CHAPTER 14

Visual, Aesthetic and Scenic Resources

CHAPTER 14: VISUAL, AESTHETIC AND SCENIC RESOURCES

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Executive Summary

Concern has been expressed by many about the possible visual effect of shale gas development (SGD) on the character of the Karoo landscape, its sense of place and on tourism in the area. Further reference to these concerns is covered in Chapter 9 on tourism (Toerien et al., 2016), Chapter 11 on social fabric (Atkinson, *et al.*, 2016) and Chapter 13 on sense of place values (Seeliger et al., 2016) of this scientific assessment report. SGD activities could affect scenic resources, the amenity value of recreation and resort areas, property values and subsequently the economy of the region, an aspect covered in Chapter 10 on economics (Van Zyl et al., 2016). Taking these concerns into account, the importance of visual, aesthetic and scenic considerations is stressed in Section 14.1.

This visual study focuses on spatial aspects relating to the distribution of scenic resources and sensitive receptors and the possible effects and risks that would arise as a result of SGD. Being a strategic visual assessment at a regional scale, the desktop study did not involve fieldwork, but instead relies on available information and the knowledge of the study area by the authors. It is important therefore that a more detailed visual assessment is carried out during the Environmental Impact Assessment (EIA)/project phase at the local scale. In the context of the Karoo study area, landforms tend to play a major role in the mapping of scenic resources at the regional scale as outlined in Section 14.2. For example, the escarpment, which roughly traverses the middle of the study area, is a major feature of visual significance.

Four scenarios are assessed, ranging from Scenario 0) the Reference Case, with no further exploration, Scenario 1) Exploration Only, Scenario 2) Small Gas and Scenario 3) Big Gas. It is anticipated that the greatest visual impacts would occur during the construction and drilling phases, which although short-term, will re-occur as new wells are opened up. With eventual decommissioning, the study area could be restored to a partly natural state over time, with reduced visual effects, taking into account the challenge of landscape rehabilitation in arid environments.

The geology of the Karoo has a profound influence on landscape characteristics within the study area, with seven landscape types being identified, ranging from the arid Ceres-Tankwa Karoo in the west to the more watered grasslands of the Eastern Plateau area, as outlined in Section 14.3. Scenic resources, such as important topographic features and cultural landscapes, as well as sensitive receptors, such as those relating to National Parks, nature reserves, human settlements and major routes have been identified. Visual buffers for each of these were determined in order to prepare a combined visual sensitivity map with *high*, *moderate* and *low* visual sensitivity zones. Zones of high scenic value seem to correlate with those of high biodiversity and heritage value.

Potential visual impacts resulting from the proposed SGD can be managed to a limited degree through a range of avoidance, mitigation and offset measures. Avoidance measures involve the protection of valuable scenic resources, including the use of visual buffers. Mitigation measures are mainly project-related, such as the control of construction activities and minimising the visual intrusion of structures in the landscape. Finally, offset measures involve compensation in one form or another for the visual intrusion caused by SGD and possible loss of scenic resources. A possible offset is the creation within the study area of a scenic wilderness corridor forming a linked system of protected landscapes. A risk assessment matrix in Section 14.4, both *without* and *with* visual mitigation, for the four scenarios, would be combined with risks identified in other Chapters, to inform possible future SGD.

National, Provincial and Local Government need to prepare for future possible SGD in South Africa in order to conserve scenic resources and protect visually sensitive receptors. Best management practices to minimise potential visual impacts have been gleaned from similar activities in South Africa and from overseas studies on SGD. These are outlined in Section 0 for the exploratory, development, rehabilitation and monitoring stages.

The level of information relating to scenic resources needs to be addressed; there being no comprehensive or standardised baseline or grading system currently in South Africa, nor fine-scale mapping for the study area. Additional information is required in particular for cultural landscapes and for private reserves, game farms and resort or tourism-related amenities that could be affected, as indicated in Section 14.6. An assessment of cumulative impacts would require information on the location and density of proposed SGD in relation to other existing and proposed activities, such as wind and solar energy developments, as well as uranium mining.

CHAPTER 14: VISUAL, AESTHETIC AND SCENIC RESOURCES

14.1 Introduction

14.1.1 Relevance of the visual study

Much of the current opposition to shale gas development (SGD) in the Karoo can be attributed to the perception that the character of the landscape will be significantly altered, particularly the Karoo's unique sense of place. This includes its sense of expansiveness, emptiness, silence and dark starlit skies at night (see Toerien et al., 2016; Atkinson et al., 2016; and Seeliger et al., 2016).

SGD activities, and their related infrastructure, tend to have an industrial connotation and could potentially compromise the iconic scenic characteristics of the Karoo, the subject of this Chapter, and the more abstract sense of place characteristics, the subject of Chapter 13 (Seeliger et al., 2016) of this report. These effects on scenic resources would be particularly felt in pristine or protected landscapes, while they may be less of an issue in previously disturbed areas. Wind and solar energy projects, along with electrical infrastructure, have already transformed some parts of the Karoo.

SGD could in addition detract from the amenity value of recreation or resort areas, and affect property values in some cases, all of which could affect the economy of the region (Van Zyl et al., 2016). Scenic resources, particularly in relation to national parks, game farms and other visitor destinations, have important economic value in the form of tourism for the Western, Northern and Eastern Cape Provinces.

The siting of the SGD activities therefore has implications for not only the scenic resource base (the receiving environment), but also for the community and the tourism industry (the receptors). The purpose of this strategic level visual assessment is to identify scenic resources at the regional scale, as well as potential sensitive receptors that could be affected, and to recommend measures to avoid, mitigate or offset possible adverse effects.

14.1.2 International and national context

SGD have been in progress in North America for some time, where a great deal of experience and precedent can therefore be derived. Europe, Australia and China on the other hand still appear to be in the early stages of developing regulatory frameworks for their respective shale gas industries (see Scottish Government, 2014). One of the challenges for the current study is that there is no precedent for SGD in South Africa as yet, which means that the potential effects are largely unknown, particularly with regard to changes in landscape character, and therefore many of the inhabitants are understandably nervous.

A notable difference between SGD in the forested biomes of the Northern Hemisphere and South Africa, from a visual perspective, is that the forested landscapes tend to be more visually absorptive than the arid Karoo landscape, which is more visually exposed and where the vegetation does not recover easily. Even though it is a harsh environment in which to live and farm, there is a great deal of romanticism surrounding the Karoo's serene, uncluttered '*vlaktes*', brilliant starlit skies and fresh air on which local eco-tourism is founded. This is partly in contrast to say Texas, in the United States (US), where oil wells and shale gas production have been in existence for some time, and the local population have become more used to the visual effects of these activities.

The proposed SGD would take place in a partly rural or wilderness type Karoo landscape, which except for centuries of grazing and widely spaced settlements, is largely unaltered and still retains its pastoral character. SGD could

GLOSSARY

Cultural landscapes	Human-modified landscapes, particularly those of aesthetic, historical or archaeological significance.
Cumulative impacts	The combined or incremental effects resulting from changes caused by a proposed development in conjunction with other existing or proposed activities.
Geomorphological features	Landforms derived from geological formations resulting in particular topographical characteristics.
Landscape typology	The classification of the landscape into units, each unit having typical physiographic or scenic characteristics.
Offsets	Measures to compensate or provide restitution as a result of adverse impacts.
Sense of place	The unique or special qualities found in a particular location, including the combined natural, cultural, aesthetic, symbolic and spiritual qualities.
Receptors	Viewers who would be affected by a proposed development, the viewers usually being residents, commuters, visitors or tourists.
View corridor	A linear geographic zone, usually along movement routes such as trails, roads and railways, visible to users of the routes.
Viewshed	A geographic zone encompassing a view catchment area, usually defined by ridgelines, similar to a watershed.
View shadow	A zone within the view catchment area that is visually obscured from the proposed development by the topography, trees or structures.
Visual buffer	A geographic zone of varying distance, indicating visual sensitivity or visual constraints for proposed development or activities.

potentially compete in places with grazing and game farm related tourism within the study area. The cumulative visual impacts of SGD activities in combination with wind and solar energy projects, is a possible concern.

14.2 Scope of the visual strategic issue and its links to other strategic issues

14.2.1 Visual Parameters

Visual-aesthetic issues are concerned with the scenic integrity of natural landscapes (environmental health) on the one hand and the psychological sense of wellbeing or 'quality of life' (human health) on the other. Visual assessments by their nature encompass both tangible and more abstract qualities of the landscape, resulting in a degree of subjectivity, with cultural undertones. This visual study focuses on spatial aspects relating to the distribution of scenic resources and sensitive receptors, while 'sense of place' is the subject of the Chapter 13 (Seeliger et al., 2016) of this report.

Visual and scenic qualities are determined by both landscape and cultural characteristics within the study area including, but not restricted to, topographical and geological features, vegetation patterns, land use activities and settlement forms (Oberholzer, 2005).

A definition of visual:
The term 'visual' broadly includes visual, scenic, aesthetic and amenity values, which contribute to an area's overall 'sense of place', and which encompass both natural and cultural landscapes.

The Visual Chapter, being part of a scientific assessment, is a desktop study and did not involve field work to ground-truth scenic resources, but instead relies on the knowledge and experience of the authors, and on available literature. Furthermore the study area is regional in scale, involving scenic resources at a broad spatial level. During the Environmental Impact Assessment (EIA) or project phase, a more detailed visual assessment would be required at the local scale involving, amongst others, viewshed analyses.

At the regional scale of the study area, landforms such as mountain ridges, escarpments and dolerite '*koppies*' play a dominant role in the mapping of scenic resources. Vegetational differences and land uses tend to only become meaningful at the local scale and have therefore not been considered in the current visual sensitivity mapping. Although vegetation, in combination with topography, provides a visual backdrop, the generally stunted nature of Karoo vegetation provides little visual screening.

14.2.2 Visual Assessment Considerations

No standardised approach to visual quality or even scenic resource mapping exists for the country as a whole at present, or for the rating of scenic resources in terms of their sensitivity or significance. Some work on this has been done for the Western Cape Province (Winter and Oberholzer, 2013). Furthermore, there is no specific legislation relating to the protection of scenic resources in South Africa at present, except for the NEMA and National Heritage Resources Act (see Box below).

Instrument	Key objective
National Instrument	
National Environmental Management: Protected Areas Act, 2003 (NEMA)	The Minister/MEC may restrict or regulate development in a 'protected environment' that may be inappropriate for the area given the purpose for which the area was declared (Section 5).
National Heritage Resources Act (Act 25 of 1999) NHRA)	Includes protection of national and provincial heritage sites, as well as areas of environmental or cultural value, and proclaimed scenic routes.
Provincial Instrument	
Protected Areas Act (PAA) (Act 57 of 2003, Section 17)	Local authority zoning schemes can be used to protect natural and cultural heritage resources through 'Conservation Areas', 'Heritage Overlay Zones' and 'Scenic Overlay Zones' including scenic routes.

In the assessment of scenic value, aspects such as landscape complexity and topographical diversity of the landscape are often considered. This is not to say that the open plains of the Karoo are without scenic value, but that they tend to be enhanced through contrast with surrounding landforms. Visual variety and scale tend to be important ingredients, particularly at the interface between landforms. Aesthetic perception is an elusive science, but coherence, legibility, complexity and mystery are some of the universal factors considered (Bell, 2012).

Another consideration in determining scenic value is the level of 'landscape integrity' or intactness, as opposed to disturbed or degraded natural and cultural landscapes. However, this is difficult to determine in a desktop study at the regional scale, and would instead be mapped at the local project scale, usually as part of a Visual Impact Assessment (VIA).

In determining 'visual sensitivity' for SGD, the authors adopted a similar approach to that used in other regional-scale scenic studies (Lawson and Oberholzer 2014, 2015). This allowed a common database and sensitivity analysis to be used covering fairly similar geographical areas. The advantage of this approach is that it provides consistency in assessing competing land uses.

14.2.3 Links to other strategic issues

The Chapter on visual issues is closely linked to that of Chapter 15 on heritage (Orton et al., 2016), taking in both natural and cultural landscapes. These include protected landscapes and heritage resources, which because of their legal status; tend to have increased visual significance.

Similarly, a close connection between the Chapters on visual impacts and sense of place values (Seeliger et al., 2016) exists, adding the dimension of 'landscape meaning', with particular reference to the Karoo. Because of the relationship to human perception and values, there is a connection to the social fabric Chapter (Atkinson et al., 2016). The Noise Chapter (Wade et al., 2016) has relevance in that noise resulting from SGD activities can adversely affect sense of place. The combination of these factors, seen together, all have potential implications for the Tourism Chapter (Toerien et al., 2016). Interestingly, the zones of high scenic value correlate fairly closely with those of high biodiversity (Holness et al., 2016) and heritage value (Orton et al., 2016).

14.2.4 Assumptions and Limitations

Being strategic in nature, the current visual aesthetic study makes use of broad baseline information, resulting in a number of assumptions and limitations listed in the Box Below.

Limitation	Included in the scope of this study	Excluded from the scope of this study	Assumption
Level of mapping detail	1: 500 000 topographical maps and 1:1 000 000 geological survey maps.	1:250 000 and 1:50 000 topographical maps.	More detailed 1:50 000 maps and aerial imagery would be used for local or project scale assessments.
Information on cultural landscapes	Included where known from previous studies.	Cultural and heritage sites.	Heritage information and mapping provided in Chapter 15 (Orton et al., 2016).
Information on private reserves, game/guest farms and resorts.	Information was included where these facilities were known.	Detailed survey of private reserves / game farms.	Detailed information would be needed at the project scale.
Viewsheds of National Parks and nature reserves	Viewsheds of SKA and SALT astronomical sites.	No viewsheds for individual features or visual receptors.	Viewshed mapping would be needed at the project scale.

14.2.5 Description of Shale Gas Development

Visually significant components of the proposed SGD are listed below for each of the scenarios, as described in Chapter 1 (Burns et al., 2016). Only those components that could have a visual effect on scenic resources or receptors within the study area are indicated in Table 14.1,Table 14.2Table 14.3, below. The four scenarios that are being considered are as follows:

Scenario 0: Reference Case
Scenario 1: Exploration Only
Scenario 2: Small Gas
Scenario 3: Big Gas

Table 14.1: Components associated with the Exploration Only scenario that could have a visual effect on scenic resources or receptors within the study area.

Activity / facility	Footprint	Height	Visual implications
Seismic exploration:			
Clearing of seismic lines 0.25 to 10 km spacing	Up to 2 000 km. ± 5 m width	n/a	Short-term vegetation clearing for pedestrian and light vehicular access. Limited visual effect.
Seismic equipment	4x vibreosis trucks 1x auger drilling truck Plus other trucks	± 3m	Short-term at each site (2-3 years total). Also has noise emissions; especially shot point method (90 dB). Limited visual effect. 12 - 24 hour operation.
Drilling exploration:			
5 drilling rigs (1 rig per campaign)	Part of wellpad	40m	Medium-term 5-10 years. Significant visual effect because of height. Also noise emissions (90 dB) 24hrs.
30 wellpads (6 wellpads per campaign)	2 ha/wellpad total: up to 120 ha	n/a	Includes drilling rig, prefabricated offices, storage tanks, parking, laydown area, stockpiles.
5 crew accomm. Camps (1 camp per campaign)	1 ha/camp total: 5ha	± 3m	Footprint could be slightly less. Probably prefabricated units.
Access roads	1 km/wellpad total: 30 km	n/a	Probably gravel surface. Limited visual effect of roads, but potentially significant effect of dust from truck traffic.
Wellpad lighting	For 30 wellpads	unknown	24 hour operational/security lighting. Directed to wellpad footprint. Visual effect at night, especially in the dark Karoo sky.
Flaring during flow-testing	For 30 wells		Approximately 30 days per well.
Total exploration area within the study area	Notional 30 x 30 km target area. Total: 5 target areas		Actual footprint of exploration area < 5% of target area. Target areas not known. Potentially scattered effect. 5 drilling campaigns assumed.

Table 14.2: Components associated with the Small Gas scenario that could have a visual effect on scenic resources or receptors within the study area.

Activity / facility	Footprint	Height	Visual implications
3 drilling rigs	Part of wellpad	40 m	Increased visual effect because of height, but short-term. Noise emissions (90 dB) 24 hours.
55 wellpads	2 ha/wellpad total: up to 220ha		Wellpad includes drilling rig, prefab offices, storage, parking, laydown area, stockpiles. Construction period 5-10 years.
550 production wells	10 wells per wellpad		Drilling short-term, with ongoing production long term, 10-30 years.
1 crew accommodation camp	1 ha	± 3 m	Refurbished exploration camp. Probably prefabricated units. Moderate visual effect.
Access roads	0.5 km - 1 km/wellpad total: 27.5+ km	n/a	Probably gravel surface. Moderate visual effect of roads. Significant effect of dust and noise from truck traffic.
Wellpad lighting	For 55 wellpads.	unknown	24hour operational/security lighting. Visual effect at night in dark Karoo sky.
Flares during drilling and well-flow testing	For 55 wellpads	unknown	Installed for safe shutdown or routine maintenance. Short-term visual effect.
Gathering and export pipeline network	Length unknown	n/a	Some visual effect during excavation, (short-term), if below ground. Mainly located in road reserves.
Gas processing plant, incl. compressor station	Number and footprint unknown	unknown	Long-term. Significant visual effect depending on scale and height. Visual effect of flares at night on dark Karoo sky.
1 CCGT power station 1000 MW. (within 100km of production block)	total: 15 ha	unknown	Long-term. Significant visual effect depending on scale and height. Connecting substation and powerline would be needed.
Initially 1 production block assumed.	Notional 30 x 30 km production block.		Potential scattered effect of wellpads and access roads. Target areas not known.

Table 14.3: Components associated with the Big Gas scenario that could have a visual effect on scenic resources or receptors within the study area.

Activity / facility	Footprint	Height	Visual implications
20 drilling rigs	Part of wellpad	40 m	Short-term at each wellpad. Longer-term in the production blocks. Increased visual effect because of height. Noise emissions (90 dB) 24 hours.
410 wellpads	2 ha/wellpad total: up to 1640ha		Includes drilling rig, prefabricated offices, storage, parking, laydown area, stockpiles.
4100 production wells	10 wells per wellpad		Drilling short-term, with ongoing production long-term, 10-30 years.
8 crew accommodation camps	1 ha/camp 2 camps per block total: 8 ha for 4 blocks	± 3m	Refurbished exploration camp. Probably prefabricated units. Moderate visual effect.
Access roads	0.5 – 1 km km/wellpad total: 205+ km	n/a	Probably gravel surface. Regular truck traffic. Potentially significant visual effect because of high density of roads and dust generation, particularly when seen from high points in the landscape.
Wellpad lighting	For 410 wellpads.	unknown	24 hour operational/security lighting. Significant visual effect at night on dark Karoo skies.
Flares during drilling and well-flow testing	For 410 wellpads	unknown	Installed for safe shutdown or routine maintenance. Short-term visual effect.
Gathering and export pipeline network	Length unknown	n/a	Some visual effect during excavation, (short-term, if below ground, but over a large distance). Mainly in road reserves.
Gas processing plants, incl. compressor stations	Number and footprint unknown	unknown	Long-term. Potentially significant visual effect depending on scale and height. Visual effect of flares at night in dark Karoo skies.
2 CCGT power stations 2000 MW each.	total: 30 ha Incl. upgrade of power station in Scenario 2.	unknown	Long-term. Significant visual effect depending on scale and height). Connecting substations and powerlines would be needed.
Total of 4 production blocks assumed.	Notional 30 x 30 km production block		Includes the single block for the Small Gas scenario.

14.2.6 Contributory factors in visual assessments

An indication of the scale of a typical wellpad with a drilling rig of 40 m, seen at a range of viewing distances, during the day or night, is given in Figures 14.1 to 14.7. The model indicates that the wellpads during drilling operations could be highly visible in the viewer’s frame of vision up to 2 km during the day, moderately visible from 2 to 5 km, and marginally visible beyond 5 km, depending on light conditions, background etc. The visibility of lights and flares at night, including ambient sky-glow, are potentially visible over greater distances in dark rural landscapes.

The figures are hypothetical, assuming a flat landscape, and although this provides some idea of the visibility of the wellpad, there are other contributory factors, such as skyline effects (where the wellpad is seen in silhouette against the skyline), which could emphasise the visibility of structures. Background topography or vegetation, and topographic complexity, could on the other hand reduce the potential visibility of structures in the landscape, especially at a distance. The landscape setting is another factor, with rural landscapes being more susceptible to visual impact than say industrial landscapes or the presence of other visual distractions. Scenic landscapes, (such as mountain passes), would be visually sensitive, particularly if they have heritage or tourism value. Finally, national parks and nature reserves are visually sensitive to even distant views, if their intention is to offer a wilderness experience. Therefore, although distance has a correlation with diminishing visibility, this does not imply that distant views of the wellpads (and other related activities) are always insignificant.

The contributory factors mentioned above were taken into consideration in determining visual sensitivity buffers and setbacks, described in Section 14.3.3 and Table 14.6, and in the visual sensitivity mapping. From the description of the scenarios in the tables above it is anticipated that the greatest visual impacts would occur during the construction and drilling phases, which although they occur over a short time period, will re-occur as new wells are opened up. Once the drilling rigs are removed the visual effect will be partly reduced, although tanks, access roads and other infrastructure would still be visible. During the decommissioning phase the site could be restored to a partly natural state over time, with reduced visual effects, taking into account the challenge of landscape rehabilitation in arid environments.

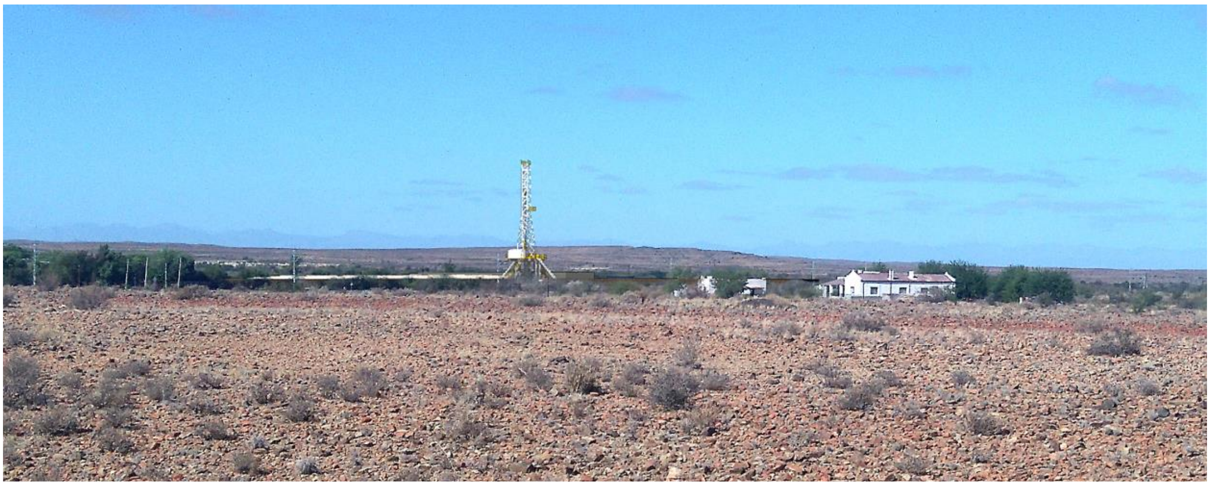

Figure 14.1: Visual simulation of a wellpad in a Karoo landscape at a distance of about 300 m. The adjacent farmhouse gives an indication of the scale of the drilling rig.

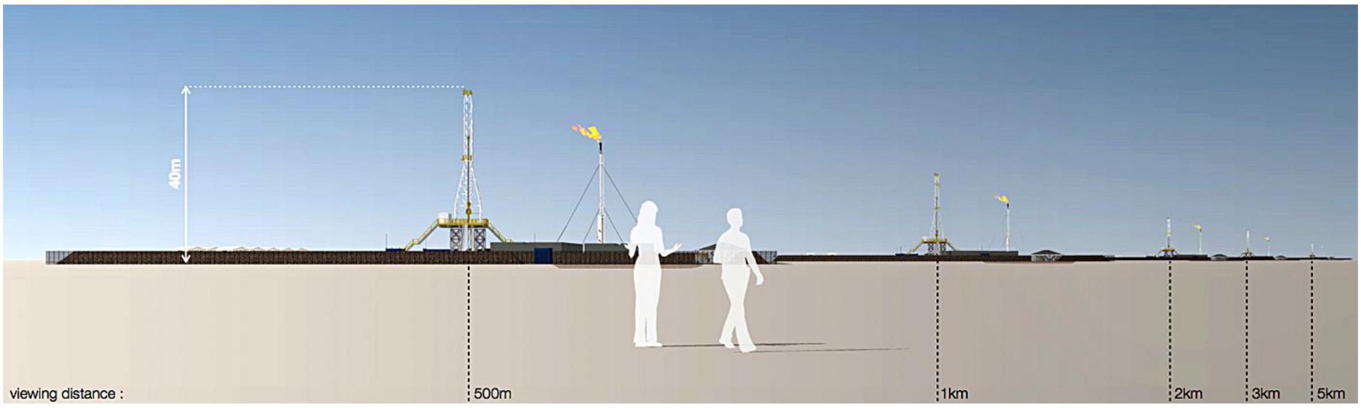

Figure 14.2: Visual simulation of a wellpad during the day indicating visibility at a range of distances from 500 m to 5 km in a flat landscape.

Figure 14.3: Visual simulation of a wellpad at night indicating visibility at a range of distances from 500 m to 5 km, (before mitigation). Visibility of lights and flares would tend to be pronounced in the dark rural landscape of the Karoo.

Figure 14.4: Wellpad with drilling rig (earthtimes.org)

Figure 14.5: Wellpad with drilling rig at night *(processingmagazine.com)*

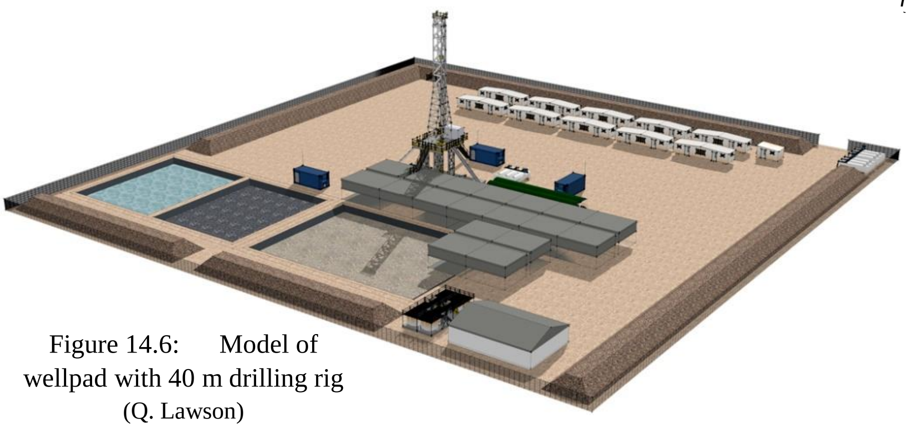

Figure 14.6: Model of wellpad with 40 m drilling rig (Q. Lawson)

Figure 14.7: Typical wellpad with drilling rig (rspb.org.uk)

14.3 Visual Sensitivity Evaluation

14.3.1 Visual characteristics of the study area

As previously indicated; landforms play a major role in determining scenic resources at a regional scale, with geology having a profound influence on landscape characteristics and therefore landscape typology. This is particularly true in the Karoo where the sparse vegetation means that the rock formations often stand out as features of interest. These geological features are described and celebrated in a number of publications (Norman and Whitfield 2006, Norman 2013).

Using a physiographic approach for landscape evaluation (Zube 1970), seven broad landscape scenic units were identified within the study area, each with their own landscape characteristics and range of significant visual features (Table 14.4). Many of these are also recognised on survey maps as distinct sub-regions, such as the Ceres-Tankwa Karoo (Figures 14.8 to 14.10).

Table 14.4: Landscape units, landform types and significant features within the study area.

Landscape Scenic Unit	Landform Type	Significant Visual Features
1. Ceres-Tankwa Karoo: Ecca Group shales with alluvium along drainage courses.	Broad, low-lying plain in the south-western part of the study area, Arid, flattish landscape with few topographic features.	The Groot, Tankwa and several other rivers (mainly dry) are the main features. The Tankwa Karoo National Park and dolerite koppies occur to the north.
2. Roggeveld-Nuweveld Mountains: Beaufort Group mudstones and sandstones	Steep escarpment and rugged mountainous terrain, the resistant sandstones forming the ridges and the mudstones in the lower lying areas. Includes the Moordenaars Karoo.	Visually sensitive scarp face and mountain ridges, as well as the SALT observatory near Sutherland. Karoo National Park and several scenic routes and mountain passes.
3. The Koup-Vlaktes-Camdeboo Plains: Beaufort Group and some Ecca Group to the south	Generally flat, arid and featureless plains with occasional dolerite dykes to the north.	Traversed by the N1, N12 and N9 National Roads, which are visual corridors. Large pans south of Beaufort West.
4. Great Fish River Valley: Ecca Group shales and Beaufort Group mudstones/sandstones	A dissected river plain in the softer Ecca shales, with gently rolling ridge and valley type topography.	Meandering Great Fish River, Sundays River and several tributaries. Addo Elephant National Park lies to the south.
5. Sneeuberg-Winterberg Mountains: Beaufort Group mudstone and dolerite intrusions	Mountainous area with high peaks over 2000m, created by the alternating sandstones and mudstones, and dolerite sills and dykes.	Camdeboo National Park, Mountain Zebra National Park. Numerous scenic *poorts* and mountain passes.
6. Great Karoo Plateau: Ecca and Beaufort Group shales and mudstone with dolerite intrusions	Vast arid and largely flat plains of the Great Karoo from Calvinia in the west to Richmond in the east.	Largely featureless, with some dolerite ridges and outcrops. Visually sensitive SKA observatory to the north. Dark skies at night.

Landscape Scenic Unit	Landform Type	Significant Visual Features
7. Eastern Plateau and Foothills: Beaufort Group sandstones and mudstones with prominent dolerite dykes and sills.	Grassy plains and mountains to the east, stretching from Middelburg to Queenstown. Higher rainfall than the west.	Scenic doleritic landforms with steep cliffs. Numerous scenic *poorts* and mountain passes.

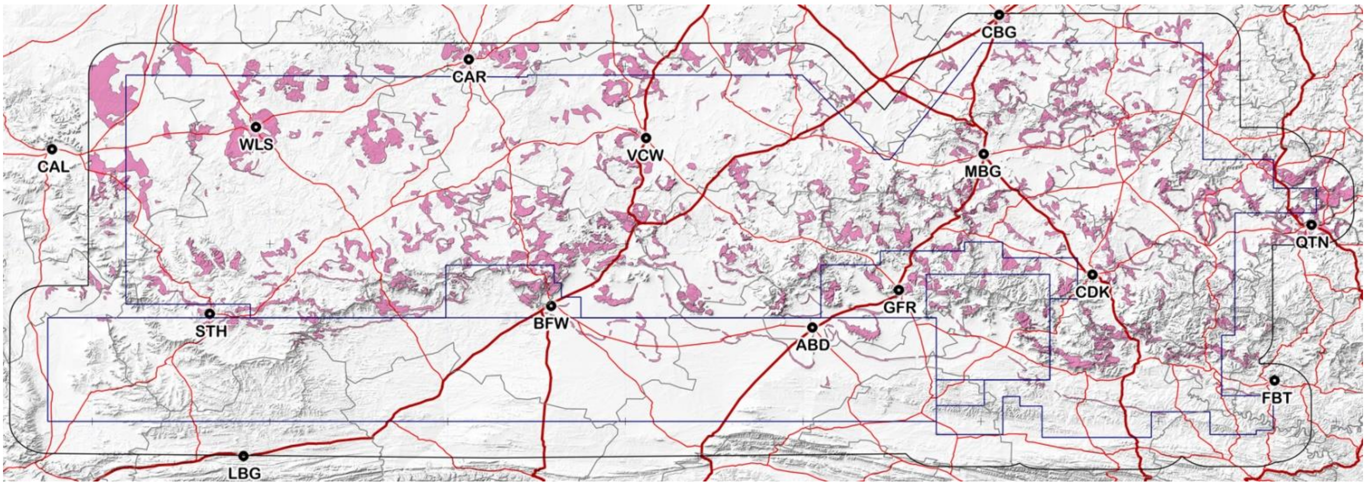

Figure 14.8: The distribution of dolerite dykes and sills in the study area have a strong influence on landscape topographic features, particularly to the east.

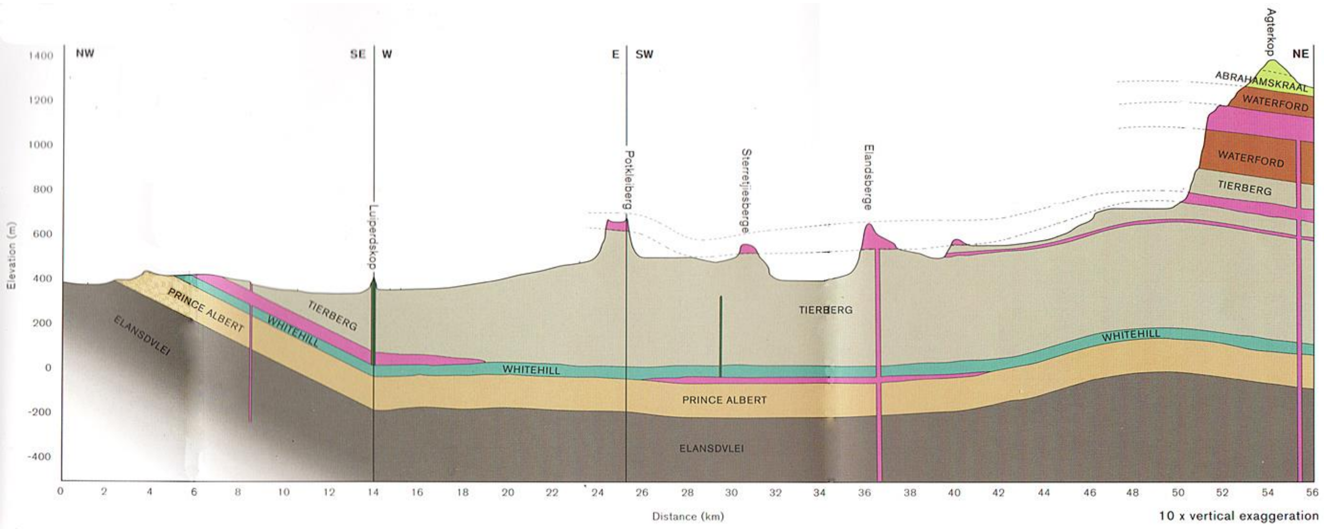

Figure 14.9: A typical section through the Tankwa Karoo indicating the influence of the dolerites (in pink) on the Karoo landscape and the shale gas formations at depth.

(Source: Rogers, J. and Smith, G. Undated. South African National Parks, 'Around the Tankwa Karoo National Park: A field guide to the geology and landscape').

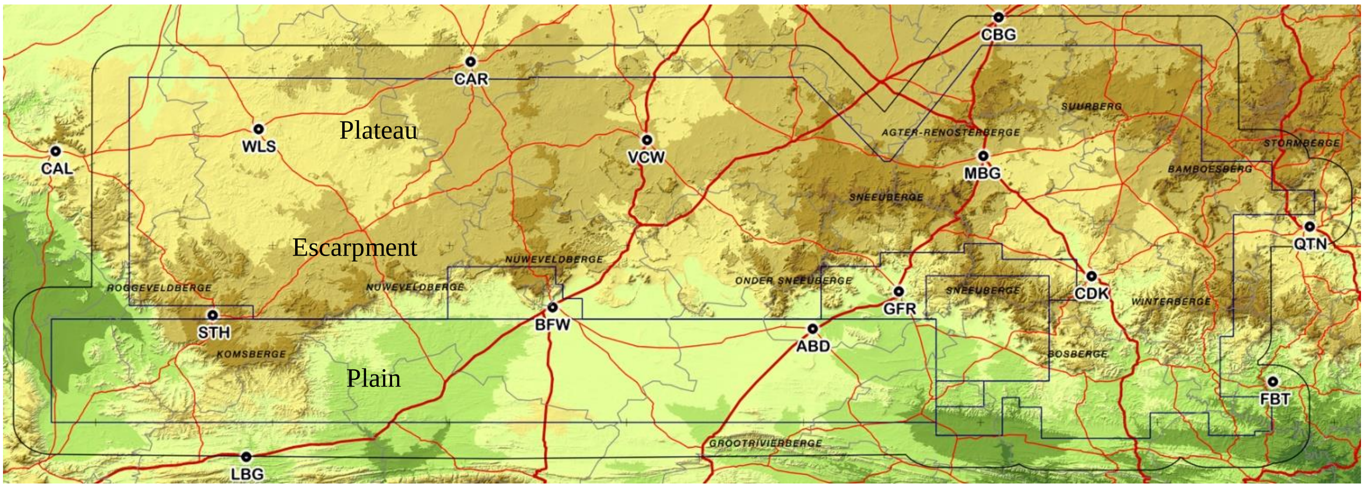

Figure 14.10: The physiography of the study area indicating the inland plateau to the north, the escarpment and mountains across the middle, and the lower-lying plains to the south.

14.3.2 Scenic resources and sensitive receptors

Aspects that play a role in visual assessments can be divided into *scenic resources* and *sensitive receptors*, as listed in Table 14.5 below, along with notes on the factors that influence their visual significance. Heritage sites have not been included here as they form part of Chapter 15 (Orton et al., 2016), although they can add to visual sensitivity.

Table 14.5: Contributing factors to visual sensitivity.

Scenic Resource	**Contributing Factors**
Topographic features (scenic units 2 and 5)	Includes features that provide interest or contrast in the generally flat Karoo landscape such as mountain peaks, escarpment rims, steep cliffs, dolerite rock outcrops or ridgelines (visually sensitive skylines), within the Roggeveld-Nuweveld Mountains, and the Sneeuberg-Winterberg Mountains.
Major rivers, water bodies, wetlands (scenic unit 4)	Water represents the lifeblood of the arid landscape, particularly in the Karoo, where it has high scenic, recreational and agricultural value. Even springs (*fonteine*), farm dams and wetlands are significant features in the arid landscape.
Cultural landscapes	Includes mainly patches of cultivated or grazing land, often along rivers in the dry Karoo landscape, notable for their rural scenic value and historical or cultural significance. Could also include proclaimed heritage sites, and important archaeological or spiritual sites relating to pre-colonial cultures.
Sensitive Receptors	(includes residents, commuters, visitors and tourists)
National Parks	Usually have scenic attributes in addition to their biological conservation role. Serve as visitor/tourist destinations. Visual significance is increased by their national protection status and visual sensitivity of visitors. Sensitive to loss of wilderness quality.
Nature Reserves	Similar scenic attributes to those of National Parks. Conservation, recreation and tourism importance. Visual significance is increased by their legislated provincial and

Scenic Resource	Contributing Factors
	municipal protection status.
Private reserves/resorts	Includes private nature reserves, game farms, recreation resorts and tourist accommodation, all of which tend to be sensitive to loss or degradation of scenic quality from visual intrusions.
Human settlements	Includes towns, villages and farmsteads where residential areas are particularly sensitive to visual intrusions, which could have an important effect on property values.
National and Provincial roads	Includes all major arterial routes which serve local and regional users for commuting, recreation and tourism, and which are visually sensitive within their view corridors.
Scenic routes and passes	Includes mountain passes and *poorts* which tend to have historical, recreational and tourism importance within the region. These are sensitive to visual intrusions along view corridors.
Passenger rail lines	Serve both commuting and tourism functions, and as in the case of roads, they are sensitive to visual intrusions along view corridors.
SA Large telescope (SALT)	Subject to core and central Astronomy Advantage Area regulations. Particularly sensitive to visual intrusions, including lights at night. Integrity of the viewshed is important.
Square Kilometre Array (SKA)	Subject to core and central Astronomy Advantage Area regulations. Radio astronomy particularly sensitive to electromagnetic intrusion. Requires a 'Radio Quiet Zone' (RQZ).

14.3.3 Visual sensitivity and visual buffers

The key scenic resources and visually sensitive receptors within the study area, within high, moderate and low visual sensitivity zones, are given in Table 14.6 below. In addition, visual buffers are indicated in response to the sensitivity zones (see Figures 14.11 and 14.12).

These buffers are seen as nominal distances for regional scale mapping and could be amended as more information becomes available at a detailed local scale. The buffers are not intended to be exclusion zones or prescriptive setbacks, but merely serve as indicators for the visual sensitivity mapping. The distinction between buffers, setbacks and exclusion areas, for the purpose of this study, is indicated in the box below (see NSW Government 2014).

Visual buffer zone	A nominal geographic area of visual sensitivity at the regional scale. Does not imply specific restrictions but could trigger the need for an EIA/VIA at the project scale.
Visual setback	A defined geographic area within which activities are regulated through bylaws or approval conditions at the EIA level. Implies specific restrictions for the siting of development.
Visual exclusion zone	A defined geographic area within which specific activities are excluded or prohibited.

At the project planning stage visual buffers could serve as a general guide, or even as a default setback, but could be reduced if the SGD activities are located outside the local viewshed or in a view shadow. Specific setbacks could be prescribed at the EIA or permitting stage of a project on a case by case basis. Furthermore, where SGD is proposed within the visual buffer zones, this could become a trigger for an EIA or Heritage Impact Assessment (HIA), including a visual assessment.

Another factor that needs to be taken into account is that setbacks at the project scale may vary depending on the scale of the infrastructure, such as large-scale wellpads, drilling rigs and gas processing plants, and smaller-scale, less visible access roads and pipelines.

A literature search revealed that there is limited information on visual buffers for scenic resources, particularly in relation to SGD, and neither is there any consistency among the various international jurisdictions or authorities. Certain states in Australia have legislated a 2 km distance between gas industries and residential areas, while in other countries it can range from 50 m to 2 km (NSW Government 2014). These are, however, usually related to noise and hazards rather than visual considerations.

The visual buffers listed in Table 14.6 below were derived partly from the contributory factors in Section 14.2.6 above, and partly from the authors’ experience with similar regional-scale SEA projects (Lawson and Oberholzer 2014, 2015), where buffers were formulated for visual sensitivity mapping purposes.

The buffers relate mainly to the scale (and height) of the shale gas wellpads and related infrastructure, which could be distributed over a wide geographic area. Less is known about the gas processing plants and power station/s, which are site-specific and would require viewshed mapping. Some of the proposed visual buffers correlate closely with the recently gazetted Regulations for Petroleum Exploration and Production (Government Gazette, 3 June 2015), indicated in the Box below.

Setback regulations for protection of water resources (Government Gazette, 2015):

Distance between wellpad and municipal wellfield (water supply)	5 km
Distance between directional drilling and municipal wellfield	2.5 km
Distance between wellpad and existing water borehole	500 m
Distance between wellpad and riparian area or 1:100 year floodline	500 m
Distance between wellpad and a wetland	1 km

Table 14.6: Visual buffers in relation to visual sensitivity mapping.

Scenic Resources	High visual sensitivity zone	Mod. visual sensitivity zone	Low visual sensitivity zone	Criteria
Topographic features (mountains, scarps, steep slopes, geological features)	within 500 m	within 1 km	beyond 1 km	Relates to significant landscape features of scenic or natural heritage value. Distances relate to scale and importance of the feature, subject to a VIA, where applicable.
Major rivers, water bodies (vleis, wetlands, dams, pans)	within 500 m	within 1 km	beyond 1 km	Scenic and recreation value. Distances similar to those in the gazetted Petroleum Regulations for protection of water resources.
Cultural landscapes (incl. cultivated lands)	within 500 m	within 1 km	beyond 1 km	Rural scenic value and possible historical or heritage value. Subject to a HIA where applicable.
Sensitive Receptors / Protected Landscapes				
National Parks	within 5 km	within 7.5 km or viewshed	beyond 7.5 km	High wilderness and scenic value, including dark skies at night. Sensitive tourist receptors. Protected by National Parks legislation.
Nature Reserves (Provincial and Municipal reserves)	within 5 km	within 7.5 km or viewshed	beyond 7.5 km	Wilderness and scenic value, including dark skies at night. Sensitive visitor receptors. Protected by ordinances and local bylaws.
Private reserves (incl. game farms, tourist accommodation)	within 2.5 km	within 5 km or viewshed	beyond 5 km	Wilderness and scenic value. Sensitive visitor receptors. Important for local tourism industry. Subject to a Social Impact Assessment (SIA) where applicable.
Human settlements (towns and villages, excl. farmsteads, rural kraals)	within 5 km	within 7.5 km or viewshed	beyond 7.5 km	Visually sensitive residents and visitors. Relates to property values. Subject to Integrated Development Plans, zoning schemes and bylaws.
National and Provincial roads (major arterial routes)	within 1 km	within 2.5 km	beyond 2.5 km	Visually sensitive commuters, residents and visitors within the view corridor. Distances subject to a VIA with viewshed mapping, where applicable.
Scenic routes, mountain passes and *poorts*	within 2.5 km	within 5 km or viewshed	beyond 5 km	Visually sensitive visitors and tourists within the view corridor. Possible historical or heritage value. Distances subject to a HIA or VIA with viewshed mapping.
Passenger rail lines (commuter and tourist routes)	within 1 km	within 2.5 km	beyond 2.5 km	Visually sensitive commuters and tourists within the view corridor. Distances subject to a VIA with viewshed mapping, where applicable.
SA Large telescope (SALT)	within 15 km viewshed	within 30 km viewshed	beyond 30 km viewshed	Subject to gazetted Astronomy Advantage Area legislation. Involves avoidance of light pollution. Distances subject to a VIA with viewshed mapping.
Square Kilometre Array (SKA)	within 7.5 km of antennae	within 15 km of antennae	beyond 15 km of antennae	Subject to gazetted Astronomy Advantage Area legislation. Involves RQZ. No-go area to be determined by EMI specialists.
Heritage sites incl. grave sites and rock art sites	See Heritage Chapter (Orton et al., 2016)			Forms part of heritage chapter, but has visual implications. Subject to a HIA/VIA at the project scale.

Note 1: Areas shown in dark red on Figure 14.11 are the actual scenic resource, feature or receptor, considered as 'very high visual sensitivity', and potentially 'no-go' areas.
Note 2: 'Visual Sensitivity Zones' in Figure 14.11 and 14.12 are visual mapping categories and not prescriptive setbacks or exclusion areas.

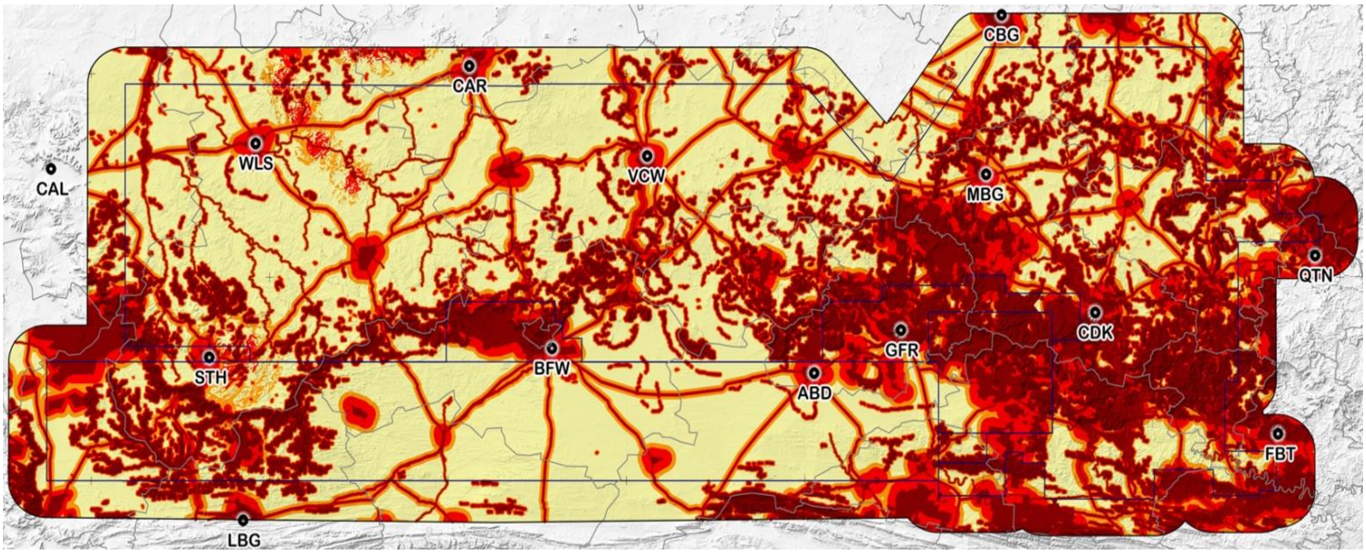

Figure 14.11: Composite map of all scenic resources and sensitive receptors, including visual buffers, indicating visual sensitivity levels from dark red (the actual feature or receptor), red (high visual sensitivity), orange (moderate visual sensitivity) and yellow (low visual sensitivity), as indicated in Table 14.6. These are not exclusion zones, but indicate visual sensitivity at the regional scale.

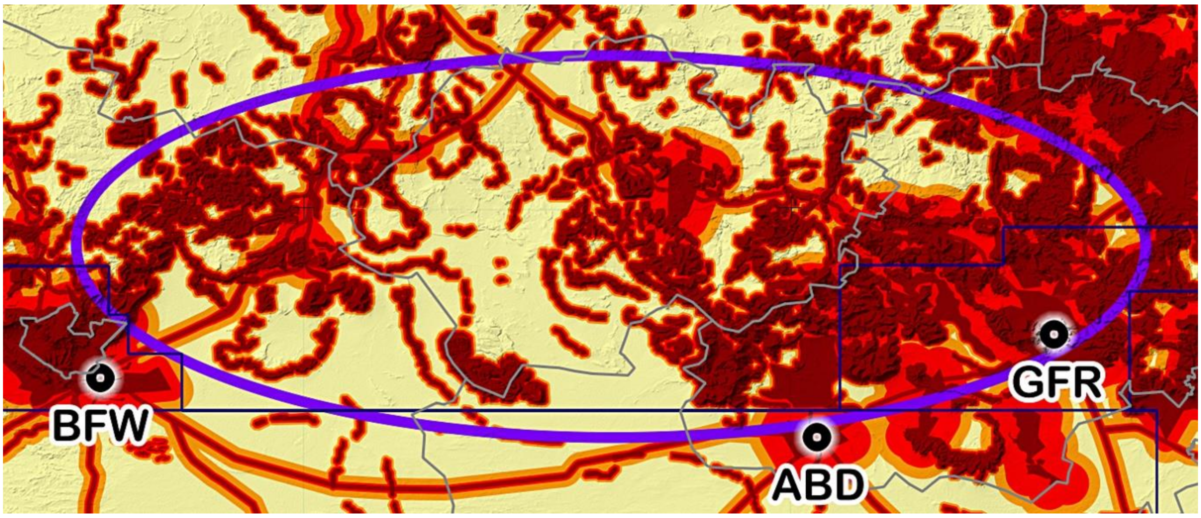

Figure 14.12: Visual sensitivity levels within an indicative prospectivity area (shown in purple). The actual prospecting area would depend on the geology.

Major Towns:

ABD	Aberdeen	GFR	Graaff-Reinet
BFW	Beaufort West	LBG	Laingsburg
CAL	Calvinia	MBG	Middelburg
CAR	Carnarvon	QTN	Queenstown
CBG	Colesberg	STH	Sutherland
CDK	Cradock	VCW	Victoria West
FBT	Fort Beaufort	WLS	Williston

14.4 Management of potential visual impacts

14.4.1 Strategies for the management of potential visual impacts

Management actions should be seen as an integral and necessary part of the planning and design of a SGD. Strategies can be divided into three possible approaches as follows (also see Table 14.7 below):

- Avoidance
- Mitigation
- Offsets

Avoidance can be seen as a pro-active approach, as it involves minimising visual impacts at the early planning stage through the identification and protection of valuable scenic resources, including the use of visual buffers where necessary. Avoidance should be achieved through Spatial Development Frameworks (SDFs) prepared by provincial and local authorities. In the case of SGD, the siting of wells is generally determined by geological and economic considerations, limiting the potential for avoidance in some cases. Micro-siting may be possible at the project scale where measures can be taken to avoid landscape or scenic features, such as relocating wellpads or re-aligning access roads.

Mitigation can be seen as a reactive approach as it involves reducing the effects of the SGD activities, and minimising visual intrusion on sensitive scenic resources or receptors at the design, construction, operational and decommissioning stages of the development (see Table 14.7). Mitigation measures could involve changes to the design or the visual screening of facilities, as well as controls through an Environmental Management Programme (EMPr). The mitigations would be formulated by the Environmental Practitioner and the specialist team, and enforced by the permitting authority.

Offsets can be seen as an inter-active approach and could take many forms. Offsets may need to be used where avoidance or mitigation measures cannot achieve the desired effect. For example, a feature or amenity that will be lost through SGD activities could be replaced with a similar amenity elsewhere as compensation, such as the establishment or enlargement of a nature reserve, or the creation of a park for residents in the area. The offsets may be proposed by the Applicant or Environmental Practitioner, and prescribed by the permitting authority.

Table 14.7: Possible visual effects and options for mitigation.

Scenario	Possible visual effects	Options for mitigation of impacts
Reference Case	*Status quo* with possibility of incremental urban sprawl, including townships. Continued construction of wind and solar energy farms with accompanying powerlines and substations. Possible increase in one-stop filling stations, billboards and other visually intrusive signage.	Commission a scenic resource study with sensitivity gradings similar to that for heritage resources (DEA). Ensure avoidance through SDFs and zoning schemes (Municipalities). Ensure mitigation through HIAs and VIAs (DEA).
Exploration only	**Localised effect on neighbouring farms/ settlements**, incl. visual clutter and noise emissions from seismic activities and wellpads/ drilling rigs. **Visual intrusion of cleared strips** in relatively uniform Karoo vegetation. **Dust and noise** created by trucks and other machinery along gravel roads. **Visual pollution, litter** from construction sites and accommodation camps. **Increased disturbance of dark skies** at night from operational lighting at wellpads, lighting from buildings and headlamps of vehicles. **Visually scattered effect in the landscape** of target areas for exploration.	Ensure setbacks from human settlements through SDFs and zoning schemes (Municipalities). Fit equipment with noise dampeners (Developers). Ensure that cleared strips are as narrow as feasible and that specimen shrubs or trees are retained where possible within the clearing (EMPr). Upgrade and stabilise public roads, where possible, as part of the exploration phase and minimise new roads as far as possible, through permit requirements (Developers). Include litter control and education in the EMPr, monitored by an Environmental Control Officer (ECO). Avoid high-mast lighting. Use reflectors to shade light sources. Use shades on windows. Avoid vehicle trips at night, through permit requirements (Developers, DEA). Cluster target areas where feasible. Select low-lying or visually absorptive areas if possible, through planning by the Applicant (Developers).
Small Gas	Increased traffic, noise and dust during the construction phase. **Fragmentation and industrialisation** of wilderness and rural areas. **Effect on rural/wilderness character** of the surroundings by SGD. **Possible visual degradation of landscape features** and historical sites from increased number of wellpads, pipelines and access roads. **Localised effect of wellpads on views** from farmsteads, settlements, possibly affecting property values.	Improve or seal road surfaces (Developers). Confine wellpads to carefully selected areas with low visibility, in zones of low visual sensitivity as indicated in Fig. 14.11 (Developers). Minimise footprint of wellpads as far as possible within the production block (Developers). Carefully site wellpads to avoid landscape features. Use existing roads where possible, and locate pipelines along roads (Developers). Ensure setbacks from human settlements (Municipalities). Create shelterbelts for visual screening (Developers).

Scenario	Possible visual effects	Options for mitigation of impacts
	Increased visual clutter arising from SGD in the exposed Karoo landscape.	Use planted berms to screen wellpads and related infrastructure. Control signage (Developers).
	Increased disturbance of dark skies at night from lighting at wellpads and from flares.	Avoid high-mast lighting. Use reflectors to shade light sources. Develop measures to screen flares from sensitive receptors (Developers).
	Perceived industrial character of 55 wellpads and of gas processing plants from visual corridors, incl. arterial and scenic routes.	Ensure setbacks from arterial and scenic routes and passenger rail lines (DEA, Municipalities). Strategically place planted berms along routes to screen development (Developers).
Big Gas	**Transformation** of rural/wilderness character, serenity and sense of place, by SGD, including 410 wellpads and heavy truck traffic.	**Avoid zones of high visual sensitivity indicated in Figure 14.11.** Apply prescribed visual setbacks from settlements and routes (DEA, Municipalities). Cluster wellpads where feasible and minimise footprints as far as possible (Developers).
	Possible visual degradation of cultural or historical landscapes from widespread wellpads, pipelines and access roads.	Carefully site wellpads to avoid landscape features. Use existing roads where possible, and locate pipelines along roads (Developers). Include protection measures in the EMPr.
	Diminished recreation amenity and tourism attraction, incl. the environs of National Parks and nature reserves.	Ensure visual setbacks from National Parks, nature reserves, and private game farms or resorts (DEA, Provincial Govertment and Municipalities).
	Disturbance of dark skies at night from lighting at 410 or more wellpads, and from flares during drilling operations.	Avoid high-mast lighting. Use reflectors to shade light sources. Develop measures to screen flares from sensitive receptors (Developers).
	Perceived industrial character of SGD activities within production block, and power station/s seen from visual corridors, incl. arterial or scenic routes and rail lines.	Site wellpads, gas processing plants and power station to minimise visibility (Developers). Ensure visual setbacks from arterial and scenic routes and passenger rail lines (DEA, Provincial Govt. and Municipalities). Locate planted berms along routes to screen development. Screen electrical substation/s from arterial and scenic routes. Avoid powerlines on visually exposed ridges or crossing arterial/scenic routes (Developers).
Cumulative Impacts	**Indirect visual impacts** from secondary industries or facilities attracted by SGD.	Subject secondary industries to similar visual scrutiny and mitigation measures (DEA, Provincial Govertment).
	Cumulative visual effect of 410 wellpads on views from settlements, possibly affecting property values.	Consider visual setbacks from human settlements (Municipalities). Locate wellpads outside viewsheds of settlements where feasible (Developers).
	Cumulative visual effects on heritage resources and sense of place.	Take into account mitigations recommended in Chapters 13 (Seeliger et al., 2016) and 15 (Orton et al., 2016) or prescribed by heritage authority (SAHRA, HWC).
	Cumulative visual effects in tandem with wind and solar energy farms, powerlines and possible uranium mining.	Ensure integrated planning at the regional scale to minimise competing land uses and excessive cumulative visual impacts, through SDFs. (Provincial and local authorities).

A possible offset for SGD in the Karoo would be the extension of existing protected landscapes in the study area to compensate for loss of scenic amenity caused by the SGD activities. This could take the form of a scenic wilderness corridor (and biosphere reserve) incorporating the current patchwork of national parks, nature reserves and river corridors into a more comprehensive, linked system of protected landscapes, within which the essential landscape qualities of the Karoo can be preserved, including dark skies at night.

The advantages of such a wilderness corridor would be to ensure the conservation of scenic diversity, biodiversity and geo-diversity as well as heritage resources (including Karoo palaeontology), as part of a broader sustainability and climate-change strategy. Economic benefits to the region could include increased eco-tourism through the introduction of trails and visitor accommodation within the corridor. Education benefits could include the provision of visitor centres explaining the geology of the Karoo and how shale gas is exploited.

The rehabilitation of shale gas drilling sites could provide useful scientific information or case studies for best practice landscape restoration in dry lands for other degraded areas in the Karoo.

14.4.2 The role of regulatory authorities

At the national level the regulations relating to Petroleum Exploration and Production (Government Gazette, 2015) should be extended to include measures for visual issues and the conservation of scenic resources, possibly with the involvement of the DEA. At the provincial level, SDFs need to take SGD into account along with appropriate best practice guidelines. At the district or local authority level, municipalities need to manage scenic resources through overlay zoning schemes and bylaws in preparation for possible SGD. An interim report on SGD has been prepared for the Western Cape (Western Cape Government, 2012), but further work, including policies and guidelines relating to scenic resources, is needed. Coordination with the Eastern and Northern Cape Provinces is also required.

14.4.3 Limits of Acceptable Visual Change

Unlike water pollution, air pollution or noise, there are no specific or quantifiable standards that can be used to determine limits of acceptable change in the case of visual impacts in the South African context. In addition, unlike heritage resources, there is no legislation in South Africa at present to specifically protect scenic resources. The default position therefore is that scenic landscapes are often, but not always, considered in heritage assessments, given that they are part of the ‘national estate’.

The tipping point for the limit of acceptable change would be related to the number, distribution and density of wellpads and related infrastructure, particularly the accompanying heavy traffic, dust and noise during construction, resulting in an industrialised landscape and the loss of the current pastoral setting. This could be determined during the development application stage, particularly for the Big Gas scenario, which involves large scale SGD.

The primary indicator for limits of acceptable change in terms of visual impacts at the regional scale would be the areas defined in this chapter as ‘very high’ and ‘high’ visual sensitivity. At the local project scale limits would be determined through viewshed mapping and public participation, and by means of the regulatory framework, usually as part of the EIA process. Sensitive landscape features should normally be identified during SDF planning processes. Setbacks and exclusion zones would to some degree define levels of acceptable change, and a number of these are listed in Table 14.8 below.

Table 14.8: Potential exclusion zones for SGD

Scenic Resource	Exclusion Zone
Topographic features	Restricting development on steep slopes, elevated landforms (NEMA legislation).
Major rivers, water bodies	Restrictions within 500 m of water courses and 1 km of wetlands, as per Regulations for Petroleum Exploration and Production (Government Gazette, 2015).
Cultural landscapes	Protection of graded heritage sites and cultural landscapes (Heritage Resources Act, 2003).
National Parks	Protection of National Parks (National Parks Act).
Nature Reserves	Protection of Provincial and Municipal Nature Reserves (Provincial Ordinances and Municipal Bylaws).
Human settlements	Provisions included in local authority planning documents (SDFs, Municipal Zoning Schemes and Overlay Zoning Schemes).
Scenic routes and passes	Protection of proclaimed historical *poorts* and mountain passes, incl. rail routes (Heritage Resources Act, 2003).
SA Large Telescope (SALT)	SALT exclusion zone (Regulations in terms of the Astronomy Geographic Advantage Act, 2007).
Square Kilometre Array (SKA)	SKA exclusion zone (Regulations in terms of the Astronomy Geographic Advantage Act, 2007).

14.4.4 Risk Assessment

A number of steps have been followed in order to determine risks relating to SGD in terms of potential visual impacts, as described below:

Step 1 – Defining the nature of the impact: In visual terms this relates to the type and scale (or intensity) of the proposed SGD activities, as indicated in Table 14.7 above. These activities for example range from exploration only to large-scale SGD, which translate into potential visual hazards.

Step 2 – Defining and mapping **receiving environments:** These relate to scenic resources and visually sensitive receptors as indicated in Table 14.6 and Figure 14.11 above in the form of high, moderate and low visual sensitivity zones.

Step 3 – Defining visual **mitigation measures**: These are listed in Table 14.7 in the form of planning policies, design measures and environmental management controls.

Step 4 – Defining **consequence levels:** These are determined for this Chapter using a combination of potential hazard (intensity of the impact), exposure (extent and duration) and vulnerability (visual sensitivity of the receiving environment) as indicated in Table 14.9. Indicators for each of these are given in the box below.

Hazard (nature of impact)	**Exposure (extent)**	**Exposure (duration)**	**Vulnerability (sensitivity)**
Low intensity (Exploration Only) Moderate intensity (Small Gas) High intensity (Big Gas)	Site scale (site environs) Local scale (local viewshed area) Regional scale (beyond local area)	Short-term (0-5 years) Medium-term (5-15 years) Long-term (15+ years)	Low in scenic resources / sensitive receptors (<10% of the area) Moderate in scenic resources / sensitive receptors (10-50% of the area) High in scenic resources / sensitive receptors (>50% of the area)

Table 14.9: Calibration of consequence[1]

Slight	**Moderate**	**Substantial**	**Severe**	**Extreme**
Tends to be low intensity SGD at the site scale over the short-term in zones with low visual sensitivity. Scenically non-intrusive, with good possibility for mitigation.	Tends to be low-moderate intensity SGD at the local scale over the short-medium term in zones with low-moderate sensitivity. Some alteration to scenic quality/sense of place with moderate possibility for mitigation.	Tends to be moderate intensity SGD at the local scale over the medium-term in zones with moderate sensitivity. Strongly affects scenic quality/sense of place and tourism potential, with some possibility for mitigation.	Tends to be moderate- high intensity SGD at the local-regional scale over the medium-long term in zones with moderate- high sensitivity. Significantly affects scenic quality/sense of place and tourism potential, with minor possibility for mitigation.	Tends to be high intensity SGD at the regional scale over the long-term in zones with high sensitivity. Drastically affects scenic quality/sense of place and tourism potential, with limited possibility for mitigation.

[1] Only average levels of consequence are indicated. A number of permutations are possible when combining indicators.

Step 5 – finally, a risk assessment matrix is provided in Table 14.10 for each scenario, both before and after mitigation, by combining probability (likelihood) of the risk occurring with the consequence level from Table 14.9 above, and following Figure 5 in Scholes et al. (2016) to grade risks. The process is repeated for each type of receiving environment (visual sensitivity zone). The 'with mitigation' risk profile is dependent on the implementation of all the mitigation options listed in Table 14.7, and the 'best practice guidelines' in Table 14.11.

Table 14.10: Risk assessment matrix

			Without mitigation			*With mitigation*		
Impact	**Scenario**	**Location**	**Consequence**	**Likelihood**	**Risk**	**Consequence**	**Likelihood**	**Risk**
Visual intrusion of industrial-type facilities on the landscape, altering the rural / wilderness character of the Karoo, including dark skies at night.	Reference Case	Low visual sensitivity zones	Moderate	Likely	Low	Slight	Very likely	Very low
	Exploration Only		Moderate	Very likely	Low	Slight	Very likely	Very low
	Small Gas		Substantial	Very likely	Moderate	Moderate	Very likely	Low
	Big Gas		Severe	Very likely	High	Substantial	Very likely	Moderate
	Reference Case	Moderate visual sensitivity zone	Moderate	Likely	Low	Slight	Likely	Very low
	Exploration Only		Substantial	Very likely	Moderate	Moderate	Very likely	Low
	Small Gas		Severe	Very likely	High	Substantial	Very likely	Moderate
	Big Gas		Extreme	Very likely	Very high	Severe	Very likely	High
	Reference Case	High visual sensitivity zones	Moderate	Likely	Low	Slight	Likely	Very low
	Exploration Only		Severe	Very likely	High	Substantial	Very likely	Moderate
	Small Gas		Extreme	Very likely	Very high	Severe	Very likely	High
	Big Gas		Extreme	Very likely	Very high	Severe	Very likely	High

Figure 14.13 presents a risk map of visual intrusion on tharacter of the Karoo across four SGD scenarios, with- and without mitigation.

14.5 Best practice guidelines

As previously indicated, there is no precedent for SGD in South Africa and therefore best practice guidelines in Table 14.11 below have been generally gleaned from experience by the authors from projects of a similar nature locally (e.g. wind and solar development, gas pipelines and processing plants), as well as from overseas best practice manuals for SGD (American Petroleum Institute (API), 2009; New York State DEC, 2009; US Fish & Wildlife Service, 2007; Eshleman and Elmore, 2013; Kansal and Field, 2013). These guidelines should be incorporated into approval permits/EMPrs and therefore considered mandatory.

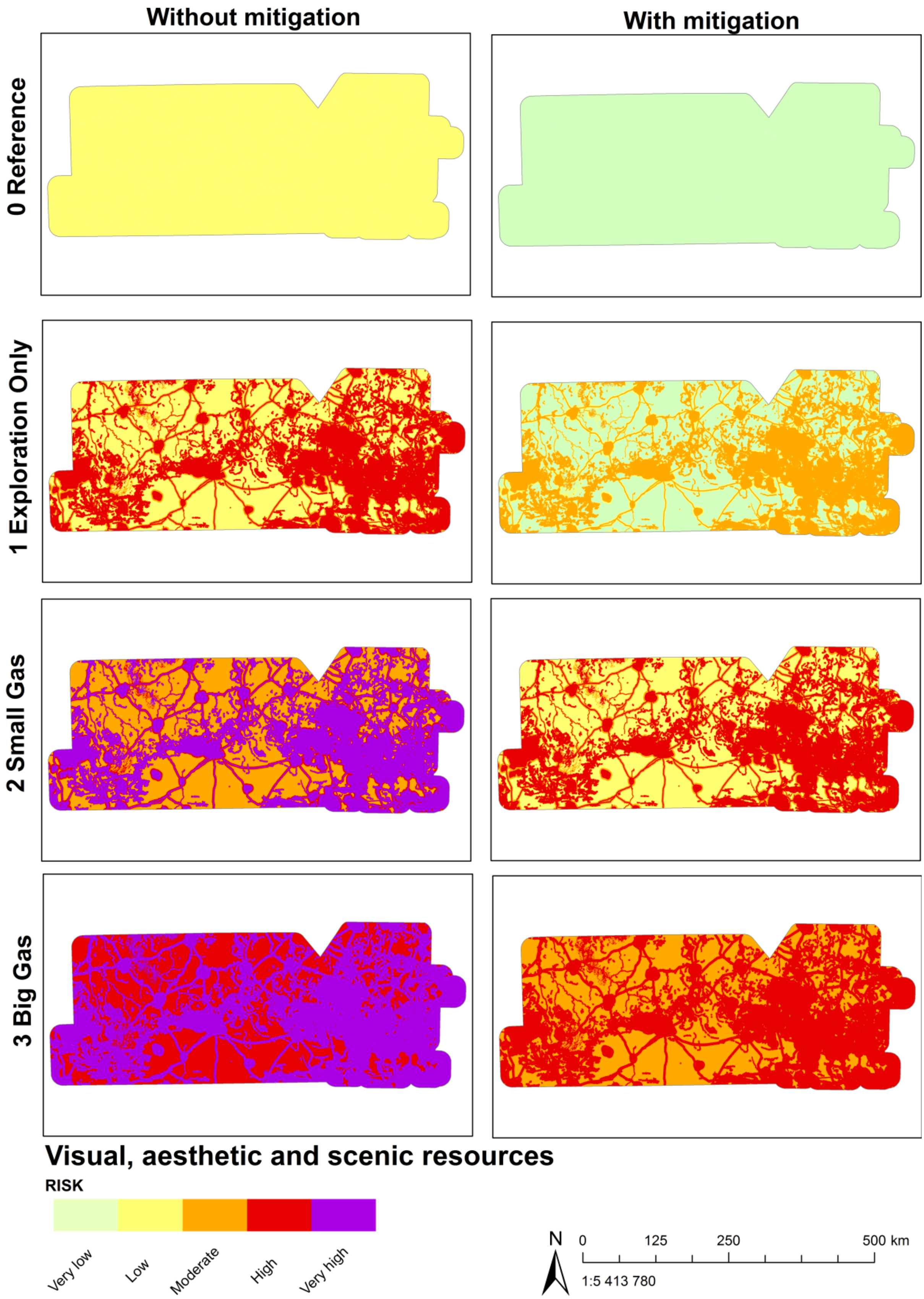

Figure 14.13: Map indicating the risk of impacts on visual, aesthetic and scenic resources across four SGD scenarios, with- and without mitigation.

Table 14.11: Best practice visual guidelines.

SGD Stage	Visual Guidelines
Exploration stage	**Location**: Take cognisance of visual sensitivity zones contained in this Visual Chapter and other regional planning documents for the various districts, including SDFs. Conduct detailed site analyses at the planning stage to identify visual constraints, important scenic features and visually sensitive receptors in the area. If necessary, commission a VIA with viewshed analyses, to determine visibility and other potential effects resulting from the proposed siting of wellpads and related infrastructure. Avoid placement of wellpads and other infrastructure on ridgelines and elevated landforms where possible because of their visual effect on the skyline. Use the mitigating effect of low-lying areas or belts of trees. Avoid placement of wellpads in proximity to visually sensitive receptors, such as National Parks, nature reserves, scenic and tourist routes. Align access roads with the natural contours and avoid steep gradients requiring additional earthworks. Use existing district and farm roads where feasible, and minimise new roads as far as possible.
Development and operation stage	**Footprint**: Minimise excessive fragmentation of natural or cultural landscapes as far as possible through grouping or sharing of infrastructure. Consider reducing the density of multiple wellpads within a specific area to reduce visual impacts on landscape character. Optimise use of multi-well drilling pads to minimise the scatter of individual wells across the landscape, and the proliferation of access roads. Reduce the footprint of wellpads as far as possible, particularly after drilling is complete. Avoid excessive loss of natural veld or agricultural land. Use previously disturbed areas in preference to pristine or agriculturally productive landscapes as far as possible. Protect surrounding veld from construction activities with temporary fencing or hoarding. Use low-profile structures where possible to reduce their visibility from adjacent viewsheds. Keep access roads as narrow as feasible. Minimise cut and fill earthworks. Locate pipelines adjacent to roads to minimise visual disturbance. **Screening**: Screen wellpads and other infrastructure by means of earth berms and/or planting. Spoil material or stored topsoil could be used in temporary berms. These are also effective if placed at strategic positions near public routes and viewpoints to screen foreground views. Locate parked vehicles under shaded carports where possible, using natural colours, to minimise their visibility in the landscape. Camouflage or disguise visually intrusive structures by means of form, colour and texture. Use colours in the olive-green or brown range to simulate the natural surroundings. Avoid reflective materials. Shade glazed surfaces to minimise reflection from windows. Consider emulating the Karoo agricultural building forms in the design of sheds and other wellpad structures to minimise their stark ‘industrial look’. **Lighting and Signage**: Minimise wellpad lighting to that required for safe operations. Use reflectors to avoid light spillage and ‘sky-glow’ effects. Use low-level bollard lights and bulkhead lights with downward reflectors in place of high level lighting for parking and footpaths. Minimise effect of flares on the Karoo sky. Consider available technology to minimise flare

SGD Stage	Visual Guidelines
	effects. Consider timing flaring to occur only in the day to avoid visual effect at night. Limit signage to only that which is absolutely necessary. Fix signage to walls or buildings to minimise visual clutter. Prohibit billboards or self-illuminated signs because of their visual intrusion. Restrict the size of signs to a maximum of 4 m^2. **Maintenance**: Maintain the wellpad and related infrastructure in a tidy, clean condition. Control litter and other waste to avoid visual impacts on the surroundings. Avoid visual scarring of the landscape caused by runoff and erosion.
Rehabilitation and post closure stage	Consider implementing interim or progressive rehabilitation as development activities cease or relocate. Remove all above-ground structures, stockpiles and storage dams at the wellpads. Grade the affected area to pre-development topographic conditions, unless the area is required for new specific uses. Scarify compacted areas and re-spread topsoil stored at the time of the initial clearing and re-seed exposed areas. Use stored rocks to simulate rock outcrops of the area. Vegetation used for the restoration to match that of the surrounding veld, unless new uses are planned for the site.
Monitoring	Ensure that the visual guidelines listed above form part of the EMP, and are included in on-going monitoring during the following stages: **Pre-construction monitoring:** Create procedures for the review of project plans, including landscape and rehabilitation plans as part of the EMP process to ensure that mitigations have been included in the design. Appoint a suitably qualified landscape architect to prepare a phased landscape development plan for all stages of the project. Implement the landscape plans by means of the mandatory EMP. **Construction monitoring**: Create procedures for ensuring that the specified visual management actions are carried out on site as part of the EMP. Appoint an ECO to educate construction workers, monitor the implementation of mitigation measures and report to the EMP Team on a weekly basis. The EMP team to include a suitably qualified rehabilitation ecologist and landscape architect. **Operational monitoring:** Create procedures for the on-going control of aesthetic aspects of the project including signage, lighting, fencing etc. to ensure that the management actions are being applied. The ECO to report on these aspects on a monthly basis. **De-commissioning monitoring:** Create procedures for the removal of structures and stockpiles at the end of the lifespan of each wellpad and related infrastructure, including re-use of the site and recycling of materials, as well as the rehabilitation or redevelopment of the site to a visually acceptable form. Monitoring of the rehabilitation by the Environmental Management Team is required, with signing off by the delegated authority.

14.6 Gaps in knowledge

An indication of limitations for the visual study, including the lack of a scenic resource baseline in the South African context, is given in Section 14.2.3. Further information on these aspects would assist in the visual-aesthetic study, including the following:

Standardised scenic resource baseline information:
A scenic resource inventory of South Africa, ideally with each resource graded according to national, regional and local significance, similar to that for heritage resources, would allow for better accuracy and consistency in visual sensitivity mapping and VIAs.

Cultural landscapes baseline information:
A clearer definition of what 'cultural landscape' includes in the South African context, with the help of heritage specialists, as well as significance grading and more detailed mapping, would help to refine overall visual sensitivity rating and mapping.

Game farms and guest farms baseline data:
A more detailed and complete inventory of all private reserves, game farms, guest farms, resorts and tourist accommodation would provide a better indication of visually sensitive receptors in the study area for mapping purposes.

Potential cumulative visual impacts:
Possible cumulative visual impacts can only be determined once a particular SGD scenario evolves and the location and density of the drilling wellpads, gas processing plants and power stations becomes more clearly defined, particularly in relation to other major activities, such as wind and solar energy developments, and possible uranium mining.

There is therefore a clear need for more detailed fine-scale mapping relating to the above at the local or district scale in order to inform visual assessments for SGD going forward.

Additional information would be needed on gas processing plants, power stations, substations and powerlines at the project stage so that viewsheds and setbacks can be determined.

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14.8 Digital Addenda 14A: A3 Visual Maps of Study Area

SEPARATE DIGITAL DOCUMENT

Map 1: Distribution of Dolerites

Map 2: Steep Slopes

Map 3: Physiography

Map 4: Landscape Scenic Units

Map 5: Scenic Resources

Map 6: Sensitive Receptors

Map 7: Scenic Resources with Buffers

Map 8: Sensitive Receptors with Buffers

Map 9: Visual Sensitivity Synthesis

Map 10: Visual Sensitivity and Prospectivity Overlay

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