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Airbase Compatibility with Spatial Planning: A Case Study of Airbase Waterkloof (South Africa)

Andre Brand

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Abstract

The primary roles of the South African National Defence Force (SANDF) are to protect and advance South Africa's strategic interests through the promotion of security and stability, and to provide military capabilities to defend South Africa and its national interests. The South African Air Force (SAAF), as an entity of the SANDF, is mandated to defend South Africa's airspace from unfriendly or unauthorised incursions. Noise emission and aviation safety, as products of air traffic movement, generate distinct spatial footprints. The productivity of an airbase can be negated if the unity between these footprints and the immediate built environment is not appropriately directed and managed. This can ultimately compromise an airbase's mission readiness. This paper, with Airbase Waterkloof (which represents the largest military operational support base within South Africa) as a case study, investigates the degree of unity that exists between an airbase and its surrounding urban environment. The paper specifically focuses on the spatial footprints generated by noise emission and aviation safety as products of air traffic movement, and the legislative measures that prevail between the SANDF, SAAF, and National and Local Governments. The findings reflect that legislative measures are clearly defined, and jurisdiction is distinctively delineated. However, the integration and mitigation of matters around noise and aviation safety are perpetrated through a process of internal policies and regulations and public participation, which is not adequate when striving to attain harmony between an airbase and the surrounding built environment.

Keywords: Airbase, Aerodrome, South African Air Force, Noise nuisance, Aviation safety, Safeguarding.

1. Introduction

Despite the strict economic conditions to which the Union Defence Force [UDF] (later the South African National Defence Force [SANDF]) was subjected, the inception of the South African Air Force (SAAF) occurred in 1920. This was facilitated by the Imperial Government (Britain), which allocated a total of 113 aircraft from its war stocks to the Union (later the Republic of South Africa). A site at Zwartkop was selected and taken over for the SAAF's first airbase [1]. Today, the SAAF has jurisdiction over several airbases across South Africa, which provide key aerial services, including transport, maritime,

search and rescue, training, and combat. Nine official airbases have been established since the SAAF was founded a century ago.

Air traffic movement, whether national, domestic, or military, starts and ends at an aerodrome. An aerodrome is a stimulus to society from the standpoint of economic growth and the services it offers to the public. These services include defending a country's airspace against unfriendly or unauthorised incursions. Noise emission and aviation safety, as products of air traffic movement, generate a distinct spatial footprint that can negate the mission readiness of an airbase if compatibility with its urban environment is not appropriately directed and managed [2].

Noise emission, also known as sound pollution or environmental noise, is the propagation of noise with varying impacts. Noise causes direct and cumulative adverse effects on health, economic, and non-material losses [3]. Noise protection and abatement concepts are based on predicting annoyance from time-integrated levels of acoustic energy and setting exposure limits, better known as noise contour zones [4]. The distinct footprint generated by noise emission is closely managed by legislative conditions that include international and national standards, noise control zonings, and noise management policies.

Aviation safety signifies the state of an aviation system in which risks associated with aviation activities related to, or in direct support of, the operation of aircraft are reduced and controlled to an acceptable level. This encompasses the theory, practice, investigation, and categorisation of flight failures, and the prevention of such failures through regulation, education, and training [5]. The footprint generated by aviation safety is stringently managed by legislative measures such as international aviation standards, acts, policies, and technical standards.

Respondent [2], in his research, 'Planning guidelines for airbases in South Africa', concluded that air traffic noise and aviation safety might negate the productivity of an airbase if the spatial footprints generated are not properly directed and managed. The aim of this paper, with airbase Waterkloof (representing the largest military operational support base in South Africa) as a case in point, is to evaluate the mitigation, or lack thereof, of air traffic noise and aviation safety footprints in reference to the surrounding urban environment. To achieve this, the paper's outline will be as follows: 1) what is an airbase; 2) what necessitates air traffic noise and the footprint generated; 3) the significance of aviation safety and the footprint generated; 4) legislative construct and importance of airbase Waterkloof as a support base; 5) spatial planning implications with reference to air traffic noise and aviation safety footprints; and 6) a synthesis to encapsulate strategic recommendations to mitigate and manage the mission readiness of an airbase and to attain harmony with the surrounding suburban area.

2. What is an airbase?

An airbase, also referred to as a military airbase, military airfield, military airport, air station, naval air station, air force station, or air force base, is an aerodrome used as a military base by a military force for the operation of military aircraft. An airbase is not only a place where military aircraft take off and land but also provides housing and support for aircraft and personnel. An airport, on the other hand, is a place where aircraft can take off and land and includes multiple

passenger terminals [6].

In South Africa, an airbase is depicted as a specific area, land or water intended to be used in whole or in part for the arrival, departure or movement of air resources, operations, logistical or other support, including any area that the Head of State may designate as an airbase and the airspace above the airbase [2]. What makes the definition pertinent is the depiction of airspace above. This indicates that an airbase or airport's safeguarding footprint (see section on aviation safety) is three-dimensional in design, considering height as a restrictive condition.

The airbases over which the SAAF has jurisdiction are divided into three broad types, consisting of official and unofficial bases. The official airbases are divided into 1) fighter airbases, providing combat operations ensuring regional stability, and 2) main support airbases, providing sustained support of combat readiness, force preparation, force employment, military flying training, and flight testing. The unofficial airbases consist of forward airbases, providing deployment support to the army [2]. Although the functionality between these airbases differs, it is their strategic location that informs the aim of the paper, which is the issue of encroachment or the potential impact of the built environment and development activities that can compromise military mission requirements and/or mission readiness of an airbase.

3. Air traffic noise

Noise is measured in units known as decibels, abbreviated to dBA. Noise can range from 1dBA (which is near silence) to 140dBA, which could be produced by a military jet aircraft. Noise level refers to the reading of an integrating impulse sound taken at a measuring point in the presence of any alleged disturbing noise [7]. A noise level meter is an instrument used to measure noise levels [8]. Noise nuisance includes all wanted and unwanted sounds and refers to any sound which disturbs or impairs, or may disturb or impair, the convenience or peace of any person [7]. The noise, which is a form of air pollution, continues to increase due to population growth, urbanisation, and the associated increase in noise sources [3]. The main associated noise sources are road, rail, and air traffic. In contrast to road and rail traffic, air traffic can more easily be understood as circumscribable noise-emitting installations, similar to industrial complexes [4].

Air traffic, which constitutes unwanted or circumscribable noise, is a complicated phenomenon and is influenced by many factors, such as the nature of the aerodrome operation, the types of aircraft using the aerodrome, and the volume of air traffic. Aviation noise has the most impact during take-off and landing. Aviation noise impact is normally contained to a limited area around an aerodrome. An assessment of the extent of the main impact area is generally made through calculating a set of noise exposure contours. These comprise what is often termed the noise footprint of the aerodrome. The calculation of air traffic noise is influenced by variables such as the height of the aircraft, the noise emission characteristics of the engines, and the flight track of the aircraft [3][4][8].

To understand the complexity of noise as a phenomenon, one needs to distinguish between the differences in the spatial extent of noise metrics, i.e., the size and shape of noise contours produced by each metric. The outcome from the different noise metrics is a set of spatial noise contours of equal sound exposure level. The cumulative spatial effects of a series of aircraft operations over a specified time are generally referred to as *'noise contours'*.

Respondents [8] and [9] distinguish four noise metrics: 1) the A-weighted Equivalent Level (LAeq) noise contour, which has the smallest spatial footprint. There are no weightings or time periods applied to the calculation of this contour. A-weighting is applied to instrument-measured sound levels in an effort to account for the relative loudness perceived by the human ear; 2) the Day Night Rating Level (LRdn) noise contour, which has the third-largest spatial footprint. A weighting of 10dB is applied to flights occurring between 22:00 and 06:00. This implies that flights between these times must be identified and classified as such; 3) the Day Night Average Level (DNL) noise contour, which has the second-largest spatial footprint. The DNL represents one of the metrics more frequently used to illustrate noise impact. A weighting of 10dB is applied to aircraft movements taking place between 22:00 and 07:00. DNL is a metric that reflects a person's cumulative exposure to sound over a 24-hour period, expressed as the noise level for the average day of the year based on annual aircraft operations; and 4) the Noisiness Index (NI) contour, which has the largest spatial footprint attributed to the additional weightings added. A weighting of 5dB is added to flights operating between 22:00 and 24:00, and 10dB to flights between 24:00 and 06:00. The variation in spatial footprint from one metric to another is the variation in the weightings applied. It is therefore easy to become confused by the size and shape of the contours if the complicated underlying assumptions are not clearly understood. Furthermore, respondent [9] put forward the notion that contours provide the guidance necessary to make sensible decisions. In their view, there are several factors to consider, namely: 1) noise contours are fuzzy boundaries, which means they tend to be uncertain and often shift with time; 2) noise contours become fuzzier as the exposure level decreases and more discrete and sharper as the exposure level increases; and 3) the accuracy of noise contours can be challenged when local conditions are not similar to the standard field conditions adopted in the noise metric applied. Consequently, it is important not to see noise contours as rigid boundaries when decisions are made.

According to the International Finance Corporation (IFC)[10], a large degree of international consensus has emerged on what constitutes unacceptable levels of noise exposure. Establishments such as the World Health Organisation (WHO), the Organisation for Economic Co-operation and Development (OECD), and the World Bank (WB) have collected data and developed assessments on the effects of noise exposure. On the basis of these assessments, guideline values for different time periods and situations have been suggested as restrictive conditions (see Table 1).

Table 1. Noise level guidelines

Receptor	Daytime (07:00 - 22:00)	Nighttime (22:00 - 07:00)
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

Note: Source: [10]

The assessment guidelines as set out in Table 1 suggest that at 55 - 60 dB(A), noise creates annoyance; at 60 - 65 dB(A), annoyance increases considerably; and above 65 dB(A), constrained behaviour patterns symptomatic of serious damage are caused. One can interpret that the air traffic *'produced'* is responsible for the aircraft noise exposure of the people

living in the vicinity of an aerodrome, which is indicative of a spatial noise footprint promoting annoyance as a restrictive condition.

4. Aviation safety

Flying carries risk, both evident and hidden, originating from an identified source, calculated and estimated. This is derived from the events of flying. The awareness of aviation safety, according to respondent [5], is the lack of cohesion between an aerodrome and its immediate surrounding environment. In their view, the state of an aviation system is twofold: it operates as a closed system, considering that flight activities generated in direct support of the operation of aircraft are restricted from external interaction, and it operates as an open system, considering that flight activities relating to the operation of aircraft in a hidden form have a direct impact on the surrounding environment. An aviation system classified as a closed system is restricted to a footprint demarcated within the confinement of an aerodrome's boundaries; and as an open system, it is restricted to a footprint expanding outside of an aerodrome's boundaries, also referred to as a safeguarding footprint.

The International Civil Aviation Organization (ICAO) [11], as the regulatory body, generates Standards and Recommended Practices (SARPs) to promote global aviation safety. One such practice is initiated by aerodrome design and measures aviation safety according to 1) the type of runway and 2) varying obstacle limitation levels. A runway is depicted as a strip of ground set aside for the take-off and landing of aircraft. The varying obstacle limitation levels are designed to impose height as a restrictive condition. These measures allow for the safe and optimum operation of an aircraft (see Tables 2 and 3). There are three kinds of runways:

1. Non-instrument, in reference to a runway intended for aircraft operation using visual approach procedures or an instrument approach to a point beyond which the approach may continue in visual meteorological conditions;
2. Non-precision approach, in reference to a runway intended for an instrument approach utilising lateral guidance but does not utilise vertical guidance, i.e., conducted with less use of automated systems than precision approaches; and
3. Instrument, in reference to a runway equipped with visual and electronic navigational aids for a precision or a non-precision approach.

Furthermore, a runway is coded according to its length and width and the aircraft type meant for that runway. Table 2 shows the different codes of runways.

Table 2. Runway type

Code	Length	Width	Code	Wingspan
1	800m and less	18m to <23m	A	<15m
2	800m to <1200m	23m to <30m	B	15m to <24m
3	1200m to <1800m	30m to <45m	C	24m to <36m
4	1800m and more	45m	D	36m to <52m
			E	52m to <65m
			F	65m to <80m

Note: Source: [11]

There are five kinds of obstacle limitation levels:

1. The approach and take-off level is the path that an aircraft follows on its final approach or take-off. The path is a gentle downward or upward slope extending from the safety level;
2. The safety level is a surface area surrounding the runway prepared or suitable for reducing the risk of damage to an aircraft in the event of an under-shoot, over-shoot, or excursion from the runway;
3. The transitional level is an area extending from the safety level and parts of the approach and take-off levels that stretches upwards and outwards to where it intersects with the inner horizontal level;
4. The inner horizontal level is a swinging arc at a pre-defined height that establishes a safe area to be used by an aircraft before commencing landing procedures; and
5. The conical level is an area that commences at the periphery of the inner horizontal level, stretching upwards and outwards to where it intersects with the outer horizontal level.

Table 3 shows the different standards associated with each obstacle limitation level, while Figure 1 illustrates the overall aviation safeguarding footprint. The safeguarding footprint depicts the airspace above an aerodrome to be free of potential obstacles.

Table 3. Obstacle limitation levels

Runway type		Non-instrument				Non-precision			Instrument	
Dimensions	Code	1	2	3	4	1/2	3	4	1/2	3/4
Conical										
Slope		5%	5%	5%	5%	5%	5%	5%	5%	5%
Height		35m	55m	75m	100m	60m	75m	100m	60m	100m
Inner horizontal										
Height		45m	45m	45m	45m	45m	45m	45m	45m	45m
Radius		2000m	2500m	4000m	4000m	3500m	4000m	4000m	3500m	4000m
Inner approach										
Width									90m	120m
Threshold									60m	60m
Length									900m	900m
Slope									2,5%	2%
Approach/Take-off										
Safety zone	Inner edge	60m	80m	150m	150m	140m	280m	280m	140m	280m
	Threshold	30m	60m	60m	60m	60m	60m	60m	60m	60m
Divergence	Each side	10%	10%	10%	10%	15%	15%	15%	15%	15%
First section	Length	1600m	2500m	3000m	3000m	2500m	3000m	3000m	3000m	3000m
	Slope	5%	4%	3,33%	2,5%	3,33%	2%	2%	2,5%	2%
Second section	Length						3600m	3600m	12000m	3600m
	Slope						2,5%	2,5%	3%	2,5%
Horizontal section	Length						8400m	8400m		8400m
	Total length	**1600m**	**2500m**	**3000m**	**3000m**	**25000m**	**15000m**	**15000m**	**15000m**	**15000m**
Transitional										
Transitional	Slope	20%	20%	14,3%	14,3%	20%	14,3%	14,3%	14,3%	14,3%
Inner transitional	Slope								40%	33,3%

Note: Source: [11]

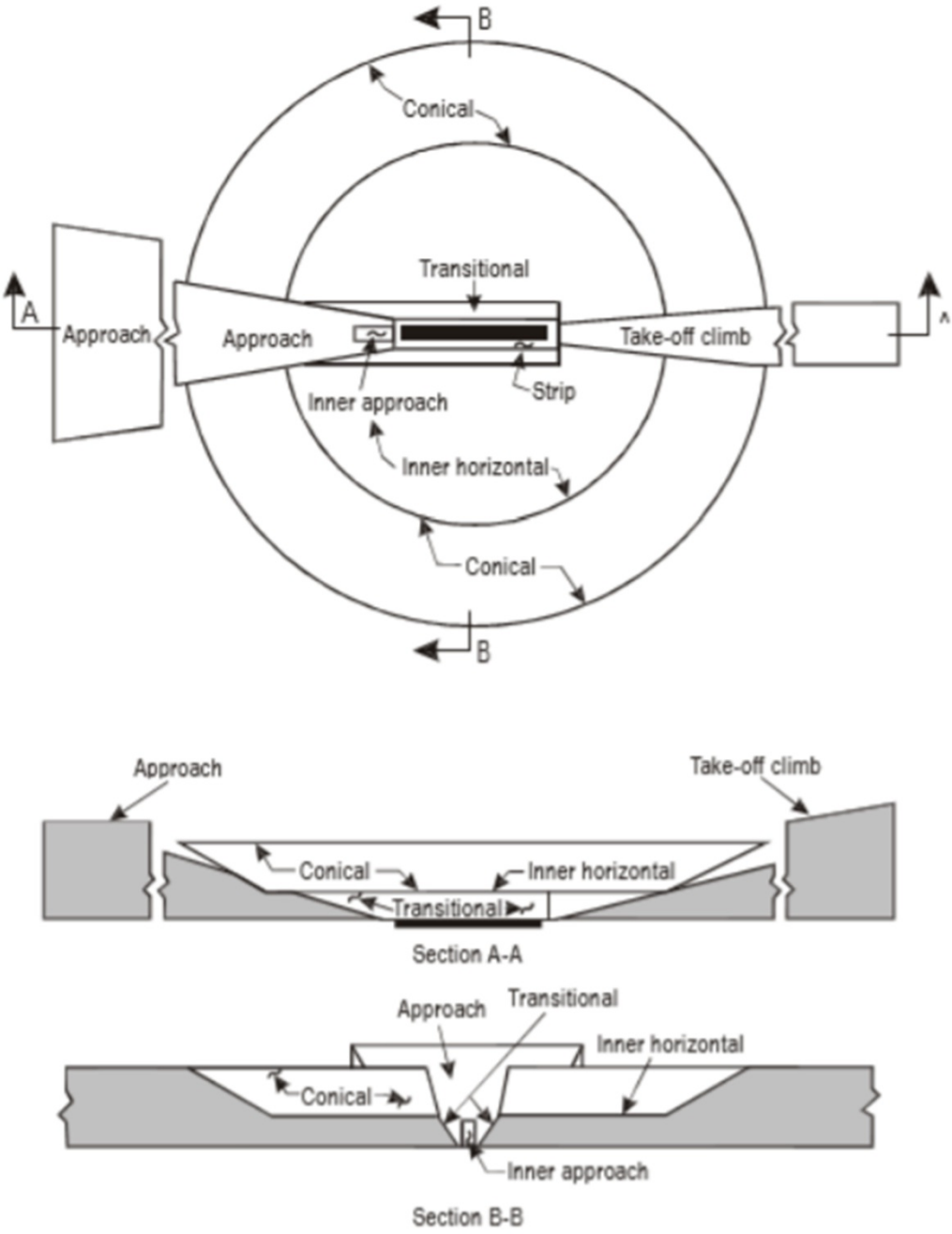

Figure 1. Obstacle limitation (safeguarding) levels

Note: Source: [11]

Although ICAO does not depict topography as a consideration for aviation safety,[2] concludes that topography is the only environmental setting that directly impacts the airspace above an aerodrome. Topography, in the narrow sense, involves the relief or terrain of the surface and the identification of specific landforms, also known as geomorphometry. In modern usage, this involves the generation of elevation data to include the graphic representation of the landform through a variety of contour lines. Contour lines encompass a value that represents the height of an area or surface above mean sea level [12]. Each obstacle limitation level is calculated in accordance with the height of the runway above mean sea level. The runway is used as the main indicator and not contour values. Consequently, considering the runway type, it is

important not to view the footprint of the varying obstacle limitation levels designed to impose height as a restrictive condition as rigid. The safety measures imposed for the different types of runways with the varying obstacle limitation levels can shift over time.

5. Airbase Waterkloof

5.1. *Historical background*

Airbase Waterkloof was established in 1938, initially as a practice forced landing field, secondary to Airbase Swartkop. As Airbase Waterkloof expanded, it became the SAAF's busiest and most productive airbase. It represents the largest operational (support) base within South Africa. Not only does it provide a crucial military role with daily training flights conducted as part of force preparation, but it is also utilised as a base for humanitarian operations as well as the accommodation of "commercial" air traffic on an emergency basis. It is also the primary airport landing facility for high-ranking international delegates. All South African Presidential flights are conducted from there, and it was declared a National Key Point [13]. It is situated within the greater Tshwane Metropolitan region just south of Pretoria (see Figure 2) and was initially constructed near the city edge. However, due to urban expansion, suburban areas now surround it. As early as 1974, the City Council requested that the airbase should be closed due to aircraft noise and the potential danger of an aviation disaster [5]. Due to financial implications and the fact that it is a major strategic support base, the SAAF never considered such a step [14]. To shed light on the dilemma of encroachment and the potential impact of a surrounded built environment, the authors first undertook a quantitative approach analysing the controlled spatial footprints expanding outside of Airbase Waterkloof's boundaries. They focused on two distinct spatial footprints, namely 1) noise exposure contours depicting a set of annoyance levels as restrictive conditions, and 2) aviation safety depicting obstacle limitation levels designed to impose height as a restrictive condition. Lastly, and to promote an alternative that sanctions a degree of cohesion between an airbase and its immediate surrounding environment, they undertook a qualitative approach investigating the harmony that prevails between the City of Tshwane and the SAAF, looking at development frameworks, policies, acts, regulations, rules, and any other orders or directions of any government or statutory body. For the qualitative approach, an unstructured interview process through the use of open questions was applied. To generate a real sense of understanding, the research questions were exploratory in nature. For the purpose of the paper, they used the data descriptively.

Figure 2. Airbase Waterkloof

Note: Source: Own compilation

5.2. *Noise exposure*

Respondent [9] asserted that during the 1960s, the government realised the need to predict noise caused by aircraft operations around all major aerodromes in South Africa. Consequently, an interdepartmental committee was established with the task of investigating the problem of noise emission. The investigation showed that there was no unified international approach to aircraft noise modelling at that stage and also no 'international model' to emulate. The decision was taken to develop a uniquely South African model, the Noisiness Index (NI). Subsequently, the need arose to revise the model due to: 1) the difficulty in maintaining and modernising the input database of noise emission values; and 2) the NI could not readily be integrated into or compared with noise caused by other sources. In 2003, the South African Bureau of Standards (SABS) drafted a new National Standard, the SANS 10117 [15], which stated that the Integrated Noise Model (INM) of choice is the Day Night Rating Level (LRdn) noise contour. Table 4 illustrates the appropriate noise level standards.

Table 4. SANS Standard 10117:2003

Receptor	LRdn
Residential (residential, school, church, educational)	45-55
Non-Residential (industrial, commercial, agricultural)	60-75
Forbidden	>80

Note: Source: [15]

In addition to the new National Standard, SANS 10117, drafted in 2003, which requires an aerodrome as part of noise management to evaluate and determine the main impact area surrounding it, the City of Tshwane [16] supplements noise standards based on the *noise districts* as defined in the South African National Standard, SANS 10103[17], drafted in 2008. Further to the *noise districts*, an additional criterion for noise control is to superimpose *controlled areas* (as defined in the Gauteng Noise Control Regulations [7]) on specific areas of the *noise control precinct*. These areas are affected by noise from roads/road traffic, airports/airfields, industrial areas, railway lines, and other significant noise sources. Each *noise control precinct* is an area where no noise from either an internal or external source that is imposed on the area may exceed the specified maximum noise level limits. There are two types of *noise control precincts*: those which are noise-sensitive and those which are major noise generators. Airbase Waterkloof is considered a major noise generator. However, the noise level criteria are to be used in a complementary manner, meaning the most stringent standard (the lowest maximum allowable ambient noise level) should be applied to ensure that the least stringent criterion for one control element should not be allowed to compromise that of another. The measurement and/or calculation of sound pressure levels are in accordance with set standards (see Table 5) as indicated in Section 3.9 of the City of Tshwane Noise Management Policy [18].

Table 5. Recommended maximum rating levels for ambient noise for various land use control precincts

Land Use Description of Noise Control Precinct	Rating Level for Ambient Noise (dBA)		
	Day-night	Daytime	Nighttime
Rural residential	45	45	35
Suburban residential	50	50	40
Urban residential – Type 1	55	55	45
Urban residential – Type 2	60	60	50
Special residential	60	60	50
Commercial	65	65	55
Central Business District	65	65	55
Office	60	60	50
Other Business	60	60	50
Light industry	70	70	55
Heavy industry	75	75	60
High tech industry	70	70	55
Mining	75	75	60
Public open space	45	45	35
Private open space	45	45	35
Education facility	55	55	-
Medical facility	55	55	45
Intensive agriculture	45	45	35
Institutional facility	*(a)	*(a)	-
Wilderness area	45	45	35
Public recreation	50	50	40
Private recreation	50	50	40
Military airbase	*(a)	*(a)	*(a)
Civil airport	*(b)	*(b)	*(b)
Public transport facility	*(a)	*(a)	*(a)
Major road area	*(b)	*(b)	*(b)
Special	*(a)	*(a)	*(a)

Notes:

**(a) As necessary; and *(b) Refer to requirements for supplementary controlled areas.*

Source: [16]

The City of Tshwane [16] also depicted other mitigating factors to potentially modify the impacts caused by aircraft and ground operations. These include 1) requiring aircraft to climb to a sufficient height before crossing any residential area; 2) ensuring the rate (power plants or engines) for take-off and approach are kept within safe limits; 3) considering potential reorientation of an aircraft; 4) relocating an aircraft further away from noise-sensitive areas; 5) using run-up

suppressors and barriers; 6) using space to separate noisy operations from sensitive areas; and 7) using buildings and screens to contain the noise within the limits of an airport boundary.

In addition to the SANS standards and the City of Tshwane Noise Management Policy[18], a White Paper on National Civil Aviation Policy was published in 2017 [19]. The White Paper delineates aircraft noise in accordance with ICAO SARP's guidelines, addressing aircraft noise through a programme which considers 1) the reduction of noise at the source; 2) land-use planning and management; 3) noise abatement; and 4) operating restrictions. The White Paper further suggests that aerodromes should establish an Environmental Committee that can address all noise-related enquiries and complaints, and should endeavour to share information on noise issues with the public.

From the deliberation with the City of Tshwane and the SAAF, it emerged that although a committee to mitigate noise-related enquiries does not exist, both institutions have their own procedures in place to manage and direct aircraft and subsequent other noises. The City of Tshwane directs and manages aircraft and subsequent other noises under the Gauteng Noise Control Regulations [7]. According to regulation 14(b), if a noise emanating from a premise is a disturbing noise or noise nuisance, or may, in the opinion of the local authority concerned, be a disturbing noise or noise nuisance, the person or entity causing such noise is instructed in writing to discontinue such noise or to take steps to lower the level of such noise to a level conforming to the required standards stipulated within the City of Tshwane Noise Management Policy [18]. Further, in accordance with Regulation 18 of the policy, any person or entity that contravenes or fails to comply shall be guilty of an offence and liable to a fine or imprisonment or both. The SAAF, on the other hand, in an effort to manage complaints, implemented what they called *"Base Operational Instructions"*. The instructions contain noise abatement procedures that restrict certain day-to-day operations and activities. For example, it prescribes minimum height restrictions and runway directions for use during flights in an effort to minimise repetitive noise. It also prohibits engine ground runs on Sundays and Public Holidays between 18h00 and 06h00. Night Flying Training can only be executed from Monday to Thursday until 22h00. All operational activities are regulated with permission from higher authority, and any activity not in compliance with the instructions requires special permission from higher authority.

In 2010, an Independent Environmental Consultant[13] compiled an Environmental Impact Assessment (EIA) to support a strategic facility upgrade programme planned for Airbase Waterkloof. One of the mitigating factors as part of the assessment revolved around determining the noise footprint (noise contours) surrounding Airbase Waterkloof, which constituted unwanted noise (see Figure 3). It also emerged that, besides aircraft, ground operations were also emphasised as a cause for noise nuisance. These could include engine testing and run-up before taxiing, including the start of roll point, standing aircraft noise on apron and terminal stands, and cargo and maintenance area noise. Although the current noise footprint aligns with the SANS standards, the City of Tshwane Noise Management Policy [18] and the Gauteng Noise Control Regulations [7] both agreed that the illustrated noise footprint is outdated and a more recent noise footprint should be determined. The City of Tshwane also suggested that the determination of a more recent noise footprint should be based on the last time the base operated at full capacity. This will create a worst-case scenario (the most stringent standard) for the existence of noise dangers that can be reflected in development conditions and recommendations. Such a worst-case scenario can buffer the potential expansion of an airbase's operations and

safeguard its mission readiness.

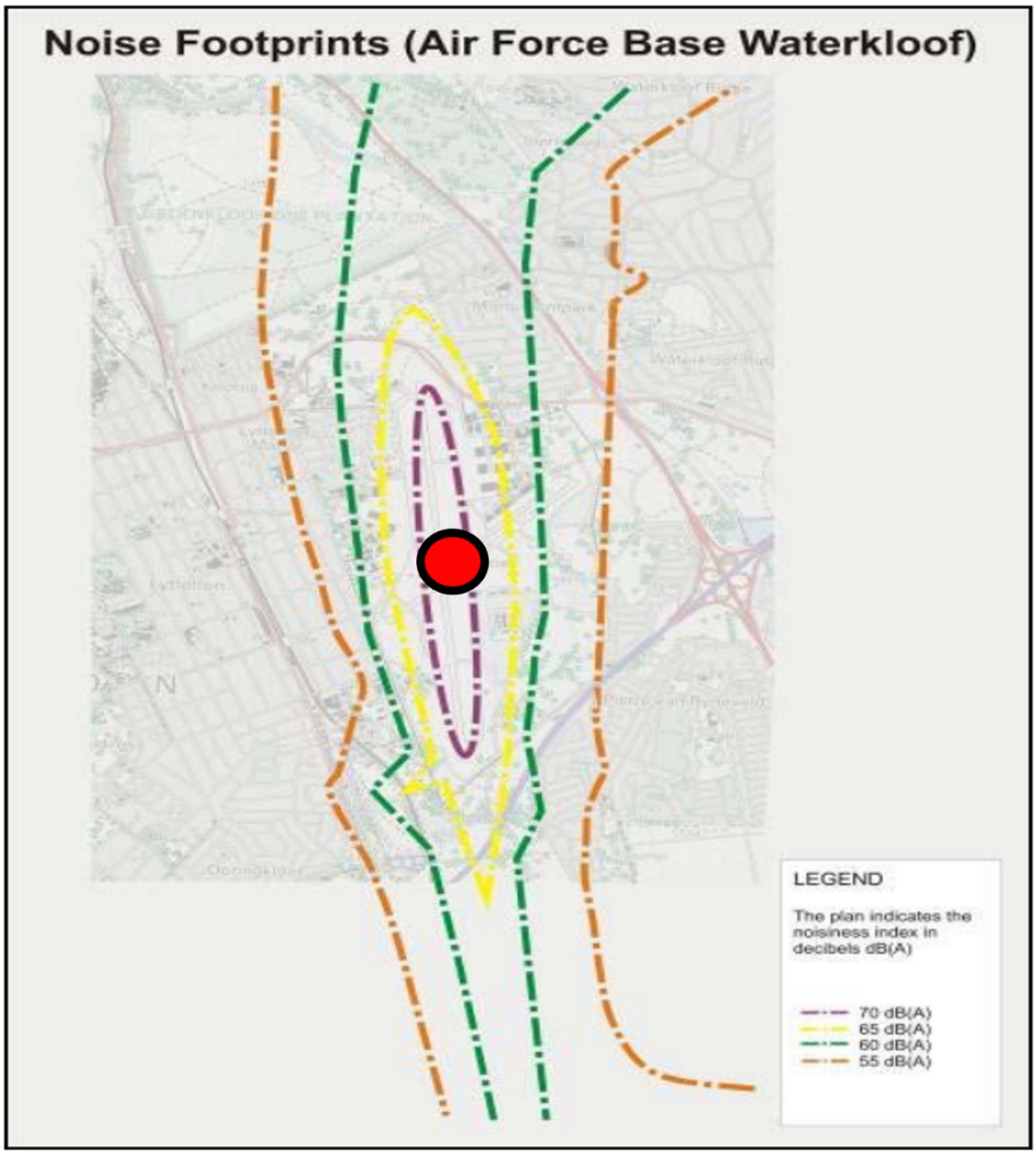

Figure 3. Noise footprint surrounding Airbase Waterkloof

Note: Source: [13]

5.3. *Aviation safety*

Obstacle limitations outside an aerodrome are regulated by the Civil Aviation Regulations[20] according to the Civil Aviation Act [21]. The SARPs imposed by ICAO are applicable, and South Africa, as a member of ICAO, is obliged to comply with these SARPs.

Section 163 of the Civil Aviation Act[21] empowers the Director of Civil Aviation to issue standards for civil aviation. The standards contain rules and requirements which are applicable in respect of particular regulations. It is imperative that an aerodrome should register safeguarding maps (varying obstacle limitation levels designed to impose height as a restrictive condition) with the Local Planning Authorities (see Figure 4) and should receive, from the Local Planning Authority, copies of applications for developments in and within the vicinity of the aerodrome [20].

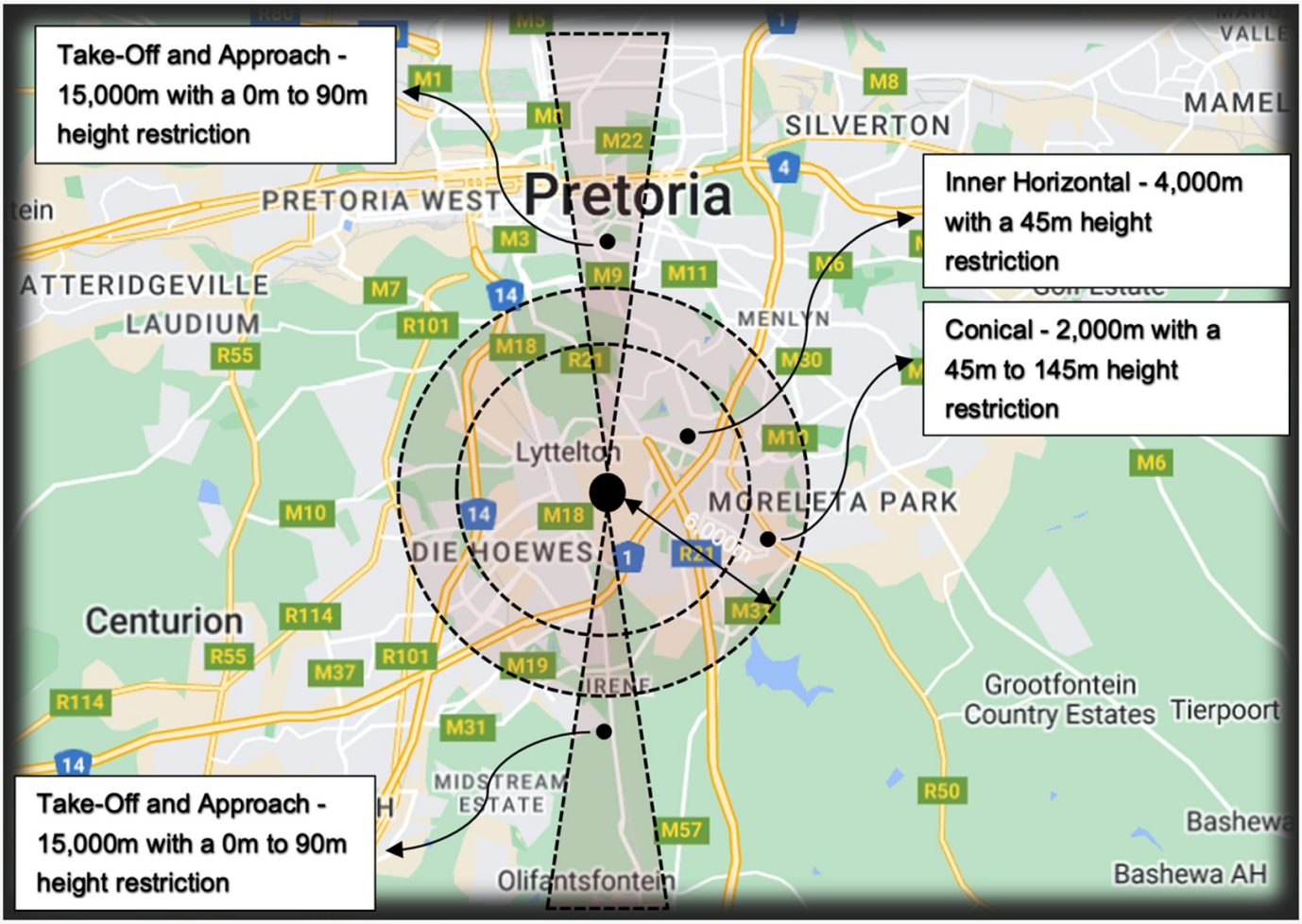

Figure 4. Estimated safeguarding map surrounding Airbase Waterkloof (Conical, Inner Horizontal, and Take-Off and Approach levels in accordance with a Code 4 Instrument runway).

Note: Source: Own compilation

According to the White Paper on National Civil Aviation Policy[19], considering the SANDF's primary mission of defence against acts of war, the SANDF is exempted from the provisions of the Civil Aviation Act [21]. The Air Traffic Navigation Services (ATNS) [22] stipulate that the reason to exclude state aircraft (Military, Customs & Police Services) emanates from the Chicago Convention (CC) on Civil Aviation (Article 3). Therefore, by transposing the CC and ICAO annexes and the Provider of Air Navigation Services (PANS) [23] into National Regulations (Civil Aviation Act and Civil Aviation Regulations and Technical Standards), state aircraft are excluded from the South African Aviation Act. Furthermore, military aerodromes are treated as *"unlicensed"* aerodromes in the South African Aeronautical Information Publication

(AIP) [24]. In retrospect, the SAAF is therefore exempted not only from the regulations and technical standards about civil aviation but also from registering safeguarding maps with the City of Tshwane or any other local authority.

From the deliberations with the SAAF, it emerged that an Obstacle Evaluation Committee (OEC) with the SAAF as the Chairperson was established in 2012. The OEC comprises members from SACA, ATNS, SAAF Aeronautical Information Services, SAAF Communications Spectrum, SAAF Environmental Services, and SAAF Town Planning. The Committee was established to debate and evaluate all developments and applications for potential infringements surrounding an airbase. Furthermore, the SAAF's Environmental and Town Planning services keep a register of all potential developments in and around military bases to guide and advise on the probable risks that can be expected.

Lastly, according to the White Paper on National Defence for the Republic of South Africa[25], apart from runways and infrastructure provision, many variables, such as restricted airspace, aerial approach zones, and safety areas (obstacle limitation surfaces), are taken into account in determining the size of an air force base (see Figure 4). This implies that the area surrounding an airbase is a critical consideration in determining an airbase's military capacity and mission readiness.

6. Planning implication

Most countries feature some sort of protection legislation as part of their national law[4]. The South African Constitution contains the most important legal rules and is interpreted to offer protection. Respondent [8] raised the question: if the Constitution is interpreted to offer protection, then under which jurisdiction does air traffic lie? Is it national, provincial, or local government? And which departments' skills and expertise are required to deal with it?

As far back as the 1970s, the then-head of the SANDF declared that the SANDF has a responsibility for the orderly planning and development of the country [26]. An instruction was given to the Head of Staff Logistics to get involved in the country's spatial planning actions. A hierarchy of spatial military plans was being formulated to create a basis for spatial planning in the SANDF. A start was made with the arrangement of regional studies, and in 1981, the SANDF Physical Development Guideline was published to establish clear guidelines within which development should take place based on the existing situation (military, economic, and political) and potential future expectations [27]. However, it is unclear if another version of the SANDF Physical Development Guideline was published or if any subsequent spatial plans were developed to denote the SANDF's involvement in the country's spatial planning actions.

With the demise of apartheid in 1994 and after two and a half decades of isolation, South Africa was welcomed back into the international community. In 1996, the White Paper on National Defence for the Republic of South Africa [25] was drafted with the intent to serve as a confidence- and security-building measure in southern Africa. The White Paper is described as a subset of government policy which is concerned with countering military threats and with the orientation, preparation, maintenance, and employment of armed forces. The overarching theme of the White Paper is the transformation of defence policy and the SANDF in light of political and strategic developments occurring at national, regional, and international levels. It not only establishes a policy framework but also the main principles of defence which accentuate mission readiness. Currently, South Africa engages in defence cooperation with several countries and

participates in regional security arrangements under the auspices of the Southern African Development Community (SADC).

In 2020, the SANDF, in support of the Government and its ongoing commitment to building a stronger and more effective State, published its latest Strategic Plan (2020 to 2025). The Strategic Plan has been developed in support of the National Development Plan (NDP) [28], stating that the role of defence will find expression in support of the Government and support to the national security architecture of the country at domestic, regional, and continental proportions [29]. South Africa adopted the NDP [28], referred to as a 'super plan' to transform economic and social inclusion. As an outflow from the NDP, South Africa also adopted Spatial Development Frameworks (SDF) [30] ranging from national to local. SDFs are the collective vision of government, businesses, and civil society to promote economic and social inclusion. These policies and legislation provide guidelines relating to spatial development, whether it is at a national, provincial, regional, or local level [31].

From the deliberations, it emerged that in accordance with Chapter 4 of the Municipal Systems Act[32], municipalities are required to consult and involve communities, interested or affected individuals, organisations, and government entities in the drafting of development frameworks. Public participation is a key element of a good governance system. The White Paper on National Civil Aviation Policy [19] alludes to this, stipulating that public participation is particularly relevant to the preparation of SDFs and Integrated Development Plans (IDPs). The White Paper is very clear on the importance of integrated development planning, stipulating that the planning and operations of an aerodrome need to balance the aerodrome's interests with those of stakeholders in the vicinity of the aerodrome. This balance implies that 1) the aerodrome needs to fit into and be in harmony with its environment, and 2) the authorities responsible for the area surrounding an aerodrome need to facilitate the integration of the airport into its environment and support the development and effective operations of the aerodrome. The Municipal Systems Act requires Spatial Development Frameworks and detailed plans reflecting land use and planning ordinances and municipal by-laws to be followed during development processes. This is evident from the Tshwane Metropolitan Spatial Development Framework (MSDF) [33] placing emphasis on integrated planning that enjoys the cooperation and contribution of different sector departments, different spheres of government, state-owned entities, and the private sector in order to programme and implement development that is geared towards achieving a shared set of development outcomes. Although the MSDF [33] provides a broad framework of reference and spatial directives in order to achieve spatial transformation within Tshwane, the SAAF as a governmental entity is restricted to a process of public participation. Such a restriction does not furnish the SAAF with the opportunity to support the built environment in an equitable manner, balancing land uses and infrastructure requirements, optimising public access, and creating liveable urban precincts. This is apparent considering that although the strategic operations of an airbase cannot be compromised, the SAAF makes every effort to comply with regulations that are not in contradiction with operations and military objectives. The SAAF established an Obstacle Evaluation Committee (OEC) to investigate developments and applications for potential infringements and lay out internal operational instructions to contain or direct noise nuisance. However, although measures around noise nuisance and obstacle limitations are clearly defined, the SAAF mainly furnishes its inputs and recommendations through the process of public participation. The City of Tshwane is not a partaking member of the Obstacle Evaluation Committee (OEC). Therefore, the existing situation is that noise

nuisance and aviation safety management are not integrated as mandatory regulatory compliance (adherence to laws, regulations, guidelines, and specifications) into the drafting of local government policies and development frameworks.

7. Synthesis

7.1. *Noise management*

To overcome the lack of integration and to endow the SAAF with some level of autonomy (self-governance), the following are proposed as potential recommendations:

1. Given the fluctuating nature of an airbase's operations due to expansion, it is recommended to frequently determine the noise footprint (main impact area as illustrated in Figure 3) surrounding an airbase by the SANS standards, the local authority's Noise Management Policy, and the Provincial Noise Control Regulations.
2. As suggested by the White Paper on National Civil Aviation Policy, it is advisable to establish an Environmental Committee that can address and mitigate all noise-related enquiries and complaints.
3. It is proposed to incorporate the noise footprint surrounding an airbase as mandatory regulatory compliance (adherence to laws, regulations, guidelines, and specifications) as part of drafting local government policies and development frameworks.

7.2. *Aviation management*

1. Developments, or construction of new buildings and infrastructure like masts, power lines, or objects, whether temporary or permanent, located in and around the vicinity of an airbase, should be evaluated for infringement on the obstacle limitation surfaces established around an airbase by the South African Civil Aviation Regulations, i.e., in accordance with obstacle limitation levels generated as SARP's by ICAO.
2. It is necessary to define the volume of airspace that should ideally be kept free or safeguarded from obstacles and to take the necessary measures to ensure the safety of aircraft.
3. The construction of new buildings and infrastructure, whether temporary or permanent, located in the defined airspace, should not come into existence without the prior approval from the SAAF.
4. Although exempted from the Civil Aviation, it is recommended to register a safeguarding footprint (varying obstacle limitation levels designed to impose height as a restrictive condition as illustrated in Figure 4) with the relevant local planning authorities.
5. It is proposed to incorporate the safeguarding footprint (obstacle limitations) surrounding an airbase as mandatory regulatory compliance (adherence to laws, regulations, guidelines, and specifications) as part of drafting local government policies and development frameworks.

8. Conclusion

The paper sets out to investigate the degree of unity between the spatial footprints generated by noise emission and aviation safety as products of air traffic movement, and the immediate surrounding built environment implicated. The aim was to negate the mission readiness of an airbase if the spatial footprints generated are not appropriately directed and managed. Part of the investigation was to examine the compatibility, or lack thereof, of current legislative conditions (spatial planning frameworks and policies) that prevail between the SANDF, SAAF, National and Local Government, with a focus on the greater Tshwane Metropolitan region, with airbase Waterkloof as the case in point. The primary challenge associated with airbase presence is the encroachment issue and the potential impact the built environment can have on the spatial footprints generated as products of air traffic movement, which can ultimately compromise an airbase's mission readiness.

The SAAF forebears did anticipate the implications around noise nuisance and flight safety, and Airbase Waterkloof was originally constructed near the city edge outside Pretoria. However, they couldn't anticipate the rate of progress, and due to urban expansion, the airbase has since been surrounded by suburban areas. Currently, Airbase Waterkloof represents the largest military operational support base within South Africa. Not only does it provide a crucial military role, but it is also the primary airport landing facility for high-ranking delegates, making it an indispensable airbase. Furthermore, considering that legislative conditions around obstacle limitations and unwanted noise are well documented and jurisdiction is distinctly delineated, one would have expected the integration of Airbase Waterkloof into its surrounding urban environment to be effortless. Integration against legislative conditions would not only safeguard the surrounding urban environment against noise and potential flight disasters but would also secure the effective operations of the airbase. Adding to the complexity is the fact that the SAAF is exempted from the Civil Aviation Act. The SAAF doesn't have to comply with the required standards for civil aviation, although the SAAF did establish an Obstacle Evaluation Committee (OEC) with Civil Aviation as a participating member. However, the City of Tshwane, as the prevalent Local Government, is not a participating member. The existing situation is that integration is restricted to a process of internal regulations (SANDF, SAAF, National and Local Government) and public participation, which is clearly not adequate when striving to attain harmony between an airbase and the surrounding built environment. One can surmise that from a legislative perspective, there is unity that secures an airbase's mission readiness, but from an integration perspective, there is a lack of unity which may negate the productivity of an airbase. In conclusion, to overcome the lack of integration and to accommodate the presence and mission readiness of an airbase, the paper devised potential recommendations (see synthesis) for consideration.

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