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Important Note

Airport Authority Hong Kong (AAHK) is responsible for preparing the Hong Kong International Airport (HKIA) Master Plan 2030 and commissioning the associated consultancies. At different stages of these consultancies, the consultants produced various documents for AAHK's consideration, culminating in the production of final reports. Where a final report was not produced, the consultants' work was consolidated into the HKIA Master Plan 2030 Technical Report. As the reports were produced at different times, they may contain outdated or inconsistent contents.

The HKIA Master Plan 2030 was not drawn up solely on the basis of the various consultancies commissioned by AAHK, but also has incorporated input from relevant airport stakeholders as well as AAHK's own input on the basis of its solid experience in airport operations. Hence, for any differences between the consultancy reports and the HKIA Master Plan 2030, the latter and the Technical Report should always be referred to.

Airport Authority Hong Kong

July 2011

NATS

AIRSPACE AND RUNWAY CAPACITY STUDY PHASE 2

Deliverable P6
Final Runway Options Report

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EXECUTIVE SUMMARY

In Phase 1 of the Airspace & Runway Capacity Study, NATS identified the maximum potential capacity within the current constraints at and around Hong Kong International Airport, subject to the conditions identified in the report, to be 68 movements per hour. Due to the desire for additional capacity to satisfy projected demand. Airport Authority Hong Kong (AAHK) proposed a third runway and associated airport infrastructure to accommodate this increase and commissioned NATS to carry out Phase 2 of the Study to investigate its feasibility. The main aims of the study are:

- to investigate the possible locations of the third runway;
- to identify the mode of operations for each option;
- to identify any airspace implications with the operation of a third runway;
- to identify the construction and ground infrastructure issues associated with each option;
- to determine the potential runway capacity for each option.

In the Second Technical Report (Deliverable P4) 15 runway options were identified. A down selection process was then undertaken in which an assessment was performed to compare the relative merits of the 15 options, taking into account the advantages and disadvantages of each option including potential airfield capacity, air traffic procedures, airport integration issues, surface access, apron planning, safety, constructional issues and environmental impacts.

This indicated that Options P, R and S Extended (including a number of variants) appear to offer the maximum potential capacity gains, which amounts to around 102 movements per hour (34 additional movements per hour over the existing two runway capacity assessed in Phase 1 of the study). These options, at the same time, represent three different design concepts including wide-spaced and close-spaced arrangements and presented opportunities for developments to build over or remain clear of the mud pits, which will have a significant construction and environmental impact if disturbed.

It is therefore proposed that these options should be subject to further detailed design work in respect of the construction aspects, ATC and operational procedures to validate the viability of these options.

The key issues are maximising capacity and the decision on whether or not to build on or over the contaminated mud pits. Depending on these decisions, the three selected options may be further refined and developed.

A number of operational issues have been identified in this report in respect of parallel approaches, wake vortex separation and ILS performance. For some of the runway options special procedures will be required to address these issues due to the unique nature of the Hong Kong operation (e.g. local terrain). Work is urgently required to validate these issues and determine if they will have an impact on capacity. It is only once this work has been completed that the definitive capacity of the three runway combination can be determined.

In order to realise the capacity increase associated with the commissioning of the third runway, the immediate airspace in the Pearl River Delta area must be significantly reorganized to accommodate the necessary procedures for the new runway and the planned capacity increases at the other airfields in the area. This will require cooperation amongst Civil Aviation Authority China (CAAC), Hong Kong Civil Aviation Department (HK CAD) and Autoridade de Aviação Civil Macao (AACM) in the Pearl River Delta Tripartite Working Group to jointly develop and implement these changes. These changes are essential in order to achieve the capacity increases identified in this report.

GLOSSARY

AAHK	Airport Authority Hong Kong
ACC	Area Control Centre
AIP	Aeronautical Information Publication
AMC	Air Movements Controller
AMN	Air Movements Controller North
AMS	Air Movements Controller South
AMSTS	Aircraft Movement Statistics System
APP	Approach Sector
APPS	Approach Surfaces
APU	Auxiliary Power Unit
ARR/Arr	Arrivals
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
BCF	Boundary Crossing Facilities
CAD	Civil Aviation Department Hong Kong
CDC	Clearance Delivery Controller
CNS/ATM	Communications, Navigation, & Surveillance for Air Traffic Management
DEH	Departure High Sector
DEM	Digital Elevation Model
DEP	Departure Sector
DEP/Dep	Departures
DFS	Deutsche Flugsicherung
DME	Distance Measuring Equipment
E	East
EAT	Expected Approach Time
ETA	Expected Time of Arrival
ETD	Expected Time of Departure
EU	Evaluation Unit
FAD	Final Approach Director Sector
FIR	Flight Information Region
FL	Flight Level
FLO	Flow Controller
GMC	Ground Movements Controller
GMN	Ground Movements Controller North
GMS	Ground Movements Controller South
HK	Hong Kong
HK CAD	Hong Kong Civil Aviation Department
HKFIR	Hong Kong Flight Information Region
HKIA	Hong Kong International Airport
IAS	Indicated Airspeed

ICAO	International Civil Aviation Organisation
LCE	Local Competency Examiner
MATC	Manual of Air Traffic Control
MCH	Macau High Sector
MCL	Macau Low Sector
MMD	Mott MacDonald[1]
MVMT	Movements
Nm	Nautical Mile
PANS	Procedures for Air Navigation Services
PDG	Procedure Design Group
PDT	Procedure Design Team
PRD	Pearl River Delta
RESA	Runway End Safety Area
RET	Rapid Exit Taxiway
RFL	Requested Flight Level
ROT	Runway Occupancy Time
RRSM	Reduced Runway Separation Minima
RVA	Radar Vectoring Area
S	South
SAR	Special Administrative Region
SARP	Standards & Recommended Practices
SDD	Situation Data Display
SID	Standard Instrument Departure
SOIR	Simultaneous Operations on Parallel or Near Parallel Instrument Runways
STAR	Standard Instrument Arrival
TAAM	Total Airport & Airspace Modeller
TMA	Terminal Control Area
TME	Terminal Radar Control East Sector
TMS	Terminal Radar Control South Sector
TOCS	Take Off Climb Surfaces
TRE	Area Radar Control East Sector
TRK	Area Radar Control East Arrivals Sector
TRN	Area Radar North Sector
TRS	Area Radar South Sector
TRU	Area Radar Upper Sector
TRW	Area Radar West Sector
VCR	Visual Control Room
VH/VHHH	Hong Kong
VM/VMMC	Macau
WP	Work Package

[1] All reference to Mott MacDonald also refers to Mott Connell.

CONTENTS

1 INTRODUCTION

This document represents the final draft of Deliverable P5, the Final Runway Options Report of the Airspace and Runway Capacity Study Phase 2 being conducted by NATS (Services) Limited for the Airport Authority of Hong Kong. This covers the work on the options for a potential third runway.

This document has been divided into main three sections:

1. The main section which gives an overview of the study and the work conducted, including the various topographical, operational, airport integration, constructional and environmental considerations;
2. The options considered but determined to be less viable as a result of the down selection process.
3. The Detailed Options describing those runway alignment options that were down selected.

With a view to enhancing the current system capacity to cope with the predicted increase in traffic demand, AAHK issued an Invitation to Tender (Ref: PRO/T049/07/OY) for a consultancy study to review the ATM procedures, airspace and runway capacities within the HK FIR. Following a competitive tender, NATS were awarded this contract by AAHK.

This study is Phase 2 of the current agreed work programme with AAHK, which considers the location of a third runway at HKIA and the associated capacity increases that may be expected.

In selecting the options that are listed in this document, many factors were considered including: geography, airport integration, potential capacity, constructional issues and existing issues with weather and airspace restrictions. Environmental impacts from each option have also been identified at a high level which may be used as pointers in the separate environmental assessment following this study.

NATS consider that the three ‘preferred’ options identified and further detailed in this report will provide the best potential capacity whilst minimising the operational issues. However it is worth noting that these may have serious constructional challenges if the decision to build over the identified ‘contaminated mud pits’ were to go ahead.

This report also identifies a number of significant operational issues associated with the operation of the third runway, including the procedures for parallel approaches, compliance with the ICAO SOIR manual and wake vortex issues. The resolution of the issues may require some kind of operational restrictions that could limit the capacity gains of some of the runway options. Further work is urgently required to investigate these issues and validate the runway capacity of the chosen options.

Detailed studies of the selected options include mode of operations, viable approach and go-around procedures and potential positions of taxiways, terminals and surface connections. Outline information of the options which were not down selected have been included.

In addition, NATS has reviewed the airspace associated with the operations of the third runway as well as the wider airspace around the Pearl River Delta area. NATS' Procedure Design Group has produced preliminary designs of the arrival, departure and missed approach procedures for the 3 down selected options and these are described in Appendix B.

2 STUDY REQUIREMENTS: AIMS AND OBJECTIVES

This second phase of AAHK's Airspace and Runway Capacity Study (Phase 2) is designed to determine the possible locations of the proposed third runway at HKIA, taking into consideration geography, airport integration, airspace restrictions, potential capacity, constructional issues and highlighting any environmental impacts. This Phase 2 Study will evaluate airspace and runway alignment solutions that meet the capacity requirements of HKIA. The ultimate solution will take into account the following issues:

- Annual and hourly capacity;
- Safety;
- Operational efficiency; and
- Obstacle clearances.

Airspace issues including local and regional airspace have been reviewed by NATS.

Where appropriate, reference will be made to ICAO SARPS, PANS, Hong Kong AIP, Hong Kong Manual of Air Traffic Control and other relevant documents together with relevant field visits in conducting the study. The study shall address three main criteria concerning the addition of the third runway:

2.1 Third Runway Alignment Options

An initial range of options was proposed, and a down selection process was conducted. This resulted in a shorter list of options that were taken forward for further detailed evaluation, taking into account capacity and operational viability.

When developing the range of options, the following have been considered:

a) The existing runway system at Chek Lap Kok is composed of two runways with alignment of 07/25 and a runway separation of 1540m. In light of current objectives, and the option for an additional runway, the study assesses the advantages and disadvantages of various runway configurations.

b) The study gives due regard to all other factors involved in determining the potential maximum runway capacity that could be achieved, notably; operational considerations and issues with the high terrain in the vicinity of Chek Lap Kok, West of New Territories and on North Lantau.

The recommendations consider the optimum airport layout, including consideration of the following items:

- Airspace and Air Traffic Control procedures;
- Runway usability;
- Runway capacity;
- ICAO Procedures (including, but not limited to, ICAO Annex 14 SARP's and Obstacle Limitation Surfaces);
- Hong Kong SAR boundary;
- Environmental issues such as the location of existing contaminated mud pits and the marine sanctuary park.

Detailed descriptions on the runway option development process are in Section 4.

2.2 Airside (Operational) Development

When considering the Airspace (Operational) development, the study will:

a) Address the capacity for varying configurations;

b) Examine, in consultation with HK CAD and the Authority, by computer simulation an optimized airspace and airfield system (include taxiway modification, if required) for the development of the new runway;

c) Recommend on the requirement for RESAs and/or inclined safety areas at the ends of that runway;

d) Address the annual and hourly capacity of the runway/taxiway system in relation to the mode of runway operation proposed;

3 OVERVIEW OF WORK PROGRAMME

The work programme has generally been conducted against the agreed schedule as defined in the Inception Report (Deliverable P2). The NATS staff primarily involved in the conduct of this work were:

Chris Danner: Project & Delivery Manager

Robin Gunter: Lead Consultant

Paul Johnson: ATCO Consultant

Jesse Yuen: TAAM Expert, in-county representative

Keavy Wilson: Commercial Co-ordinator

The work has made significant use of NATS' operational and simulation experience and the close working methods employed by NATS between these two disciplines.

It must be emphasised that this was a very demanding work programme against very tight timescales. A project such as this would normally be conducted by NATS over a considerably longer timeframe. The results presented herein are as detailed as possible within the agreed scope of the work; however, it is highly likely that further work and/or studies will be required before implementation of the recommendations presented.

3.1 Methodology Overview

NATS, in conjunction with their sub-contractor Mott MacDonald[2], conducted this work based on three firm foundations:

The knowledge that NATS have built up of the HK FIR and HKIA operations through their conduct of the Phase 1 study coupled with the detailed Mott MacDonald knowledge of HKIA design and operation plus the surrounding environmental issues;

The vast experience of ATC operations and airport design resident within NATS and Mott MacDonald;

The vast experience of ATC and HKIA operations resident within AAHK and CAD and their work conducted to date on the future airspace and airport options.

NATS' proposed methodology is as outlined in the diagram below.

[2] All reference to Mott MacDonald also refers to Mott Connell.

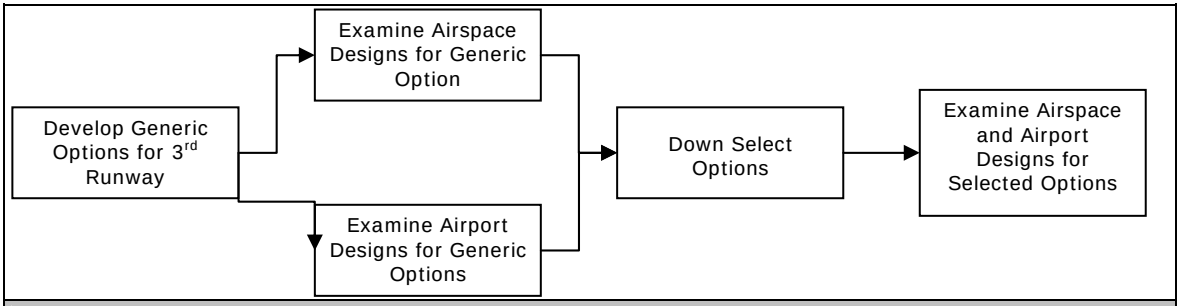


Figure 3.1 Proposed Methodology

3.2 Work Programme

The project plan described herein consists of ten Work Packages (WP). These are outlined below and described in more detail in the following sections.

Table 3.1 Work Packages	
WP0	Programme Management
WP1	Familiarisation
WP2	PRD Airspace Incorporation
WP3	CNS/ATM Overview
WP4	Development of Generic Runway Options
WP4a	PDT Assessment
WP5	Assessment Methodology Development
WP6	Evaluation of Airspace for Generic Runway Option
WP7	Evaluation of Airport for Generic Runway Options
WP8	Option Selection
WP9	Detailed Runway Design Assessment

A brief description of the work conducted in each WP is given below[3].

Table 3.2 Work Package Descriptions	
WP0	Oversee of the programme and liaison with the customer Project Manager (Mr Chris Au Young). Delivery of all bi-weekly progress reports and the minutes of all meeting held. Delivery of all project deliverables.
WP1	Familiarisation for NATS' subcontractors Mott MacDonald with Phase 1 study and results.
WP2	Simulate PRD Airspace. NATS Phase 1 HKFIR airspace model and PRD airspace integrated.
WP3	Review of current and future CNS/ATM equipment. Report made available to AAHK and CAD.
WP4	Review of potential third runway options. Development of generic options. Delivery of First Technical Report to AAHK and CAD.
WP4a	Procedure Design Group's assessment of proposed generic options.
WP5	Development of assessment methodology and delivery of Methodology Report to AAHK and CAD. Development of baseline matrix for selection of generic options.

[3] It is not intended to repeat detailed information contained in NATS' progress reports herein.

WP6	Development of TAAM airspace model evaluating HK airspace to implement generic options.
WP7	Analysis of proposed airport design and environmental impact on airport for generic runway options.
WP8	Down selection of feasible design options. Delivery of Second Technical Report to AAHK and CAD.
WP9	Further in-depth analysis of selected options by Procedure Design Team, TAAM expert and ATC Operational Experts. Further analysis of airport design by Mott MacDonald. Preparation and delivery of draft final and final reports.

3.3 Deliverables

The following deliverables were delivered as part of this study:

Table 3.3 List of Deliverables

Deliverable	Description	Date Delivered
P1	Draft Project Plan & Work Programme	15th November 2007
P2	Inception Report: Agreed Project Plan & Work Programme	November 2007 (see below)
P3	First Technical Report	31st January 2008
P4	Second Technical Report	3rd March 2008
P5	Draft Final Report	27th March 2008
P6	Final Report	July 2008
P7.x	Bi-Weekly Progress Reports	As appropriate
P8.x	Progress Meeting Minutes	As appropriate
I1	CNS/ATM Overview Report	14th December 2007
I2	Assessment Methodology	24th December 2007

Deliverable **P1** is considered as being the Technical Proposal that was used for discussions at the meetings of the 8th and 15th November 2007.

The programme deliverables requested by AAHK have been identified within the project commencing with the letter P herein; internal deliverables (those of significant importance to the project) have been identified by commencing with the letter I herein.

4 RUNWAY OPTION DEVELOPMENT

The series of options evaluated were based upon a range of generic layout concepts which were selected to demonstrate the broadest range of possible runway alignments. These layouts can be broadly characterised as follows:

- Aligned at an angle to the existing runways;
- Parallel with the existing runways;
- Parallel and significantly staggered from the existing runways;
- Remote from HKIA.

4.1 Initial Option Development

Fifteen initial options were developed:

- Option A - Cross Runway;
- Option B - Angled Runway;
- Option C - Far Spaced Parallel Runway (>2000m Separation);
- Option D - Parallel Runway 1525m Separation;
- Option E - Parallel Runway 1035m to 1524m Separation;
- Option F - Parallel Runway 915m to 1034m Separation;
- Option G - Parallel Runway 760m to 914m Separation;
- Option H - Parallel Runway 380m to 759m Separation;
- Option J - South of Lantau Island;
- Option K - South East of HKIA;
- Option M - North of HKIA;
- Option N - Eastern Staggered, Close Spaced, Parallel Runway;
- **Option P - Wide Spaced Parallel Runway (2240m) Offset to the West;**
- **Option R – Parallel Runway at 1525m Offset to the West;**
- Option S - Western Staggered, Close Spaced, Parallel Runway;

All of these initial options add a third runway with a length of 3800m. The aim was to start with a generic length for all options that will accommodate all types of air traffic movements. The runway length would then be refined in the later stages to take into account any physical constraints and the chosen mode of operations.

The fifteen options identified each falls into one of the categories of runway alignment mentioned above.

Options A and B are non-parallel options.

Options C, D, E, F, G and H are parallel runways with no stagger. These options have been selected to reflect the standard runway separations specified in ICAO Annex 14 and PANS-OPS and to enable a clear distinction between each option.

Options P and R are variants of Options C and D respectively, each gaining a western stagger.

Options N and S are variants of the close parallel Option H with an eastern and a western stagger respectively.

Options J and M are remote from the current airport.

These options were analysed to initially determine their advantages and disadvantages. The aim was to analyse these options to a level of detail that would enable some comparisons to be made between the options.

Results from the initial analysis were documented in detail in Deliverable P3 First Technical Report and Deliverable P4 Second Technical Report. A summary of the results has been produced in a tabular format in Appendix A.

The initial analyses for the close parallel Options H, N and S identified some issues which would require a dependent mode of operations between the existing north runway and the new runway in one or both directions of operation. A solution was found by combining the eastern and western stagger of Options N and S to give rise to a sixteenth option - Option S Extended. It has a runway length of over 5500m.

- **Option S Extended - Close Spaced, Parallel Runway Extended to the West;**

4.2 Down Selection

These sixteen options were then analysed and became clear that some of the options stood out as better options than others. The down selection process aimed to compare the sixteen options based on their identified attributes and select a subset to take forward to the next phase of refinement and detailed analysis.

The process was twofold. First, each of the options was judged by their ability to meet all of the mandatory criteria to deliver a safe and viable operation. Secondly, from an air traffic point of view, viable arrival, departure and missed approach paths are essential to enable the new runway to be operated safely and efficiently.

The next stage was to judge the options by comparing their attributes – potential capacity, airside integration, terminal development, surface access and operational viability. During this process, the siting of a runway remote from HKIA was not considered to be a viable option due to the lack of connectivity and the inability to integrate with the current infrastructure. At the end of this process, three options remained, and based on the fact that all three offered potential benefits, it was decided to take Options P, R and S Extended forward to the next phase of the study.

4.3 Other Options

The rest of the options have therefore not been studied any further beyond the initial stage. These options are shown above with a grey background and the chosen options are highlighted in **BOLD** below.

4.4 Further Development of Selected Options

The three selected options were further developed to add more details such as the approach/departure obstacle surfaces, marine exclusion zones and initial apron and terminal proposals. Each option was also subjected to an initial procedure design review to determine that the proposed approach, departure and missed approach procedures were viable. The runway length has also been adjusted based on factors such as the territorial boundary and operational requirements.

Option S Extended was further developed to include a number of variants:

- **Option S Extended Variant A – Closely Spaced Parallel Runway Extended to the West (With Boundary Crossing Facility Design Variant A)**
- **Option S Extended Variant B – Closely Spaced Parallel Runway Extended to the West (With Boundary Crossing Facility Design Variant B)**
- **Option S Extended Variant C – Closely Spaced Parallel Runway Extended to the West (With a Third Terminal to the West of the Airport)**
- **Option S Extended Variant D – Closely Spaced Parallel Runway Extended to the East and West**
- **Option S Extended Variant E – Closely Spaced Parallel Runway Extended to the East and West (Relocated Boundary Crossing Facilities)**

The process of designing a runway is a complex matter and at the conclusion of this study, each option has only been developed to a conceptual level with sufficient detail to enable a high level evaluation to take place. However, in a number of instances, such as the series of parallel options of varying separation, further detail has been produced to enable a distinction to be drawn between the operational advantages and disadvantages of each option.

This report contains the NATS and MMD initial evaluation of all sixteen options, and further in-depth details of Options P, R and S Extended.

5 CONSIDERATIONS

The report reflects the initial evaluation of sixteen runway options, reviewing the factors affecting the operational and construction impact at a high level. These are high level considerations that have been evaluated in general terms but which will require detailed investigation subsequent to this report.

Factors that have been considered in this review are:

5.1 Topographical

1. Lantau Island to the south limits some of the options. Its height and extent restricts approach, missed approach and departure routes and generates significant wind vortices in certain meteorological conditions;
2. The high ground northwest of Kowloon that forms a ridge along the north shore of the sea channel between Lantau and the mainland that leads to the Tsing Ma Bridge and the Tai Lam Valley. This is a significant obstacle for departures from the existing runways in the Runway 07 direction and arrivals to the existing runways in the 25 direction;
3. Tai Lam valley itself may offer a potential eastbound departure route. It is at present used as a missed approach route for Runway 07L, but requires the ability for aircraft carrying out a missed approach to achieve a higher than normal climb rate. Much of the southern end of this valley contains a reservoir, a natural park, and a significant residential development along the coast;
4. The ridge between the Tai Lam and Castle Peak valleys;
5. Castle Peak valley, which contains the major town of Tuen Mun at it southern end;
6. Castle Peak itself, which is the highest land in the immediate area to the north;
7. The high ground in the northern part of the SAR;
8. The local meteorological conditions, in particular the wake vortex interactions on closely spaced runways.

Figure 5.1 Topography

5.2 Airspace & Airport Capacity

- All options can be considered to have some airspace implications;
- It has been assumed that the airspace changes recommended in the Phase 1 report have been implemented. This could have been implemented as a stand alone project, but there will be benefits in developing an integrated program covering the Phase 1 changes and the revisions to the PRD airspace;
- It has been assumed that the proposed changes to the PRD airspace are in place i.e. that Hong Kong traffic can operate in the airspace to the north and west and that all new inbound/outbound routes to/from HK are integrated with adjacent airfields i.e. Macao, Zhuhai and Shenzhen.
- It is assumed that any additional navigation aids can be provided as and where necessary;
- No runway options have been rejected because of airspace issues, (e.g. the cross runway interaction with Shenzhen) but the issues have been noted and might impact on the operational acceptability and the eventual capacity.
- Parallel runway options have an interaction with Macau in the Runway 07 direction for arrivals and for departures from Runway 25, especially if additional SIDs to the West are included to improve the departure capacity of the airfield;
- The further west a proposed new runway is positioned, the interaction with Macau becomes more critical;
- The north runway missed approach profile creates an interaction with the Shenzhen circuit;
- Any SIDs to the North or North East used by aircraft departing to southerly destinations will have to route behind or above the approach sequence for Runway 25, creating an interaction with arriving traffic;

Many of the operational procedures associated with a third runway (such as a northerly circuit at Hong Kong, a long final in the Runway 07 direction and SIDs from Hong Kong routing to the North) are dependant on revisions to the PRD Airspace. It is assumed that this work will go hand in hand with the physical development of the airport infrastructure and that the airspace changes will be in place in a timely manner to support the opening of the new runway. This is considered to be essential in order to achieve the capacity increases identified in this report. Without the airspace changes, it is unlikely that the third runway will deliver any capacity increases over and above those identified in the Phase 1 report.

Recommendation:

RR1: Undertake additional work to identify solutions to all the relevant airspace issues.

This Phase 2 study also assumes that the missed approaches for the existing Runways 07L and 25R have been redesigned and that these runways have been proven fully independent from the existing Runway 07R and 25L departures.

The assumptions are based on maximising capacity with 3 serviceable runways. Degraded modes of operation for maintenance or other runway closures are not considered. Night time closures will affect the modes of operation chosen and this will have to be considered carefully at a later stage to avoid restricting capacity.

5.3 Airport Integration (Operational)

- Evaluate the ability of a new runway to integrate with the existing airport's facilities and operations;
- The potential modes of airfield operations considering which apron, passenger and cargo terminal areas are to be served;
- The ability to move aircraft between terminals (passenger and cargo), runways and maintenance areas;
- Evaluate the requirements for the taxiway and apron infrastructure to integrate with the new runway and terminals considering the traffic flows and physical constraints such as the obstacle clearance surfaces;
- In some options, only one taxiway has been provided to link the new and the existing parts of the airfield. Due to the limited amount of traffic between the areas, this will provide sufficient capacity when operating in Terminal mode. This does not provide any contingency and it may be operationally desirable to ensure that there are always two routes available between all parts of the airfield;
- HKIA is unusually affected by local meteorological phenomenon and these factors need to be considered carefully as part of the development of operational procedures for the third runway. All runway options will have specific meteorological features that will need to be taken into account and suitable equipment provided to support the operation. A summary of the relevant criteria and proposed equipment has been provided by HKO in the Appendix.

5.4 Airport Integration (Aprons and Terminals)

In assessing the performance of each option consideration has been given to how each new runway and its support aprons and terminal facilities can integrate with the existing airport's facilities and operations.

This can be broken down broadly into the following issues;

- The ease with passengers and bags from flights arriving at the new terminal can transfer to connecting flights at the existing terminal and vice versa;
- The ability of the current and future terminal buildings to share landside facilities;
- The need to provide additional key airfield facilities such as fire and rescue and air traffic control to service the new runway;
- The ability for cargo to be transferred from the cargo facility to aircraft parked on the new aprons;

Generally the performance of the three generic terminal locations can be characterised as follows;

5.4.1 Terminal to the North – Options P and R

For all practical purposes this is a separate airport. Due to its remoteness from the existing terminals and the barrier formed by the central runway it will be extremely challenging to provide airside connectivity that provides an acceptable level of performance. There is no potential to share landside facilities and new airfield facilities will have to be provided due to the distance of the new runway from the existing ones.

Access to and from the cargo and maintenance areas is possible but not helped by the distance involved and the intervening central runway.

5.4.2 Terminal to the East – Option S Extended Variants A/B/D/E

Due to their proximity to the existing terminals these options offer the best potential for integration of facilities and services. A high quality airside transfer product should be possible and some landside facilities shared.

With a closely spaced runway it is likely that existing airside facilities should also be able to provide coverage for the new runway.

Access to and from the cargo and maintenance areas is possible but not helped by the distance involved and the busy aprons and taxiways of the existing terminals that lie in between.

5.4.3 Terminal to the West – Option S Extended Variant C

The location of the new terminal building between the existing runways means that providing airside connectivity should be possible but will not be straightforward due to the position of the Fuel Farm and Maintenance Facility between the two terminal complexes.

With a closely spaced runway it is likely that existing airside facilities should also be able to provide coverage for the new runway.

Access to and from the cargo and maintenance facilities should be straightforward.

5.5 Surface Access

In assessing the performance of each option, consideration has been given to how the new terminal facilities for each option would be served by surface access connections. Key issues being;

- The general ease of extending the existing surface access facilities to serve the extended airport;
- The ability to extend the Airport Express Rail link (or in some cases other existing railways) to any new passenger terminal(s). Any need to split the route prior to its arrival at the existing terminal complex is seen as a significant disadvantage, resulting in a high risk that passengers travelling to the airport and those meeting inbound passengers may catch the wrong train;
- The ability to extend the existing primary bus system to any new passenger terminal(s). Any need to have separate main routes that would not also serve the existing terminal complex is seen as a significant disadvantage, resulting in a risk that passengers and meeters/greeters travelling to the airport may catch the wrong bus;
- The need to avoid penetration of obstacle limitation surfaces by ground access routes.

Generally the performance of the three generic terminal locations can be characterised as follows;

5.5.1 Terminal to the North – Options P and R

Having passed through the existing passenger terminal complex the surface access links would have to be extended, probably on a viaduct to the new passenger terminal facility. There is a possibility that passengers might get off at the wrong terminal, but with the two complexes being on the same line retrieving the situation should be straightforward.

5.5.2 Terminal to the East – Option S Extended Variants A/B/D/E

The close proximity of the two terminal complexes means that surface access terminuses can either be shared or at least be almost adjacent offering an excellent surface access product.

5.5.3 Terminal to the West – Option S Extended Variant C

Surface access connections to the new terminal would have to split from the current links well before the existing terminals to follow a route along the southern shore of the airport island (See Figure 5.1). In the case of the main line rail link it is unlikely that there would be a connection between the two terminal complexes, this means that it would be essential for passengers to board the correct train at their point of origin. Passengers who find themselves at the wrong terminal would probably have to board a bus or other intra airport link to retrieve the situation.

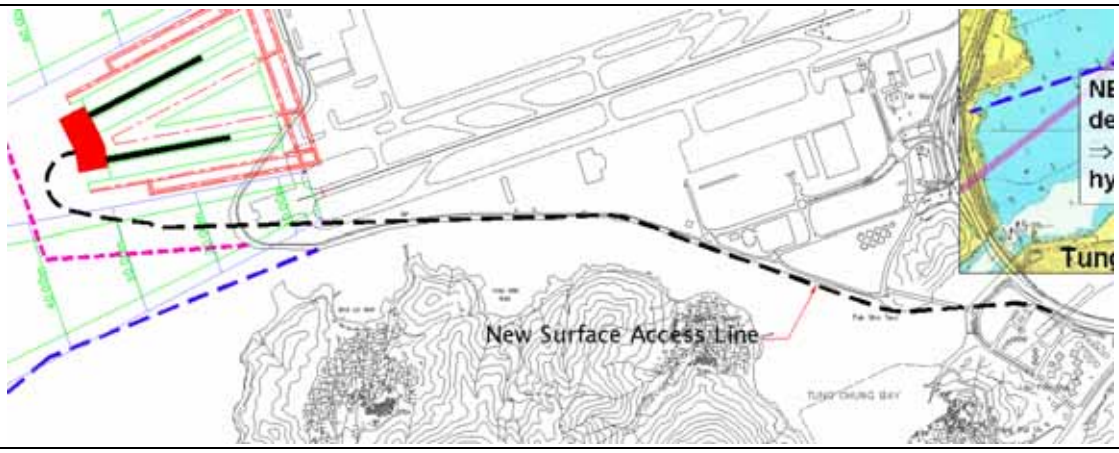


Figure 5.1 Surface Access Route for Option S Extended Variant C (Western Terminal)

5.6 Construction Issues

- The desire to avoid the mud pits and its associated additional financial cost. Consideration of sites outside the mud pit areas, relocation of mud pits prior to reclamation, piled, or floating structures.
- Potential impacts on local shipping routes, including separate consideration of large commercial ships and smaller local ferries, fishing vessels and leisure craft.
- The ability to bridge over retained sea routes.
- Taxiway slope limitations.
- Bridge clearance height limitations.
- Construction of road and rail surface access routes.
- Location of any planned infrastructure, for example, the Tuen Mun-Lantau link, the Hong Kong-Zhuhai-Macau Bridge and its associated Boundary Crossing Facilities and the Tung Chung Logistics Park. This should allow for any revised operational procedures on the existing and new runways.

5.7 Environmental Issues

All the options will inevitably have some form of environmental impact. Impacts that arise from the generation of additional air traffic movements have been ignored as

they are consistent across all options. Instead impacts specific to the physical arrangement of facilities have been highlighted, including;

- The impact of aircraft noise on principal residential areas;
- New areas that would be disturbed by aircraft noise;
- Environmentally significant marine habitats and breeding grounds;
- Impact upon tidal currents and beaches;
- Disturbance of the contaminated mud pits;
- The supplied data on environmentally significant marine areas and breeding grounds;
- Landscape impact;
- Surface access route impacts;
- Relative aircraft taxiing distances and arrival and departure route distances;
- Sea channels, although the extent and significance of local sea and tidal currents has not been examined in any detail.

Options where the components of the runway are located within a Marine Park or on top of the Mud Pits have considerable environmental issues. Serious concerns will be raised by Green Groups and Agriculture, Fisheries and Conservation Department.

5.7.1 Contaminated Mud Pits

The location of the contaminated mud pits has been determined by information supplied by the Fill Management Committee (FMC) at the Civil Engineering Development Department (CEDD). The information that was acquired from the CEDD to enable the project team to plot the locations of the mud pits was obtained from their website. The data obtained from the web site identified the existing mud pits but did not show the location of the proposed mud pits. The location of the proposed mud pits was faxed by FMC giving outer boundary co-ordinates of the proposed mud pits. A CAD drawing of the mud pits has not been issued by FMC or the CEDD and the area designated for their mud pit use is the larger gazetted area defined as a dumping zone, the mud pits in theory could be anywhere within this zone. The locations of the mud pits that have been shown on the various drawings represents the published CEDD data with the gazettal coordinates obtained from the CEDD website.

Note: the mud pits numbered 1 to 3 are capped and the mud pits numbered 4 are being capped therefore the information contained on the CEDD website (PDF plans) is a reasonable representation of the location of the mud pits (numbered 1-4). However number 5 mud pits are due to be filled until 2011 and therefore the extent of the area to be used is uncertain and the areas shown represent the outer boundary of the mud pits.

5.8 Obstacle Limitation Surfaces

In developing the S Extended suite of options considerable attention has been given to ensuring that the Take Off Climb Surfaces (TOCS) and Approach Surfaces (APPS) for the northern and central runways are respected by taxiing aircraft.

For example in the case of S Extended Variants A, B, D and E, in order to ensure that the tailfins of taxiing aircraft do not infringe the Runway 25 APPS or the Runway 07C TOCS the taxiways to the north east of these runways have been angled to respect these surfaces (see Figure 5.2). Where the resulting taxiways are arranged as a < they would not be used simultaneously, but singly dependent upon the prevailing direction of runway operation, controlled either by taxiway bars, or possibly physical

exclusion methods. Further work is required to ensure that all regulatory requirements are met in the design of the chosen solution.

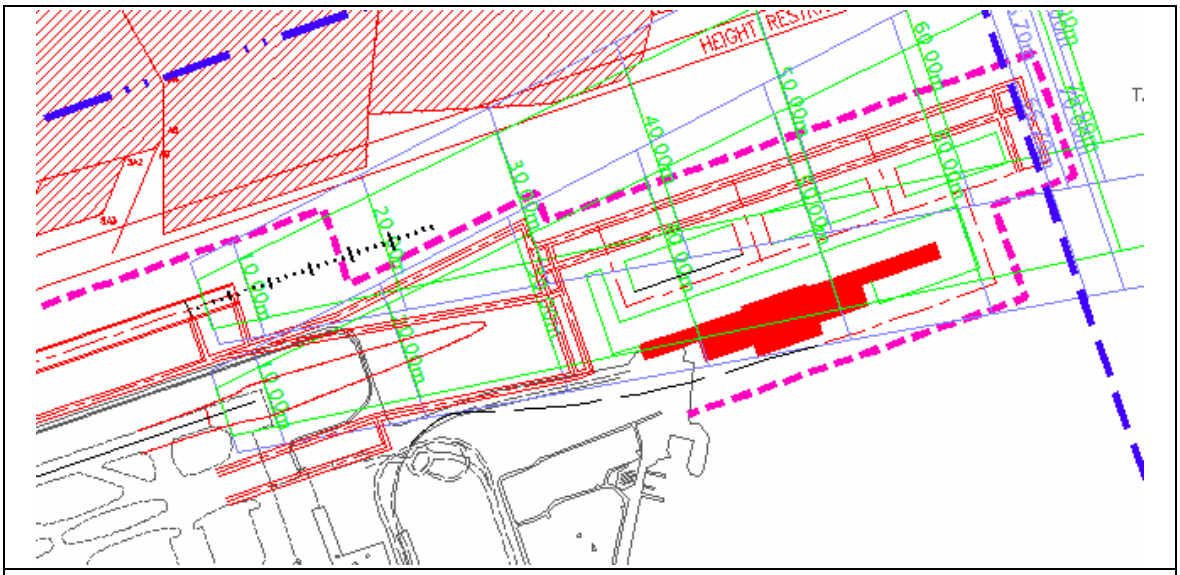


Figure 5.2 Obstacle Surface at Departure End of Runway 07L & 07C

Recommendation:

RR2: Once a definitive design has been selected, undertake a design review to ensure that all obstacle clearance surfaces are appropriately protected and incorporated into the Airport Height Restriction Plan.

5.9 Public Safety Zones

It is understood that no Public Safety Zones (PSZ) are currently declared at HKIA. However, given their existence at many other international airports around the world and to cater for the possibility of them being introduced at HKIA at some point in the future it is prudent to consider the impact of such an eventuality.

The practical impact of PSZs is to restrict the development of high occupancy facilities within the area of the PSZ to reduce the potential loss of life in the event of an aircraft crash on take off or landing. In practice this only impacts upon Options S Extended Variants A,B and D where as drawn a proportion of the aircraft aprons would sit within what is likely to be the 10^{-5} contour of the PSZ should one ever be implemented (see Figure 5.3).

Given that these are only remote stands with a relatively low intensity of use this may well be acceptable. However, a further consequence is that these options only have 75% of the apron area of the other aprons. If the apron were to be extended to the north to accommodate additional contact stands on a satellite this would sit within the potential PSZ of the central runway which is unlikely to be acceptable given its likely level of occupation.

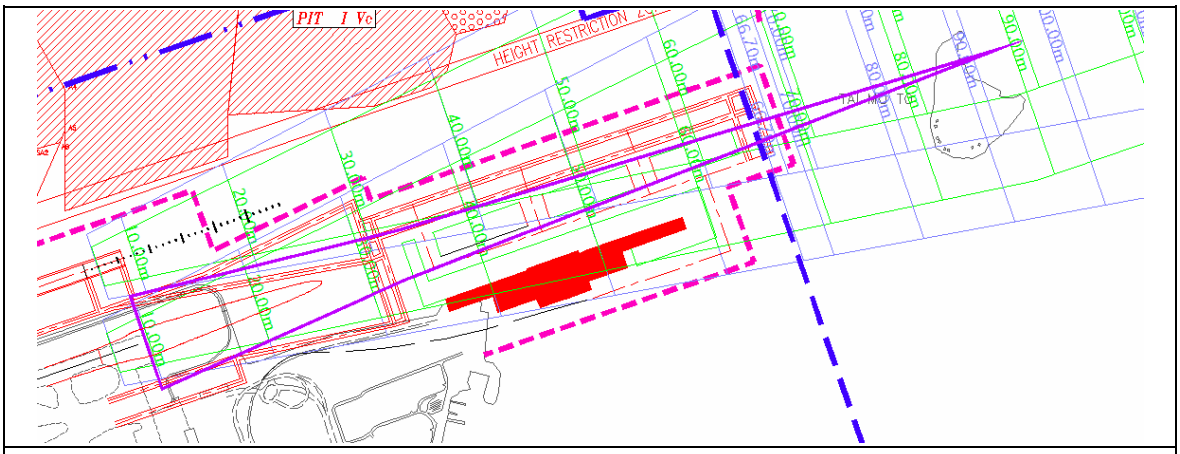


Figure 5.3 Extent of Public Safety Zone

5.10 Apron and Stand Planning

The apron frontage for all options has been normalised to be equivalent to that of Option R which is circa 4000m. This compares with the existing "Y" concourse which provides 3750m of contact stands and therefore the proposed new terminal has a higher level of service or alternatively allows for an increase in average aircraft size. The 4000m frontage of stands can provide up to 44 Code F stands and this can be flexed to provide a wide range of stand combinations, for example, 4 Code F, 10 Code E and 60 Code C stands which gives a total of 74 stands. This is broadly comparable with the provision of stands for the existing two runways, once the mid-field development has been completed.

It is our understanding that once the mid-field complex is complete, there will be a total provision of 145 stands for the two existing runways which will have a peak runway capacity of 68 movements/hour. The third runway will add a further 34 movements/hr, an increase of 50%, therefore on a simple pro rata basis, the additional apron frontage of 4000m (around 74 mixed used stands) would increase the stand supply by around 50% to match the increase in runway capacity. More detailed analysis only becomes possible with a far greater level of understanding of the airlines that would use the new facility, the type of aircraft they operate, the nature of their services and therefore, the stand mix and peak stand demand. Once this has been decided, TAAM modelling can be used to validate the exact requirements.

It should be noted that Options S Extended Variants A, B and D supply 25% less additional apron frontage. This is because of constraints caused by existing projects, e.g. the Boundary Crossing Facilities and link roads, to the south and east of the new terminals location and concerns over the potential for Public Safety Zones to the north (see Figure 5.3). Option S Extended Variant E has therefore been developed to address this shortfall. Further work will be required to integrate the new apron in this variant and the adjacent BCF because of the proximity of these two projects. This needs to be done to ensure each project will obtained the respective required space for development.

The breakdown between pier served and remote stands is broadly shown as two thirds to one third respectively, but in all cases other than Option S Extended, Variants A, B and D there is sufficient flexibility to amend this split to reflect more detailed analysis at a later stage.

5.11 Terminal Buildings

The terminal buildings shown in each of the options are indicative only and their arrangement has simply been determined by what appears to be most logical given the shape and orientation of the space available.

Undoubtedly alternative arrangements are possible, but it is not considered necessary to consider them at this stage as they would not materially affect the debate and would only further complicate a complex set of issues.

All options have sufficient space for adequate passenger terminal facilities. Their associated aprons present a far more significant spatial challenge.

5.12 Maritime Exclusion Zone

Details of the current Maritime Exclusion Zone have been obtained from the Aviation Security Ordinance (CAP. 494) Restricted Area drawing ASO/RA021A and details of the restrictions within the zone were obtained from the Airport Authority Hong Kong website. Current practice appears to be conservative and safeguards for vessels with an air draft of (circa) 55m rather than the stated 30m on the charts. However for sake of consistency equivalent clearances have been provided around the new runways as exist around the current airport. If the extension of this zone into Chinese territorial water is considered to be an issue there should be potential to refine the size of these zones.

5.13 Territorial Waters

Where necessary some options have been tailored to ensure that all physical works including approach lighting is located within Hong Kong territorial waters. In a number of instances the Maritime Exclusion Zone still extends across the boundary into Chinese waters, but as described in Section 5.12 above there maybe potential to reduce the size of this zone.

Recommendation:

RR3: Undertake additional work on the detailed development of the ground infrastructure and associated issues.

5.14 Assumptions

The following assumptions have been used in identifying an appropriate mode of operations for each option and hence the potential capacity figures:

- The terminal locations, and terminal occupancy patterns have not been firmly established, but terminal mode has been assumed.
- It is assumed that there will be no crossing of the centre runway since any crossing of the centre runway is likely to reduce capacity.
- The airspace design is generic, and detailed work on the handling of crossover traffic has not yet been undertaken, however, it is assumed that some degree of crossover traffic can be accommodated. If compass mode is required, this may lead to crossing of the centre runway and a potential loss of capacity.
- The conditions for conducting parallel approaches from outside 10Nm have yet to be established. Due to the longer final, this review assumes that parallel approaches are not possible below 1525m, but this still needs to be validated. If this distance needs to be increased, it could significantly impact on the potential capacity of certain options.

- The separation of 15 degrees has been assumed between departures and missed approaches from the existing two runways.
- The Runway 07C departure and the Runway 07L missed approach are not considered to be separated below 1525m although this needs to be validated.
- The existing runways are independent.
- South runway arrivals and departures are dependent and this restricts the capacity of this runway in Mixed Mode.

6 ATC PROCEDURE ISSUES

6.1 SOIR Compliance

The ICAO SOIR Manual (Doc 9643) describes a number of modes of operation for Simultaneous Operations on Parallel or Near Parallel Instrument Runways. The purpose of this manual is to assist with implementing these commonly used modes of operation by providing guidance on the procedures, training and safety requirements. In any case, the local ATC service provider is still responsible for producing a safety case to support the implementation, but the basic procedures and the identification of some of initial safety requirements have are already been provided. These options should not be considered as the only way of operating parallel runways, in particular, the SOIR manual only addresses 2-runway operations, not 3-runway operations. Local procedures will be required for operations outside the scope of the SOIR manual, and it is possible that a 3-runway operation may not be fully SOIR compliant in all respects.

There are two key issues in terms of SOIR compliance in respect of the potential operations planned for Hong Kong. These are the separation between SIDs and Missed Approach procedures and the development of simultaneous parallel and/or staggered approaches outside 10Nm (see Parallel Approach section below).

Separation between SIDs and Missed Approach procedures will, as far as possible, be SOIR compliant, however a number of exceptions are required. The requirement for separation between a departure and a missed approach (ICAO Mode 4) is 30 degrees (based on a runway separation of 760m or greater). This is not possible between the missed approach from the existing Runway 07R and a departure from the existing Runway 07L due to terrain.

High level design of a SID from the existing Runway 07L has been undertaken as part of this study with a track adjustment of 15 degrees left to go out through Tai Lam Valley. Such a SID from the existing Runway 07L is possible with a climb gradient similar to the existing SID from Runway 07R depending on the track guidance available. The increased runway separation of 1540m (over the ICAO minimum requirement of 760m) is a factor in mitigating the reduced track separation of 15 degrees from the required 30 degrees from the missed approach from Runway 07R.

The position of a new northerly runway at HKIA is dependent upon the terrain to the north east of the airfield. Initial procedure design work indicates that a fully parallel option to the north of the existing airport would have an unacceptable climb gradient for the missed approach and SID in the Runway 07 direction. As a result, it is likely that some degree of stagger to the west will be required. In order to provide an acceptable operational scenario in the three runway configuration, the separation between the 07L missed approach and the 07C departure will need to be assessed. This may also require a stagger to the west for any runway spacing below 1525m. The closer spaced the runways are, the greater the stagger likely to be required.

Particular consideration needs to be given to the closely spaced parallel runway options below 760m. For these very closely spaced runways, some of the options are

staggered, and so may be operated within the terms of the SOIR Manual, however closely spaced parallel options H and S Extended do not have sufficient stagger. Many runways around the world like this are operated with independent arrivals and departures.

The separation between the Runway 07C SID and Runway 07L Missed Approach also requires special attention. It has been designed with 30 degrees separation (SOIR compliant) but due to terrain both procedures turn left, which is not covered in the SOIR manual. Similar situations exist at other major airports, and this may be considered acceptable, however there is an additional constraint in that, due to terrain, the controller is not able to use radar vectors to resolve any potential conflicts.

6.2 SOIR Compliance Table

The following table lists the interactions between SIDs and Missed Approach tracks for the prime options P, R and S Extended, indicating which are SOIR manual compliant, and describing the issues identified during this study.

Table 6.1 Option P SOIR Compliance

Option P Wide Spaced Parallel Runway (2240m) with 2000m Offset to the West		
Runway & Procedure	**Separation**	**SOIR Compliance and Notes**
07L Missed Approach v 07C SID	30 degrees	Yes – due to 30 degrees track separation between the Missed Approach and SID. No – because the SID turns towards the Missed Approach Track. Considered acceptable due to the runway offset and stagger.
07C SID v 07R SID & Missed approach	15 degrees	SID v SID Yes – due 15 degrees track separation. SID v Missed Approach No – due less than 30 degrees track separation. The increased runway separation of 1540m (over the ICAO minimum requirement of 760m) is a factor in mitigating the reduced track separation of 15 degrees.
07R SID v 07R Missed Approach	Same track	No – due to lack of track separation. These are dependant.
07L and 07R parallel approaches	3780m	No – as final approach outside 10nm is required, but not considered to be a problem due to the runway offset and stagger.
25R Missed Approach v 25R SID	30 degrees	Outside the scope of the SOIR manual. The SID and Missed Approach turn in the same direction but considered to be acceptable due to similar operations at other airports. (Note: proposed solution is to climb the departure on runway heading in case of a Missed Approach. A Missed Approach from both 25R and 25C at the same time is considered to be remote).
25C Missed Approach v 25R SID and 25L SID	15 degrees	No – due less than 30 degrees track separation. The increased runway separation of 1540m (over the ICAO minimum requirement of 760m) is a factor in mitigating the reduced track separation of 15 degrees.

25R and 25C parallel approaches	2240m	No – as final approach outside 10nm is required. Further investigation required into parallel approaches outside 10nm.

Table 6.2 Option R SOIR Compliance

Option R Wide Spaced Parallel Runway (1525m) with 1430m Offset to the West		
Runway & Procedure	**Separation**	**SOIR Compliance and Notes**
07L Missed Approach v 07C SID	30 degrees	Yes – due to 30 degrees track separation between the Missed Approach and SID. No – because the SID turns towards the Missed Approach Track. Considered acceptable due to the runway offset and stagger.
07C SID v 07R SID & Missed approach	15 degrees	SID v SID Yes – due 15 degrees track separation. SID v Missed Approach No – due less than 30 degrees track separation. The increased runway separation of 1540m (over the ICAO minimum requirement of 760m) is a factor in mitigating the reduced track separation of 15 degrees.
07R SID v 07R Missed Approach	Same track	No – due to lack of track separation. These are dependant.
07L and 07R parallel approaches	3065m	No – as final approach outside 10nm is required, but not considered to be a problem due to the runway offset and stagger.
25R Missed Approach v 25R SID	30 degrees	Outside the scope of the SOIR manual. The SID and Missed Approach turn in the same direction but believed to be acceptable due to similar operations at other airports. (Note: proposed solution is to climb the departure on runway heading in case of a Missed Approach. A Missed Approach from both 25R and 25C at the same time is considered to be remote).
25C Missed Approach v 25R SID and 25L SID	15 degrees	No – due less than 30 degrees track separation. The increased runway separation of 1525m (over the ICAO minimum requirement of 760m) is a factor in mitigating the reduced track separation of 15 degrees.
25R and 25C parallel approaches	1525m	No – as final approach outside 10nm is required. Further investigation required into parallel approaches outside 10nm.

Table 6.3 Option S SOIR Compliance		
Option S Extended Closely Spaced Parallel Runway (380m) Extended to the West		
Runway & Procedure	**Separation**	**SOIR Compliance and Notes**
07L Missed Approach v 07C SID	30 degrees	Yes – the stagger is sufficient to compensate for the reduced offset between the runways (380m rather than the minimum 760m). No – because the SID turns towards the Missed Approach Track. Wake vortex issue may also be relevant. Further work required to validate these issues.
07C SID v 07R SID & Missed approach	15 degrees	SID v SID Yes – due to 15 degrees track separation. SID v Missed Approach No – due less than 30 degrees track separation. The increased runway separation of 1540m (over the ICAO minimum requirement of 760m) is a factor in mitigating the reduced track separation of 15 degrees.
07R SID v 07R Missed Approach	Same track	No – due to lack of track separation. These are dependant.
07L and 07R parallel approaches	1920m	No – as final approach outside 10nm is required. Further investigation required into parallel approaches outside 10nm.
25R Missed Approach v 25C SID	45 degrees	No - The SID climbs straight ahead and Missed Approach turns north, so has more than the required 30 degrees, but there is insufficient offset between the runways (380m rather than the minimum 760m). Similar operations exist at other airports. This is more likely to be acceptable in the case of variants D and E due to the stagger to the East. Wake vortex issue may also be relevant. Further work required to validate these issues.
25C SID v 25L SID and 25L Missed Approach	15 degrees	SID v SID Yes – due to 15 degrees track separation. SID v Missed Approach No – due less than 30 degrees track separation. The increased runway separation of 1540m (over the ICAO minimum requirement of 760m) is a factor in mitigating the reduced track separation of 15 degrees.
25R and 25L parallel approaches	1920m	No – as final approach outside 10nm is required. Further investigation required into parallel approaches outside 10nm.

Recommendation:

RR4: Undertake a review of SOIR compliance in respect of the chosen runway options to identify the relevant issues, develop mitigation measures and validate the capacity of each option.

6.3 ILS Performance

A survey of the ILS accuracy is required. In the case of the existing runways, this should be based on flight check data to measure the actual performance of the ILS in the local environment. Since no new runway has been built and no ILS system has been installed, the ILS signal for the third runway should be modelled to perform this analysis. The outcome of this analysis (along with other factors such as the accuracy of the aircraft navigation systems) can be used to calculate the distance from touchdown from which parallel approaches can be supported.

The outcome of this work should aim to provide the evidence that parallel approaches can be supported out to around 18-20 miles from touchdown. If this distance is significantly less, it may be that parallel approaches might not be viable due to the minimum radar vectoring altitude required in the Runway 25 direction.

In the event that this range is determined not to be sufficient, either an improvement of the ILS equipment, or the use of alternative technology, would be required to support parallel and/or staggered approaches.

Recommendation:

RR5: Undertake an analysis of ILS performance to enable parallel and/or staggered approaches to be carried out from around 18-20nm from touchdown. Identify ILS or other technological solutions to address any identified problems.

6.4 Wake Vortex

Most of the proposed operations are separated in respect of wake vortex except Option S Extended in the Runway 25 direction. For the centre and north runway to be considered independent according to the SOIR manual, 1950m stagger is required. (The reduced stagger of 1889m in the Runway 07 direction may not be significant). In the Runway 25 direction the stagger is 0m (Variants A, B and C) or 1000m (Variants D and E). The special circumstances at Hong Kong in terms of turbulence, crosswinds and tailwinds mean that this situation requires careful consideration. The problem only arises when an aircraft landing on Runway 25R conducts a missed approach simultaneously with a departure from Runway 25C. The possibility exists that the wake vortex from the missed approach aircraft might drift into the path of the departure. Variants D and E have been specifically designed to mitigate this problem, but due to terrain only have 1000m stagger (less than the SOIR requirement). ATC procedures will be required to mitigate the problem. In addition it is possible that a specific wake vortex warning system might mitigate the problem in some wind conditions. Additional spacing might also be required to further mitigate this issue, which will significantly impact on the capacity of Option S Extended in the Runway 25 direction.

Recommendation:

RR6: Investigate the wake vortex problem identified with Option S Extended to develop appropriate procedures, identify any equipment required and to quantify any capacity limitations.

6.5 Parallel Approaches

Another area that will require further work is the length of final when conducting either Independent Parallel approaches (ICAO Mode 1) or Dependent Parallel approaches (ICAO Mode 2). With three runways, it will be essential to perform parallel approaches to at least two of the runways. The ICAO SOIR manual states that vertical or lateral separation must be maintained until 10Nm from touchdown.

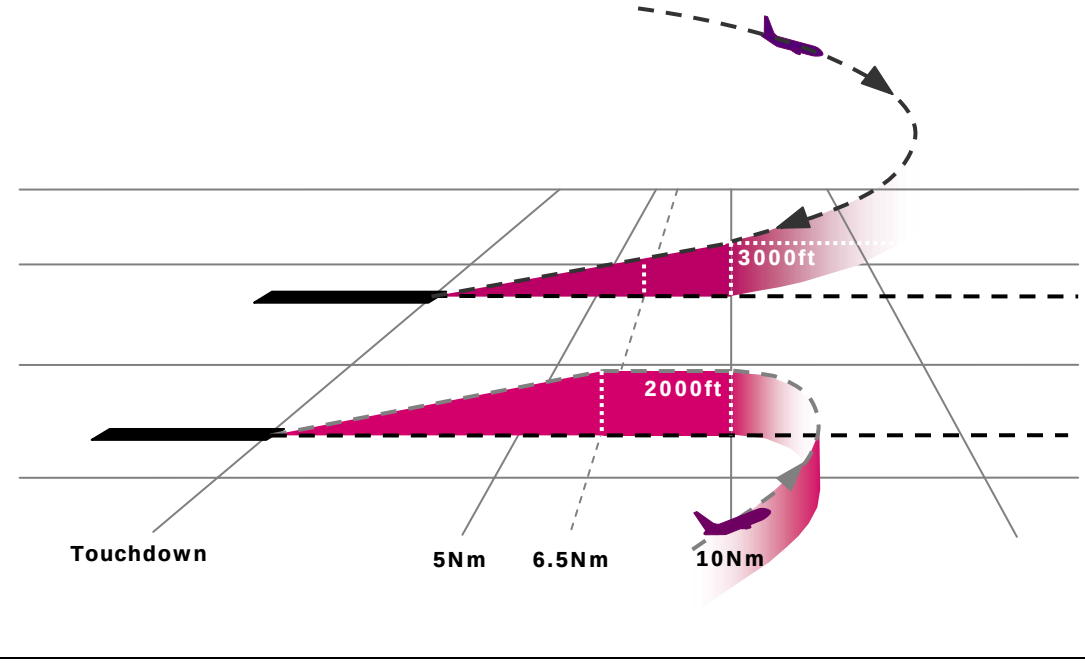


Figure 6.1 ICAO SOIR Procedures for Parallel Approaches

This is not possible in the Runway 25 direction because of the terrain; therefore the parallel approaches will need to start at around 18 to 20Nm from touchdown. Due to the interaction with Macau, it may also be helpful to do the parallel approaches from more than 10Nm out in the Runway 07 direction to provide vertical separation from Macau traffic. The need to provide parallel approaches from more than 10Nm means that the ICAO minimum separations (915m or 1035m) will need to be increased. In the event that SOIR compliant parallel approaches cannot be achieved, then the operation will be limited to 3Nm staggered approaches, maintaining standard radar separation.

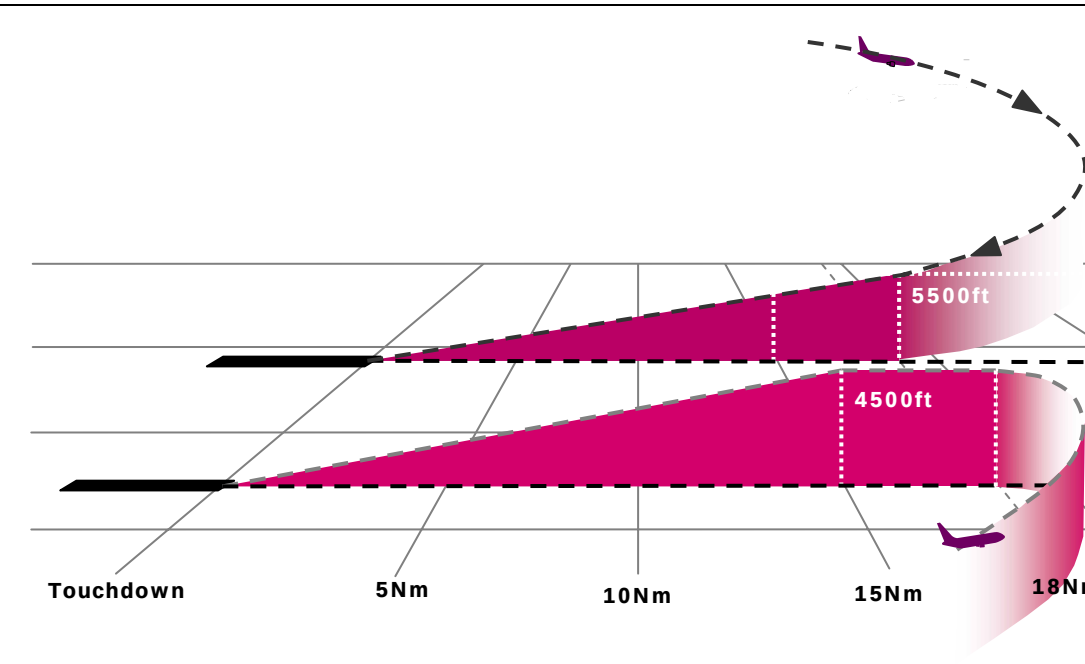


Figure 6.2 Suggested Procedures for Parallel Approaches in Hong Kong

When designing the parallel approach procedures, a key element is the breakout manoeuvre in the event of an aircraft failing to follow the final approach track. In some countries, this is a descending turn away from the runway centreline. Due to the terrain, only climbing breakout manoeuvres will be possible at Hong Kong.

This detailed future implementation work will need to take place after Phase 2.

Recommendation:

RR7: Develop procedures to allow parallel approaches to be undertaken in excess of 10nm from touchdown. This should identify the minimum acceptable spacing between the parallel approaches and appropriate breakout manoeuvres.

6.6 Dependant Parallel Runways

In cases where independent operations cannot be achieved, there may be a capacity advantage in operating 2 closely spaced dependant runways. With single runway operations, the departing aircraft cannot be cleared for take off until the landing aircraft is clear of the runway. With the dependant pair, the departing aircraft can be cleared for take off once it has been confirmed that the arrival has landed.

The following diagrams show the timelines for the two types of operation:

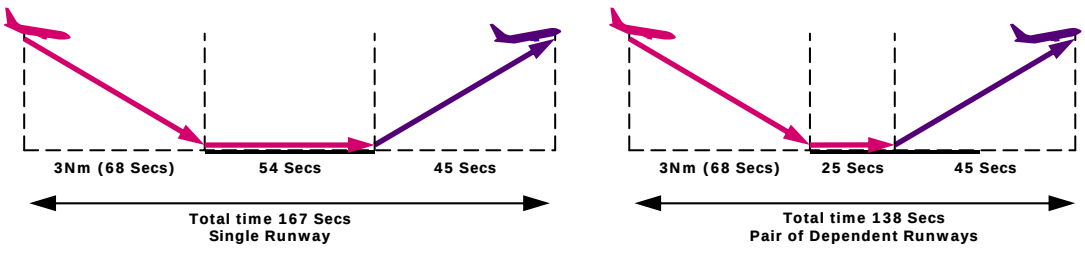


Figure 6.3 Single Runway vs Pair of Dependent Runway Arrival/Departure Timeline

A single runway operation, based on 6Nm spacing, has a time interval of 167 seconds. The breakdown of this total time is shown in the diagram. With 2 dependant runways, the time to assess that the aircraft has landed has been reduced from 54 seconds to 25 seconds, so reducing the overall time by 29 seconds. This gives a time difference of 138 seconds. Using the usual 10% contingency a time difference of 151 seconds has been used in these calculations. The reduced time difference increases the runway capacity from 44 per hour for single runway operations to 48 per hour for the dependant pair of runways.

6.7 Procedure Design Group (PDG) Work

The PDG input played a key role in determining the potential for each runway option and thus the maximum capacity increase. A number of SIDs and Missed Approach procedures were analysed to identify issues associated with those runway options identified for detailed work. A full report on the PDG work is provided in Appendix B of this Report. This work must be considered as “proof of concept” in nature and detailed design work will need to be undertaken once a particular runway option is chosen.

In addition to the simulation work required for the development of all procedures, it is important for aircraft operators to be consulted in relation to the various factors which affect the design of the flight procedures with significant turns and higher than normal climb gradients. This is particularly relevant in the case of the missed approach procedures over Castle Peak, and the possibility of missed approach procedures which involve an immediate turn. It is essential to ensure pilot acceptance of these

procedures, and that pilots understand the reasons that rigid adherence to these procedures is essential to ensure that the design safety criteria are maintained.

Recommendation:

RR8: Aircraft operators should be consulted regarding the design of flight procedures with significant turns and higher than normal climb gradients to ensure that flyability and pilot acceptance is achieved.

6.8 Safeguarding for Future Flight Procedures

The PDG has developed "proof of concept" SIDs and Missed Approach procedures for the new runway options. Many of these procedures infringe on the danger area VHD5. This will limit the altitude that will be available for use and in some cases may render VHD5 as being not viable. A review of the operation of VHD5 to assess if the uses of the area may be limited to low altitude, or to consider the possibility of relocating the danger area should be undertaken. The ability to implement these new flight procedures is an essential requirement for the introduction of the third runway and limitations on their availability due to VHD5 is likely to compromise the operation of the airport.

Recommendation:

RR9: Undertake a review of VHD5 to assess if the operation can be restricted to sufficiently low altitudes to allow unrestricted operation of the third runway, or alternatively to consider relocating VHD5.

In order to provide separation between the Runway 25C SID and Runway 25L SID and Missed Approach, the 25L SID and Missed Approach must turn left. The SID must turn left by 15 degrees to be compliant with the SOIR manual. The Missed Approach should ideally turn left 30degrees. If the terrain does not allow this then a lower value may be acceptable due to the increased separation of the runways above the ICAO minimum.

Recommendation:

RR10: Put in place the necessary safeguarding to allow the 25L SID and Missed Approach to turn left immediately, restricted only to high ground.

7 CAPACITY

These calculations have used for the capacity figures developed in the Phase 1 report, Stage 5, as a baseline. Terminal mode of operations has been chosen for the wide-spaced options with additional stands built between the runways. The capacity gain for each option will depend on the choice of traffic to be handled by each runway – i.e. arrivals/departures/mix of arrivals and departures. This choice is individual for each option and has been made so that the maximum throughput can be maintained sustainably. In general, terminal mode has been assumed for arrivals and departures to avoid crossing of the centre runway. There are a number of other potential variables and improvements, such as the choice of final approach speed and contingency allowances. These have the potential to change the actual capacity of the airport, but will affect all the options in similar ways, so therefore will make little difference to the comparative benefits of each runway option.

The potential capacity figures used to calculate the capacity of each runway option are:

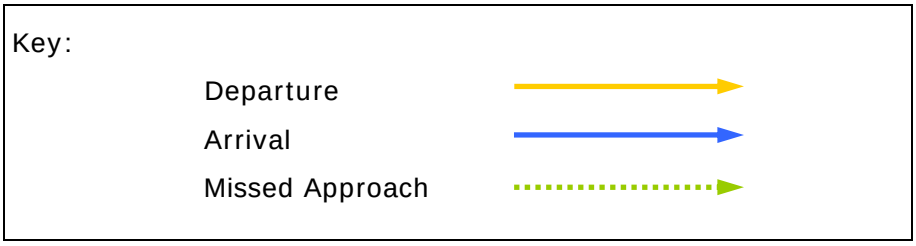
Table 7.1 Potential Runway Capacities		
Runway	**Minimum Separation**	**Potential Scheduled**

		Capacity
Arrivals Only	3Nm	33 per hour
Departures Only	90sec	35 per hour
Mixed Mode (South Runway)	8Nm Based on the HK MATC Requirement	34 per hour
Mixed Mode (Other Runways)	6Nm	44 per hour
Pair of Dependant Runways		48 per hour

For compatibility with the calculations in the Phase 1 report, these figures are all based on ICAO style spacing at 170 knots to 5DME, with three quarters of a nautical mile catch up allowance within 5 DME, a 10 knot headwind and 10% contingency allowance. These figures have also been validated by TAAM modelling.

The sustainable available increase for each option (the lowest increase depending on the runway direction) is shown in **BOLD**.

Note: Optional or restricted runway options not available for scheduling purposes are shown in brackets.



7.1 Annual Capacity

The Phase 1 report calculated the potential traffic growth for each year until 2025 in order to estimate the maximum annual capacity of the two runway airport.

Based on these assumptions, the following estimate of the annual capacity of a three runway airport, considering the prime options P, R and S extended concludes that a maximum potential hourly figure of 102 movements is operationally viable.

The contingency allowance for runway direction changes needs to be considered for all three runways. At night it is assumed that one runway will close, leaving two runways in operation. These figures are scaled as a 50% increase on the Phase 1 night movements. If the traffic demand existed, then it would be possible to increase these figures during the night period based on the use of two runways.

It is recommended that recovery periods are built into the schedule after consultation with all stakeholders on the size of the contingency and positioning of theses allowances during the day.

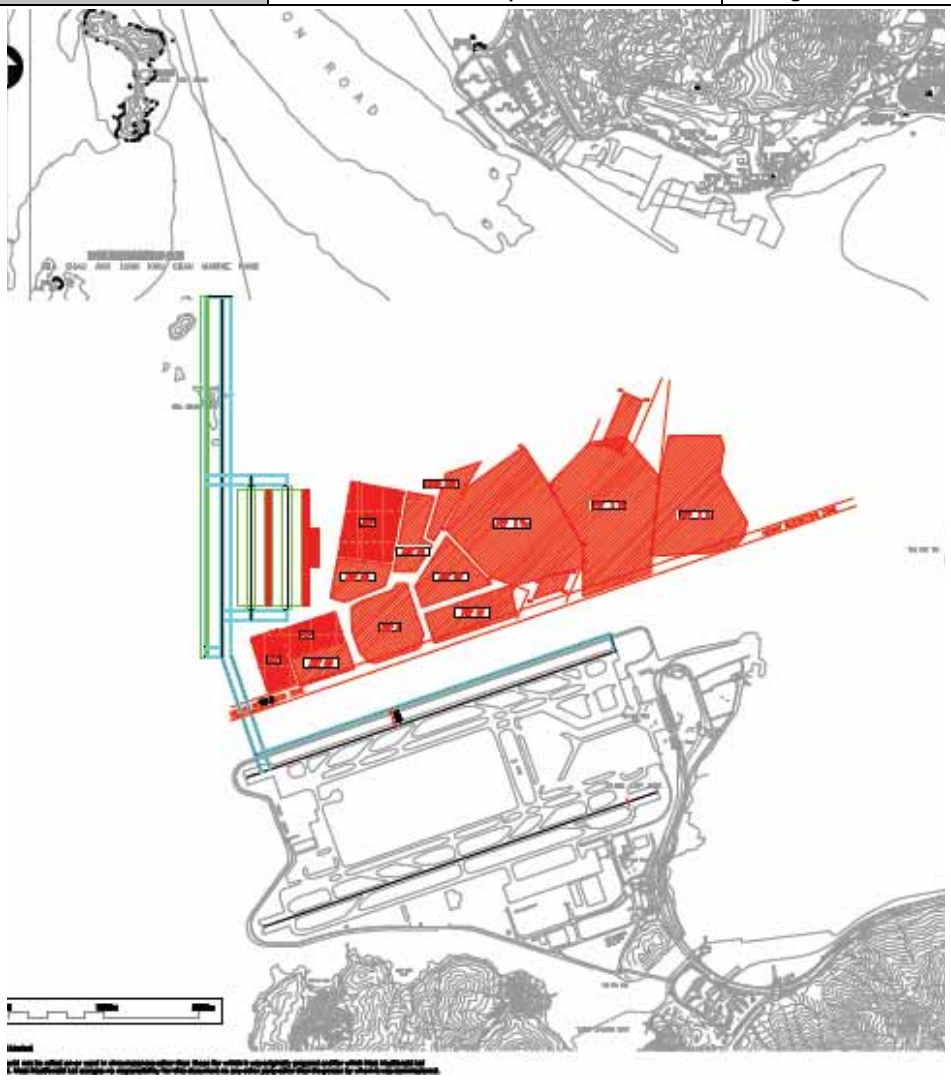
As a result of these considerations, it would appear that a daily capacity in the range 1650 to 1800 movements is achievable. Using the Design Day/Annual ratio of 0.0029 supplied by AAHK, this would provide an annual capacity in the range of 570,934 to 622,837.

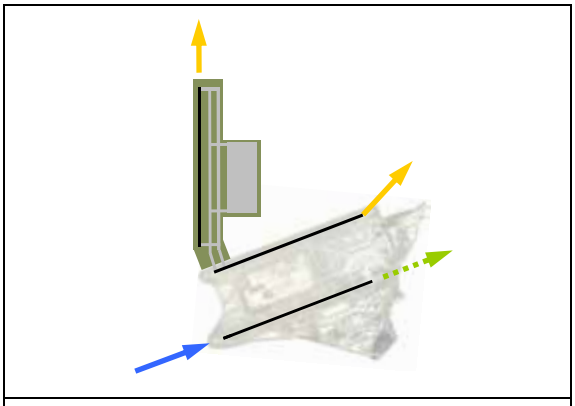
As with the Phase 1 report, the runway capacity is dependant on the airspace capacity. In order to achieve these capacity figures, the airspace development and other supporting infrastructure such as staff and equipment must be available in addition to the ground infrastructure of taxiways, aprons and terminals etc.

8 OTHER OPTIONS

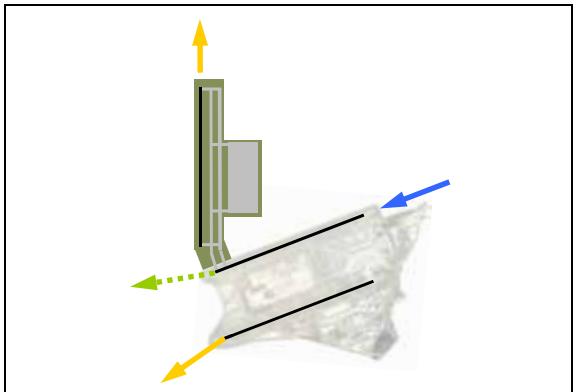
Of the 16 original options, 3 were down selected for detailed study. This section provides a brief description of the remaining 13 options that have not been considered for detailed study at this stage. As referred to earlier in this report, these options have not been selected due to their inherent disadvantages in terms of airport integration and operational viability. The capacities quoted are potential based on the modes of operation selected for each option and described below.

8.1 Option A Cross Runway

Option A	Hong Kong International Airport Third Runway Study Other Options	Runway Separation: N/A – Proposed Runway Aligned North/South
		
General Description	A near perpendicular runway with a self-contained set of airside, passenger terminal and landside facilitates located adjacent to its southern end. Intended to avoid mud pits.	



Option A Runway 07 Direction		
Runway	**Use**	**Capacity**
Northerly	Departures	35
07L	Departures	35
07R	Arrivals	33
Total		**103**
Increase		**35**



Option A Runway 25 Direction		
Runway	**Use**	**Capacity**
Northerly	(Departures)	(35)
25R	Arrivals	33
25L	Departures	35
Total		**68 (103)**
Increase		**0** (35)

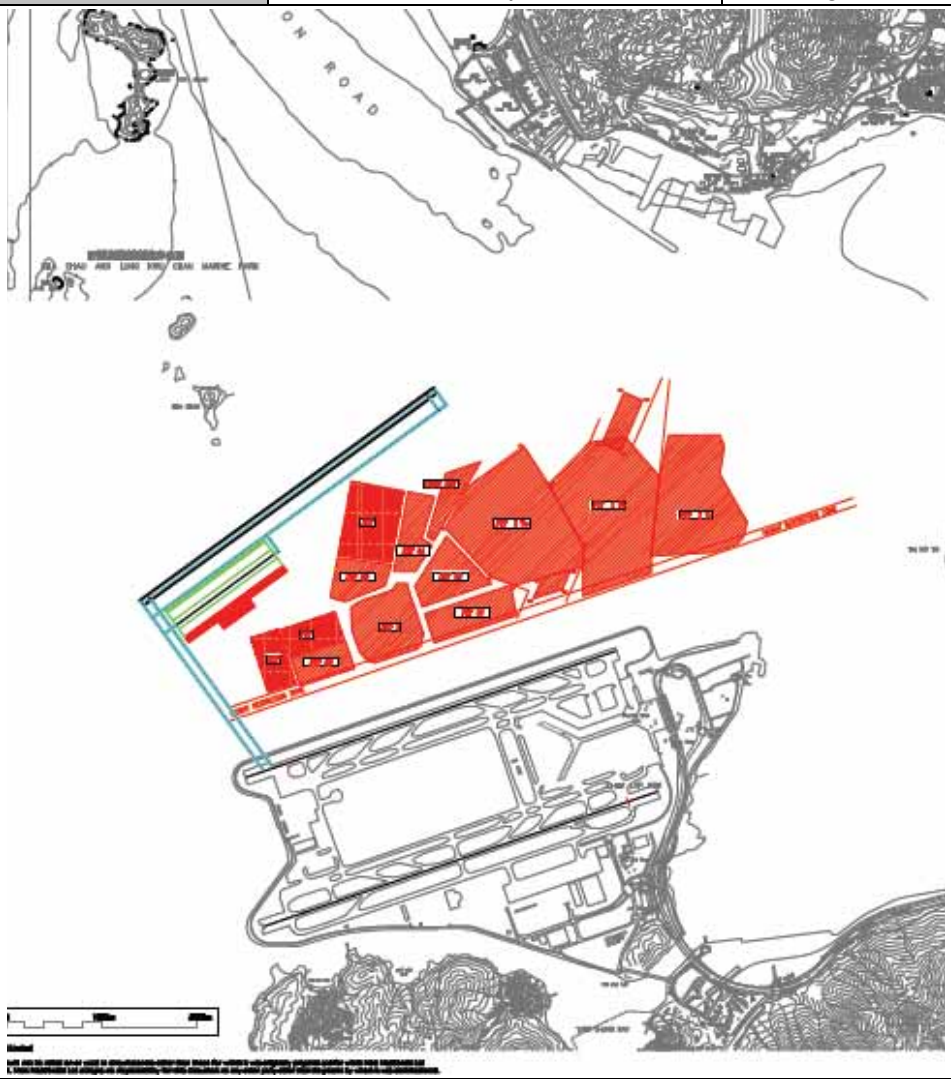
Note: In the Runway 07 direction, the imbalance in departure and arrival capacity may not allow all 103 movements be utilised sustainably. In the Runway 25 direction, the northerly runway can only be used in certain wind conditions, providing a potential runway capacity of 103 per hour in these conditions, but this would not be available for scheduling purposes. The integration of this traffic into the PRD airspace, particularly the interaction with Shenzhen will require additional work that has yet to be undertaken.

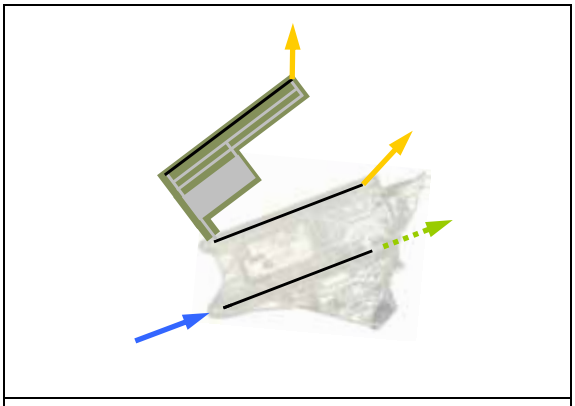
New Runway		
Length	3800m	
Offset	N/A	
Stagger	N/A	
Taxiways		
Parallel	Twin to new runway. One north existing Runway 07L/25R.	
Cross-field	Twin cross-field links at west end only.	
New Apron	Full access from new runway and existing Runway 07L/25R.	
Existing T1 Apron	No normal access to new runway.	
Mid-field Apron	No normal access to new runway.	
Existing Cargo Apron	No normal access to new runway.	
Taxiing Complexity	**Compass Mode**	**Terminal Mode**
Normal Operations	Runway 07L/25R must be frequently crossed at west end.	Runway 07L/25R must be frequently crossed at west end.
With Runway Closures	Long distances from existing aprons to start Rwy18. Long distances from new apron to Runway 07R/25L.	

Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). Expansion only practical to the North.
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Very difficult due to distance and intervening runway/taxiways. Distance mandates APM. Coaching only back-up possible. Airside road link also required which must cross Runway 07C/25C. Surface/tunnel/bridge required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	All options possible. Selection to best fit relevant dimensions.
Cargo Centre to New Apron	New facility required. Airside road access from existing cargo area also required, but distance and travel time will limit its usefulness for most cargo.
Passenger Terminal	
Configuration	Limited space for apron and terminals if mud pits avoided and taxiway links at west end of CLK kept to reasonable length. Final layout may require runway 18/36 located further west to improve space for apron, terminal and landside facilities. Most terminal concepts then possible.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). Expansion only practical to the north.
Surface Access	
Road	Existing roads and rail line may be extendable to T3 around east and north side of 07L/25R on embankment or viaduct. Short mud pit crossing required.
Rail	
Sea	New ferry terminal.
Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	New facilities required for new apron – split operations.
ATC	New ATC Tower may be required. Threshold Rwy18 6km from existing VCR.
Fuel	New facilities required for new apron.
Shipping Lanes	Major obstruction to shipping lanes north of CLK reclamation. Bridges required for small vessels under taxiway links and surface access.

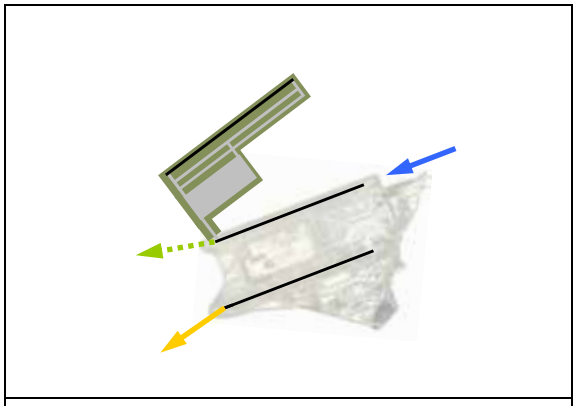
Construction	
Mud Pits	Concept devised to avoid mud pits, although surface access will have to cross them.
Reclamation	Concept assumes reclamation of area required for runway, parallel taxiways, new apron, terminal and support facilities. The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. The western side of the runway will be subject to a high degree of exposure and wave action. The eastern side of the runway will be exposed to the north eastern Monsoon and the resulting winds will have a long fetch (circa 20km). The wave and monsoon action could be mitigated by using a viaduct solution; however we anticipate that the apron area will require land reclamation.
Environment	
Noise	As with most options, the departure route from Runway 07L to the Tai Lam valley will regularly overfly residential areas along shoreline and the country park inland. Due to its alignment, the new runway (18/36) would only have a modest effect on the noise climate of existing residential and rural areas.
Ecology	Significant change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Significant impact on marine life at North Lantau (mainly dolphins and porpoises) in the Shau Chau and Lung Kwu Chau Marine Park (mainly dolphins and fish attracted by the artificial reef).
Summary	
	Option A has been planned to avoid the mud pits, however in doing so the airfield layout creates a number of constraints to the airport and to Hong Kong itself. The orientation of the new runway crosses deep water and therefore causes impacts on the shipping channel and current flow. The depth of the channel increases the amount of fill required to create the new island structure. The remote location of the new runway and terminal effectively creates a second airport however the orientation dictates that the movements are heavily restricted due to the conflicts with arrivals and departures on the existing runways.

8.2 Option B Angled Runway

Option B	Hong Kong International Airport Third Runway Study Other Options	Runway Separation: N/A – Proposed Runway Aligned NE/SW
		
General Description	Acutely angled runway with a self-contained set of airside, passenger terminal and landside facilitates located adjacent to its southern end. Intended to avoid mud pits. Sketch shows single full length parallel taxiway, but twin parallel taxiways possible if runway moved north.	



Option B Runway 07 Direction		
Runway	**Use**	**Capacity**
Northerly	Departures	35
07L	Departures	35
07R	Arrivals	33
Total		**103**
Increase		**35**



Option B Runway 25 Direction		
Runway	**Use**	**Capacity**
Northerly		0
25R	Arrivals	33
25L	Departures	35
Total		**68**
Increase		**0**

Note: In the Runway 07 direction this option could be used to offload departure peaks. In the Runway 25 direction, the conflict with the existing airport is likely to create a dependent operation with little or no capacity increase. The separation of the approach and departure from the new runway to the terrain to the north east has not yet been assessed.

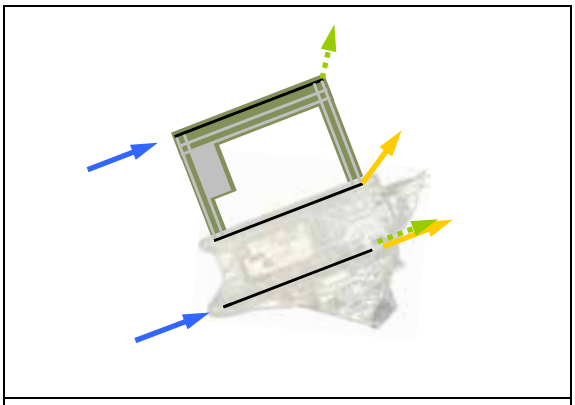
New Runway		
Length	3800m	
Offset	N/A	
Stagger	N/A	
Taxiways		
Parallel	Single or twin to new runway. One north existing Runway 07L/25R.	
Cross-field	Twin cross-field links at west end only.	
New Apron	Full access from new runway and extg Rwy 07L/25R.	
Existing T1 Apron	No normal access to new runway.	
Mid-field Apron	No normal access to new runway.	
Existing Cargo Apron	No normal access to new runway.	
Taxiing Complexity	**Compass Mode**	**Terminal Mode**
Normal Operations	Rwy 07L/25R must be frequently crossed at west end.	Rwy 07L/25R must be frequently crossed at west end.
With Runway Closures	Long distances from existing aprons to start Rwy23. Long distances from new apron to Rwy 07R/25L.	

Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). Expansion only practical to the Northeast.
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Very difficult due to distance and intervening runway/taxiways. Distance mandates APM. Coaching only back-up possible. Airside road link also required which must cross Rwy 07C/25C. Surface/tunnel/bridge required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	All options possible. Selection to best fit relevant dimensions.
Cargo Centre to New Apron	New facility required. Airside road access from existing cargo area also required, but distance and travel time will limit its usefulness for most cargo.
Passenger Terminal	
Configuration	Limited space for apron and terminals if mud pits avoided and taxiway links at west end of CLK kept to reasonable length. Final layout may require runway 05/23 located further northwest to improve space for apron, terminal and landside facilities. Most terminal concepts then possible.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). Expansion only practical to the northeast.
Surface Access	
Road	Existing roads and rail line may be extendable to T3 around east and north side of 07L/25R on embankment or viaduct. Short mud pit crossing required.
Rail	
Sea	New ferry terminal.
Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	New facilities required for new apron – split operations.
ATC	New ATC Tower may be required. Thresholds Rwy05/23 4.5km from existing VCR.
Fuel	New facilities required for new apron.
Shipping Lanes	Substantial obstruction to shipping lanes north of CLK reclamation. Bridges required for small vessels under taxiway links and surface access.

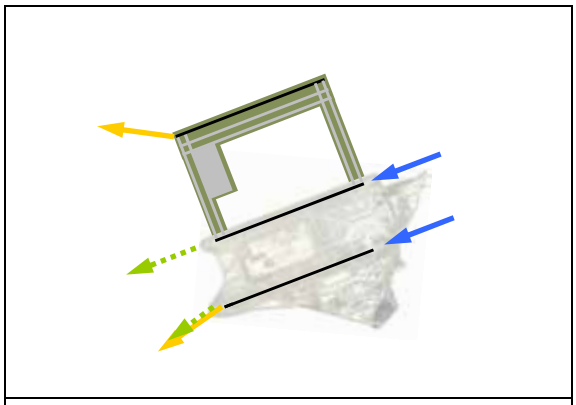
Construction	
Mud Pits	Concept devised to avoid mud pits, although surface access will have to cross them.
Reclamation	Concept assumes reclamation of area required for runway, parallel taxiways, new apron, terminal and support facilities. The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. The western side of the new runway and taxiways will be subject to a high degree of exposure and wave action. The eastern side of the new runway and taxiways will be exposed to the north eastern Monsoon and the resulting winds will have a long fetch (circa 20km). The wave and monsoon action could be mitigated by using a viaduct solution; however we anticipate that the apron area will require land reclamation.
Environment	
Noise	As with most options, the departure route from Rwy 07L to the Tai Lam valley will regularly overfly residential areas along shoreline and the country park inland. Departure route from Rwy 05 to the Tuen Muen Lam valley will regularly overfly residential areas.
Ecology	Significant change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Impact on marine life at North Lantau (mainly dolphins and porpoises) in the Shau Chau and Lung Kwu Chau Marine Park (mainly dolphins and fish attracted by the artificial reef).
Summary	
	Option B has been planned to avoid the mud pits however in doing so the airfield layout creates a number of constraints to the airport and to Hong Kong itself. The orientation of the new runway crosses deep water and therefore causes impacts on the shipping channel and current flow. The depth of the channel increases the amount of fill required to create the new island structure. The remote location of the new runway and terminal effectively creates a second airport however the orientation dictates that the movements are heavily restricted due to the conflicts with arrivals and departures on the existing runways.

8.3 Option C Far Spaced Parallel Runway (>2000m Separation)

Option C	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: Approx 2800m
		
General Description	A parallel runway, with sufficiently separation to ensure the runways, aprons and terminal facilities are not located over the mud pits (although apron and terminal area limited for that reason). New taxiways must cross mud pits.	



Option C Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	35
07C	Departures	35
07R	Mixed	34
Total		**102**
Increase		**34**



Option C Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Departures	35
25C	Arrivals	33
25L	Mixed	34
Total		**102**
Increase		**34**

Note: In the Runway 07 direction, the runway may need to be offset to the degree required to achieve the desired climb gradient on the missed approach. A greater offset may be required to achieve a departure and approach to the north runway.

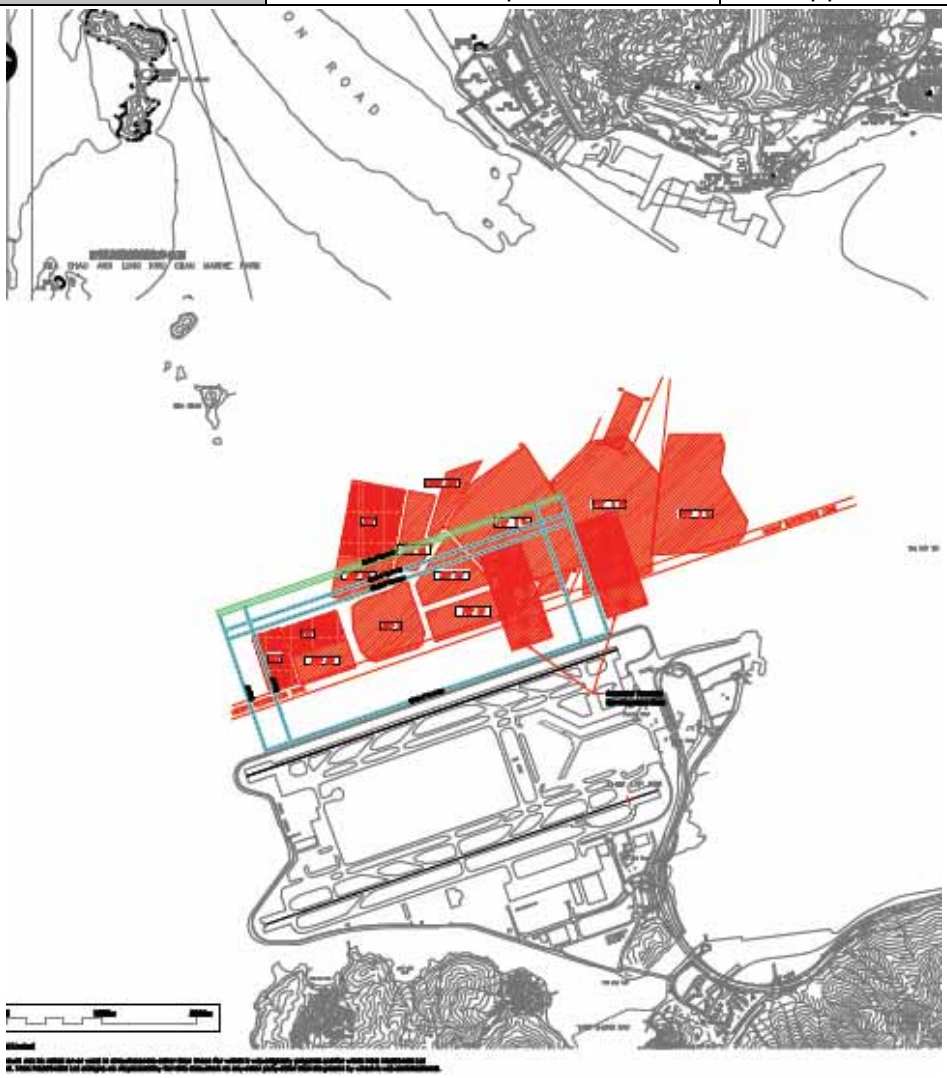
New Runway			
Length	3800m		
Offset	2800m		
Stagger	0m		
Taxiways			
Parallel	Twin to new runway. One or two north Rwy 07C/25C (existing 07L/25R).		
Cross-field	Twin cross-field links at east and west ends (minimum).		
	Compass Mode		**Terminal Mode**
	Full Access	Rwy Crossing	
New Apron	Rwy 07L/25R Rwy 07C/25C	Rwy 07C/25C to Rwy 07R/25L	No normal access to existing Rwy 07R/25L
Existing T1 Apron Mid-field Apron	Rwy 07C/25C Rwy 07R/25L	Rwy 07C/25C to Rwy 07L/25R	No normal access to new Rwy 07L/25R
Existing Cargo Apron	Rwy 07R/25L	Rwy 07R/25L to Rwy 07C/25C Rwy 07C/25C to Rwy 07L/25R	Normally use Rwy 07R/25L only
Taxiing Complexity	**Compass Mode**		**Terminal Mode**
Normal Operations	Rwy 07C/25C must be frequently crossed at either end.		Minimal Complexity.

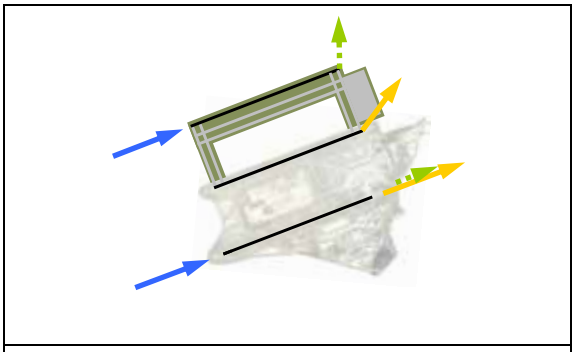
With Runway Closures	Reasonable distances from existing aprons to Rwy 07C/25C and Rwy 07R/25L. Long distances from new apron to Rwy 07C/25C. Very long distances from existing aprons to start Rwy 07L/25R. Very long distances from new apron to Rwy 07R/25L.
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). In this case, providing a larger apron than shown clear of the mud pits requires increased runway separation. Otherwise, expansion only practical to the South or East over mud pits.
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Very difficult due to distance and intervening runway/taxiways. Distance mandates APM. Coaching only back-up possible. Airside road link also required which must cross Rwy 07C/25C. Surface/tunnel/bridge required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	All options possible. Selection to best fit relevant dimensions.
Cargo Centre to New Apron	New facility required. Airside road access from existing cargo area also required, but distance and travel time will limit its usefulness for most cargo.
Passenger Terminal	
Configuration	Limited space for apron and terminals if mud pits are avoided. Final layout may require runway 07L/25R to be located further north and taxiways west to improve space for apron, terminal and landside facilities. Terminal concepts still likely to be limited if mud pits avoided.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). See comment on aprons.
Surface Access	
Road	Existing roads and rail line may be extendable to T3 around east and north side of 07L/25R on embankment or viaduct, but must pass under eastern cross-field taxiways. Short mud pit crossing required.
Rail	
Sea	New ferry terminal within taxiway zone.

Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	New facilities required for new apron – split operations.
ATC	New ATC Tower may be required. Thresholds Rwy05/23 4.5km from existing VCR.
Fuel	New facilities required for new apron.
Shipping Lanes	Substantial obstruction to shipping lanes north of CLK reclamation. Several bridges required for small vessels to pass under cross-field taxiways and new surface access.
Construction	
Mud Pits	Concept devised to minimise construction over mud pits, although cross-field taxiways and surface access will have to cross them.
Reclamation	Concept assumes only partial reclamation of area between new runway and existing airport reclamation. The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. The western side of the new runway and taxiways will be subject to a high degree of exposure and wave action. The eastern side of the new runway and taxiways will be exposed to the north eastern Monsoon and the resulting winds will have a long fetch (circa 20km). The wave and monsoon action could be mitigated by using a viaduct solution; however we anticipate that the apron area will require land reclamation.
Structures	Concept requires surface access road and rail links that are probably on a viaduct. Passing these under eastern cross-field taxiways may require a partially immersed solution. Cross-field taxiways to existing airport reclamation probably on a viaduct for a significant part of their length to allow water flows and small vessels to pass beneath. Airside road and APM links either in tunnel or on viaduct alongside taxiway links.
Environment	
Noise	As with most options, the departure route from Rwy 07C to the Tai Lam valley will regularly overfly residential areas along shoreline and the country park inland. Departure route from Rwy 07L to the Tuen Muen valley will regularly overfly residential areas.
Ecology	Significant change to current flow at Tuen Mun and North Lantau, although that may be partially alienated by building cross-field taxiways on viaduct. Possible change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Impact on marine life at North Lantau (mainly dolphins and porpoises) in the Shau Chau and Lung Kwu Chau

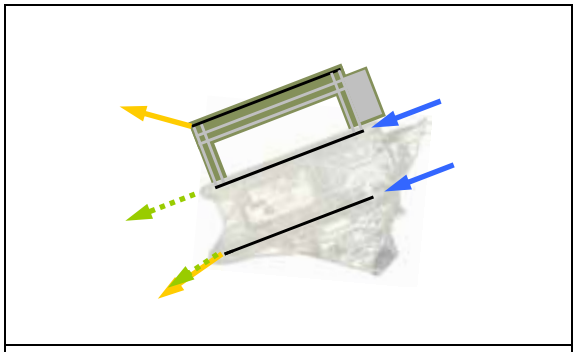
	Marine Park (mainly dolphins and fish attracted by the artificial reef).
Summary	
	Option C is a very wide spaced parallel runway planned to avoid building on top of the mud pits however the cross taxiways will requiring piling as they cross the mud pits. The location of the new runway crosses a deep part of the channel and therefore causes impacts on the shipping channel and current flow. The depth of the channel increases the amount of fill required to create the new island structure. The location of the new terminal would require a long and tortuous surface access route. The widely spaced runways simplify ATC procedures and potentially offer a significant capacity increase.

8.4 Option D Parallel Runway 1525m Separation

Option D	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: Approx 1525m
		
General Description	A parallel runway, with sufficiently separation to permit independent operation of all three the runways. Aprons and terminal facilities are located in mid-field and/or east end zone over the mud pits.	



Option D Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	35
07C	Departures	35
07R	Mixed	34
Total		**102**
Increase		**34**



Option D Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Departures	35
25C	Arrivals	33
25L	Mixed	34
Total		**102**
Increase		**34**

Note: In the Runway 07 direction, the runway may need to be offset to the degree required to achieve the desired climb gradient on the missed approach. A greater offset may be required to achieve a departure and approach to the north runway.

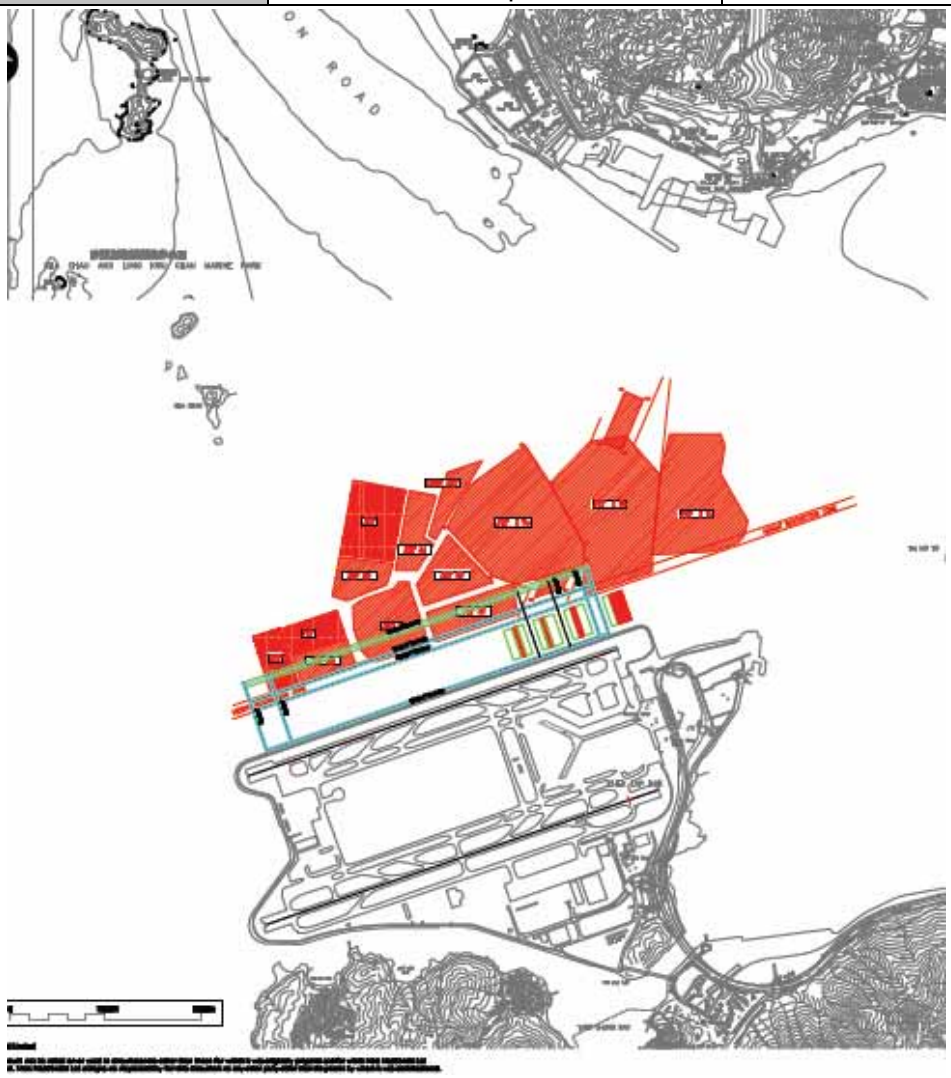
New Runway			
Length	3800m		
Offset	1525m		
Stagger	0m		
Taxiways			
Parallel	Twin to new runway. One or two north Rwy 07C/25C (existing 07L/25R).		
Cross-field	Twin cross-field links at east and west ends (minimum).		
	Compass Mode		**Terminal Mode**
	Full Access	Rwy Crossing	
New Apron	Rwy 07L/25R Rwy 07C/25C	Rwy 07C/25C to Rwy 07R/25L	No normal access to existing Rwy 07R/25L
Existing T1 Apron Mid-field Apron	Rwy 07C/25C Rwy 07R/25L	Rwy 07C/25C to Rwy 07L/25R	No normal access to new Rwy 07L/25R
Existing Cargo Apron	Rwy 07R/25L	Rwy 07R/25L to Rwy 07C/25C Rwy 07C/25C to Rwy 07L/25R	Normally use Rwy 07R/25L only
Taxiing Complexity	**Compass Mode**		**Terminal Mode**
Normal Operations	Rwy 07C/25C must be frequently crossed at either end.		Minimal Complexity.

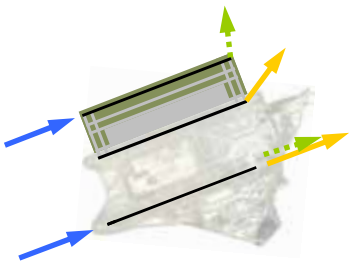
With Runway Closures	Reasonable distances from all aprons to Rwy 07C/25C. Long distances from existing aprons to start Rwy 07L/25R. Long distances from new apron to Rwy 07R/25L.
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). In this case, we anticipate that the full area between the new runway 07L/25R will be reclaimed, proving ample potential apron and terminal development space.
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Difficult due to intervening runway/taxiways. Distance mandates APM. Coaching or second APM as back-up. Airside road link also required which must cross Rwy 07C/25C. Surface/tunnel/bridge required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	All options possible, but a phased construction of core terminal to the east and a series of satellite cross-field piers likely to best fit the dimensions and configuration.
Cargo Centre to New Apron	New facility required. Airside road access from existing cargo area also required, but distance and travel time will limit its usefulness for most cargo.
Passenger Terminal	
Configuration	Limited space for apron and terminals if mud pits are avoided. Final layout may require runway 07L/25R to be located further north and taxiways west to improve space for apron, terminal and landside facilities. Terminal concepts still likely to be limited if mud pits avoided.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). See comment on aprons.
Surface Access	
Road	Existing roads and rail line may be extendable to T3 around east end of 07L/25R on embankment or viaduct, but must pass under eastern cross-field taxiways. Short mud pit crossing required.
Rail	
Sea	New ferry terminal within taxiway zone.

Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	New facilities required for new apron – split operations.
ATC	New ATC Tower may be required. Thresholds Rwy 07L/25R 4.5km from existing VCR.
Fuel	New facilities required for new apron.
Shipping Lanes	Significant obstruction to shipping lanes north of CLK reclamation.
Construction	
Mud Pits	Concept devised to minimise construction over mud pits, although cross-field taxiways and surface access will have to cross them.
Reclamation	Concept assumes full reclamation of area between new runway and existing airport reclamation. The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. The western side of the new runway and taxiways will be subject to a high degree of exposure and wave action. The eastern side of the new runway and taxiways will be exposed to the north eastern Monsoon and the resulting winds will have a long fetch (circa 20km).
Structures	Concept requires surface access road and rail links that probably pass around east end of runway 07C/25C on a viaduct. If required, passing these under eastern cross-field taxiways may require a tunnelled solution. Cross-field taxiways to existing airport reclamation probably on a viaduct for a significant part of their length to allow water flows and small vessels to pass beneath. Airside road and APM links in tunnel.
Environment	
Noise	As with most options, the departure route from Rwy 07C to the Tai Lam valley will regularly overfly residential areas along shoreline and the country park inland. Departure route from Rwy 07L to the Tuen Muen valley will regularly overfly residential areas.
Ecology	Change to current flow at Tuen Mun and North Lantau. Possible change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Impact on marine life at North Lantau (mainly dolphins and porpoises) in the Shau Chau and Lung Kwu Chau Marine Park (mainly dolphins and fish attracted by the artificial reef).

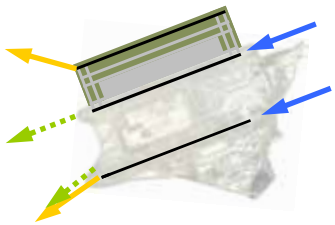
Summary	
	Option D is a wide spaced parallel runway that sits on top of the mud pits. A major disturbance to the sediments within the mud pits could have an impact on marine life. The current and shipping channel will both be adversely affected. The 1525m spacing does allow the new facilities to be integrated within the existing airport. The widely spaced runways simplify ATC procedures and potentially offer a significant capacity increase.

8.5 Option E Parallel Runway 1035m to 1524m Separation

Option E	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: 1035-1524m
		
General Description	A parallel runway, with sufficiently separation to permit independent IFR departures, requiring radar monitoring for independent parallel instrument approaches. Aprons and terminal facilities are located in mid-field and/or east end zone. About half the development would be over the mud pits.	



Option E Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	24
07C	Departures	24
07R	Mixed	34
Total		**82**
Increase		**14**



Option E Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Departures	35
25C	Arrivals	33
25L	Mixed	34
Total		**102**
Increase		**34**

Note: As the runway separation reduces, at some point the conflict between the 07L missed approach and 07C departure becomes significant. It is assumed that Runway 07L and Runway 07C are dependant.

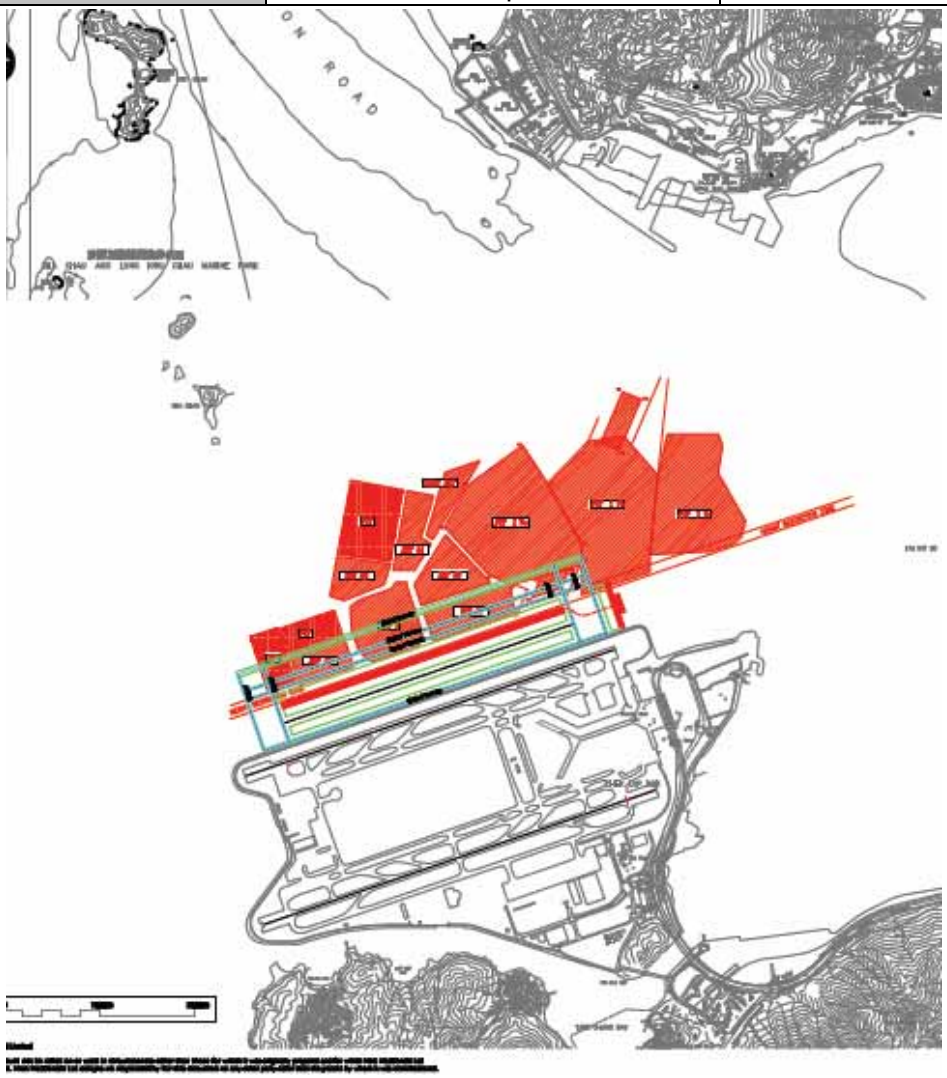
New Runway			
Length	3800m		
Offset	1035-1524m		
Stagger	0m		
Taxiways			
Parallel	Twin to new runway. One or two north Rwy 07C/25C (extg 07L/25R). Plus, optionally, a single apron taxiway between a row of contact stands and a row of remote stands.		
Cross-field	Twin cross-field links at east and west ends (minimum) and, optionally, a series of short cross-field apron taxiways.		
	Compass Mode		**Terminal Mode**
	Full Access	Rwy Crossing	
New Apron	Rwy 07L/25R Rwy 07C/25C	07C/25C to Rwy 07R/25L	No normal access to existing Rwy 07R/25L
Existing T1 Apron Mid-field Apron	Rwy 07C/25C Rwy 07R/25L	Rwy 07C/25C to Rwy 07L/25R	No normal access to new Rwy 07L/25R
Existing Cargo Apron	Rwy 07R/25L	Rwy 07R/25L to Rwy 07C/25C Rwy 07C/25C to Rwy 07L/25R	Normally use Rwy 07R/25L only

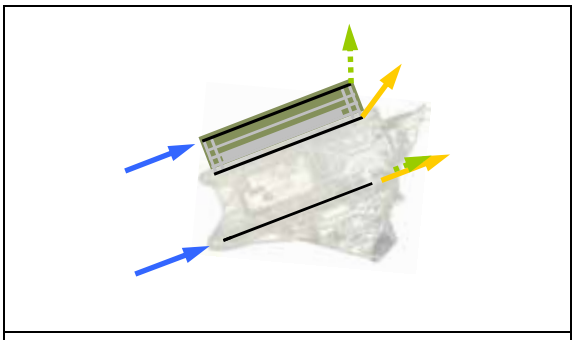
Taxiing Complexity	Compass Mode	Terminal Mode
Normal Operations	Rwy 07C/25C must be frequently crossed at either end.	Minimal Complexity.
With Runway Closures	Reasonable distances from all aprons to Rwy 07C/25C. Increased distances from existing aprons to start Rwy 07L/25R. Long distances from new apron to Rwy 07R/25L.	
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). In this case, the full area between the new runway 07L/25R will be reclaimed, proving a long apron and terminal development space with a width determined by the selected runway separation distance.	
Airside Connectivity		
Existing Terminals to New Terminal (airside)	Difficult due to intervening runway/taxiways. Distance noticeably shorter than with some options, but still mandates APM. Coaching or second APM as back-up. Airside road link also required which must cross Rwy 07C/25C. Surface/tunnel/bridge required.	
Existing Terminals to New Terminal (landside)	As surface access.	
New Terminal to Piers	Longitudinal piers, or a series of short cross-field piers possible. A phased construction of core terminal to the east and a series of satellite piers most likely option. Due to length of pier zone, APM needed for passenger movement.	
Cargo Centre to New Apron	New facility may not be needed. Airside road access from existing cargo area required, but distance and travel time from existing cargo area more than desirable. May be determined by selected runway separation distance.	
Passenger Terminal		
Configuration	Limited width for apron, piers and core terminal. Terminal concepts likely to be limited.	
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). See comment on aprons.	
Surface Access		
Road	Existing roads and rail line may be extendable to T3 around east end of 07L/25R on embankment or viaduct, but must pass under eastern cross-field taxiways. Short mud pit crossing required.	
Rail		
Sea	New ferry terminal within taxiway zone.	

Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	New facilities required for new apron – split operations.
ATC	New ATC Tower may be required.
Fuel	New facilities required for new apron.
Shipping Lanes	Limited obstruction to shipping lanes north of CLK reclamation.
Construction	
Mud Pits	Concept devised to minimise construction over mud pits, although cross-field taxiways and surface access will have to cross them.
Reclamation	Concept assumes full reclamation of area between new runway and existing airport reclamation. The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. The western side of the new runway and taxiways will be subject to a high degree of exposure and wave action. The eastern side of the new runway and taxiways will be exposed to the north eastern Monsoon and the resulting winds will have a long fetch (circa 20km).
Structures	Concept requires surface access road and rail links that probably pass around east end of runway 07C/25C on a viaduct. If required, passing these under eastern cross-field taxiways may require a tunnelled solution. Cross-field taxiways to existing airport reclamation probably on a viaduct for a significant part of their length to allow water flows and small vessels to pass beneath. Airside road and APM links in tunnel.
Environment	
Noise	As with most options, the departure route from Rwy 07C to the Tai Lam valley will regularly overfly residential areas along shoreline and the country park inland. Departure route from Rwy 07L to the Tuen Muen valley will regularly overfly residential areas.
Ecology	Disturbed sediments in the mud pits resulting in deterioration of water quality affecting marine life Minor change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Impact on marine life at North Lantau (mainly dolphins and porpoises).

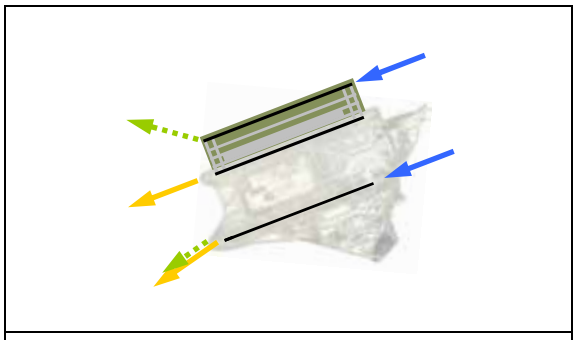
Summary	
	Option E is a 1035m separation parallel runway that allows for a new midfield terminal development. The new runway and associated apron has limited impact on the shipping channel, current flow and marine life; however the new runway and associated land reclamation overlays a large proportion of the mud pits and therefore has the potential to disturb a large amount of contaminated sediment. Surface access to the new terminal will be difficult due to the need to cross two taxiways, alternatively an eastern terminal could be provided with an APM linking the core terminal building and the pier(s). The runway spacing creates an interaction between the north and centre runways, limiting the potential capacity increase.

8.6 Option F Parallel Runway 915m to 1034m Separation

Option F	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: 915-1034m
		
General Description	A parallel runway, with sufficiently separation to permit independent IFR departures, requiring radar monitoring for independent parallel instrument approaches. Aprons and terminal facilities are located in mid-field and/or east end zone. About half the development would be over the mud pits.	



Option F Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	24
07C	Departures	24
07R	Mixed	34
Total		**82**
Increase		**14**



Option F Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Arrivals	33
25C	Departures	35
25L	Mixed	34
Total		**102**
Increase		**34**

Note: As the runway separation reduces, at some point the conflict between the 07L missed approach and 07C departure becomes significant. It is assumed that Runway 07L and Runway 07C are dependant.

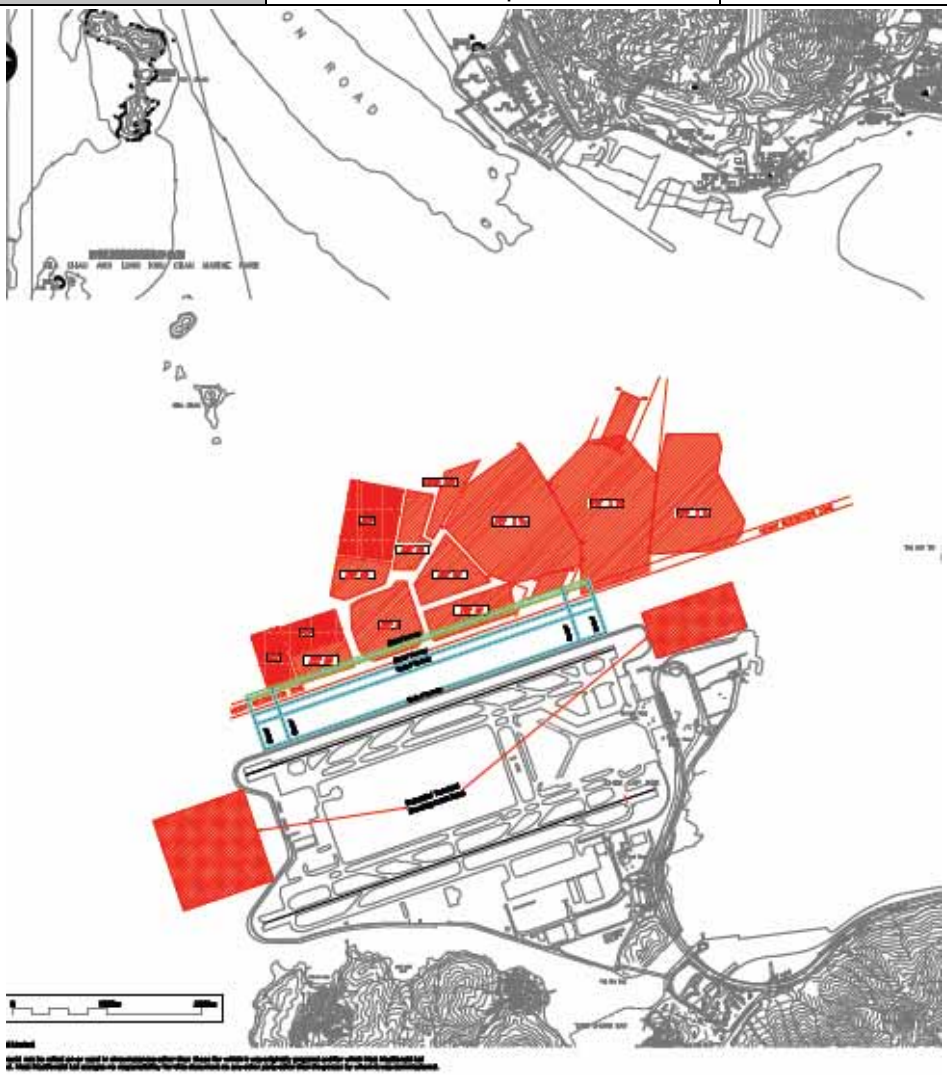
New Runway			
Length	3800m		
Offset	915-1034m		
Stagger	0m		
Taxiways			
Parallel	Twin to new runway. One or two north Rwy 07C/25C (existing 07L/25R). A single apron taxiway between a row of contact stands and a row of remote stands.		
Cross-field	Twin cross-field links at east and west ends (minimum).		
	Compass Mode		**Terminal Mode**
	Full Access	Rwy Crossing	
New Apron	Rwy 07L/25R Rwy 07C/25C	Rwy 07C/25C to Rwy 07R/25L	No normal access to existing Rwy 07R/25L
Existing T1 Apron	Rwy 07C/25C Rwy 07R/25L	Rwy 07C/25C to Rwy 07L/25R	No normal access to new Rwy 07L/25R
Mid-field Apron			
Existing Cargo Apron	Rwy 07R/25L	Rwy 07R/25L to Rwy 07C/25C Rwy07C/25C to Rwy 07L/25R	Normally use Rwy 07R/25L only
Taxiing Complexity	**Compass Mode**		**Terminal Mode**
Normal Operations	Rwy 07C/25C must be frequently crossed at either end.		Minimal Complexity.

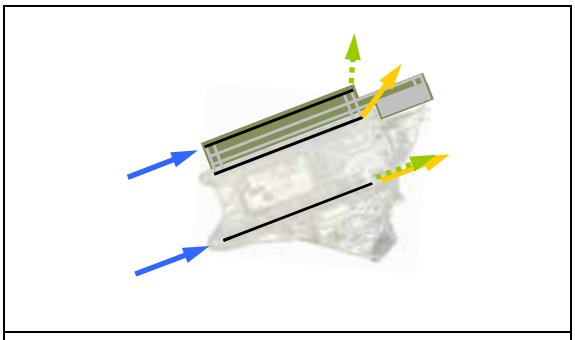
With Runway Closures	Reasonable distances from all aprons to Rwy 07C/25C. Increased distances from existing aprons to start Rwy 07L/25R. Long distances from new apron to Rwy 07R/25L.
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). In this case, the full area between the new runway 07L/25R will be reclaimed, proving a long, but narrow apron and terminal development space.
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Difficult due to intervening runway/taxiways. Distance noticeably shorter than with some options, but still mandates APM. Coaching or second APM required as back-up. Airside road link also required which must cross Rwy 07C/25C. Surface/tunnel/bridge required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	Longitudinal piers, or a series of short cross-field piers possible. A phased construction of core terminal to the east and a series of cross-field satellite piers most likely option due to width available being inefficient for a longitudinal pier arrangement. Due to length of pier zone, APM needed for passenger movement.
Cargo Centre to New Apron	New facility may not be needed. Airside road access from existing cargo area required, but distance and travel time from existing cargo area more than desirable.
Passenger Terminal	
Configuration	Limited width for apron, piers and core terminal. Terminal concepts likely to be limited.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). See comment on aprons.
Surface Access	
Road	Existing roads and rail line may be extendable to T3 around east end of 07L/25R on embankment or viaduct, but must pass under eastern cross-field taxiways. Short mud pit crossing required.
Rail	
Sea	New ferry terminal within taxiway zone.

Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	New facilities required for new apron – split operations.
ATC	New ATC Tower unlikely to be required.
Fuel	New facilities required for new apron.
Shipping Lanes	Limited obstruction to shipping lanes north of CLK reclamation.
Construction	
Mud Pits	Concept devised to minimise construction over mud pits, although cross-field taxiways and surface access will have to cross them.
Reclamation	Concept assumes full reclamation of area between new runway and existing airport reclamation. The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud.
Structures	Concept requires surface access road and rail links that probably pass around east end of runway 07C/25C on a viaduct. If required, passing these under eastern cross-field taxiways may require a tunnelled solution. Cross-field taxiways to existing airport reclamation probably on a viaduct for a significant part of their length to allow water flows and small vessels to pass beneath. Airside road and APM links in tunnel.
Environment	
Noise	As with most options, the departure route from Rwy 07C to the Tai Lam valley will regularly overfly residential areas along shoreline and the country park inland. Departure route from Rwy 07L to the Tuen Muen valley will regularly overfly residential areas.
Ecology	Disturbed sediments in the mud pits resulting in deterioration of water quality affecting marine life Minor change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Impact on marine life at North Lantau (mainly dolphins and porpoises).

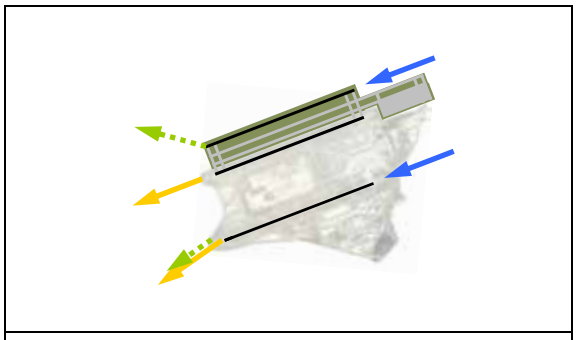
Summary	
	Option F is a 915m separation parallel runway that allows for a new midfield terminal development. The new runway and associated apron has limited impact on the shipping channel, current flow and marine life; however the new runway and associated land reclamation overlays a large proportion of the mud pits and therefore has the potential to disturb a large amount of contaminated sediment. Surface access to the new terminal will be difficult due to the need to cross two taxiways, alternatively an eastern terminal could be provided with an APM linking the core terminal building and the pier(s). The terminal area is heavily constrained by the spacing of the parallel runways. The runway spacing also creates an interaction between the north and centre runways, limiting the potential capacity increase.

8.7 Option G Parallel Runway 760m to 914m Separation

Option G	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: 760-914m
		
General Description	A parallel runway with a separation of a least 760m to achieve independent IFR departures and segregated Arrival/Departure operations. Aprons and terminal facilities are located in either the east or west end zones shown. The new runway would be developed over the mud pits.	



Option G Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	24
07C	Departures	24
07R	Mixed	34
Total		**82**
Increase		**14**



Option G Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Arrivals	33
25C	Departures	35
25L	Mixed	34
Total		**102**
Increase		**34**

Note: As the runway separation reduces, at some point the conflict between the 07L missed approach and 07C departure becomes significant. It is assumed that Runway 07L and Runway 07C are dependant.

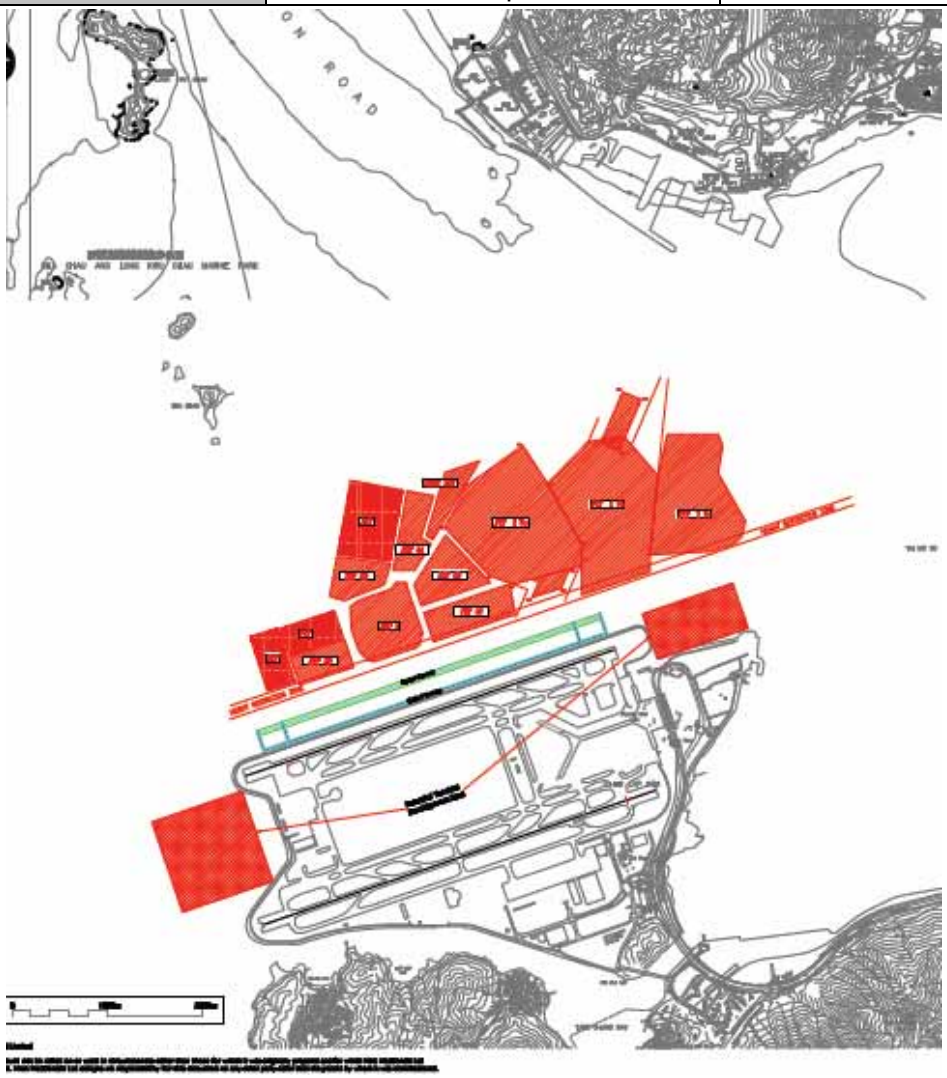
New Runway			
Length	3800m		
Offset	760-914m		
Stagger	0m		
Taxiways			
Parallel	Twin to new runway. One north Rwy 07C/25C (extg 07L/25R).		
Cross-field	Short twin cross-field links at east and west ends (minimum).		
	Compass Mode		**Terminal Mode**
	Full Access	Rwy Crossing	
New Apron	Rwy 07L/25R Rwy 07C/25C	Rwy 07C/25C to Rwy 07R/25L	No normal access to existing Rwy 07R/25L
Existing T1 Apron	Rwy 07C/25C Rwy 07R/25L	Rwy 07C/25C to Rwy 07L/25R	No normal access to new Rwy 07L/25R
Mid-field Apron			
Existing Cargo Apron	Rwy 07R/25L	Rwy 07R/25L to Rwy 07C/25C Rwy 07C/25C to Rwy 07L/25R	Normally use Rwy 07R/25L only
Taxiing Complexity	**Compass Mode**		**Terminal Mode**
Normal Operations	Rwy 07C/25C must be frequently crossed at either end.		Minimal Complexity.

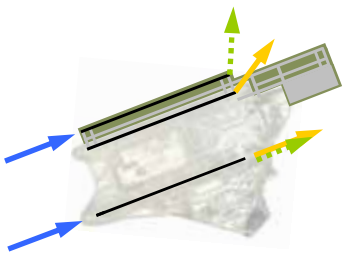
With Runway Closures	Reasonable distances from existing aprons to start Rwy 07L/25R. Long distances from new apron to far end Rwy 07L/25R. Very long distances from new apron to far end Rwy 07R/25L.
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). In this case, the parallel alignment (with the 760m separation) of this runway would not allow sufficient space for a midfield development, between the existing 07L/25R Runway and the proposed new parallel runway. New apron at East or West end to size required.
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Most difficult if new apron at west end due to distance and intervening aprons and taxiways. Distance noticeably shorter than with some options, but still mandates APM. Coaching or second APM required as back-up. Much shorter links to a new apron and terminal at the east end. Airside road link also required which must pass under cross-field taxiways.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	Most pier concepts possible. A phased construction of core terminal to the east and a series of attached or satellite piers most likely option. APM may not be necessary needed for T3 core to T3 pier passenger movement.
Cargo Centre to New Apron	New facility not required for locational reasons. Airside road access from existing cargo area required, but distances and travel time from existing cargo area some of the shortest of the options.
Passenger Terminal	
Configuration	Reclamation for apron, piers and core terminal can be virtually of any size and shape. Terminal concepts likely to be limited by surface access considerations, but not apron or runway configuration issues.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). See comment on aprons.
Surface Access	
Road	Existing roads and rail line may be extendable to T3 around east end of 07L/25R on embankment or viaduct, but must pass under eastern cross-field taxiways. Short mud pit crossing required.
Rail	
Sea	New ferry terminal within taxiway zone.

Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	New facilities required for new apron – split operations.
ATC	New ATC Tower unlikely to be required.
Fuel	New facilities required for new apron.
Shipping Lanes	Limited obstruction to shipping lanes north of CLK reclamation. Several bridges required for small vessels to pass under cross-field taxiways and new surface access.
Construction	
Mud Pits	Concept devised to minimise construction over mud pits, although cross-field taxiways and surface access will have to cross them.
Reclamation	Concept assumes full reclamation of area between new runway and existing airport reclamation. Part of the area between the new and existing runways may be difficult to use. The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud.
Structures	Concept requires surface access road and rail links that probably pass around east end of runway 07C/25C on a viaduct. If required, passing these under eastern cross-field taxiways may require a tunnelled solution. Cross-field taxiways to existing airport reclamation probably on a viaduct for a significant part of their length to allow water flows and small vessels to pass beneath. Airside road and APM links in tunnel.
Environment	
Noise	As with most options, the departure route from Rwy 07C to the Tai Lam valley will regularly overfly residential areas along shoreline and the country park inland. Departure route from Rwy 07L to the Tuen Muen valley will regularly overfly residential areas.
Ecology	Disturbed sediments in the mud pits resulting in deterioration of water quality affecting marine life Minor change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Impact on marine life at North Lantau (mainly dolphins and porpoises).

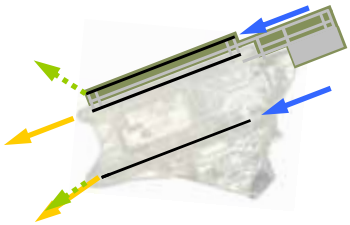
Summary	
	Option G is a 760m separation parallel runway that requires a new terminal to be constructed adjacent to the existing exhibition centre or on the western end of the airport. The new runway and associated apron has limited impact on the shipping channel, current flow and marine life; however the new runway and associated land reclamation overlays a proportion of the mud pits and therefore has the potential to disturb a large amount of contaminated sediment. Surface access to the new terminal at the eastern end can be achieved by a relatively simple extension to the existing system, but connections to the western site are difficult. The north and centre runways are dependant, limiting the potential capacity increase.

8.8 Option H Parallel Runway 380m to 759m Separation

Option H	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: 380-759m
		
General Description	A parallel runway with a separation of at least 380m to facilitate dependent operations. Aprons and terminal facilities are located in either the east or west end zones shown. With a 380m separation, the new runway would be developed clear of the mud pits.	



Option H Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	24
07C	Departures	24
07R	Mixed	34
Total		**82**
Increase		**14**



Option H Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Arrivals	33
25C	Departures	35
25L	Mixed	34
Total		**102**
Increase		**34**

Note: As the runway separation reduces, at some point the conflict between the 07L missed approach and 07C departure becomes significant. It is assumed that Runway 07L and Runway 07C are dependant.

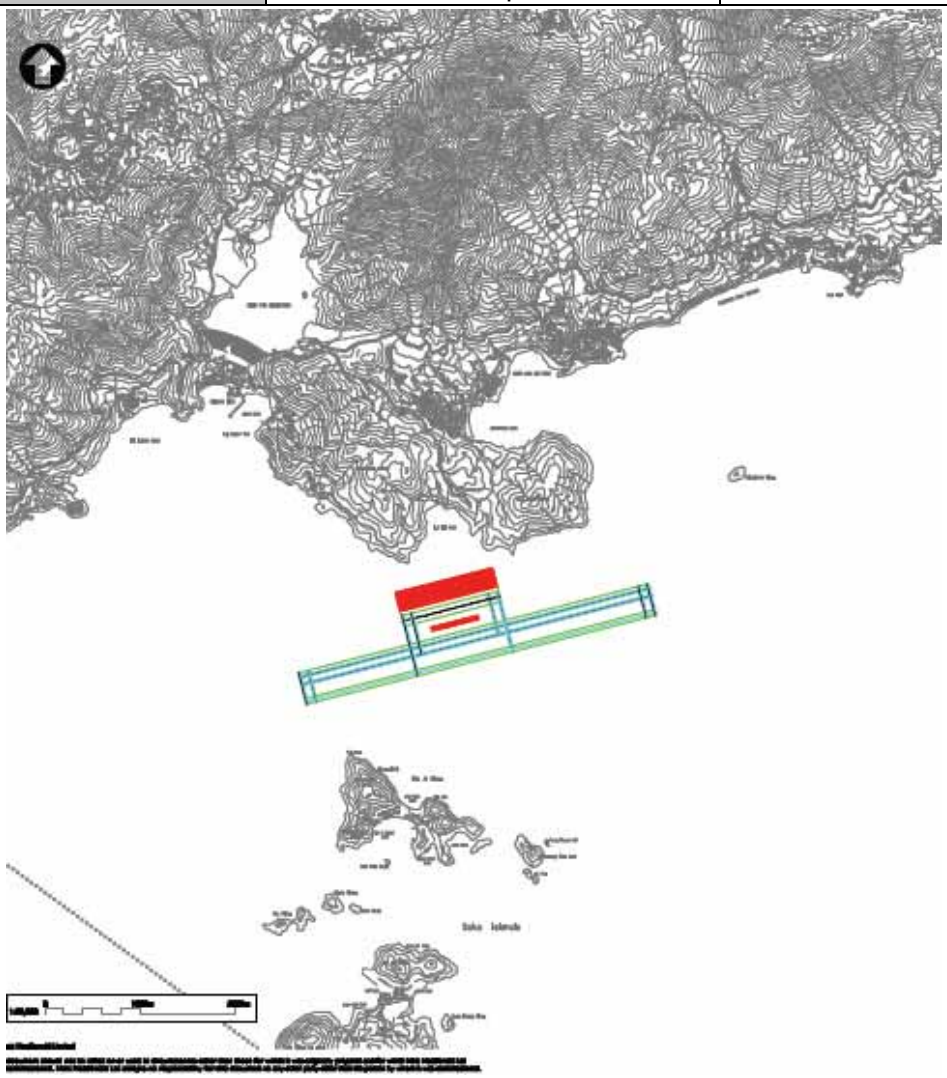
New Runway		
Length	3800m	
Offset	380-759m	
Stagger	0m	
Taxiways		
Parallel	Single parallel taxiway in-between new runway and Rwy 07C/25C (extg 07L/25R).	
Cross-field	None	
	Compass Mode	**Terminal Mode**
New Apron	Designed to access new runway via central taxiway with no runway crossing.	Designed to access new runway via central taxiway with no runway crossing.
Existing T1 Apron Mid-field Apron	Access to new runway possible with extended taxi distance via central taxiway around the ends of 07C/25C to avoid runway crossing.	No normal access to new Rwy 07L/25R.
Existing Cargo Apron	Crossing of Rwy 07R/25L required to Rwy 07C/25C Access to new runway possible with very extended taxi distance via central taxiway around the ends of 07C/25C to avoid runway crossing.	Normally use Rwy 07R/25L only.

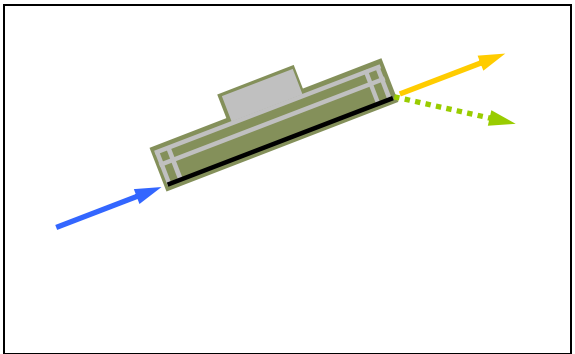
Taxiing Complexity	Compass Mode	Terminal Mode
Normal Operations	Access to new runway with extended taxi distance via central taxiway around the ends of 07C/25C to avoid runway crossing.	
With Runway Closures	Reasonable distances from existing aprons to start Rwy 07L/25R. Reasonable distances from new apron to Rwy 07R/25L.	
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). In this case, the close parallel alignment of this runway would not allow space for a midfield development between the existing 07L/25R Runway and the proposed new parallel runway. New apron at East or West end to size required.	
Airside Connectivity		
Existing Terminals to New Terminal (airside)	Most difficult if new apron at west end due to distance and intervening aprons and taxiways. Distance noticeably shorter than with some options, but still mandates APM. Coaching or second APM required as back-up. Much shorter links to a new apron and terminal at the east end. Airside road link also required which must pass under cross-field taxiways.	
Existing Terminals to New Terminal (landside)	As surface access.	
New Terminal to Piers	Most pier concepts possible. A phased construction of core terminal to the east and a series of attached or satellite piers most likely option. APM may not be necessary needed for T3 core to T3 pier passenger movement.	
Cargo Centre to New Apron	New facility not required for locational reasons. Airside road access from existing cargo area required, but distances and travel time from existing cargo area some of the shortest of the options.	
Passenger Terminal		
Configuration	Reclamation for apron, piers and core terminal can be virtually of any size and shape. Terminal concepts likely to be limited by surface access considerations, but not apron or runway configuration issues.	
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). See comment on aprons.	
Surface Access		

Road	Existing roads and rail line may be extendable to T3 around east end of 07L/25R on embankment or viaduct, but must pass under eastern cross-field taxiways. Short mud pit crossing required.
Rail	
Sea	New ferry terminal within taxiway zone.
Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection.
Cargo	New facilities required for new apron – split operations.
ATC	New ATC Tower unlikely to be required.
Fuel	New facilities required for new apron.
Shipping Lanes	Limited obstruction to shipping lanes north of CLK reclamation. Several bridges required for small vessels to pass under cross-field taxiways and new surface access.
Construction	
Mud Pits	Avoids the mud pits.
Reclamation	Concept assumes full reclamation of area between new runway and existing airport reclamation. The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud.
Structures	Concept requires surface access road and rail links that probably pass around east end of runway 07C/25C on a viaduct. If required, passing these under eastern cross-field taxiways may require a tunnelled solution. Cross-field taxiways to existing airport reclamation probably on a viaduct for a significant part of their length to allow water flows and small vessels to pass beneath. Airside road and APM links in tunnel.
Environment	
Noise	As with most options, the departure route from Rwy 07C to the Tai Lam valley will regularly overfly residential areas along shoreline and the country park inland. Departure route from Rwy 07L to the Tuen Muen valley will regularly overfly residential areas.
Ecology	Minor change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Impact on marine life at North Lantau (mainly dolphins and porpoises).

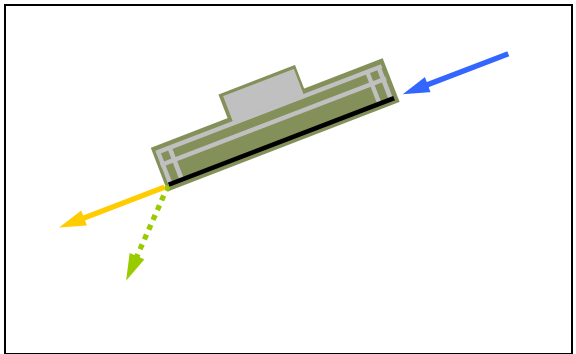
Summary	
	Option H is a 380m separation parallel runway that requires a new terminal to be constructed adjacent to the existing exhibition centre; providing a 380m separation runway should allow the land reclamation to avoid overlaying the mud pits. The new runway and associated apron has limited impact on the shipping channel, current flow and marine life. Surface access to the new terminal at the eastern end can be achieved by a relatively simple extension to the existing system, but connections to the western site are difficult. The north and centre runways are dependant, limiting the potential capacity increase.

8.9 Option J South of Lantau Island

Option J	Hong Kong International Airport Third Runway Study Other Options	Runway Separation: N/A – Proposed Runway South of Lantau
		
General Description	A new runway with all supporting airside and landside infrastructure.	



Option J Runway 07 Direction		
Runway	**Use**	**Capacity**
07	Mixed	44
07L	Arrivals	33
07R	Departures	35
Total		**112**
Increase		**44**



Option J Runway 25 Direction		
Runway	**Use**	**Capacity**
25	Mixed	44
25R	Arrivals	33
25L	Departures	35
Total		**112**
Increase		**44**

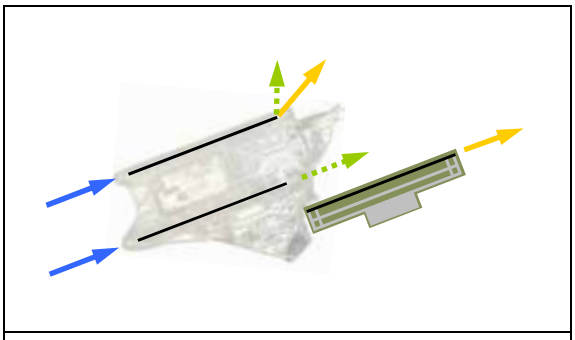
New Runway	
Length	3800m
Offset	N/A
Stagger	N/A
Taxiways	
Parallel	Twin to new runway.
Cross-field	None.
New Apron	Full access from new runway.
Existing T1 Apron	No access to new runway.
Mid-field Apron	No access to new runway.
Existing Cargo Apron	No access to new runway.
Taxiing Complexity	There is no change to the taxiing distances due to the new runway being a stand alone facility.
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). Expansion only practical to the northeast.
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Almost impossible due to remote location of new stand alone facility.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	All options possible. Selection to best fit relevant dimensions.

Cargo Centre to New Apron	New facility required.
Passenger Terminal	
Configuration	Terminal space available is unconstrained, within reasonable limits. The final layout may require the new 05/23 runway to be positioned further south than shown.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length).
Surface Access	
Road	New road and rail link to be constructed to the new, stand alone, airport. New link to be constructed by tunnelling N-S through Lantau Island.
Rail	
Sea	New ferry terminal.
Ancillary Facilities	
Aircraft Maintenance	New Facility Required.
Cargo	New Facility Required.
ATC	New Facility Required.
Fuel	New Facility Required.
Shipping Lanes	No disruption to shipping lanes.
Construction	
Mud Pits	There are no Mud Pits located South of Lantau Island.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. Sea bed level below -10mpd; requiring extensive reclamation that could interfere with natural sea currents. High degree of exposure to wind and wave action on the western side of the site. Airport site adjacent to proposed Liquefied Petroleum Gas Depot.
Environment	
Noise	The new airport is located adjacent to a affluent residential area and the 05 SID together with the 23 STAR pass very close to Disneyland Hong Kong.
Ecology	Impact on marine life at South Lantau (mainly dolphins and porpoises). Change to current flow at South Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tong Fuk (e.g. Tong Fuk Beach, Upper and Lower Cheung Sha Beach). Generation of environmental impacts on communities and ecosystems where none currently exist.

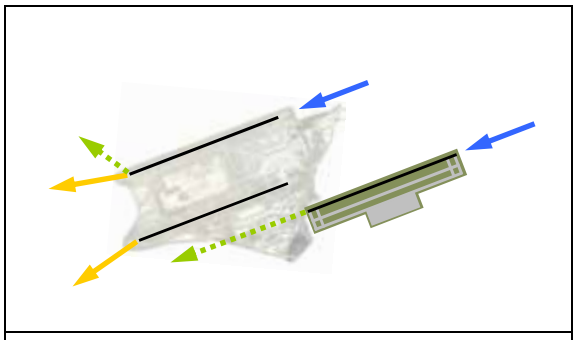
Summary	
	Option J is a full length runway to the south of Lantau Island. Due to the remote location of the new airport there is no impact on the mud pits or shipping lanes. The sea depth is currently unknown; however it is understood to be significant (10-20m). The new earth structure will impact on both marine life and sea currents. Access to the Liquefied Petroleum Gas Depot would be severed by the new airport. Surface access to the new airport would require significant investment to create new road and rail links through the mountain connecting the new airport with CLK and Hong Kong. The runway is independent from the existing airport, potentially offering the highest capacity increase. The challenge of integrating the flight paths with the existing airport will be significant, particularly if opposite direction operations are envisaged compared with the existing airport.

8.10 Option K South East of HKIA

Option K	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: >1035m
		
General Description	A parallel runway to the South east of the existing 25L/07R with nearly a 5000m stagger to the east.	



Option K Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Mixed	34
07C	Arrivals	24
07R	Departures	24
Total		**82**
Increase		**14**



Option K Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Mixed	34
25C	Departures	24
25L	Arrivals	24
Total		**82**
Increase		**14**

Note1: In the Runway 25 direction, this mode of operations requires terrain safe approaches and missed approaches for the new runway. The Runway 07 direction requires terrain safe departures. An initial review indicates this is unlikely. If any of these operations are not possible, the new runway is not useable, resulting in no capacity increase.

Note2: The existing south runway and the new runway are dependent.

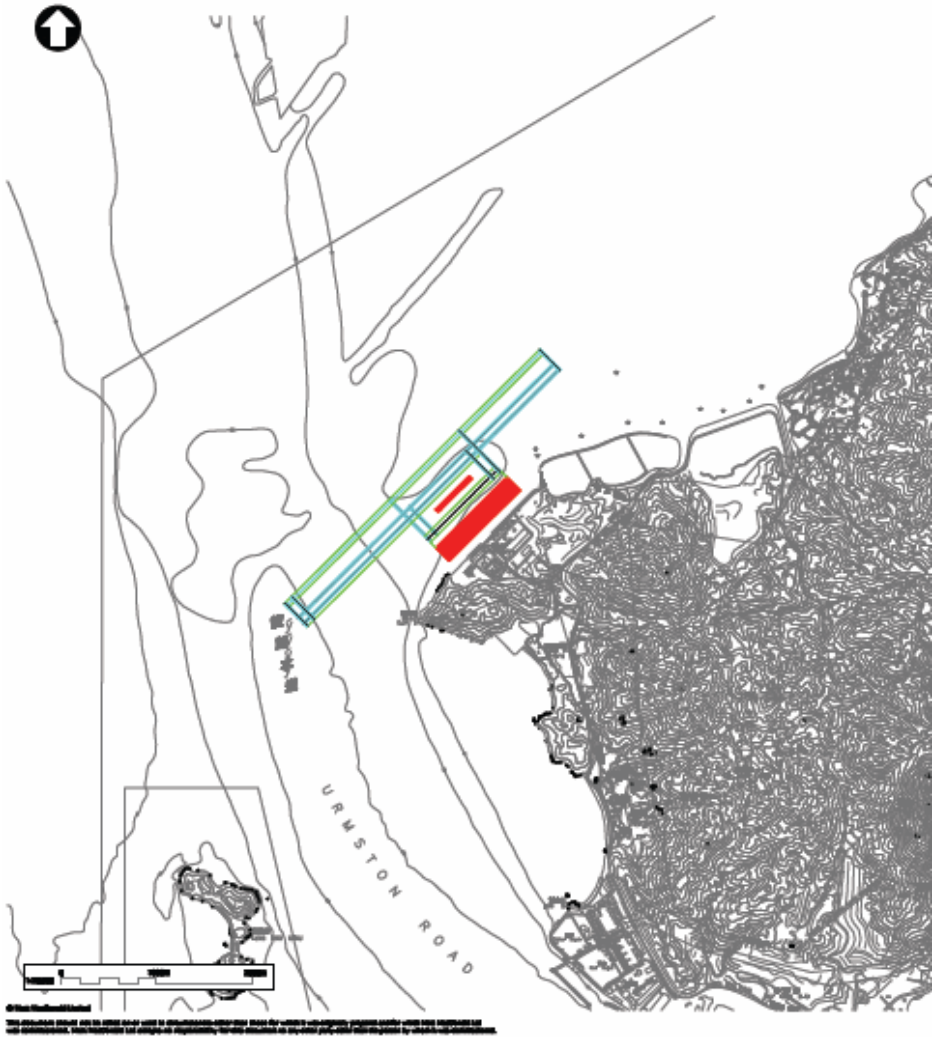
New Runway	
Length	3800m
Offset	>=1035m
Stagger	5000m
Taxiways	
Parallel	Triple to new runway. One north proposed Rwy 07R/25L.
Cross-field	Twin cross-field links at west end only.
New Apron	No normal access to existing runways.
Existing T1 Apron	No normal access to new runway.
Mid-field Apron	No normal access to new runway.
Existing Cargo Apron	No normal access to new runway.

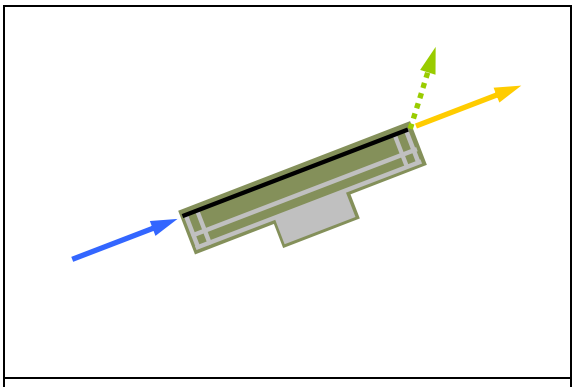
Taxiing Complexity	**Compass Mode**	**Terminal Mode**
Normal Operations	Existing Rwy 07R/25L must be frequently crossed at east end.	Minimal Complexity.
With Runway Closures	Very long distances from existing aprons to start of the new Rwy07/25. Very long distances from new apron to existing Rwy 07L/25R.	

Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length).
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Very difficult due to distance and intervening runway/taxiways. Distance mandates APM. Coaching only back-up possible. Airside road link also required. Surface/tunnel/bridge required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	All options possible. Selection to best fit relevant dimensions.
Cargo Centre to New Apron	New facility required. Airside road access from existing cargo area also required, but distance and travel time will limit its usefulness for most cargo.
Passenger Terminal	
Configuration	Limited space for apron and terminals if 1035m separation is to be maintained. The terminal could be developed in a long thin pier to accommodate a large number of contact stands.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). Expansion only practical to the northeast.
Surface Access	
Road	Existing roads and rail line may be extendable to T3 around east and north side of 07L/25R on embankment or viaduct. Short mud pit crossing required.
Rail	
Sea	New ferry terminal.
Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	New facilities required for new apron – split operations.
ATC	New ATC Tower may be required.
Fuel	New facilities required for new apron.
Shipping Lanes	Shipping lanes are not obstructed by the construction of the new runway and associated taxiways; however the Tung Chung ferry is severed by the cross taxiways. Taxiway bridge required for this and local coastal marine access.

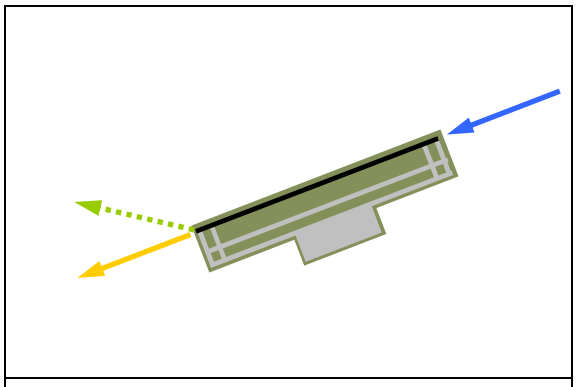
Construction	
Mud Pits	The taxiway to the north of the proposed runway appears intrude into one of the mud pits that are located to the east of the existing airport.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. Possible conflict with Tuen Mun to Chep Lak Kok link Possible conflict with option 2 of the Macau-Zuhai-Hong Kong Bridge Toll Plaza.
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages in Tai Ho.
Ecology	Aircraft noise nuisance and visual pollution to villages in Tai Ho. Impact on marine life at North Lantau (mainly dolphins and porpoises). Increase in sedimentation during construction affecting culture fisheries at Ma Wan Fish Culture Zone.
Summary	
	Option K is a full length runway to the south of the existing southern runway with a eastern stagger of 5km. The location of the proposed new runway and associated terminal building allow an easy connection into the existing road and rail system. The proposed location of the new runway conflicts with a number of proposed pieces of planned infrastructure including the Tuen Mun/CLK link, Macau/Zuhai/Hong Kong toll plaza and the Yung Chung logistics park. The taxiway links will also sever the Tung Chang ferry and construction will effect the culture fishery. The existing surface access corridors will require modification to accommodate the taxiway system. The southern pair of runways are dependant, limiting the potential capacity increase. It is considered to be unlikely that terrain safe approach and departure/missed approach paths can be devised for the new runway.

8.11 Option M North of HKIA

Option M	Hong Kong International Airport Third Runway Study Other Options	Runway Separation: N/A – Proposed Runway North of HKIA
		
General Description	A new runway with all supporting airside and landside infrastructure.	



Option M Runway 07 Direction		
Runway	**Use**	**Capacity**
07	Mixed	44
07L	Arrivals	33
07R	Departures	35
Total		**112**
Increase		**44**



Option M Runway 25 Direction		
Runway	**Use**	**Capacity**
25	Mixed	44
25R	Arrivals	33
25L	Departures	35
Total		**112**
Increase		**44**

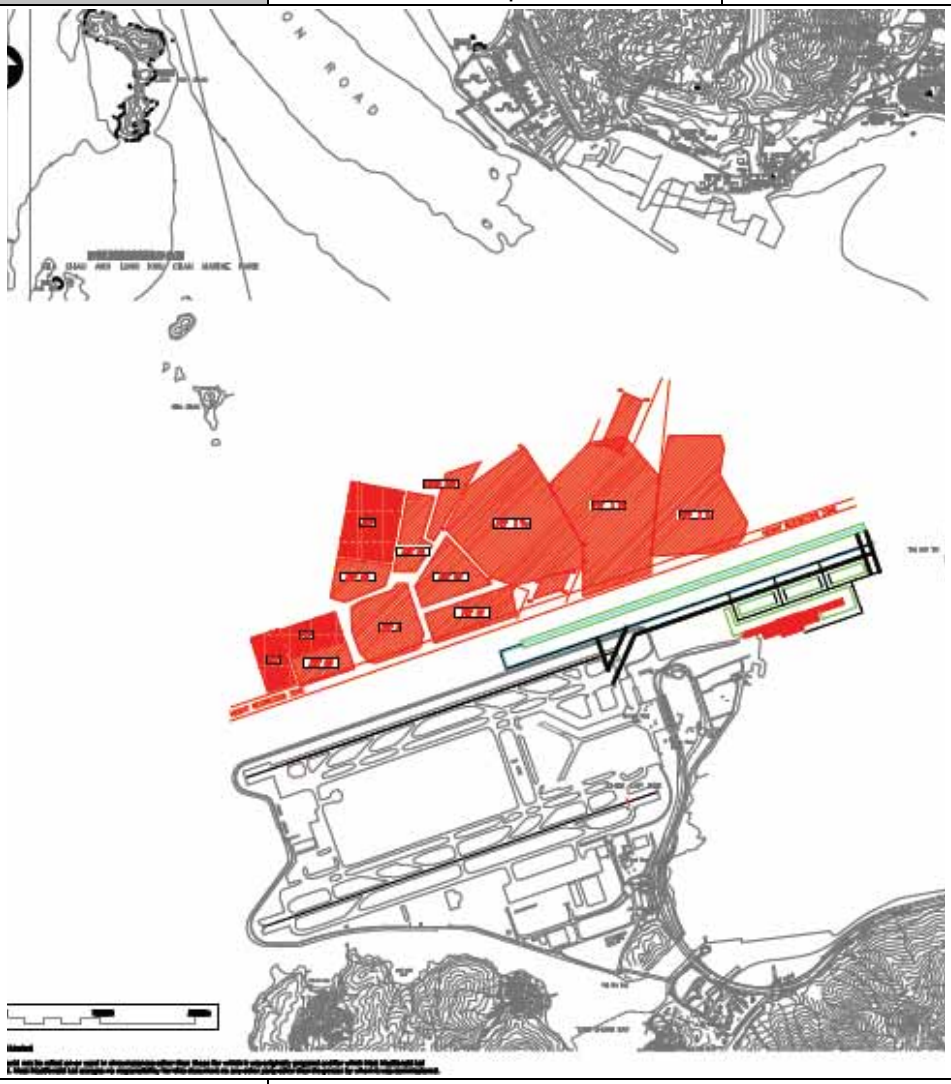
Note: The integration of this traffic into the PRD airspace, particularly the interaction with Shenzhen will require additional work that has yet to be undertaken.

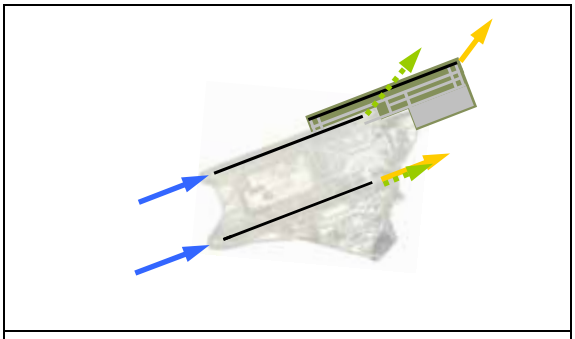
New Runway	
Length	3800m
Offset	N/A
Stagger	N/A
Taxiways	
Parallel	Twin to new runway.
Cross-field	None.
New Apron	Full access from new runway.
Existing T1 Apron	No access to new runway.
Mid-field Apron	No access to new runway.
Existing Cargo Apron	No access to new runway.
Taxiing Complexity	There is no change to the taxiing distances due to the new runway being a stand alone facility.
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length).
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Almost impossible due to remote location of new stand alone facility.
Existing Terminals to New Terminal (landside)	As surface access.

New Terminal to Piers	All options possible. Selection to best fit relevant dimensions.
Cargo Centre to New Apron	New facility required.
Passenger Terminal	
Configuration	Terminal space available is unconstrained, within reasonable limits. The final layout may require the new 05/23 runway to be positioned further south than shown above.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length).
Surface Access	
Road	Existing land access limited, new surface access links would need to be constructed to the new airport. tunnel required to service new airport facility.
Rail	
Sea	New ferry terminal.
Ancillary Facilities	
Aircraft Maintenance	New Facility Required.
Cargo	New Facility Required.
ATC	New Facility Required.
Fuel	New Facility Required.
Shipping Lanes	Airport site adjacent to busy sea channel.
Construction	
Mud Pits	There are no Mud Pits located in the area.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. Sea bed levels along Urmston Road very deep -20mpd. TSW Borrow Pits, located to the north east of airport site, exact position not known. Pits not thought to be contaminated. Airport located adjacent to Black Point Gas Fired Power Station and the pipeline serving the power station runs close to the end of the runway, exact position not known.
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages at Lung Kwu Shueng Tan.
Ecology	Disturb Seagrass bed and Horseshoe crab nesting sites at Ha Pak Nai. Disturb Intertidal species at Pak Nai Site of Specific Scientific Interest. Impact on marine life at Urmston Road (mainly dolphins as Urmston Road is the Indo-Pacific Humpback Dolphin

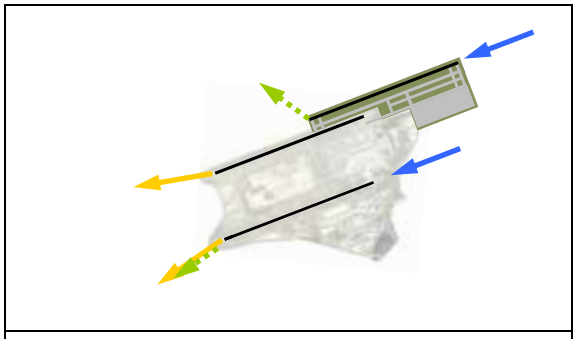
	Feeding Ground). Affect water quality of seawater intake at Black Point Power Station. Change to current flow at Lung Kwu Sheung Tan resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Lung Kwu Sheung Tan.
Summary	
	Option M is a full length runway to the north of the existing airport. Due to the remote location of the new airport there is no impact on the mud pits or shipping lanes. The sea depth is currently unknown; however it is understood to be significant (10-20m). The new earth structure will impact on both marine life and sea currents including a sea grass bed and the Horseshoe crab nesting site at Ha Pak Nai, more importantly the new airport island will disturb the inter-tidal species at Pak Nai (SSSI). The proposed location of option M is adjacent to Black Point power station and will require significant highway and rail investment to connect the new airport to with CLK and Hong Kong. The runway is independent from the existing airport, potentially offering the highest capacity increase. The challenge of integrating the flight paths into the PRD airspace will be significant, particularly the interaction with Shenzhen.

8.12 Option N Eastern Staggered, Close Spaced, Parallel Runway

Option N	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: >= 380m
		
General Description	A parallel runway with a separation of at least 380m plus a stagger of approximately 3000m to enable the aprons and terminal to be located adjacent to the runaway.	



Option N Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Departures	24
07C	Arrivals	24
07R	Mixed	34
Total		**82**
Increase		**14**



Option N Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Arrivals	33
25C	Departures	35
25L	Mixed	34
Total		**102**
Increase		**34**

Note1: In the Runway 25 direction, this mode of operations requires a terrain safe approach. The Runway 07 direction requires a terrain safe departure. If either of these operations is not possible, the new runway is not useable, resulting in no capacity increase.

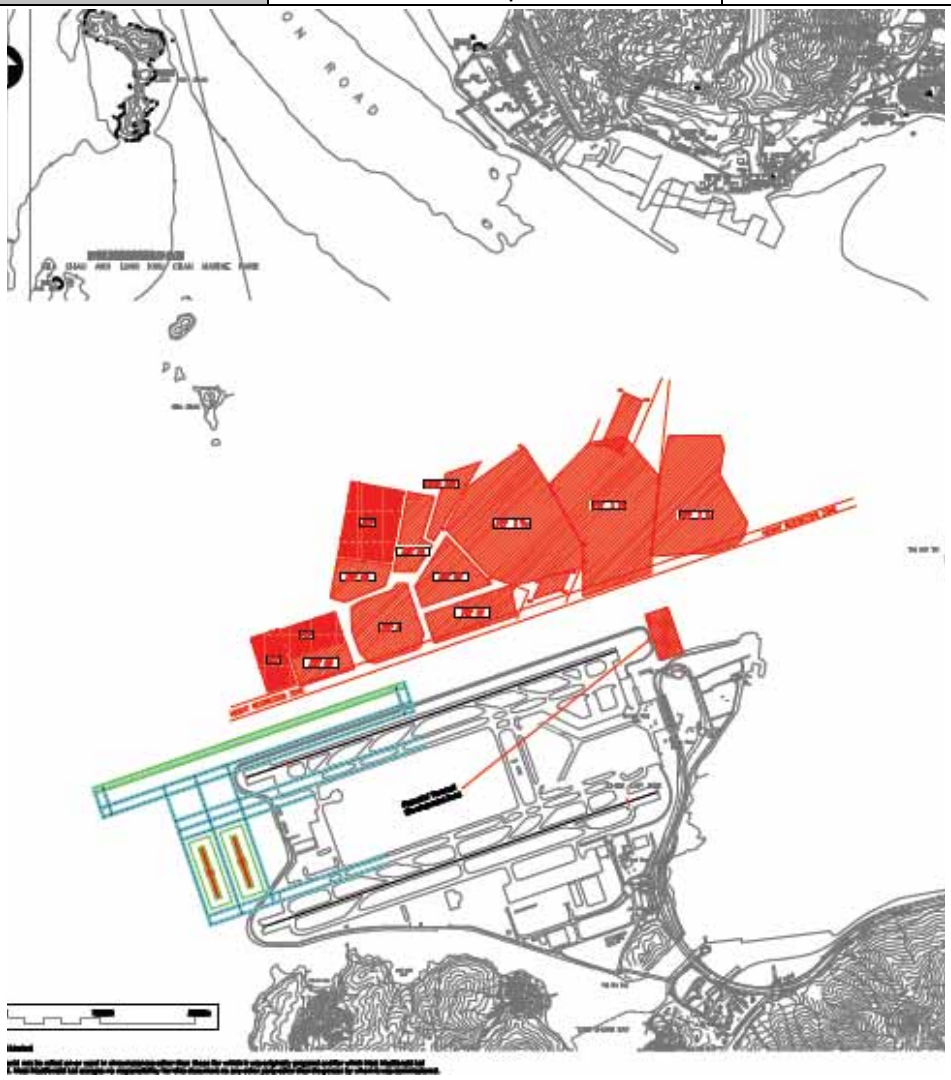
Note2: In the Runway 07 direction the existing north runway and the new runway are dependent.

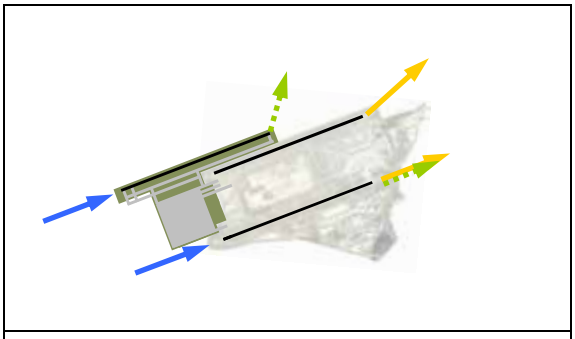
New Runway		
Length	3800m	
Offset	>=380m	
Stagger	3000m	
Taxiways		
Parallel	Twin to new runway.	
Cross-field		
New Apron	Limited access to existing 07R/25L.	
Existing T1 Apron	Limited access to new runway.	
Mid-field Apron	Limited access to new runway.	
Existing Cargo Apron	No normal access to new runway.	
Taxiing Complexity	**Compass Mode**	**Terminal Mode**
Normal Operations	Complex taxiway arrangement between 07C/25C and 07L/25R.	Minimal Complexity.
With Runway Closures	Long distances from existing aprons to start of the new Rwy07/25. Long distances from new apron to Rwy 07L/25R.	

Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). New apron at East or West end to size required.
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Difficult due to intervening taxiways between core processor and satellites and other terminals. Distance mandates APM. Coaching only back-up possible. Airside road link also required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	Terminal core and piers at opposite ends of runways.
Cargo Centre to New Apron	Airside road access from existing cargo area also required.
Passenger Terminal	
Configuration	Core processor and satellites at opposite ends of runway this will require APM to run approximately 4.5km between processor and satellites.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length).
Surface Access	
Road	Extension of existing road and rail should be simple as new terminal is adjacent to existing conference centre.
Rail	
Sea	
Ancillary Facilities	
Aircraft Maintenance	Good taxiway connection for occasional use.
Cargo	Long journey times from existing cargo centre to new apron.
ATC	New ATC Tower may be required.
Fuel	New facilities required for new apron.
Shipping Lanes	Shipping lanes are not obstructed by the construction of the new runway and associated taxiways.
Construction	
Mud Pits	The construction avoids the Mud Pits.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. The western cross taxiways will be subject to a high degree of exposure and wave action. The fuel farm will be cut off from the Island fuel farm.

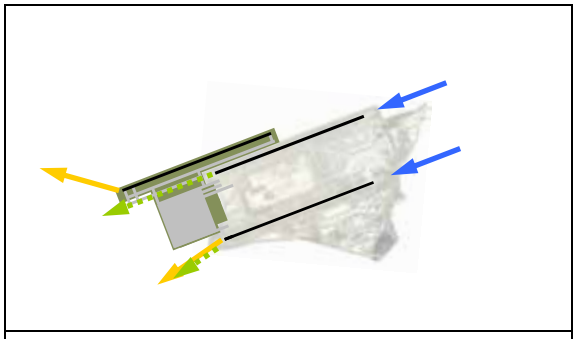
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages in Tai Ho.
Ecology	Disturbance to Horseshoe Crab Area near Sham Wat Wan Minor change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Minor impact on marine life at North Lantau (mainly dolphins and porpoises).
Summary	
	Option N is a 380m separation parallel runway that requires a new terminal to be constructed adjacent to the existing exhibition centre; providing a 380m separation runway should allow the land reclamation to avoid overlaying the mud pits. The new runway and associated apron has limited impact on the shipping channel, current flow and marine life. Surface access to the new terminal can be achieved by a relatively simple extension to the existing system. The position of the new runway would require some over flying of the proposed runway during certain operational events. The northern pair of runways are dependant, limiting the potential capacity increase. Terrain safe approach and departure/missed approach paths need to be devised for the new runway.

8.13 Option S Western Staggered, Close Spaced Parallel Runway

Option S	Hong Kong International Airport Third Runway Study Other Options	Parallel Runway Runway Separation: >= 380m
		
General Description	A parallel runway with a separation of at least 380m plus a stagger of approximately 2000m to enable the aprons and satellites to be located behind the maintenance facility with the terminal located either to the north east of the existing terminal or adjacent to the new aprons.	



Option S Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	33
07C	Departures	35
07R	Mixed	34
Total		**102**
Increase		**34**



Option S Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Mixed	24
25C	Arrivals	24
25L	Departures	34
Total		**82**
Increase		**14**

Note: In the Runway 25 direction the existing north runway and the new runway are dependent.

New Runway		
Length	3800m	
Offset	>=380m	
Stagger	2000m	
Taxiways		
Parallel	Twin to new runway.	
Cross-field	Three cross field taxiways accessing new apron and both of the existing taxiways.	
New Apron	Access to existing 07R/25L.	
Existing T1 Apron	Limited access to new runway.	
Mid-field Apron	Access to new runway.	
Existing Cargo Apron	Limited access to new runway.	
Taxiing Complexity	**Compass Mode**	**Terminal Mode**
Normal Operations	Minimal Complexity.	Minimal Complexity.
With Runway Closures	Long distances from existing aprons to start of the new Rwy07/25.	
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length).	

Airside Connectivity	
Existing Terminals to New Terminal (airside)	Difficult due to Landside areas between terminal areas and intervening taxiways. Distance mandates APM. Coaching only back-up possible. Airside road link also required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	All options possible. Selection to best fit relevant dimensions.
Cargo Centre to New Apron	Airside road access from existing cargo area also required, but distance and travel time will limit its usefulness for most cargo.
Passenger Terminal	
Configuration	Limited space for apron and terminals if without increasing runway separation.
Size	Terminal size and concept kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length).
Surface Access	
Road	Extension of existing road and rail should be simple as new terminal is adjacent to existing conference centre.
Rail	
Sea	Access from existing ferry terminal.
Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	Long journey times from existing cargo centre to new apron.
ATC	New ATC Tower may be required. Threshold Rwy 25R possibly obscured by existing terminal from existing VCR.
Fuel	New facilities required for new apron.
Shipping Lanes	Shipping lanes are not obstructed by the construction of the new runway and associated taxiways.
Construction	
Mud Pits	The construction avoids the mud pits.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. Possible integration with the proposed immersed tube road tunnel and the Tuen Mun – Chep Lak Kok toll plaza. Original design for the Tsing Lung Bridge was amended to accommodate the aeronautical surfaces relating to the existing HKIA runways, the proposed eastern stagger could create further restrictions upon the design.

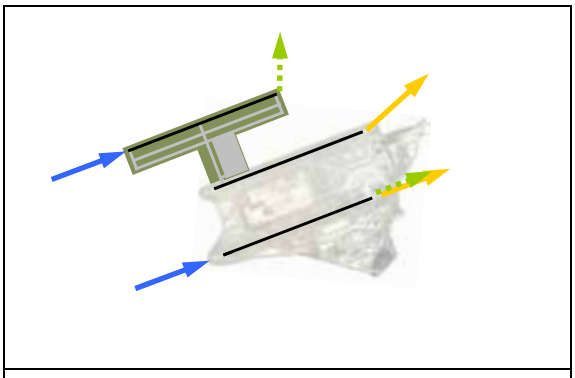
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages in Tai Ho.
Ecology	Impact on marine life at North Lantau (mainly fish attracted by the artificial reef and dolphins and porpoises). Least impact of options considered.
Summary	
	Option S is a 380m separation parallel runway that requires a new terminal to be constructed adjacent to the existing fuel farm. Providing a 380m separation runway should allow the land reclamation to avoid overlaying the mud pits. The new runway and associated apron has limited impact on the shipping channel, current flow and marine life. Surface access to the new terminal could be achieved by wrapping an extension to the existing rail link and highway around the southern and western parts of the existing airport island. The new apron and terminal will sever access to the existing fuel farm. The northern pair of runways are dependant, limiting the potential capacity increase.

9 DETAILED OPTIONS

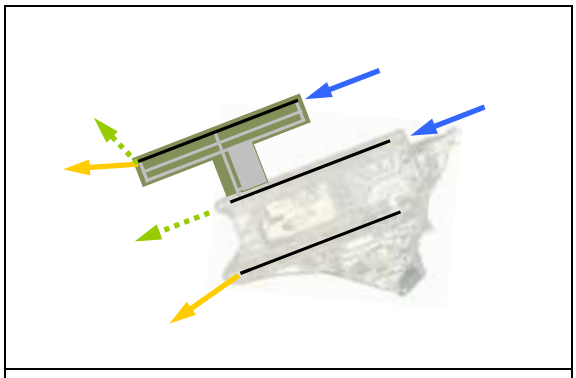
This section describes in detail the 3 options that have been selected in the down selection process, including a number of variants.

9.1 Option P Wide Spaced Parallel Runway (2240m) Offset to the West

Option P	Hong Kong International Airport Third Runway Study Detailed Options	Parallel Runway Runway Separation: 2240m
		
General Description	A parallel runway, with a westerly stagger of 2000m to enable the terminal and aprons to be provided outside the mud pits. The runway has been shortened to ensure that the approach lights do not enter Chinese Territorial Waters.	



Option P Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	33
07C	Departures	35
07R	Mixed	34
Total		**102**
Increase		**34**



Option P Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Mixed	44
25C	Arrivals	33
25L	Departures	35
Total		**112**
Increase		**44**

Note: In the Runway 25 direction the existing north runway and the new runway are dependent.

New Runway		
Length	3446m	
Offset	2240m	
Stagger	2000m	
Climb Gradients		
Procedure	Speed Limit	Climb Gradient
07L Missed App 45 Left		6.6%
07L Missed App 135 Left	185 knots	4.4%
07L Missed App 135 Left	200 knots	4.4%
25R Missed App 45 Right		2.8%
25R SID 15 Right		3.3%
07L SID 15 Left*		8.6%
* Runway not normally used for departures as proposed for 3-runway operations		
Taxiways		
Parallel	Twin Code F to new runway.	
Cross-field	Single from new runway and apron to existing airport site.	
New Apron	Limited access to existing 07R/25L.	
Existing T1 Apron	Limited access to new runway.	
Mid-field Apron	Limited access to new runway.	
Existing Cargo Apron	No normal access to new runway.	

Taxiing Distances	Start 07L	Start 07C	Start 07R	Start 25L	Start 25C	Start 25R
T1 Apron (North)	8514	3814	4686	2668	958	9048
T1 Apron (South)	8758	4390	4594	745	3278	9409
T2 (mid-field) Apron	8042	2938	3589	1854	2089	8186
T3 Apron	2858	2317	4623	7061	5860	2886
Main Cargo Apron	8322	4053	3063	1217	4809	9191
	Measured from centre of apron to runway end along taxiways. Distances are not weighted by frequency of use.					

Taxiing Complexity	Compass Mode	Terminal Mode
Normal Operations	Simple cross field taxiway connects 07L/25R and the existing runways.	Minimal Complexity.
With Runway Closures	Long distances from existing aprons to start of the new Rwy07/25. Long distances from new apron to Rwy 07L/25R.	

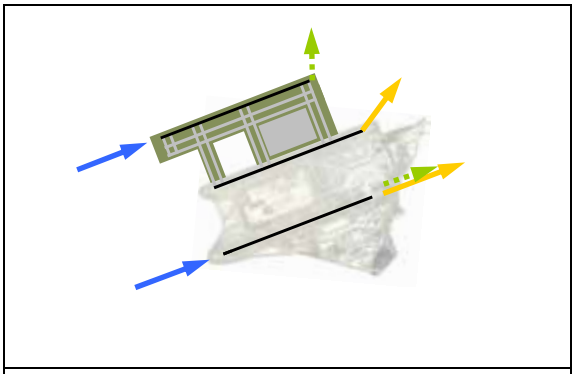
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). Apron frontage approximately 4km for 44 Code F equivalent stands.
Airside Connectivity	
Existing Terminals to New Terminal (airside)	Difficult due to intervening runways and taxiways together with the location at the extreme end of existing runway 07L/25R. Distance mandates APM. Coaching only back-up possible. Airside road link also required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	All options possible. Selection to best fit relevant dimensions.
Cargo Centre to New Apron	Airside road access from existing cargo area also required, but distance and travel time will limit its usefulness for most cargo.
Passenger Terminal	
Configuration	A linear terminal and pier configuration is assumed to best fit available space and minimise cost.
Size	Terminal size and concept kept constant for all options unless a specific constraint on the terminal size or configuration.
Surface Access	
Road	Road and rail to be expanded around the northern end of the existing airport site. Consideration should be given to
Rail	

	avoiding the approach and departure surfaces for runway 25R/07L.
Sea	
Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection for occasional use.
Cargo	Possible new cargo facility required, suitable locations are available for the new facility adjacent to the new terminal and apron.
ATC	New ATC Tower may be required.
Fuel	New facilities required for new apron.
Landside	Land side facilities will have to be re-provided. Potential areas adjacent to new terminal are available for landside development.
Shipping Lanes	Shipping lanes narrowed due to extent of separation between runways, plus potential impact on the north/south shipping lane that lies to the west of the airport.
Construction	
Mud Pits	The construction has minimal impact upon the Mud Pits.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. The western cross taxiways will be subject to a high degree of exposure and wave action.
Territorial Waters	All physical works lie within the HKG territorial waters. If the maritime exclusion zone is increased in line with current practice this would extend into Chinese Mainland waters. However, current practice appears to be conservative and safeguard for vessels with an air draft of (circa) 55m rather than the stated 30m.
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages in Tai Ho.
Ecology	Change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Impact on marine life at North Lantau (mainly dolphins and porpoises) and in the Shau Chau and Lung Kwu Chau Marine Park (mainly dolphins and fish attracted by the artificial reef).

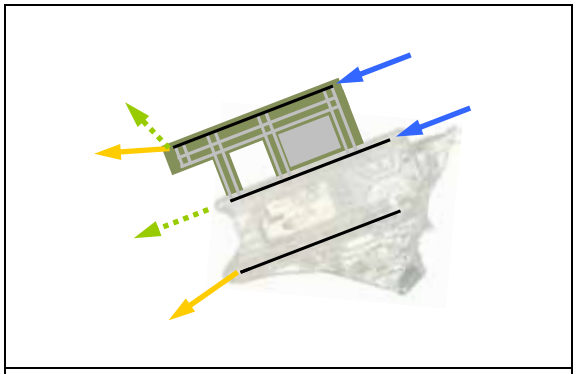
Potential Air Traffic Issues	
ILS	ILS and or alternative technology required to support parallel and/or staggered approaches outside 10nm from touchdown
SOIR Compliance Issues* *See Table 6.1	07L Missed Approach v 07C SID 07C SID v 07R SID & Missed Approach 07R SID v 07R Missed Approach 07L and 07R parallel approaches 25R Missed Approach v 25R SID 25C Missed Approach v 25R SID and 25L SID 25R and 25C parallel approaches
Wake Vortex	No issues identified
Summary	
	A parallel runway, with a westerly stagger of 2000m to enable the terminal and aprons to be provided outside the mud pits. The runway has been shortened to ensure that the approach lights do not enter Chinese Territorial Waters. Connections between the new terminal, the existing terminals and landside access are quite difficult due to the distances involved and the need to cross the approach and departure surfaces of the centre runway. In the Runway 25 direction segregated mode on the existing runways and a high density mixed mode operation on the new runway would provide the highest capacity. In the Runway 07 direction, the conflict between the Runway 07L and Runway 07C SIDs means that the new runway is used for landing only.

9.2 Option R Parallel Runway at 1525m Offset to the West

Option R	Hong Kong International Airport Third Runway Study Detailed Options	Parallel Runway Runway Separation: 1525m
		
General Description	A parallel runway positioned with a western stagger of approximately 1430m. The terminal and apron facilities can be provided in mid field zone.	



Option R Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	33
07C	Departures	35
07R	Mixed	34
Total		**102**
Increase		**34**



Option R Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Mixed	44
25C	Arrivals	33
25L	Departures	35
Total		**112**
Increase		**44**

New Runway	
Length	3800m
Offset	1525m
Stagger	1430m

Climb Gradients		
Procedure	Speed Limit	Climb Gradient
07L Missed App 45 Left		6.8%
07L Missed App 135 Left	185 knots	4.4*%
07L Missed App 135 Left	200 knots	4.4*%
25R Missed App 45 Right		2.6%
25R SID 15 Right		3.3%
07L SID 15 Left **		5.8%

* Missed approaches were all constructed based on 5.0% obstacle assessment surfaces. Missed approach climb gradients less than 5.0% would need to be recalculated using appropriate obstacle assessment surfaces.
** Runway not normally used for departures as proposed for 3-runway operations

Taxiways	
Parallel	Twin Code F to new runway.
Cross-field	Three pairs of twin taxiways from new runway and apron to existing airport site.
New Apron	Access to existing 07R/25L.
Existing T1 Apron	Access to new runway.
Mid-field Apron	Access to new runway.
Existing Cargo Apron	Access to new runway.

Taxiing Distances	Start 07L	Start 07C	Start 07R	Start 25L	Start 25C	Start 25R
T1 Apron (North)	6642	3814	4686	2668	958	3209
T1 Apron (South)	7718	4390	4594	745	3278	3904
T2 (mid-field) Apron	5809	2938	3589	1854	2089	3026
T3 Apron	3102	2049	4623	4161	3248	1939
Main Cargo Apron	6960	4053	3063	1217	4809	5155
	Measured from centre of apron to runway end along taxiways. Distances are not weighted by frequency of use.					

Taxiing Complexity	Compass Mode	Terminal Mode
Normal Operations	Three pairs of cross field taxiways connect the new runway with the existing site.	Minimal Complexity.
With Runway Closures	Long distances from existing aprons to start of the new Rwy07/25. Long distances from new apron to Rwy 07L/25R.	

Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). Apron frontage approximately 4km for 44 Code F equivalent stands. Expansion only practical to the southwest of the terminal zone.

Airside Connectivity	
Existing Terminals to New Terminal (airside)	Difficult due to intervening runways and taxiways. Distance mandates APM. Coaching only back-up possible. Airside road link also required.
Existing Terminals to New Terminal (landside)	As surface access.
New Terminal to Piers	All options possible. Selection to best fit available space and minimise cost.
Cargo Centre to New Apron	Airside road access from existing cargo area also required, but distance and travel time will limit its usefulness for most cargo.

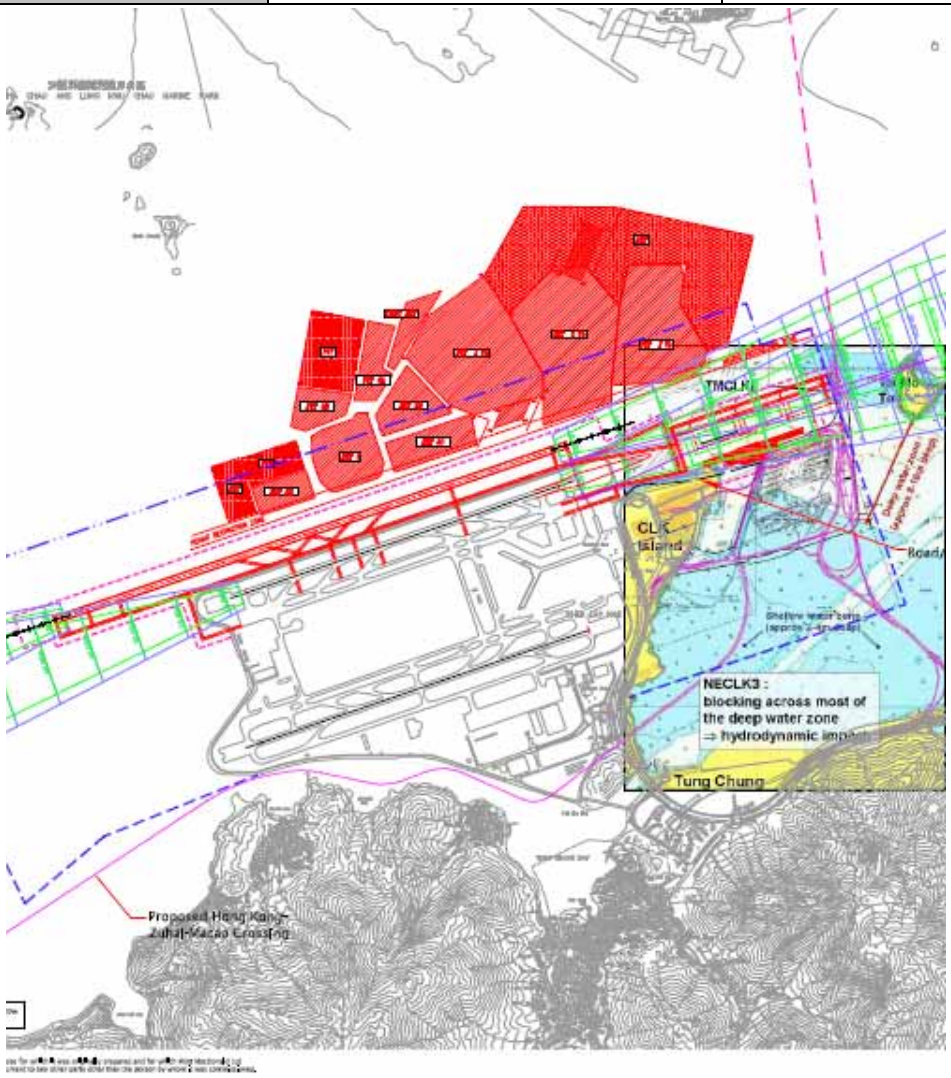
Passenger Terminal	
Configuration	A linear terminal and pier configuration is assumed. If alterations to the taxiway system can be made then a toast rack arrangement could be implemented.
Size	Terminal size and concept kept constant for all options unless a specific constraint on the terminal size or configuration.

Surface Access	
Road	Road and rail to be expanded around the northern end of the existing airport site. Consideration should be given to avoiding the approach and departure surfaces for runway 25R/07L. The major constraint is the dual taxiways that surround the terminal site.
Rail	
Sea	Use of existing Skypier.
Ancillary Facilities	
Aircraft Maintenance	Adequate taxiway connection.
Cargo	Possible new cargo facility required. Long journey times from existing cargo centre to new apron.
ATC	New ATC Tower may be required.
Fuel	New facilities required for new apron.
Landside	No real location exists for a landside area that is close to the new terminal, unless an area to the east of the proposed dual cross taxiways can be feasibly developed.
Shipping Lanes	Shipping lanes narrowed due to extent of separation between runways, plus potential impact on the north/south shipping lane that lies to the west of the airport.
Construction	
Mud Pits	Overlay of the mud pits will require the disposal of displaced contaminated mud.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. The western cross taxiways will be subject to a high degree of exposure and wave action. The eastern cross taxiways will be exposed to the north eastern Monsoon and the resulting winds will have a long Fetch (circa 15km). The wave and monsoon action could be mitigated by using a viaduct solution; however the apron area will require land reclamation.
Territorial Waters	All physical works lie within the HKG territorial waters. If the maritime exclusion zone is increased in line with current practice this would extend into Chinese mainland waters. However, current practice appears to be conservative and safeguard for vessels with an air draft of (circa) 55m rather than the stated 30m.

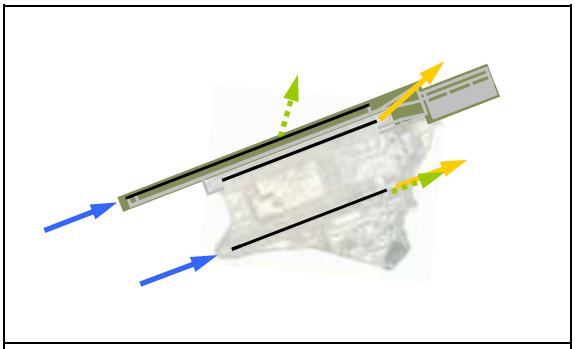
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages in Tai Ho.
Ecology	Disturb sediments in the mud pits resulting in deterioration of water quality affecting marine life Significant change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Impact on marine life at North Lantau (mainly dolphins and porpoises) and in the Shau Chau and Lung Kwu Chau Marine Park (mainly dolphins and fish attracted by the artificial reef).
Potential Air Traffic Issues	
ILS	ILS and or alternative technology required to support parallel and/or staggered approaches outside 10nm from touchdown
SOIR Compliance Issues* *See Table 6.2	07L Missed Approach v 07C SID 07C SID v 07R SID & Missed Approach 07R SID v 07R Missed Approach 07L and 07R parallel approaches 25R Missed Approach v 25R SID 25C Missed Approach v 25R SID and 25L SID 25R and 25C parallel approaches
Wake Vortex	No issues identified
Summary	
	A parallel runway positioned with a western stagger of approximately 1430m. The terminal and apron facilities can be provided in mid field zone. Connections between the new terminal, the existing terminals and landside access are quite difficult due to the distances involved and the need to cross the approach and departure surfaces of the centre runway and taxiways associated with the new terminal. In the Runway 25 direction segregated mode on the existing runways and a high density mixed mode operation on the new runway would provide the highest capacity. In the Runway 07 direction, the conflict between the Runway 07L and Runway 07C SIDs means that the new runway is used for landing only.

9.3 Option S Ext Var A & B Close Spaced Parallel Runway Extended to the West

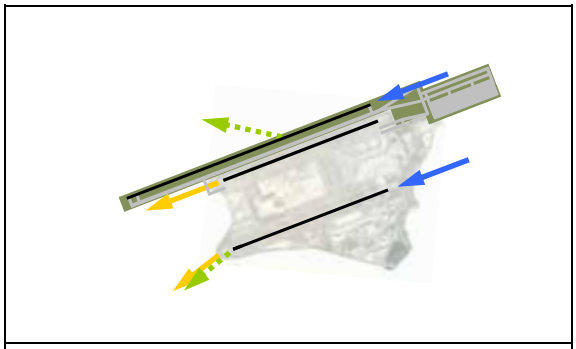
Option S Ext Variants A/B	Hong Kong International Airport Third Runway Study Detailed Options	Parallel Runway Runway Separation: 380m



General Description	A very long parallel runway with a separation of 380m. The 1889m stagger in the westerly direction provides close to SOIR compliance between the 07C SID and the 07L missed approach in respect of the runway offset. In the Runway 25 direction, the 25C SID and 25R missed approach are not SOIR compliant. Variant A differs from Variant B only by the orientation of the Boundary Crossing Facilities. There is no difference to any proposed airport related structure.



Option SExt AB Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	33
07C	Departures	35
07R	Mixed	34
Total		**102**
Increase		**34**



Option SExt AB Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Arrivals	33
25C	Departures	35
25L	Mixed	34
Total		**102**
Increase		**34**

New Runway	
Length	5689m
Offset	380m
Stagger	1889m

Climb Gradients		
Procedure	Speed Limit	Climb Gradient
07L Missed App 45 Left		6.1%
07L Missed App 135 Left	185 knots	3.6*%
07L Missed App 135 Left	200 knots	3.6*%
25R Missed App 45 Right		2.5%
25R SID 15 Right**		3.3%
07L SID 15 Left**		6.2%

* Missed approaches were all constructed based on 5.0% obstacle assessment surfaces. Missed approach climb gradients less than 5.0% would need to be recalculated using appropriate obstacle assessment surfaces.
** Runway not normally used for departures as proposed for 3-runway operations

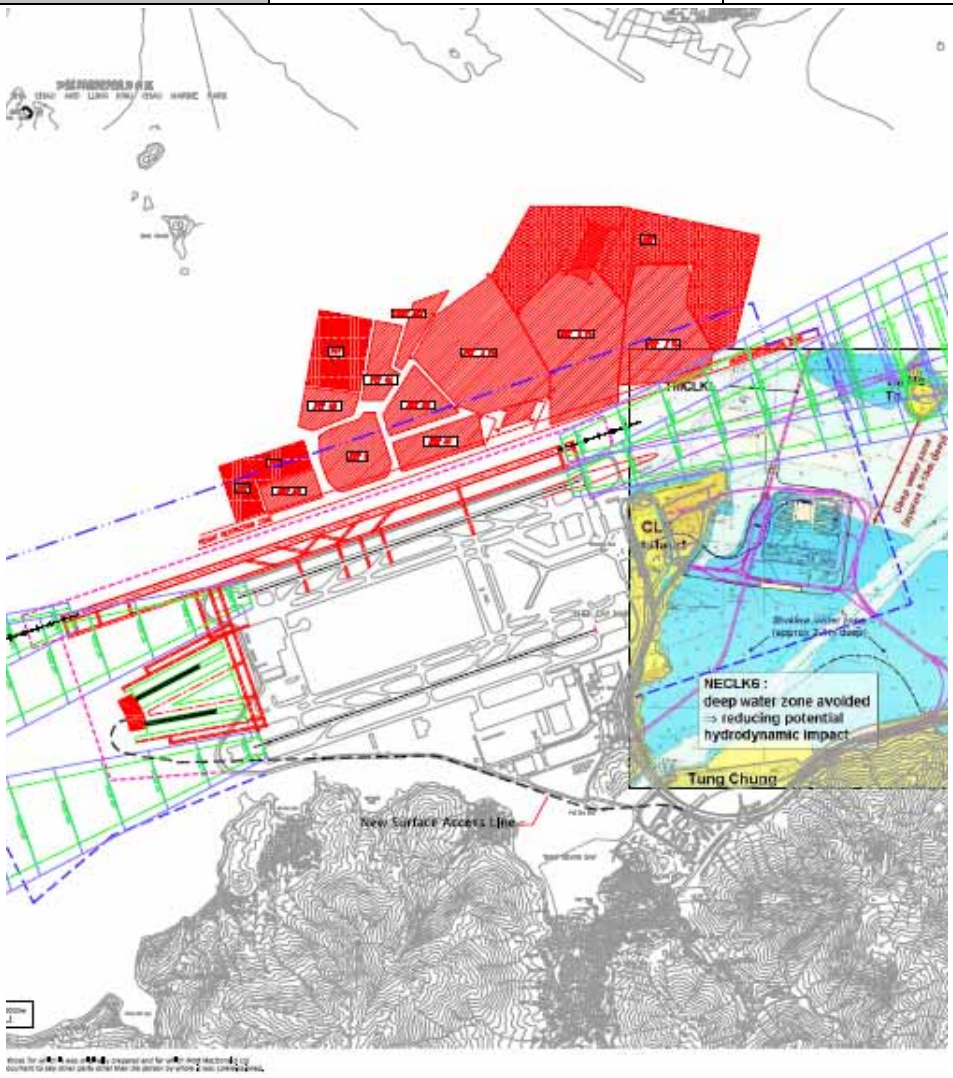
Taxiways	A taxiway between the runways allows landing traffic to access the terminal areas without crossing the centre runway.
Parallel	Single Code F to new runway.
Cross-field	Taxi around the end of the central runway, or multiple runway crossings accessing the existing aprons.
New Apron	Access to existing 07R/25L and new runway via central taxiway.
Existing T1 Apron	Access from new runway via taxiway around the end of the central runway, or runway crossings.
Mid-field Apron	Access from new runway via taxiway distances around the end of the central runway, or runway crossings.

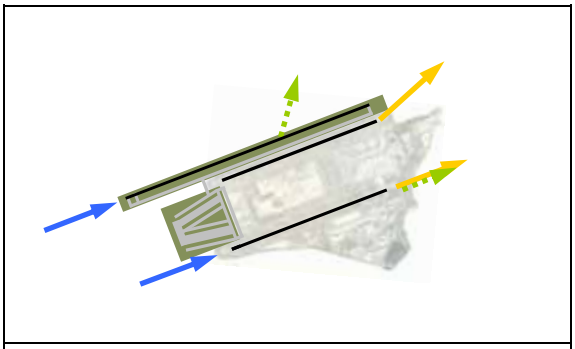
Existing Cargo Apron	Access via runway crossings.					
Taxiing Distances	**Start 07L**	**Start 07C**	**Start 07R**	**Start 25L**	**Start 25C**	**Start 25R**
T1 Apron (North)	6122	3814	4686	2668	958	3178
T1 Apron (South)	6829	4390	4594	745	3278	4037
T2 (mid-field) Apron	5688	2938	3589	1854	2089	2328
T3 Apron	8038	6622	8241	5961	2941	2713
Main Cargo Apron	6358	4053	3063	1217	4809	5378
	Measured from centre of apron to runway end along taxiways. Distances are not weighted by frequency of use.					
Taxiing Complexity	**Compass Mode**				**Terminal Mode**	
Normal Operations	Minimal Complexity.				Minimal Complexity.	
With Runway Closures	Short distances from existing aprons to start of the new Rwy07/25.					
Aprons	The apron zone for option Sx A&B has been reduced to 75% of the baseline due to a combination of development constraints to the East and South and Public Safety Zone concerns to the north. Apron frontage approximately 3km for 33 Code F equivalent stands.					
Airside Connectivity						
Existing Terminals to New Terminal (airside)	Proximity of new terminal to existing terminals should facilitate a high quality connection; however, the distance mandates APM. Coaching only back-up possible. Airside road link also required.					
Existing Terminals to New Terminal (landside)	As surface access, an integrated landside campus is possible.					
New Terminal to Piers	Fully integrated; however the space available is very tight and lends itself to a linear solution.					
Cargo Centre to New Apron	New apron will be difficult to access from the Cargo Centre.					
Passenger Terminal						
Configuration	Linear Configuration is required due to alignment of the site.					
Size	Terminal size and concept kept constant for all options unless a specific constraint on the terminal size or configuration.					

Surface Access	
Road	Extension of existing road and rail should be simple as new terminal is adjacent to existing conference centre, this will provide an integrated campus.
Rail	
Sea	Skypier may require relocation.
Ancillary Facilities	
Aircraft Maintenance	Good taxiway connection for occasional use.
Cargo	Long journey times from existing cargo centre to new apron a new cargo facility will be required for the new apron; however a suitable location is still to be found.
ATC	Existing ATC tower should be sufficient for the expanded airport.
Fuel	New facilities required for new apron.
Landside	Very limited areas adjacent to new terminal are available for landside development due to the proposed BCP.
Shipping Lanes	Shipping lanes are not obstructed by the construction of the new runway and associated taxiways, plus potential impact on the north/south shipping lane that lies to the west of the airport.
Construction	
Mud Pits	The construction avoids the Mud Pits.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud.
Territorial Waters	All physical works lie within the HKG territorial waters. If the maritime exclusion zone is increased in line with current practice this would extend into Chinese mainland waters. However, current practice appears to be conservative and safeguard for vessels with an air draft of 55m to the west and 65m to the east rather than the stated 30m.
Public Safety Zone	A proportion of the aircraft aprons would sit within the 10^{-5} contour of the PSZ should one ever be implemented.
Obstacle Surfaces	In order to ensure that the tailfins of taxiing aircraft do not infringe the Runway 25 APPS or the Runway 07C TOCS the taxiways to the north east of these runways have been angled to respect these surfaces. Where the resulting taxiways are arranged as a < they would not be used simultaneously, but singly dependent upon the prevailing direction of runway operation, controlled either by taxiway bars, or possibly physical exclusion methods.

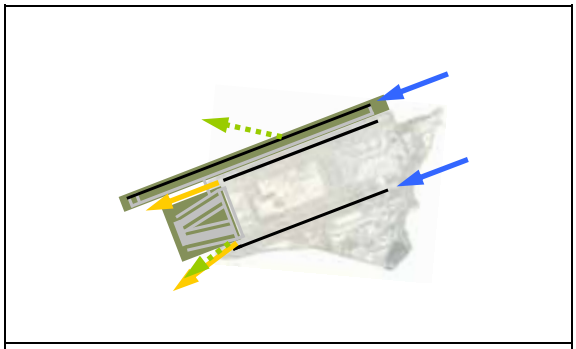
Boundary Crossing Facilities	In Variant A the BCF would clash with the new terminal unless the BCF can be moved slightly to the south. In Variant B it would appear that they can co-exist provided the portal for the TMCLKL is carefully designed. In either case the existence of the BCF will significantly inhibit the ability to develop ancillary support facilities.
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages in Tai O.
Ecology	Impact on marine life at North Lantau (mainly fish attracted by the artificial reef and dolphins and porpoises).
Potential Air Traffic Issues	
ILS	ILS and or alternative technology required to support parallel and/or staggered approaches outside 10nm from touchdown
SOIR Compliance Issues* *See Table 6.3	07L Missed Approach v 07C SID 07C SID v 07R SID & Missed Approach 07R SID v 07R Missed Approach 07L and 07R parallel approaches 25R Missed Approach v 25C SID 25C SID v 25L SID and 25L Missed Approach 25R and 25L parallel approaches
Wake Vortex	25R Missed Approach v 25C Departure 07L Missed Approach v 07C Departure
Summary	
	A very long parallel runway with a separation of 380m with a 1889m stagger in the westerly direction. The only difference between Variants A and B is the terminal configuration, and Variant B would appear to co-exist more easily with the BCF and the TMCLKL. Landside connectivity is excellent due to the ability to integrate the new terminal with the existing landside complex. The offset provides close to SOIR compliance between the Runway 07C SID and the Runway 07L missed approach in terms of the required stagger, but both flight paths turn in the same direction. In the Runway 25 direction, the 25C SID and 25R missed approach are not SOIR compliant. A safety justification will be required in order to operate the runways independently in the Runway 25 direction, otherwise the runways must be considered as dependant.

9.4 Option S Ext Var C Close Spaced Parallel Runway Extended to the West

Option S Ext Variant C	Hong Kong International Airport Third Runway Study Detailed Options	Parallel Runway Runway Separation: 380m
		
General Description	A very long parallel runway with a separation of 380m. The 1889m stagger in the westerly direction provides close to SOIR compliance between the 07C SID and the 07L missed approach in respect of the runway offset. In the Runway 25 direction, the 25C SID and 25R missed approach are not SOIR compliant.	



Option SExt C Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	33
07C	Departures	35
07R	Mixed	34
Total		**102**
Increase		**34**



Option SExt C Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Arrivals	33
25C	Departures	35
25L	Mixed	34
Total		**102**
Increase		**34**

New Runway	
Length	5689m
Offset	380m
Stagger	1889m

Climb Gradients		
Procedure	Speed Limit	Climb Gradient
07L Missed App 45 Left		6.1%
07L Missed App 135 Left	185 knots	3.6*%
07L Missed App 135 Left	200 knots	3.6*%
25R Missed App 45 Right		2.5%
25R SID 15 Right**		3.3%
07L SID 15 Left**		6.2%

* Missed approaches were all constructed based on 5.0% obstacle assessment surfaces. Missed approach climb gradients less than 5.0% would need to be recalculated using appropriate obstacle assessment surfaces.
** Runway not normally used for departures as proposed for 3-runway operations

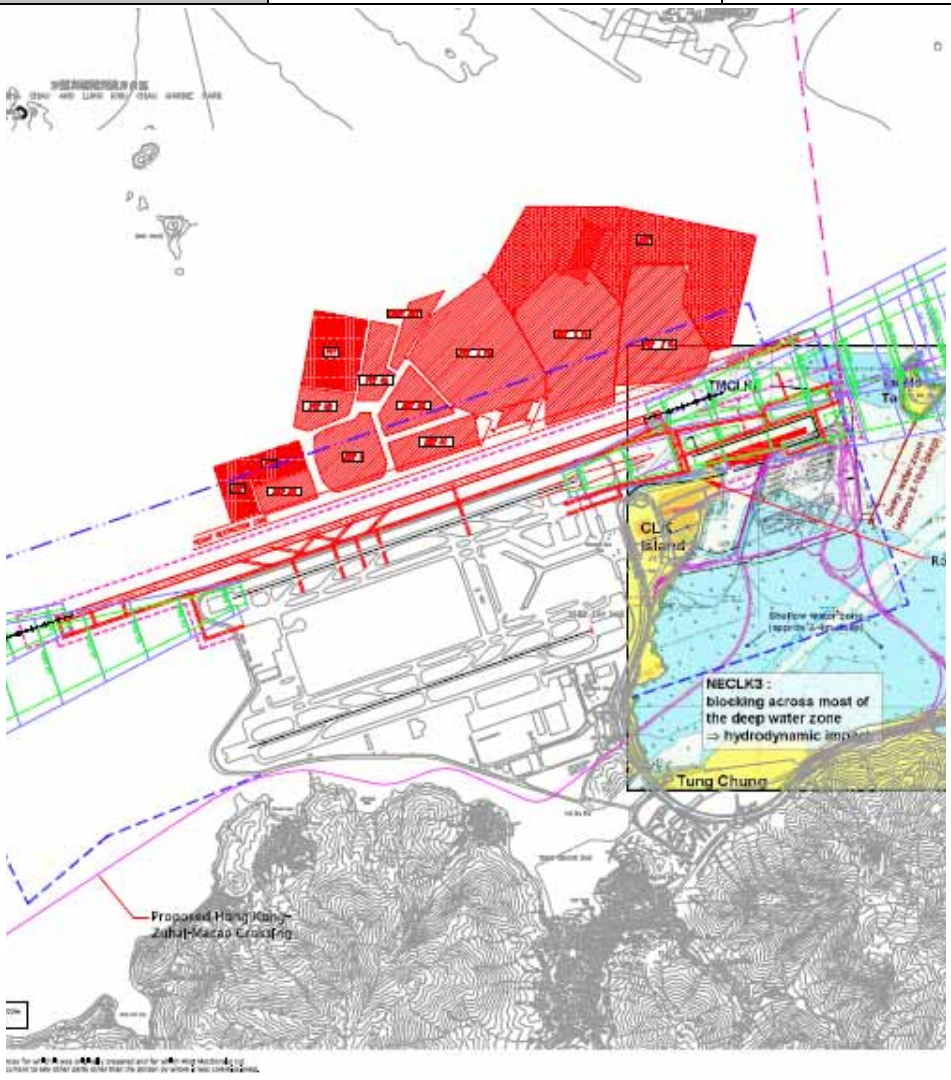
Taxiways	A taxiway between the runways allows landing traffic to access the terminal areas without crossing the centre runway.
Parallel	Single Code F to new runway.
Cross-field	Taxi around the end of the central runway, or multiple runway crossings accessing the existing aprons.
New Apron	Access to existing 07R/25L and 07L/25R. Access to new runway via central taxiway or runway crossings, impeded by 07C and 25C operational surfaces.
Existing T1 Apron	Access from new runway via taxiway around the end of the central runway, or runway crossings.

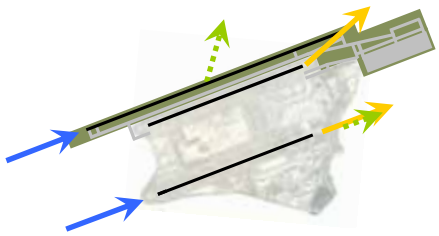
Mid-field Apron	Access from new runway via taxiway distances around the end of the central runway, or runway crossings					
Existing Cargo Apron	Access via runway crossings.					
Taxiing Distances	**Start 07L**	**Start 07C**	**Start 07R**	**Start 25L**	**Start 25C**	**Start 25R**
T1 Apron (North)	6642	3814	4686	2668	958	3209
T1 Apron (South)	7718	4390	4594	745	3278	3904
T2 (mid-field) Apron	5809	2938	3589	1854	2089	3026
T3 Apron	3182	1295	1307	5490	4875	5367
Main Cargo Apron	6960	4053	3063	1217	4809	5155
	Measured from centre of apron to runway end along taxiways. Distances are not weighted by frequency of use.					
Taxiing Complexity	**Compass Mode**				**Terminal Mode**	
Normal Operations	Minimal Complexity.				Minimal Complexity.	
With Runway Closures	Short distances from existing aprons to start of the new Rwy07/25.					
Aprons	Apron size kept constant for all options unless a specific reason for a difference (e.g. separate airfield, short haul runway length). Apron frontage approximately 4km for 44 Code F equivalent stands. Expansion limited unless the new terminal is positioned sufficiently far to the west to provide an expansion zone adjacent to the maintenance base.					
Airside Connectivity						
Existing Terminals to New Terminal (airside)	Difficult due to intervening Maintenance Centre, fuel farm and taxiways between new terminal and other terminals. Distance mandates APM. Coaching only back-up possible. Airside road link also required.					
Existing Terminals to New Terminal (landside)	As surface access. Journey time will be considerable.					
New Terminal to Piers	Terminal core and piers well integrated.					
Cargo Centre to New Apron	Airside road access from existing cargo area required and straightforward.					
Passenger Terminal						
Configuration	Nature of the site between the Obstacle Limitation Surfaces of the two runways lends it self to a rectilinear arrangement.					
Size	Terminal size and concept kept constant for all options unless a specific constraint on the terminal size or configuration. Significant development space is available.					

Surface Access	
Road	Expansion of the road and rail network will be required along the southern edge of the airport to allow a link to be provided to the new terminal.
Rail	
Sea	
Ancillary Facilities	
Aircraft Maintenance	Good taxiway connection for occasional use.
Cargo	Short journey times from existing cargo centre to new apron.
ATC	New ATC Tower may be required to see new apron and taxiways.
Fuel	New facilities required for new apron.
Landside	New facilities required for new apron and the fuel loading point relocated.
Shipping Lanes	Shipping lanes are not obstructed by the construction of the new runway and associated taxiways, plus potential impact on the north/south shipping lane that lies to the west of the airport.
Construction	
Mud Pits	The construction avoids the Mud Pits.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud. The fuel farm will be cut off from the Island fuel farm.
Territorial Waters	All physical works lie within the HKG territorial waters. If the maritime exclusion zone is increased in line with current practice this would extend into Chinese mainland waters. However, current practice appears to be conservative and safeguard for vessels with an air draft of 55m to the east and 65m to the west rather than the stated 30m.
Obstacle Surfaces	The piers and aprons have been arranged to respect the OLSs of the existing runways. In order to ensure that the tailfins of taxiing aircraft do not infringe the Runway 25 TOCS or the Runway 07C APPS the cross taxiways to the south west of the fuel farm and maintenance facilities will either have to operate effectively as runway crossings or be moved further to the west below the surfaces.

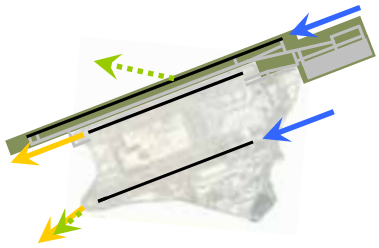
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages in Tai O.
Ecology	Disturbance to Horseshoe Crab Area near Sham Wat Wan Minor change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Minor impact on marine life at North Lantau (mainly dolphins and porpoises).
Potential Air Traffic Issues	
ILS	ILS and or alternative technology required to support parallel and/or staggered approaches outside 10nm from touchdown
SOIR Compliance Issues* *See Table 6.3	07L Missed Approach v 07C SID 07C SID v 07R SID & Missed Approach 07R SID v 07R Missed Approach 07L and 07R parallel approaches 25R Missed Approach v 25C SID 25C SID v 25L SID and 25L Missed Approach 25R and 25L parallel approaches
Wake Vortex	25R Missed Approach v 25C Departure 07L Missed Approach v 07C Departure
Summary	
	A very long parallel runway with a separation of 380m with a 1889m stagger in the westerly direction. In Variant C the terminal is located to the west of the island. This allows unlimited area for apron and terminal development, but creates significant connectivity problems, both airside and landside, due to the distance involved and the intervening airport infrastructure. The offset provides close to SOIR compliance between the Runway 07C SID and the Runway 07L missed approach in terms of the required stagger, but both flight paths turn in the same direction. In the Runway 25 direction, the 25C SID and 25R missed approach are not SOIR compliant. A safety justification will be required in order to operate the runways independently in the Runway 25 direction, otherwise the runways must be considered as dependant.

9.5 Option S Ext Var D Close Spaced Parallel Runway Extended to the East & West

Option S Ext Variant D	Hong Kong International Airport Third Runway Study Detailed Options	Parallel Runway Runway Separation: 380m
		
General Description	A very long parallel runway with a separation of 380m. The 1889m stagger in the westerly direction provides close to SOIR compliance between the 07C SID and the 07L missed approach in respect of the runway offset. In the Runway 25 direction, the additional 1000m offset over Variants A,B and C provides some additional separation between the 25C SID and 25R missed approach while not fully SOIR compliant.	



Option SExt D Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	33
07C	Departures	35
07R	Mixed	34
Total		**102**
Increase		**34**



Option SExt D Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Arrivals	33
25C	Departures	35
25L	Mixed	34
Total		**102**
Increase		**34**

New Runway	
Length	6689m
Offset	380m
Stagger	1889m/1000m

Climb Gradients		
Procedure	Speed Limit	Climb Gradient
07L Missed App 45 Left		6.1%
07L Missed App 135 Left	185 knots	3.6*%
07L Missed App 135 Left	200 knots	3.6*%
25R Missed App 45 Right		2.5%
25R SID 15 Right**		3.3%
07L SID 15 Left**		6.8%

* Missed approaches were all constructed based on 5.0% obstacle assessment surfaces. Missed approach climb gradients less than 5.0% would need to be recalculated using appropriate obstacle assessment surfaces.
** Runway not normally used for departures as proposed for 3-runway operations

Taxiways	A taxiway between the runways allows landing traffic to access the terminal areas without crossing the centre runway.
Parallel	Single Code F to new runway.
Cross-field	Taxi around the end of the central runway, or multiple runway crossings accessing the existing aprons.
New Apron	Access to existing 07R/25L. Access to new runway via central taxiway or runway crossings, impeded by 07C and 25C operational surfaces.
Existing T1 Apron	Access from new runway via taxiway around the end of the central runway, or runway crossings.
Mid-field Apron	Access from new runway via taxiway around the end of

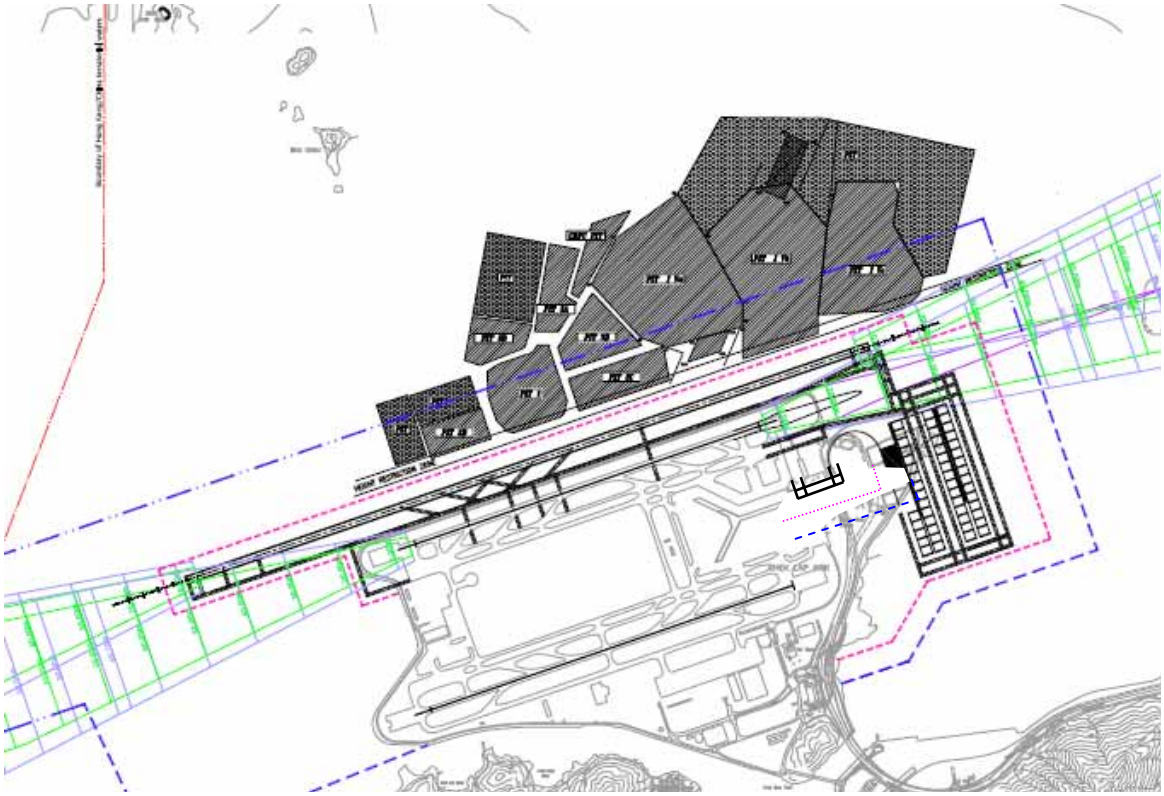
	the central runway, or runway crossings.					
Existing Cargo Apron	Access via runway crossings.					
Taxiing Distances	**Start 07L**	**Start 07C**	**Start 07R**	**Start 25L**	**Start 25C**	**Start 25R**
T1 Apron (North)	6055	3814	4686	2668	958	2771
T1 Apron (South)	6877	4390	4594	745	3278	4902
T2 (mid-field) Apron	5299	2938	3589	1854	2089	3966
T3 Apron	7938	6426	7577	5501	2778	1415
Main Cargo Apron	2604	4053	3063	1217	4809	6097
	Measured from centre of apron to runway end along taxiways. Distances are not weighted by frequency of use.					
Taxiing Complexity	**Compass Mode**				**Terminal Mode**	
Normal Operations	Minimal Complexity.				Minimal Complexity.	
With Runway Closures	Short distances from existing aprons to start of the new Rwy07/25.					
Aprons	The apron zone for Option S Extended Variant D has been reduced to 75% of the baseline due to a combination of constraints to the East and South and safety concerns to the north. Apron frontage approximately 3km for 33 Code F equivalent stands.					
Airside Connectivity						
Existing Terminals to New Terminal (airside)	Proximity of new terminal to existing terminals should facilitate a high quality connection; however, the distance mandates APM. Coaching only back-up possible. Airside road link also required.					
Existing Terminals to New Terminal (landside)	As surface access, an integrated landside campus is possible.					
New Terminal to Piers	Fully integrated; however the space available is very tight and lends itself to a linear solution.					
Cargo Centre to New Apron	New apron will be difficult to access from the Cargo Centre.					
Passenger Terminal						
Configuration	Linear Configuration					
Size	Terminal size and concept kept constant for all options unless a specific constraint on the terminal size or configuration.					

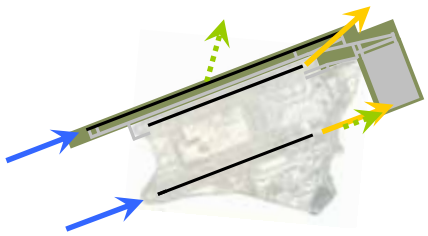
Surface Access	
Road	Extension of existing road and rail should be simple as new terminal is adjacent to existing conference centre, this will provide an integrated campus.
Rail	
Sea	Skypier may require relocation.
Ancillary Facilities	
Aircraft Maintenance	Good taxiway connection for occasional use.
Cargo	Long journey times from existing cargo centre to new apron a new cargo facility will be required for the new apron; however a suitable location is still to be found.
ATC	Existing ATC tower should be sufficient for the expanded airport.
Fuel	New facilities required for new apron.
Landside	Very limited areas adjacent to new terminal are available for landside development due to the proposed BCP.
Shipping Lanes	Shipping lanes are not obstructed by the construction of the new runway and associated taxiways, plus potential impact on the north/south shipping lane that lies to the west of the airport.
Construction	
Mud Pits	The construction avoids the Mud Pits.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud.
Territorial Waters	All physical works lie within the HKG territorial waters. If the maritime exclusion zone is increased in line with current practice this would extend into Chinese mainland waters. However, current practice appears to be conservative and safeguard for vessels with an air draft of 55m to the west and 65m to the east rather than the stated 30m.

Public Safety Zone	A proportion of the aircraft aprons would sit within the 10^{-5} contour of the PSZ should one ever be implemented.
Obstacle Surfaces	In order to ensure that the tailfins of taxiing aircraft do not infringe the Runway 25 APPS or the Runway 07C TOCS the taxiways to the north east of these runways have been angled to respect these surfaces. Where the resulting taxiways are arranged as a < they would not be used simultaneously, but singly dependent upon the prevailing direction of runway operation, controlled either by taxiway bars, or possibly physical exclusion methods.
Boundary Crossing Facilities	The terminal options in Variant D are similar to those in Variants A and B. As in Variant A the BCF would clash with the new terminal unless the BCF can be moved slightly to the south. In a design similar to Variant B it would appear that they can co-exist provided the portal for the TMCLKL is carefully designed.
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages in Tai O.
Ecology	Disturbance to Horseshoe Crab Area near Sham Wat Wan Minor change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Minor impact on marine life at North Lantau (mainly dolphins and porpoises).
Potential Air Traffic Issues	
ILS	ILS and or alternative technology required to support parallel and/or staggered approaches outside 10nm from touchdown
SOIR Compliance Issues* *See Table 6.3	07L Missed Approach v 07C SID 07C SID v 07R SID & Missed Approach 07R SID v 07R Missed Approach 07L and 07R parallel approaches 25R Missed Approach v 25C SID 25C SID v 25L SID and 25L Missed Approach 25R and 25L parallel approaches
Wake Vortex	25R Missed Approach v 25C Departure 07L Missed Approach v 07C Departure

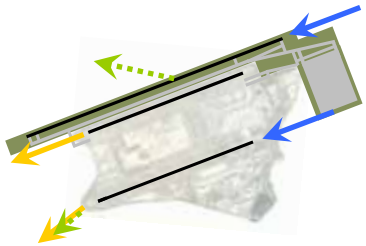
Summary	
	A very long parallel runway with a separation of 380m. In addition to the 1889m stagger in the westerly direction a further 1000m has been added in the easterly direction to provide a degree of SOIR compliance in both directions. The terminal options would be similar to Variants A and B. The offset provides close to SOIR compliance between the Runway 07C SID and the Runway 07L missed approach in terms of the required stagger, but both flight paths turn in the same direction. In the Runway 25 direction, the additional 1000m offset provides some additional separation between the Runway 25C SID and Runway 25R missed approach while not being fully SOIR compliant.

9.6 Option S Ext Var E Close Spaced Parallel Runway Extended to the East & West

Option S Ext Variant E	Hong Kong International Airport Third Runway Study Detailed Options	Parallel Runway Runway Separation: 380m
		
General Description	A very long parallel runway with a separation of 380m. The 1889m stagger in the westerly direction provides close to SOIR compliance between the 07C SID and the 07L missed approach in respect of the runway offset. In the Runway 25 direction, the additional 1000m offset over Variants A,B and C provides some additional separation between the 25C SID and 25R missed approach while not fully SOIR compliant. Extended terminal area due to relocation of the BCF.	



Option SExt E Runway 07 Direction		
Runway	**Use**	**Capacity**
07L	Arrivals	33
07C	Departures	35
07R	Mixed	34
Total		**102**
Increase		**34**



Option SExt E Runway 25 Direction		
Runway	**Use**	**Capacity**
25R	Arrivals	33
25C	Departures	35
25L	Mixed	34
Total		**102**
Increase		**34**

New Runway	
Length	6689m
Offset	380m
Stagger	1889m/1000m

Climb Gradients		
Procedure	Speed Limit	Climb Gradient
07L Missed App 45 Left		6.1%
07L Missed App 135 Left	185 knots	3.6*%
07L Missed App 135 Left	200 knots	3.6*%
25R Missed App 45 Right		2.5%
25R SID 15 Right**		3.3%
07L SID 15 Left**		6.8%

*Note: Missed approaches were all constructed based on 5.0% obstacle assessment surfaces. Missed approach climb gradients less than 5.0% would need to be recalculated using appropriate obstacle assessment surfaces.
** Runway not normally used for departures as proposed for 3-runway operations

Taxiways	A taxiway between the runways allows landing traffic to access the terminal areas without crossing the centre runway.
Parallel	Single Code F to new runway.
Cross-field	Taxi around the end of the central runway, or multiple runway crossings accessing the existing aprons.
New Apron	Access to existing 07R/25L. Access to new runway via central taxiway or runway crossings, impeded by 07C and 25C operational surfaces.
Existing T1 Apron	Access from new runway via taxiway around the end of the central runway, or runway crossings.
Mid-field Apron	Access from new runway via taxiway around the end of

	the central runway, or runway crossings.					
Existing Cargo Apron	Access via runway crossings.					
Taxiing Distances	**Start 07L**	**Start 07C**	**Start 07R**	**Start 25L**	**Start 25C**	**Start 25R**
T1 Apron (North)	6055	3814	4686	2668	958	2771
T1 Apron (South)	6877	4390	4594	745	3278	4902
T2 (mid-field) Apron	5299	2938	3589	1854	2089	3966
T3 Apron	9309	6873	8347	6575	3155	2536
Main Cargo Apron	2604	4053	3063	1217	4809	6097
	Measured from centre of apron to runway end along taxiways. Distances are not weighted by frequency of use.					
Taxiing Complexity	**Compass Mode**				**Terminal Mode**	
Normal Operations	Minimal Complexity.				Minimal Complexity.	
With Runway Closures	Short distances from existing aprons to start of the new Rwy07/25.					
Aprons	Aprons have been kept constant for all options unless there is a specific constraint on the apron capacity or configuration. Option S Extended Variant E assumes the BCF has been relocated to allow sufficient apron space to be made available.					
Airside Connectivity						
Existing Terminals to New Terminal (airside)	Proximity of new terminal to existing terminals should facilitate a high quality connection; however, the distance mandates APM. Coaching only back-up possible. Airside road link also required.					
Existing Terminals to New Terminal (landside)	As surface access, an integrated landside campus is possible.					
New Terminal to Piers	Fully integrated with a series of satellites connected by an APM.					
Cargo Centre to New Apron	New apron will be difficult to access from the Cargo Centre.					
Passenger Terminal						
Configuration	Satellite terminal arrangement.					
Size	Terminal size and concept kept constant for all options unless a specific constraint on the terminal size or configuration.					

Surface Access	
Road	Road and Rail expansion will require realignment of the railway track and removal of the pinched loop, a new close loop can e installed for both road and rail.
Rail	
Sea	Ferry port will require relocation.
Ancillary Facilities	
Aircraft Maintenance	Good taxiway connection for occasional use.
Cargo	Long journey times from existing cargo centre to new apron a new cargo facility will be required for the new apron. The new facility could be provided to the south of the new terminal.
ATC	There may be sightline issues from the existing ATC tower to the new aprons.
Fuel	New facilities required for new apron.
Landside	Significant potential for landside development exists to the south and west of the new terminal, depending on the position of the relocated BCF.
Shipping Lanes	Shipping lanes are not obstructed by the construction of the new runway and associated taxiways, plus potential impact on the north/south shipping lane that lies to the west of the airport.
Construction	
Mud Pits	The construction avoids the Mud Pits.
Reclamation	The exact depth of the sea bed is unknown at present; however it is known that the site underlain by marine mud.
Territorial Waters	All physical works lie within the HKG territorial waters. If the maritime exclusion zone is increased in line with current practice this would extend into Chinese mainland waters. However, current practice appears to be conservative and safeguard for vessels with an air draft of 55m to the west and 65m to the east rather than the stated 30m.

Public Safety Zone	The new terminal and apron are clear of an potential PSZ for runway 25C.
Obstacle Surfaces	In order to ensure that the tailfins of taxiing aircraft do not infringe the Runway 25 APPS or the Runway 07C TOCS the taxiways to the north east of these runways have been angled to respect these surfaces. Where the resulting taxiways are arranged as a < they would not be used simultaneously, but singly dependent upon the prevailing direction of runway operation, controlled either by taxiway bars, or possibly physical exclusion methods.
Boundary Crossing Facilities	In Variant E the BCF has been displaced to allow unrestricted development of the new terminal. The exact space available may be dependant on a revised location for the BCF.
Environment	
Noise	Aircraft noise nuisance and visual pollution to villages in Tai O.
Ecology	Disturbance to Horseshoe Crab Area near Sham Wat Wan Minor change to current flow at Tuen Mun and North Lantau resulting in change in deposition along the coastlines affecting sedimentation and water quality on beaches at Tuen Mun (e.g. Butterfly Beach and beaches at Castle Peak Bay). Minor impact on marine life at North Lantau (mainly dolphins and porpoises).
Potential Air Traffic Issues	
ILS	ILS and or alternative technology required to support parallel and/or staggered approaches outside 10nm from touchdown
SOIR Compliance Issues* *See Table 6.3	07L Missed Approach v 07C SID 07C SID v 07R SID & Missed Approach 07R SID v 07R Missed Approach 07L and 07R parallel approaches 25R Missed Approach v 25C SID 25C SID v 25L SID and 25L Missed Approach 25R and 25L parallel approaches
Wake Vortex	25R Missed Approach v 25C Departure 07L Missed Approach v 07C Departure

Summary	
	A very long parallel runway with a separation of 380m. In addition to the 1889m stagger in the westerly direction a further 1000m has been added in the easterly direction to provide a degree of SOIR compliance in both directions. The possibility that the position of the BCF could be adjusted, or re-located, allows more flexibility in the terminal design and the ability for the apron to provide the full number of aircraft stands. The offset provides close to SOIR compliance between the Runway 07C SID and the Runway 07L missed approach in terms of the required stagger, but both flight paths turn in the same direction. In the Runway 25 direction, the additional 1000m offset provides some additional separation between the Runway 25C SID and Runway 25R missed approach while not being fully SOIR compliant.

10 RECOMMENDATIONS

RR1: Undertake additional work to identify solutions to all the relevant airspace issues.

RR2: Once a definitive design has been selected, undertake a design review to ensure that all obstacle clearance surfaces are appropriately protected and incorporated into the Airport Height Restriction Plan.

RR3: Undertake additional work on the detailed development of the ground infrastructure and associated issues.

RR4: Undertake a review of SOIR compliance in respect of the chosen runway options to identify the relevant issues, develop mitigation measures and validate the capacity of each option.

RR5: Undertake an analysis of ILS performance to enable parallel and/or staggered approaches to be carried out from around 18-20nm from touchdown. Identify ILS or other technological solutions to address any identified problems.

RR6: Investigate the wake vortex problem identified with Option S Extended to develop appropriate procedures, identify any equipment required and to quantify any capacity limitations.

RR7: Develop procedures to allow parallel approaches to be undertaken in excess of 10nm from touchdown. This should identify the minimum acceptable spacing between the parallel approaches and appropriate breakout manoeuvres.

RR8: Aircraft operators should be consulted regarding the design of flight procedures with significant turns and higher than normal climb gradients to ensure that flyability and pilot acceptance is achieved.

RR9: Undertake a review of VHD5 to assess if the operation can be restricted to sufficiently low altitudes to allow unrestricted operation of the third runway, or alternatively to consider relocating VHD5.

RR10: Put in place the necessary safeguarding to allow the 25L SID and Missed Approach to turn left immediately, restricted only to high ground.

11 CONCLUSIONS

The study identified and evaluated a number of possible location options for a third runway in Hong Kong, of which three options, Options P, R and S Extended were selected for further detailed analysis. Each option possesses its own set of environmental, constructional and operational issues. These have been described in detail in this report.

The key issues are maximising capacity and the decision on whether or not to build on or over the contaminated mud pits. Depending on these decisions, the three selected options may be further refined and developed.

There is a significant amount of work to be completed, including parallel approaches, SOIR compliance, wake vortex, procedure design and airspace development, but the potential capacity figures quoted are an indication of the operational benefits that a third runway could provide.

The decision to select a specific option must be subject to additional work in, as a minimum, the following areas:

- Further detailed development of the ground infrastructure based on the considerations identified in this report;

- Resolution of all relevant airspace issues;
- Determine that parallel and/or staggered approaches can be conducted outside 10nm;
- Review and identify resolutions to SOIR compliance issues.
- Identify and mitigate wake vortex issues in respect of Option S Extended.

It is only once this work has been completed that the definitive capacity of the three runway combination can be determined.

APPENDIX A – RUNWAY OPTIONS MATRIX

NATS

AIRSPACE AND RUNWAY CAPACITY STUDY PHASE 2

Deliverable P6
Appendix A Options Comparison Matrix

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Multicriteria Matrix

Option		A	B	C	D	E	F	G	H
Mandatory Requirements	Airside Integration								
	Access to New Runway from Existing Aprons	Fail[1]	Fail[1]	Fail[1]	Pass	Pass	Pass	Pass	Pass
	Access to New Aprons from Existing Runways	Pass	Pass	Fail[2]	Pass	Pass	Pass	Pass	Pass
	Operational Viability								
	Potential Impact of Terrain on App/Dep Procedures	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Viable Missed Approach Procedures	Pass	Pass	Fail[3]	Fail[3]	Fail[3]	Fail[3]	Fail[3]	Fail[3]
	Overall Assessment	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail

Option		J	K	M	N	P	R	S	SX
Mandatory Requirements	Airside Integration								
	Access to New Runway from Existing Aprons	Fail[4]	Pass	Fail[4]	Pass	Pass	Pass	Pass	Pass
	Access to New Aprons from Existing Runways	Fail[4]	Pass	Fail[4]	Pass	Pass	Pass	Pass	Pass
	Operational Viability								
	Potential Impact of Terrain on App/Dep Procedures	Pass	Fail[5]	Pass	Pass	Pass	Pass	Pass	Pass
	Viable Missed Approach Procedures	Pass	Fail[6]	Pass	Fail[7]	Pass	Pass	Fail[8]	Pass
	Overall Assessment	Fail	Fail	Fail	Fail	Pass	Pass	Fail	Pass

Note: Pass/Fail indicates that this item passed or failed the down selection criteria.

Numbered Notes in Table:

1. New runway is more than 4km away from the current terminal complex and involves a runway crossing.
2. New apron and terminal is more than 4km away from the closest existing runway in at least one direction.
3. Any 07 missed approach paths for runways without a western stagger may not clear Castle Peak.
4. Runway remote from existing airport – provides no integration.
5. Runway location too close to mountains on Lantau. The peaks at Fa Peng Teng, Tai Yam Teng and Yam Tsai along the northern shore of Lantau may be an issue for 25L approaches.
6. Runway location too close to mountains on Lantau. Missed approach path sandwiched between SID off 25C and mountains. No viable missed approaches off 07C independent from SID off 07R. Dependent operations required.
7. Close parallel runway with an eastern stagger. Missed approach for Runway 07C overflies Runway 07L. Dependent operations required.
8. Close parallel runway with a western stagger. Missed approach for Runway 25C overflies Runway 25R. Dependent operations required.

NATS

HKIA Third Runway Options - Comparison of Primary Differences

Option		A	B	C	D	E	F	G	H	J	K	M	N	P	R	S	SX Var A/B	SX Var C	SX Var D	SX Var E
New Runway	Orientation	18/36	05/23	07/25	07/25	07/25	07/25	07/25	07/25	05/23	07/25	03/21	07/25	07/25	07/25	07/25	07/25	07/25	07/25	07/25
	Separation	n/a	n/a	2800m	1525m	≥1035m	≥915m	≥760m	≥380m	n/a	1000m	n/a	≥380m	2240m	1525m	≥380m	≥380m	≥380m	≥380m	≥380m
	Offset (approx)	n/a	n/a	0m (Note 3)	0m (Note 3)	0m	0m	0m	0m	n/a	5000m	n/a	2500m E	1500m W	1500m W	2500m E	E & W	E & W	E & W	E & W
Runway Capacity	Direction of Ops	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W	E / W
D:Departures A:Arrivals M:Mixed Mode	New Runway	35D / (35D)	35D / 0	33A / 35D	33A / 35D	24A / 35D	24A / 35D	24A / 35D	24A / 35D	44M / 44M	34M / 34M	44M / 44M	24D / 33A	33A / 44M	33A / 44M	33A / 24D	33A / 33A	33A / 33A	33A / 33A	33A / 33A
	Existing 07L/25R	35D / 33A	35D / 33A	35D / 33A	35D / 33A	24D / 33A	24D / 33A	24D / 33A	24D / 33A	34M / 34M	24A / 24D	34M / 34M	24A / 35D	35D / 33A	35D / 33A	35D / 24A	35D / 35D	35D / 35D	35D / 35D	35D / 35D
	Existing 07R/25L	33A / 35D	33A / 35D	34M / 34M	34M / 34M	34M / 34M	34M / 34M	34M / 34M	34M / 34M	34M / 34M	24D / 24A	34M / 34M	34M / 34M	34M / 35D	34M / 35D	34M / 34M	34M / 34M	34M / 34M	34M / 34M	34M / 34M
No Normal Runway Crossing	Total	103 / **68**	103 / **68**	**102** / **102**	**102** / **102**	**82** / 102	**82** / 102	**82** / 102	**82** / 102	**112** / **112**	**82** / **82**	**112** / **112**	**82** / 102	**102** / 112	**102** / 112	102 / **82**	**102** / **102**	**102** / **102**	**102** / **102**	**102** / **102**
	Increase over 2 Runways	35 / **0**	35 / **0**	**34** / **34**	**34** / **34**	**14** / 34	**14** / 34	**14** / 34	**14** / 34	**44** / **44**	**14** / **14**	**44** / **44**	**14** / 34	**34** / 44	**34** / 44	34 / **14**	**34** / **34**	**34** / **34**	**34** / **34**	**34** / **34**
		Note 1	Note 2	Note 3	Note 3	Note 4	Note 4	Note 4	Note 4		Note 5	Note 6	Note 7	Note 8	Note 8		Note 9	Note 9	Note 9	Note 9
Construction Issues	Mud Pits	Avoids	Avoids	Avoids, but Taxiway Cross	Build Over	Build Over	Build Over	Part Over	Avoids	Avoids	Avoids	Avoids	Avoids	Avoids	Build Over	Avoids	Avoids	Avoids	Avoids	Avoids
(All Approx)	Reclamation Size	Base Size =100%	Similar to Base Size	Similar to Base Size	Similar to Base Size	Similar to Base Size	90% Base Size	60% Base Size	60% Base Size	Similar to Base Size	Similar to Base Size	Similar to Base Size	70% Base Size	Similar to Base Size	Similar to Base Size	90% Base Size	Similar to Base Size	110% Base Size	Similar to Base Size	Similar to Base Size
	Parallel Taxiways	3x 3.8km	3x 3.8km	3x 3.8km	3x 3.8km	3x 3.8km	3x 3.8km	3x 3.8km	3.8km	2x 3.8km	2x 3.8km	2x 3.8km	3.8km	2x 3.8km	2x 3.8km	3.8km	5689m	5689m	6689m	6689m
	Taxiway Links	2x 1.5km	2x 2.5km	4x 2.5km	4x 1.3km	4x 0.8km	4x 0.7km	4x 0.5km	none	none	2x1.5km	none	2km	2x 1.3km	2x 1.3km	2km	0km	0km	0km	0km
	Surface Access	5km Viaduct	5km Viaduct	5km Viaduct	3km Viaduct or Reclaim	3km Viaduct or Reclaim	3km Viaduct or Reclaim	2km Reclaim	2km Reclaim	7km Tunnel	1km Reclaim	11km Major New Route fr Tuen Mun	2km Reclaim	5km Viaduct	5km Viaduct	6km Viaduct or Reclaim	0km	2km Reclaim	0km	0km
Airport Planning	Apron	Separate	Separate	Separate	Separate	Mid-field	Mid-field	At East or West End	At East or West End	Entirely Separate	Separate	Entirely Separate	At East End	Mid-field	Mid-field	At West End	At East End	At West End	At East End	At East End
Connectivity	Acft Aprons	Minimal	Minimal	Poor	Good	Good	Good	Fair	Fair	None	Poor	None	Good	Fair	Fair	Fair	Fair	Good	Fair	Good
	T3 to T1/T2	Long Diffic't APM & Road Routes	Long Diffic't APM & Road Routes	Long Diffic't APM & Road Routes	APM & Road Cross 07C/25C	APM & Road Cross 07C/25C	APM & Road Cross 07C/25C	APM & Road Routes	APM & Road Routes	None	Long Diffic't APM & Road Routes	None	APM & Road Routes	Long Diffic't APM & Road Routes	Long Diffic't APM & Road Routes	Long Diffic't APM & Road Routes	APM & Road Routes	APM & Road Routes	APM & Road Routes	APM & Road Routes
	Existing cargo to new Apron	Very Long Road Route	Very Long Road Route	Very Long Road Route	Long Road Route	Long Road Route	Long Road Route	Long Road Route	Long Road Route	None	Very Long Road Rte	None	Long Road Route	Long Road Route	Long Road Route	Long Road Route	Long Road Route	Reasonable Road Route	Long Road Route	Long Road Route
	Taxiing	Long Taxi T3 - 25R	Long Taxi T3 - 25R	Long Taxi T3-07C/25C	Similar to Existing	Similar to Existing	Similar to Existing	More than Existing	More than Existing	Similar to Existing	Similar to Existing	Similar to Existing	Similar to Existing	Similar to Existing	Similar to Existing	Similar to Existing	More than Existing	Similar to Existing	More than Existing	More than Existing
	Pier Concepts	Linked or Satellites	Linked or Satellites	Linked or Satellites	Linked or Satellites	Long Narrow	Long Narrow	Probably Linked	Probably Linked	Linked or Satellites	Probably Linked	Linked or Satellites	Probably Linked	Linked or Satellites	Linked or Satellites	Linked or Satellites	Linked or Satellites	Linked or Satellites	Linked or Satellites	Linked or Satellites
	Surface Access	Long Extension	Long Extension	Long Extension Under Twys	Significant Extension	Significant Extension	Significant Extension	Depends on T3 Location	Depends on T3 Location	Tunnel Major Cost Element	Junction/ Station before T1	Entirely New	Simple Extension	Long Extension	Long Extension	Depends on T3 Location	Simple Extension	Long Extension	Simple Extension	Can Create a Closed Loop Road & Rail
Main Sea Lane	Effect	Substantial Obstruction	Substantial Obstruction	Substantial Obstruction	Substantial Obstruction	Obstruction	Obstruction	Obstruction	Minor Obstruction	No Obstruction	No Obstruction	Access to Power Stn	Minor Obstruction	Significant Obstruction	Significant Obstruction	Minor Obstruction	Minor Obstruction	Minor Obstruction	Minor Obstruction	Minor Obstruction
Environment	Noise	SID over Tai Lam	SID over Tai Lam & Tuen Mun	SID over Tai Lam & Tuen Mun	SID over Tai Lam & Tuen Mun	SID over Tai Lam & Tuen Mun	SID over Tai Lam	SID over Tai Lam	SID over Tai Lam	SID over Tai Lam, Noise S Lantau	SID over Tai Lam, Tung Chung	SID over Tai Lam	SID over Tai Lam	SID over Tai Lam & Tuen Mun	SID over Tai Lam & Tuen Mun	SID over Tai Lam	SID over Tai Lam	SID over Tai Lam	SID over Tai Lam	SID over Tai Lam
	Current Flow	Substantial Obstruction	Significant Obstruction	Significant Obstruction	Obstruction	Obstruction	Obstruction	Minor Obstruction	Minor Obstruction	Local Obstruction	No Obstruction	Local Obstruction	Minor Obstruction	Significant Obstruction	Significant Obstruction	Minor Obstruction	Minor Obstruction	Minor Obstruction	Minor Obstruction	Minor Obstruction
	Construction Impacts			Piling will Disturb Mud Pits	Major Mud Pit Disturbance	Major Mud Pit Disturbance	Major Mud Pit Disturbance	Some Mud Pit Disturbance	Disturbs Mud Pits		Disturbs Tai Ho		Significant Impact	Significant Impact	Major Mud Pit Disturbance	Significant Impact	Significant Impact	Significant Impact	Significant Impact	Significant Impact
	Marine Life	Significant Impact	Significant Impact	Significant Impact	Significant Impact	Some Impact	Some Impact	Minimal Impact	Minimal Impact	Local	Some Impact	Numerous Impacts	Some Impact	Significant Impact	Significant Impact	Some Impact	Some Impact	Some Impact	Some Impact	Some Impact

03/08/2008
Approved By:

Project Manager

Notes:

All elements in the table reflect our present level of understanding. Examination of a short list in more detail may reveal additional matters for consideration. That may particularly apply in relation to approach and departure routes and the space required for new aprons and terminals.

Operational input may be required in relation to acceptable departure gradients, approach gradients and missed approach gradients.

Some construction and environmental impacts may depend on the chosen design for that option and the selected method of construction.

All dimensions are approximate and may also depend on the chosen design for that option.

Numbered Notes in Table:

1. In the westerly direction, the northerly runway can only be used in certain wind conditions, providing a theoretical runway capacity of 103 per hour in these conditions, but this capacity would not always be available and thus not useable for scheduling purposes
2. In the easterly direction this option could be used to offload departure peaks. In the westerly direction, the conflict with the existing airport is likely to create a dependent operation, with little or no capacity increase. The separation of the approach and departure from the new runway to the terrain to the north east has not yet been assessed.
3. In the easterly direction, the runway may need to be offset to the degree required to achieve the desired climb gradient on the missed approach. A greater offset may be required to achieve a departure and approach to the north runway.
4. As the runway separation reduces, at some point the conflict between the 07L missed approach and 07C departure becomes significant. It is assumed that Runway 07L and Runway 07C are dependant.
5. In the runway 25 direction, this mode of operations requires terrain safe approaches and missed approaches for the new runway. The runway 07 direction requires terrain safe departures. An initial review indicates this is unlikely. If any of these operations are not possible, the new runway is not useable, resulting in no capacity increase. The existing south runway and the new runway are dependent.
6. The integration of this traffic into the PRD airspace, particularly the interaction with Shenzhen will require additional work that has yet to be undertaken.
7. In the westerly direction, this mode of operations requires a terrain safe approach. The easterly direction requires a terrain safe departure. If either of these operations is not possible, the new runway is not useable, resulting in no capacity increase. In the easterly direction, the existing north runway and the new runway are dependent.
8. The degree of stagger to the west will be dependent on the requirement for a terrain safe arrival, departure and missed approach in respect of the terrain to the north east of the airfield.
9. In the westerly direction, the threshold of the new runway may have to be displaced to provide terrain clearance for the approach.

APPENDIX B – PROCEDURE DESIGN WORK

NATS

AIRSPACE AND RUNWAY CAPACITY STUDY PHASE 2

Deliverable P6
Appendix B Procedure Design Report

www.nats.co.uk

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1 INTRODUCTION

As part of the study to determine potential locations of a proposed new runway at HKIA, the Procedure Design Group was asked to analyse several runway possibilities. These analyses were intended to determine the suitability of each location for departures, ILS approaches, and missed approaches. This report presents the results of these analyses.

2 ASSUMPTIONS

- It is assumed that the obstacle data provided by CAD combined with the digital elevation model from the shuttle radar topography mission provides a complete obstacle and terrain environment.
- It is assumed that the locations and elevations of significant aerodrome points and navigation aids in the Hong Kong AIP are accurate.
- Only the initial straight segment of the departures have been analysed to a distance of 50km. It is assumed that once termination fixes have been selected for the new SIDs, a suitable track can be designed that does not require an increase to the specified climb gradient.
- ILS approaches have only been analysed from the FAP to the turn point. It is assumed that a suitable initial and intermediate segment can be designed to intercept the localiser prior to the FAP.
- Only the first turn and the subsequent straight segment of the missed approaches have been analysed to a distance of 50km. It is assumed that a suitable track back to the IAF can be designed that does not require an increase to the specified climb gradient.
- It is assumed that the shipping lanes will be kept far enough away from the new runway that ship superstructures will not penetrate the obstacle assessment surfaces or require an increased missed approach climb gradient.
- It is assumed that danger area VHD5 is inactive.
- The impact to SKARA (Shek Kong airspace) has not been considered.

3 METHODOLOGY

All four runway options are parallel to the current 07L/25R runway. They are separated a certain distance to the North of the current 07L/25R runway and displaced or extended by a certain distance to the East or West. The threshold elevations have been assumed to be the same as the current 07L/25R runway at 22ft.

3.1 Departures

SID climb gradients were calculated based on 15° track adjustments immediately after departure. Each SID was analysed for both no track guidance and three levels of RNP.

3.2 ILS Approaches

Both Cat I and Cat II approaches were analysed for each runway end. A standard 3° glide path angle was used with a reference datum height of 15m and a course width at threshold of 210m. An intermediate altitude of 1,700ft has been used for the 07 direction and intermediate altitudes of 4,500ft or below have been used for the 25 direction. Options R and S Extended (Variants D and E) require the intermediate altitude to be lowered in order for the FAF to “shadow” the mountain and take

advantage of the reduced obstacle clearance criteria for the intermediate approach segment. This may require the intermediate segment to be lengthened in order to provide the required obstacle clearance throughout the initial segment. A 5% missed approach climb gradient has been used in the 07 direction and a 2.5% missed approach climb gradient has been used in the 25 direction.

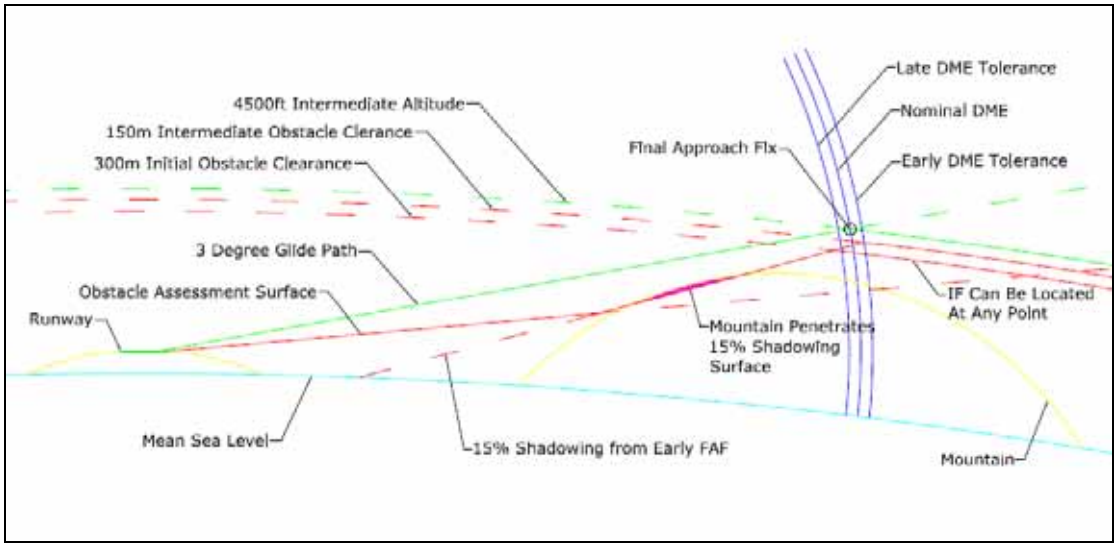

Figure 3.1 Ability of the FAF to "Shadow" The terrain.

Note: For definition of Aircraft Category see ICAO Manual of All Weather Operations (Doc 9365)

3.3 Missed Approaches

The missed approach calculations are based on the aircraft climbing straight ahead to 300ft then turning 45° to the north. Turns prior to 0 DME are prohibited. The choice of the 300ft turn height is based on the PANS-OPS criteria. SOIR requirements state that "the nominal departure track diverges immediately after take-off by at least 30 degrees from the missed approach track of the adjacent approach." The objective is for the missed approach to turn by 30 degrees as soon as possible. The lowest allowable turn height is calculated by taking the aerodrome elevation of 8.5344m (28ft), adding an A380 at 24.1m, and applying the required 50m obstacle clearance. This gives 82.6344m or 271.1102ft which is rounded up to 300ft. The turn altitude for 25R is higher at 500ft in order to get the missed approach climb gradient down to 7.0%. A turn altitude of 300ft requires a climb gradient of 7.7% to clear the tower on Castle Peak.

3.4 Low Level Missed Approaches

The possibility of a low level turning missed approach for the new Runway 07L has been investigated. This has the advantage of a reduced climb gradient, but would require pilot acceptance due to the significant turn in the missed approach procedure. Operationally, it could potentially reduce the conflict with the Shenzhen circuit and position the aircraft downwind for a new approach. A left turning missed approach over the water has been analysed for each of the four options and with two different speed restrictions. In all cases, the missed approach involves climbing straight ahead to 300ft then turning left by 135 degrees. Turns before 0 DME are prohibited.

The first analysis is of the missed approaches with a speed restriction of 185 knots IAS, the lowest allowable missed approach speed restriction for category D aircraft. As the results were favourable, a second analysis was undertaken for the missed approaches with a speed restriction of 200 knots IAS.

3.5 RNP values

The general guidance on the choice of RNP values in the current version of PANS-OPS states that Departure procedures are normally based on RNP 1. Where necessary and appropriate, they may be based on RNP 0.5 or RNP 0.3. Departures are not associated with an RNP value less than RNP 0.3. This has been used in the calculations conducted by the PDG and values for RNP 1, RNP 0.5, and RNP 0.3 have been provided.

In the final draft of the new PBN Manual and the proposed amendments for the next edition of PANS-OPS, the RNP 0.5 and RNP 0.3 no longer exist. They have now been replaced with RNP APCH and RNP (AR) APCH which are for approach use only. This means that the best navigation specification now allowed for departures is Basic-RNP. If a lower RNP value was used, then a separate safety case would be required, and it might have to be restricted to approved operators only.

For missed approaches, the RNP APCH navigation specification only supports RNP values below 1 for the final approach segment. Anything lower than RNP 1 in the missed approach segment would have to use RNP (AR) APCH. The "AR" in the navigation specification title refers to "Authorization Required". This means that, before a particular operator can fly a particular AR procedure with a particular type of aircraft, they must first receive approval from the state regulator that all the required elements have been appropriately addressed. Procedure design for these procedures is also based on an entirely new "RNP AR Procedure Design Manual" which is still in the final draft stage.

Analyses of lower RNP values can be undertaken as further work. A rough analysis of RNP 0.15 for Option S Extended (Variants D and E) has been included for information.

4 EXISTING 07L SIDS

In order for HKIA to function efficiently as a three-runway airport, it is necessary for departures and missed approaches from each runway to be separated from the other runways as far as practicable. The most obvious conflicts with the current procedures were the 07L SIDs which turn to the right and conflict with the 07R SIDs and missed approaches.

An initial investigation has been performed to determine the climb gradient required for a SID from 07L that turned left by 15 degrees. The climb gradient was calculated for departures with no track guidance, conventional navigation, and RNP navigation. The conventional navigation climb gradients require the installation of a VOR or NDB between 22°22’10.5852”N, 114°00’31.6872”E and 22°22’22.0152”N, 114°00’49.8636”E.

Table 4.1 Existing 07L Minimum SID Climb Gradients

Navigation Aid Type	**Minimum Climb Gradient**
No Track Guidance	6.1%
NDB	5.4%
VOR	4.7%
RNP 1	6.1%
RNP 0.5	5.4%
RNP 0.3	4.4%

Table 4.2 Existing 07L and 25R Minimum Missed Approach Climb Gradients

Navigation Aid Type	**Minimum Climb Gradient**

25R ILS	5%
07L ILS	7%

RNP 0.3 is expected to be the most common application of RNAV for approach and departure procedures. Using RNP 0.3 has resulted in a SID for the existing Runway 07L with a climb gradient roughly on par with the existing 07 SIDs. The RNP 0.3 SID off the existing 07L should cater for all departures capable of departing off 07R today. There shall be little service degradation when the new SID is implemented.

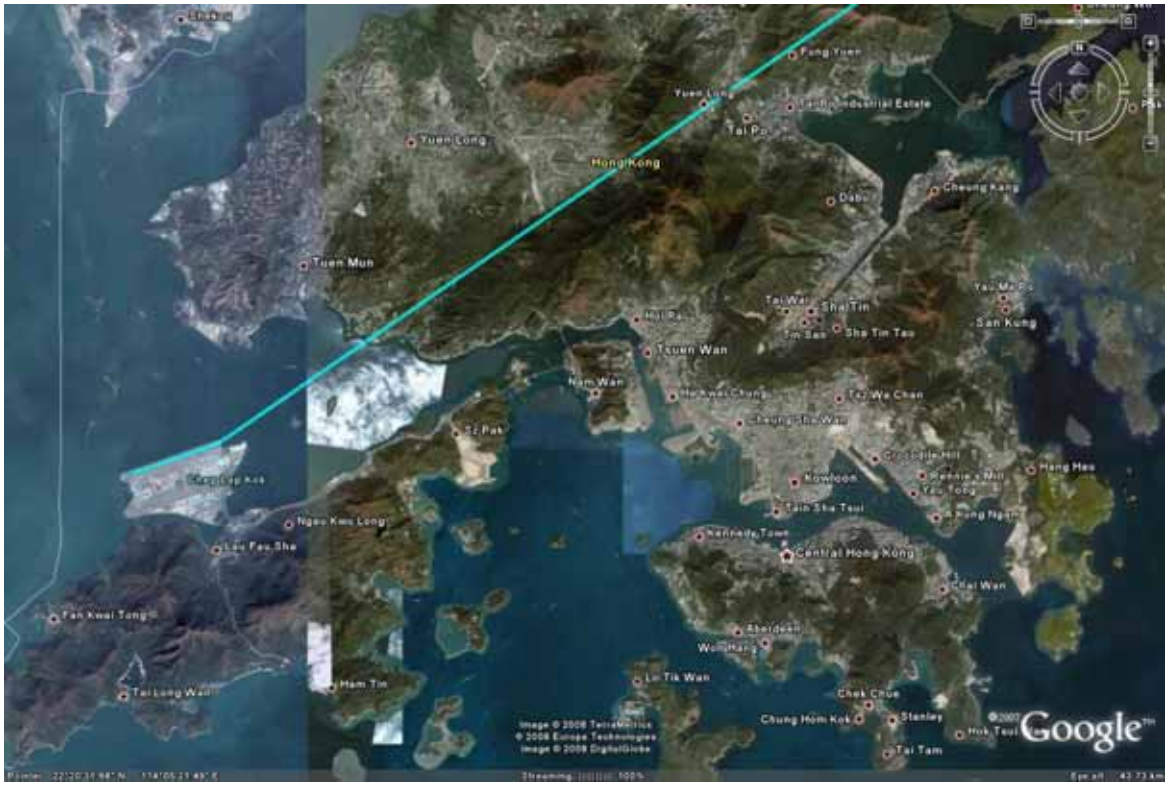

Figure 4.1 Indicative SID from existing 07L

The objective of the PDG work has been to design SID and missed approach procedures for the new runway options with climb gradients that are not significantly worse than the existing runways, so avoiding any additional operational restrictions.

5 NEW RUNWAY OPTIONS

Four options were chosen for detailed investigation. They are:

- Option P
- Option R
- Option S Extended (Variants A, B and C)
- Option S Extended (Variants D and E)

Each of these options is detailed below.

Note: The procedure diagrams are for illustration only.

5.1 Option P

Option P was to be located 2240m north of the current 07L/25R runway and displaced to the west. Displacements ranging from 500m to 3,000m were analysed for suitability

based on the ability to design an ILS approach from the east. A displacement of 2000m to the west was determined to be sufficient while also allowing a viable missed approach in both directions. The runway is 3446m long with a 300m clearway on each end.

5.1.1 Departures

Table 5.1 Option P Minimum SID Climb Gradients				
Navigation	**Conventional**	**RNP 1**	**RNP 0.5**	**RNP0.3**
07L Option P*	8.6%	8.6%	8.0%	7.1%
25R Option P	3.3%	3.3%	3.3%	3.3%
* Runway 07L not normally used for departures as proposed for 3-runway operations				

The climb gradients for 07L Option P are quite steep due to the proximity of the terrain to the East of the airport. The application of RNP navigation does not improve the required climb gradient as the controlling obstacle, the hill to the East of Tuen Mun, is directly on the flight path. Using RNP navigation, however, it may be possible to have aircraft turn further left and travel up the Tuen Mun valley and avoid the peak to the east, resulting in a lower climb gradient. As part of the PRD airspace review, the SID for Macau Runway 34 needs to be re-designed. The climb gradient of the Runway 25R SID will then have to be re-assessed to ensure separation from the new Macau SID.

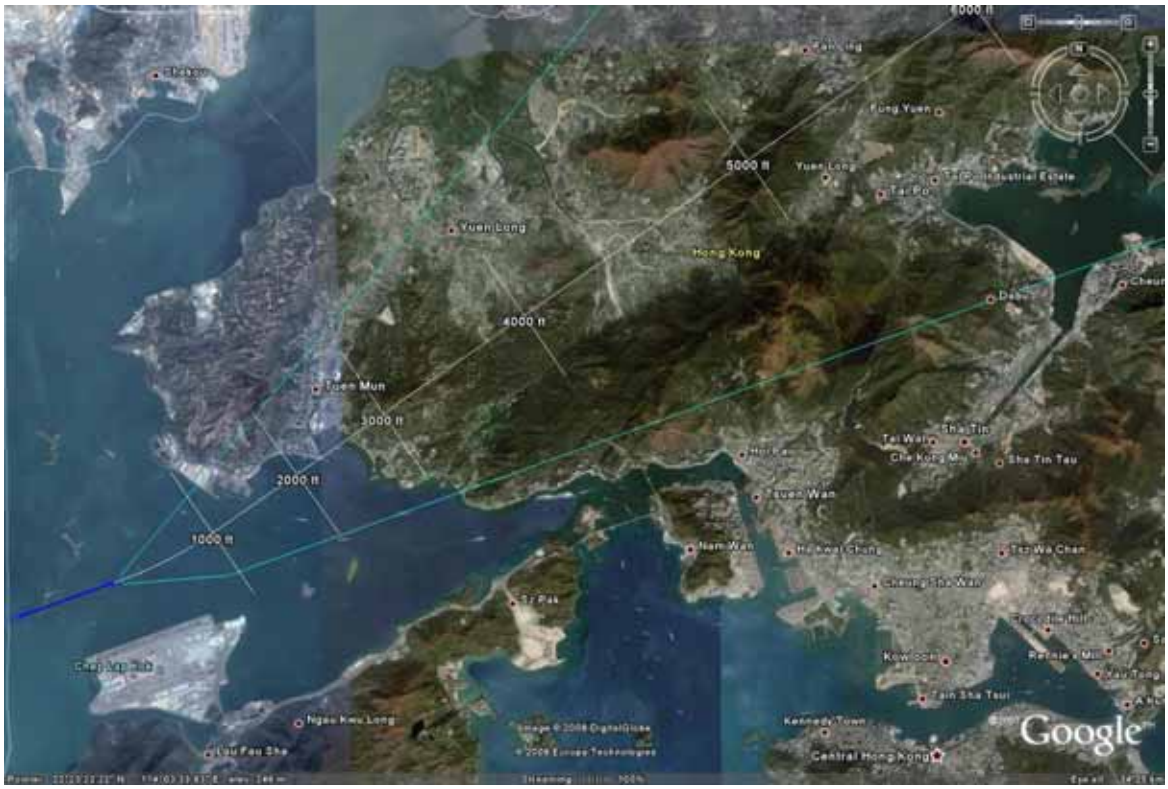

Figure 5.1 Option P Runway 07L SID

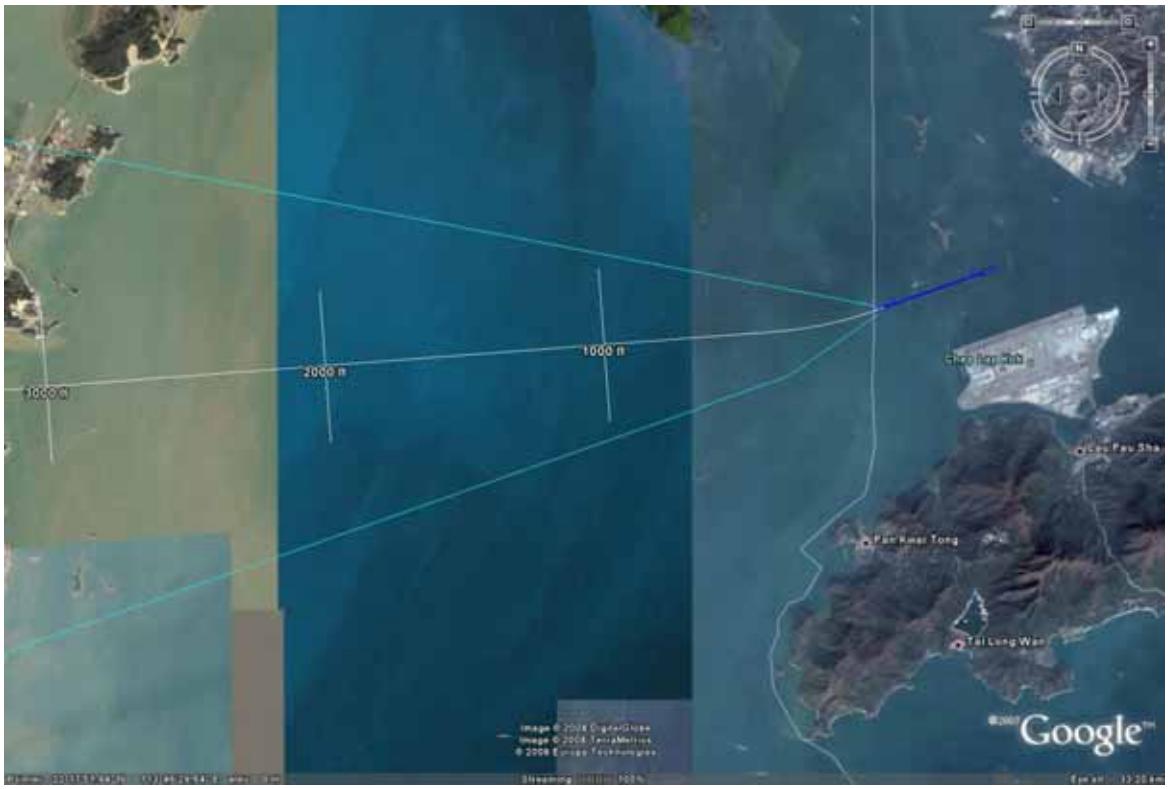

Figure 5.2 Option P Runway 25R SID

5.1.2 ILS Approaches

Table 5.2 Option P ILS Heights					
Aircraft Category		**A**	**B**	**C**	**D**
07L Option P OCA (OCH)	**CAT I**	**154** (132)	**164** (142)	**173** (151)	**183** (161)
	CAT II	**65** (43)	**82** (60)	**95** (73)	**108** (86)
25R Option P OCA (OCH)	**CAT I**	**219** (197)	**229** (207)	**238** (216)	**248** (226)
	CAT II	**129** (107)	**145** (123)	**159** (137)	**172** (150)

There are no penetrations of the obstacle assessment surfaces for 07L Option P and only a couple of spurious DEM points for 25R Option P close to the threshold.

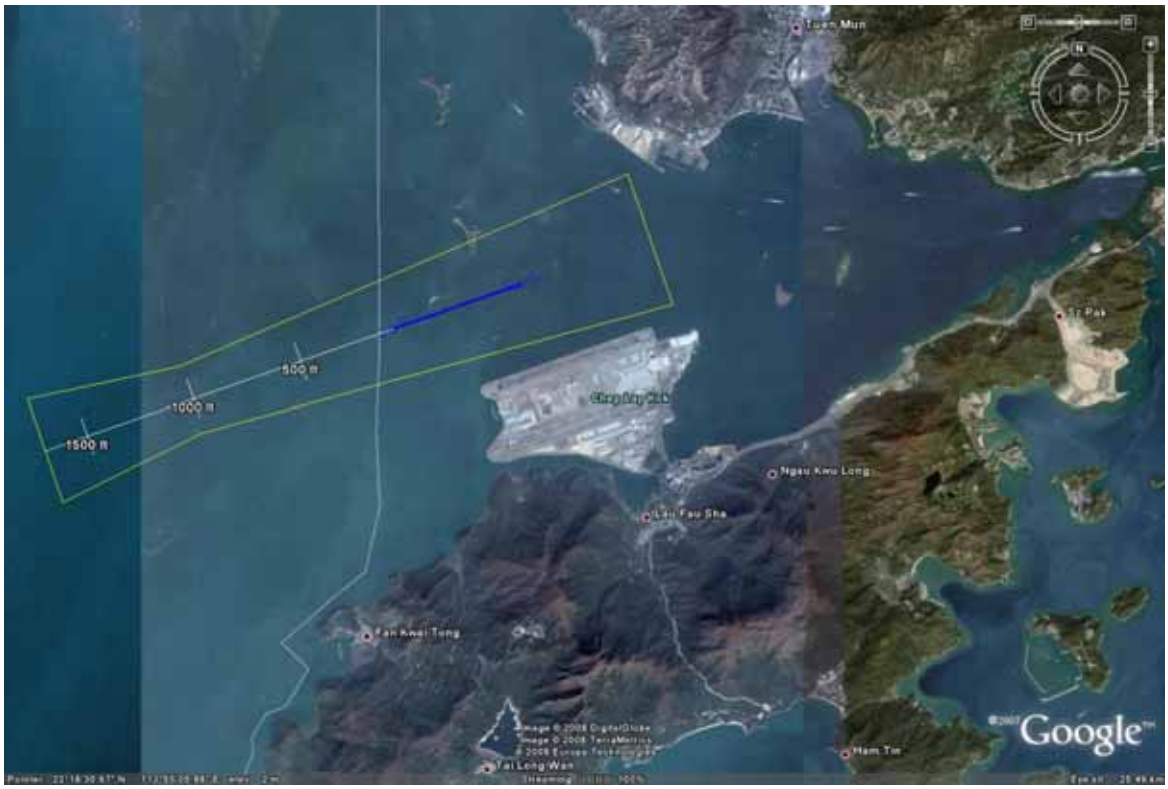

Figure 5.3 Option P Runway 07L ILS

Figure 5.4 Option P Runway 25R ILS

5.1.3 Missed Approaches

For 07L, the missed approach turns 45° left. The critical obstacle is the tower on top of Castle Peak which results in a missed approach climb gradient of 6**.6%**. For 25R, the missed approach turns 45° right. The critical obstacle is the island of Neilingding Dao which results in a missed approach climb gradient of **2.8%**. The low level missed approach has a climb gradient of 4.4% and the critical obstacle is the chimneys SW of Tuen Mun.

Table 5.3 Option P Missed Approaches

Missed Approach	Climb Gradient	Critical Obstacle
07L 45 Left	6.6%	Tower on Castle Peak
07L 135 Left 185 Knots	4.4%	Chimneys SW of Tuen Mun
07L 135 Left 200 Knots	4.4%	Chimneys SW of Tuen Mun
25R 45 Right	2.8%	Neilingding Dao

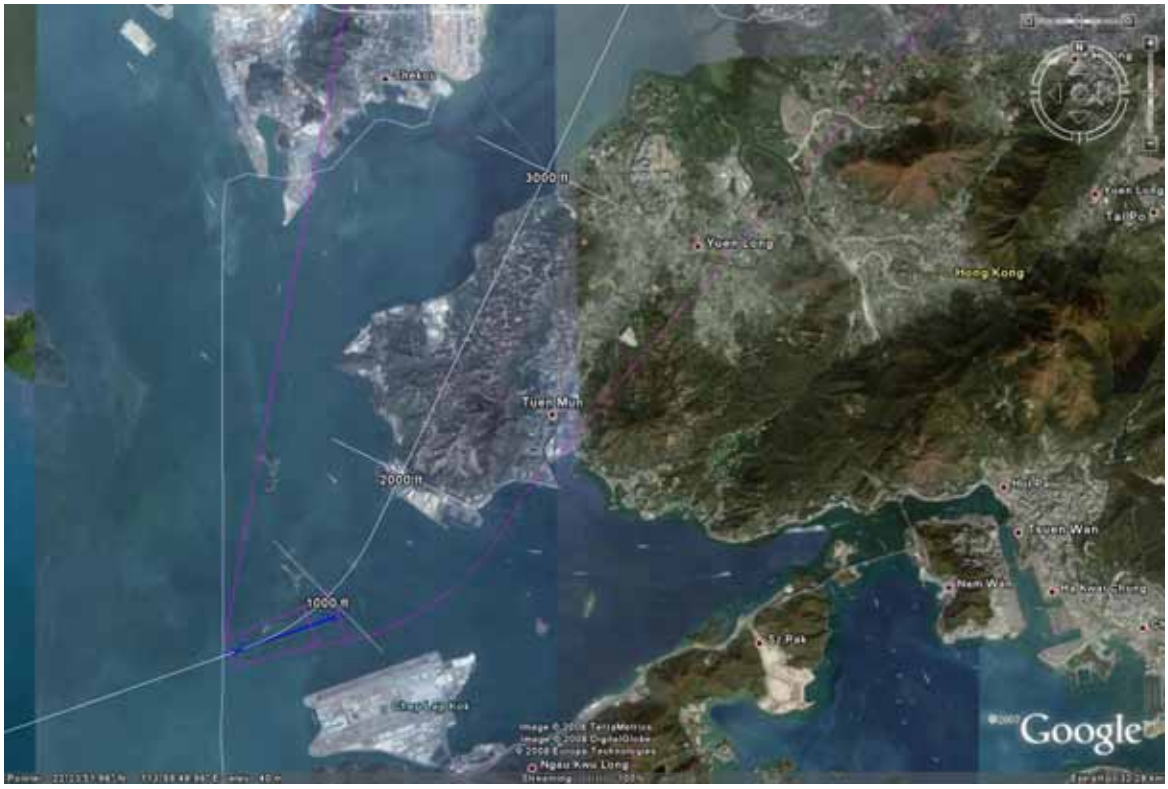

Figure 5.5 Option P Runway 07L 45 degree Missed Approach

Figure 5.6 Option P Runway 07L 135 degree Missed Approach 185 knots

Figure 5.7 Option P Runway 07L 135 degree Missed Approach 200 knots

Figure 5.8 Option P Runway 25R 45 degree Missed Approach

5.2 Option R

Option R was to be located 1,525m north of the current 07L/25R runway and displaced to the west. Displacements ranging from 500m to 3,000m were analysed for suitability based on the ability to design an ILS approach from the east. A displacement of 1000m to the west was determined to be sufficient while also allowing a viable missed approach in both directions. The selected position is 1430m west. The runway is 3,800m long with a 300m clearway on each end.

5.2.1 Departures

Table 5.4 Option R Minimum SID Climb Gradients

Navigation	Conventional	RNP 1	RNP 0.5	RNP0.3
07L Option R*	5.8%	5.8%	5.8%	5.8%
25R Option R	3.3%	3.3%	3.3%	3.3%
* Runway 07L not normally used for departures as proposed for 3-runway operations				

The climb gradients for 07L Option R are quite steep due to the proximity of the terrain to the East of the airport. The application of RNP navigation does not improve the required climb gradient as the controlling obstacle, the hill to the East of Tuen Mun, is directly on the flight path. Using RNP navigation, however, it may be possible to have aircraft turn further left and travel up the Tuen Mun valley and avoid the peak to the east, resulting in a lower climb gradient. As part of the PRD airspace review, the SID for Macau Runway 34 needs to be re-designed. The climb gradient of the Runway 25R SID will then have to be re-assessed to ensure separation from the new Macau SID.

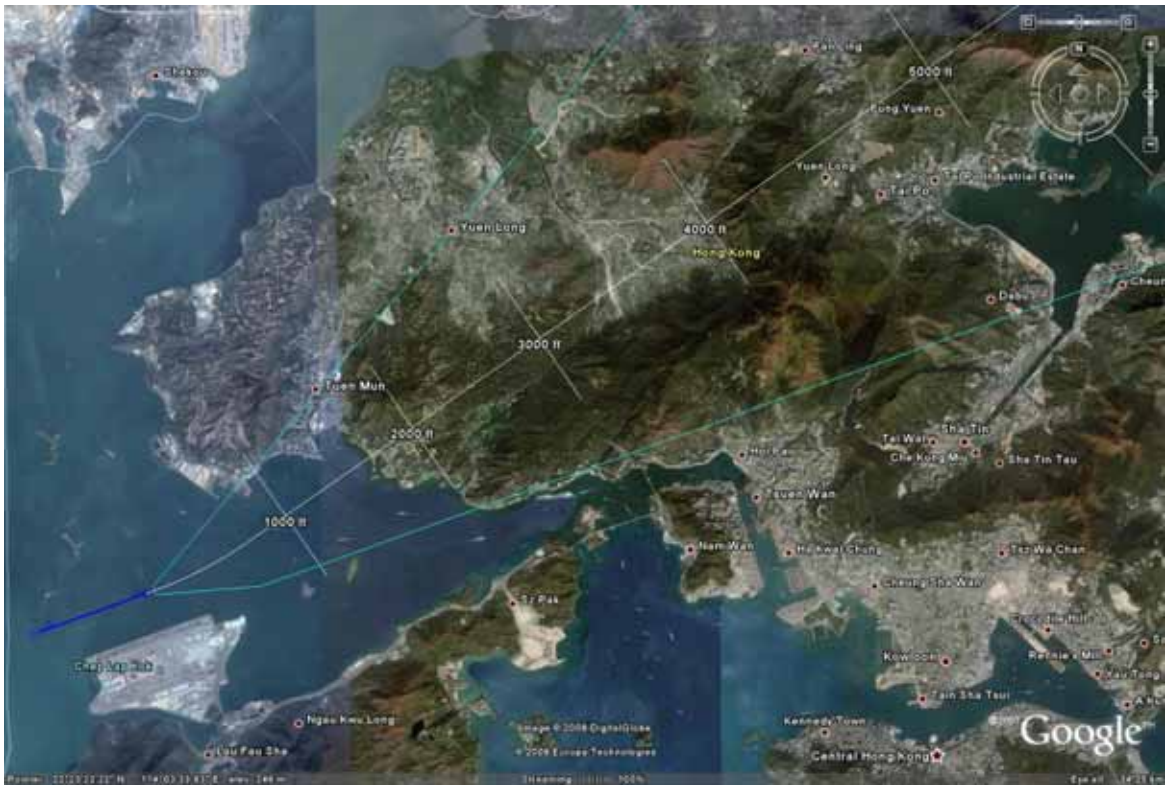

Figure 5.9 Option R Runway 07L SID

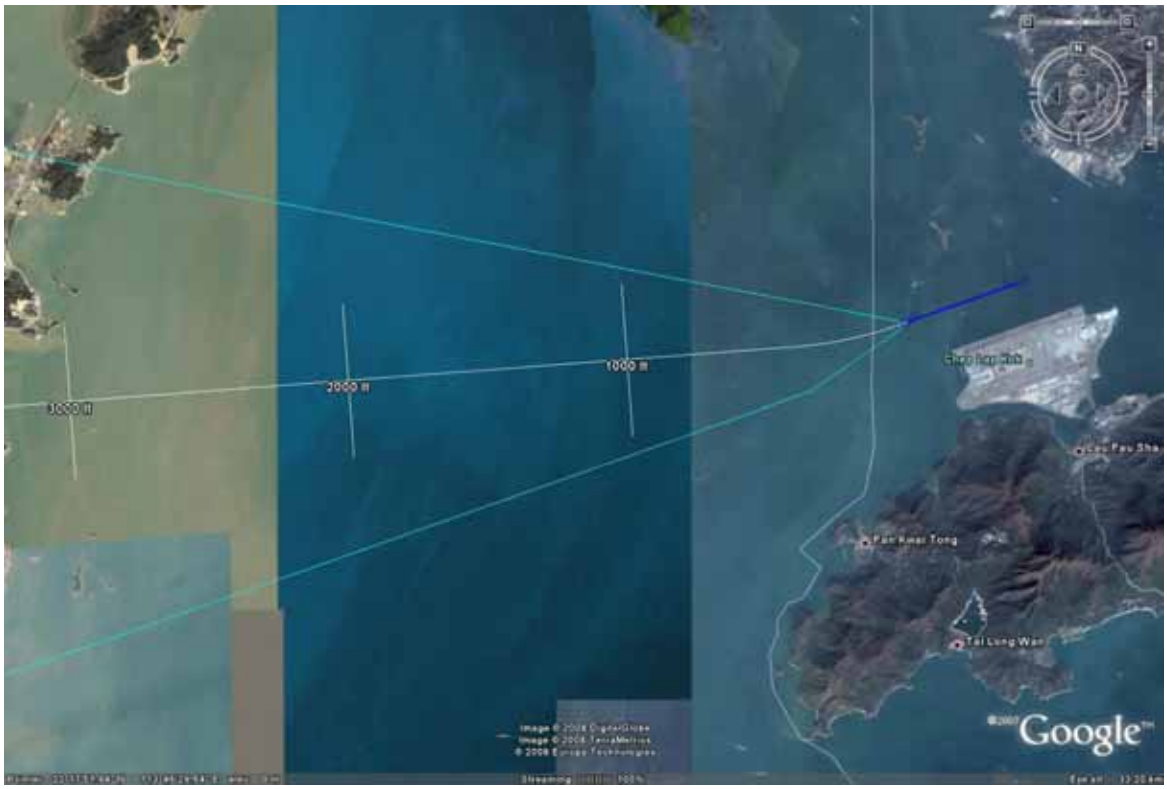

Figure 5.10 Option R Runway 25R SID

5.2.2 ILS Approaches

Table 5.5 Option R ILS Heights					
Aircraft Category		**A**	**B**	**C**	**D**
07L Option R OCA (OCH)	**CAT I**	**154** (132)	**164** (142)	**173** (151)	**183** (161)
	CAT II	**65** (43)	**82** (60)	**95** (73)	**108** (86)
25R Option R OCA (OCH)	**CAT I**	**264** (242)	**274** (252)	**283** (261)	**293** (271)
	CAT II	**175** (153)	**192** (170)	**205** (183)	**218** (196)

An intermediate altitude of 4,200ft has been used, which may require the intermediate segment to be lengthened. There are no penetrations of the obstacle assessment surfaces for 07L Option R and only a couple of spurious DEM points for 25R Option R close to the threshold.

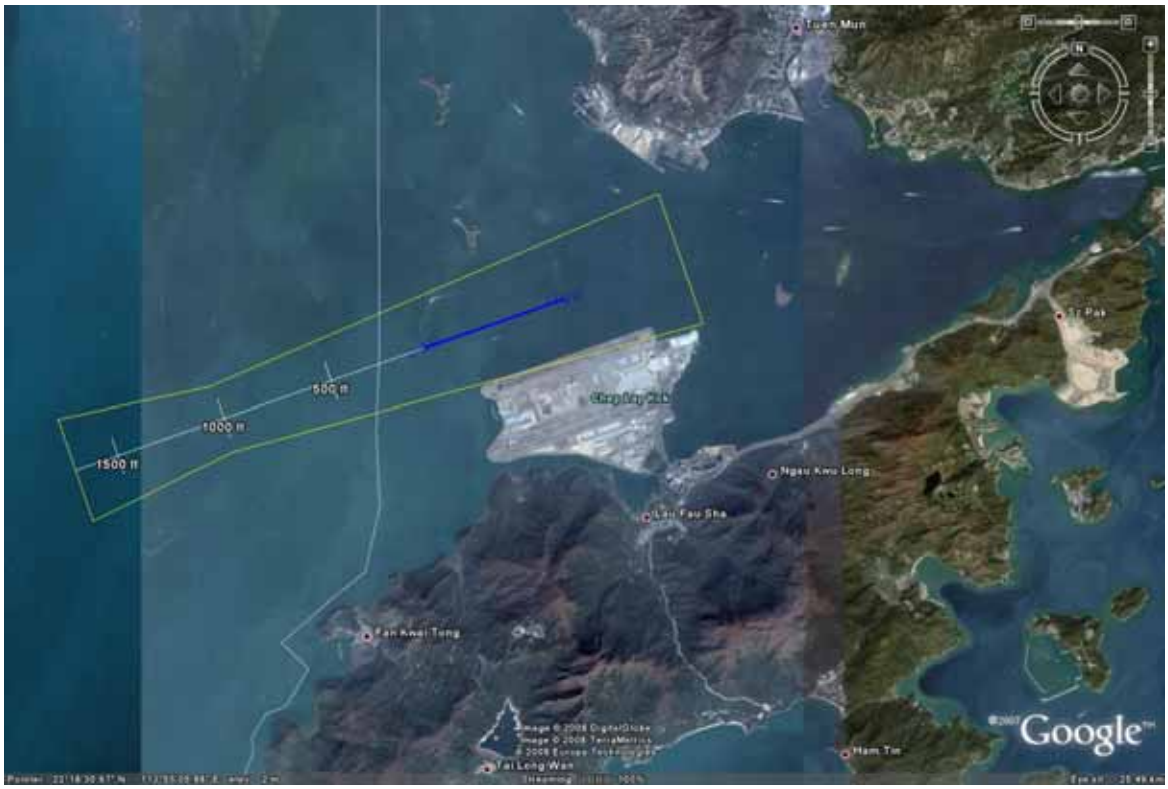

Figure 5.11 Option R Runway 07L ILS

Figure 5.12 Option R Runway 25R ILS

5.2.3 Missed Approaches

For 07L, the missed approach turns 45° left. The critical obstacle is the tower on top of Castle Peak which results in a missed approach climb gradient of **6.8%**. For 25R, the missed approach turns 45° right. The critical obstacle is the island of Neilingding Dao which results in a missed approach climb gradient of **2.6%**. The low level missed approach has a climb gradient of 4.4% and the critical obstacle is the chimneys SW of Tuen Mun.

Table 5.6 Option R Missed Approaches

Missed Approach	Climb Gradient	Critical Obstacle
07L 45 Left	6.8%	Tower on Castle Peak
07L 135 Left 185 Knots	4.4%	Chimneys SW of Tuen Mun
07L 135 Left 200 Knots	4.4%	Chimneys SW of Tuen Mun
25R 45 Right	2.6%	Neilingding Dao

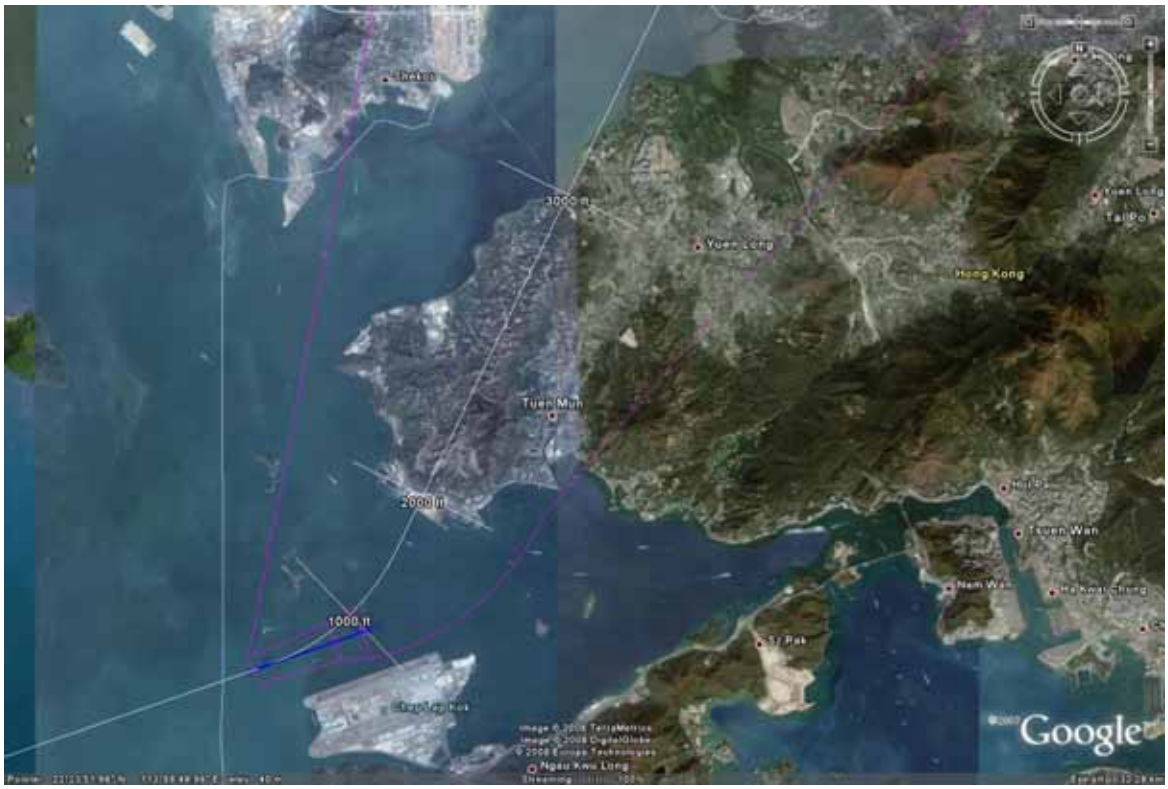

Figure 5.13 Option R Runway 07L 45 degree Missed Approach

Figure 5.14 Option R Runway 07L 135 degree Missed Approach 185 knots

Figure 5.15 Option R Runway 07L 135 degree Missed Approach 200 knots

Figure 5.16 Option R Runway 25R 45 degree Missed Approach

5.3 Option S Extended (Variants A, B and C)

Option S was to be located 380m north of the current 07L/25R runway and displaced to the west. Due to the proximity of Option S to the current 07L/25R runway, it would not be possible to design SOIR compliant procedures for westerly operations in this configuration. To alleviate this problem, it was decided to investigate the possibility of extending the runway to the east as well as displacing it. An extension of 1889m to the west while aligning the runway with the full length of the existing runways would allow fully SOIR compliant procedures in an easterly direction but would still not allow SOIR compliance in a westerly direction. The runway is 5689m long with a 300m clearway on each end.

5.3.1 Departures

Table 5.7 Option S Extended (Variants A, B and C) Minimum SID Climb Gradients

Navigation	Conventional	RNP 1	RNP 0.5	RNP0.3
07L Option S Ext Var A/B/C	6.2%	6.2%	5.8%	5.2%
25R Option S Ext Var A/B/C	3.3%	3.3%	3.3%	3.3%
New runway not normally used for departures as proposed for 3-runway operations				

The climb gradients for 07L Option S Extended (Variants A, B and C) are quite steep due to the proximity of the terrain to the East of the airport. As part of the PRD airspace review, the SID for Macau Runway 34 needs to be re-designed. The climb gradient of the Runway 25R SID will then have to be re-assessed to ensure separation from the new Macau SID.

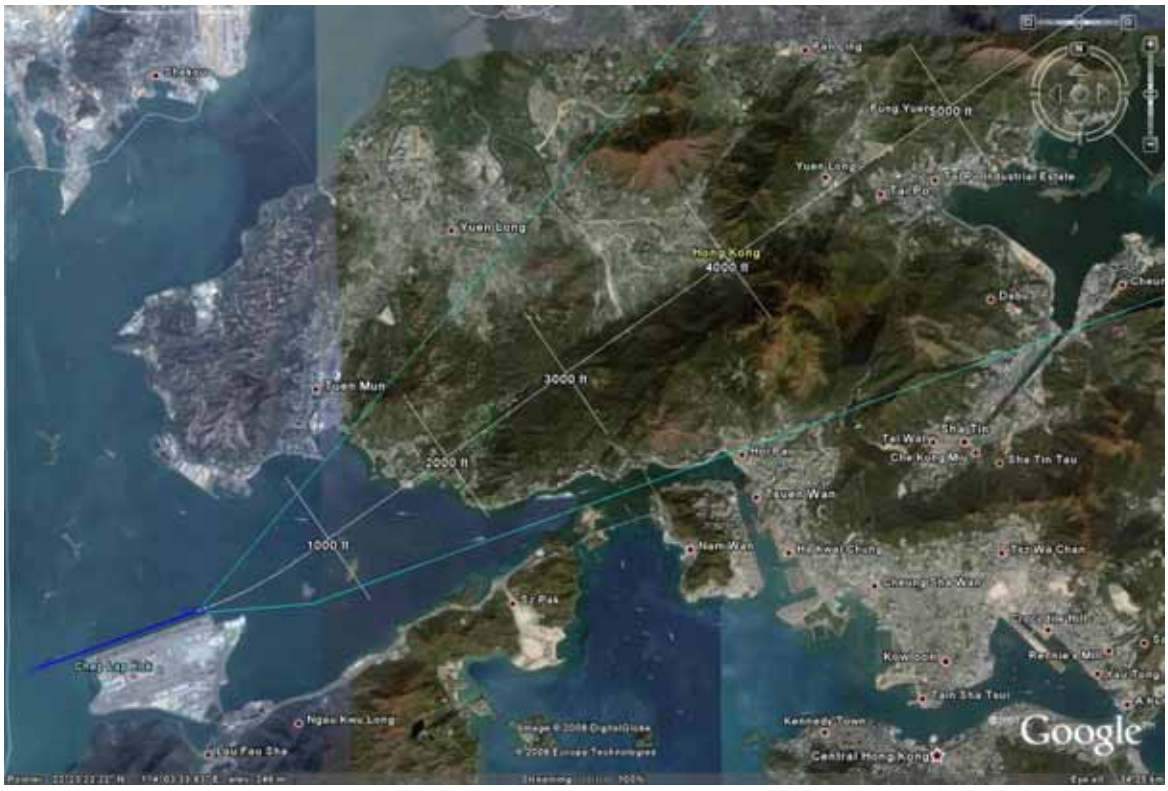

Figure 5.17 Option S Extended (Variants A, B and C) Runway 07L SID

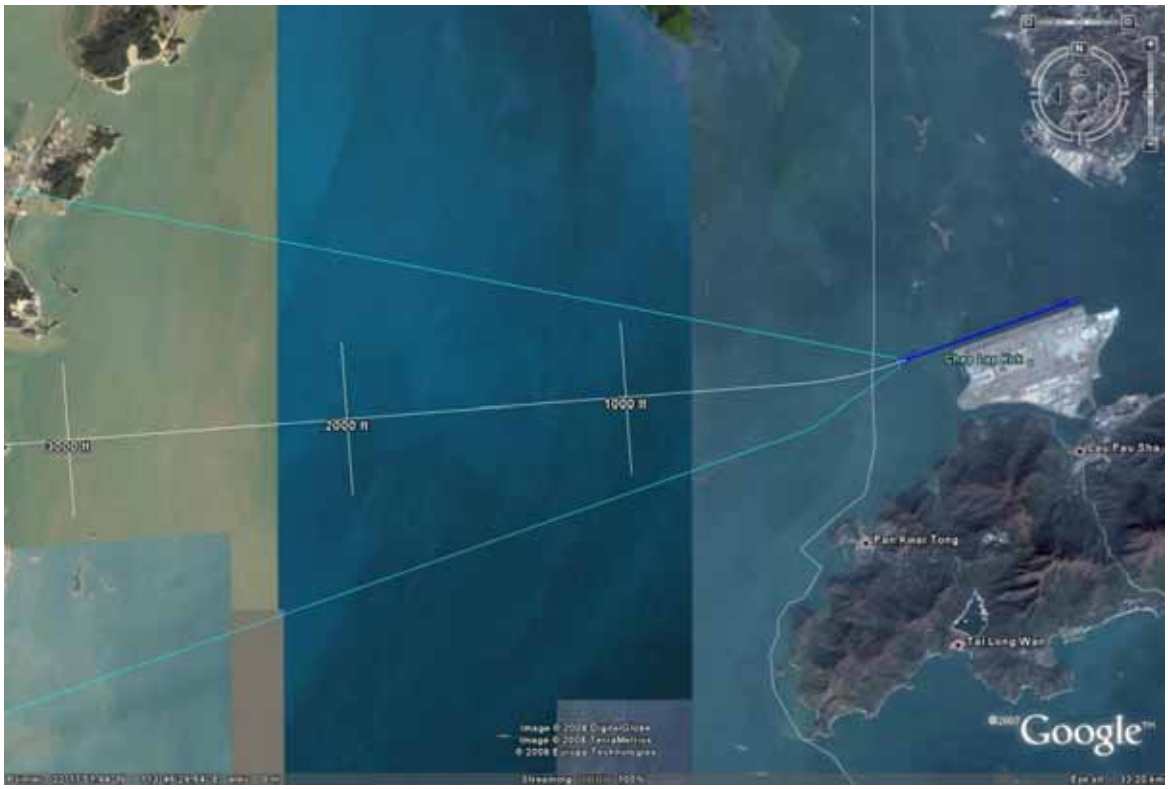

Figure 5.18 Option S Extended (Variants A, B and C) Runway 25R SID

5.3.2 ILS Approaches

Table 5.8 Option S Extended (Variants A, B and C) ILS Heights					
Aircraft Category		**A**	**B**	**C**	**D**
07L Option S Ext (A,B,C) OCA (OCH)	**CAT I**	**154** (132)	**164** (142)	**173** (151)	**183** (161)
	CAT II	**65** (43)	**82** (60)	**95** (73)	**108** (86)
25R Option S Ext (A,B,C) OCA (OCH)	**CAT I**	**175** (153)	**185** (163)	**195** (173)	**204** (182)
	CAT II	**86** (64)	**103** (81)	**116** (94)	**129** (107)

It should be noted that this is an extremely long runway which results in a very narrow localiser beam. These results are only valid if the localiser commissioning report certifies that the course width is 210m at the threshold. There are no penetrations of the obstacle assessment surfaces for 07L and only a couple of spurious DEM points for 25R Option R close to the threshold.

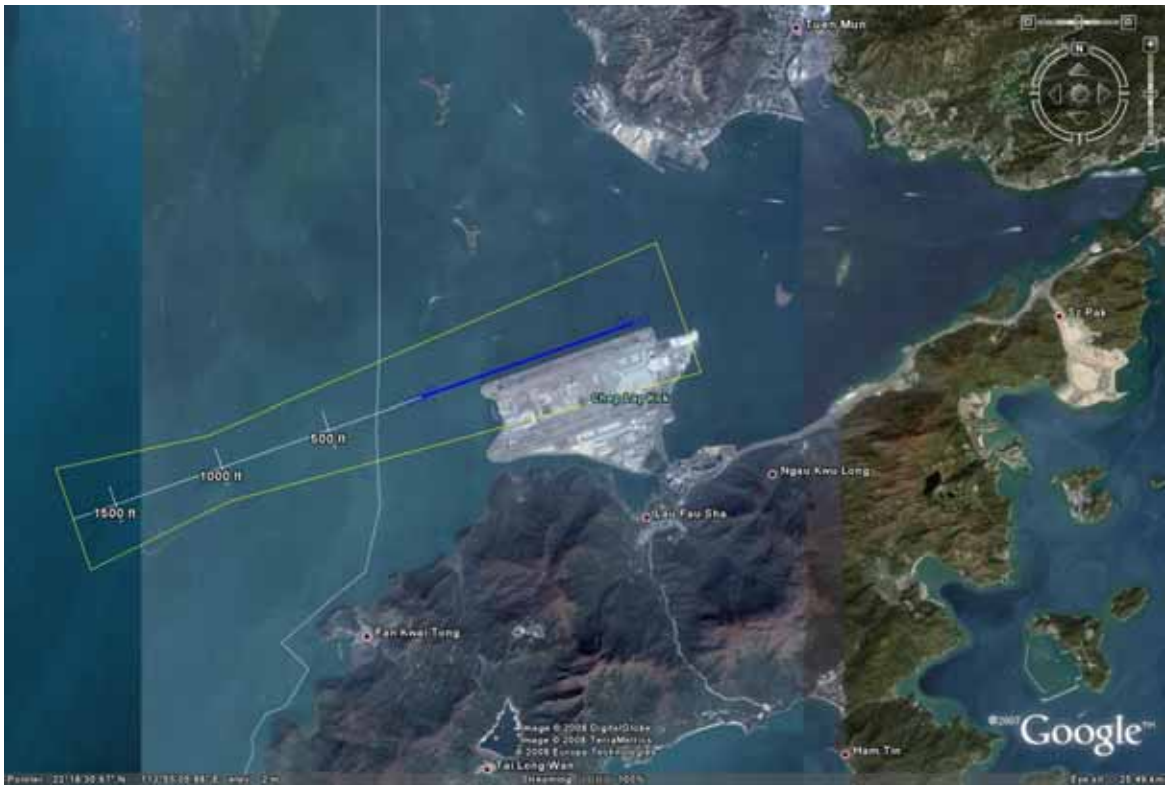

Figure 5.19 Option S Extended (Variants A, B and C) Runway 07L ILS

Figure 5.20 Option S Extended (Variants A, B and C) Runway 07L ILS

5.3.3 Missed Approaches

For 07L, the missed approach turns 45° left. The critical obstacle is the tower on top of Castle Peak which results in a missed approach climb gradient of **6.1%**. For 25R the missed approach turns 45° right. The missed approach climb gradient of **2.5%**. The low level missed approach has a climb gradient of 3.6% and the critical obstacle is the chimneys SW of Tuen Mun.

Table 5.9 Option S Extended (Variants A, B and C) Missed Approaches

Missed Approach	Climb Gradient	Critical Obstacle
07L 45 Left	6.1%	Tower on Castle Peak
07L 135 Left 185 Knots	3.6%	Chimneys SW of Tuen Mun
07L 135 Left 200 Knots	3.6%	Chimneys SW of Tuen Mun
25R 45 Right	2.5%	No Obstacles

Figure 5.21 Option S Extended (Variants A, B and C) Runway 07L 45 degree Missed Approach

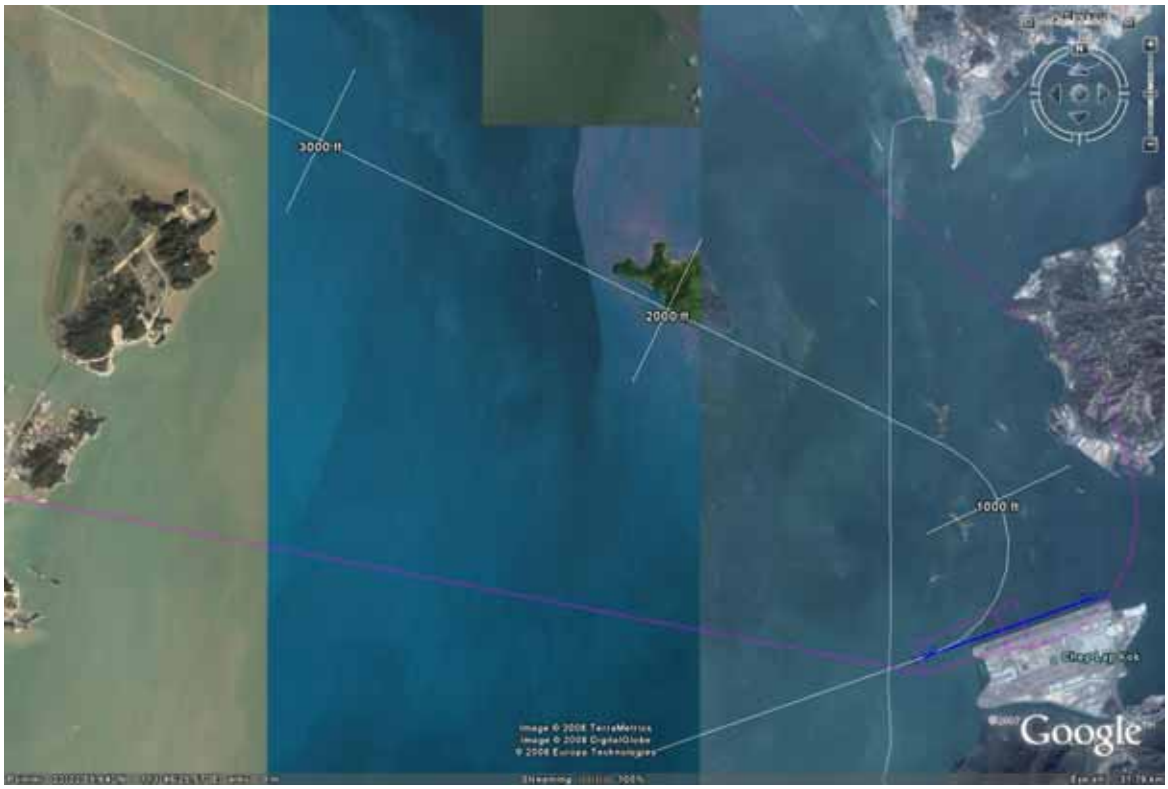

Figure 5.22 Option S Extended (Variants A, B and C) Runway 07L 135 degree Missed Approach 185 knots

Figure 5.23 Option S Extended (Variants A, B and C) Runway 07L 135 degree Missed Approach 200 knots

Figure 5.24 Option S Extended (Variants A, B and C) Runway 25R 45 degree Missed Approach

5.4 Option S Extended Variants (D and E)

Option S was to be located 380m north of the current 07L/25R runway and displaced to the west. Due to the proximity of Option S to the current 07L/25R runway, it would not be possible to design SOIR compliant procedures for westerly operations in this configuration. To alleviate this problem, it was decided to investigate the possibility of extending the runway in both directions as well as displacing it. An extension of 1889m to the west would allow fully SOIR compliant procedures in an easterly direction, while an extension of 1000m to the east would not be fully SOIR compliant in a westerly direction, but would improve the situation and may be operationally more acceptable. The runway is 6689m long with a 300m clearway on each end.

5.4.1 Departures

Table 5.10 Option S Extended (Variants D and E) Minimum SID Climb Gradients

Navigation	Conventional	RNP 1	RNP 0.5	RNP0.3
07L Option S Ext Var D/E	6.8%	6.8%	6.2%	5.1%
25R Option S Ext Var D/E	3.3%	3.3%	3.3%	3.3%
New runway not normally used for departures as proposed for 3-runway operations				

The climb gradients for 07L Option S Extended (Variants D and E) are quite steep due to the proximity of the terrain to the East of the airport. If a reduced TODA and TORA were published then a more reasonable climb gradient could be achieved but this would be highly unusual. Both the airport authority and the civil aviation authority would have to approve such a plan. As part of the PRD airspace review, the SID for

Macau Runway 34 needs to be re-designed. The climb gradient of the Runway 25R SID will then have to be re-assessed to ensure separation from the new Macau SID.

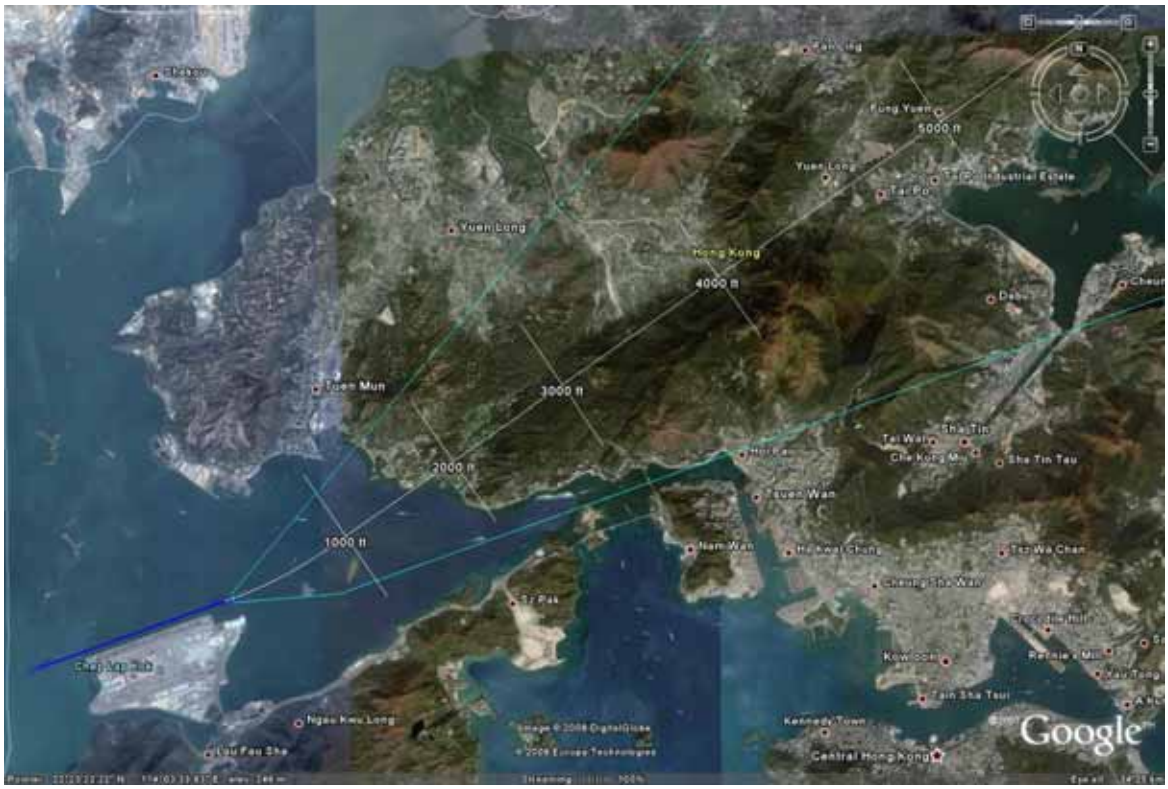

Figure 5.25 Option S Extended (Variants D and E) Runway 07L SID

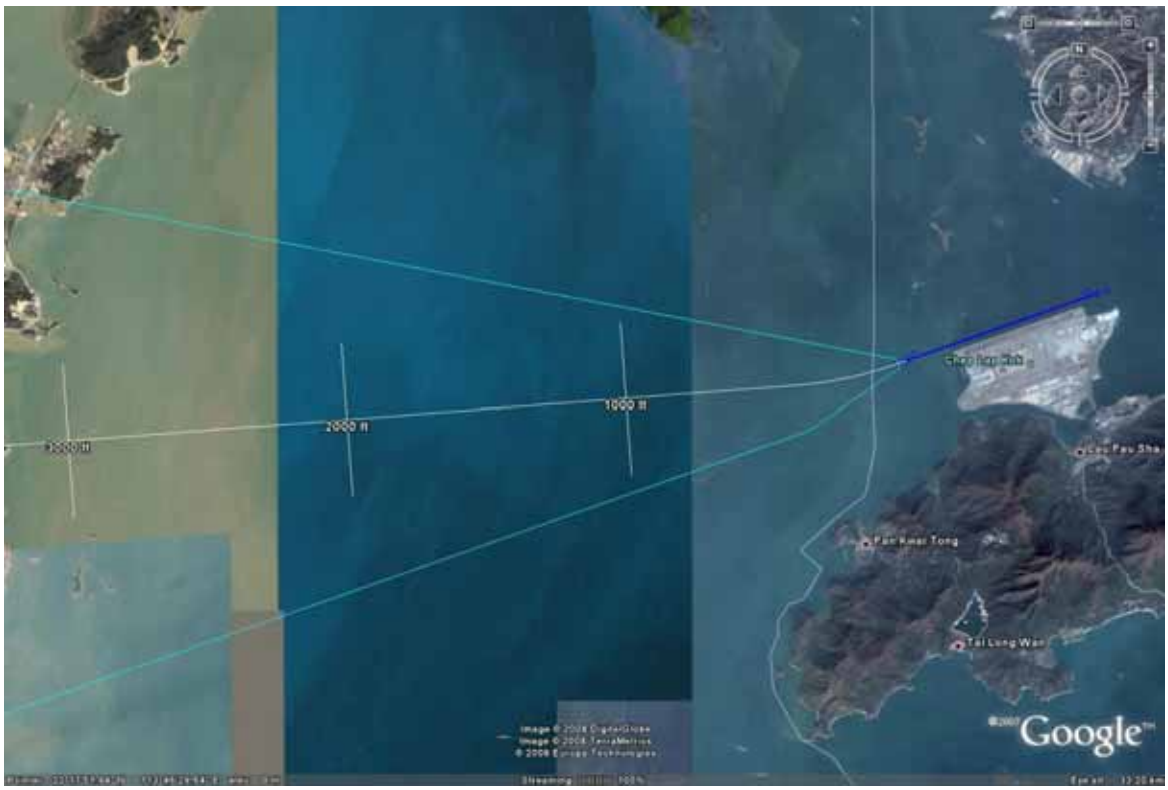

Figure 5.26 Option S Extended (Variants D and E) Runway 25R SID

5.4.2 ILS Approaches

Table 5.11 Option S Extended (Variants D and E) ILS Heights					
Aircraft Category		**A**	**B**	**C**	**D**
07L Option S Ext D/E OCA (OCH)	**CAT I**	**154** (132)	**164** (142)	**173** (151)	**183** (161)
	CAT II	**65** (43)	**82** (60)	**95** (73)	**108** (86)
25R Option S Ext D/E OCA (OCH)	**CAT I**	**154** (132)	**164** (142)	**173** (151)	**183** (161)
	CAT II	**65** (43)	**82** (60)	**95** (73)	**108** (86)

It should be noted that this is an extremely long runway which results in a very narrow localiser beam. These results are only valid if the localiser commissioning report certifies that the course width is 210m at the threshold. An intermediate altitude of 4,000ft has been used, which may require the intermediate segment to be lengthened. There are no penetrations of the obstacle assessment surfaces for 07L Option S Extended (Variants D and E) and only a glide path antenna for 25R which can be ignored. These values are therefore the lowest possible for an ILS.

Figure 5.27 Option S Extended (Variants D and E) Runway 07L ILS

Figure 5.28 Option S Extended (Variants D and E) Runway 25R ILS

5.4.3 Missed Approaches

For 07L, the missed approach turns 45° left. The critical obstacle is the tower on top of Castle Peak which results in a missed approach climb gradient of **6.1%**. For 25R, the missed approach turns 45° right. The climb gradient of **2.5%**. (The calculated climb gradient is 2.2% but the ICAO nominal climb gradient is 2.5%.) The low level missed approach has a climb gradient of 3.6% and the critical obstacle is the chimneys SW of Tuen Mun.

Table 5.12 Option S Extended (Variants D and E) Missed Approaches

Missed Approach	Climb Gradient	Critical Obstacle
07L 45 Left	6.1%	Tower on Castle Peak
07L 135 Left 185 Knots	3.6%	Chimneys SW of Tuen Mun
07L 135 Left 200 Knots	3.6%	Chimneys SW of Tuen Mun
25R 45 Right	2.5%	No Obstacles

Figure 5.29 Option S Extended (Variants D and E) Runway 07L 45 degree Missed Approach

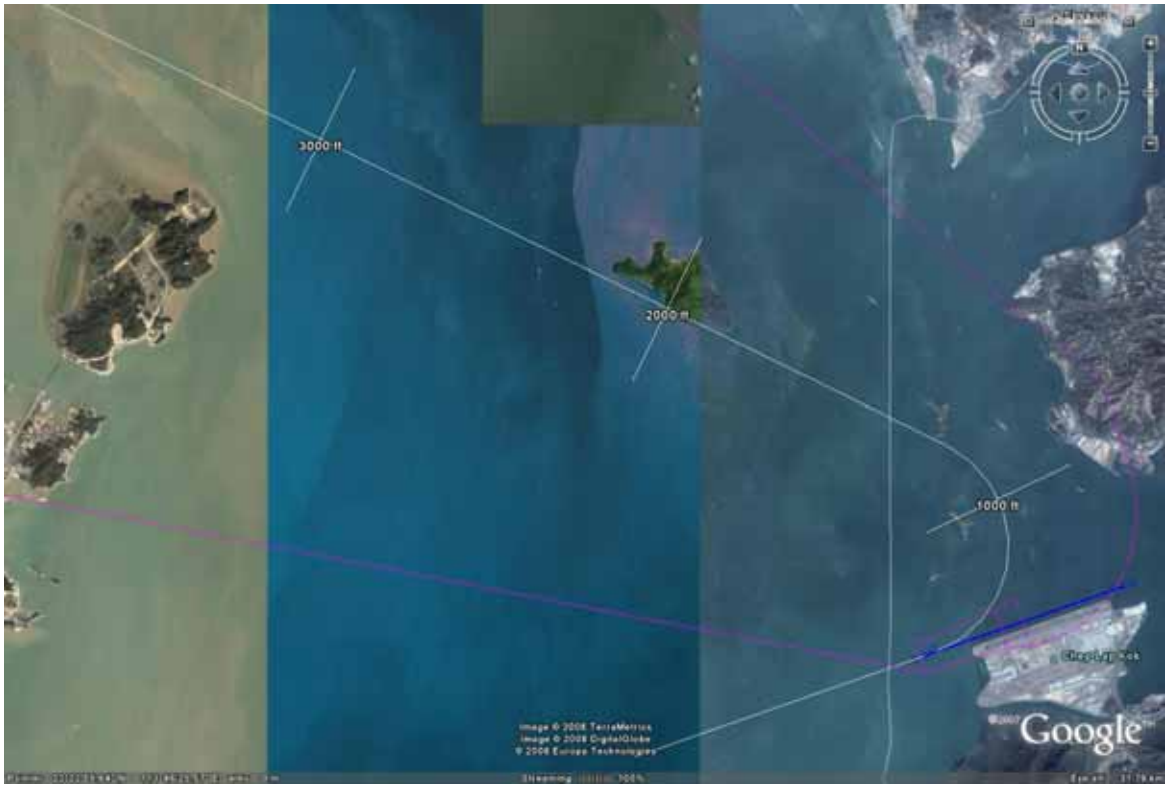

Figure 5.30 Option S Extended (Variants D and E) Runway 07L 135 degree Missed Approach 185 knots

Figure 5.31 Option S Extended (Variants D and E) Runway 07L 135 degree Missed Approach 200 knots

Figure 5.32 Option S Extended (Variants D and E) Runway 25R 45 degree Missed Approach

APPENDIX C – METEOROLOGICAL REPORT BY HKO

香港天文台
HONG KONG OBSERVATORY

Our ref.: HKO 350/184/10

14 March 2008

Airport Authority Hong Kong
(Attn.: Mr. Chris Au Young)
HKIA Tower, 1 Sky Plaza Road
Hong Kong International Airport
Lantau, Hong Kong
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Airspace and Runway Capacity Study Phase 2
Deliverable 4, Second Technical Report (March 2008)
Comments of HKO

Reference is made to the meeting on 7 March 2008 among AAHK, CAD, HKO and NATS on the captioned Report. Further to our discussion in the meeting, please find attached the detailed comments of HKO for your consideration and incorporation into the Report. The comments include the meteorological factors which may affect the usage of the third runway as well as the meteorological observations, instrumentation and data processing required for the operation of this runway. We hope that the information would be useful to your airspace and capacity study at present, as well as the detailed engineering study of the third runway to be carried out in the future.

Please note that the attached document includes general comments applicable to all runway options and specific comments for each option. For those runway options marked as "discounted" in the captioned Report, we were given to understand in the above meeting that they would not be pursued further by AAHK and as such only the major comments are provided.

As spoken in the above meeting, we would be happy to provide further inputs on the captioned study from meteorological perspectives. Please keep us posted on the progress of the matter.

Yours sincerely,

(P.W. Chan)
for Director of the Hong Kong Observatory

Encl.
c.c. CAD (Attn.: Mr. Raymond Li) – fax: 2910 0186

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HKO's comments on the
Second Technical Report (first draft dated 3.3.2008), Deliverable P4,
Airspace and Runway Capacity Study Phase 2

General Comments

1. Meteorological factors:

(a) It is recommended that the consultants should take into consideration the effects of weather, including, *inter alia*, crosswind, low visibility, thunderstorms, sea breeze, windshear and turbulence, as well as aircraft wake vortex in predicting the capacity of the third runway. HKO will support the consultant studies by providing available climatological information and statistics.

(b) In respect of windshear and turbulence, the meteorological studies leading to the setting up of the existing Windshear and Turbulence Warning System (WTWS) only covered the two existing runways. Depending on the location and orientation of the third runway, it is recommended that another study of the effects of low-level windshear and turbulence be conducted by the consultants on this new runway to ensure flight safety.

(c) The captioned draft Report mentioned in various places about "wave effects of the north eastern monsoon and the resulting winds have a long fetch". It is recommended that wave effects of both east to northeasterly flow and southwesterly flow (in association with the northeast monsoon, southwest monsoon, and tropical cyclones, etc.) be considered by the consultants.

2. Meteorological observations, instrumentation, and data processing:

(a) In respect of meteorological support for the third runway itself, it is recommended that the consultants should reflect in their study reports:

- the need of enhancing the existing provision of meteorological observations and reports and instrumentation, including, *inter alia*, additional anemometers, visibility and RVR sensors, and ceilometers, for weather measurement along the third runway and its approach/departure corridors, and the associated Aerodrome Meteorological Observing System for processing and displaying the additional weather data for the forecasters and air traffic controllers. These enhancements are in general applicable to all runway options;
- the need of enhancing the existing WTWS for providing runway-specific windshear and turbulence alerts for the third runway, including, *inter alia*, enhancement of the LIght Detection and Ranging (LIDAR) Windshear Alerting System (LIWAS), Terminal Doppler Weather Radar (TDWR) system, anemometer-based windshear alerting system (including weather buoys), and turbulence alerting system components;
- the need of enhancing the existing Airport Thunderstorm and Lightning Alerting System (ATLAS) and of establishing new/additional observation points to cover the additional airport area arising from the construction of the third runway;
- the need of enhancing the existing meteorological data processing systems for the transmission and reception of the additional meteorological data for the third runway, for the generation of meteorological information and products from the data, and for

display and dissemination of the meteorological information and products to the forecasters and aviation users. This will apply to all runway options even though the extent of the enhancement would depend on the new/additional instrumentation/observation points and the enhanced provision of meteorological information and products required.

(b) In respect of installation of anemometers for the third runway, it is recommended that the consultants should design the third runway and its taxiways to allow installation of anemometers following ICAO and WMO requirements so that their measurements are representative of the wind conditions along the runway (especially at the runway thresholds) and not adversely affected by aircraft jet blast/wake vortex. In particular, locations between two closely spaced parallel runways will be frequently affected by aircraft jet blast/wake vortex and are therefore not suitable for installation of anemometers.

(c) In respect of meteorological support for the increase in air traffic brought by the third runway, it is recommended that the consultants should reflect in their study reports that the third runway will bring further increase of air traffic at the airport and neighbouring airspace, requiring development of enhanced meteorological products, e.g. thunderstorm nowcasting products, meteorological inputs to reduced separation and capacity declaration, etc. to increase the efficiency of air traffic flow control and management in the region. This will be further elaborated in HKO's comments on the Airspace and Runway Capacity Study Phase 1 report (Deliverable 0.6).

Specific comments on the runway options (Section 6 of the captioned draft Report):

Option A (discounted)

Meteorological factors:

- The prevailing wind in Hong Kong is easterly. With the proposed orientation, the utility of the third runway would be affected by strong crosswind. Therefore, the estimated capacity increase of 35 departures brought by the third runway will need to be re-visited.
- The 07R arrival is indicated as the only arrival corridor for the 07 configuration, which is the main runway direction used at HKIA due to the prevailing easterly wind in Hong Kong. Compared with the 07L arrival corridor which is currently the mostly used arrival corridor for HKIA, the 07R arrival corridor is more frequently affected by terrain-induced windshear and turbulence due to its proximity to the complex terrain of Lantau Island. As a result, the level of safety and efficiency (e.g. more missed approaches due to windshear) of flight operations at HKIA will likely be decreased.

Meteorological observations and instrumentation:

- A separate LIDAR, a separate weather radar, additional weather buoys would be required for the third runway for windshear and turbulence alerting because this runway could not be covered by the existing LIDARs, TDWR and weather buoys in the provision of runway-orientated windshear, microburst and turbulence alerts.

Option B

Meteorological factors:

- The operation of the third runway may be affected by terrain-induced windshear and turbulence as well as localized thunderstorm development in association with Castle Peak.
- With the third runway further north of the existing airport island, its operation may be more frequently affected by the lower visibility in north to northwesterly winds.
- Airflow disturbances associated with the new concourse south of the third runway, if built, may affect the third runway, e.g. in southeasterly to southwesterly flow.
- The 07R arrival is indicated as the only arrival corridor for the 07 configuration, which is the main runway direction used at HKIA due to the prevailing easterly wind in Hong Kong. Compared with the 07L arrival corridor which is currently the mostly used arrival corridor for HKIA, the 07R arrival corridor is more frequently affected by terrain-induced windshear and turbulence due to its proximity to the complex terrain of Lantau Island. As a result, the level of safety and efficiency (e.g. more missed approaches due to windshear) of flight operations at HKIA will likely be decreased.

Meteorological observations and instrumentation:

- Apart from installing a complete suite of instrumentation for meteorological measurement along the third runway and its approach/departure corridors, a new/relocated office for weather observation by human weather observers together with a separate meteorological garden may be required for the third runway because this runway is far away from the existing office and meteorological garden on the control tower located between the two existing runways. The distance from the existing office to 3 NM beyond the arrival runway threshold is roughly 9 km, larger than the 8 km coverage of aerodrome observation required by Annex 3 of ICAO.
- A separate LIDAR and additional weather buoys would be required for the third runway for windshear and turbulence alerting because this runway could not be covered by the existing LIDARs and weather buoys in the provision of runway-orientated windshear and turbulence alerts.

Options C and D

Meteorological factors:

- The operation of the third runway may be affected by terrain-induced windshear and turbulence as well as localized thunderstorm development in association with Castle Peak.
- With the third runway further north of the existing airport island, its operation may be more frequently affected by the lower visibility in north to northwesterly winds.
- Airflow disturbances associated with the new concourse for the third runway, if built, may affect the third runway, e.g. in southeasterly to southwesterly flow, as well as the centre runway, e.g. in northeasterly to northwesterly flow.

Meteorological observations and instrumentation:

- Apart from installing a complete suite of instrumentation for meteorological measurement along the third runway and its approach/departure corridors, a new/relocated office for weather observation by human weather observers together with a separate meteorological garden may be required for the third runway because this runway is far away from the existing office and meteorological garden on the control tower

located between the two existing runways. The distance from the existing office to 3 NM beyond the arrival runway threshold is roughly 9 km, larger than the 8 km coverage of aerodrome observation required by Annex 3 of ICAO.

- A separate LIDAR and additional weather buoys would be required for the third runway for windshear and turbulence alerting because this runway could not be covered by the existing LIDARs and weather buoys in the provision of runway-orientated windshear and turbulence alerts.

Options E and F

Meteorological factors:

- Depending on the location of the new concourse south of the third runway, if built, airflow disturbances associated with it may affect the third runway, e.g. in southeasterly to southwesterly flow, as well as the centre runway, e.g. in northeasterly to northwesterly flow.

Meteorological observations and instrumentation:

- A separate LIDAR and additional weather buoys would be required for the third runway for windshear and turbulence alerting because this runway could not be covered completely by the existing LIDARs and weather buoys in the provision of runway-orientated windshear and turbulence alerts.
- A complete suite of instrumentation for meteorological measurement along the third runway and its approach/departure corridors should be installed. The anemometers installed for the centre runway may need to be re-located to south of the runway to avoid adverse effects by jet blast/wake vortex and possible obstruction by the new concourse between the third and centre runways.

Options G and H

Meteorological factors:

- Due to its proximity, the new concourse east of the centre runway, if built, may generate airflow disturbances to affect the third runway and the centre runway.

Meteorological observations and instrumentation:

- The third runway and the centre runway are rather close together. A LIDAR-based wake vortex monitoring and alerting system would need to be in place. The LIDAR would also be used for windshear and turbulence alerting over the third runway. Additional weather buoys / relocation of the existing weather buoy(s) may also be required for windshear alerting.
- The anemometers installed for the centre runway may need to be re-located to avoid adverse effects by jet blast/wake vortex.

Option J (discounted)

Meteorological factors:

- Depending on the distance away from Lantau Island, the third runway could be affected by terrain-induced windshear and turbulence in northeasterly to northwesterly flow.
- Located close to the South China Sea, the third runway may be more affected by sea fog, e.g. in spring time, as well as sea waves effects of southerly flow in association with the southwest monsoon and tropical cyclones.

Meteorological observations and instrumentation:

- The third runway is effectively a new airport. The whole suite of meteorological instrumentation and observational facilities would be required, including, inter alia, new office for weather observation, new meteorological garden, complete suite of instrumentation for meteorological measurement along the third runway, separate LIDAR, separate weather radar and additional weather buoys for windshear and turbulence alerting.

Option K (discounted)

Meteorological factors:

- Due to its proximity to Lantau Island, the third runway would be affected by terrain-induced windshear and turbulence.

Meteorological observations and instrumentation:

- A separate LIDAR and additional weather buoys would be required for the third runway for windshear and turbulence alerting because this runway could not be covered completely by the existing LIDARs and weather buoys in the provision of runway-orientated windshear and turbulence alerts.

Option M (discounted)

Meteorological factors:

- Depending on the distance away from Castle Peak, the operation of the third runway may be affected by terrain-induced windshear and turbulence as well as localized thunderstorm development in association with Castle Peak.

Meteorological observations and instrumentation:

- The third runway is effectively a new airport. The whole suite of meteorological instrumentation and observational facilities would be required, including, inter alia, new office for weather observation, new meteorological garden, complete suite of instrumentation for meteorological measurement along the third runway, separate LIDAR, separate weather radar and additional weather buoys for windshear and turbulence alerting.

Option N (discounted)

Meteorological factors:

- Due to its proximity, the new concourse south of the third runway, if built, may generate airflow disturbances to affect the third runway and the centre runway.

Meteorological observations and instrumentation:

- The third runway and the centre runway are rather close together. A LIDAR-based wake vortex monitoring and alerting system would need to be in place.
- Another LIDAR would be required for the third runway for windshear and turbulence alerting because this runway could not be completely covered by the existing LIDARs.

Option P and R

Meteorological factors:

- With the third runway further north of the existing airport island, its operation may be more affected by the lower visibility in north to northwesterly winds.

- Airflow disturbances associated with the new concourse may affect the third runway, e.g. in southeasterly to southwesterly flow, as well as the centre runway, e.g. in northeasterly to northwesterly flow.

Meteorological observations and instrumentation:

- Apart from installing a complete suite of instrumentation for meteorological measurement along the third runway and its approach/departure corridors, a new/relocated office for weather observation by human weather observers together with a separate meteorological garden may be required for the third runway because this runway is far away from the existing office and meteorological garden on the control tower located between the two existing runways. The distance from the existing office to 3 NM beyond the arrival runway threshold is roughly 10 km, larger than the 8 km coverage of aerodrome observation required by Annex 3 of ICAO.
- A separate LIDAR would be required for the third runway for windshear and turbulence alerting. With significant westward extension, this runway could not be covered completely by the existing LIDARs.
- Additional weather buoys would be required for the third runway for windshear alerting because this runway could not be covered by the existing weather buoys in the provision of runway-orientated windshear alerts. However, there may not be sufficient space within the Hong Kong waters to the west of the third runway to install weather buoys for windshear alerting purpose.

Option S and S – extended

Meteorological factors:

- Airflow disturbances associated with the new concourse may affect the third runway and the existing runways.

Meteorological observations and instrumentation:

- Apart from installing a complete suite of instrumentation for meteorological measurement along the third runway and its approach/departure corridors, a new/relocated office for weather observation by human weather observers together with a separate meteorological garden may be required for the third runway because this runway is far away from the existing office and meteorological garden on the control tower located between the two existing runways. The distance from the existing office to 3 NM beyond the arrival runway threshold is roughly 11 km, larger than the 8 km coverage of aerodrome observation required by Annex 3 of ICAO.
- A separate LIDAR would be required for the third runway for windshear and turbulence alerting. With significant westward extension, this runway could not be covered completely by the existing LIDARs.
- Additional weather buoys would be required for the third runway for windshear alerting because this runway could not be adequately covered by the existing weather buoys in the provision of runway-orientated windshear alerts. However, there may not be sufficient space within the Hong Kong waters to the west of the third runway to install weather buoys for windshear alerting purpose.
- The third runway and the centre runway are close together. A LIDAR-based wake vortex monitoring and alerting system would need to be in place.