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South Africa Airside Capacity Enhancement Study for Air Traffic Navigation Services

Task 6 Report: Specifications and Recommendations

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LIST OF ACRONYMS

AAR ....Airport Arrival Rate

AASA....................Airlines Association of Southern Africa

ACSA....................Airports Company South Africa

ADR ....Airport Departure Rate

ADS-B..................Automatic Dependent Surveillance Broadcast

AFT ....Airport Flow Tool

ALPA-SA.............Air Line Pilots' Association South Africa

ANSP ....Air Navigation Service Provider

A-SMGCS............Advanced Surface Movement Guidance & Control System

ATC.......................Air Traffic Control

ATCT ....Air Traffic Control Tower

ATNS ....Air Traffic Navigation Services

CAA ....Civil Aviation Authority

CAMU..................Central Airspace Management Unit

CAT.......................ILS Category

CBOT……………Controlled Off-block Time

CTOT ....Calculated Take-off Time

FAA.......................Federal Aviation Administration

FACT ....Cape Town International Airport

FAOR....................OR Tambo International Airport

FALA ....Lanseria Airport

FAPM....................Pietermaritzburg Airport

FALE.....................King Shaka International Airport

FAVG....................Virginia Airport

FAYP ....Ysterplaat Airport

GA.........................General Aviation

IACM ....Integrated Airport Capacity Model

ICAO.....................International Civil Aviation Organisation

IFR ....Instrument Flight Rules

ILS........................Instrument Landing System

LVO ....Low Visibility Operations

LVP......................Low Visibility Procedures

MAP.....................Million Annual Passengers

NextGen ....FAA Next Generation Air Transportation System

NM ....Nautical Mile

PBN......................Performance Based Navigation

TFM ....Traffic Flow Management

TMA.....................Terminal Control Area

R...........................South African Rand

RNAV ....Area Navigation

ROT......................Runway Occupancy Time

RVR ....Runway Visual Range

RWY ....Runway

SID ....Standard Instrument Departure

SSI........................Station Standing Instructions

STAR ....Standard Terminal Arrival Route

TMA.....................Terminal Control Area

TMI ....Traffic Management Initiative

TOBT……………Target Off-block Time

TSAT…………….Target Start-up Approval Time

TWY ....Taxiway

USTDA ....United States Trade and Development Agency

VFR......................Visual Flight Rules

VMC ....Visual Meteorological Conditions

1 Introduction

Air Traffic and Navigation Services (ATNS) and Airports Company South Africa (ACSA) have engaged Metron Aviation, Landrum & Brown, and ACA Associates (study team) to conduct a South Africa Airside Capacity Enhancement Study (SA ACES). This report provides recommendations for implementation for a set of airside capacity enhancements researched in Tasks 1 through 5. To assist ATNS, ACSA, and other stakeholders with the evaluation of the airside capacity enhancements, the study team collected additional information, such as high-level performance specifications, suggested evaluation criteria and budget guidelines that will assist in making selection decisions.

1.1 Background

This section restates the purposes of the five previous tasks in order to show the lead in to this report. The findings from each of the reports provide the foundation on which this report stands.

1.1.1 Task 1

For Task 1, the study team gathered relevant airside and airspace data in order to gain support for the initial plan and proposed methodologies for future tasks. The study team met with ATNS and ACSA to identify the specific operational challenges of FAOR, FALE, and FACT, and gain an understanding of ATNS's and ACSA's financial and procurement processes.

1.1.2 Task 2

Under Task 2, the study team analyzed the operational constraints identified in Task 1 and recommended a set of enhancements that may address the challenges. Additionally, this task validated the current capacity through the use of Metron Aviation's Integrated Airport Capacity Model (IACM).

1.1.3 Task 3

The Task 3 report[1] provides the methodology and major assumptions for conducting a financial and economic analysis of the recommended enhancements. These items are recapped in Table 1. In addition to the assumptions discussed in the prior report, the analysis in this report makes use of the following cost estimates:

1. New taxiway pavement construction costs are taken from an Excel spreadsheet provided by ACSA and included as Appendix A. The rates of R3000 per m^2 at FAOR and FALE (Category F), and R 1750 at FACT (Category E) are used to approximate the capital cost of pavement construction. The analysis does not take

[1] Metron Aviation, "SA ACES for ATNS, Task 3 Report: Economic and Financial Analysis". 13 March 2013

any other implementation costs into account or additional ongoing operational costs (such as maintenance) when considering additional pavement.

2. A professional-grade labor rate of R3000 per day is used to estimate the implementation cost of operational enhancements. The number of days required to implement these enhancements is estimated based on the experience of the study team and discussions with ATNS and ACSA.

Table 1: Financial Analysis Assumptions Recap

Measure	Value
Traffic forecast	Mac MacDonald 2012 base case
Costs	
Code E Airports Taxiway pavement construction (R /m^2)	R1,750
Code F Airports Taxiway pavement construction (R /m^2)	R3,000
Professional labor rate (R/day)	R3,000
Benefits	
Aircraft cost (R/hour)*:	
FAOR	R 34,260
FALE	R 29,160
FACT	R 28,260
Passenger time (R/hour)*	R500
Financial	
Discount rate*	12%
* See Task 3 Report for description	

1.1.4 Task 4

The purpose of Task 4 was to review South African laws, regulations, and standards that may impact the implementation of airside capacity enhancements and determine how South Africa's procurement rules and regulations and the internal procurement processes of ACSA and ATNS are likely to affect the implementation of this recommended enhancements.

1.1.5 Task 5

Task 5 was a subjective review of the potential environmental effects of the recommended capacity enhancements affecting airspace and airport operations, but was not a full-scale environmental analysis. The task focused on both the positive and negative implications of the capacity-enhancing capabilities from an environmental perspective.

1.2 Task 6 Report Organization

Section 2 provides recommendations for each enhancement, including a description, performance specifications where applicable, estimated budget requirements, recommended next steps, and recommended groupings of enhancements.

Section 3 describes the evaluation criteria to be considered during the implementation decision-making process. This section also introduces the idea of enhancement triggers for deciding when to initiate implementation.

Section 4 is a list of recommended, qualified vendors required for the implementation of the capacity enhancements.

Section 4 summarizes the recommendations and specifications and discusses the next steps.

2 Recommended Capacity Enhancements

This section presents the recommended enhancements for FAOR, FALE, and FACT. For each enhancement, where applicable, a table of specifications was completed. In many cases, the process required to develop a set of detailed specifications is beyond the scope of this study. Further discussions with ATNS, ACSA, and stakeholders are required to gather appropriate data and information, and to initiate this process.

The enhancement recommendations in this document are grouped similarly to the preliminary Environmental Impact Assessment (EIA) grouping used in Task 5 and shown in Table 2 below. The groups are referred to as "Efficiency Groups" due to their potential changes to operation. This method of grouping provides consistency between Task 5 and this statement of recommendations. Furthermore, this grouping will be carried forward through to Task 8, Implementation Plan. The columns in Table 2 provide the reader with an understanding of the specific elements of the group and the location of a more detailed description within this document. The "Capacity Enhancement Category" is the recommended enhancement. The "Impact Area" is a designation of what segment of operations will be affected, be it "Airspace" for changes to airspace operations and procedural changes or "Airside" for changes to airside operations or physical changes to the airfield layout. The "Candidate Capacity Enhancement Initiative" specifies more detail for the "Capacity Enhancement Category" when multiple initiatives contribute to the overall enhancement. "Document Section" is a reference to a more detailed definition of the "Candidate Capacity Enhancement Initiative."

Table 2: Recommended Enhancements

Efficiency Group	Capacity Enhancement Category	Impact Area	Candidate Capacity Enhancement Initiative	Document Section
Runway/Taxiway Utilisation Focus for Greater Throughput	Minimum required separation on final approach	Airspace	• Apply Minimum Authorised Separation on Final • Reduce Minimum Separation	2.1.1
	Low Visibility Procedure operations	Airspace	Review Low-Visibility Operations	2.1.5
	Addition of RETs	Airside	• Add RETs to RWY03L/21R (FAOR) • Add RETs to 03R/21L, refine Echo, and add additional RET (FAOR) • Add RETs (Rwy24) for direct access to Alpha & Bravo apron gates (FALE) • Realignment of Runway Exits (FACT)	2.3.1
	Near-term Implementation of Master Plan	Airside	• Add extended taxiway pavement at the end of RWY03L (FAOR) • Near term implementation of Master Plan improvements (FAOR)	• 2.3.1 • 2.3.3 • 2.3.5
Airfield Operational Efficiencies	Pilot Reaction Time (PRT)	Airspace	Readiness for Imminent Departure (Improved Pilot Reaction Times)	2.1.2
	Increase Holding Point areas and frequency	Airfield	• Multiple Departure Line-up Queues • Multiple Intermediate Departure Holding Points • Add CAT I hold lines and allow CAT I holds pre-departure • Parallel By-Pass Taxiway (FACT)	• 2.3.3 • 2.3.4 • 2.3.7
	Intersection Departures	Airspace	Intersection Departures	2.3.2
Efficient Runway & Arrival/ Departure Capacity Utilisation	Departure Sequencing	Airspace	Departure Sequencing	2.1.3
	Performance Based Navigation	Airspace	• Performance-Based Standard Instrument Departure • Performance-Based Navigation	2.1.13

Efficiency Group	Capacity Enhancement Category	Impact Area	Candidate Capacity Enhancement Initiative	Document Section
Efficiency & Predictability in Taxiway Utilisation	Standard Taxi Routes	Airfield	Standard (Coded) Taxi Routes	2.2.1
Balancing of Arrival/Departure Demand	Arrival/ Departure Balancing	Airfield	• Arrival/Departure Balancing • Increase mix ops/arrivals on RWY03L/21R (FAOR)	• 2.3.8
Updates to Airport Flow Tool for Better Airport/Airspace Management	Airspace Review and Redesign	Airspace	• Airspace Review and Redesign • Modify Airport Flow Tool (AFT) to do better airspace management, GDPs, AFPs	• 2.1.4 • 2.1.10
Efficiencies Based on Conditional Clearances	Conditional Clearances	Airspace	Conditional Clearances	2.1.6
Peak Demand/Non-Std. Ops. Performance Limits & Traffic Management	Limiting Operations During Periods of Day	Airspace	• Limit Operations during Peak Periods • Limit Operations of Non-Standard Performance • Tower Coordinator • Traffic Management Coordination	• 2.1.7 • 2.1.12 • 2.1.9
	Utilisation of remote gates (FALE)	Airfield	• Utilise remote gates (FALE)	2.3.6
Airfield & Airspace Slot Optimisation	Slot Optimisation and CTOT Compliance	Airspace	• Slot Optimisation • CTOT	2.1.8
Traffic Management Coordination	Supervisory staff in ATCCC (Traffic Management Coordination)	Airspace	Supervisory staff in ATCCC	2.1.9
Airspace/Airport Demand Prediction Awareness	VFR traffic included in traffic demand predictions	Airspace	Use historical VFR demand predictions, or restrict VFR traffic	2.1.11

2.1 Airspace Capacity Enhancements Recommendations/Specifications

The following subsections describe the airspace capacity enhancements. A specification table is provided at the end of each section.

2.1.1 Minimum Required Separation on Final Approach

This enhancement recommends that under nominal operational conditions, ATNS space aircraft at a minimum of four nautical miles (NM) on final between like wake vortex categories and not provide additional buffers in spacing. Spacing aircraft at minimum increases the arrival rate, and thereby increases an airport's effective capacity. Spacing aircraft at minima requires the ability to manage an increase in the controller workload resulting from closer monitoring, more precise speed control, and increased communication with pilots. In addition, pilot adherence to assigned speeds is a necessity. Current ATNS separation rules require a minimum of five NM (which may be increased based on the combination of leading and following aircraft) between two successive arrivals. Internationally, in the United States for example, airports operate safely and efficiently at separation standards of less than five NM (below three NM at some airports). The reduction in separation to four NM would require the following:

- A certified single sensor airport surveillance radar (ASR) or digital automation system that allows for the flight to be identified up to 40 NM from the antenna.
- Terminal separation standards that allow for longitudinal separations less than or equal to four NM between aircraft.
- The following wake vortex turbulence separation requirements for flights operating directly behind, directly behind and less than 1000 feet below, or following an aircraft conducting an instrument approach.
  - Light behind a large (medium wake vortex category) – four NM.
  - Light behind a B757 – five NM.
  - Light behind a heavy – six NM.
  - All like types as leaders and followers – four NM.

It is also recommended that ATNS take the following criteria into consideration when implementing new departure procedures, which will allow the reduction of departure separation to below two minutes between successive departures, allowing for increased runway throughput.

- A certified single sensor ASR or digital automation system that allows for the flight to be identified up to 40 NM from the antenna.
- Terminal separation requirements that allow for longitudinal separations less than or equal to four NM between aircraft.
- Radar identification with the aircraft is established within one mile of the takeoff runway.
- Between aircraft departing the same runway or parallel runways separated by less than 2,500 feet− separation will be one mile if courses diverge by 15 degrees immediately after departure; otherwise use terminal separation value if flights do not diverge. (This will require implementation of revised SIDS).
- Separate IFR/VFR aircraft taking off behind a heavy jet/B757 departure by a minimum of two minutes.

Continued research into the requirements for FAOR, FALE, and FACT to reduce separation minima in VMC conditions is necessary including research into ICAO and CAA regulatory requirements. This research, along with certification, radar equipment updates (if necessary), procedural updates, and training are the bulk of the costs for this enhancement.

In the Task 2 report, IACM was used to estimate the new capacities based on the reduced separation, and then applied the new capacities to a two-week sample of historical airport flow tool data to assess the benefit between the current declared rates and the higher rates based on reduced separation. The benefit is estimated to be between five and ten seconds of delay reduction per flight.

Table 3: Separation Specifications

Specification	Description
Budget	Costs estimates may include: • South African CAA approval process for reduce separation requirements • Training • Certification for terminal radar systems • Cost of STAR/SID development/simulation
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	N/A
Regulations	• ICAO Annex 11 • ICAO PANS-ATM • ICAO Doc 9689 • ICAO Doc 9859
Guidance	• Safety Assessment: Annex 11 and PANS-ATM direct States to undertake safety assessments for significant changes in airspace organisation, ATS procedures or the introduction of new equipment, systems or facilities. • Information on performing safety assessments is contained in the Manual on Airspace Planning Methodology for the Determination of Separation Minima (Doc 9689) and in the Safety Management Manual (Doc 9859). • CARS and Cats: These regulations would probably not require amendment • AIP, SSI's: Amendments required • User consultation: Required

2.1.2 Pilot Reaction Times (Improved Readiness for Imminent Departure)

In the context of this study, the pilot reaction time (PRT) is the time difference between when an aircraft is cleared for take-off and when the aircraft starts its take-off roll. Runway occupancy time (ROT) is a key element in airport capacity and PRTs can have significant impact on ROTs. This enhancement is focused on ensuring that when pilots are instructed to occupy the runway in preparation for departure (line up and wait) or are cleared for take-off, that they do so without delay. This delay either results from performing tasks that could have been done earlier, or from a slow reaction to an ATC clearance. Minimising these reaction times reduces runway occupancy time and as a result, increases an airport's effective capacity. The effectiveness of this enhancement is dependent on pilots' awareness of the impact that delays between receiving a clearance and complying with it has on airport capacity and executing clearances in a timely manner. Expeditious compliance with an ATC clearance is common at most major airports in the world.

It is recommended that PRTs be monitored on a twice per year cycle at the three airports. Whatever procedure is used to monitor the PRTs, it must be followed precisely in each instance to ensure correct and accurate monitoring. Staff carrying out the timing measurements must have good understanding that the effort is to measure the time difference between when the take-off clearance is given and the commencement of take-off roll. PRTs can be categorized in a number of ways, but could be by: operator, aircraft type within an aircraft operator's fleet, and overall aircraft type. Graphs should be produced which will clearly show actual PRTs, improvements in PRTs over time, and/or trends. ATNS and ACSA should meet with aircraft operators after each survey and discuss the associated results.

When aircraft operators are identified that have significantly higher average PRTs, they should be engaged to explore potential improvements to their procedures. For example, pilots could conduct pre-departure checklists prior to requesting takeoff clearance rather than after receiving a take-off clearance

International operators often have the highest average PRTs. While it can be challenging to engage international operators, the airlines' operational departments should still be contacted in order to bring the anomaly to management's attention.

ATNS and ACSA need to be able to demonstrate that all initiatives, no matter how small, will provide increased throughput or improved system efficiency.

Performance specifications can be developed after a series of surveys have been carried out. Internationally, a PRT of 6 seconds is considered to be average.[2]

[2] Operational Performance and Airport Capacity Assessment for Brisbane Airport – National Air Traffic Services

Table 4: PRT Specifications

Specification	Description
Budget	Minimal costs to conduct periodic reviews of PRTs, maintain data, and conduct supporting analyses.
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	A standard PRT will need to be set for each airport (the study team recommends 6 seconds as an initial bench mark). However, the PRT standard will not be fixed, but evaluated every 6 months or so.
Regulations	No regulations needed.
Guidance	ATNS, ACSA

2.1.3 Pre-Departure Sequencing Automation Improvements

ATNS has implemented a very sophisticated air traffic flow management (ATFM) system which issues calculated take-off times (CTOT) to all flights departing and arriving at FAOR, FACT, and FALE. Because this airport flow tool (AFT) is a strategic/pre-tactical scheduling tool, it lacks the ability to carry out tactical departure sequencing. In addition to the sophisticated ATFM system, ACSA has implemented Airport Collaborative Decision Making (A-CDM) processes at all three airports. The application of these two processes can be optimized by engaging pre-departure sequencing.

Improved departure sequencing helps to improve runway utilization. This is accomplished by taking into account factors such as variable taxi times, wake turbulence separation, the assigned departure procedure, and aircraft departure performance in order to reduce the spacing between successive departures.

Pre-departure sequencing is best exercised with full implementation of A-CDM. The aim of pre-departure sequencing is to enhance flexibility, increase punctuality and improve slot adherence by practicing all the other elements in A-CDM: Information-sharing, Milestone Approach, Variable Taxi time, Adverse Conditions and Collaborative Management of flights. A-CDM is a concept that promotes intense collaboration among stakeholders and relies on the timely exchange of high-quality information, which can then be interpreted in exactly the same way by all partners.

In support of this improvement, it is recommended that a pre-departure sequencing tool be procured by ATNS/ACSA to manage the tactical sequencing. The tool should be able use the Controlled Off-block Time (COBT) issued by the AFT as the initial Target Off-block Time (TOBT). Based on aircraft progress and the tactical traffic situation on the movement areas, ATC can provide a Target Start-up Approval Time (TSAT), which places each aircraft in an efficient pre-departure sequence. This results in regulated traffic flows towards the runways. Controllers remain responsible for ensuring runway throughput, the efficient use of capacity, and the maintenance of safety.

As stated earlier, ATNS and ACSA are fortunate that they have implemented ATFM and A-CDM at all three study airports. The potential benefits of implementing full A-CDM and integrating the two systems will lead to greater benefits for the aviation community. Pre-departure sequencing cannot be successfully implemented in isolation. All of the elements of A-CDM must be implemented to be effective. The process of full A-CDM implementation, as laid out in the EUROCONTROL Airport CDM Manual, is therefore recommended.

Table 5: Departure Sequencing Specifications

Specification	Description
Budget	R4.5million
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	N/A
Regulations	ICAO and CAA regulations need to be adhered to
Guidance	ATNS, ACSA, SADOT, and SACAA guidance will be required for implementation.

2.1.4 Airspace Review and Redesign

This recommendation is for airspace review and redesign in the three Terminal Control Area (TMAs) that serve the study airports. As the study has revealed, there are constraints in the TMAs that lead to capacity restrictions at the three study airports.

In the case of FAOR, the capacity of the satellite airfields contributing to the TMA demand is greater than the capacity of the FAOR TMA. Presently, the demand for the satellite airfields does not often exceed the capacity of the TMA; however, there are instances when demand at Lanseria (FALA) does push the TMA airspace to capacity. Recently, effective TMIs were initiated at FALA, which address this issue.

It is understood by the study team that a complete review and re-design of the Gauteng airspace is underway. This effort is timely and it is recommended that the study concentrates much of its attention on the airspace design in the north western sector of the TMA because most of the constraints brought to the study team's attention were in this region. Procedures to de-conflict FALA traffic from FAOR traffic need to be developed. Once this is done, amendments to the airspace can be designed to best accommodate these flows. This may require re-location or curtailment of sport aviation in the vicinity of the three airports.

It is also recommended that a complete study be done to analyse the benefits of implementing an approach control service for FALA from the FAJS ATCC.

Presently, Wonderboom (FAWB) does not generate significant demand. There are plans, however, to develop the airfield which could lead to additional demand in the future. The anticipated increase in demand should be considered during this study.

While there are less apparent airspace redesign issues at FALE, the impact of Virginia (FAVG), Richards Bay (FARB), and Pietermaritzburg (FAPM) airspaces should be continually reviewed to ensure airspace design meets procedure requirements. The development of PBN procedures (Section 2.1.13) may require review and redesign of the FALE airspace.

At FACT, there is less demand placed on the TMA by satellite airfields with the exception of Ysterplaat (FAYP). However, FACT airspace is complex, as most of the traffic arrive and depart through a 110 degree arc. Additionally, the terrain plays a major role in the design of procedures and airspace. The development of PBN procedures (Section 2.1.13) (in addition to the existing South African Airways PBN procedures) may require review and redesign of the FACT airspace.

A process for approaching airspace redesign has been established in the Airspace Management Handbook[3] within the United States (US) Federal Aviation Administration (FAA) to analyze airspace changes. The handbook outlines an eight-step process to conduct and evaluate airspace redesign:

1. Characterize the Problem
2. Perform Initial Evaluation
3. Initiate Airspace Study
4. Conduct Airspace Study
5. Summarize and Present Results
6. Select Airspace Change
7. Plan Implementation at Field Facility
8. Evaluate After Implementation

While these eight steps are high-level steps, each one contains detailed information to proceed in the analysis with the following highlights related to key elements of each step. Note that some airspace redesign and analysis may have already begun for certain areas related to the three terminal area ATC environments in South Africa; however, this process can be used and adapted as necessary to ensure critical components of the airspace review and redesign process are successful.

[3] Federal Aviation Administration; Airspace Management Handbook, Version 2.2, December 2005, Mitre Corporation; document completed under the National Airspace Redesign Program.

Table 6: Airspace Review and Design Specifications

Specification	Description
Budget	Average of ~$300,000 USD per terminal area. Highly dependent on level of modeling and simulation and required coordination
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	ATNS airspace redesign standards
Regulations	Environmental Impact Assessment (EIA) Regulations, Implementation of Sections, 21 22 & 26 of the Environment Conservation Act, April 1998
Guidance	ATNS, ACSA

2.1.5 Low Visibility Procedures Review

Low visibility procedures (LVP) are instituted when the cloud ceiling is at or less than 200 feet and the runway visual range (RVR) is at or less than 600 metres. This requires air traffic control to increase separation between successive arrivals to maintain safety. The current LVPs for FAOR, FALE, and FACT ensure that the separation minima for VMC conditions are doubled to 10 NM, by increasing the separation to 12 NM and sometimes 16 NM between successive aircraft. The added separation is to protect the ILS localizer sensitivity area by requiring no movement within the sensitivity area while an aircraft is within 10 NM of the runway threshold. The overall effect reduces the airports' arrival capacities to less than half that of their normal values.

The added separation to protect the localizer sensitivity area may be conservative and warrants further investigation. Other airports, such as those in some European states, have reduced separation to two NM between runway threshold crossings and required no movement in the localizer sensitivity area for its protection. The study team recommends a more extensive study to compare LVP for FAOR, FALE, and FACT with those of similar airports based on fleet mix, fleet equipage, runway layout, weather, terminal area automation, and ILS. The goal of the analysis would be to establish new LVP separation standards that could increase the capacity of the airport during periods of inclement weather.

Table 7: Low Visibility Operations Specifications

Specification	Description
Budget	The resources allocated to the task will determine the budget.
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	N/A
Regulations	• CAO Doc 9476 Manual of Surface Movement and Guidance Control Systems, Chapter 5 • ICAO Doc 9830* Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual. • IR-OPS Subpart E Low Visibility Operations (LVO) • Acceptable Means of Compliance (AMC) and Guidance Material (GM) to IR-OPS Part-SPA • EU-OPS 1 Subpart E (All Weather Operations). • UK CAP 168: Licensing of Aerodromes, Appendix 2B • European Action Plan for the Prevention of Runway Incursions, All Appendices • ICAO Doc 9870 App B - Best Practices on the Flight Deck • European Action Plan for the Prevention of Runway Incursions App D - Flight Crew Best Practices • ICAO Doc 7013* "European Guidance Material On Aerodrome Operations Under Limited Visibility Conditions
Guidance	• AIP, SSI's: Amendments required • User consultation: Required

2.1.6 Conditional Clearances

Conditional clearances are procedures designed to expedite traffic flow on the airport surface when the surface weather conditions are VMC. The practice of conditional clearances is used frequently in the United States to maintain the flow of traffic but it is applied at the discretionary judgment of the controller and conditional clearances must be acknowledged by the pilots.

Given the current traffic levels in South Africa, conditional clearances pose little short-term benefit due to the duration and volume of traffic at the study airports and due to the mandatory smoothing of demand via the AFT tool.

If the reductions in separation minima, improvements in departure sequencing, and enhancements to the AFT flow control process are successful, then conditional clearances may provide additional benefits. However, those benefits may only be on the order of tens-of-minutes per day, which is a fraction of the benefit from other recommendations presented in this document.

Table 8: Conditional Clearances Specifications

Specification	Description
Budget	To be determined by ATNS, but should include: • training of controllers and pilots on new procedures.
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	N/A
Regulations	ICAO and CAA regulations need to be adhered to
Guidance	ATNS, ACSA, SADOT, and SACAA guidance will be required for implementation.

2.1.7 Limiting Operations to certain aircraft categories during periods of day

It is recommended that ATNS and ACSA, through a consultative process with aircraft operators, identify times of the day when it would be beneficial to have aircraft in similar wake turbulence categories or of similar performance types operate. Furthermore, aircraft may be separated in space by assigning them to separate runways and routes (in the case of FAOR only). This enhancement may be implemented by excluding certain classes of operations during specific time periods. The exclusion must specify its scope. An example of scope may be to outline what General Aviation (GA) operations are restricted at what times; e.g., only RNP-equipped GA during an arrival push at FAOR. The scope may also be defined by assigning different approach or departure fixes that segregate the fleet mix for more efficient operations. Currently, the overall large separation minima overshadow the benefits from specific wake vortex separations between two flights. Given a reduction under the rules in the first recommendation (Section 2.1.1), the focus would be to separate the light category from the heavy category and B757s.

One significant challenge presented by limited operations is the perception of inequity by the excluded airspace users. In order for this enhancement to work, all stakeholders (ATNS, ACSA, and AASA, CAA, etc.) must collaborate in the definition of the objectives and the development of benefits. The manner in which operations are made exclusive should also be done collaboratively to ensure that certain groups of operators are not benefitting unfairly while others suffer the consequences. Likewise, stakeholders must be motivated to participate for the overall improvement to airspace and airport operations. Stakeholder incentives are necessary and should be defined in such a way that they help meet the overall objectives of implementing limited or exclusive operations.

There are several ways to implement limited operations. TMIs, specifically GDPs/AFPs are strong candidates due to the ability to assign slots based on predefined groups. Special or independent arrival and departure queues can be established that restrict arrivals and departures to those flights that are capable of overcoming certain arrival or departure constraints. Airspace restrictions can be employed to limit use of Restricted Areas (FAR). The list of collaboratively developed operational objectives of ATNS, ACSA, and other stakeholders will lead to the determination of potential applications of this enhancement.

Given the commonality and near-term benefits of PBN capabilities, it is recommended that PBN procedures be used to distinguish among users. New RNP procedures at FACT can be augmented to allow for limited operations and opportunities should be sought for implementing similar procedures at FAOR and FALE. However, other equipage options are available for consideration. An extensive study is currently underway by Metron Aviation in the US that is evaluating concepts such as best-equipped, best-served, operational incentives, and the use of equipage-aware TMIs. The list of potential equipage candidates is long and falls into the category of Communication, Navigation, and Surveillance (CNS). Examples include PBN, Data Communications, GPS, WAAS, ILS, and ADS-B, to name just a few. As an application example of this enhancement, NAV CANADA deployed an ADS-B network in the Hudson Bay region, an area that lacked radar coverage and required procedural separation and its associated significant separation minima. Today, only ADS-B equipped aircraft are allowed to use the routes at certain altitudes. Non-equipped aircraft must fly at lower or higher altitudes where procedural separation is applied. [4]

Limiting operations to certain aircraft categories during periods of day could be a relatively easy technical solution through the Score Airport Slot Allocation system. Aircraft groupings may be initially attained through this system. Functionality to do "aircraft grouping slot allocation" within Score will need to be investigated.

It is also recommended that TMIs, specifically GDPs, be used for limiting operations. This will require changes to AFT, ATNS's data infrastructure that is responsible for data input to AFT and to the flight operators' data infrastructure in order to include information on flights that allow the equipage distinction among flights. This will also require changes to the algorithms and the processes by which the TMIs are executed. Metron Aviation is conducting research for the FAA which shows this is a near-term and cost-effective way to apply this enhancement [5,6]. Research includes testing the use of exclusionary periods during GDPs in the New York airspace (JFK, LGA, and TEB) and the Chicago airspace (ORD and MDW), with different PBN capabilities and procedures as the limiting factors.

Excluding or segregating dissimilar types of operations can reduce the complexity of managing different types of operations, thereby reducing controller workload, increasing capacity, and improving efficiency. Additionally, there is the potential for increased revenue for all stakeholders as airspace and airport throughputs are improved. In general, benefits are realized through a reduction in delay or an increase in capacity or throughput. The benefits are a function

[5] Metron Aviation, July 7, 2012, *TFM Methods and Application to PBN Use in Metroplex Environment*

[6] Metron Aviation, March 13, 2013, *Capability-Aware Traffic Flow Management Operational and Functional Description*

of each flight operator's percent of operations at the airport and the operational characteristic on which operations are being segregated. For example, at FACT, SAA may realize more benefits than a competitor operating without the ability or approval to fly RNP-AR procedures during instrument meteorological conditions (IMC). Recall that SAA operates the majority of the flights at FACT and they are "better" equipped for certain operations. A thorough cost benefit analysis and sensitivity analysis are needed to quantify the impact of a variety of methods for limiting operations.

As noted, buy-in from aircraft operators is the main challenge to the use of limited operations. It is recommended that ATNS and ACSA include this discussion in their regular stakeholder meetings held to develop and refine the concept of limited operations. These collaborative meetings should use demonstrations and simulations to assess the feasibility at each airport.

This enhancement requires further research of demand, procedures, infrastructure, and technologies that will enable implementation. As the concept is refined, decisions will need to be made regarding when limited operations should ideally be implemented. The timing is based on a short list of potential triggers: an increase in demand to a certain level or a desired level of throughput. The objective should be to improve efficiency before demand increases or the fleet mix becomes more complex. Improved efficiency will set the foundation for ATNS and ACSA to handle future demand and will lead to increased capacity. Task 8, Implementation Plan, will provide a more detailed discussion of the triggers and timeline for limiting operations.

Table 9: Limiting Operations Specifications

Specification	Description
Budget	To be determined by ATNS but should include: • Development of new procedures • Technology acquisition or enhancement • Required infrastructure
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	N/A
Regulations	CARS and CATS: Approval would be required from the Commissioner of Civil Aviation, with amendments to be determined.
Guidance	• AIP, SSI's: Definite amendments required • User consultation required

2.1.8 Slot Optimisation and CTOT Compliance

2.1.8.1 Slot Optimisation

This enhancement proposes to optimise the slot assignments for overall improved airport utilisation. Slot assignment is dependent on the agreement of numerous parties including airport authorities, airlines, and traffic management organisations. The effectiveness of slot assignments is dependent on the level of compliance by pilots and ATNS to the assigned times.

This enhancement also involves allocating slots based on the direction of turn after takeoff. Due to limited taxi staging areas at most airports, there are occasions when a departure queue all turn in the same direction after takeoff. This results in a lack of optimal runway and airspace usage. Presently, the Score slot allocation system can be configured to accommodate direction of turn, but the AFT system cannot. The situation could be managed tactically by the tower controllers, but is often very difficult due to the constraints of the airport ground. A pre-departure sequence tool will also have the functionality to allocate start up times based on the SID allocated to an aircraft (Section 2.1.3).

The current level of demand at FALE does not warrant it being classified as a Level 3 coordinated airfield. It is recommended that ATNS and ACSA consider re-classifying the category of FALE to either a level I or II airport

Further consideration could be given to removing application of TMI's from FALE on a daily basis and implement them only when the AAR and ADR is constrained.

It also recommended that aircraft not be issued a CTOT or that the CTOT be ignored when they are departing from FALE and FACT to non-regulated airfields. This will improve ATC's ability to effectively manage departures. This may require the addition of functionality to the existing version of AFT.

Table 10: Slot Optimisation Specifications

Specification	Description
Budget	Possible amendments to functionalities of Score and AFT.
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	CTOT compliance standards will need to be high for concept to be successful.
Regulations	Regulations would need to be formulated.
Guidance	ATNS, ACSA, SADOT, and SACAA guidance will be required for implementation.

2.1.8.2 CTOT Compliance

A key aspect of effective air traffic management and overall aviation system performance is linked to the accuracy of the time an aircraft actually departs in comparison to its CTOT. This enhancement proposes that every effort be made to ensure compliance to the CTOT. High levels of compliance have a direct bearing on controller workload by reducing the traffic peaks associated with non-compliance.

While South Africa has an enviable record with regard to slot compliance, it can be improved. For an ATFM system to be fully effective, comprehensive post-event analysis must take place. Part of this post-event analysis will be analyzing the CTOT compliance of aircraft operators and ATCC on a daily/weekly/monthly basis. ANSP's that have a mature ATFM system have daily post-event telephone conferences and non–compliance is brought to the attention of the appropriate entity.

It is recommended that a daily telephone conference be initiated by the CAMU with ATCC, AMC, aircraft operators and SAWS. The CAMU should provide a full post-event briefing on the previous day's events, along with a CTOT compliance report (this could be positive or negative results). See Section 2.1.12, Improved CDM Practices.2.1.12

In addition to the daily feedback on compliance, monthly reports could be supplied to the aircraft operators at the appropriate management level. During industry forums, statistics can be shared to incentivize aircraft operators to be more compliant.

The CTOT compliance standard must take into account the requirement for ATC to tactically manipulate traffic for optimization of departure flows through the runway and terminal airspace, particularly on airports where limited taxi staging areas exist. ATNS may also want to reconsider the -5/+10 CTOT compliance applied to ATC. A narrower compliance window may produce significant improvement in CTOT compliance.

Table 11: CTOT Specifications

Specification	Description
Budget	To be determined by participants, but should include: • Teleconferencing equipment
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	CTOT compliance standards are to be set both for ATC and aircraft operators.
Regulations	Amendment to the CTOT compliance regulations
Guidance	None required

2.1.9 Supervisory Staff in ATCCs

It is recommended that an ATC supervisor staff structure be created at all three of the study airports. Using other international ATCCs as a basis, it is recommended that ATNS implement a management structure as follows: At the two larger centers – FAOR and FACT, a Watch Supervisor would assume overall responsibility for operational service delivery during a shift. A supervisor for each discipline (tower approach and en route) in the ATCC would be overseen by the Watch Supervisor. At FALE it is recommended that a supervisor be appointed for each discipline (tower and approach). Supervisory staff could also be appointed to other ATCCs depending on positions and staffing levels.

Through supervisors, the following could be achieved: improved coordination of resource outages and weather disruptions; improved staff utilization; effective management of stakeholder queries/dispute resolution; and accomplishment of preliminary incident investigation; etc.

The Watch Supervisor (FAOR and FACT) and supervisors at smaller ATCCs would also fulfill the roll of Flow Manager in the Flow Management Position (FMP).

The current Flow Management procedures as laid out in the South African Aeronautical Information Publication (SA-AIP) state there is a requirement for a Flow Management Position (FMP) in all three of the study airports. The FMP would be responsible for flow management processes in the ATCC. Part of the recommended improved CDM process will be to have daily and ad hoc telephone conferences to discuss flow management procedures for the day. The FMP will represent the ATCC during these calls. The FMP will be able to assess the flow requirement best suited to the entire ATCC, and then collaborate with the CAMU. The CAMU, in turn, will take the system-wide requirements into consideration before implementing a TMI, for example. The supervisor will be able to monitor the performance of the staff and the effect of the TMI and amend it through the CAMU, as appropriate.

Table 12: Supervisory Staff Specifications

Specification	Description
Budget	To be determined by ATNS, but should include: • Additional staffing numbers will need to be amended and additional budgeting for extra staffing undertaken.
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	• US FAA Order 7210.3X[7] • US FAA Staffing Outlook[8]
Regulations	Investigation of Licensing requirements for supervisory staff.
Guidance	ATNS

2.1.10 Airspace Flow Programs

This enhancement will make recommendations for ATNS to be able to carry out Airspace Flow Programs (AFPs) that are completely configurable to ATNS requirements. The CAMU software will need to be upgraded so that this configurable TMI can be implemented according to operational requirements.

In the case of implementing an AFP for an airport's TMA while a Ground Delay Program is implemented at the airport (i.e., FAOR), the software currently lacks appropriate filters to specifically target the flights to control. While the system allows all flights to be considered, it does not have the filtering ability to exclude specific, targeted flights from rationing. So in the case of FAOR, the flights controlled by the GDP will absorb a significant portion (more than 50%) of the available AFP capacity. This causes all other flights within the TMA to compete with FAOR traffic that retains a higher arrival priority. This lack of filtering ensures that in order to affect change on the TMA capacity, the airport rate must be lowered as the airport's traffic cannot be segregated from the overall TMA control.

For this recommendation to be implemented, ATNS will need to procure an upgrade of their existing software solution.

[7] http://www.faa.gov/documentLibrary/media/Order/FAC.pdf
[8] US FAA, *A Plan for the Future, 10-Year Strategy for the Air Traffic Control Workforce, 2012-2021*. 2012.

Table 13: AFP Specifications

Specification	Description
Budget	To be determined by ATNS, but should include: • Software requirements analysis • Software development and testing
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	Determined by software provider
Standards	Recognized software standards
Regulations	N/A
Guidance	ATNS, ACSA

2.1.11 Visual Flight Rules (VFR) traffic included in traffic demand predictions.

There are instances where VFR flights are not included in demand predictions. Training flights, particularly at FACT, do not file flight plans. It is recommended that ATNS meet with aircraft operators (flight schools included) and come to an agreement that all flights arriving or departing from any of the three study airports must file flight plans. It is recommended that ATNS publish a Notice to Airmen (NOTAM) stating the requirement to file flight plans and follow the NOTAM with a publication in the SA-AIP.

Table 14: VFR Demand Specifications

Specification	Description
Budget	To be determined by ATNS but expected to be minimal.
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	N/A
Regulations	Published requirement for all traffic departing and arriving at study airfields to file flight plans.
Guidance	ATNS, ACSA

2.1.12 Improved CDM Practices

There is a need to have better coordination between ATNS (internal and external) entities, ACSA, aircraft operators and the South African weather Service (SAWS). It is common practice in mature ATFM/CDM environments to have regular ATFM/CDM telephone conferences (FAA and Airservices Australia). It is recommended that ATNS, through the CAMU, conduct at least a daily telephone conference. Additional telephone conferences should be conducted as circumstances dictate. It is noted that the CAMU does have an effective method for notifying stakeholders of TMI's, but it does not include a fully collaborative component to developing the TMI, which the telephone conferences can help to address.

It is recommended that the CAMU host and facilitate a morning telephone conference where aircraft operators, military operations (FUA), ATCC, ACSA (other relevant airport operators), and SAWS are able to call into a common phone number. The first component of the telephone conference could be a description of the daily airspace plan, as compiled by the CAMU. This should be developed and distributed prior to the conference call. The weather impacts expected on this daily plan could be discussed and mitigated. Should there be any anticipated amendments to the TMI's, they should be explained and mitigated by the CAMU and/or the ATC centers involved. Aircraft operators should have the opportunity to discuss the impacts on their operations resulting in possible amendments to the TMI. The conference call will also give the aircraft operators an opportunity to raise any particular needs they may have in order to optimize their operations.

The second part of the telephone conference should be a post-event analysis of the previous day's operations with feedback from all parties, which could include CTOT compliance statistics and TMI performance (under delivery or over delivery).

During the day there could be ad hoc teleconferences facilitated by the CAMU if the need arises as a result of changing weather conditions, resource outages, staffing constraints, etc.

Table 15: Improved CDM Practices Specifications

Specification	Description
Budget	To be determined by participants, but should include: • Cost of teleconference equipment
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	N/A
Regulations	N/A
Guidance	ATNS, ACSA, AASA, ALPA, other stakeholders

2.1.13 Performance-based Standard Instrument Departures and Arrivals

It is clear that to increase the throughput of the runways, a reduction in separation between departing and arriving traffic is required. It will be noted that there are other capacity enhancement recommendations in this report which propose greater throughput of the runways. In addition to these recommendations, the reduction of departure separation minima can be improved by revision of departure and arrival procedures.

In the case of FAOR departing aircraft are required to climb on runway headings for extended distances for noise and separation reasons. As many of the existing SIDs take noise constraints into consideration, it is recommended that a review of SIDs be accomplished taking into account noise footprints of modern aircraft. New SIDs will enable earlier turns from extended centerlines allowing for additional divergent departure courses.

It is recommended that ATNS/ACSA implement Performance Based Navigation (PBN) procedures at all three of the study airports. The benefits of PBN procedures are well-documented. PBN procedures allow for more efficient use of airspace, route placement, and development of arrival/departure procedures that result in fuel efficiency and noise mitigation.

ICAO requirements in terms of Terrain and Obstacles data can be complex and compliance with regulations required for PBN implementation can be costly. In order to abide with the requirements and to match most recommendations, Metron Aviation suggests the following methodology for implementing PBN procedures:

1- Identify airport environment type (terrain, structures, etc.)
2- Study current arrival and departure paths
3- Identify future departure and arrival path (RNP APCH, RNAV SID)
4- Create zone of interest
5- Define technologies based on needed accuracy and airport environment

a. Digital Elevation Model and obstacle extractions
b. On site data survey
c. Aerial surveys

6- Acquire satellite data when needed
7- Define control points and zones to survey on the ground (e.g. previous AIP, pylons)
8- Perform ground data survey
9- Extract obstacle data from satellite images
10- Compile data
11- Create recommendations on procedure design
12- Final report to Civil Aviation Authorities.

Some of the above steps may have already been completed as a result of existing PBN procedure development.

Table 16: Performance-based SIDS & STARS Specifications

Specification	Description
Budget	R4million per runway
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	N/A
Regulations	ICAO and SACAA regulations need to be adhered to.
Guidance	ATNS, ACSA, SADOT, and SACAA guidance will be required for implementation.

2.2 Airport/Airside Procedural Capacity Enhancements Impacts

This section describes a procedural airside enhancement, standard taxi routes.

2.2.1 Standard Taxi Routes

The taxi route commonly used between gate areas and departure runways can involve many different taxiways. At a number of airports standard taxi routes have been formalised with a naming coding for each route. Use of standard taxi routes increases efficiency, reduces the potential for error, and reduces workload associated with communications and read-back of taxi clearance. Implementation of standard taxi routes requires formalisation, coordination, and publishing of the routes. Such standard routes could also be defined as part of the airports SMGCS plan for low visibility conditions. The study steam recommends additional research to model a variety of routes and assess the overall benefits.

Table 17: Standard Taxi Routes Specifications

Specification	Description
Budget	To be determined by ATNS, will include simulation costs.
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	CAASA, ICAO
Regulations	ATNS, ICAO,
Guidance	ATNS, ACSA, ICAO

2.3 Airport Specific Infrastructure Capacity Enhancements

Many of the suggested enhancements are dependent upon or strengthened by associated enhancements of airfield pavement. The enhancements can provide better surface flow that may ultimately enable a reduction in the average in-trail spacing between successive operations, thereby increasing an airport's capacity. All infrastructure enhancements recommended for the airports are additions of taxiway pavement. As such, the specifications for inclusion of these enhancements would be consistent with the ACSA standards for taxiway pavement, including layer-works, and edge lighting. The total pavement area and relative location for each recommended enhancement have been identified in the drawings and described in the related text below. This level of detail enables relative comparison of cost to potential benefits adequate for this stage, as defined in the financial analysis methodology described in Task 3. This information also provides the basis for further planning, engineering and preparation of more detailed cost estimates by ACSA's Project Management Department at a later stage, when activity levels would trigger the need for any of these enhancements.

The costs associated with the recommended taxiway pavement are based on ACSA development average hard and soft unit cost factors in Table 1. While the ultimate costs may vary, these unit costs are used included to provide a consistent estimate of the preliminary expected potential ratio of benefit to cost, and to determine if the costs fall within the threshold of R 20Million, as defined in Task 3.

The specific infrastructure enhancement recommendations for additional taxiway pavement fall into three functional categories:

- Addition of new RETs or refinements to existing RETs to facilitate reduced ROTs and related improvements in runway throughput. (FAOR: RWY 21R, RWY 21L, RWY03R; FALE: RWY 24; and FACT: RWY01/19). The benefits of RETs are two-fold. First, the reduction in time on the runway represents a direct savings in total travel time. Second, in some cases a reduction in ROT may enable a reduction in average in-trail separation between successive arrivals, thereby increasing peak hour capacity. The ability to achieve the latter benefit depends on a variety of factors, including fleet mix, runway use and applicable air traffic control procedures. For purposes of this report, the benefits of RETs are quantified herein based on the potential to reduce travel time through a reduction in ROT.

- Improvement to the configuration of runway end hold pads, including the addition of Parallel Taxiway entry points to Runway Thresholds to facilitate Sequencing of Departure Queues (FAOR: RWY03L; and FACT: RWY01/19). These improvements offer the potential to reduce departure queue delay, which is a component of overall outbound travel time.

- Addition of parallel taxiway segments reduces head-to-head conflicts on single taxiway segments (FALE: Extension of TWY Golf). This improvement offers the potential to reduce both inbound and outbound taxi delay, also a component of overall travel time.

Each of these infrastructure enhancements would require different amounts of new pavement and enable different efficiency benefits. The estimated areas and the determinations of their relative benefits are included for each recommendation in the following sections.

2.3.1 Addition of RETs/Reduction of ROT

This section is a combination of two enhancements: Addition of RETs and Arrival/Departure Balancing. They were combined because the enhancements both focus on the addition or refinement of RETs.

2.3.1.1 FAOR Addition of Rapid Exit Taxiway to 21R

The addition of RETs to RWY03L/21R would facilitate the assignment of arrivals to the inboard runway, thereby improving balance of traffic by runway and reducing inbound taxi time. This initiative would also help accommodate pilot requests for landing on this runway during certain times of the day to save the long taxi distance from RWY03R/21L. The recommended RETs should be located as shown in Figure 1 to efficiently serve both north and south flow operations.

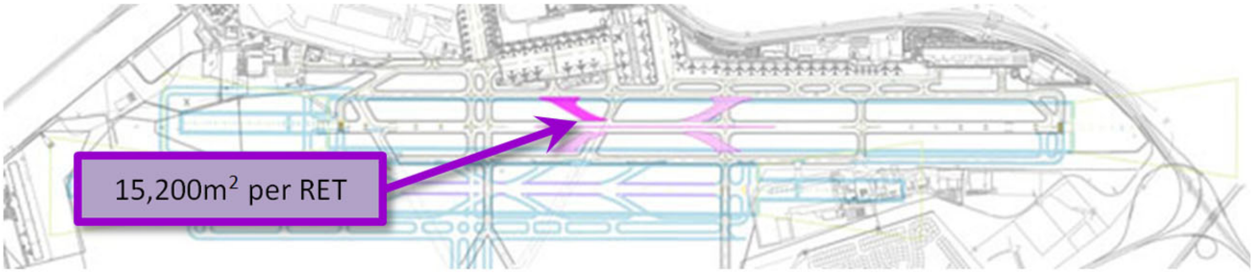

Figure 1: RETs for RWY03L/21R

Currently, this runway has one 30 degree RET on RWY03L. All other runway exits are 60 degree, 90 degree, or even 120 degree. This results in very low runway exit speeds and very high runway occupancy times. Data shows that the RWY03 average ROT for medium aircraft is about 55 seconds, while that for runway 21 is 72 seconds.

Each individual RET would require approximately 15,200 m^2 of new paving, assuming the location did not overlay any portion of existing taxiways. The number of RET's, to be added would depend on the benefit of reduction in ROT. As RWY21R currently has no RET and higher average ROTs are experienced on this runway, the addition of an RET for RWY21R would have the highest benefit compared to the addition or refinements of the other runway exits on RWY03L/21R.

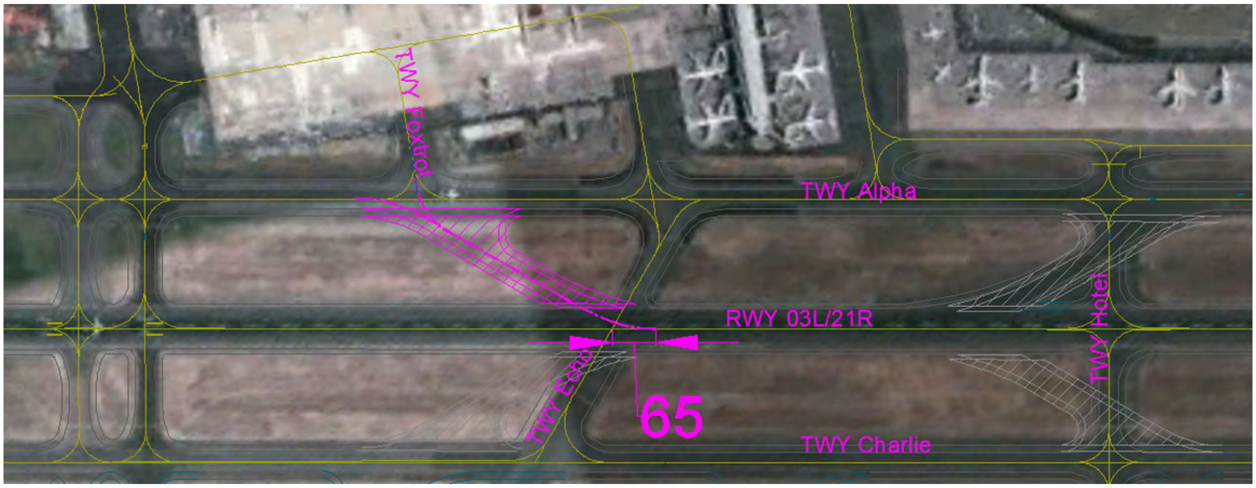

Figure 2: RET for RWY21R

The assumed location for the new RET would be to initiate the RET about 65 metres north of the existing Taxiway (TWY) Echo and align the exit with TWY Foxtrot. This would allow aircraft to continue either onto TWY Alpha or slow to continue on TWY Foxtrot. Based on the results of runway exit modeling that considers expected fleet mix and aircraft performance characteristics, by adding a 30 degree RET on RWY21R, the average ROT for medium aircraft can be reduced to 53 seconds, assuming aircraft can exit the runway at the RET using an runway exit speed of 50 knots.

Since there are no RETs planned to be added to RWY03L/21R as part of the Master Plan, the installation of these RETs would require review of design by ACSA's Project Management Department. The construction material specifications would be the same as for any typical ACSA taxiway, unless specialty permeable pavement was used.

Financial Analysis

The construction of the RET on 21R would cost more than R45 million (Table 2) and result in a 19 second reduction in ROT for aircraft landing on 21R. Currently, less than 1% of arrivals at FAOR use this runway; at this utilization, the savings in aircraft ROT time and reduced passenger trip time cannot justify the construction cost. If 21R's share of arrivals were to increase to around 14%, the RET can be justified based on reduced ROT and passenger time. If 21R's share of FAOR arrivals increased to 25%, the RET can be justified based on aircraft operating savings alone. Based on this analysis, the addition of other RETs on RWY 03L21R would not be justified in the near term.

Table 18: FAOR RETs Financial Analysis Summary

	RET Runway 21R	RET Runway 21L	RET Runway 03R
Cost			
New pavement area (m2)	15,200	16,112	13,114
Capital cost (R million)	R45.6	R48.3	R40.2
Benefit			
Reduction in ROT (sec)	19	8.5	3.0
% of arrivals on Runway	0.4%	11.0%	82.0%
Year 1 benefit from aircraft and pax time saved (Rand)	R 193,952	R 2,386,125	R 6,277,934
NPV (R million)	Negative	Negative	R15

2.3.1.2 FAOR Addition of Rapid Exit Taxiway to 21L

The FAOR Master Plan does include the addition of RETs on RWY03R/21L (Figure 3). Until such time as the Master Plan is implemented, the ROTs for south flow operations would benefit from the addition of an RET for RWY21L and the refinement of the current fillets of the connection to Taxiway Echo to enable it to be better used as an RET (Figure 4).

Figure 3: FAOR Master Plan for 03R/21L at 55 MAP Capacity Level

Figure 4: Refine Taxiway Echo for RWY 03R and add additional RET to RWY21L

The proposed additional RET for RWY21L is located exactly as included in the Master Plan. The estimated area of new pavement is 16,112 m^2 and would be consistent with the ultimate development. The specifications for this initiative should follow the development standards already identified for that construction phase.

Although this runway has a 30 degree high speed exit (TWY RR), its location is not optimal. Application of the Runway Exit Design Interactive Model (REDIM) estimated an average ROT time of 71.5 seconds for medium aircraft, consistent with the data provided by the airport. This average ROT time can be reduced to less than 63 seconds with the recommended improvement provided that a 50 knot runway exit speed is used.

The construction of the RET on RWY21L would cost more than R48 million (see table 2) and result in an 8.5 second reduction in ROT for aircraft landing on RWY21L. Currently, 11% of arrivals at FAOR use this runway; at this utilization, the savings in aircraft ROT time and reduced passenger trip time cannot justify the construction cost. If RWY21L's share of arrivals were to increase to around 25%, the RET can be justified based on reduced ROT and passenger time. Based on this analysis, the addition of other RETs should be reviewed again if the RWY21L share of arrivals reaches 20%.

2.3.1.3 FAOR Addition of Rapid Exit Taxiway to 03R

The existing fillets proposed in the Master Plan at the TWY Echo crossing of RWY03R/21L could enable a rapid exit except that at high speeds the aircraft would need to continue on parallel TWY Yankee, as the end point for the RET centerline extends past the alignment of TWY Echo. To facilitate a true rapid exit, the centerline of the RET proposed in the master plan would need to be 45 metres offset and to begin the exit 100 metres sooner to the south (Figure 5) so the centerline of the RET aligns with the centerline of Taxiway Echo.

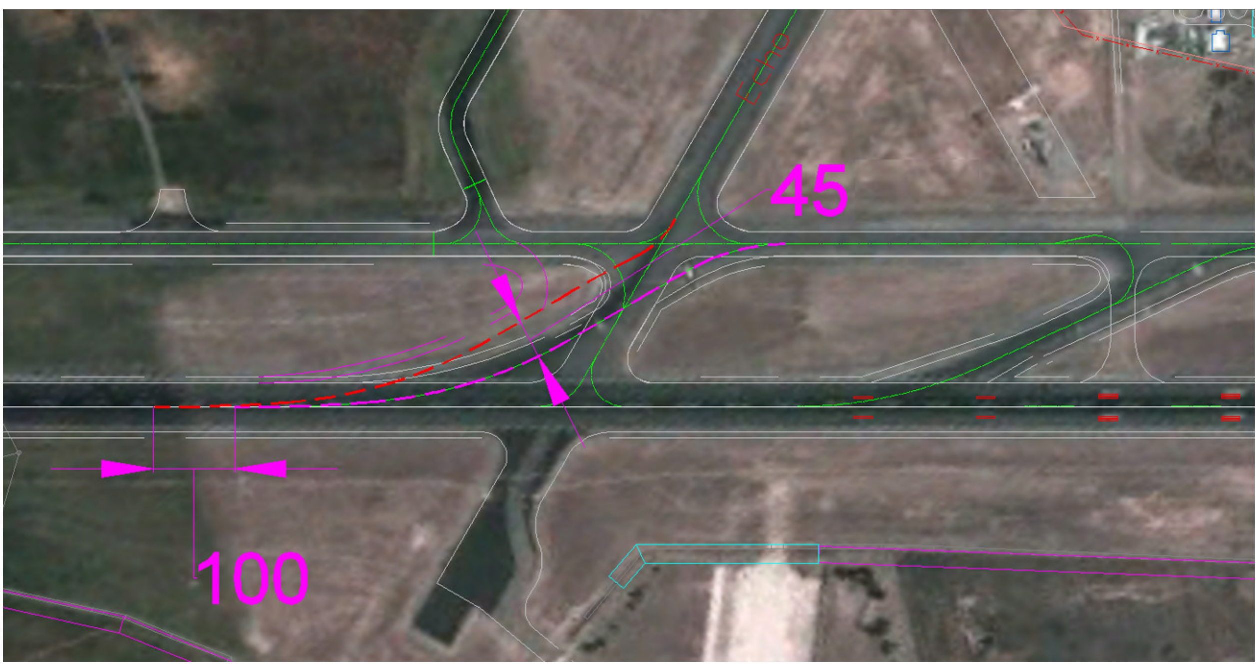

Figure 5: FAOR Proposed Taxiway Echo RET for 03R

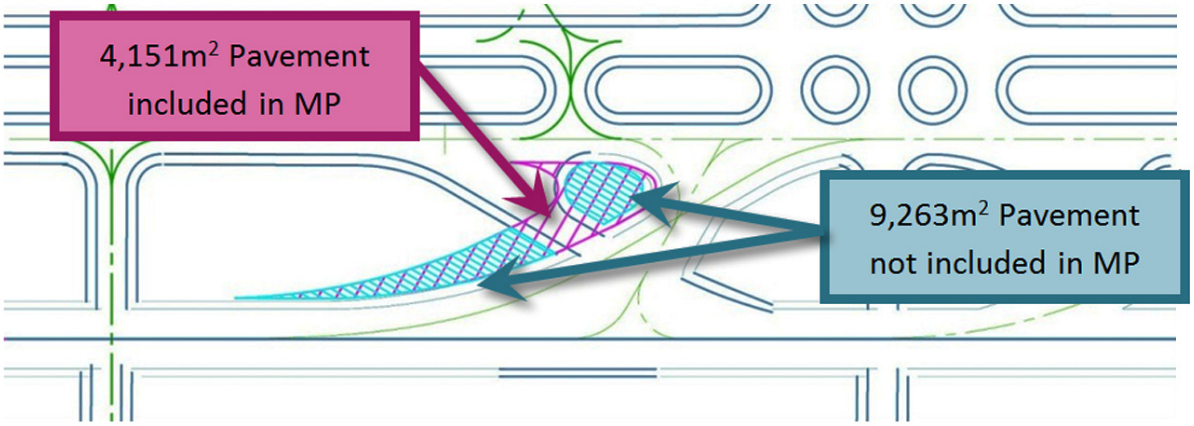

Figure 6: FAOR Change From Master Plan for Taxiway RE

Refining existing TWY RE would require the addition of approximately 13,414 m^2 of pavement, of which 9,263 m^2 would be in addition to future pavement included within the Ultimate Master Plan (Figure 6).

According to the REDIM analysis conducted, this re-alignment of RET would be able to reduce the current baseline average ROT time (include all aircraft types) by 3 seconds (from 57.5 to 54.5 seconds). With the re-alignment of the RET, a greater percentage of aircraft will be able to use this exit, and continue onto TWY Echo.

The RET on RWY03R would cost around R40 million (table 2) and result in a 3.0 second reduction in ROT for aircraft landing on RWY03R. Runway 03R handles more than 80% of the arrivals at FAOR, so even though the time saved per arrival is low, the total time saved by this RET exceeds those on 21R and 21L. This RET can be justified by the savings in aircraft ROT time and reduced passenger trip time. This could elevate the value of this enhancement to implementation in the near term.

2.3.1.4 Add RETs to RWY 24 toward Alpha and Bravo Aprons at FALE

The addition of RETs to RWY24 enable arriving aircraft in south flow that miss the exit at Taxiway Golf (or are trying to avoid the hot spot at that location) to exit the runway directly toward the Alpha and Bravo Aprons, rather than continuing to the south threshold at a lower speed.

The proposed additional RETs for RWY24 are located exactly as included in the Master Plan. The estimated area of new pavement for each RET would be approximately 19,710 m^2 for a total of 39,420 m^2 of new pavement if both RETs were constructed. These RETs would be consistent with the ultimate development and should follow the ACSA development standards already identified for that construction phase (see Figure 7).

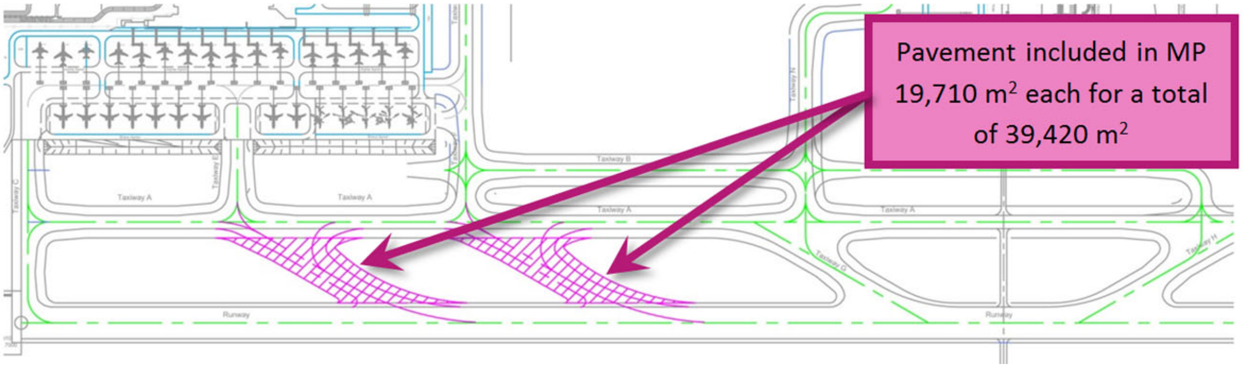

Figure 7: FALE Proposed RETs for RWY24

The reported average ROT times at FALE are very high. Based on recent surveys, the ROT for medium aircraft is 69 seconds for RWY 06, and 96 seconds for RWY 24. REDIM analysis shows that the average ROT time can be reduced to 58 seconds for the medium aircraft. One additional 30-degree RET at a location about 2,535 metres from the threshold to runway 24 can result in moderate reduction in average the ROT to 54.5 seconds. The third RET at about 2965 metres will probably be used by a small number of Heavy aircraft that overshoot the other RETs, but will not likely affect average ROT significantly. However, these two new RETs do provide operational flexibility for the landing aircraft to have direct access to the apron area. Note that the standard REDIM calculation assumes a runway exit speed of 50 knots at the 30 degree RETs—it is likely that in actual operation a lower speed may be used which will result in higher ROT times.

Table 19: FALE RETs Financial Analysis Summary

	1st RET Runway 24	2nd RET Runway 24
Cost		
New pavement area (m^2)	19,710	19,710
Capital cost (R million)	R59.1	R59.1
Benefit		
Reduction in ROT (sec)	38	4.5
% of arrivals on Runway	65.0%	65.0%
Year 1 benefit from aircraft and pax time saved (Rand)	R 15,615,141	R 1,849,161
NPV (R million)	R 84	Negative

The addition of the first RET to runway 24, at a construction cost of R59 million, reduces the ROT by 38 seconds. This RET can be justified based on the savings of aircraft operating time and passenger time. However, a second RET on the same runway, which would produce additional ROT savings of 4.5 seconds, cannot be supported financially (Table 19).

2.3.1.5 Realignment of Runway Exits at FACT

Add RETs to RWY01/19. The RETs would reduce the ROTs for all arrivals, thereby potentially reducing in-trail spacing and increasing efficiency of the airport's operations

The runway intersections with Taxiways Charlie an Echo can be enhanced to provide more rapid exits for either north or south flow. Currently these taxiways provide intersection exits that are slow in north flow, and extremely tight in south flow operations. The current south facing angles also make visibility difficult when needed for intersection departures. Increasing the fillet pavement to a radius of 95 metres would facilitate at least a 90 degree exit in south flow. See Figure 8.

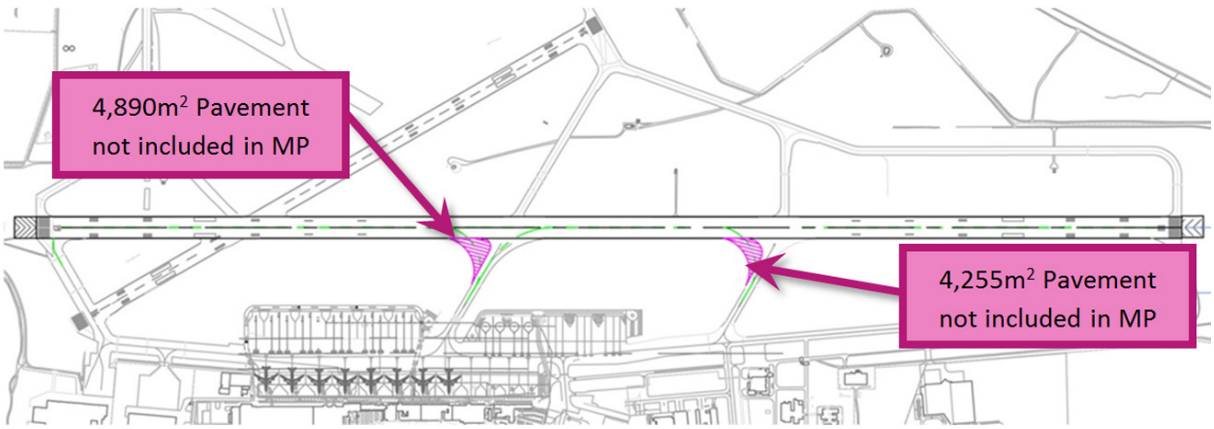

Figure 8: FACT Enhancements of RETs

The additional pavement required to widen the fillets for these two locations would require a total of 9,145 m^2 of new taxiway pavement. The resulting decrease in ROT would likely be minimal, in the range of 2 seconds average in south flow (RWY19) and not a measurable difference in north flow (RWY01) as these are relatively small additions to existing taxiways.

Realignment of RETs at TWY Echo would require about 4,890 m^2 of new paving and TWY Charlie would require 4,255 m^2 of new paving, with a total of 9,145 m^2 of new taxiway pavement (Figure 9).

The enhancement of the first RET to RWY 19 at TWY Echo at a construction cost of R8.6 million, will reduce the ROT by 2 seconds and the enhancement of the second RET at TWY Charlie, at a construction cost of R7.4 million, reduces the ROT by 1 seconds. Even though the time saved per arrival is low, the construction costs are also relatively low. The RET enhancements for TWY Charlie can be justified by the savings in aircraft ROT time and reduced passenger trip time; the cost for TWY Echo is slightly larger, so the justification of its enhancement is more marginal (Table 20).

Table 20: FACT Realignment of Runway Exits Financial Analysis Summary

	TWY Echo Runway 19	TWY Charlie Runway 19
Cost		
New pavement area (m2)	4,255	4,890
Capital cost (R million)	R7.4	R8.6
Benefit		
Reduction in ROT (sec)	2.0	2.0
% of arrivals affected	44.0%	44.0%
Year 1 benefit from aircraft and pax time saved (Rand)	R 941,991	R 941,991
NPV (R million)	R 1,035,686	-R 75,564

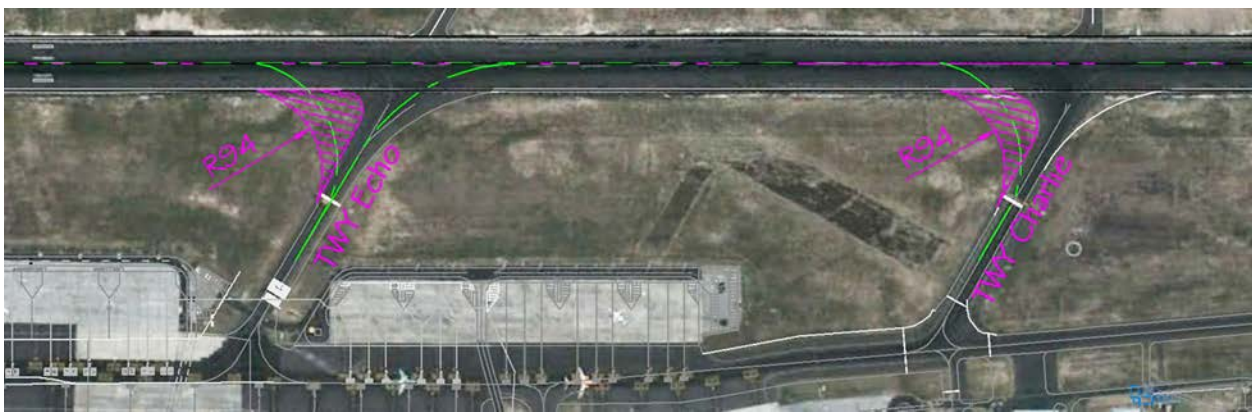

Figure 9: FACT RET Enhancement Details

Table 21: Additional RET Specifications

Specification	Description
Budget	R45.6, R48.3, R40.2, R59.1, R59.1, R7.4, R8.6
Quality	Per ACSA Standards
Reliability	Per ACSA Standards
Durability	Per ACSA Standards
Warranties	Per ACSA Standards
Standards	ACSA, ICAO Code E & Code F Taxiway standards
Regulations	ACSA, ICAO,
Guidance	ATNS, ACSA, ICAO

2.3.2 Intersection Departures

This recommendation is to promote intersection departures to help facilitate departure sequencing for optimal throughput. Although, intersection departures are accepted at the discretion of the pilots, appropriate use of intersection departures can help relieve departure separation requirements. For example, this recommendation could apply in the cases where smaller aircraft can be sequenced before larger aircraft. Intersection departures are a reasonable option to reduce taxi times for small aircraft that may not need the full runway length. For instance, intersection departures can allow a smaller aircraft taxiing behind a heavy to depart before the heavy, thereby minimising the wake vortex turbulence separation minima from two minutes to a smaller separation requirement that would be needed to just maintain terminal radar separation.

The recommendation would provide benefits in increased capacity where the wake vortex minima would be reduced between two departing aircraft as well as a reduction in taxi time for certain aircraft. Furthermore, benefits may be limited to FALE and FACT, since the elevation at FAOR may incline pilots to favor full-runway departures over intersection departures. Note that some airlines promote minimum power departures which require full runway length and make intersection departures difficult.

Table 22: Intersection Departures Specifications

Specification	Description
Budget	To be determined by ATNS after consultation with airlines
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	CAASA, ICAO, Environmental (Noise Impact) assessment would be required
Regulations	No amendments to regulations anticipated
Guidance	• AIP, SSI's- Amendments required • User consultation- Required

2.3.3 Extension of Taxiway Pavement at the End of RWY03L & the Use of Multiple Line Up Queues at FAOR

The additional length planned for Taxiways Alpha and Charlie and the connection behind the south end of the RWY03L threshold would enable additional departure queuing distance, and would provide air traffic controllers with space to optimise the sequence of departures by assigning aircraft to one of three separate taxiway connectors to RWY03L, as shown in Figure 10 and Figure 11.

This extension of the taxiways provides queuing and entry options that are compatible with the existing condition. The taxiway extensions at the end of the RWY03L threshold would require approximately 61,900 m^2 of new pavement. The pavement recommended for this taxiway extension is exactly as included in the Master Plan improvements and would follow the ACSA standard specifications consistent with that phase of development.

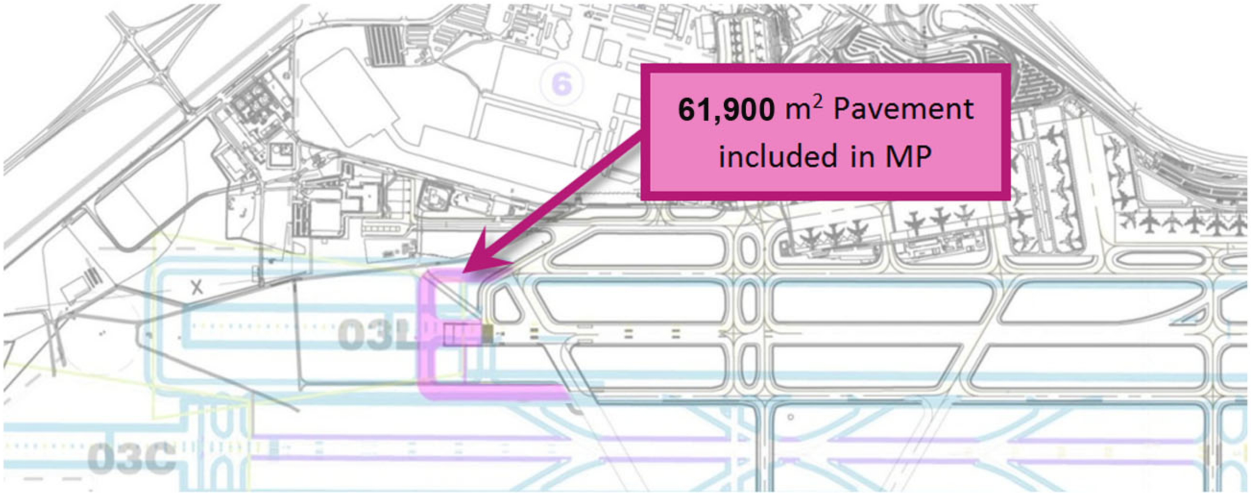

Figure 10: FAOR Taxiway Extension at RWY03L

The estimated cost of this development would be R185.7 million. As such, this enhancement far exceeds the range identified for near term enhancements. The primary benefit of these extensions is to facilitate tactical sequence of departures to reduce wake turbulence and in-trail spacing requirements, thereby decreasing average departure separation. Multiple runway entry points (at existing TWY Juliet from both TWY Alpha and TWY Charlie, the current entrance at the end of TWY Alpha and both new entrances of the extension) also enable multiple holding point areas, where the sequence of departures can be alternated between different entry taxiways.

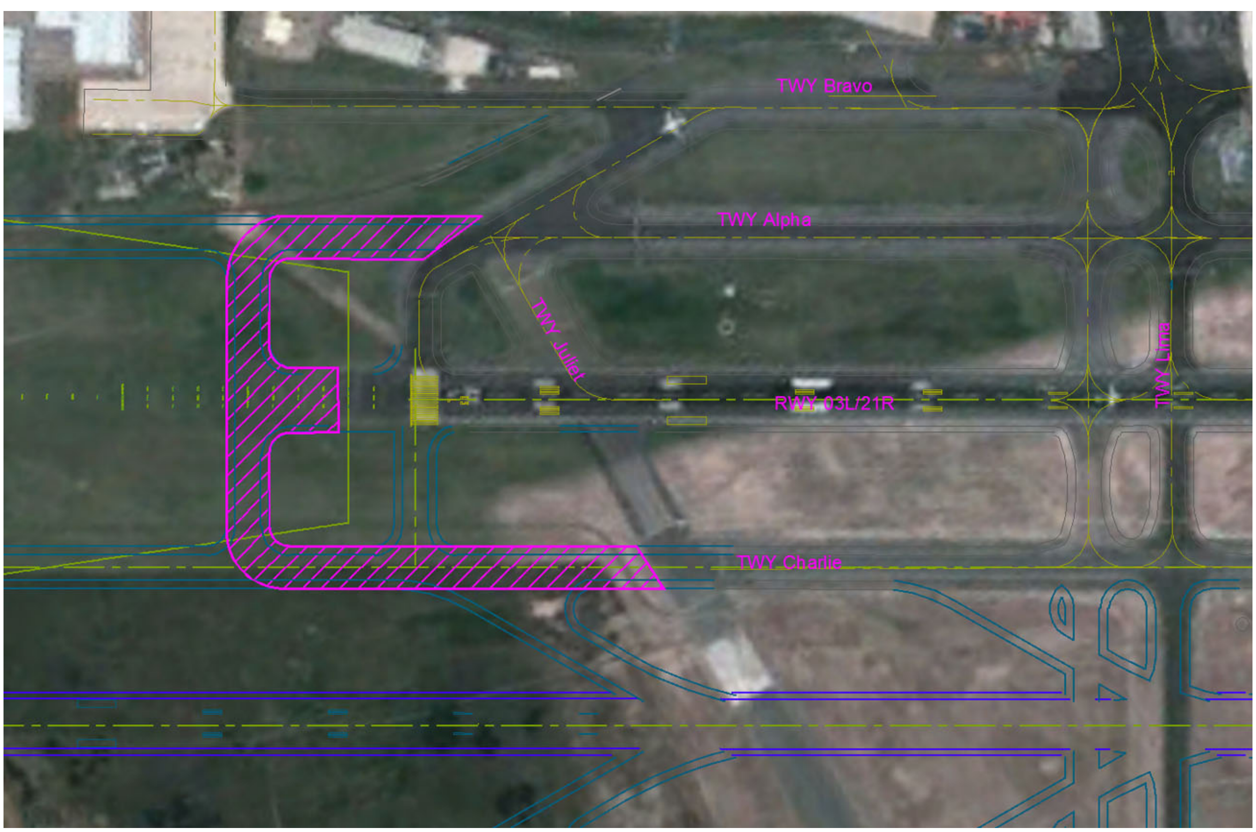

Figure 11: FAOR Taxiway Extension at RWY03L – Close-Up

As the benefits of this infrastructure enhancement directly link to changes in procedures and is influenced by the detailed characteristics of forecast demand, the total benefits in efficiency and capacity could only be quantified with a high degree of fidelity through simulation modeling that compares the existing condition and operations with the changes afforded by the option. Unfortunately, the full simulation modeling is beyond the scope of this study. Case examples, where weather events require re-sequencing of time critical departures, could be requested from airline stakeholders. Although the cost of this enhancement is beyond the limit set for near-term consideration, the potential for benefits, when combined with procedural enhancements, could potentially be justified by the savings in departure queue delay and reduced passenger trip time. At such time as peak hour demand and departure delays reach a critical level, detailed simulation of this potential enhancement could validate the potential value.

2.3.4 Parallel By-Pass Taxiway at FACT

By-pass taxiways that are perpendicular to the existing runway threshold entry points at TWY A2[9] and TWY B3 would provide additional runway entry points to provide air traffic controllers with added flexibility to optimize the departure sequence. This improvement could be provided by adding a by-pass taxiway offset by 80 metres parallel to the adjacent taxiway centre line. The addition of by-pass taxiways at each of the RWY01/19 thresholds enables additional departure queuing flexibility, and the potential to optimise the sequence of departures as aircraft could enter the runway via the By-pass taxiway entry points, giving each runway an additional point of entry (Figure 12-Figure 14).

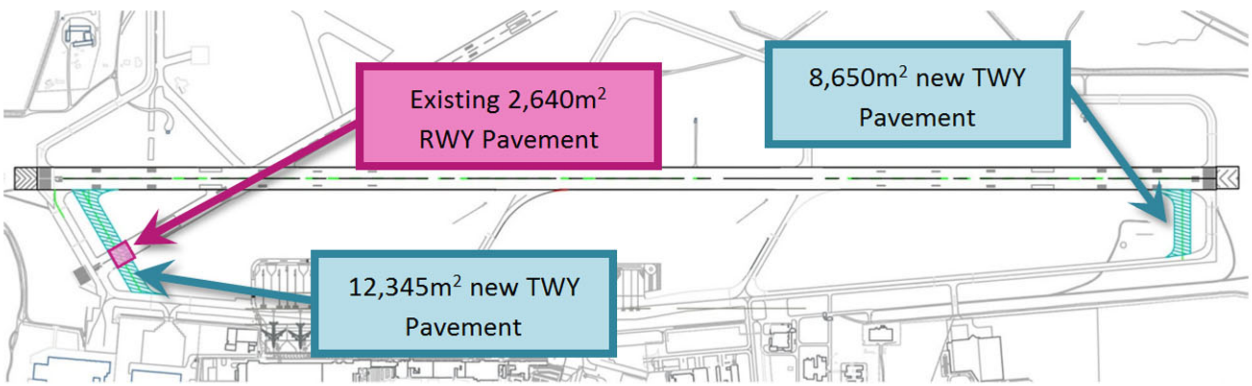

Figure 12: FACT By-Pass Taxiway RWY01/19

These taxiways include 20,995m^2 of new pavement (8,650m^2 at RWY01 and 12,3345m^2 at RWY 19) and cross over 2,640m^2 of the existing runway pavement in RWY16/34. Each taxiway would be at Code E standards at a separation of 80 metres from center line to the adjacent taxiway centerline.

[9] As RWY16/34 is currently underutilised, it is assumed that crossings would be allowed at times by-pass resequencing would be needed.

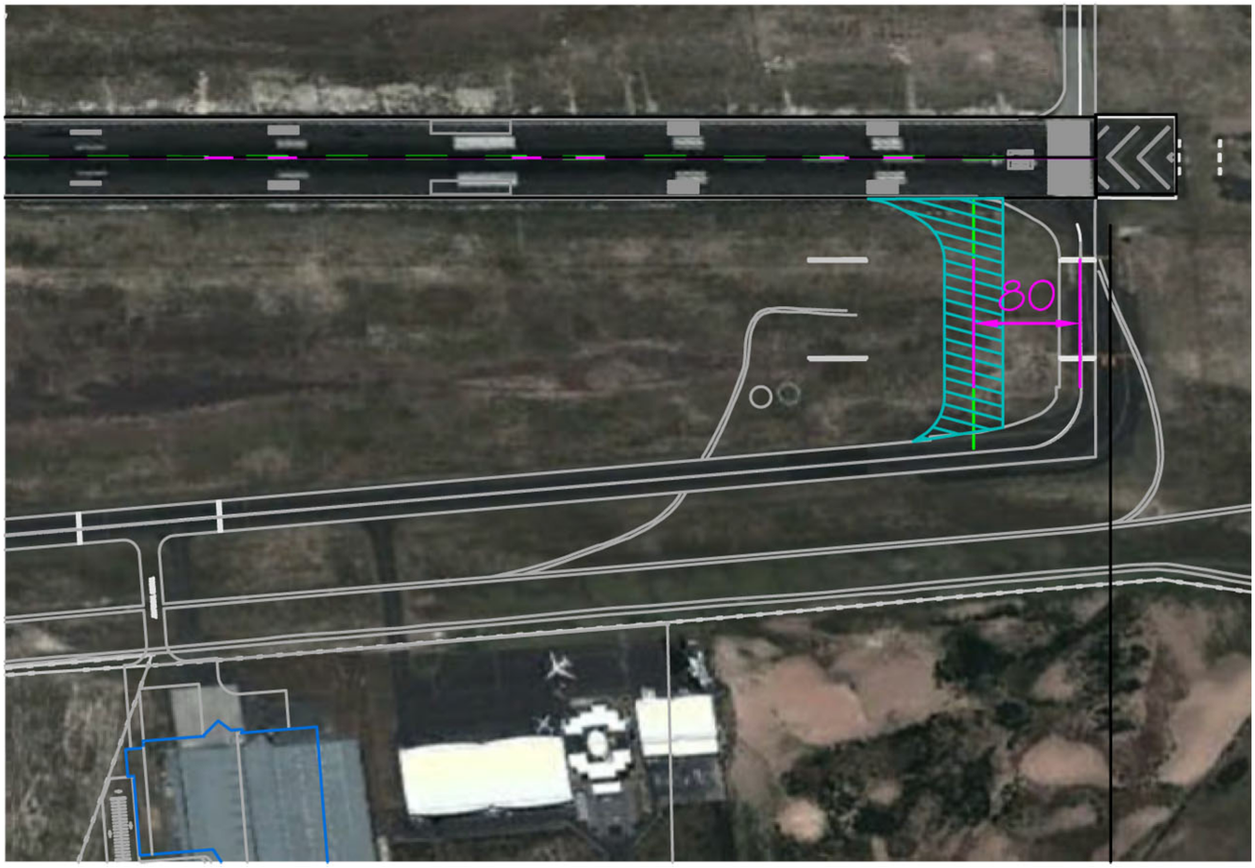

Figure 13: FACT Parallel Taxiway to TWYB3 at RWY01

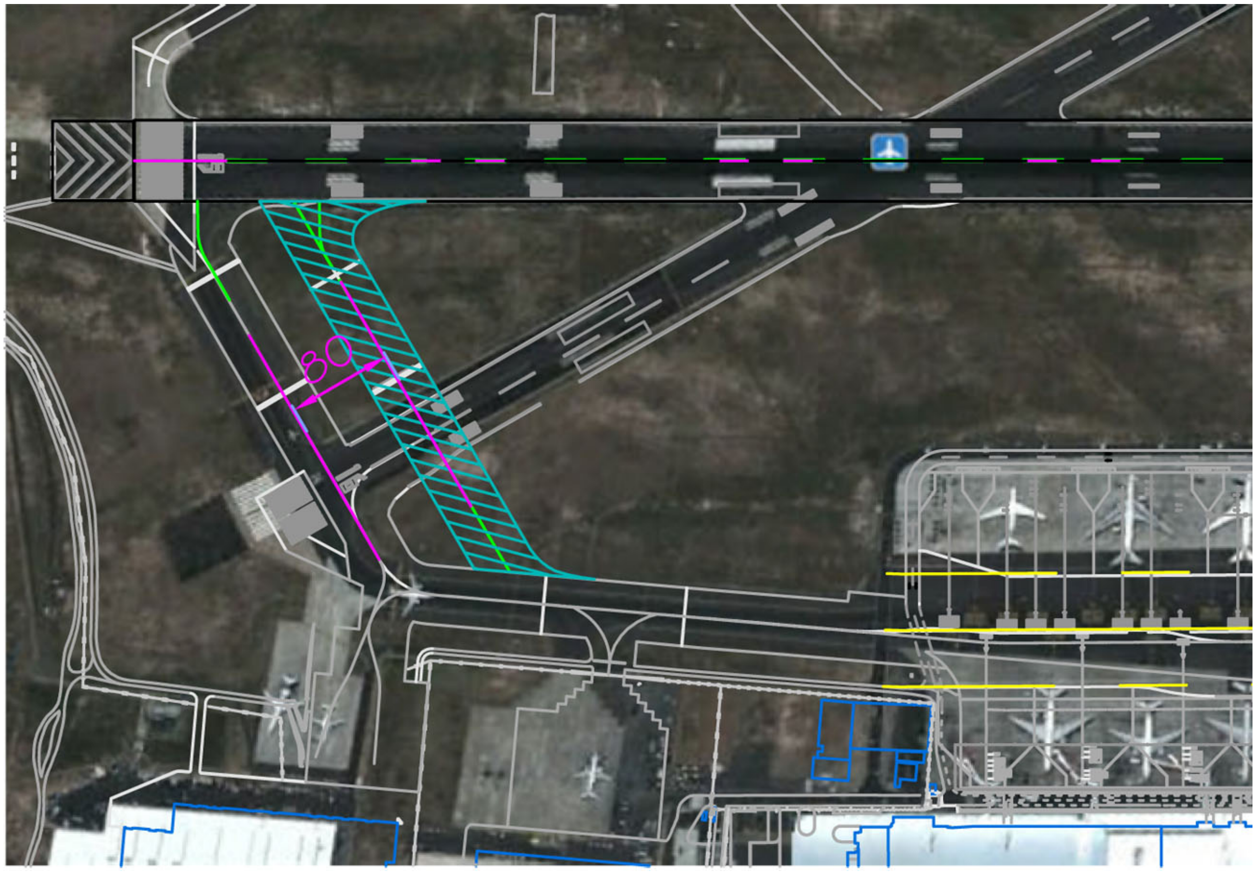

Figure 14: FACT Parallel Taxiway to TWYA2 at RWY19

Although the pavement recommended for this taxiway extension is not included in the Master Plan improvements, the specifications would still follow the ACSA standard specifications consistent with Code E taxiway development.

The estimated cost of this development would be R15.1 million for the Taxiway parallel to TWY B3 at RWY 01 threshold and R21.6 million for the Taxiway parallel to TWY A2 at RWY 19. As such, these enhancements, if taken separately, fall within the range that might be considered for near term enhancements.

The primary benefit of these extensions is to facilitate tactical sequence of departures to reduce wake turbulence separation and in-trail spacing requirements, and consequently decrease separations for departures. The addition of these by-pass taxiways would provide two runway entry points for each runway threshold, allowing air traffic controllers to alternate departure clearance as necessary to maximize throughput.

As the benefits of these infrastructure enhancements directly link to changes in procedures and detailed characteristics of demand, the total benefits in efficiency and capacity could only be quantified through simulation modeling that compares the existing condition and operations with the changes afforded by these options. Unfortunately, the full simulation modeling is beyond the scope of this study. Case examples where events could require re-sequencing of time critical departures could be requested from airline stakeholders as the basis of financial costs or benefits of departure sequencing. As the cost of this enhancement is within the limit set for near term consideration, the potential for benefits, when combined with procedural enhancements, could potentially be justified by the savings in departure queue delay and reduced passenger trip time. At such time as peak hour demand and departure delays reach a critical level, detailed simulation of this potential enhancement could validate the potential value.

Table 23: By Pass Taxiways at Runway Thresholds - Summary of Cap-Ex

Airport	Improvement	Area (m2)	Construction Cost (R million)
FACT	Parallel bypass taxiway at RWY01	8,650	R 15.1
FACT	Parallel bypass taxiway at RWY19	12,345	R 21.6
FAOR	Extended taxiway at end of RWY 03L	61,900	R 185.7

2.3.4.1 Addition of Parallel Taxiway segments reduces head-to-head conflicts on single taxiway segments at FALE

As activity increases at FALE, conflicts at the hot spot that result in head-to-head flows on segments of TWY Alpha could impact capacity and efficiency. The time impact of conflict and delay events, even if only a measurable in seconds may, indicate values sufficient to justify the cost of the taxiway extensions as the frequency of such events increase with future demand.

Any segment of parallel taxiway could be implemented as a separate project when it is identified as contributing capacity benefits (by calculating the impact of conflict and delays eliminated). The area of pavement associated with each segment is identified in Table 24 and, Figure 15 and Figure 16.

Table 24: Add Parallel Taxiway Access at FALE – Components

Airport	Improvement	Area (m2)	Construction Cost (R million)
FALE	Taxiway G1 extension	3,235	R 9.7
FALE	Taxiway B1 extension	21,480	R 64.4
FALE	Taxiway B2 extension	21,480	R 64.4

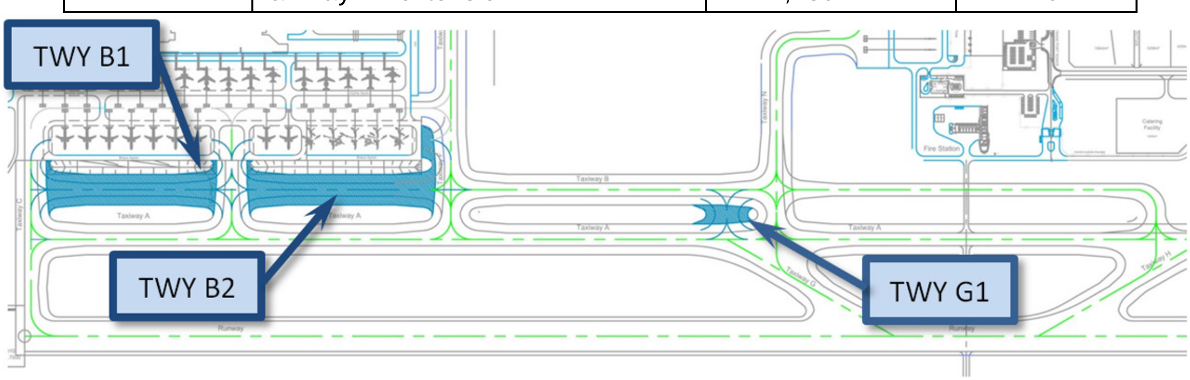

Figure 15: FALE Additional Parallel Taxiway Segments

If each of the identified parallel taxiway segments were developed, the additional pavement required would be approximately 131,720 m^2. The pavement recommended for these taxiway extensions are exactly as included in the Master Plan and would follow the ACSA standard specifications consistent with that phase of development.

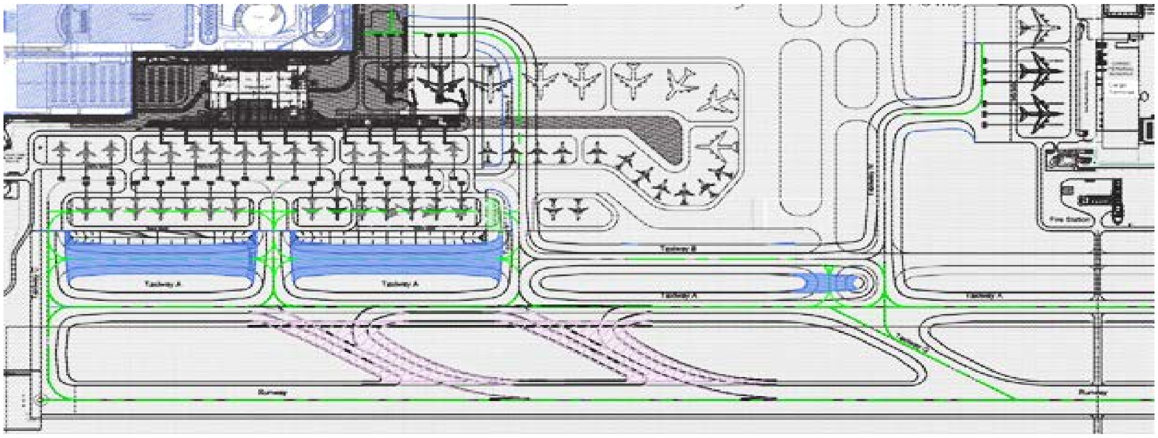

Figure 16: FALE Master Plan with Overlay of Potential Airside Improvements

The estimated cost of the two extensions to TWY Bravo would each cost an estimated R 64.4 million, and therefore would be beyond the limits of near term development. However, the extension of Taxiway Golf would have an estimated cost of R 9.7 million, which would fall within the range identified for near term enhancements.

Although the cost of this enhancement is within the limit set for near term consideration, current activity may not be sufficient to justify the costs. As the benefits to the reduction of conflicts at the Hot Spot with the extension of Taxiway Golf would depend on the level of activity as well as the operational taxi procedures implemented by ATNS, the total benefits in efficiency and capacity could only be determined through simulation modeling that compares the existing condition and operations with the changes afforded by this option. Unfortunately, the full simulation modeling is beyond the scope of this study. Nonetheless, with the current volume of peak hour demand, this initiative is not expected to generate significant reductions in delay. As peak hour demand increases, it is likely that this initiative would justify its cost.

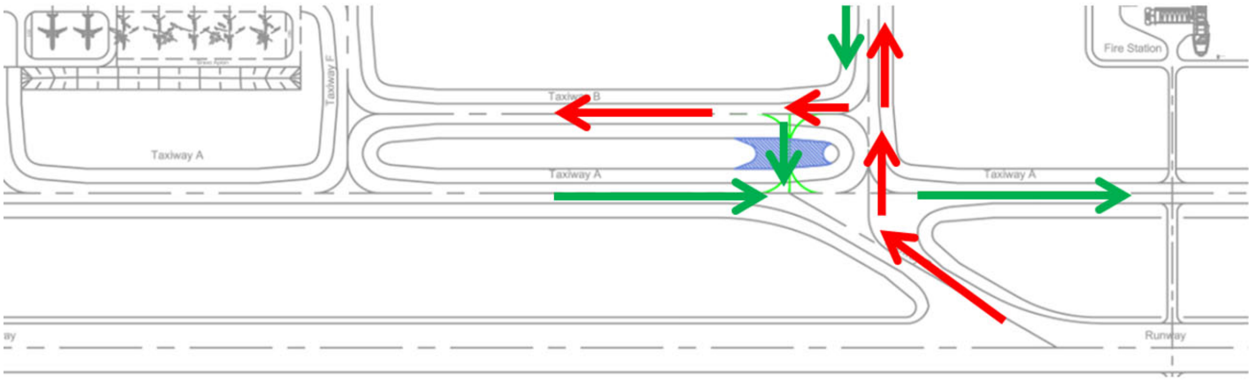

Figure 17: FALE Extension of Taxiway Golf

Example procedures and taxiway flows could be developed as an illustration of operational benefits in peak conflict conditions if sufficient documentation of conflict could be provided by ATNS to calculate conflict delay at the Hot Spot. At such time as peak hour demand and head-to-head activity delays reach a critical level, detailed simulation of this potential enhancement could validate the potential value.

2.3.5 Near-Term Implementation of Master Plan Elements to Enhance Taxiway System

This enhancement encompasses the taxiway enhancements discussed in Sections 2.3.1 and 2.3.3. A summary of the specifications are provided in Table 25.

Table 25: Near-Term MP Specifications

Specification	Description
Budget	FAOR RWY 21 L RET- R48.3 Million
	FAOR TWY extensions at RWY 03L - R185.7 Million
	FALE RETS for RWY 24 - R64.4 Million x 2
	FALE Extension of TWY Golf - R9.7 Million
	FALE Extension of TWY Bravo - R48.3 Million
Quality	Per ACSA Standards
Reliability	Per ACSA Standards
Durability	Per ACSA Standards
Warranties	Per ACSA Standards
Standards	ACSA, ICAO Code E & Code F Taxiway standards
Regulations	ACSA, ICAO,
Guidance	ATNS, ACSA, ICAO

2.3.6 Utilisation of Remote Gates

As FALE is an official Point of Entry for international arrivals there will always be the possibility of unscheduled General Aviation flights that will arrive at FALE to clear immigrations. As any such flights may impact scheduled operations and capacity, FALE may implement a policy to assign unscheduled GA to use the furthest remote gates. This would prioritize the use of the nearest aircraft gates for convenience of access for scheduled flight which may be likely to have ongoing connecting flights to other destinations. By the very nature of being unscheduled, GA flights in need of immigration processing could not expect priority access or expedited processing.

Table 26: Remote Gate Utilization Specifications

Specification	Description
Budget	To be determined by ATNS/ACSA
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	CAASA, ICAO
Regulations	ATNS, ICAO,
Guidance	ATNS, ACSA, ICAO

2.3.7 Addition of Holding Point Lines

The holding point distances from the runway are different as per ILS category. There is also provision for a "visual holding point'. This "visual holding point" can be co-located with any of the ILS Category holding points or it could be located closer that the CAT I holding point. It is recommended that ACSA reassess the holding point lines at the three study airports and mark the holding points appropriately to optimize throughput of the runways. This enhancement requires appropriate policy changes to realise the additional capacity provided by the additional lines.

Table 27: Holding Point Lines Specifications

Specification	Description
Budget	Cost of paint and services
Quality	To be determined by ACSA
Reliability	To be determined by ACSA
Durability	To be determined by ACSA
Warranties	To be determined by ACSA
Standards	To be determined by ACSA
Regulations	N/A
Guidance	ATNS, ACSA, AASA, ALPA consultation on required policy changes

2.3.8 Independent Parallel or Segregated Parallel Runway Operations at FAOR for RWY03/21 & Efficient Runway Utilization

Discussions with ATNS and ACSA resulted in the recommendation to evaluate the use of independent parallel operations or segregated parallel operations on RWY03/21 at FAOR.

Currently, the runways are sufficiently spaced (greater than 1800 metres) and they have the necessary radar monitoring system (surveillance radar with a minimum azimuth accuracy of 0.3 degrees (one sigma) or better and update period of 5 seconds or less). However, FAOR is unable to run independent or segregated parallel operations due to:

- Current missed approach procedures are noncompliant of the required missed approach procedures for the use of independent/segregated parallel operations,
- required minimum radar separation between the departure and arrival runways is not attained, and
- required spacing on final is not attained for the preceding landing to report clear of the runway before the following receives landing clearance.

Additionally, ATNS procedures also require that the departure can only be released once the arrival on the parallel runway is "landing assured". The definition of "landing assured" is not clearly defined and therefore should be removed or clarified.

There are several modes of parallel operations that are available if the safety requirements are met. However, this section specifically focuses on independent and segregated parallel operations.

- **Independent Parallel Approaches** - Independent parallel approaches are one type of simultaneous parallel approaches to parallel or near parallel instrument runways where radar separation minima between aircraft on adjacent extended runway centre lines are not prescribed.
- **Independent Parallel Departures** - Independent parallel departures fall under the category, simultaneous parallel departures and is described as simultaneous departures in the same direction from parallel instrument runways. This mode also requires that recommended wake vortex separation standards are applied
- **Segregated Parallel Operations** - Segregated parallel operations is the simultaneous operations on parallel or near-parallel instrument runways in which one runway is used exclusively for approaches and the other runway is used exclusively for departures. Segregated parallel operations can be used such that one runway is used exclusively for arrivals or departures, and the other runway is used for both arrivals and departures.

There are several recommendations for implementing this enhancement. FAOR should update the missed approach procedures, which require that the missed approach track for one approach diverges by at least 30 degrees from the missed approach track of the adjacent approach. Likewise, the current spacing on final approach at FAOR is 12 NM at the outer marker and 10nm to touchdown. This is very conservative compared to international practices. In the United Kingdom, for example, the arriving aircraft must be cleared to land by 3 NM and the departure clearance must be issued before the arrival aircraft is at 8 NM. Therefore, current spacing standards should be reduced (Section 2.1.1). ATNS and ACSA, along with their stakeholders, must conduct an assessment of all current procedures, regulations, and standards affecting the implementation of independent and segregated parallel operations. This should be done during the periodic stakeholder meetings that are already underway. Since aircraft landing on RWY31R/21L routinely cross RWY31L/21R to reach the passenger terminal, the airport layout should also be studied further to assess whether independent or segregated parallel operations require airport infrastructure changes. The recommended enhancements in Section 2.3 may be an enabler.

The use of independent or segregated parallel operations will allow for increased runway capacity and provide greater flexibility for ATNS and ACSA. It is also noted that this enhancement, with the stated recommendations, will enable more efficient LVPs (Section 2.1.5) by removing the dependencies that are currently in place among departing and arriving aircraft. It is sufficient to implement this enhancement as soon as the minimum requirements are met, as immediate benefits are probable through LVPs.

Table 28: Independent and Segregated Parallel Runway Operations Specifications

Specification	Description
Budget	To be determined by ATNS
Quality	N/A
Reliability	N/A
Durability	N/A
Warranties	N/A
Standards	• ICAO Annex 14 Aerodromes • ICAO Doc 4444 PANS-ATM • ICAO Doc 8168 PANS-OPS • ICAO Doc 9643 Manual on Simultaneous Operations on Parallel or near parallel Instrument Runways (SOIR) • ICAO Doc 9870 App B - Best Practices on the Flight Deck • ICAO Doc 9870 App C - Air Traffic Control Best Practices
Regulations	• CARS and CATS: change probably not required. • AIP, SSIs: require amendments • ICAO: Compliance with the documents listed as references
Guidance	ATNS, ACSA, ICAO

3 Evaluation Criteria

It is important that all stakeholders agree in advance on the criteria that will be used to evaluate capacity enhancements. ATNS and ACSA understand their own organizations' needs but will benefit from the guidance of well-designed and clearly articulated evaluation criteria, which are acceptable to all stakeholders.

Once established, ATNS and ACSA will use the evaluation criteria to both identify potential capacity enhancements and to determine whether they will meet the intended objectives of their respective organizations. Artfully crafted evaluation criteria will facilitate accurate comparison of alternatives, identification of trade-offs, and prioritization of enhancements. Good evaluation criteria are characterized by several qualities that help make sure that the right information is provided to decision-makers.

In general, effective evaluation criteria should be:

- Measurable – The enhancement should result in a positive and measurable change in capacity. This change may be an increase in capacity during peak times, reduced delays, and or reduced travel times. The justification of the enhancement should include a concise description of the amount of change and its financial impact, if any, on each of the stakeholders. Changes that have a significant impact on environmental or economic development, or employment objectives of stakeholders should be also be identified and quantified.
- Practical – enhancements must be accepted by all stakeholders as being possible to achieve based on mutually agreed evaluation criteria. The enhancements also need to make common sense in meeting national political objectives. This study proposed a financial evaluation approach that justifies the cost of enhancements based on the value of the time saved to airlines and passengers. The study team did not consider certain capacity enhancements that required that neighboring countries adopt new rules because they were deemed to be not practical.
- Unambiguous – the benefits of a capacity enhancement must be well-defined to all stakeholders, because a lack of clarity will damage the ability of the stakeholders to reach a consensus. Thus an inexpensive capacity enhancement, one that costs less than R20million, which can be justified on the basis of saving a couple of seconds per plane should state that fact as the justification, and not simply say that it is new technology and will be good to have.
- Comprehensive – the evaluation of a major capacity enhancement's benefits should consider the effect that that enhancement may have on other parts of the system as well as all stakeholders. The challenge is to find a good balance between being comprehensive and concise.

3.1 Enhancement Triggers

The study team believes that triggers can play an important role in determining when airport and airspace capacity enhancements need to be made. Indeed, the use of triggers is becoming a best practice at large airports because they help stakeholders anticipate future investment needs instead of waiting for a problem to develop. Typically triggers are quantitative measures of demand (e.g., annual, daily or peak hour movements or frequency of peak hours throughout a typical day) which will cause delays to reach a level that is unacceptable to airlines and the traveling public. Triggers could also be defined based on routinely recorded delay metrics.

A major theme in this report is that certain recommended enhancements produce measureable efficiency benefits in the form of delay reduction or reduced operating time. Therefore, it is important to express the enhancement triggers in the same metric dimension (time) to ensure consistency across enhancement categories. This is not a trivial experiment, as one of the many challenges of airport and airspace planning is that delays do not grow linearly as traffic rises because factors that cause delays frequently interact resulting in exponential delay growth that if not anticipated can cause significant problems for airlines, the traveling public, and the local economic catchment areas. Further, the magnitude and nature of aircraft delay is heavily influenced by forecast demand distributional characteristics, such as fleet mix and hourly profiles (among other factors), which are very dynamic and are influenced by airline strategies. Comprehensively quantifying the complex and inter-related causalities of delay at future levels of demand is beyond the scope of this study, but the study team will expand on the topic of triggers with a preliminary analysis and how they can be applied to the three airports in Task 8. A preliminary attempt at quantifying the delay effect would follow a proposed methodology such as:

- Query stakeholders to define acceptable average delay levels per flight.
- Analytically grow scheduled demand to meet estimated demand growth from Mac MacDonald forecasts for specific levels (e.g., 5%, 10%, 15% growth).
- Assume some proportionate growth of the demand across operational hours.
- Apply the same delay reduction methodology used to estimate the effects of reduced separation in Section 2.1.1, that is,
    - Apply current capacity levels to generate a baseline capacity delay distribution.
    - Apply future estimated capacity levels to generate future estimated delay distributions.
- Compare the future estimated delay distributions to the acceptable levels of delay established by the stakeholders.
- Interpolate between data points to estimate delays pairs of demand levels and capacity enhancements capacities.
- Identify cases in which the future estimated delay distributions show levels that are “at” or “near” the acceptable levels of delay. These delay levels will identify the forecast demand levels for trigger targets.

4 Recommended U.S. Sources of Supply

The Statement of Work requires that the study team recommend US service providers and manufacturers that can help with the implementation of the recommended enhancements.

There are many qualified companies, too many to list here, so the study team recommends using the vendor search services of the American Association of Airport Executives (AAAE)[10] for an extensive list of service providers and manufacturers. However, a sample of qualified companies is provided in Table 29.

[10] American Association of Airport Executives, www.aaae.org

Table 29: Sample of Recommended US Suppliers

Company	POC	Address	Phone	Fax	Email	Goods/Services
Metron Aviation	James Gaughan	45300 Catalina Court, Suite 101 Dulles, VA 20166	+1-703-456-0123	+1-703-456-0133	info@metronaviation.com	ATM products and services, airspace design, procedures development
Landrum & Brown Worldwide Services, Inc.	Doug Goldberg	11279 Cornell Park Drive Cincinnati, OH 45242	+1-513-530-1219		dgoldberg@landrum-brown.com	Aviation and airport planning
ACA Associates, Inc.	Don Schenk	545 Fifth Avenue, Suite 640 New York, NY 10017	+1-212-808-4420		dpschenk@aca-assoc.com	Consulting and financial advisory
The Burns Group	John E. Burns	6700 Old McLean Village Drive, Suite 201 McLean, VA 22101	+1- 703- 760-9076	+1-215-405-2510	jburns@burns-group.com	Airport design and construction
Ennis-Flint		115 Todd Court Thomasville, NC 27360	+1-336-475-6600	+1-336-475-7900	sales@flinttrading.com	Airfield Marking/Striping
Honeywell	Chris Benich	101 Constitution Ave NW Washington, DC 20001	+1-202-662-2662		chris.benich@honeywell.com	Airport solutions
Iridium Communications		**Headquarters**: 1750 Tysons Boulevard, Suite 1400 McLean, VA 22102 USA	+1-703-287-7400	+1-703-287-7450		
Iridium Communications		**Europe/Middle East/Africa**: Thremhall Park Bishop's Stortford Herts, CM22 7WE UK	+44 1279 874455	+44 1279 874456		

5 Summary and Next Steps

The purpose of the SA ACES Task 6 report, Specifications and Recommendations, is to provide recommendations for implementation of the set of airside capacity enhancements researched in Tasks 1 through 5. The enhancements were organized by Efficiency Group, Capacity Enhancement Category, Impact Area (airspace or airside), and Candidate Capacity Enhancement Initiative. A detailed, written description was provided that recommends specific steps to be taken toward implementation of the capacity enhancement initiatives. Cost data was provided to assist ATNS and ACSA with determination of the budget required for implementation. For those enhancements where no budget information is provided, it was determined by the study team, ATNS, and ACSA that this information was not readily available and cost information should be updated by ATNS and ACSA after review of the report. High-level specifications were also provided where applicable.

The Task 7 report, Development Impact Assessments, will provide a high-level assessment of the impacts to aviation infrastructure, markets, human capacity building, and technology by the recommended enhancements. The Task 8 report, Implementation Plan, will use the contents of this report and feedback from ATNS, ACSA and other stakeholders to develop a plan for implementation of the enhancements described in Section 2. Implementation will include a comprehensive joint road map for ATNS and ACSA and a prioritization of the enhancements based on ATNS and ACSA goals. Tasks 1-6 and the subsequent Task 8 report should encourage consensus for collaboration among ATNS, ACSA, and other stakeholders in implementing the proposed enhancements and developing strategies for meeting future demand requirements. Feedback from ATNS and ACSA on this report will be considered in the development of the implementation plan.

Appendix A

ACSA PROJECT MANAGEMENT
PROJECT BACK-UP INFORMATION -INFRASTRUCTURE
BUILDING COST RATES Rev 2 (2012-10-22)

			Below rates exclude P&G, Sundry costs, Contingency, Esclation & Fees	Pure indicative guideline, can vary per region, type of construction, consultant involvement, information risk profile, direct costs. (Below are high-level for order-of-magnitude estimates only)				*Rates excluding Escalation*
	ELEMENT	**UNIT**	Base Date January 2012 (ZAR)	**P&G**	**SUNDRY DEVELOPMENT COSTS (1% Landside, 2% Airside)**	**Contingency**	**Fees**	Base Date January 2012 (ZAR)
	APRON WORKS INCLUDING LAYERWORKS, EXCLUDES BULK EARTHWORKS							
1.	Concrete apron stands inclusive of stormwater, sleeves, fire water, electrical, fuel (average stand rate)	m2	2,140					3,040
2.	Miscellaneous hard stand areas (allowance)	m2	1,120					1,600
3.	Nose service Roads (average between high & low traffic roads)	m2	810	15%	2%	10%	10%	1,150
4.	Taxilanes and tail service roads	m2	740					1,060
5.	Staging area (precast block paving)	m2	480					690
6.	*Average rate per sq. meter (as per sample estimate Code C)*	*m2*	1,540					2,180
	TAXIWAYS (ASPHALT) INCLUDING LAYERWORKS, EXCLUDES BULK EARTHWORKS							
7.	Taxiways including layerworks & edge lighting	m2	1,240					1,750
8.	Taxiway shoulders	m2	560					800
9.	Taxiway strip	m2	60					80
10.	Taxiway incl. layerworks & edge lighting	m	4,270	15%	2%	10%	10%	6,060
11.	Taxiway shoulders (17.5m both sides)	No	8 400-4 5000					11 200- 61 800
12.	*Average rate per meter (25m Code F)*	*m*	*52,950*					75,160
13.	*Average rate per sq meter (25m Code F)*	*m2*	*2,110*					3,000
	RUNWAYS (ASPHALT) INCLUDING LAYERWORKS, EXCLUDES BULK EARTHWORKS							
14.	New runway, inclusive of sleeves, lights, ILS, etc.	m2	1,610					2,280
15.	Runway shoulders	m2	560					800
16.	Runway ungraded strip	m2	60					80
17.	Runway graded strip and Runway End Safety Area (RESA)	m2	110	15%	2%	10%	10%	160
18.	Optional illumininated signs, stop bars	No	8 400-4 5000					11 200- 61 800
19.	*Average rate per meter (60m, 4.2km, Code F)*	*m*	*124,680*					176,950
20.	*Average rate per sq meter (60m, 4.2km, Code F)*	*m2*	*2,080*					2,960
	EARTHWORKS/ROADWAYS							
21.	Airside asphalt service roads, inclusive of layerworks, street lights & stormwater	m2	*790*	15%	2%	10%	10%	1,110
22.	At grade access roads ("provincial standard"), including layerworks, stormwater, lights, traffic signals	m2	*1,690*	15%	2%	10%	10%	2,360
	PARKING, EXCLUDES BULK EARTHWORKS							
23.	Structured parking (public) - per bay - *PROVISIONAL*	bay	*86,000*	13%	1%	10%	15%	124,120
24.	Structured parking (basement) - per bay - *PROVISIONAL*	bay	*131,540*	13%	1%	10%	15%	189,880
25.	On-grade parking (shaded, fenced, lights) - per bay - *PROVISIONAL*	bay	*13,150*	13%	1%	10%	10%	18,210
			-					
	PERIMETER FENCE/SECURITY GATES		-					
26.	Perimeter walls with PIDS or other security measures - *PROVISIONAL*	m	*3,940*	8%	2%	10%	10%	5,280
27.	Security gate - *PROVISIONAL*	item	*7,307,480*	8%	2%	10%	15%	10,183,140
28.	Super security gate - *PROVISIONAL*	item	*22,484,560*	8%	2%	10%	15%	31,332,790
	TERMINAL & OTHER BUILDINGS, EXCLUDING BULK EARTH, EXTERNAL SITE & SERVICES WORKS							
1.	Terminal building excluding Baggage & X-ray machines	m2	13,150	20%	2%	10%	16%	20,570
2.	Terminal building including Baggage & X-ray machines	m2	17,200	20%	2%	10%	16%	26,870
3.	Pier Terminal building excluding telescopic Air bridges, Seating & ADS but including fixed bridges	m2	13,720	13%	2%	10%	16%	20,120
4.	Pier Terminal building including telescopic Air bridges, Seating & ADS but including fixed bridges	m2	18,210	13%	2%	10%	16%	26,760
5.	Telescopic air bridges	No	4,834,180	5%	2%	10%	5%	5,979,880
6.	ADS (per unit)	No	736,370	5%	2%	10%	5%	910,850
	CIVIL REHAB WORKS							
1.	Concrete Rehabilitation (Preliminary)	m2	1,890	20%	2%	10%	13%	*2,740*
2.	Asphalt Rehabilitaion (Preliminary)	m2	1,550	20%	2%	10%	13%	*2,250*
	DOMESTIC TERMINAL BUILDINGS							
1.	Terminal building refurbishment excluding baggage and X ary machines (Preliminary)	m2	7 800-10 800	15%	2%	10%	16%	*11 150-15 400*