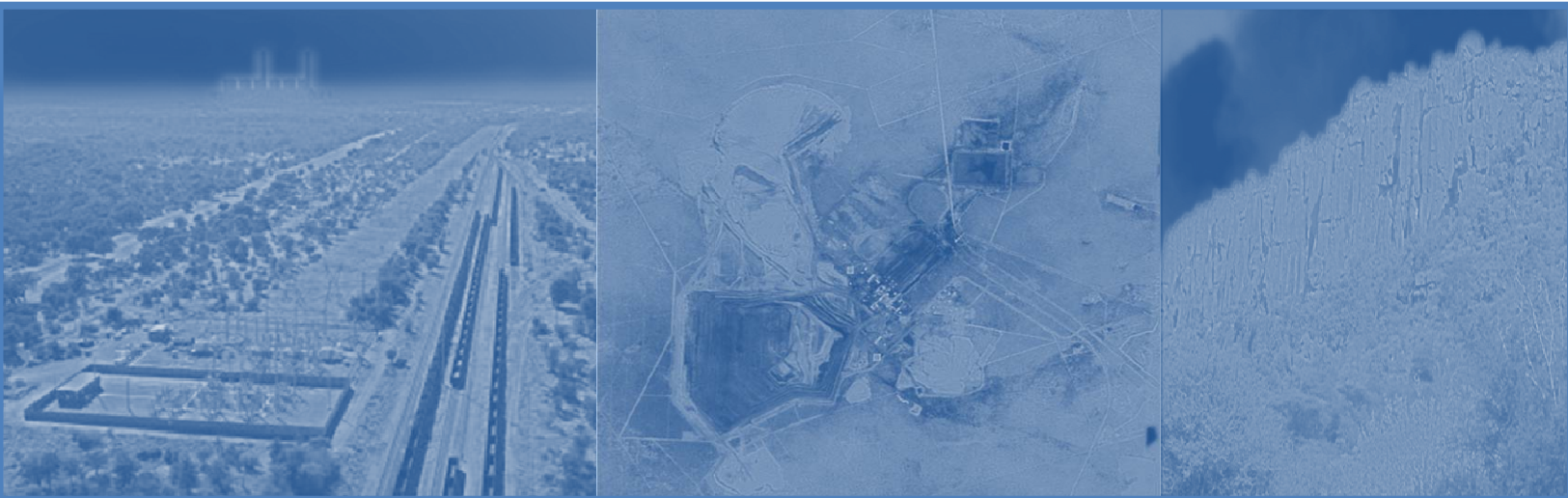




SUSTAINABLE DEVELOPMENT OF THE WATERBERG COALFIELDS

Scenarios for Optimal Settlement Patterns

**Report 1 of 2
August 2010**



THE RESEARCH QUESTION

What settlement patterns, related to the mining and energy-generation developments in the Waterberg coalfields, will contribute to the sustainable development of the region?

The development of settlements is contingent on many factors: **settlements are thus an outcome, rather than a driver of development**. This report therefore looks at the drivers of settlement and how these differ to create settlements that either contribute to, or detract from post-mining social, environmental and economic sustainability of the region. This study, commissioned by the Coaltech Research Organisation, is intended to inform future planning of the Waterberg region. The study was undertaken to determine which factors are most influential in preventing the socio-economic collapse of settlements – including primarily the settlement patterns - so often associated with post-mining landscapes. This document emerges out of a scenario planning process that envisaged four possible scenarios for the development of the Waterberg coalfields. These scenarios identified the key drivers of development and looked at the causal factors of the shift from one scenario to another.

This document is intended to **inform decision-making** around the development of the Waterberg coalfields. It explores how settlement patterns might unfold if additional power-stations and other coal-related industries are established. The report is aimed at **mining houses and related energy producers** that will be exploiting the coal reserves in the Waterberg, to inform their settlement and social and labour planning. Other stakeholders who might benefit from the report include:

- **local, provincial and national government**, to assist in their development planning;
- stakeholders in the **downstream/upstream industries** related to the mining, power-station and energy-related developments;
- **any company** that might develop energy-related facilities in the region; and
- both **urban and rural residents within the area**, to empower their inputs into the development planning processes.

This document contains four plausible scenarios for the development of the Waterberg coalfield and is supported by a separate Fact Base Report (Report 2 of 2) which describes the current context of the Waterberg in some detail, along with a limited number of predicted impacts related to possible future developments.



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HOW TO USE THESE REPORTS

The results of the study are contained in two separate but supporting documents.

Report 1 of 2 contains the Scenarios that were developed as a result of the study. A basic summary of the current socio-economic, settlement and environmental context of the Waterberg, specifically the Lephalale area, is also provided. Requirements for sustainable settlements are presented.

Following the section on the four Scenarios, the study team makes recommendations that support the eventual unfolding of the long term, sustainable scenario option – i.e. highly consolidated settlements with radical cooperation between all stakeholders. This scenario is entitled the Beautiful Game. It is a given that the implications of these recommendations would have to be investigated further. In the Appendices, the thresholds for sustainable urban development are provided, as are the characteristics of mono-economy towns, such as mining towns.

Most importantly, the Scenario report can be read as a stand-alone document.

Report 2 of 2 contains the Fact Base that was used to describe the current context, or starting point for the development of the Scenarios.. This provides more comprehensive referenced baseline data collected at a desk-top level, and as a result of a brief site visit. It lists in some detail the known planned and proposed developments in the area, without specific reference to the companies involved. A limited quantification summary of anticipated socio-economic and key environmental consequences of these known developments is presented.

The Appendices contain details of the project team, the methodology employed for the project, assumptions and limitations of the study, key stakeholders identified during the desk-top study, those stakeholders with whom meetings were held, the interview guideline that was used, and finally, mapping of the results of the analysis of the indicators chosen for the project. This final table depicts a highly summarised evaluation, presented in simple “robot report” colouring for each indicator, in each scenario, during operations and post-operational (i.e. extremely long term). This forms the conceptual basis on which the scenarios were developed.

The Fact Base is intended for use by people wishing to know more detail about the Waterberg, about the current context, and about the derivation of the scenarios.

Please note that, as is appropriate for scenario development, maps are conceptual, and are not necessarily accurately geo-referenced.

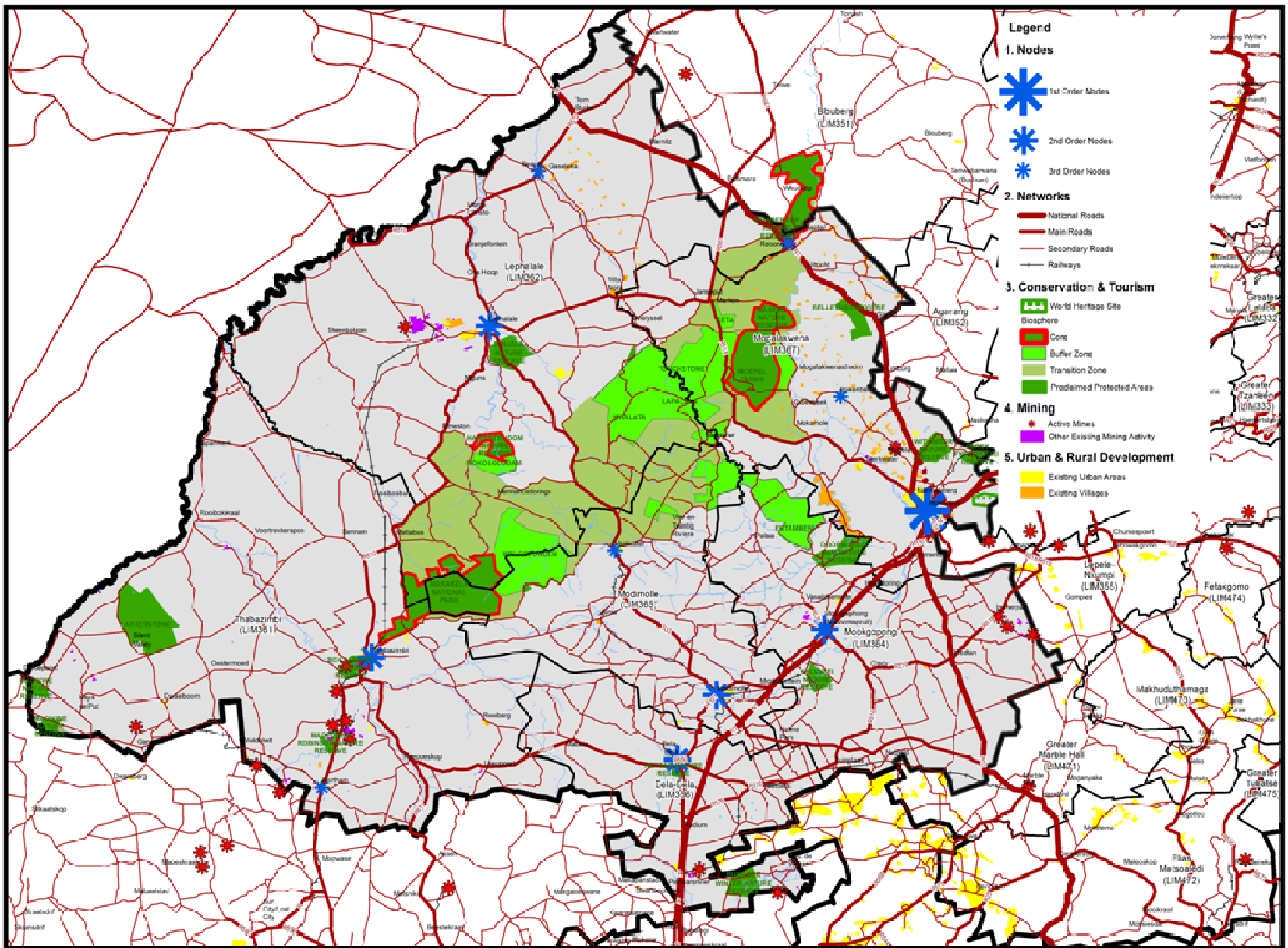


Figure 1: Map of the Waterberg (source: draft Environmental Management Framework, Environomics, 2010)

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WHY SCENARIOS AND NOT PLANS OR FRAMEWORKS?

For the purposes of this study, sustainable development was defined as “a dynamic process in which the combined economic, environmental, and social systems meet the needs of the current human population, while maintaining or increasing the resources and productive capacities that are passed on to future generations”ⁱ. In the South African context, this includes the need to maintain a dynamic balance between creating a fair and equal society, through an equitable distribution of wealth and opportunity, and sustaining the biophysical environment’s ability to support an acceptable quality of life for this and future generationsⁱⁱ.

Sustainable development thus requires the integration of many factors, including issues relating to economic, social and financial matters, human, environmental and man-made/manufactured assets. These aspects are all linked in a complex system, so that changes in one factor can have effects on other factors, directly and indirectly, as well as cumulatively. Finally, when charting a path for sustainable development, we are required to look far into the future to ensure intergenerational equity, one of the underpinning elements of sustainable development.

The multiplicity of factors to be considered, the long time-horizons that are involved and high levels of

Four possible and plausible scenarios are described, but only one delivers the desired long-term sustainability for the Waterberg: this scenario is entitled “The Beautiful Game”.

uncertainty suggest that conventional planning practices cannot yield the necessary results. In such situations **scenarios** can be more useful in informing decision-making and learning in situations of high uncertainty. Scenarios can help to interpret and deal with change, assist planners to anticipate crucial events and open new possibilities and insights. Via systems thinking, scenarios recognise that many factors may combine in

complex ways to create unexpected futures. Scenario development is therefore well suited to any futures-thinking related to sustainable development.

The scenarios envisaged for the Waterberg were conceptualised at high level, supported by a desk-top level fact base and were informed by a series of indicators chosen as representative criteria for “success”, available in the fact base. The scenarios are presented as stories about the coalfield area, focussing on Lephalale (formerly Ellisras), at some time in the distant future, when the coal reserves have all been exploited to their maximum potential, and the mining operations have mostly closed or are closing. The starting point for all the possible scenarios is of course today, and the current context of the Waterberg is summarised first as the springboard for the developments and related settlement scenarios.

Findings from the study indicate that some of the potential problems that might arise are already evident. This can be seen in the “Business as Usual” scenario. The platinum mining area and the Mpumalanga coalfields were used as proxies to substantiate the findings of this study. Significantly, both proxy areas are characterised by dispersed settlement patterns and are associated with negative environmental and socio-economic impacts. The socio-economic impacts relating to each scenario are described qualitatively within each scenario: a quantitative summary is also provided.

THE WATERBERG COALFIELDS 2010

For the full details of the current context (i.e. baseline) of the Lephalale area, on which this summary and the Scenarios are based, please refer to the Fact Base (Report 2 of 2).

CONTEXT

Coal contributes 93% of the total electricity consumed in the countryⁱⁱⁱ. Rapid economic growth and a massive electrification programme have resulted in an energy crisis in South Africa. To contribute to meeting the energy needs of the country, plans are in place to develop the Waterberg coalfields to fire new power-stations, and other energy-delivery technologies. These plans will not assist in realising government commitments to reduce carbon emissions in the medium term.

Current plans for the Waterberg coalfields to the west and north of Lephalale (the largest town and the economic hub of the municipality, and the fastest growing town in South Africa^{iv}, growing at an annual rate of 30% for the past 3 years) include the expansion of an existing coalmine, to deliver to a power station currently under construction. The planning processes in place are articulated in the 2010 Integrated Development Plan (IDP) for Lephalale^{vi} and a current review of the 2006 Spatial Development Framework (SDF)**Error! Bookmark not defined.** by the municipality. The planning processes seem to be ineffective, in as far as settlement patterns, service-related infrastructure provision and demand display a significant degree of disconnect at, and between the different tiers of government.

Possible future developments include additional coal mines, six to nine power stations, and other water intensive industries that require coal.

To the south east of Lephalale lies the Waterberg Biosphere Reserve, awarded international status by United Nations Education, Scientific and Cultural Organisation in 2001^v. Running towards the north on the outskirts of Lephalale, is the Mokolo River, which is already demonstrating negative impacts relating to sand mining, other mining and power-station development, and the Mokolo Dam: the current sole supply of water for the Lephalale municipality and for irrigation farmers^{vi, vii}. Environmental conditions are deteriorating in the area.

BASELINE SUMMARY

- An **holistic regional development framework** is not yet in place^{viii}, and the national priority for energy supply related development overrides local priorities^{x, xvii}. Some of the local community nonetheless support the development of energy-related industries.
- There are high unemployment and poverty rates (over half the population)^{viii}, a low Human Development Index of 0.48, and rapidly increasing crime rate (average of 19%, as high as 40%)^{viii}. Nearly one third of the population receives some form of social grant. Very high unemployment is mainly due to the poorly developed skills-base of the population, high levels of concentration of the local economy, underutilised economic projects and activities, and limited economic development in the secondary nodes **Error! Bookmark not defined.** Unemployment level measures in SA exclude people who are not actively looking for work. In this context, the poverty rates read together with the employment rates give fuller picture of employment levels.

- The skills shortage is significant. The main occupations in Lephalale town are elementary (such as street vendors, domestic helpers, cleaners, messengers, and labourers in all sectors ^{ix}), followed by craft and trade, with a declining farming community ^x.
- Imported labour is increasing social tensions ^{xi}.
- Local business is limited and unsophisticated; the highest number of households within the Lephalale municipality fall within the R6,001 – R12,000 annual income bracket ^{vi}.
- There is a small urban population (approximately 36,000) against 90,000 rural inhabitants ^{vi}.
- Settlement patterns, housing, social conditions and cultural norms are based on a legacy of apartheid forced removals^{xii,xiii}, with conflicting information about landclaims, including suggestions of a massive backlog of unresolved land claims ^{xiv, xv, xvi}. Whatever the current situation, should development of the coalfield proceed, a number of existing settlements in the area may have to be removed or displaced.
- There are uncoordinated, dispersed and rapidly increasing informal settlements **Error! Bookmark not defined.**, characterized by low-density sprawl ^{viii}.
- Lephalale Municipality has three focus areas in terms of addressing the housing need in the municipal area: Lephalale, Steenbokpan and Stockpoort. The dispersed settlement pattern is thus already entrenched in the spatial development framework for Lephalale At present Steenbokpan is attracting some speculative private sector investment in anticipation of prospective developments in the Waterberg coalfield. This is in proximity to “PDA1” the preferred potential development area identified in the Lephalale already receiving significant attention^{vi}. Within the town itself, infill between the three nodes of Onverwacht, Ellisras and Marapong ^{vi} will be promoted, to accommodate 50,000 future housing units, which is believed to be sufficient for at least the next 20 to 30 years ^{vi}. The current and proposed inefficient, dispersed and fragmented spatial development pattern is likely to influence future developments, unless a comprehensive strategy is implemented to counter negatives and encourage positives.
- Land and house prices are spiralling ^{vi}, by as much as 300% per annum; in Potential Development Area 1 (in the vicinity of Steenbokpan), farmland is selling at 3 times the price of land outside of the “future node” ^{vi}. There is a high risk of housing oversupply, without adequate services.
- The road network is poorly maintained and highly dispersed ^{xvii}, with no Integrated Transport Plan (ITP), or Road Master Plan (RMP) for the municipality ^{vi}; modes of transport in the area are up to 50% by foot, 30% by bus (municipal or taxi) and 20% by private vehicle, as passenger or driver ^{vi}. **Error! Bookmark not defined.**
- Education quality and facilities are poor. Teacher/pupil ratios are significantly below the national standard ^{vi}, while 60% of the schools lack water, 43% need sanitation services, and 24% have to be electrified. The Further Education and Training (FET) college is 100% oversubscribed and is in need of additional human resources and facilities.
- All service delivery is poor **Error! Bookmark not defined.**, due in part to inadequate and deteriorating infrastructure. There is also a significant lack of capacity and funding in the Lephalale municipality, with high staff turnover, and very limited support from provincial or national government ^x. Most utilities are owned by private companies and operated by the municipality. The Lephalale municipality’s first (of 5) strategic goals is the provision of infrastructure and services ^{vi}.

- In 2005/2006, reports indicated that there was insufficient water availability for current needs and for proposed future developments^{xviii}, ^{xix}. A recent report^{xx} indicates a contrary view, and alleges that the sustainable yield of the Mokolo Dam can meet reserve requirements and supply approximately 30 mil m³/a of water to the municipality, mining and power operations. This nonetheless presupposes that the state of the dam (quantity and quality of water) is not degraded any further. Lephalale municipality has extremely poor quality drinking water^{xxi}, and failed to present information for Green Drop certification for waste-water treatment in 2009^{xxii}.
- The maximum energy demand exceeds supply capacity^{vi}; the current power distribution network is insufficient to support the projected 12.5% per annum load growth for the next 3 years in the existing reticulated areas; the load growth over the past 20 years has been at 1.5% per annum^{vi}.
- There is huge economic dependency on mining which supplies over 40% of the municipality's GGP.
- The Lephalale municipal area has a significant shortage of health-related services **Error! Bookmark not defined.**, with a notable increase in asthma and sexually transmitted infection cases reported at clinics within the municipal area.
- Waste management is poor^{xxiii}, with an unlicensed waste disposal site that is being investigated for expansion.
- The Lephalale Development Forum (chaired by the municipality) is attended by all major stakeholders, with a primary focus on infrastructure development, not social needs^x.

KNOWN AND PLANNED ECONOMIC DEVELOPMENTS

KNOWN ADDITIONAL DEVELOPMENTS^{xxiv}

Within a broad agenda to ramp up exploitation of the Waterberg coalfield, there exist both planned and possible developments. Planned developments include:

- The **expansion of an existing coalmine** to supply the new power station, currently under construction;
- The planned development of **a Coal Bed Methane project**, on the border between Limpopo Province and Botswana; and
- A planned **energy project** within Botswana.

All municipal planning is based only on these known developments^{vi}.

PLANNED ADDITIONAL DEVELOPMENTS^{xxiv}

There are also a number of likely additional developments including:

- **Water intensive** industries that require accessible coal mining developments.
- It is widely acknowledged that **additional power stations** will likely be developed. An environmental impact assessment (EIA) process has thus been initiated to prepare for a possible third and fourth coal-fired station to be located on one of three possible sites to the south of Steenbokpan. Each planned power station will require 16 million tons of coal per month for pulverized fuel and are designed as supercritical for higher efficiencies. All planned power stations are pulverized fuel (PF) with fluidized gas desulphurization at the back end. Significantly, it has been stated that there is enough coal in the reserves to power from six to nine power-stations^{xxv}.
- A **mining joint venture** aims to produce about 7 million tons/annum of steam coal and 2 million tons per annum of coking coal. The acreage is a sizeable one, being slightly smaller than that of the existing mine, and is contiguous to the westward part of the currently exploited resource.
- A five-well **coal-bed-methane (CBM)** test was completed at a coal bearing location approximately 25 km north-west of Lephalale in 2006. Following successful testing of a 200 kw platinum fuel cell placed on the Waterberg site, a further 39 wells will be drilled in 2010 in the Beaufort Coal Seam to establish its estimated 1 trillion cubic feet (TCF) reserve by 2012. It is expected that this might lead to a feasibility study for a 300 MW power station. Coal bed methane extraction can also result in the extraction of significant quantities of water: estimates for the CBM field in the Waterberg anticipate production of some 2 million m³/annum of water.

SUSTAINABLE SETTLEMENTS: SOME REQUIREMENTS AND DRIVERS

Sustainable human settlements need to provide the physical, spatial, technological, cultural, socio-economic and institutional framework to support all the processes related to sustainable development. This is a multidimensional problem, including issues of spatial characteristics, geographical location, settlement dimensions, environmental conditions, economic viability, institutional ability and structure, human development, social relationships, and values and aspirations ii, ^{xxvi}.

HUMAN SETTLEMENTS...

“...mean the totality of the human community – whether city, town or village – with all the social, material, organizational, spiritual and cultural elements that sustain it” (United Nations, 2002)

The drive to deliver on housing backlogs and the inequities entrenched by the apartheid regime has meant that government focus has been on delivering quantity. Since 1994 the post-Apartheid South African government has built approximately 2.7 million new housing units. For the most part these have conformed to the suburban convention of freehold ownership and the familiar "one-house per plot" housing form.

More recently, however, such housing delivery has come under intense criticism for perpetuating apartheid urban form, increasing sprawl and locking people into particular places in the context of increasing labour mobility. As a result the government has shifted its housing policy. New thinking about housing is to:

- Enhance housing choice by widening the range of housing alternatives, particularly for the urban poor;
- Pro-actively intervene in the restructuring of cities;
- Promote the creation of sustainable human settlements – places and spaces that offer the full range of urban amenities, maximise existing resources and minimise impacts on the carrying capacity of the natural environment ^{xvii}.

An opportunity exists in the Waterberg to pursue this new approach by creating housing and settlement patterns that will enhance the sustainability of the area in the long term. In order to do so, the systemic relationships between the factors driving sustainable development need to be addressed, given their interdependencies and interconnectedness – in this case with specific reference to drivers of sustainable settlements.

Many indicators for the sustainability of human settlements have been derived ii. These indicators are a mix of policy, environmental, social, economic and “urban structure and form” qualities. The latter is one of the most important, given that structure and form determine quality of life, resource efficiency, and can be a key determinant of socio-economic equity. A model which uses these qualities, and delivers on the various systemic interdependent requirements is that of the “Compact City” ⁱⁱ. The Compact City (consolidated) model is based on the realisation of two principles: integration and densification.

Integration implies areas of mixed use (function – especially residential, commercial, social services and most importantly public space) **and** socio-economic integration. Densification combats urban sprawl and

provides economies of scale for effective and affordable service delivery and economic activity, with one condition being an acceptable ratio between residential density (number of dwellings) and population density (people per square metre). Integration and densification are not however absolutes: their successful delivery of sustainable settlements requires the principles of diversity and choice to be fulfilled, whereby consolidated settlements must allow for a range of opportunities (work, leisure, health-care etc) for diverse groups of people. In order for choice to be exercised regarding the diversity of opportunities, certain thresholds of population must be achieved for sustainable access and use to be assured (see Appendix 1).

This approach accords with the National Spatial Development Perspective which argues that “A sustainable city in South Africa will therefore have to make provision for different income groups and different preferences, while ultimately striving towards more compact development” ii.

Future settlement and economic development opportunities should therefore be channelled into activity corridors and nodes that are adjacent to or that link the main growth centres. Infrastructure investment should primarily support localities that will become major growth nodes^{xxvii}.

SUMMARY OF SOCIO-ECONOMIC CONSEQUENCES

In the context of this study – which relates specifically to settlement – the following factors are significant: the **anticipated increase in number of people, increased demand for water**, and the **additional demand for housing and related socio-economic infrastructure** that are necessary for sustainable settlements. The following sections explore:

- Broad **quantitative** effects of future developments in the Waterberg, based on details outlined in the Fact Base (Report 2 of 2).
- Broad **qualitative** effects of the planned and possible future developments outlined in four possible scenarios.

The numbers in Table 1 are estimates based on similar developments, reported by companies, or calculated (see Report 2 of 2).

The construction impacts have not been quantified clearly by all the companies. However, other than the parallel development of the new power station and the mine expansion, the peak construction times vary considerably over a period of about 12 years: it is likely therefore that various influx peaks of mainly construction contractors will be seen. The biggest peak is likely in about 2015, of approximately 35,000 people, thereby increasing the current population – which has already grown by 30% since 2007- by over 30%.

Table 1: Some Pertinent Socioeconomic Data on Known and Probable Development in the Waterberg Coalfields

Note: The table refers to mining and energy-related developments only.

Project	Number of People							Number of Houses		Water Use
	Construction Peak	Construction Year(s)	Maintenance (3 mths/yr)	Direct Jobs: Operation	Indirect Jobs: Operation	Total Job Estimate	Estimated Total Population	Operation	Location	million m ³ per annum
Operational power station (base case)	NA		2,000	950					Lephalale	4.5
ADDITIONAL										
Additional power station plus mine expansion		2012	2,000	1,750	583	2,333	9,869	2,333	Lephalale	10.5
Water Intensive coal-based Industry	25,000	2013-2016		3,500	1,167	4,667	60,000*	14,184	Potential Development Area 1	36.0
Mine for above				1,800	600	2,400	10,152	2,400	Unknown	2.5
Additional power station 1 (incl mine)	7,000	2015-2021	2,000	1,931	643	2,574	10,888	2,574	Lephalale	10.5
Additional power station 2 (incl mine)	7,000	2018	2,000	1,931	643	2,574	10,888	2,574	Unknown	10.5
New mine (possibly export)	800	pre-2014		800	266	1,066	4,509	1,065	Lephalale	2.5
TOTALS	~40,000		6,000	11,712	3,902	15,614	106,306	25,130		73

*This number was provided by the company as an estimate of the total population within the PDA1 settlement, not only that related to mining and power-generation. Thus, it must be noted that the other calculations in this table regarding total populations relate only to the power-generation and associated mining operations, and do not attempt to predict the total settlement size, as has been provided to the project team by Company E.

THE SCENARIOS

Scenario development requires that two factors are chosen on which the outcomes of the scenarios are based and measured. For this study, the first critical factor is the **viability of all natural resources**, including the coal reserves, water, and all components of the biosphere. The extremes of this factor relate to the duration of viability of the resource: long-term or short-term.

The other critical factor in determining the scenarios is the **degree of cooperation within the social systems**, between all stakeholders. The extremes of this factor relate to a “winner takes all” situation compared to what was termed a “virtuous collaboration” where all stakeholders collaborate for the greater good in the development of the area. This is depicted in Figure 2. The scenarios are written in the present future tense: we are now “there”...

In the long term, **only consolidated settlements are sustainable**ⁱⁱ, driven by radical cooperation and a shared vision between all players in the area. Given recent social history, achieving cooperation will require special attention and effort.

Critical to the settlement patterns that evolve is the **degree of cooperation**. Without radical collaboration between the main players – government, the powerful and smaller economic and commercial players in the industries, and civil society – dispersed settlements are the inevitable result. In the long term, **dispersed settlements**, especially (but not limited to) those dependent on a single entity or operation, **are unsustainable and fail**. This is because sufficient thresholds are not created for economic diversification and social amenity/service supply (see Appendix 1 and Appendix 2).

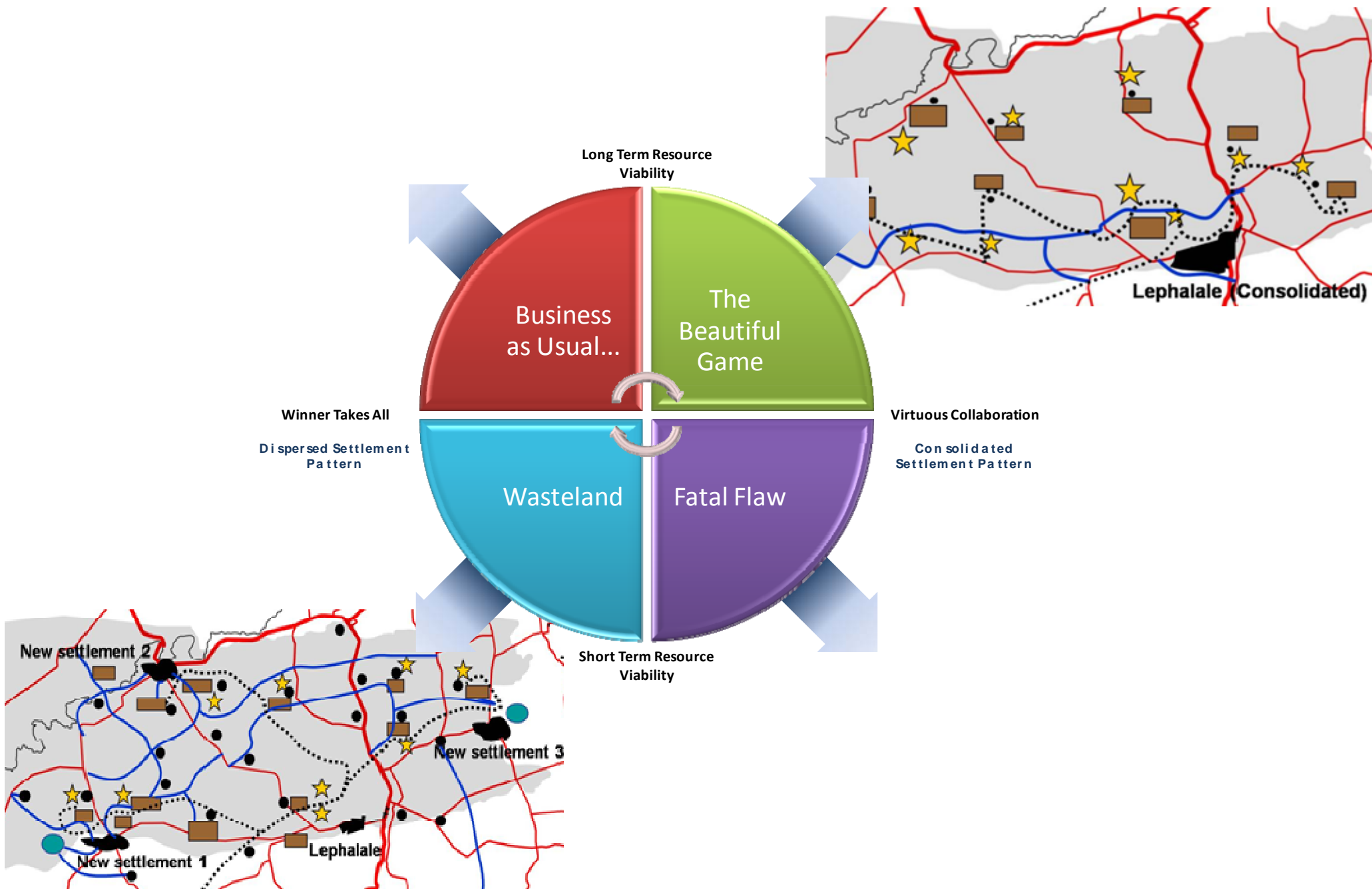


Figure 2: Four Long-Term Scenarios for the Waterberg Coalfield Developments

SCENARIO 1: BUSINESS AS USUAL: WELL INTENTIONED POWERFUL PLAYERS

During the operational phase....

Over the past 30 or so years, settlement has developed around the three main nodes of Lephalale, Steenbokpan and Stockpoort, based on the Lephalale IDP of 2010; business continued “as usual” in the municipality, and the settlements have evolved as typical mono-economy areas - in this case either mining or power generation (see Appendix 2 for characteristics of mono-economy settlements). Despite the evidence that characteristics of the traditional boom phase were present as early as 2010, no long-term vision was set for the area; such evidence included sprawling residential development patterns, increasing income inequality, increasing crime rates, dramatic growth in the property market, and the rapid increase in informal settlements. Reviews of the spatial development frameworks (SDF) and integrated development plans (IDP) continued every 5 years. The district has developed taking into account the expressed needs of the main players, with the government trying to establish the means to address the needs of these players and address broader social needs, including infrastructure and service delivery.

This mostly results in accommodation of interests and “consensus based” decisions, which largely address short-term, pragmatic concerns. The main industrial players have developed the nodes of Lephalale/Marapong, and Steenbokpan. Stockpoort has been developed by government in accordance with the 2010 IDP. Each centre is characterised by the needs and wants of each of these companies; Lephalale and Marapong reflect traditional mining-town characteristics, based on the housing and commercial needs of employees and their dependents. Planning generally accommodates the bare minimum of public amenities on the understanding that additional facilities might be provided over time. The communities in the area, who were placed in the Waterberg as a result of being forcibly removed in the apartheid era, and those who have current land claims, remain unable to exercise their limited legal rights to participate in the process by which mining permits and licenses are conferred.

The three main towns are functional and not unpleasant places to live. The powerful companies have collaborated to some extent, primarily to ensure that their needs are addressed. People have moved into the area; developers and speculators took advantage of the promised boom, and have built houses, shops and banking facilities in each town. Lephalale has grown, with some degree of diversification which provides a very narrow range of commercial and social services. The potential to grow is present in Lephalale, but the presence of alternative facilities in the satellite towns tends to undermine Lephalale’s economy. This has limited Lephalale Municipality’s ability to spend additional money on infrastructure and development.

The dispersed pattern of these three main towns has caused a dramatic increase in infrastructure costs, due to the distances and fragmented network needing to be covered. The improvement of infrastructure in Lephalale is not a priority, as government funds have been focussed on the development needs of the satellite towns, to service the boom around the mining and power generation developments. The larger, powerful companies required some development within Lephalale, and as a consequence, the town is a patchwork of older, under-serviced areas, and newer, well-serviced areas.

Because of the limited economy in Lephalale, itinerant workers tend to gravitate towards the satellite towns in the hope of finding work. They are settled in mostly under-serviced and poor quality RDP housing (that was erected very fast to cope with the massive influx of people) or shack dwellings on the

periphery of the main towns. These informal settlements became “the community” of the mine, and hence received some financial aid, in the form of infrastructure and service provision. These communities are therefore entirely dependent on the mine or plant for their existence.

Government-funded infrastructure provision has not been able to keep pace with the rate of economic development, not least because of lack of capacity and funding, and uncertainties over municipal and provincial priorities and responsibilities. As a consequence, each of the main commercial players has invested massively in highly dispersed infrastructure to meet their own needs, although it is largely managed by the municipality. The companies cooperate with the municipality and local government to make some provision for the under-serviced areas managed by the municipality, specifically as part of their corporate social investment programmes. Where government capacity fails, companies step in to manage and maintain the infrastructure corridors, including water, energy supply, roads and housing. The extent of uncoordinated infrastructure development detracts from Lephalale’s ability to grow.

Similarly, education and health services are largely privatised, with each of the three main towns boasting a small hospital, a number of private clinics, and private schools for the families of the employees. Children of low-skilled labourers who live in the informal settlements around the main towns either have to walk or travel by taxi to the government schools in Lephalale, or have no schooling at all. Lephalale never reached the thresholds for the development of a group of FET colleges for the various economic activities in the area, and the sole FET College, having received a revamp through a mix of private and government funding early in the boom, is related exclusively to mining and supporting services. Members of the original local community, remain marginalised, under-educated and under-skilled.

Smaller mines have opened over the years. Each mine has been licensed individually and without consideration of existing or planned licenses in the area, with each of the companies following the precedents set by the larger initial developments; there is no incentive for them to do otherwise.

The resultant sprawl of small residential and commercial towns around each mine has created a “spider-web” network of smaller, largely under-maintained roads in the area. Except for the pre-existing rail to Grootegeluk mine - which is used exclusively for product from the mine having been upgraded to accommodate the additional production - all transport of people, product and commercial goods is by road. The sprawl of settlements never provided the consolidation and critical mass necessary to create a central rail terminus. The only public transport that exists is in Lephalale, where a limited bus service is available. There is a large and mature minibus taxi sector, for local and long-distance travel. The volume of traffic on the roads, and the use of the roads by heavy vehicles have degraded the road network faster than it can be maintained – disputes over responsibilities for maintenance are rife. Road safety is a major problem for the local authorities. Police and emergency services have been stretched to capacity and often the larger private companies have to step in to assist.

Farming in the area has slumped to a virtual stand-still. Farm labourers left early in the growth period in the hope of finding better paid work in the mining towns; a hope largely unrealised.

The air and water pollution generated by the unconsolidated settlements, poorly maintained transport networks, and related mines and power generation facilities have affected land capability and air quality. In the winter months, smog affects large areas, focussed on the main towns, mines and power stations. The rates of lung diseases in the informal settlements are high, especially in children and those affected by HIV/AIDS or tuberculosis.

-Combating crime is a constant battle. High levels of inequality between and within the settlements, areas of high poverty, and significant unemployment levels aggravate the existing high levels of crime. Social stresses related to community relocation are ongoing; relocation is required each time a mine opens within the coalfield “triangle”, which is populated with many scattered rural dwellings. Where possible though, relocation is to existing settlements, especially those of smaller mines that have closed, and have left behind their settlement-related infrastructure. This has afforded the mining companies the opportunity to invest to some degree in social upliftment and empowerment programmes within the relocated communities.

Prostitution levels rose fast with development and remain high; this has contributed to the rapid increase in HIV/AIDS rates; at 50%, it nearly matches that of neighbouring Botswana, especially along the east-west corridor that has developed between that country and Lephalale.

The biggest challenge of all – after 30 years of development - remains water. The Mokolo dam could only supply the water needs of a single power-station, and water has been piped in from Gauteng’s return water flows for over 20 years. Energy-based industries continue to consume more water per year than all other water users in the district. The growth of Gauteng has created massive competition for its water resources, and the cost of water piped to the Waterberg area is higher than any other mining centre. The municipality can no longer afford to pay for the water, and market forces dictate the final end-users.

The environment has suffered severe degradation from the lack of water, signs of which were evident as early as 2010, contributing to the fall in tourism to the area, and the degradation of the former Biosphere Reserve. The Mokolo River habitat is now mostly alien invaders, with the indigenous flora either having been used as firewood for the informal settlements, or having died out due to water stress and pollution. Because of all the mining and energy-related activities, the limited groundwater supplies on which all rural settlements were dependant, have largely dried up.

This has forced many rural people to move to the informal settlements around the mining developments scattered across the area, who are themselves suffering from severe water deficit. Social tensions run high in these settlements centred on competition for resources and patent disparities in living conditions and services. Divisions between social groups deepen and break into open conflict. Municipal authorities come under attack. Although the Lephalale municipality remains functional – assisted by private funding, there is constant conflict over access to land, water and government funding.

These tensions are exacerbated in the long term when mining begins to decline. Development over the past 70 years, driven by the interest of those with economic, political or social power, now stutters. The government has tried to keep pace and service all needs, but by default, the needs of the economically powerful entities dominated, even in the long term.

Lephalale, having been the largest and most diversified town in the area, remains functional but at an ever reducing scale, and is slowly stagnating. There has been reasonable prosperity, although not without significant pockets of poverty, throughout the development of the area. There are some empty houses in Lephalale, and the industrial zone has contracted significantly, having serviced the mining and power generation facilities almost exclusively. Steenbokpan remains, but has contracted significantly, as technological improvements reduce dependency on lower-end skills. Shops have closed, and the banking sector is smaller. The government run schools are crowded, but the private schools are

shrinking.

The coal resource has lived up to its promise, and some very large-scale mining continues in the district. Due to the extent of the coalfields, their quality, and the long-term viability of the resource, the larger mines have expanded enormously. In many cases, the smaller mines have been bought out by the larger players, and absorbed into their operations. The settlements built to service these smaller bought-out mines are now owned by the larger companies, on which they are in turn entirely reliant. Technological development and investment has allowed the retrofitting of the power-stations; they continue with less reliance on coal.

The settlements around each of the smaller, individual mines have all collapsed, as they had no alternative economic activity to the mining. With many of the people from these settlements moving into Lephalale, the informal settlement around that town has mushroomed. Together with the few massive mining operations, traffic along the east-west corridor to Botswana helps to maintain the larger towns; the transient nature of residents though continues to contribute to increases in crime, prostitution and other related social ills. Private security firms are on the increase.

Up to about 2020, increased interest in the area brought a boom in the tourism sector, which has now all but died. The extensive mining and number of power stations mean that the area is no longer an attractive landscape, and the pollution from the scattered developments has impacted significantly on the Waterberg Biosphere Reserve, which consequently lost its international status. The Mokolo River only runs sporadically. Some people that were employed by the mines are trying to reinvigorate the farming sector, but with very limited success. Ecological functionality is impeded by the highly truncated/bisected developments, pollution, environmental degradation, and the severe water deficit, all of which are exacerbated by the massive, dispersed footprint of the developments. Only the hardiest of game remain viable for farming; however, the trophy hunting market has also largely collapsed because the area is no longer a “wilderness” experience.

The road network is in serious disrepair; as mines closed, road maintenance declined. Only the primary corridors remain; maintenance of these remains hotly contested, but due to their importance, a public-private partnership between government and the most powerful companies has evolved to address this. Other private infrastructure relating to water, energy and housing has been handed over to the municipality as a gesture of goodwill from the exiting companies. The municipality however does not have the resources – human, financial, technical or policy – to manage the huge burden this creates, and national priorities continue to drive local spending. The massive footprint created by the dispersed settlements and infrastructure undermine the management and continued functionality of infrastructural services. Consequently, formerly privately owned infrastructure is falling into disrepair and disuse.

Unemployment and poverty in the district is on a steady increase. There is an increasing exodus of young and working-age people to the southern and western Platinum belt, despite its decline due to market oversupply, and to Gauteng in search of work. Some do manage to find work in the towns of Lephalale and Steenbokpan. The demographic profile of the area is slowly changing to higher numbers of very young and very old, highly skewed towards women, who remain behind to attend to families. Service protests and conflict over resources is rife. The spatial and settlement proxy between Lephalale and Witbank is displayed in Figure 3, to illustrate the possible development path on which the Waterberg are already finding itself. It can be anticipated that, should this continue, the socio-economic consequences associated with such dispersed settlement patterns – as illustrated in the Mpumalanga coalfields – will emerge in the Waterberg.

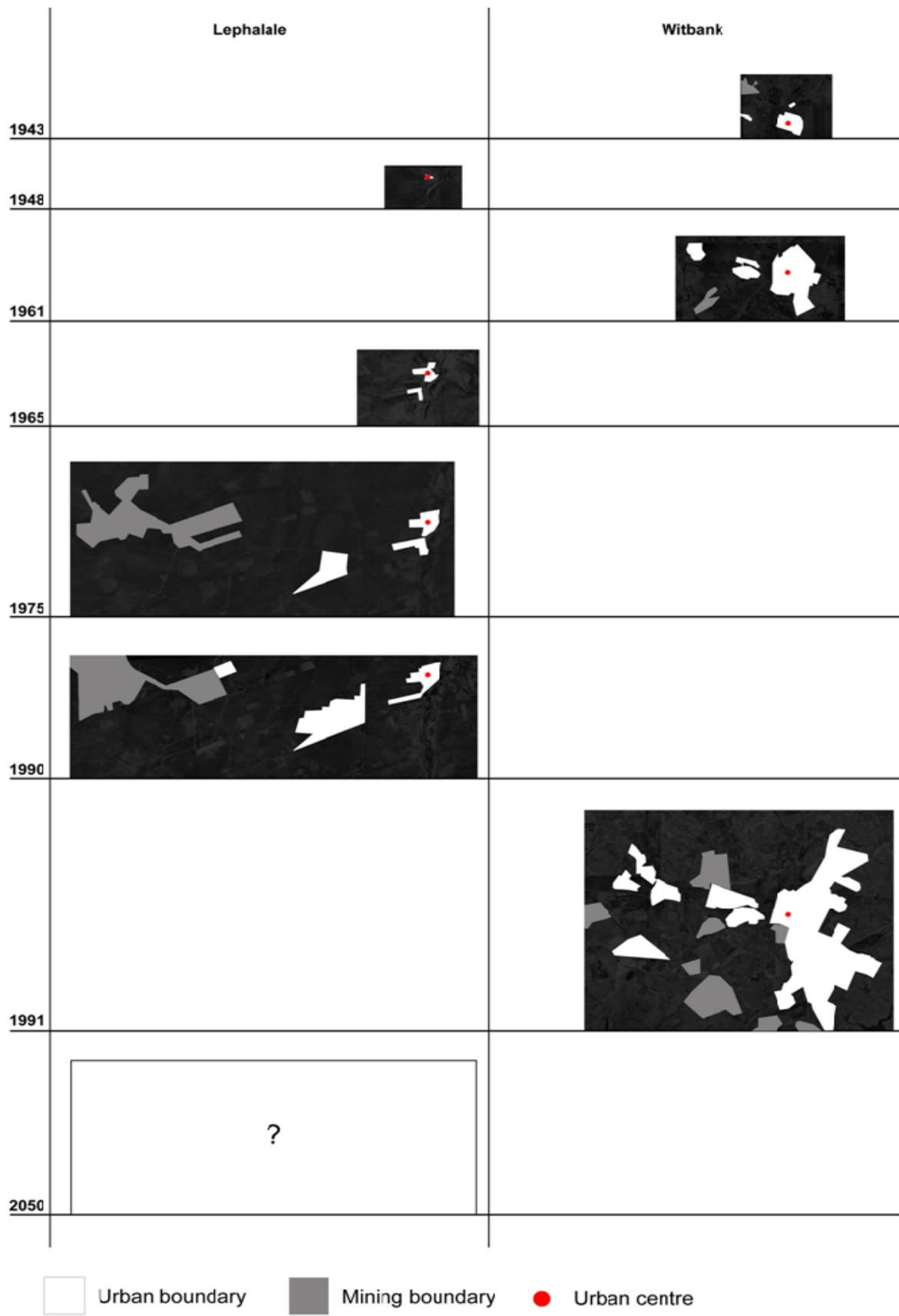


Figure 3: The Lephalale and Witbank Spatial Development Proxy

SCENARIO 2: WASTELAND

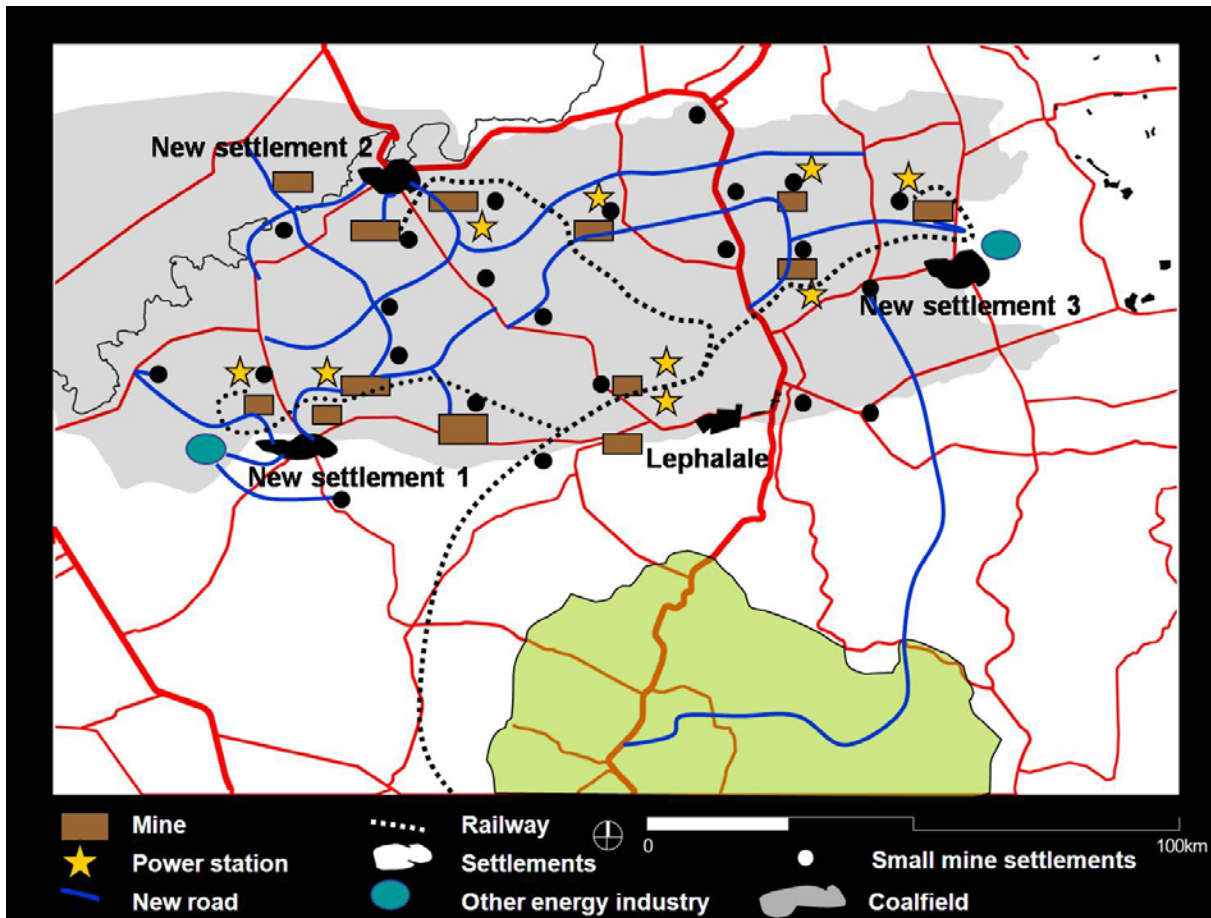


Figure 4: The "Wasteland" Spatial Pattern

As with Scenario 1, over the last few decades, settlement developed around the three main nodes of Lephalale, Steenbokpan and Stockpoort, based on the Lephalale IDP of 2010 and business continued "as usual" in the municipality. However, rather than companies settling in "for the long haul", short-term economic gains dominated decision making, driven by the severe energy deficit in the country. This short-termism constrained cooperation between industry and government, and between the main players within the industry. Self-interest on the part of all players still dominates. Many smaller companies converged on the area shortly after 2010, to benefit from the development of the coalfields leveraged by the larger entities, especially those in power-generation. The rate of development has been such that the coalfield is now largely exhausted, not least through exploitation by shallow-mining companies that have moved off the land, taking all their capital equipment with them. Deep mining did not see as much interest, given the greater capital investment needed, longer-term pay-back and ready availability of the shallow resource. The boom that resulted from the coalfield development was extreme, where speculation was rife, and many people had huge financial gains; however this was short-lived. Low-rise housing development proliferated, rates of car ownership increased, and the retail sector expanded dramatically (e.g. fast food). A casino was even built for the district. Developers built opportunistically, without any development framework in mind: whatever might sell was the driver.

As a result of people wanting to live close to where they worked, settlements sprang up everywhere around mines, in a completely haphazard way, with no regard for provincial or municipal planning: the opportunity was too great to miss. Urban edges of settlements have become blurred. The competition for services overwhelmed the under-resourced municipality that essentially had to focus its attention on service delivery to the poor and marginalised. Little revenue was created due to the main industrial entities leaving, and the municipality spiralled into dysfunction. Public roads remain, but because of the intensity of over-use and low maintenance, even these are hazardous.

While the main settlements reached the thresholds for the development of higher-end services, the lack of cooperation and the uncoordinated nature of settlement development meant that these opportunities were never realised. The occupational profile within Lephalale has reverted to one similar to that of 2010, in which trade, craft and elementary occupations dominate. The FET college has closed, as the mines no longer require the skills emanating from the college. The residential areas in Lephalale – especially the middle income areas – are characterised by abandoned houses. Shabby and run-down prefabricated structures dominate in the formal lower-income areas, having serviced the mines temporarily, especially during the construction phases. The huge taxi-ranks are little used; local travel dominates, with infrequent long-distance services running (see Appendix 2). There is no public transport any more as there are not enough people to use it. Most of the major banks have closed their offices, and shops stand empty.

The blur of settlements has been exacerbated by relocation practices of the mines within the coalfield “triangle”. The rate of expansion and the lack of cooperation meant that each mine was obliged to build settlements for those to be relocated. This has had the effect of intensifying urban sprawl, and the dependencies of those communities on the mine for social amenities and service provision. These relocations – each done as needed by each company - have contributed to the fragmented settlement pattern, as mining companies built new housing as compensation for the relocations, with little or no reference to spatial planning issues, or the needs of each relocated community. All available funds have been utilised to build the settlements, with no additional funding available to invest in community empowerment. When mines closed after relatively short life-spans, these communities quickly failed, not least because the mining companies – even those with good intentions - did not have the time to contribute to the establishment of post-closure frameworks or structures that might have aided the communities (see Appendix 2). Smaller settlements are now all largely abandoned, including the factories, shops and in some cases, even the older power stations within or close to them. Infrastructure is visibly deteriorating; paint is peeling off buildings, roads are cracked with large potholes, and bridges remain broken. The road network is very dense, characterised by untarred and under-maintained minor roads. Devastated settlements sprawl from Lephalale to the Botswana border, with a scatter of ghost towns, which extend across the border. Many of the abandoned settlements are illegally occupied, especially by economic migrants from Botswana, who cannot be contained or controlled.

As mining declines, social tensions arising from poverty, unemployment, and a sense of dispossession and disenfranchisement by those previously employed in mining and related services, are exacerbated by xenophobia. The district is characterised by violence and crime, very high prostitution and high HIV/AIDS rates. The air smells of coal (acid), and sewage, as the infrastructure is now defunct. People cough and hospitals are chronically understaffed with long queues every day. Social polarisation is extreme, with a total failure of public infrastructure, not least because local government has collapsed as there is no sale of electricity and water. For a while, the private sector paid public authority salaries, but with increasing competition for resources, powerful interests have privatised all services. These run efficiently, but are less accessible and less equitable. The companies are concerned at a political level

about the surrounding population, but interventions are restricted to welfare, not empowerment. The local population is characterised by the very young, the very old, the sick or disabled – the most vulnerable and marginalised sectors of society. The main settlements emerged around the siting of the power stations and the largest of the coal mines: the economy never diversified – there was no time and no incentive - and is now solely driven by energy generation. Most energy generation is through drilling and *in situ* gasifying, using technology from China, in a reciprocal agreement for export of coal from the Waterberg. These main settlements are not towns but enclaves, with highly distinctive characteristics. Even Lephalale very quickly became largely a “private town”, with a sprawling periphery of extreme poverty. The need for rapid service delivery, which could not be met by the municipality, resulted in each large company developing its own exclusive infrastructure, including that for provision of all services; every enclave even has its own generator. Prosperous groups live mainly around the power stations; devastation surrounds them. The only reason these enclaves exist is to service the power stations.

Within these gated enclaves, the quality of life is very high. Every possible amenity is provided, as are all necessities, with supermarkets dedicated to meeting the needs of those within the enclave. There are some permanent professionals, and permanent contractors within the settlement, who live in large high-quality family housing; processed water is used for irrigation and gardens flourish in the otherwise grey landscape. The permanent professionals command very high salaries, and some use helicopters for travel. The power stations are now highly mechanised, and only a limited number of mainly professional engineers are employed. None of the permanent professionals stay for more than five years. All other employees are accommodated in boarding houses, and operate on a two-week on, two-week off, fly-in, fly-out basis.

Education for the children of those on a full time residential basis is provided by private tutors, with planned group work for psycho-social development. Even the roads are privatised, and company vehicles use private security firms. Industry trucks are fortified against hijacking, and truck drivers are protected. All vehicles have tracker devices, and are monitored along the entire route. Local people often try and hitch rides illegally, and despite the risk of being fired, relationships grow between the truck drivers and the local community. With mainly men in the enclaves, and the fly-in fly-out arrangements, prostitution is not limited to the poorer areas.

Other than the six coal-fired power stations that initially developed in the area, only the oldest coal mine continues to thrive, servicing the global demand and exporting coal via a private rail line to China and India. Rapid expansion of these economies has driven up coal prices, and the company is exempted from the carbon tax by the national and global growth imperative. Other energy industries proved successful, and have expanded due to peak global oil demand; their massive and increasing water use requires that water is piped in from Gauteng return water flows. As a result, Hartbeespoort Dam has become severely polluted; together with Gauteng’s pace of economic growth, this has caused political tensions between the Provinces – and between South Africa and Lesotho - about inter-basin transfers and access to water. The Waterberg has essentially no water, and water is constantly sought for drinking, cleaning and cooking. Bottled water is available, but most people can’t afford it. Illegal tapping of water from the private pipelines is rampant, with a flourishing black market in water. The water tankers that regularly truck water into the poor areas are frequently the source of violence. Cooperation between the platinum and coal mines is entirely absent, as they compete for water allocations in the area.

The intensity and pace of development has resulted in rapid degradation of the environment. The Waterberg, specifically the triangle of Lephalale, Steenbokpan and Stockpoort, resembles the post-mining landscape of the Mpumalanga coalfields in the earlier part of the 21st Century. The air and water pollution is significantly higher than in Scenario 1, due to the rate of development, and the focus on short-term economic benefit to the detriment of environmental management investments. In the winter months, air pollution levels are critical, not only in the local region, but also in Johannesburg and Gaborone, due to dominant circulation patterns. With the ever-receding water table, and the social and environmental conditions surrounding the massif, the Waterberg Biosphere Reserve lost its status rapidly, following a review by UNESCO. All of the long-term after-effects of Scenario 1 have been realised, in a very short space of time.

SCENARIO 3: FATAL FLAW

On the other side of the Scenario scales, a consolidated pattern of settlement emerges. In this scenario, the widely-accepted Lephalale SDF review in 2010 recognised that the long term post-mining outlook for the area was poor and therefore decided to consolidate settlement. This decision was taken to ensure adequate population thresholds were achieved to allow for economic diversification and the creation of viable socio-economic services. Location theory was also recognised in the planning for the area, where settlement is known to be driven by resources, markets and transport infrastructure.

The growth of consolidated settlements is entirely dependent on cooperation and collaboration between all stakeholders, all sharing a common vision of the future. The SDF therefore required the restructuring of the Lephalale Development Forum to adopt settlement planning as a main thrust, boosted and supported by the private companies and national government. In line with the Waterberg 2010 SDF and draft Environmental Management Framework (EMF) for the Waterberg, instead of planning three dispersed settlements, Lephalale was identified as the only major node for growth in pursuit of threshold population densities. The settlement was planned to accommodate a light industrial and commercial area to buffer the central heavy industrial zone south of the residential neighbourhoods. Housing types were carefully planned according to the likely profiles of the employees of the various companies: some larger family units, but mostly higher density, medium-rise apartments to constrain the urban footprint. This resulted in a distinct urban edge, bounded in the north by coal-bed methane projects.

Settlements around the mines and other plants are restricted to skeleton personnel; those that have to be on-site at all times. Most importantly, everything in these settlements is built to be removed; housing is prefabricated, and due to low residential densities in these areas, septic tank systems can be used effectively, obviating the need for piped sewage systems. Other than a very small local general dealership, all shopping and entertainment is provided in Lephalale. In this scenario, all stakeholders have accepted the model proven viable at Venetia diamond mine in northern Limpopo, where personnel are bussed 80 km to the mine and 80 km back every day from and to Mussina. It was also recognised that many people in Johannesburg and Pretoria travel up to 100 km per day to and from work, commuting between the two cities.

As people moved into the town - with the growing development of the coalfields and power stations - shops, banking, educational facilities and all types of commercial developments were created by a mix of private and public funding, sometimes through public-private partnerships (PPPs). Corporate social investment programmes from all companies in the area were earmarked for the upgrading of the existing Lephalale town. The consolidation of people and facilities allowed the development of a functional and effective public transport system; car ownership therefore was not excessive, and the town was planned so that most activities required on a daily basis (such as schooling and shops) can be reached on foot (see Appendix 1).

Similarly, the population density and consolidation of development allowed for the creation of smaller, more functional health services supported by two large and sophisticated hospitals: one private, one public. Social amenities such as libraries, sports facilities and even a movie theatre could develop based on the captive market.

Simultaneously, the light and heavy industrial sector of Lephalale developed to service the broader base

of the economy. In keeping with the long-term energy future of the region, investment in technologies to reduce environmental impacts of mining and energy generation was significant.

Tourism has thrived, and a vibrant tourism-service sector develops. Environmental management by all sectors of the economy is stringent, guided by the Wilderness vision, and by conditions imposed by financial lending institutions, including the World Bank. The SDF, and adherence to it, attracts significant foreign investment in the energy and environmental sectors. The Waterberg Biosphere Reserve status has been upgraded to a globally protected reserve, as the area within the massif has thrived, except for problems associated with the significant water deficit in the region. However, as the National Water Act of the time allowed for first priority being the environment, the Reserve has preferential claim on water delivered to the area.

There are two main transport corridors, along the east-west axis and north-south. All utilities and services are contained within these narrow, highly utilised corridors, with rail, water, electricity lines, oil pipelines and roads concentrated together. Maintenance and upgrading of this infrastructure is therefore made more efficient through easy access. Collaboration between South Africa and Botswana resulted in a high-velocity highway being built between the Botswana border and Lephalale. Heavy trucks are diverted around Lephalale through bypasses, but all other traffic passes through the town, which becomes the gateway to all points on the compass: south to Gauteng, north to Zimbabwe, east to the Waterberg Biosphere Reserve and Polokwane and west to Botswana. The central crossroads in the town is regionally recognised as a place of urban art.

The success of this scenario is however threatened by the viability of two primary natural resources; the coal and water. In this scenario, a significant factor was overlooked, resulting in an initial flourishing of consolidated development, followed by a rapid downward spiral.

Coal...

In 2010, stakeholder opinions were expressed that the coal reserves are not as extensive as they were being made out to be at the time, or are so seriously structurally impaired as to impede their economic viability. In this version of the Fatal Flaw scenario, this prediction unfortunately proves to be true: at some stage in the development of the coal-field, it emerges that the field is not as viable as first thought. The mining sector slumps completely. Because the settlement has been planned in a densified, consolidated pattern, Lephalale contracts to some degree, but in the face of further collapse, is able to continue on the basis of other economic sectors. Lephalale does not however have as many specialised services available as it had during the mining boom.

The highly-restricted settlements around the mines, because they are very small and were built as temporary structures, with minimal infrastructure development of any kind, are easily rehabilitated, being well within the mine's environmental financial provision allocations. There are however significant job losses as the entire sector collapses. Some of these jobs are absorbed in the fairly successful construction sector. The more functional municipality, due to the PPP's in place, is able to provide at least limited basic services to the newly unemployed for a period.

The coal-fired power stations and other energy industries continue to operate, but now rely exclusively on coal imported via the rail corridor to Lephalale. This increases costs to the point that the energy produced may become uncompetitive, even in the global market. These operations therefore continue under ever-increasing cost-cutting pressures.

Water...

As far back as 2010, there was clear evidence of severe water stress in the Waterberg. Despite this, all planned developments continued, including the highly water-intensive industries. The pipelines from the Mokolo Dam, and from Gauteng were constructed, and this supplied water for some time. However, the envisaged rates and volumes of supply, on the basis of which development plans were implemented, cannot meet demand, for any number of reasons including:

- The location of coal-dependent, highly water intensive industries in the Waterberg;
- Global water stress related to climate change;
- Inter-basin transfer inequities and competition for the water resource;
- Regional inequities and competition for the water resource; and/or
- Access to clean water becomes a higher national priority than energy supply.

In the case of water supply failure, all heavy industrial sectors are severely impacted, and ultimately fail. Lighter industry and the services sector can however continue to operate in Lephalale. As for the coal resource, the long term success of Lephalale is dependent on the duration of economic activity, and the extent to which the economy has been able to diversify, assuming there are no other constraints. Even tourism is impacted however, as the natural environment slowly changes to one suited to water scarcity, and loses its aesthetic value and capacity to support large game. Some of the heavy industrial facilities, including power stations are abandoned, as they are too expensive to remove. An entrepreneur sets up a single “historical industrial ecology” tour that attracts schools and policy makers from around the country.

SCENARIO 4: THE BEAUTIFUL GAME

In this consolidated settlement scenario, long-term sustainability of the Waterberg is assured. Settlement in the municipality is focussed on a high-growth and densified Lephalale, as was the case in Scenario 3. All the related benefits of consolidated settlements have been realised, but with some added advantages and consequences that have resulted from a number of factors, described below. Not least of these was the recognition of the need for radical coordination, through integrated and collaborative planning and the alignment of interests in crafting a new pathway for development.

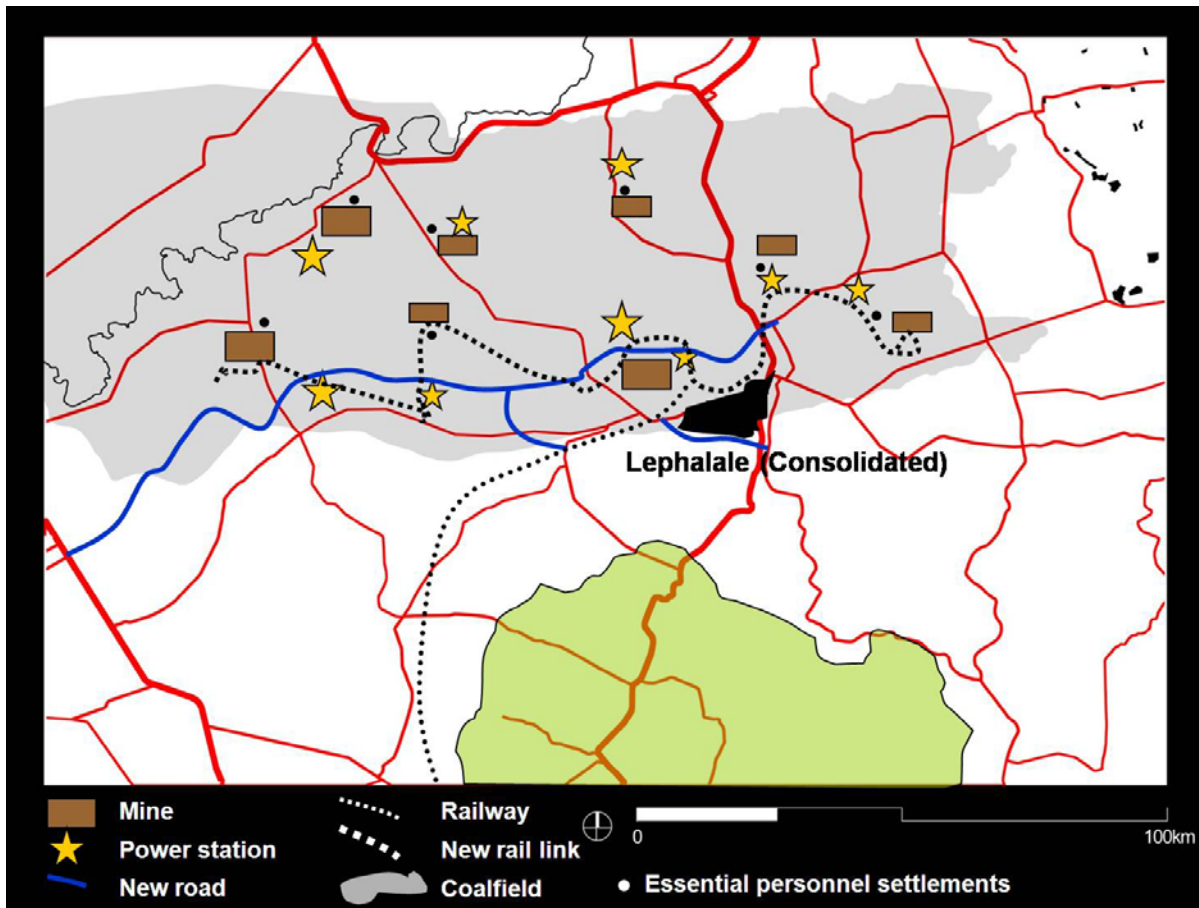


Figure 5: The “Beautiful Game” Spatial Pattern

As a foundational step, the revised SDF and the EMF were combined into a master plan for the municipality taking into account the views of all stakeholders, with which every sector of society had to comply. In order to assist in the implementation of the SDF and monitoring of compliance, the provincial and national government departments provided human and financial resources to the district and the municipality, in recognition of role that the area was going to play in servicing the then and future national energy imperative. The master plan also identified a 100 year vision for the area as “**The Place of Wild Energy**”, to which all future development had to contribute. Developing this shared vision warranted specific attention and was achieved by employing one of a number of processes designed to take account of the interests of a wide range of stakeholders and to build strategies premised on a holistic appreciation of the range of issues and factors at play^{xxviii, xxix}. The long-term supply of energy remained the focus of the developments, within the constraints and opportunities afforded by the

natural environment in the Waterberg.

In 2010, the National Planning Commission persuaded the Department of Mineral Resources (DMR) and the Department of Water Affairs (DWA) not to issue any mining or development approvals prior to the release of a comprehensive Development Framework and associated Vision for the district. Following the release of the Development Framework, mining licenses were granted not on a site-basis any more, but on a regional basis, reliant on the Framework, and taking into account global commodity supply, demand and prices. As a result, the exploitation of the coalfields did not keep accelerating, as with the other scenarios, but occurred at a slower and more considered pace, nonetheless meeting the energy demand. Similarly, the southern Waterberg Platinum belt has not been developed, due to concerns of a global oversupply.

In order to achieve this model of issuing permits, DMR has a system that enables logical and optimised extraction processes over time, and considers the cumulative effect of mining on natural resources^{xxx}. More informed environmental impact assessments (EIAs), which focus on the “how to” of environmental management and rehabilitation are ongoing, but with better enforcement, due to the additional resources provided by the Provincial and National governments. Regulatory amendments facilitate this process, such that mining decisions are based on a better understanding of the resource base. The understanding of the coal-field viability is therefore more realistic and lives up to its potential. Mining permits also require guarantees of governance. The permitting process allows for additional plans to prioritise local community people in corporate social spending; in 2010, employees were the priority of the then social and labour plans (SLPs). Legal amendments were also made around the same time such that by 2020, local communities owned 20% of the shares of all mining activities in the area.

Mining is seen as, and indeed is, a short-term, temporary land use in the Waterberg. As a condition of being granted a license to operate in the coalfields, mining and other companies have had to agree to house employees and families in the Lephalale residential zone, to the extreme north of the town, and to use the dedicated transport corridors for all utilities. The corridors were rezoned as national assets (and responsibilities). An infusion of capital from surpluses of economic activities in the region thus financed the development of infrastructure and social capital. The development of dense corridors and settlements have helped to contain the related environmental impacts, sterilised less land, and made impacts easier to manage at the same time. The non-developed parts of the district retain a wilderness look and feel, with game farming and nature areas. Although people move in voluntarily from dispersed rural settlements, some are still living in dispersed homesteads, using the aquifer which is still viable. Some rural communities have been able to remain, living according to their needs without being forced to move or accept developmental changes, while still receiving basic services from the municipality.

Coal bed methane (CBM) has proven viable, and is expanding in preference to coal mining; this, combined with the slower mining developments, significantly reduces the environmental impacts of the sector in the district. The CBM fields to the north also constrain the city limits, as small gas plants limit urban sprawl without undue ecological or aesthetic disruption.

Of massive significance in tipping the scales between long term sustainability or not is that around 2010, when the water constraints became clear, there was a deep questioning of the assumptions underpinning the approach at the time. Synergies were sought, especially based on the possible water resulting from the CBM developments. Regional water treatment technology investigations therefore began in earnest, based on the success of the eMalahleni water treatment programme.

Fundamental to the sustained success of the area is that the highly water-intensive industries that had been exploring the potential of the Waterberg reconsidered their location plans, given the disconnect between their massive water needs, and the water constraints in and uncertainties of supply to the area. These industries opted for alternate locations on this basis.

Bulk water is piped into the district from Gauteng, but at hugely reduced volumes given the absence of water intensive industries; consequently, tensions do not arise between the water use areas. Water is used as **the** determinant of development and recycled treated water from the various plants in the area is used for irrigation and industrial processes.

The limited and well managed environmental impacts resulting from this settlement pattern, the required land-use practices and the policy implementation has allowed the ecosystem to maintain its functional integrity. The Waterberg massif is globally significant and has retained its UNESCO status. The tourism industry continues to grow and diversify, including the development of an extreme adventure sector.

Within Lephalale, which reflects a process of maximum consolidation of the settlements, a few key characteristics have emerged or been created. The Lephalale FET has a focussed faculty of energy resources, from the perspective of the environment and other resources. It is thriving thanks to the diversified economy, and produces local skills. The FET college was also supplemented by mining related skills and equipment from the colleges that were closing in the Mpumalanga coalfields at around the same time, supported by the simultaneous intervention of the Mining Qualifications Authority (MQA). The limited satellite settlements remain as for Scenario 3.

The consolidation and densification of Lephalale allows for diversified retail and cultural activities as in Scenario 3. Town planners have also taken into account the “Wild” aspect of the vision; all public areas are planted with indigenous species, and landscaped to fit in with the natural surroundings as far as practicable. To counteract the built-up impression of the densification of Lephalale, streets are wide enough to accommodate heavily planted verges, trees and pedestrian/cycle tracks along most major routes. Lephalale has also been consciously developed as **the** gateway into the conservation area within the massif.

The industrial zones – both light and heavy – are clearly defined and contained, where impacts are well-contained. Using the Vision as a guide, industries develop based on energy, water and long-term economic diversity. This has contributed to the commercialisation of research, where alternative technologies are the focus of attention, as have the tax incentives and fiscal support for the development of Lephalale (driven by the national energy imperative). A series of synergistic industries have emerged, creating an industrial ecology hub, the funding for which was sought from a number of agencies early in the development of the coalfields. The most significant of these synergies is the alternative energy cooperative. Based on studies started in 2010, research has allowed for pyrite to be removed from the coal, and the hub supports this activity. The pyrite is used in two streams: one to supply the solar panel industry within the hub, the other to create the acid required in the uranium industry elsewhere in the country (with nuclear energy receiving more attention). Solar panels are being built for use on the post surface-mining landscape which is largely flat. The district’s climate is ideally suited to the generation of solar energy. The solar fields are expanding at a steady pace, and feeding into the national grid, as part of the energy future depicted in the Vision. Other renewable energy industries have developed, including energy from algae.

With the pyrite removed from the coal wastes, these are now inert and eminently suited to the manufacture of bricks, which are sold and used locally. Similarly, gypsum, resulting as a by-product from the coal washing, is being fashioned into bricks, based on cooperation between the East-German post-mining group and South Africa. These downstream industries require power, but little water, and are ideal for the Waterberg district. The industrial ecology hub has become such a unique environment in South Africa that it forms part of the local tourist routes. The hub therefore links solar energy, coal, manufacturing, and tourism, while assisting to ensure the long term diversity of the economy.

RECOMMENDATIONS

Sustainable settlements are the outcome of consultation processes, coordinated planning and a high level of cooperation between all stakeholders. The recommendations are thus structured around the activities that, if introduced early enough in the development of the area, will enable sustainable settlement, and support the “Beautiful Game Scenario”. It is recognised and advised that all recommendations need to be subjected to further investigation to ascertain their viability and the effect their implementation might have.

Forums for Development

- The Lephalale Development Forum should be modelled on other examples of successful partnerships, such as that of the Western Limb Producer’s Forum (WLPF). Key characteristics of such forums are ^{xxxi}:
 - Recognising and accepting the need for partnership;
 - It must be recognised and accepted by all parties involved that the Forum is a **structure for full partnerships**, not simply for engagement.
 - Identify and build upon the partnering organisations’ **‘core complementary competencies’**. As a general rule, the closer participants’ activities and benefits [in the partnership] align with their core activities, the more likely the partnership’s overall chance of success’ ^{xxxi pg 4}. In the WLPF, all platinum and chrome producers collaborate on issues of mutual importance, and then engage with other stakeholders, such as the municipality, on a collective basis, around the issues on which they have developed a position.
 - Successive stages entail different requirements of effort and corresponding set of skills. **During early stages, a vital role is played by champions** within partnering organisations in identifying the potential and purpose of the partnership and in building concomitant support from their organisations’ leadership.
 - Developing clarity and realism of purpose;
 - **Significant time** needs to be set aside to build mutual respect and consensus.
 - Negotiating and reaching agreement on the partnership objectives and governance structures may require the contributions of a **skilled facilitator**, to identify areas of convergence and divergence, and assist the forum to negotiate both. It is critical that areas of divergence be openly acknowledged, respected and discussed by all parties.
 - Ensuring commitment and ownership;
 - The partners ought to negotiate and **agree on governance structures**, including decision-making processes. Formalising such agreements in a memorandum of understanding is likely to make it is easier to resolve difficulties or to ‘scale up’ the partnership’s activities.
 - Developing and maintaining trust;
 - Occurs as outcome of the later stages in the partnership development, and **is cyclical in nature**. Initiate the process by aiming for realistic and initially modest outcomes.

requirement for effectiveness; the *actors* involved in a partnership and the partnership *process* itself must be accountable, with an overarching need for transparency.

- There needs to be clear distinctions among the partners between **accountability for dialogue**, and accountability for **implementation**. The former must precede the latter in any partnership.
- Participation in the revamped Forum should be expanded to include, at the very least, National and Provincial Government representatives of the Department of Mineral Resources; the Department of Energy; the Department of Environmental Affairs; the Department of Water Affairs; the Treasury; and the National Planning Commission. This is especially important given the historical absence of active involvement of central government in dealing with mine closure and related planning ^{xxxii}.
- The Chamber of Mines should facilitate the development of an industry-based cooperative structure relating to the Waterberg that would participate in the Lephalale Development Forum. The purpose of such an entity would be to encourage cooperation, find synergies, share resources and information, plan in a coordinated way, and align perspectives and positions on issues of importance in the Waterberg. This structure should be open to non-Chamber members to ensure that all mining- and energy-related development in the area is coordinated.

Planning

- The Spatial Development Framework (SDF) and the Integrated Development Plan (IDP) should be reviewed in light of the findings of this report, and the Environmental Management Framework (EMF) once complete. The development of satellite towns should be discouraged, in that they may prevent adequate socio-economic thresholds from being achieved in Lephalale.
- The SDF and IDP should be revised with the full participation of the revamped Development Forum, with input from the Environmental Management Framework (EMF), and from other parties such as researchers/academic institutions or individuals, relevant technology companies, urban designers, planners and architects.
- A review of current mining-related research (in Universities and other research institutions) should be undertaken nationally, and published, to determine which current or planned projects might have significant application in the development of the Waterberg coalfield, especially from an environmental perspective.
- Partnerships should be sought with the people and institutions that were involved in the former East-German coalfield rehabilitation project, in order to learn first-hand from their experience and to explore the opportunities to transfer any learning and technology, as well as build capacity through skills development in cooperation with the German team. This would be of specific benefit in the development of the industrial ecology hub.

In the Lusatian mining district of eastern Germany, where over hundred years 75,000 ha of land have been turned into dumps by the strip mining of lignite, new approaches for creating ecologically sustainable post-mining landscapes are being implemented. At the heart of this initiative is a centre of excellence, 'Mine-site Recultivation', which was established in Cottbus. The centre generates plans for creating region specific and sustainable post-mining landscapes ^{xxxiii}. Post-mining landscapes are seen as providing unique opportunities to redesign landscapes starting with the soil, and continuing with the remodelling of the terrain and the re-designing of the built

environment. A shared vision of the future usage of the land guides this process. Questions which were asked in Lusatia include, "...what should it look like, this "new land"? How can this process be controlled? And what potentials does such "new land" offer to the people of the region?^{xxxiv} Innovations include turning mine sites into new energy sites for wind and solar power, water treatment on a large scale with harvesting of metals from acid mine waters, embedding the area's mining history into the new landscape, creation of a lake district, and large scale thinking and engagement on the future use of the land. With reference to the Waterberg, the centre in Cottbus presents a good model for envisioning and planning post-mining / post industrial landscapes. The advantage in the Waterberg is that, there is an opportunity for an early start, and that the new landscape could be built while mining and fossil fuel based energy production is in progress

- The recent settlement history of the area must be assessed to obtain insight into potential concerns about settlement and resettlement, to properly acknowledge the sensitivities to settlement in the area, and to provide a sound planning platform.

Resourcing of Local Government

- The high priority of Lephalale as a development area, and its related national importance should allow National government to re-align funding and resourcing mechanisms such that the local structures receive the financial and resource support necessary to deliver on the national energy priorities, simultaneous with national and international conservation priorities^{xxxv}.

Revisit Water Supply Assumptions

- The assumptions about the provision of water need to be revisited, including those relating to the engineering solutions proposed. A national perspective on projected water availability country-wide needs to be taken into account, along with the development projections for the Gauteng area, and its likely water needs. The Australian model should be examined for its transferability relating to national water priorities and mining^{xxx}.

Infrastructure and Settlement

- All applications for development in the Waterberg, but especially relating to the exploitation of the Lephalale coalfields, should be reviewed against the criteria for success that have been proposed in this study. Licensing and permitting, especially of mining applications, must take the regional context into account, and the effect that the rate of exploitation of the resource may have on the long term sustainability of the area.
- Private developers should not be allowed to construct any further housing for the foreseeable future. The backlog of services to currently under-serviced new developments must be accurately determined, and until this issue is resolved, no further construction should be permitted.
- All the coal and energy companies must commit to house their employees and families in Lephalale.
- RDP housing should not be built in the rural community areas.
- Any plan for the future development and consolidation of Lephalale town should pay particular attention to:
 - The location of additional schools,

- The location of additional libraries and hospitals,
 - All other urban design issues, including all the thresholds (see Appendix 1),
 - Options for subsidised solar power for housing, and
 - Options for waterless process for sewage management.
- The history of communities which have been forcibly relocated in the recent past should be taken into account in any plans for re-settlement. In these instances, issues related to restitution, rather than “simply” compensation - are likely to arise. The legacy of forced removals in this area underscores the necessity of a shared vision of the future or master plan. The experiences of communities restored to their land may be instructive in developing appropriate capacitation strategies for relocated communities.

Financing

- From the outset, financing of the development of the industrial energy, water and sustainability hub should be pursued through mechanisms such as the clean development mechanism (CDM), and various other funding agencies with the appropriate profiles. Example of this are the various entities related to the World Bank that fund environmental and energy infrastructure projects in developing countries, especially related to coal. These are the International Bank for Reconstruction and Development (IBRD), the International Finance Corporation (IFC), the Global Environment Facility (GEF), and the Global Carbon Initiative (GCI)^{xxxvi}. The IFC and IBRD also participate in clean technology funding^{xxxvii}. Such clean technology may relate directly to research and development of environmentally sensitive technology, as well as to transport considerations, as one example.
- Regional multilateral banks have also been cited as possible sources of support in the carbon-efficiency market, including the African Development Bank. Bi-lateral assistance is already available in South Africa from, for example, the US Trade and Development Agency (in the example provided, for coal-bed methane projects)^{xxxvi}. Private sector financing, especially from international boutique venture capitalist firms, should also be explored.
- There are potentially a number of barriers that must be overcome to access clean technology funding, especially as a developing country/country in transition. Such barriers include where government policies encourage continuity in existing technology/processes (such as a preference for “end of pipe” solutions), lack of environmental stewardship, the absence of legally binding agreements, the paucity of political will, and a lack of information^{xxxviii}. In order to overcome these barriers, policy, cooperation and financing solutions need to be created that allow developed countries to fulfil their commitment of official development assistance (ODA) up to 0.7% of their gross national product (GNP) to developing countries, and transfer environmentally sound technologies on preferential terms^{xxxviii}. The development of the Waterberg as a new centre of South Africa’s energy provides an ideal opportunity for such cooperation.

Building Skills and Services

- The Witbank area should be examined closely for opportunities to absorb technology, educational personnel, equipment and other resources from entities that are closing in the Witbank area, including for example the FET College that is currently being shut down. Similarly, opportunities to absorb resources from the mine-funded hospitals and clinics should be explored.

- The development of FET colleges and similar institutions should take preference over the development of for example, a University. FET colleges can provide more applicable skills and learning opportunities to a wider variety of people than can a University.

APPENDIX 1: URBAN THRESHOLDS FOR VARIOUS FACILITIES ⁱⁱ

	FACILITY	ACCESS	THRESHOLDS
EDUCATION	Crèche or nursery school	Should be accessible by pedestrian networks Maximum travel (by foot or vehicle) 10 minutes Maximum walking distance 750 m	Estimated minimum population 5,000
	Primary school	Should be accessible by foot, bicycle and vehicle Maximum travel 20 minutes Maximum walking distance 1,5 km	Estimated minimum population 3,000-4,000
	High school	Maximum travel 30 minutes Maximum walking distance 2,25 km	Estimated minimum population 6,000-10,000
	Tertiary facilities		Age participation rates in tertiary education are below 10% in many poorer countries... The rate of 35% is considered the threshold for 'developed' countries ^{xxix} . One university per 300,000 people in the USA with an age participation rate of 50%. Population size can be less than 300,000 because adults also pursue tertiary education ^{xl} .
	Adult learning facility		"Adult learning centres are not usually provided as standalone facilities and generally 'double up' with some other form of facility (e.g. community centre).
HEALTH	Mobile clinic	Must be accessible by foot. Maximum walking distance 1 km	5,000 people
	Clinic	Maximum walking distance 2 km, but situated along a public transport route. Maximum travel time 30 min	5,000 people
	Hospital	Along public transport routes	No specific figures
COMMUNITY	Libraries	Walking distance of 1,5 km to 2,25 km. Public transport: 20-30 minutes travel time	5,000-50,000
	Community centre	Walking distance of 1,5 km to 2,25 km. Public transport: 20-30 minutes travel time	10,000 people
	Religious centres		About 2,000 people are needed to support a single church
	Municipal offices or pay points	Accessible by public transport 30 minutes travel time	50,000 people
	Post office	Walking distance of 2 km 30-40 minutes travel time	11,000 people
	Police station	Walking distance of 1,5 km 20 minutes travel time	25,000
	Fire station		60,000
	Children's home		200,000
Community information centre	1 km walking distance Accessible by public transport, 15 min travel time	22,000	

Note that the threshold population must exist within the access limits, thus giving rise to specific population density requirements. At the same time, if the settlement is to be sustainable, these thresholds must be maintained and supported.

APPENDIX 2: TYPICAL CHARACTERISTICS OF MINING / MONO-ECONOMY TOWNS

- Vulnerable to commodity prices and global economic trends^{xli}.
- Subject to “boom and bust” cycles with rapid development at first, and deterioration when the minerals are depleted or commodity prices fall^{xlii}.
- Characteristics of the “boom” phase include:

	Evident in Lephalale area?
High capital investment on infrastructure by the mining company ^{xlii}	Yes
Dramatic growth in the property market (in Burgersfort the property market has grown with 61% per year from 2003 to 2008) ^{xli}	Yes
Around 80% of residential property development by mining companies, remaining 20% by private developers ^{xliii}	Yes
Shortage of affordable housing, sharp increase in the prices of residential property	Yes
Backyard rental ^{xliv}	Unknown
Rapid increase in informal settlements	Yes
Rising crime levels ^{xlv}	Yes

- The current trend is that mining companies promote home ownership of the company-owned residential properties by selling units to employees, regardless of the fact that the mining town may not be a sustainable settlement beyond mining, and regardless of the financial pressure that a mortgage bond would put on employees if the mine closes or commodity prices tumble^{xliv}.
- Circular migration patterns - significant proportion of the population maintain households in other (mostly rural) areas, own formal housing units in these areas, and plan to return to these areas once the mine closes or when they retire.
- Social feuds exposing instability in social structures, indicative of competition among leaders to gain maximum advantage from mining development^{xlvi}.
- High dependency on the mining company for development, employment and maintenance – mono-economy driven by mining.
- Lack of entrepreneurial tradition and experience.
- Due to the high levels of support provided by the mining company, local government becomes less proactive in community development.
- Those community members who would be most able to mobilise community action and support local government, are the ones most likely to leave once the mine closes.
- Lack of a strong cohesion, due to strong “social cleavages” between those working for the mine, and those who don’t.

- Skills levels of those employed by the mine is mostly mining-specific, and employees would experience difficulty to be employed in another sector if the mine close or scales down operations^{xlvii}.
- Economic diversification is often repressed due to:
 - Small population,
 - Remote location,
 - Unproductive areas surrounding the mine,
 - Perceived success of employment by the mine, as opposed to available alternatives, and
 - Authoritarianism of mine management.
- Municipalities often experience difficulty to plan in an integrated manner, due to:
 - The “boom-bust” nature development in a mining town (don’t want to invest too much capital in an unsustainable settlement), and
 - Lack of information on mine planning with regard to expansion or closure (hence hard to plan for land availability, bulk and internal infrastructure)^{xlviii}.

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