and respond positively to climate challenges. Key priorities include:

- Renewable energy and waste-to-energy strategies
- Biodiversity and energy conservation
- Green building standards
- Sustainable public transport
- Moving towards carbon-neutral cities

The notion of sustainability is not limited to green matters only. It also includes:

- Quality of life
- The cost of living
- Efficiency in providing infrastructure services
- The costs of providing sustainable services

Quality of infrastructure therefore has multiple dimensions, and infrastructure investments must pursue multiple objectives. Increasingly, cities will, for example, have to migrate towards greener infrastructure technologies, and will have to identify green retrofitting opportunities in their infrastructure renewal programmes in order to meet international climate change and carbon targets. To ensure full social integration, higher levels of service for both infrastructure and social amenities should be pursued across the board, financial viability permitting. To ensure financial viability in the longer run, cities will have to balance investment for social purposes and those that increase their revenue base. Infrastructure investments should pursue wealth creation, limiting dependencies on cities' coffers and those of other spheres of government.

This Cities Infrastructure Delivery and Management System (CIDMS) Toolkit supports investment decision making in line with stated city strategic outcomes and objectives. It provides guidance on how to construct an asset management system that is both responsive to city strategy and informs and strengthens city strategy. This is achieved through an asset management policy and strategy aligned to the city strategy, and a multicriteria decision support system to evaluate the benefits and costs of investment opportunities, again aligned to strategic outcomes. These matters are dealt with in **Module 2: Establishment of an Asset Management System** of this toolkit. In addition, this toolkit also provides methodologies, guidelines and quantitative techniques for the financial and economic appraisal of capital investment proposals in **Module 8: Investment Appraisal and Planning.** These include financial appraisal techniques such as Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit-Cost Analysis (BCA). This is to ensure that cities make financially sound investment decisions that do not adversely affect their long-term financial sustainability.

This toolkit also supports planning around appropriate levels and standards for urban spaces by offering an extensive range of levels and standards of service hierarchies for municipal infrastructure and social amenities, as well as methodologies for:

- Spatially determining appropriate catchment sizes and travelling distances for municipal services
- Spatially profiling the state of service provision in a city

These tools and techniques are presented in **Module 4: Levels of Service and Customer Profiling** of this toolkit.

It is natural to want to spread a city's capital budget across all wards, thereby ensuring spatial equality. Indeed, this is the approach followed by most cities over the past decade or so. But this approach is not in the best interests of a city. This is because:

Capital funding will always be limited

A city's structure changes over time, and various suburban spaces will invariably find themselves in different phases of development, decline and renewal, necessitating different infrastructure responses

Infrastructure investment is one of the few, but powerful levers a city has at its disposal to influence urban shape, internal structure and fabric

CITIES' INFRASTRUCTURE DELIVERY AND MANAGEMENT SYSTEM **CIDMS** 1.28

1.4.3 *Spatial prioritisation and focusing of infrastructure investment*

These factors all point to the need to prioritise infrastructure investment spatially:

01 CAPITAL FUNDING SPREAD EQUALLY OVER CITY SPACES HAS NEGLIGIBLE IMPACT

Funding, whether in public or private organisations, is always limited relative to needs. Economists refer to this as the basic economic problem. Applied to cities, there is increasing recognition that there simply isn't sufficient funding available to spread equitably across a city, and for which scale capital investment benefits become insignificant.

To illustrate this point, consider a city with a municipal area spanning 2 000 km^2, which equates to 200 000 ha. Assuming that the city has a sizeable capital budget of R10 billion per annum, and it wishes to spread that equally across the municipal space, the investment per hectare amounts to a meagre R50 000/ha, which generally is not sufficient to provide infrastructure and social amenities for even one household. ***This reality forces cities to prioritise infrastructure investment spatially, and to focus investments in particular spatial locations, to achieve value-for-money investments.***

03 INFRASTRUCTURE INVESTMENT AS A LEVER

A city should have a strategic spatial vision for itself, which should be articulated in its Spatial Development Framework (SDF). In a South African city, there will be several hundred thousand to millions of actors simultaneously making decisions on accommodation and movement that may shape a city other than the one desired in the SDF. Fortunately a city has few, but very powerful instruments at its disposal to ensure the successful implementation of its spatial vision. These include control of land use, development applications, and the type, size and location of infrastructure investment.

The principle of spatial prioritisation is increasingly acknowledged and applied in city spaces. The National Treasury's Urban Networks' Strategy is founded on the principle of hierarchical connectedness, and calls for the spatial prioritisation of investment within defined spatial zones of intervention. The Neighborhood Development Programme of the National Treasury produced the "Urban Hub Design Toolkit" to assist municipalities to identify, evaluate and develop hubs in relation to the overarching urban network.

> *"...there is increasing recognition that there simply isn't sufficient funding available to spread equitably across a city..."*

02 CHANGING CITY STRUCTURES AND DIFFERENT PHASES OF DEVELOPMENT

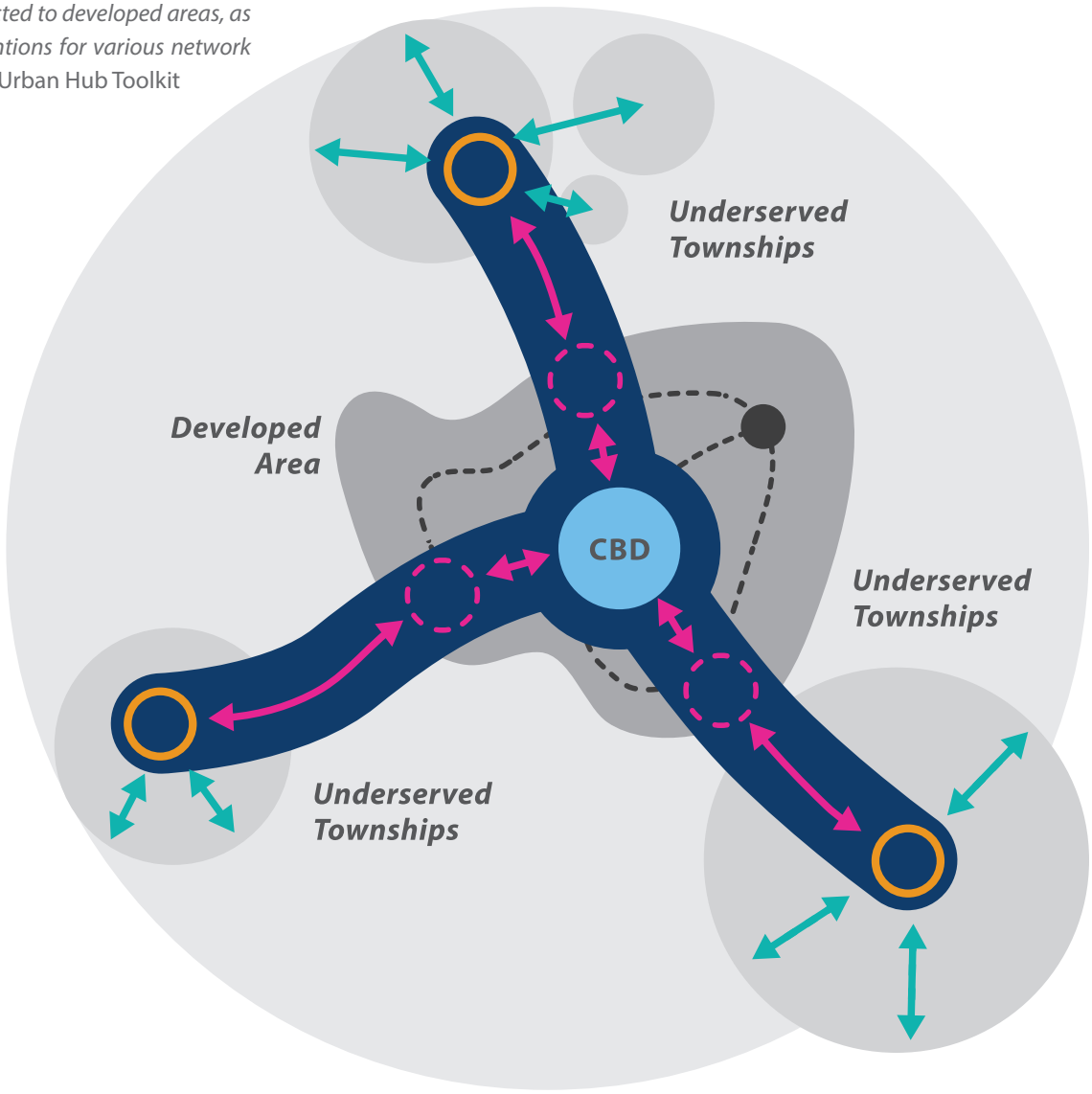
Over time, city structures tend to migrate from a monocentric to polycentric form. A monocentric city structure is one with a dominant core, the Central Business District (CBD), which is the hub of economic activity and employment in the city. A polycentric city is generally one with a weak, diffused core, and several competing primary nodes. Employment opportunities in a polycentric city is dispersed.

As cities migrate from a monocentric to polycentric structure, various areas at suburban scale invariably find themselves in a state of development, growth, decline or renewal. ***This necessitates a spatially nuanced urban planning and infrastructure asset management set of responses responsive to both the overarching strategic spatial vision for the city, and the needs of a suburban area depending on its development status.*** For example: if a city desires a strong urban core and the CBD has been in decline for a few years, the appropriate response would be to develop a CDB design framework with the objective of revitalising the CBD, typically as an urban renewal programme.

Such a programme would typically require focused, sizeable capital investment in that space to, for example, upgrade or renew infrastructure capacities, introduce additional social amenities, reconfigure street layouts or retrofit the CBD to improve public transportation and develop complete streets.

FIGURE 1.14: Urban network concept

The urban network concept, indicating network elements such as the CBD, corridors and townships to be connected to developed areas, as well as desired interventions for various network elements Source: NDP Urban Hub Toolkit



NETWORK ELEMENTS		PRIMARY NETWORK	SECONDARY NETWORK	INTERVENTION
CBD	CBD	✕		Regeneration and management
↔	Primary transport link	✕		Develop/upgrade and management
Y	Activity corridor	✕		Infill & densification
○	Urban hubs	✕	✕	Mixed-use development and management
↔	Secondary transport link		✕	Develop/upgrade

The National Treasury's Integrated Cities Development Grant (ICDC) likewise has a spatial orientation, requiring investments to contribute to, among other aspects, high-density corridor development. SPLUMA by its very nature also adopts a spatial approach. SPLUMA and the various urban policies and strategies discussed in preceding sections generally indicate a preference for spatially-focused infrastructure investment in informal settlements and their incremental upgrading, in inner city spaces, in primary nodes, and along transit-oriented development corridors.

This toolkit offers various techniques and tools to assist city planners in constructing robust SDFs. These take into account infrastructure capacities; the current state of service provision; the condition of infrastructure and risk exposure; and the capital cost of infrastructure development across the surface of the municipal area.

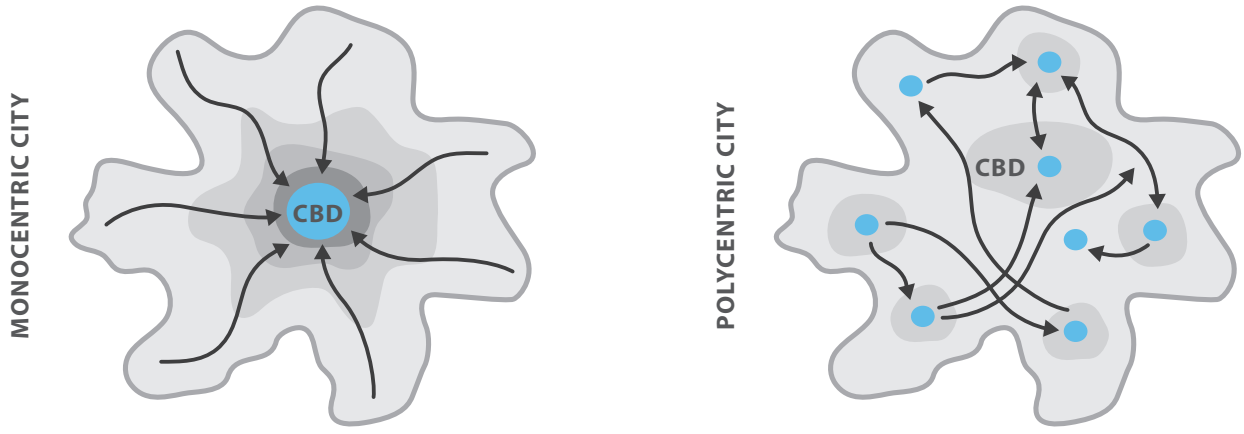


FIGURE 1.15: *Configurations of monocentric and polycentric cities*

1.4.4 Towards greater resource efficiency

Cities will increasingly need to become carbon-neutral spaces. They will also need to take steps to become more resource efficient, especially with regards to the consumption of water and energy, as well as focus on curbing the generation of waste. This will necessitate incremental green retrofitting or reconfiguration of existing infrastructure systems and municipal building portfolios. Future infrastructure planning and investment should increasingly focus on reducing and reusing scarce natural resources, for example by converting waste to energy. This will be challenging. Municipal potable water and electricity distribution systems to date have tended to be supply focused, and have become major sources of revenue for cities. The introduction of green building codes and the installation of site-specific energy technologies such as solar panels and heat pumps at scale will reduce dependency on carbon-intensive power plants and will assist in cities becoming more carbon friendly. The implementation of such programmes for low-income housing units is also likely to be advantageous to cities as the benefits of savings on bulk purchase costs of electricity that is supplied to these households either free or at subsidised rates will alleviate cost pressures. But when the approach is followed with medium-to-high income households, cities are likely to suffer revenue losses.

Greater resource efficiency also means optimising existing infrastructure capacities, and managing the demand for infrastructure services by means of spatial optimisation. Tools and techniques for doing so are provided in **Module 5: Demand.** The choice of location of infrastructure development also influences the cost of construction, due to factors such as slope and soil conditions. **Module 5** further provides a spatial capital cost premium development surface tool to assist cities to make optimum locational choices for infrastructure, all other things being equal.

1.5 HOW TO USE THIS TOOLKIT

1.5.1 Overall approach and lay-out of this toolkit

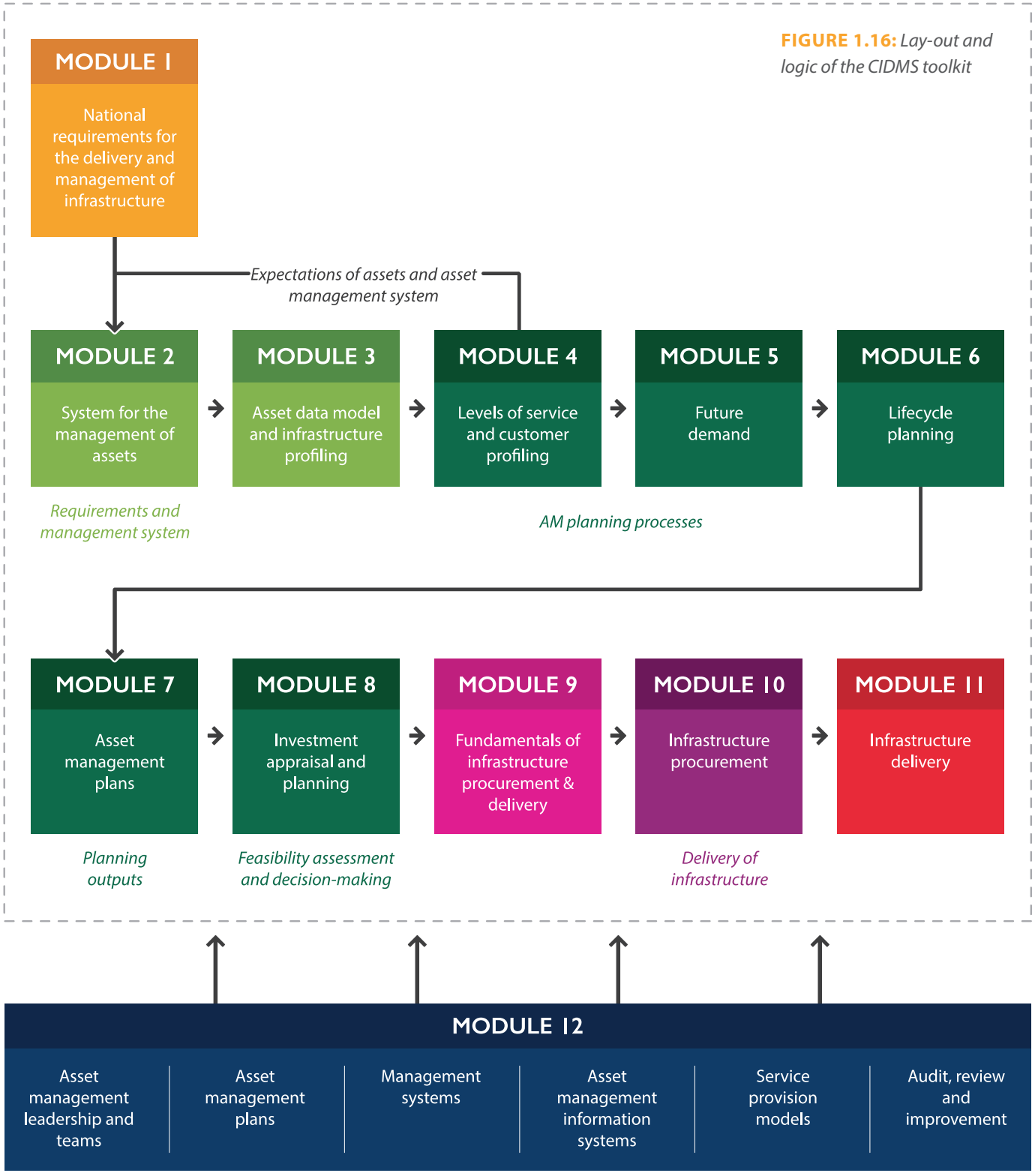
Government's Infrastructure Delivery Management Standard (IDMS) is aimed at improving performance on the delivery of infrastructure. The overall premise is that good planning is a prerequisite to the delivery of quality infrastructure. This toolkit follows suit and adopts an infrastructure asset management approach to ensure robust planning that will result in relevant, viable city infrastructure and social amenity portfolios of assets.

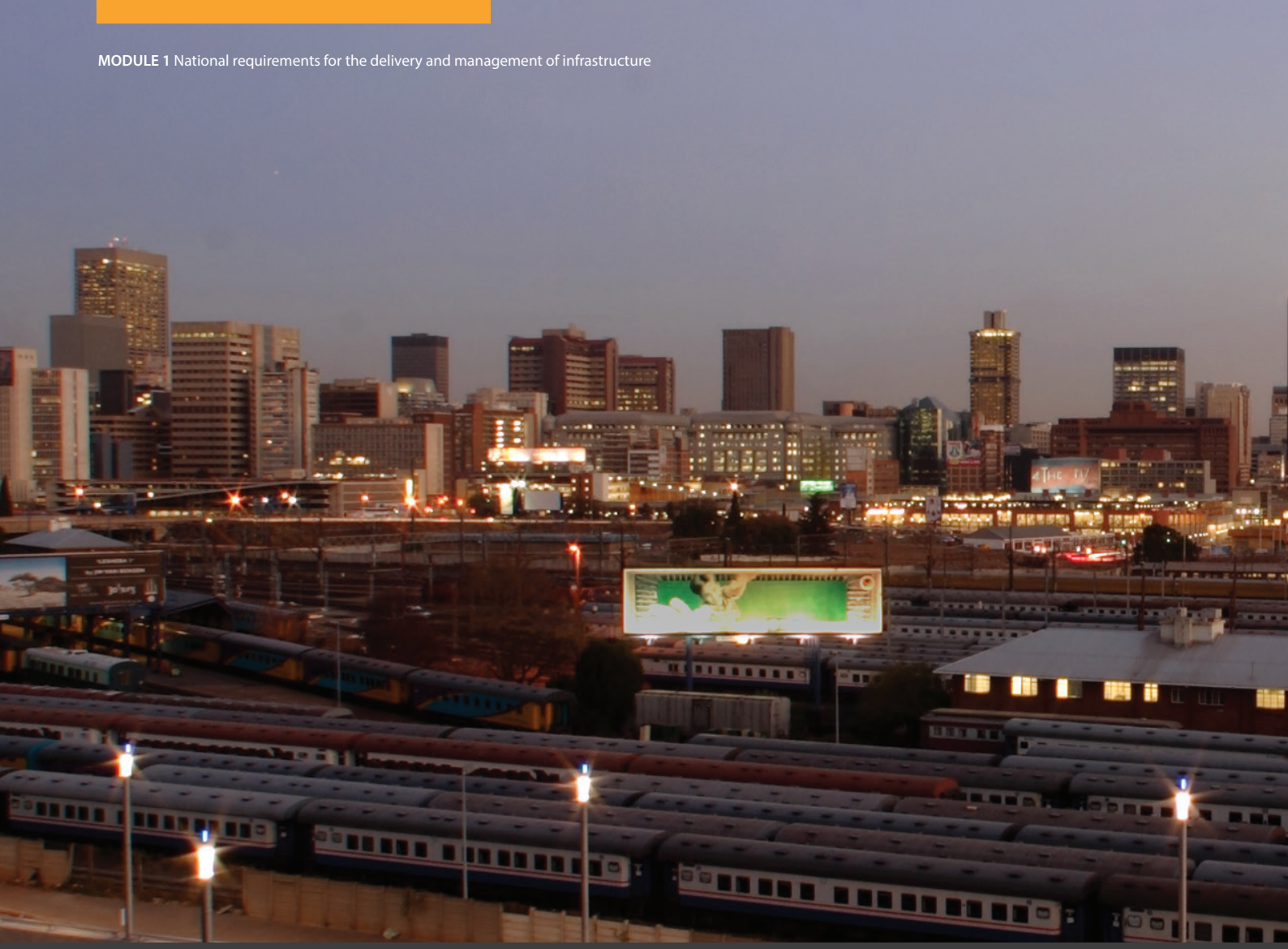
The CIDMS Toolkit comprises 12 modules as shown in **Figure 1.16. Module 1** describes key national requirements for urban infrastructure, and establishes the normative framework for CIDMS. **Module 2** introduces the CIDMS and describes the approach to identifying stakeholders and their requirements, and to establishing AM policy and strategy. **Module 3** presents the asset data model and provides guidance on the profiling of infrastructure for purposes of developing a state of city assets report that establishes current infrastructure capabilities, risks, constraints and lifecycle needs.

Module 4 provides the approach and techniques used to profile customers, determine their needs and to establish levels and standards of service with respect to infrastructure and community service packages. **Module 5** focuses on future demand, inclusive of estimating and spatially apportioning future demand as well as demand management strategies for all major infrastructure services. **Module 5** also emphasises the need for sustainable practices, planning for climate change resilience and the adoption of green infrastructure technologies as appropriate.

Armed with knowledge and informed estimates on current infrastructure capacities and needs, current and future levels of service and demand, it is possible to proceed with lifecycle planning. **Module 6** provides processes and techniques for developing lifecycle strategies and plans per asset portfolio. **Module 7** offers guidance on the preparation of AM plans and how these feed into and are directed by the city strategic AM plan. A key output is the city infrastructure programme delivery plan and aligned performance plan. Note that this first version of the toolkit does not focus in detail on infrastructure operations and maintenance, though these are critical activities within the asset life cycle. The focus is instead on capital works such as new construction, upgrading and renewal. However, operations and maintenance are still included in life cycle strategies and planning and financial feasibility assessment, dealt with in **Module 6: Lifecycle Planning**, appraisal and budgeting. **Module 7: Asset management plans**, also includes in its scope operations and maintenance.

FIGURE 1.16: *Lay-out and logic of the CIDMS toolkit*





Module 8 provides the approach and methodology for infrastructure investment appraisal and prioritisation. Several asset portfolios in the city space, such as roads and stormwater, are not revenue-generating and conventional appraisal techniques are not suitable to assess proposed projects. Likewise, some insight and interpretation is required to assess the benefits of activities such maintenance expenditure, risk reduction or other "soft" benefits such as social upliftment. On the other hand, attractive project proposals are sometimes associated with negative externalities such as environment degradation, noise pollution and other adverse impacts. This module therefore defines benefits and costs for major infrastructure services. It offers investment appraisal techniques at the level of project proposals. Ultimately, though, cities are faced with capital constraints and have to make difficult choices regarding which projects to include in capital budgets from a range of infrastructure services. To this end **Module 8** also presents a multi-criteria analysis system to enable prioritisation.

Modules 9 – 11 articulate the infrastructure procurement and delivery system, inclusive of contracting methods, processes, controls and governance arrangements. This suite of modules also provides guidance on the packaging of programmes and projects in line with the requirements of mSCOA.

Module 12 describes AM enablers. It defines key roles, competencies and organisational arrangements for AM. It describes the approach to the review and improvement of the AM system, offers guidance on the packaging of AM plans, and presents high-level functionality requirements for AM information systems.

Many topics are included in the scope of this toolkit, and most are dealt with thoroughly in it. In several instances though, good manuals and guidelines already exist which extensively and authoritatively deal with specialist topics peripheral to this toolkit. Users of this toolkit are referred to these sources for additional reading where considered appropriate. Nonetheless, it will be possible for users of this toolkit to use this source to fully design, implement and operate the Cities Infrastructure Delivery and Management System.

1.5.2 Words

This toolkit uses many words such as assets, capital and maintenance, which users will immediately recognise, and others which they may not. It is natural to accept familiar words at face value, and to ignore the definitions for such words. This is not advisable. The practice of infrastructure asset management, as noted before, is a multidisciplinary one, involving engineers, accountants, financial analysts, economists, social science practitioners and urban planners. All attach their own meaning to words.

This toolkit concerns itself with planning and delivering infrastructure assets and other community assets such as recreation facilities and cemeteries. But what is an "asset"? When asked for a definition of an asset, most people will probably say an asset is something you own that is of value to you. But the accounting definition of an asset is very different. It states that an asset is a resource owned or controlled by an entity as a result of past events and from which future economic benefits or service potential are expected to flow to the entity. Analysis of this definition shows that ownership is not necessary, one merely has to have control over the resource. And it is not enough that the resource has value right now, it has to deliver benefits in the future. In the case of assets such as infrastructure systems and social amenities, the future span of those benefits must be for a period longer than twelve months.

The complexity doesn't stop there. What in practice is an asset: the totality of a city's potable water supply system, consisting of many facilities such as water treatment plants, reservoirs, pressure towers and pump stations, or the facilities themselves? Or is an asset the major elements comprising facilities, such as pumps and motors? What if a city doesn't have just one, but several water supply systems? Detailed guidance on what is considered an asset is provided in **Module 3: Asset data model and infrastructure profiling.**

The take-home message here is that users are advised to read all definitions offered in this toolkit very carefully. Defining terms are generally provided in this toolkit wherever they first appear, and a glossary of all terms is included at the start of the toolkit for easy reference.

1.6 SUMMARY

The future prosperity of South Africa will be determined by the ability of cities to: accelerate economic growth, facilitate wealth and job creation and develop well-functioning and attractive urban spaces that promote social upliftment and inclusion, which are also climate resilient and well governed.

Infrastructure systems and social amenities are critical enablers to achieving these outcomes. Accordingly, cities need not only to increase the pace of investment in infrastructure, but improve the quality thereof, and then sustain both the higher levels and quality of infrastructure investment. This requires across-the-board investment to eradicate service access backlogs, to reshape cities to become more inclusionary, to function better and to become more resource efficient. It also requires investment in infrastructure for population and economic growth. Existing infrastructure is the backbone of the city, and requires ongoing investment in renewal to ensure that the growth aspirations of cities are not impaired.

This toolkit presents best practice processes and techniques to assist cities to specifically deal with current urban challenges and to respond to the vision articulated in the National Development Plan and emerging urban policies. Practices are nuanced to enable the adoption of a relevant suite of practices depending on the capacity of each city.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