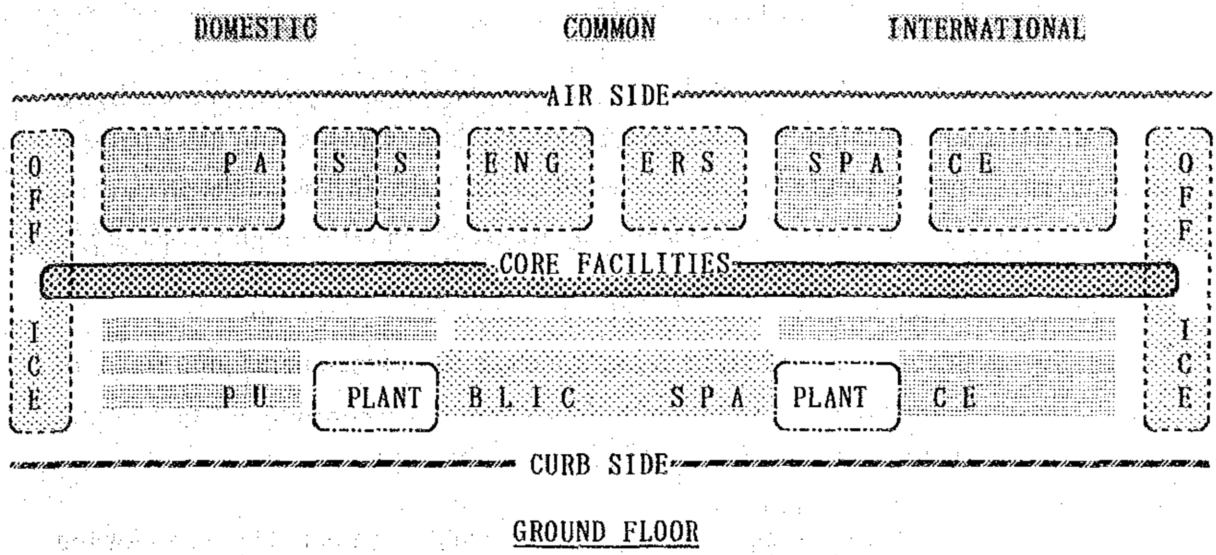


Figure 9.3-4 Block Planning

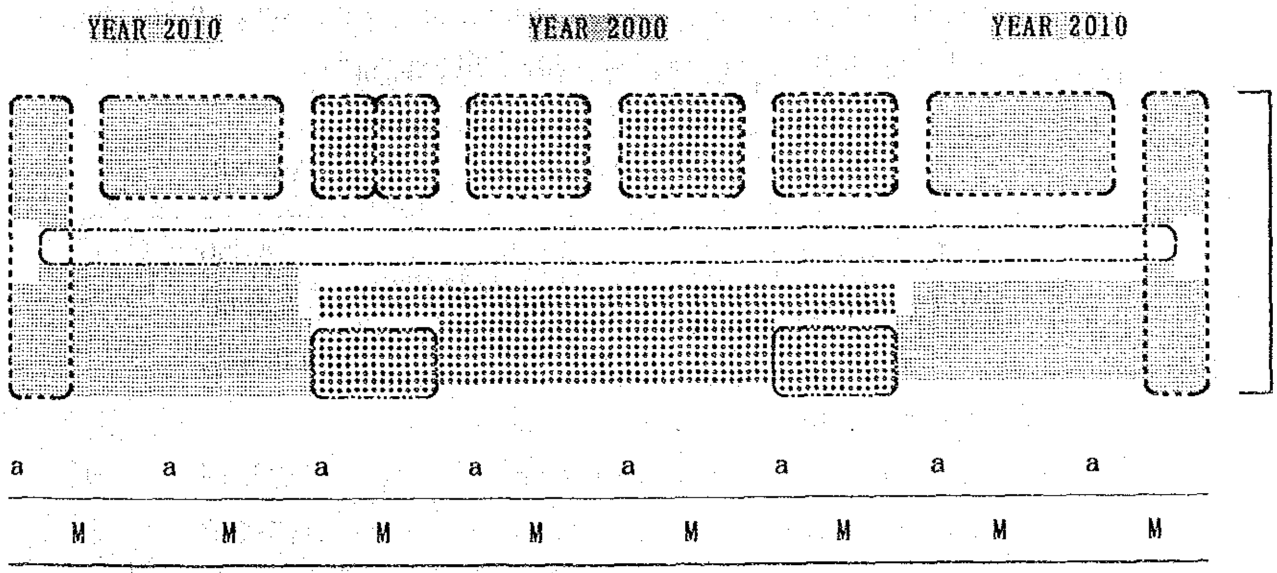


Figure 9.3-5 Modular Planning

9.3.2 Cargo Terminal

1) Scale of Cargo Terminal Building

Most of the methods to calculate air cargo area requirements are based on the concept of the Average Peak Day. Considering the relatively simple nature and small scale of the operation in Tokua, the gross-area-per-ton parameter is used to figure out the general cargo storage space based on annual volume.

It is considered that the larger the air cargo movements, unit figure of cargo treatment becomes larger because of mobilization of larger aircraft and an increase of a cargo treatment efficiency.

Unit figure of the gross-area-per-ton will be computed by the following manner according to a guide line of Japanese Transportation Ministry.

Unit figure (B)f/m2 = $0.0096\ V^{0.77}$

Based on a projection of cargo movements by the Study Team, the following is the summary of air cargo building sizes.

	Year 2000	Year 2010
Cargo t/year(A)	3,320	6,650
Unit figure (B)	5t/m^2	8.4t/m^2
	(0.2m^2/t)	(0.119m^2/t)
Air lines space(C)		
C=A/B	664m^2	792m^2
Agencies' space(E)	332m^2	396m^2
Total (C+E)	996m^2	1,188m^2

Agencies' space (E) is calculated as 50% of air lines space(C).

The depth of a cargo building is somewhat between 15 m - 20 m for the scale of this cargo terminal.

2) Design Concept

a) Airlines' space and agencies' space

Air lines and agencies space are planned to be attached to each other in this case, since the annual volume of cargo is smaller than 5,000 t. In case the annual volume of cargo is larger than 10,000 t, airlines and agencies space are located separately.

b) Considering the manner of handling air cargo in Tokua Airport, the majority of the cargo will be carried by passenger flights. Exclusive air cargo freights would be quite limited. Accordingly, the cargo terminal area should be located close to the passenger terminal apron. Access to the cargo terminal should be clearly separated from the access to the passenger terminal building.

c) International Freight

Since the volume of international freight handled at Tokua is envisaged to be quite small, international freight is planned to be handled at a corner of the domestic warehouse by designating the corner as a bonded area.

d) Cold Storage

Provision will be made for the installation of cold storage facilities for both imports and exports, but particularly for exports. However, it is recommended that these facilities be constructed by airlines and/or cargo agents. The policy is that the individual companies should install and operate them at their own expense.

9.3.3 Access Road and Parking Lot

1) Access Road

Peak hour traffic volume of the access road is estimated on the assumption that the passengers and visitors come in and go out of the airport with a certain time lags before departure and after arrival of aircraft, that is, the departing passengers and their greeters will arrive at the airport 60 minutes before the departure time, and the arriving passengers and their greeters will leave the airport 30 minutes after the arrival time.

Peak Hour Traffic Volume

Items	Volume in Years		Remarks
	2000	2010	
Peak Hour Traffic	274	373	Both Directions
Designed Hour Traffic	180	250	One Directions

Accordingly, two lanes of carriageway (one each) for both directions should be provided with the projected volume.

2) Parking Lot

The required number of cars to park in a parking lot is calculated by the following formula:

$$E = P \times C$$

where, E : Required number of cars to park

P : Number of passengers at peak hour

C : Number of cars to park per passenger at peak hour (assumed C = 0.8/one passenger at peak hour)

The number of cars to park and the area of car parking lot is calculated as shown below.

Number of Cars to Park and Area Requirements

Items	Quantities in Years	
	2000	2010
No. of Car to Park	206	284
Parking Lot Area	5,200 m^2	7,100 m^2

9.4 Airport Support Facilities

9.4.1 Control Tower

As noted earlier, none of ATC facilities have existed in the Tokua Airfield. It is essential to install control tower in the first phase development, as suggested by DCA programme to provide ATC services in the region, since ICAO specifies that ATC facilities should be provided for an airport to be utilized for international operations. The location and the height of the tower has to be carefully designed that a controller can command a good view of all movement of aircraft in the air and on the ground and of vehicles on the ground. The design should be free from an exterior sound, dust and humidity and be in conformity with other requirements as mentioned as the following.

1) Basic Considerations

(1) Siting Requirements

The control tower is designed to meet the specific requirements for siting as listed up hereunder. (The first four requirements are considered as mandatory.)

a) Primary consideration must be given to the local control position. A clear, unobstructed and direct view of the approach to the end of the primary instrument runway and all other active runways and landing areas is required .

b) Complete visibility of all airport surface areas to be utilized in aircraft movement under the control of the air traffic control tower must be secured. Primary consideration must be given to the ground control position, though all operating positions should have the same capability. A clear, unobstructed and direct view of taxiway and runways is required.

c) Depth perception must be secured to permit control tower staff to differentiate the number and type of grouped aircraft and/or ground vehicles, and to observe their movement and position relative to the airport surface areas. Perception is enhanced where the controller's line of sight is perpendicular or oblique, not parallel, to the line established by aircraft and/or ground vehicle movement, and where the line of sight intersects the airport surface at a vertical angle greater than 35 minutes.

d) A site plot of sufficient area is to be secured to accommodate the initial and future building area with its expanded dimensions, personnel and facility vehicle parking, if required, and fuel storage as dictated by local requirements.

e) The tower cab should be oriented towards south direction or alternatively east, north, or west, in the order of preference in the southern hemisphere. Avoid orientations that will place a view of the runway approach in line with rising or setting sun.

f) Visibility is to be unimpaired by direct or indirect external light sources. Such sources are ramp lights, parking area light, and reflective surfaces.

g) Visibility is to be secured of all ground operations of aircraft and ground vehicles not previously specified, on ramps, parking areas and test areas.

h) Consideration of local weather phenomena to preclude restriction to visibility due to fog or ground haze.

i) Minimize exterior noise and signal interference to electronic equipment.

j) Minimize exterior noise and signal interference to electronic equipment.

k) Provide an access to the site which avoids areas of aircraft operations.

(2) Tower Cab Eye Level Determination

The grade of the airport traffic surface for each section must be considered. Where the section in question encompasses a rising taxiway grade leveling off at a runway end (the fartherest point) the grade of the runway end in the direction of the line of sight is the most important. The movement of aircraft and/or ground vehicles on the taxiway will be discernible if the 35 minute minimum angle is established relative to the runway grade, thus affording the ability to determine the position of aircraft and/or ground vehicles on the runway. However, if the taxiway grade slopes down to the runway end, the 35 minute minimum angle should be established relative to the taxiway. The minimum eye level elevation for a particular tower site can be determined by the following formula:

Ee = Eas+D tan.(35 min. +Gs)

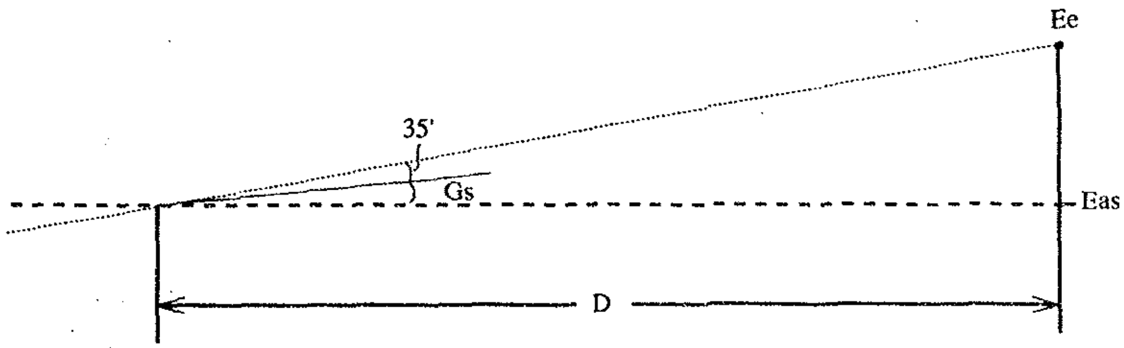
Where:

Ee = Eye level elevation (Cabin floor elevation +1.5 m)

Eas = Average elevation for section of airport traffic surface in question

D = Distance from proposed tower site to section of airport traffic surface in question.

Gs = Angular slope of airport traffic surface measured from horizontal and in direction of proposed tower site.



(3) Operational Considerations

a) The tower should be equipped so as to permit the controller reliable, clear and rapid communications with aircraft in his area of responsibility.

b) Reflections in the cab glass and sun or lamp glare through the windows should be kept to a minimum. Vertical supports for the cab roof should be kept to the smallest feasible diameter so as to minimize their obstruction of the controller's view. The supports should also be as few as possible commensurate with minimizing refections.

c) The layout of working positions will be determined by the locations of the tower in relation to the maneuvering area, and more especially, the approach direction which is most frequently used at the aerodrome. The tower consoles should be designed so as not to exceed the height of the window sill.

d) Flexibility and far-sightedness are primary considerations in the initial installation in order to avoid major structural or installation modifications in the future due to changing operational requirements.

e) Ideally,a control tower should be of the required height and should have ample space to ensure an optimum working environment for personnel (including expansion capabilities), be energy efficient, durable and aesthetically pleasing,all at moderate cost.

f) Therefore, at the important aerodromes or at those where significant future traffic developments are expected, it is better to have a separate control tower structure which is optimally sited, specifically designed to fulfil its operational purpose and whose height is sufficient to best meet ATC needs.

(4) Structural Requirements

Free-standing control towers have 3 main components: Cab Shaft and Base-Building. The space reserved for the tower cab should be ample but not excessive. The dimensions of polygonic cabs are suggested as follows:

Level of Activity		Approximate Number of Personnel Simultaneously Present in Cab	Cab Area (m2)
Low	:	Not more than 6	21
Intermediate	:	Between 6 and 12	32
Major	:	More than 12	50

a) Minimum clear height from cab floor to ceiling should be 3 m.

b) There should be a walkway around the exterior of the tower cab. The walkway should be as narrow as possible and as low as possible, including railing, so as not to impair the controller's close-down view.

c) Due to its location, a control tower cab is normally exposed to changes in atmospheric conditions and a wide variance in temperature. Therefore, a good air circulation is required to retain reasonable working conditions.

d) Where required, a building at the base of the tower shaft may be added as a single or multiple story structure.

e) The combination of a base building with a non-functional tower shaft limits the use of the shaft to the point where it houses only a minimal amount of mechanical and electronic equipment but no support personnel

f) A single or two-story base building lends itself to a more convenient and efficient circulation of people. The disadvantages are larger site required and higher construction costs.

g) A free-standing functional shaft, without an associated base building requires a small area. It can be readily constructed in prefabricated sections and assembled on location in less time than a conventional building.

h) The combination of a base building with a non-functional tower shaft limits the use of the shaft to the point where it houses only a minimum amount of mechanical and electronic equipment but no support personnel

i) A single or two-story base building lends itself to a more convenient and efficient circulation of people. The disadvantages are larger site required and higher construction costs.

9.4.2 Administration Building

Based on the organization chart shown in Figure 10.7-1 required area is roughly figured out. More elaboration will be made during the course of the subsequent study.

9.4.3 CFR Building

1) As an essential requirement of the airport fire station, ICAO states that its location should ensure that response time for aircraft accidents and incidents is two minutes, and do not exceed three minutes, to the end of each runway in optimum conditions of visibility and surface conditions. Since it is observed that a large proportion of aircraft accidents and incidents occur on, or close to, the runways.

2) Considering the proximity of the sea on both end of the runway, access roads should be provided to each side. By the same reason launching ramps and crash gates should be provided as well.

3) Fire Fighting Equipments

Following equipments are to be installed for B737;

- 2 Major fire vehicles
- 1 Light vehicle
- 2 Rescue boats plus life rafts
- 5 Breathing apparatus plus accessories
- 16 Firemen to man the unit
- Communication and alerting equipment and circuitry

- 10,000 Litres overhead water tank
- Fire hydrants, booster pump
- Overhead fuel tank
- Drill tower
- Hoist for drying hoses
- Rescue equipments

Above B737 requirements plus followings for B747;

- 1 Major vehicles
- 4 Fire men to man the unit

9.4.4 Maintenance Shop

The maintenance shop is expected to perform a complete overhaul of vehicles and construction and maintenance equipment. The equipments to be provided in the maintenance shop are as follows;

1) Lifting and moving equipment
2) Compressed air equipment
3) Lubrication equipment
4) Printing equipment
5) Metal forging equipment
6) Welding equipment
7) Oxy-acetylene cutting/welding equipment
8) Washing equipment
9) Engine reconditioning equipment
10) Electric equipment
11) Battery chargers
12) Body-fender repair equipment
13) Truck overhaul and tire service equipment
14) Machine tools

Besides mechanical workshop and depot, there are depot for ground services and workshop for building maintenance.

9.4.5 Fuel Farm

The fuel supply facilities as they are now at the existing Rabaul Airport, will be provided and operated by private oil companies for all future development stages. To this end, no investment plan will be assumed. However, for the purpose of planning a fuel farm, its location, approximate dimension, and the required capacity of the fuel supply facilities have been estimated as follows:

1) Fuel Storage Capacity Requirements

The required fuel storage capacity should be based on the type of operating aircraft, frequency of operations, fuel uplift per aircraft and different type of fuel required, for a period of time determined by the reserved policy of an airport. It is, however, a common practice at many airports to provide a storage capacity for one week demand. The required fuel storage capacity as shown below.

Table 9.4-1 Required Amount of Fuel per Week

Aircraft Type	Kind of Fuel	Total Capacity (kl)	
		2000	2010
B747	JPA-1	–	564
A310, B767	JPA-1	54	231
B737, MD80s	JPA-1	200	387
DHC8, DHC7 and Small Aircraft		71	110
Total		325	1,292

In computing the required fuel storage capacity at the airport, the following design standards and assumption are used:

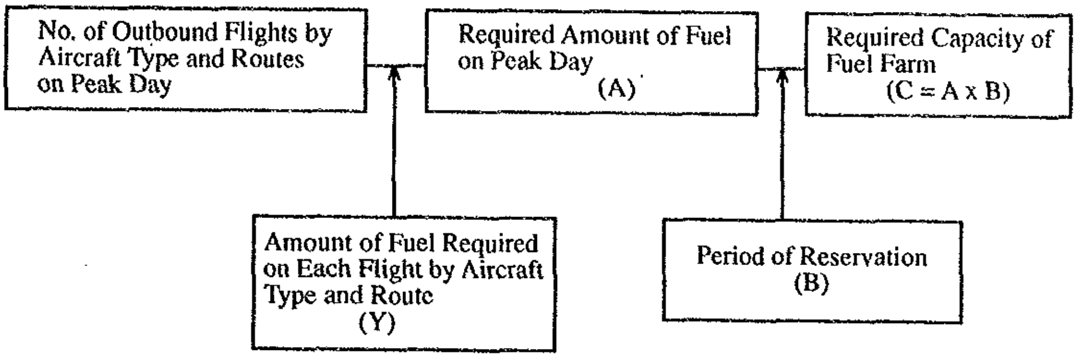
(1) Design Standards: Airport Facilities Design Standard, Ministry of Transport, Japan

(2) All originating and stop-over flights would get fuel at the airport

(3) All aeroplanes would load fuel enough to a next destination.

excluding the routes of Madang, Wewak and Manus.

Thus, the required storage capacity can be obtained in accordance with the following procedures:



where, Y is determined by the following equations by the aircraft type:

Aircraft Type	Y (kl)
Large Jet	$Y = 0.013 X + 4.80$
Medium Jet	$Y = 0.0076 X + 3.20$
Small Jet	$Y = 0.0041 X + 0.75$
Non Jet	$Y = 0.001 X + 0.60$
Small Aircraft	$Y = 0.0002 X + 0.12$

Note: X is distance (km) to the next refueling airport

2) Fuel Tank Yard

The location of fuel tank yard would be located at the west end of the concourse of the passenger terminal building, inside of the airport compound.

The capacity of tanks in the storage yard should be of 330 kl in the year 2000 and 1,290 kl in the year 2010. Assuming that each tank has a storage capacity of 300 kl, 6 tanks in the minimum tank yard area is estimated at approximately 6,000 m^2 in the year 2010.

9.4.6 Electrical Facilities

Electrical power supply at Tokua Airport will consist of a commercial power and stand-by power of diesel engine generators.

Commercial power at Tokua Airport should be extended from Kokopo. The Kokopo power transmission lines presently has the maximum supply capacity of 2 M watts which will be insufficient considering the airport's large load of its required scales. Therefore the current "Area and Zone Substation MVA Load Forecast" in Gazelle system planned by the Electricity Commission should be reconsidered including the Tokua Airport development project.

The secondary power supply will be catered by the diesel engine generators in combination with uninterruptible power system (UPS) to prevent from interruption in case of transferring from the main power to the secondary power. Some radio facilities and computers can not allow even a few seconds of interruption.

9.4.7 Water Supply and Sewage Treatment

1) Water Supply

Water consumption in general is relation to type of facilities. In the airport area the following water consumption rates are commonly used in Japan.

Passenger terminal area	0.023 t/m^2
Cargo terminal area	0.003 t/m^2
Administration area	0.009 t/m^2

Peak day consumption:

	Year 2000	Year 2010
Passenger terminal	115.0 t	184.0 t
Cargo terminal	1.1 t	1.8 t
Administration	5.4 t	10.8 t
Others (10% of above)	12.2 t	19.7 t
Total	133.7 t	216.3 t

As a maximum consumption of a peak day 50% of above total amount is added;

	Year 2000	Year 2010
Maximum water consumption;	200 t	324 t

However, this is the case in Japan. Considering the situation of Rabaul, Probably 50% of this amount is sufficient.

Therefore, the estimated water demand for Tokua Airport will be;

Year 2000	:	100 t/day
Year 2010	:	162 t/day

2) Sewerage Treatment

Future waste water volume were estimated based on the future water consumption demand multiplied by a return factor. For year 2000, 80 t/day of waste water are expected to be dispersed from the airport site and by year 2010, 130 t/day.

9.5 Operation Equipments

9.5.1 Navigation Aids

Aiming at reducing the hazard to aircraft to a minimum, navigation aids are essential to guide aircraft for the safety operations.

1) Aids to final approach and landing

Non-visual aids to final approach and landing are the instrument landing system (ILS) and the microwave landing system (MLS). Since it is intended that transition from ILS to MLS be in accordance with an ICAO transition plan as a boundary in 1998, MLS should be introduced in Tokua Airport.

2) Short-distance aids

In localities and along routes where conditions of traffic density and low visibility necessitate a ground based short-distance radio aid to navigation for the efficient exercise of air traffic control, or where such short-distance aid is required for the safe and efficient conduct of aircraft operations, the aid is the VHF omnidirectional radio range (VOR). Doppler VOR will be preferable at Tokua Airport to minimize the site error by trees etc.

While, at localities where for operational reasons, or because of air traffic control reasons such as air traffic density or proximity of routes, there is a need for a more precise navigation service than that provided by VOR, distance measuring equipment (DME) is installed and maintained in operation as a complement to VOR.

At Tokua Airport, a D-VOR collocated with DME will serve an efficient aircraft operation.

3) Radio beacons

A non-directional radio beacons (NDB) is installed and maintained in operation at a locality where an NDB, in conjunction with direction-finding equipment in the aircraft, fulfils the operational requirement for a radio aid to navigation.

The existing 125 watts double side band aeronautical beacon transmitter, type ND500-02 manufactured by NAUTEL, Canada will be used before the runway extension.

An new NDB should be installed instead of the present NDB.

4) Radar

Radar should be provided to attain a safe, prompt and orderly flow of air traffic. An airport surveillance radar (ASR) has a function to detect aircraft within the radius of 70 nautical miles from the airport. A consideration of a anticipated aeronautical operational practices indicates that the secondary surveillance radar (SSR) system, in order to give a clear, unambiguous display compatible with the display of any associated primary radar, should be introduced to provide signals to augment the desired radar returns, and also to provide means of aircraft identification through the transmission of pulse coded replies from the aircraft.

9.5.2 AMS and AFS Systems

1) Air-ground VHF communication system

50 watts VHF/AM transmitter will be a proper output power at Tokua Airport to provide a field strength of a least 75 micro volts per meter (minus 109 dBW/m^2)within the operational coverage of the equipment, on the basis of free space propagation.

2) AFTN

Public telephone lines installing by PTC to Tokua Airport should be also used for aeronautical fixed telecommunication network. Leased line from PTC will be the most reliable and economical. DCA can be released from the maintenance of the line, which is the responsibility of PTC. As a back up system for AFTN, however, single sideband HF communication system should be installed at Tokua Airport with several frequencies to minimize the effect by feeding.

9.5.3 Lighting Systems

1) Aerodrome beacon (ABN)

An aerodrome beacon should be provided at Tokua Airport intended for use at night, with the characteristics of showing either coloured flashes alternating with white flashes or white flashes only. The light from the beacon shows at all angles of azimuth and the vertical light distribution extends upwards not more than 1° from a certain elevation.

2) Simple approach lighting system (SALS)

The system which should be installed in runway 28 end at the year 2000 and in runway 10 end at the year 2010 for geographical reason consists of a row of lights on the extended center line of the runway extending over a distance of not less than 420 m from the threshold with a row of lights forming a crossbar 18 m or 30 m in length at a distance of 300 m from the threshold.

3) Approach lighting system (ALS)

The system should be provided in runway 28 end at the year 2010 consisting a row of lights on the extended center line of the runway extending over a distance of 900 m from the runway threshold with a row of lights forming a crossbar 30 m in length at a distance of 300 m from the runway threshold.

4) Precision approach path indicator (PAPI)

PAPI system should be provided for the final approach to the runway 28 and 10. The system will consist of a wing bar of 4 sharp transition multi-lamp or paired single lamp units equally spaced. It will be located on the left side of the runway.

5) High intensity runway edge lights (HIRL)

It should be provided at Tokua Airport intended for use at night and for precision approach. The lights are placed along the full length of the runway and are in two parallel rows equidistant from the center line.

6) Runway end lights (REL)

It should be provided for the runway end and the lights are placed on a line at right angles to the runway axis as near to the end of the runway as possible and not more than 3 m outside the end.

7) Runway center line lights (RWCL)

It need not be installed because they are normally provided on a precision approach runway category II or III, while Tokua will be category I.

8) Runway overrun light (RWOL)

It should be installed at both sides of the runway to identify the runway overrun. The lights will be placed on the end of the overrun, at least six sets symmetrically with the extension of the runway centerline.

9) Runway threshold identification light (RTIL)

It should be installed at the threshold of a non-precision approach runway when additional threshold conspicuity is necessary or when it is not practicable to provide other approach lighting aids. It would be therefore not necessary to install it in the final stage of the year 2010.

10) Taxiway center line lights (TWCL)

The lights will not be necessary for Tokua Airport, because there will not be a high volume of traffic and taxiway edge lights provides adequate guidance.

11) Taxiway edge light (TWL)

It should be provided on a holding bay and apron intended for use at night. TWL on a straight section of a taxiway should also be spaced at uniform longitudinal intervals of not more than 60 m.

12) Wind direction indicator light (WDIL)

Two sets of wind direction indicators should be installed near at both end of the runway. The light intensity should be well enough to identify the wind direction from the at least 300 meters above the ground.

13) Apron floodlighting (AFL)

These lightings should be provided on an apron, and on a designated isolated aircraft parking position, intended to be used at night. The lightings will be located so as to provide adequate illumination on all apron service areas, with a minimum of glare to pilots of aircraft in flight and on the ground, aerodrome and apron controllers, and personnel on the apron.

9.5.4 Meteorological Equipment

Meteorological equipment should be provided as a total system of weather observation. For this purpose the communication and the monitoring interface with National MET Center in Port Moresby will be required at Tokua Airport.

And an automatic weather station should be installed consisting of;

- wind speed sensor
- wind direction sensor
- air temperature sensor
- RVR
- relative humidity sensor
- rainfall sensor
- rainfall intensity sensor
- automatic pressure sensor
- ceilometer
- regulating unit

9.6 ATC Operations

9.6.1 Airspace

1) Obstacle Limitation Surfaces

The air space around aerodromes should be maintained free from obstacles to keep the aircraft operations safe in the airspace.

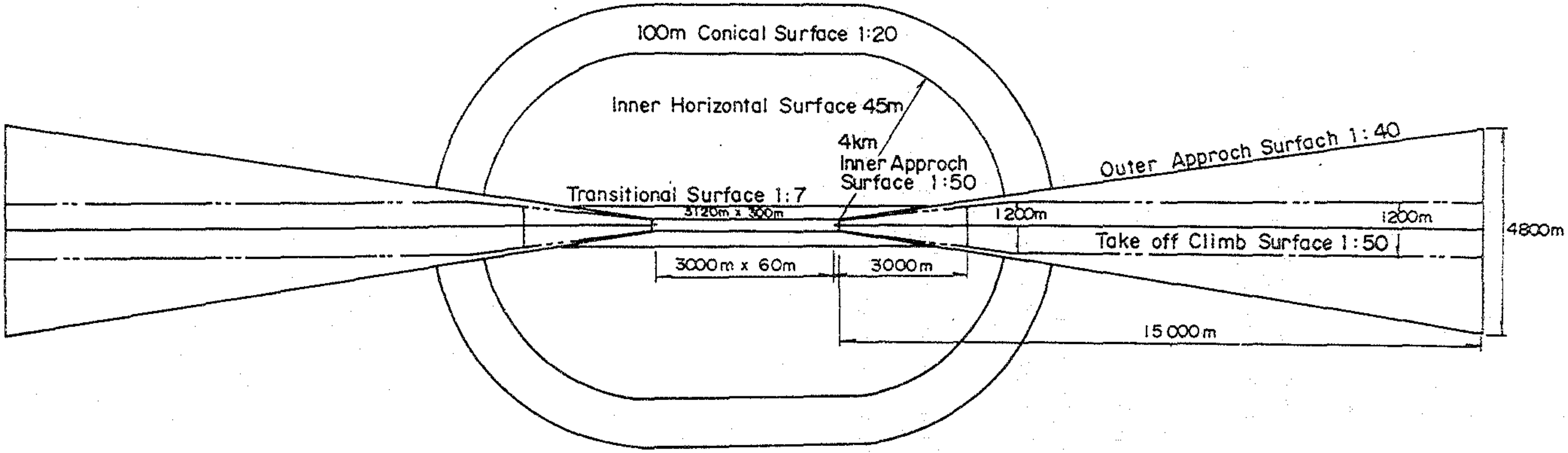
Figure 9.6-1 shows its requirement.

2) Airspace in the vicinity of Tokua Airport

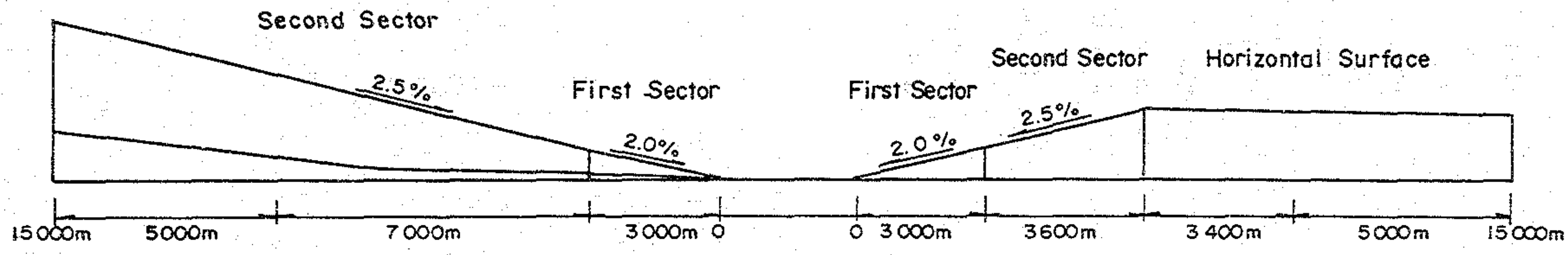
The airspace configurations within 10 nautical miles of said airport, shown in Figure 9.6-2, have almost no operational problems in its all guardrants.

3) Minimum Enroute Altitude (MEA) in the main routes of flights

In consideration of the optimum flight routes, MEA should be maintained as shown in Figure 9.6-3.



Plane



Longitudinal Section

Figure 9.6-1 Obstacle Limitation Surfaces

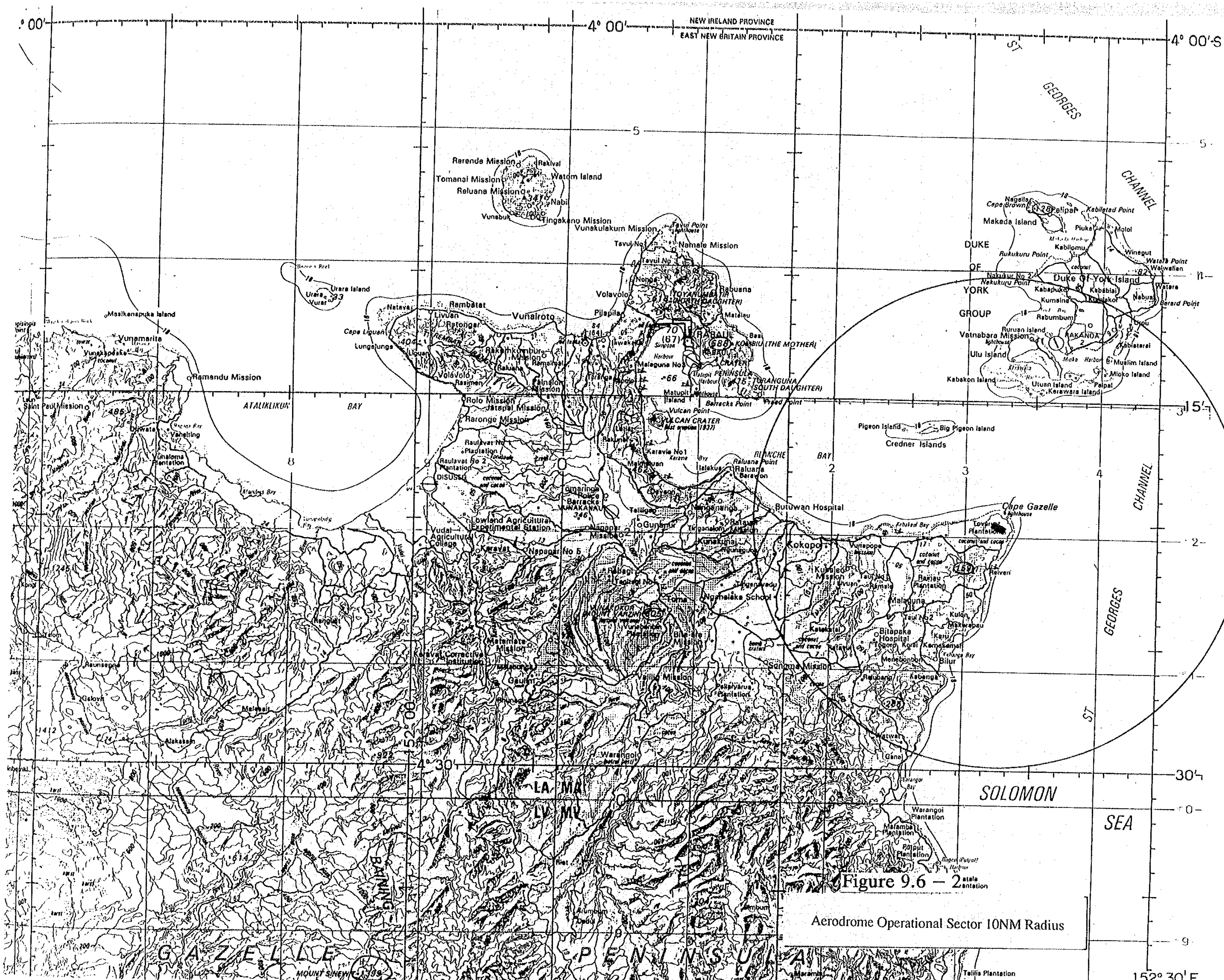


Figure 9.6 — 2

Aerodrome Operational Sector 10NM Radius

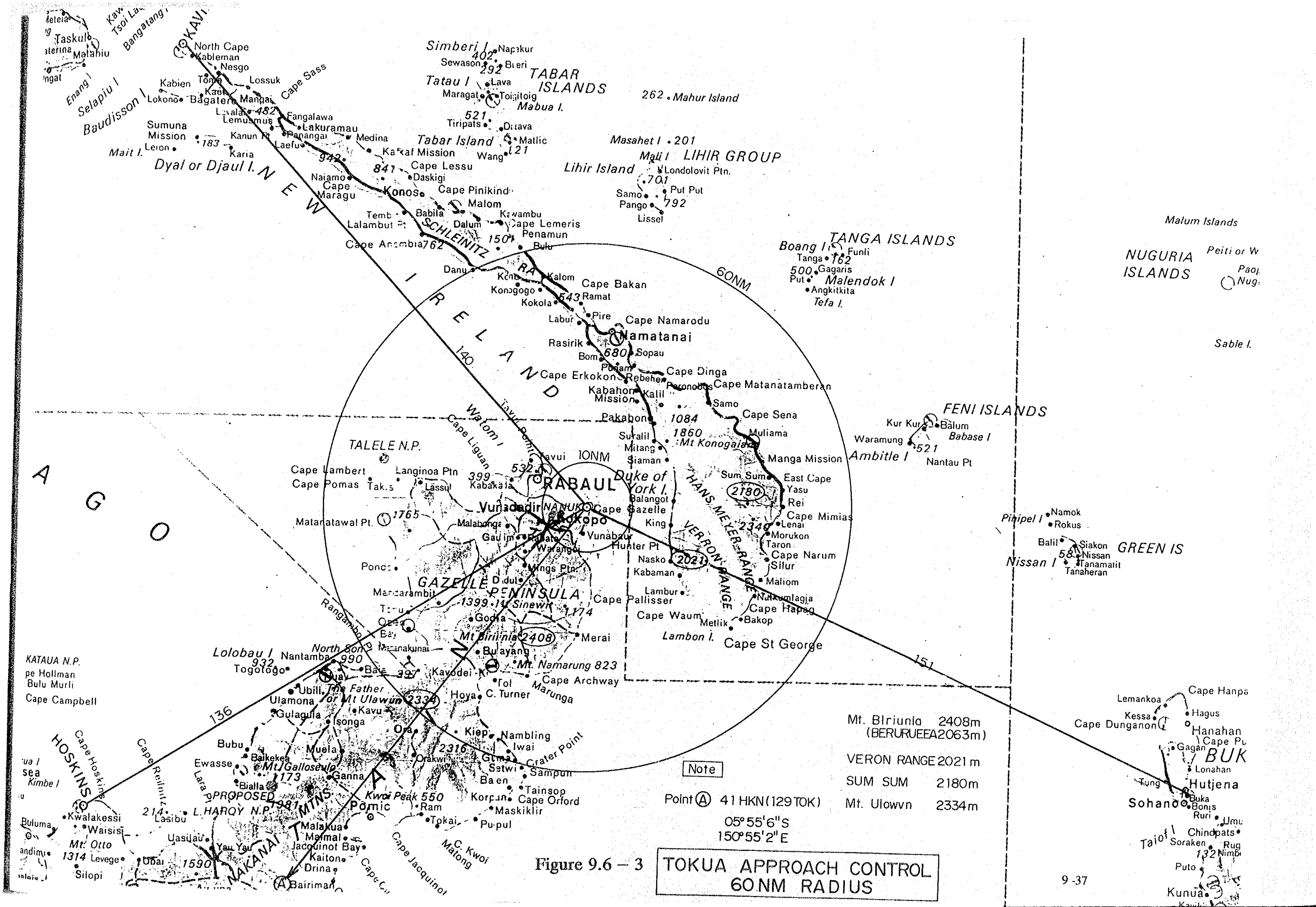


Figure 9.6 — 3

TOKUA APPROACH CONTROL
60NM RADIUS

	Departures		Arrivals
D_1	TOK → KAV 3000 feet or above within 10 NM from TOK	A_1	KAV → TOK 4000 feet or above until 10 NM from TOK
D_2	TOK → BUK 8000 feet or above within 20 NM from TOK	A_2	BUK → TOK 8000 feet or above until 20 NM from TOK
D_3	TOK → HKN (POM) 5000 feet or above within 20 NM from TOK	A_3	HKN POM → Ⓐ → TOK 8000 feet or above until 25 NM from TOK

Note 1. Ⓐ 41 HKN/129 TOK
05°55'6"S, 150°55'2"E

2. The shortest distance to the Controlled Area from TOK is 81 NM southeasterly.

9.6.2 Air Traffic Control

In the proposed airport of Tokua, the air traffic control services should be provided through the authentic ATC and not at an AIS level as the present Rabaul Airport.

1) Air Traffic Services

(1) ATS Services, including a Surface Movement Control.

(2) Approach Control (i.e. within 60 NM Radius)

(3) Search and Rescue Alerting Services

2) Required areas for the respective ATC services

(1) Aerodrome Control Zone 10 NM radius of TOK

(2) Approach Control Area 60 NM radius of TOK, up to the altitude of FL 245.

9.6.3 Establishment of Departure and Arrival Routes

The establishment of several standard routes for departures and arrivals are encouraged not only for ATC but for operations of public transport to use in their operations. The purpose of establishment of SIDs and STARs is to allow both pilots, despatchers and air traffic controllers.

1) to make clear reference to any ATS routes without the need to resort to the use of geographical coordinates or other means so as to describe it

2) to relate an ATS route to a specific vertical structure of the air space

3) to indicate that a route is used primarily or exclusively by certain types of aircraft.

In order to meet this purpose, SIDs and STARs should

1) permit the identification of any ATS route in a simple and unique manner;

2) avoid redundancy and permit utmost brevity in operational use; and

3) be usable by both ground and airborne automation systems.

9.6.4 Radar Control

Radar Control services, if provided, will greatly upgrade the air traffic control and attain a safe, expeditious and orderly flow of air traffic.

However, a lot of air traffic controllers who are fully rated for the radar control have to be trained before such radar operation, now no trained rated radar controllers in country.

This is a matter of DCA who can introduce the radar control operation by taking into account the total and overall air traffic control system in PNG where radar control services are not provided at present.

9.7 Proposed Phasing of Project Implementation (Refer to Table 9.7-1)

Table 9.7-1 Proposed Phasing of Project Implementation

	ITEM	1. Short Term (Earliest ~ 2000)	2. Master Plan (2010)
1.	Fundamental Facilities		
	Runway	2,200 m x 45 m with T.P.	3,000 m x 45 m
	Runway Strip	2,320 m x 150 m	3,120 m x 300 m
	Taxiways	148.5 m x 30 m x 2 650 m x 23 m (Parallel)	148.5 m x 30 m x 7 with H.B. 3000 m x 23 m (Parallel)
	Main Apron	205 m x 140 m	430 m x 190 m
	GA Apron	107 m x 140 m	162 m x 63 m
	GSE Movements	11,600 m^2	17,900 m^2
	Others	42,000 m^2 (Airfield Road)	50,000 m^2 (Airfield Road)
2.	Building		
	Passenger Terminal	5,000 m^2	8,000 m^2
	Cargo Terminal	360 m^2	600 m^2
	Parking Lot	5,200 m^2	7,100 m^2
	Control Tower	635 m^2 (Aerodrome only)	635 m^2 (Plus Radar Control)
	Administration Building	778 m^2	1,244 m^2
	CFR Building	381 m^2	461 m^2
	Maintenance Shop & Depot	924 m^2	1,298 m^2
	Fuel Farm	4,000 m^2	6,000 m^2
	Others		
3.	Operational Equipment		
	VOR	O	O
	DME	O	O
	NDB	O	O
	AMS	O	O
	AFS	O	O
	ALS	–	R/W 28 O
	SALS	R/W 28 O	R/W 10 O
	ATC Equipment	O Aerodrome and Approach Control	O Plus Radar Control
	ATC Radar	–	O
	Wx Radar	–	O
	Wx Observation Gauges and Station	set O	Full set O
	Aerodrome Lighting	set O	Full set O
	Runway Lighting	set O	Full set O
	Taxiway Lighting	set O	Full set O
	PAPI	O	O
	ILS (MLS)	–	O
	Fire Fighting Equipment	set O	Full set O
	Work shops Equipment & Storage	set O	Full set O
	Security equipment	set O	Full set O
	Others		
4.	Utilities		
	Electric	O	O
	Water Supply	O	O
	Air Conditioning	O	O
	Telephone, etc.	set O	Full set O
	Others		

10. MASTER PLAN OF TOKUA AIRPORT DEVELOPMENT

10.1 Airfield Layout

10.1.1 Runway Orientation and Location

1) Runway Orientation

Table 10.1-1 shows the wind coverage of existing runway categorized in the crosswind components of 13 knot and 20 knot as the result of study in 5.1.

Table 10.1-1 Wind Coverage of Existing Runway

Crosswind	Rainy Season	Dry Season	All Year
13 knot	97.1%	90.7%	95.2%
20 knot	99.6%	98.7%	99.3%

As a general rule, the orientation of runway should be such that the usability factor of the airport is not less than 95 per cent according to ICAO standards.

Wind coverages of existing runway in the both categories of 13 and 20 knot crosswind are more than 95 per cent for rainy season and all year wind analyses. However, wind coverage of dry season wind analysis in the categories of 13 knot crosswind is only 90.7 per cent.

Regarding the general aviation for small aircraft, runway orientation with clockwise rotation to 28 through 66 degrees from the existing runway would be recommended in order to keep the coverage more than 95 per cent in the crosswind components of 13 knot as shown in Figure 10.1-1.

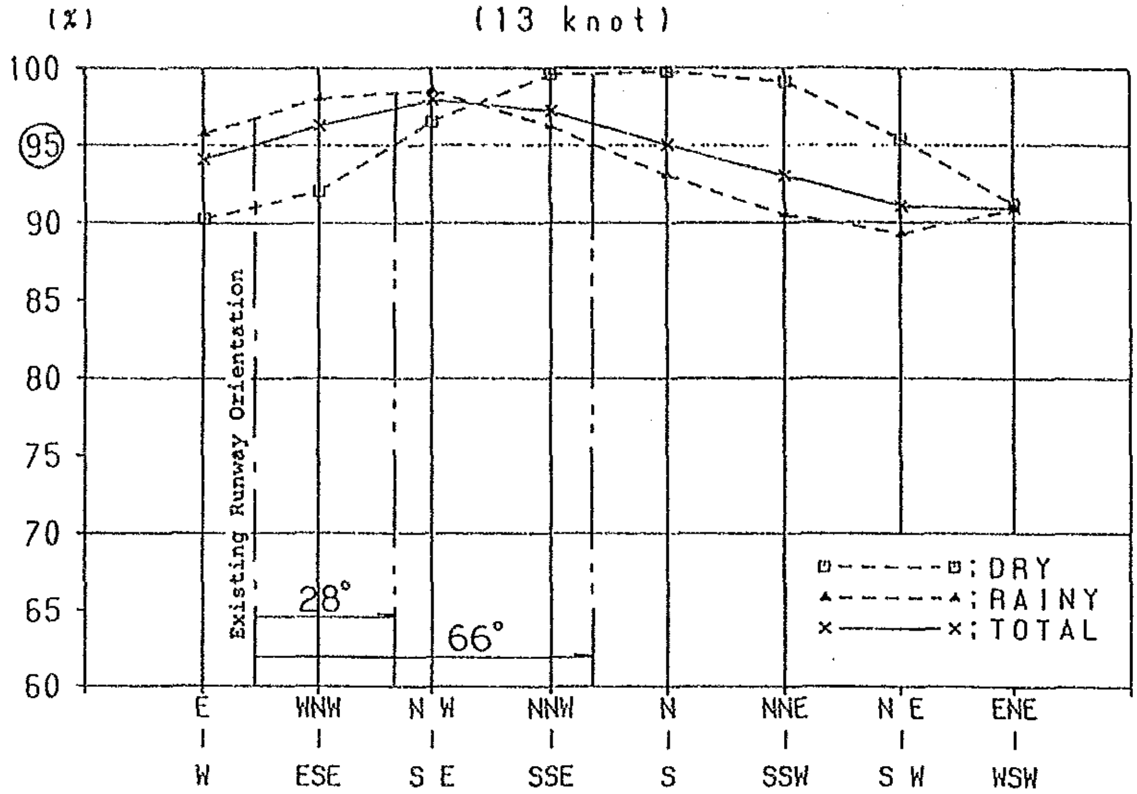


Figure 10.1-1 Comparison of Wind Coverage in the Crosswind Components of 13 knot.

2) Establishment of Airport Layout Options

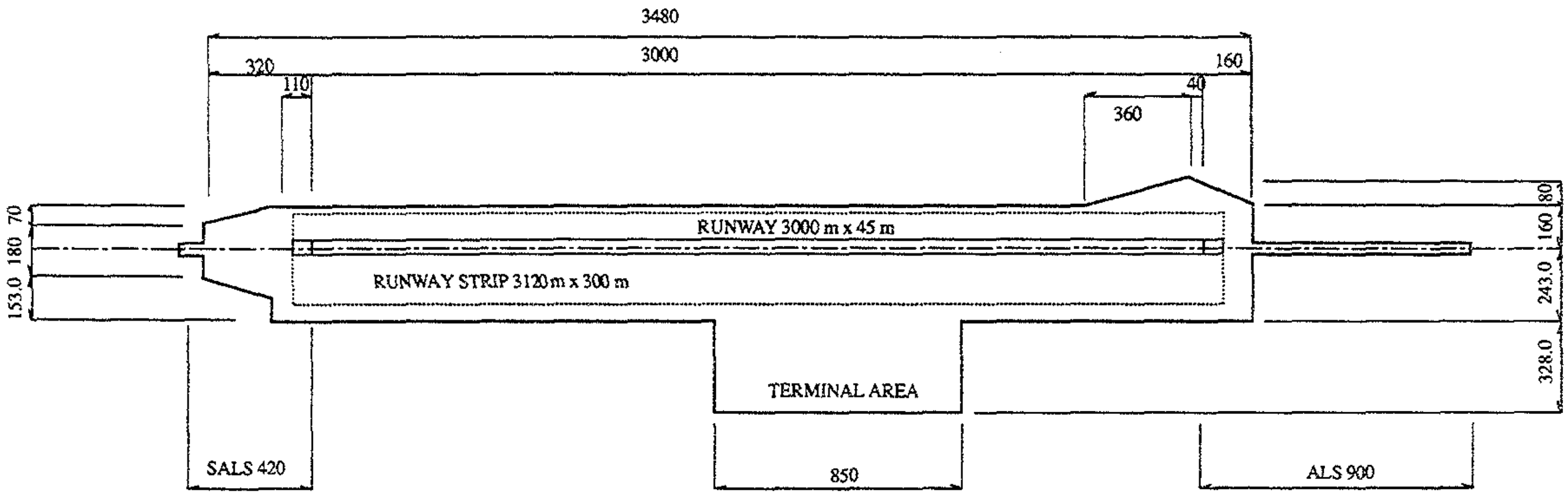
The approximate size required for master plan is as illustrated in Figure 10.1-2 based on the results of Chapter 9, "Establishment of Required Scales".

Taking into account the wind analysis above mentioned, airport required scales, site topography, and volcanic activities, the following three (3) options for airport layouts were selected as shown in Figure 10.1-3 ~ 10.1-5.

Option - 1 : Location extended from the existing runway to about 300 m eastern and 1,000 m western side to avoid an influence of Tsunami (High Tidal Wave) and any extension of airport fundamentals and NAVAIDs in the sea.

Option - 2 : Runway orientation with clockwise rotation of 30 degrees about at 350 m point from the eastern existing runway threshold so as to keep the coverage more than 95 percent in the crosswind components of 13 knot and so as to avoid airport facilities except ALS to be constructed in the sea.

Option - 3 : Runway orientation with clockwise rotation of 45 degrees (approximately highest wind coverage direction) from the existing runway center point so as to avoid airport facilities except ALS to be constructed in the sea.



Unit : m

Airport Area Approx. 167.2 ha
except ALS & SALS

Figure 10.1-2 General Dimensions of Airport Master Plan

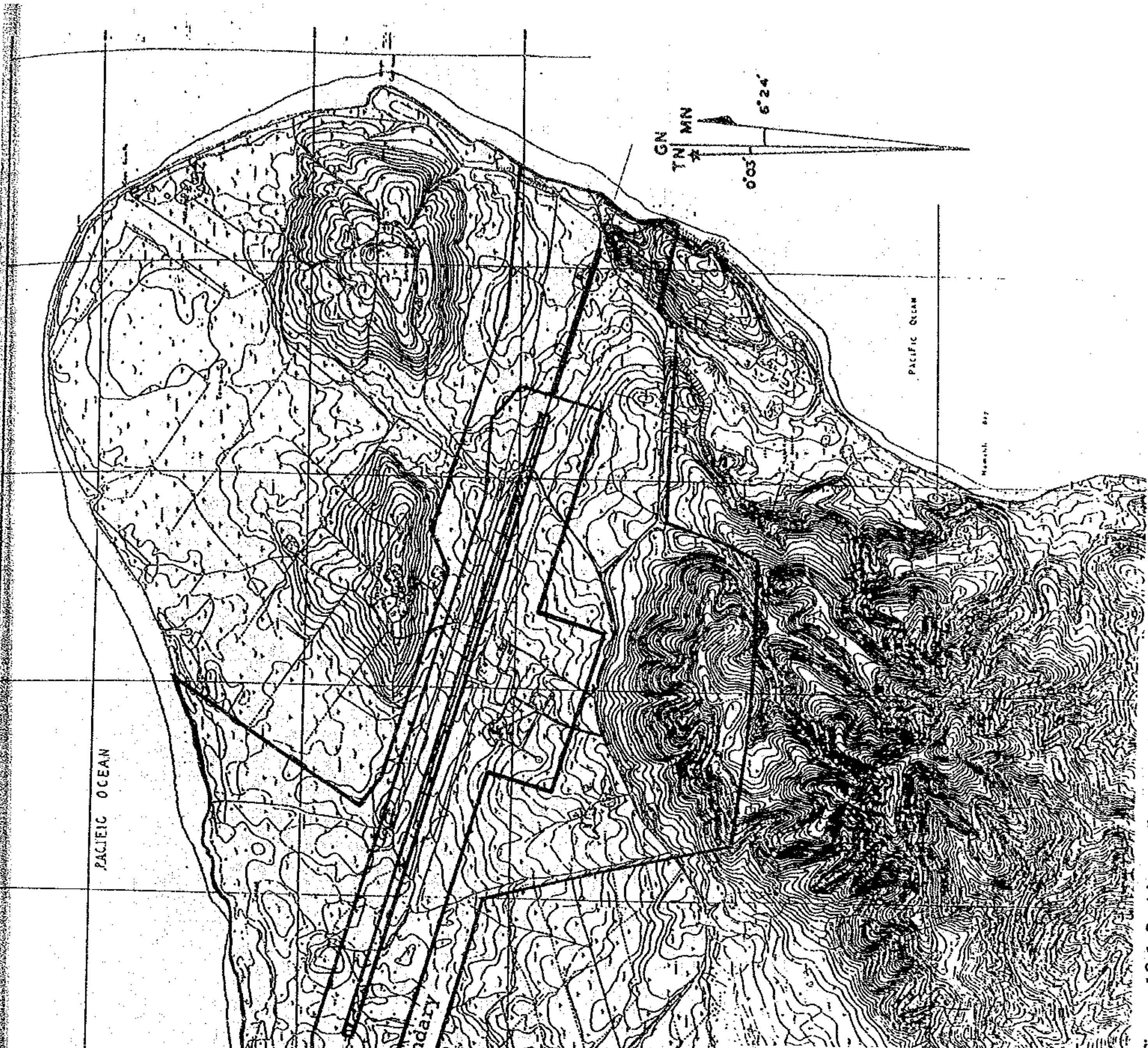


Figure 10.1-3 Airport Layout Option-1

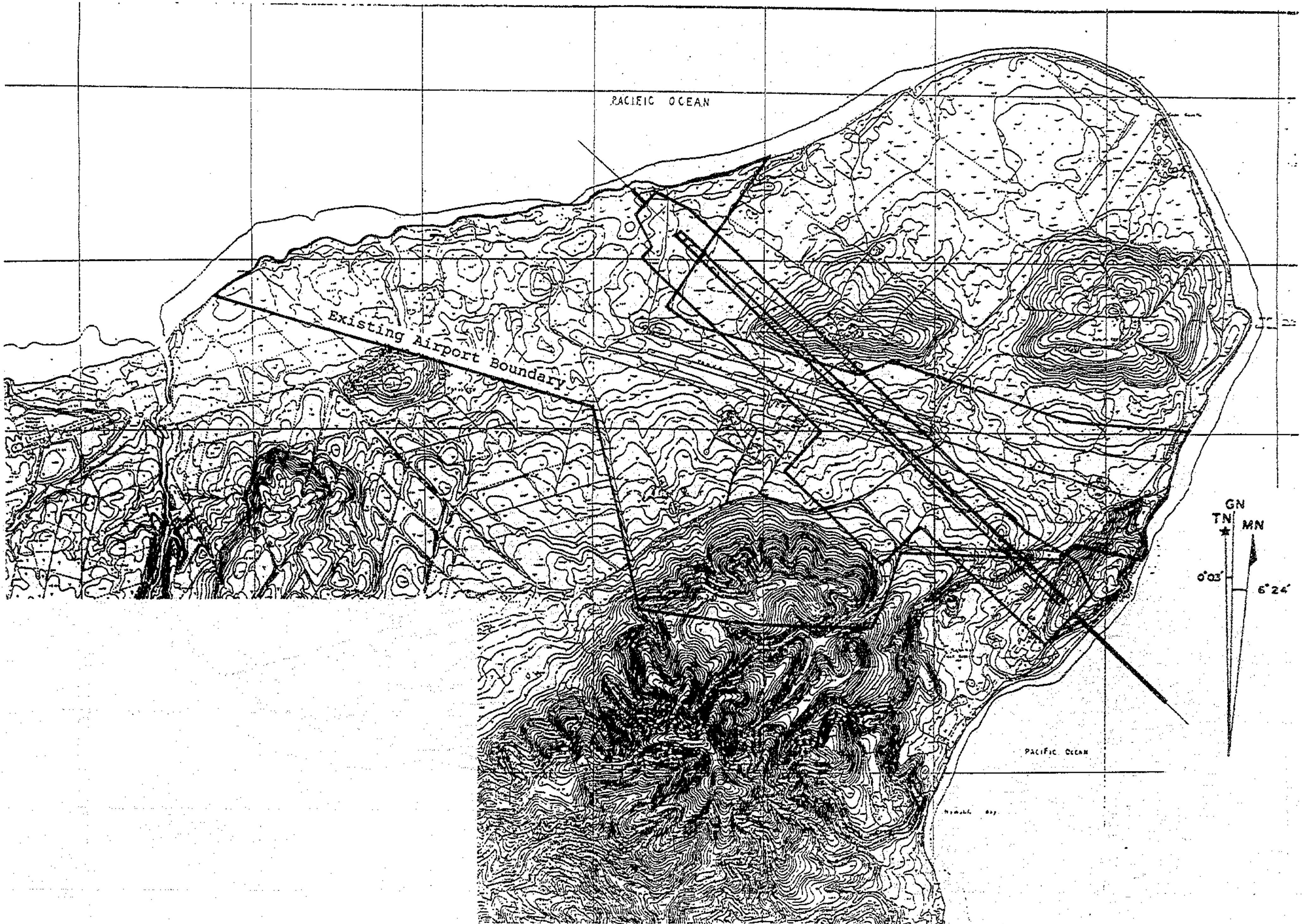


Figure 10.1-4 Airport Layout Option-2

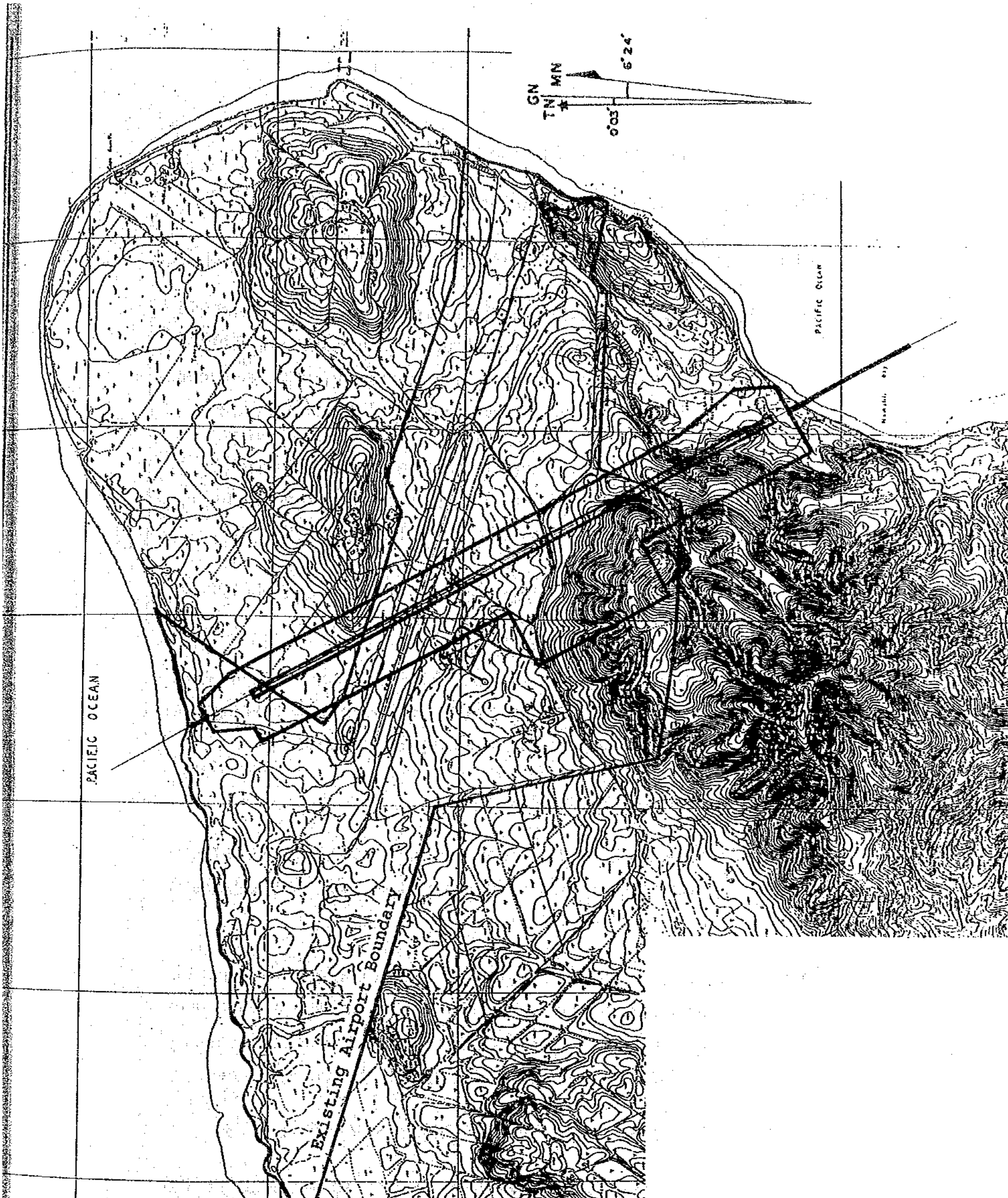


Figure 10.1-5 Airport Layout Option-3

3) Comparative Evaluation of Airport Layout

Table 10.1-2 shows the rough comparative evaluation results.

Main disadvantages for each option are given below.

(1) Option-3 will be located in the portion of the southern hill and will be required cut and bank the most considerable earthwork volumes of the three options in order to prepare for the airport fundamental and terminal facilities and to secure obstacle limitation surfaces.

(2) Option-2 and Option-3 will be required to construct the ALS facilities in the sea and to acquire additional land including customary land of approx. 54 ha and 57 ha respectively.

(3) Wind coverage of Option-1 in the crosswind components of 13 knot is only 90.7 per cent during the dry season.

As a result of overall evaluation, Option-1 is recommended as the most preferable airport layout in the proposed site, though wind coverage for small aircraft is less than 95 per cent during the dry season.

4) Secondary Runway Consideration

As typical locations, two (2) optional sites were selected to construct a secondary runway as shown in Figure 10.1-6. The study result on these site were found to be as follows:

Site 1: On the western portion of the airport compound so that the secondary runway would be located at an angle of 45 degrees against the main runway and the north end of the secondary runway located as close as possible to the primary runway.

The secondary runway orientation : RWY15 – RWY33

Results: (1) Amount of earthwork is estimated to be about 200,000 m^3.

(2) The southern portion of the runway will penetrate into the non-government area adjacent to the airport south-western boundary.

Table 10.1-2 Roughly Comparative Evaluation of Airport Layout

Options / Comparison Items	Option-1	Option-2	Option-3
1. Runway Orientation	100-280	130-310	145-325
2. Wind Coverage			
1) Crosswind Component 20 knot			
(1) All Year	99.3%	Approx. 99%	Approx. 99%
(2) Dry Season	98.7%	Approx. 99%	Approx. 99%
(3) Rainy Season	99.6%	Approx. 99%	Approx. 98%
2) Crosswind Component 13 knot			
(1) All Year	95.2%	Approx. 97%	Approx. 98%
(2) Dry Season	90.7%	Approx. 95%	Approx. 99%
(3) Rainy Season	97.1%	Approx. 98%	Approx. 98%
3. Obstacle Limitation Surfaces	- Southern hill projects over inner horizontal surface	- Northern and southern hill projects over transitional and inner horizontal surfaces	- Southern hill projects over transitional and inner horizontal surfaces
4. Land Acquisition	- Not necessary	- Approx. airfield 54 ha - Necessity of customary land acquisition	- Approx. airfield 57 ha - Necessity of customary land acquisition
5. Utilization of Existing Facilities	- Existing runway could be complete-ly utilized	- Almost not utilized	- Same as Option-2
6. Earthwork Volumes	- Considered the least earthwork volume	- Considered the second most earthwork volume	- Considered the most earthwork volume
7. Environment		- Influence to the sea by construc-tion of ALS	- Same as Option-2
8. Project Cost	- Considered the most economical	- Considered the second highest	- Considered the highest due to the most earthwork
Main Disadvantages	- Wind coverage of crosswind component 13 knot during dry season is 90.7%	- The second highest project cost - ALS to be constructed into the sea - Customary land acquisition	- The highest project cost - Customary land acquisition

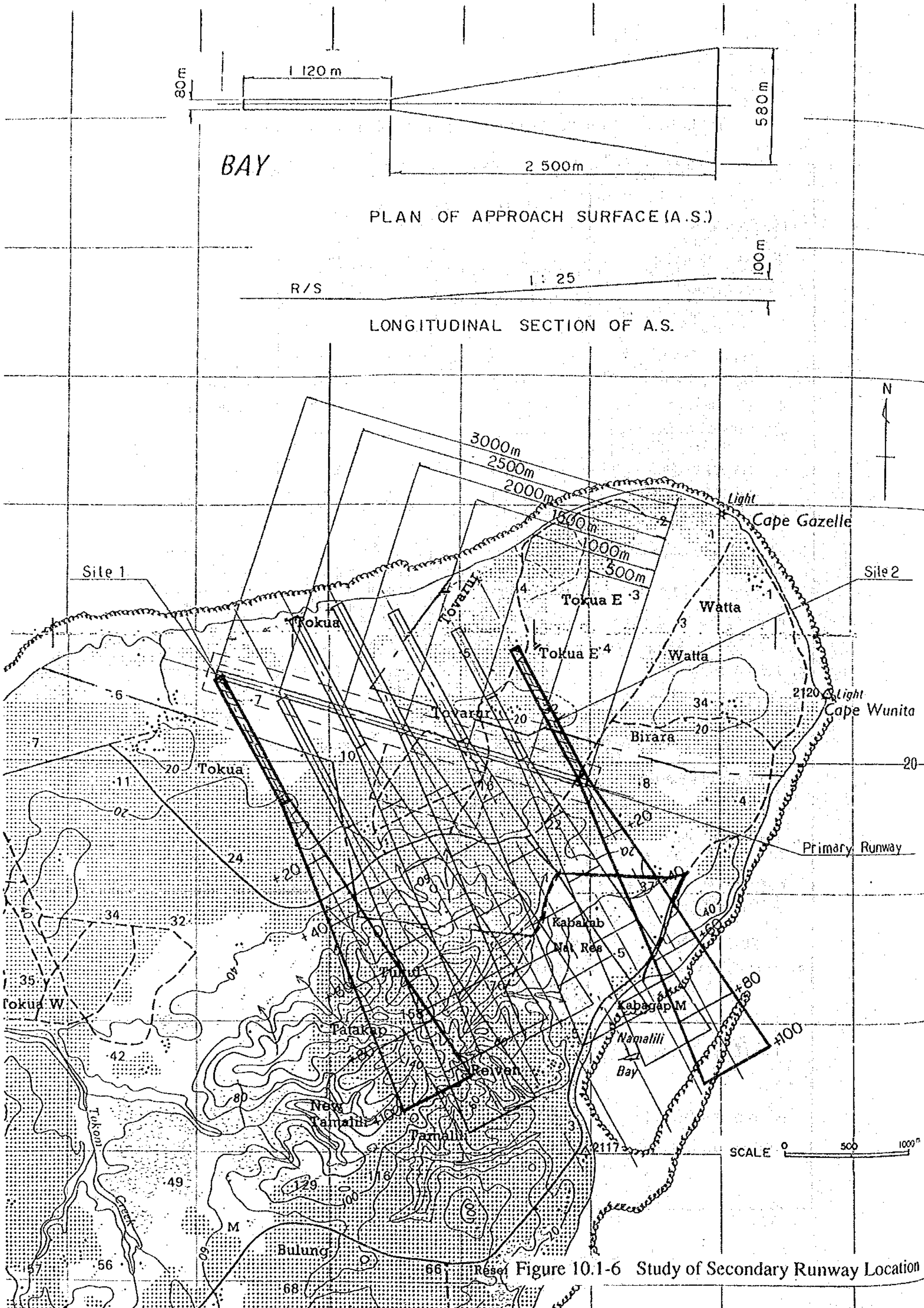


Figure 10.1-6 Study of Secondary Runway Location

(3) The most hampering factor is that the hills located on the southern quadrant of the airport penetrate over the final approach surface to the RWY15. Through a computer calculation, the amount of the earth of the hills is roughly estimated to be 20 million m^3.

(4) The cost of just clearing the hills is then estimated to approximately range over 30 billions Yen or 200 millions Kina.

(5) It is also almost impossible to dispose of this tremendous amount of soil, since it is far more than the need for the airport construction.

Site 2: On the eastern portion of the airport compound so that the south end of the secondary runway intersect with the main runway at an angle of 45 degrees.

Results: (1) Amount of earthwork is estimated to be about 400,000 m^3.

(2) There are no prominent obstacle found on the northern and southern approach areas.

(3) However, about 2/3 of the northern portion of the runway and the runway strip would penetrate into the plantation area.

(4) It is also notable that every movement of general aviations (small aircraft) have to cross the preferential runway 28 end, after taxiing out for take-off and taxiing in after arrival.

(5) Travelling distance from/to their apron area is very long and inadequate for small aircraft operations.

Based on the above studies, the construction of the secondary runway is not recommendable from the economic view point, matter of land acquisition and operational problem etc.

10.1.2 Runway, Taxiway and Apron

Airport layout plan based on the airport requirements for Master plan is shown in Figure 10.1-7.

1) Runway

A runway of 3,000 m in length and 45 m in width, with 7.5 m shoulders on the both sides, should be planned to avoid the influence of Tsunami and to provide any facilities to be construction in the sea. Therefore, the runway is extended from the both existing runway thresholds to about 300 m eastern and 1,000 m western side.

2) Runway Strip

A runway strip of 3,120 m in length, including 120 m (60 m x 2) of the over-run areas at the both runway thresholds, and 300 m in width is planned to cater for CAT-I operation of ILS.

3) Taxiways

Five conventional taxiways of 30 m in width, with 7.0 m shoulders on the both sides, are planned at an interval of about 500 m. Two holding bays are planned on the both runway thresholds.

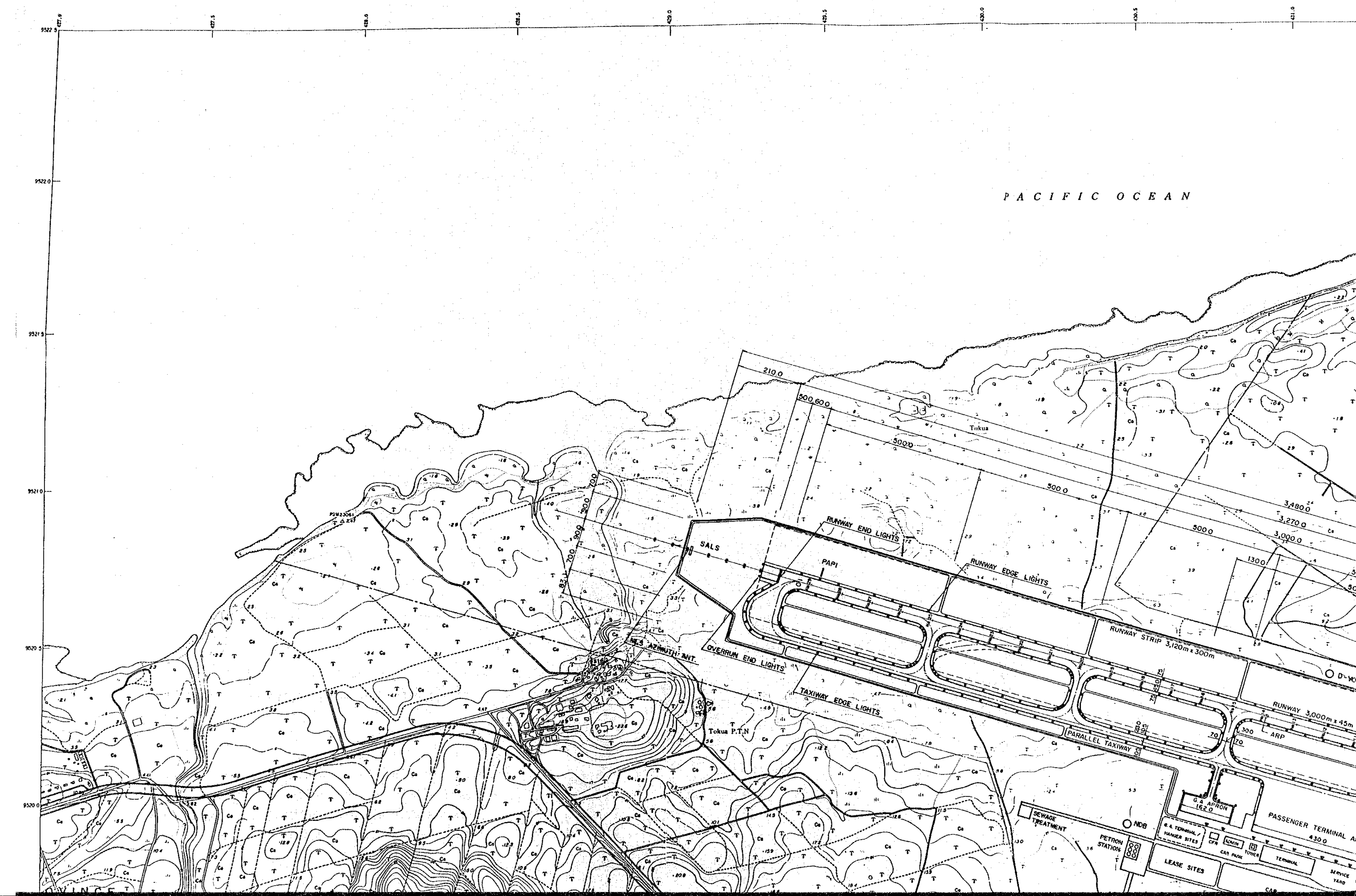
A parallel taxiway of 3,000 m in length and 23 m in width, with 10.5 m shoulders on the both sides, is planned with 182.5 m separation between the centerlines of runway and proposed taxiway, conforming to the ICAO Standards.

4) Apron

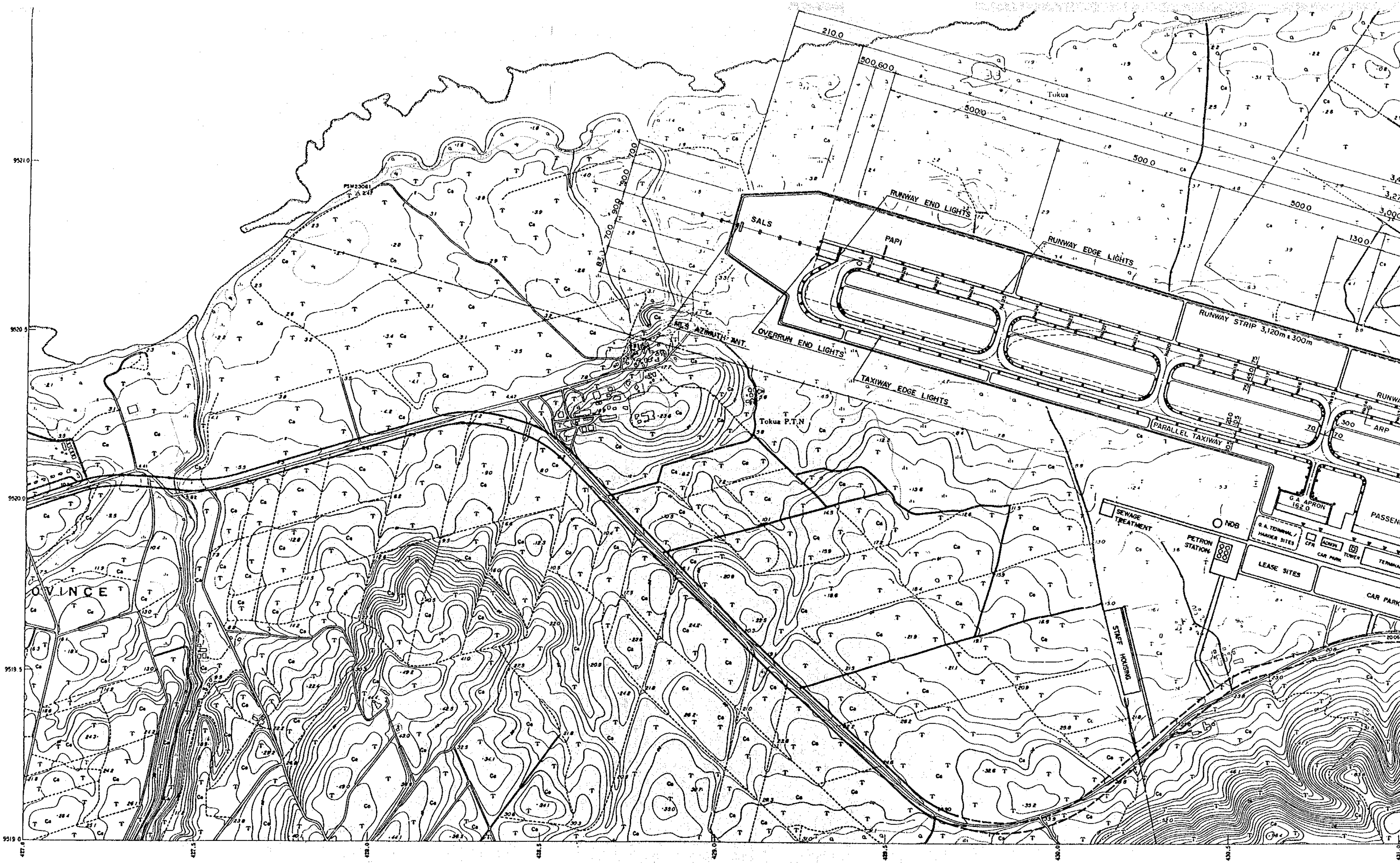
The location of the terminal area including the apron is planned to be located of approximately the existing airstrip terminal area taking into account the existing airport boundary and the future expansion of terminal area.

(1) Passenger Terminal Apron

The positions for each aircraft stand on the apron are planned as shown in Figure 10.1-8.


PACIFIC OCEAN
Tokua
SALS
RUNWAY END LIGHTS
PAPI
RUNWAY EDGE LIGHTS
RUNWAY STRIP 3,120m x 300m
OVERRUN END LIGHTS
ILS AZIMUTH ANT.
TAXIWAY EDGE LIGHTS
PARALLEL TAXIWAY
RUNWAY 3,000m x 45m
ARP
G.A APRON
162.0
PASSENGER TERMINAL
430.0
SEWAGE TREATMENT
NDB
PETRON STATION
LEASE SITES
Tokua P.T.N
210.0
500.0
3,480.0
3,270.0
3,000.0
130.0


LEGEND
Cape Gazelle
Watta P.T.N
Tokua. E
EAST NEW BRITAIN PROVINCE
GAZELLE PENINSULA
KOKOPO
Tovarur P.T.N
Birara P.T.N
Cape Wunita
Light
LOCATION DIAGRAM
TOKUA
WIND ROSE
(PERIOD : JANUARY 1990 - DECEMBER 1990)
D-VOR / DME
RUNWAY 3,000m x 45m
ARP
PERIMETER ROAD
MLS ELEVATION ANT.
RUNWAY END LIGHTS
PASSENGER TERMINAL APRON
TERMINAL
CAR PARK
TOWER
ALS
SITES



COMPILED by Japan International Cooperation Agency in using stereo-photogrammetric methods from photography flown in June 1991.

PLACE NAMES shown on this map have not necessarily been approved by the PNG Place Names Committee.

BOUNDARIES shown on this map are not to be considered authoritative.

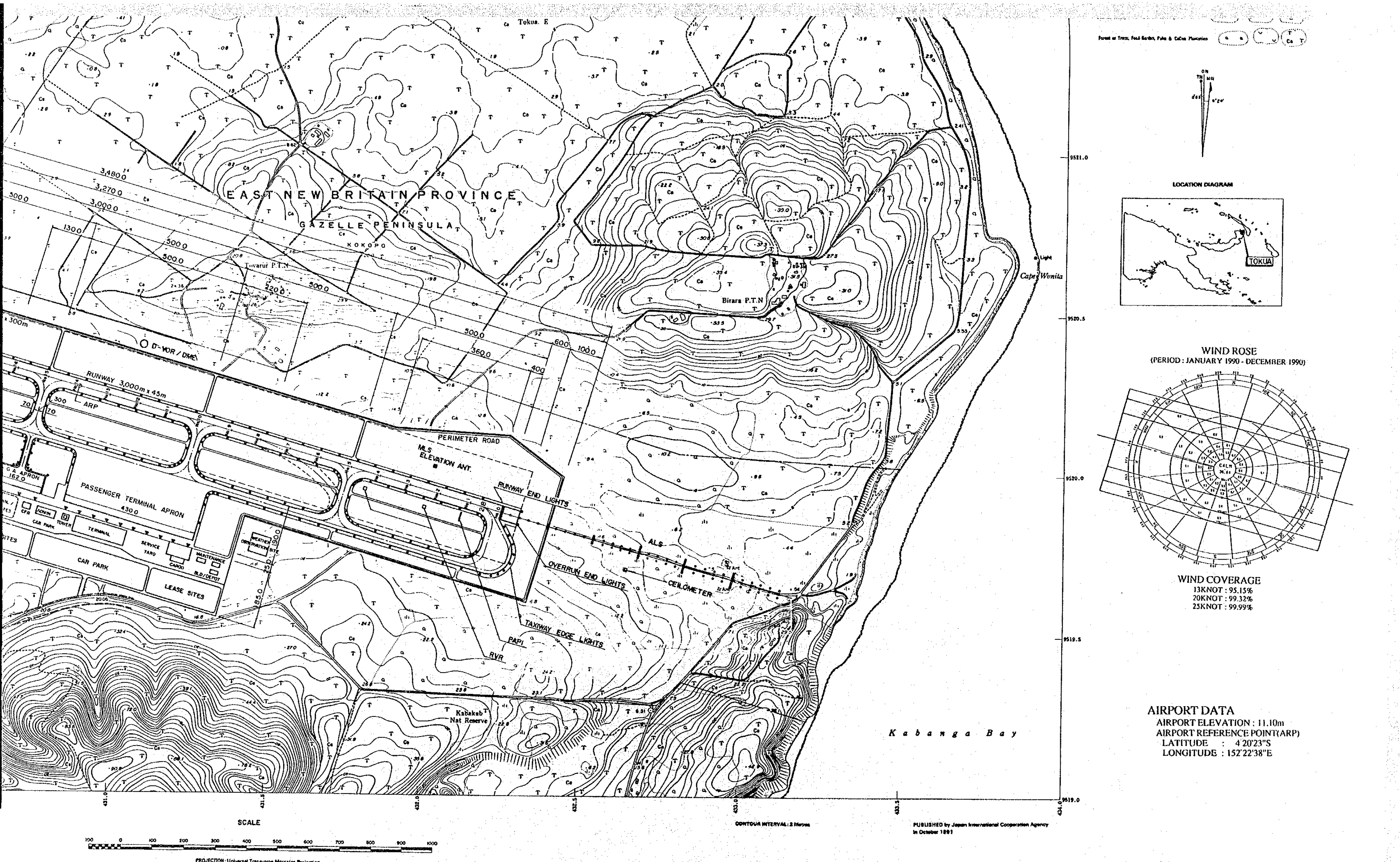


Figure 10.1-7 Airport Layout Plan (Master Plan)

Depth of the apron should be 190 m to cater for B747, the biggest type of aircraft, and not to infringe into the transitional surface.

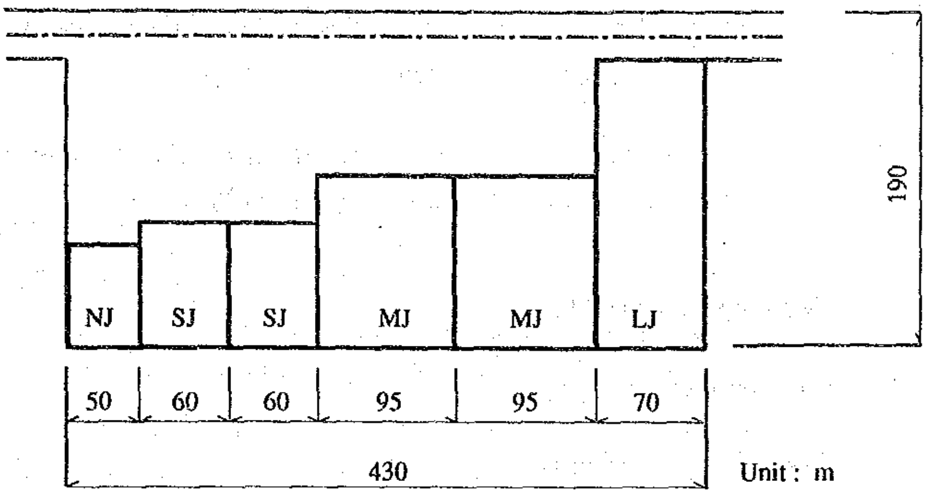


Figure 10.1-8 Passenger Terminal Apron Arrangement for Master Plan

(2) General Aviation Apron

The positions of general aviation apron based on the JCAB standards are planned to allocate mixture of single-engined plane (10 m in length and 12 m in width) and twin-engined plane (14 m in length and 18 m in width) as shown in Figure 10.1-9.

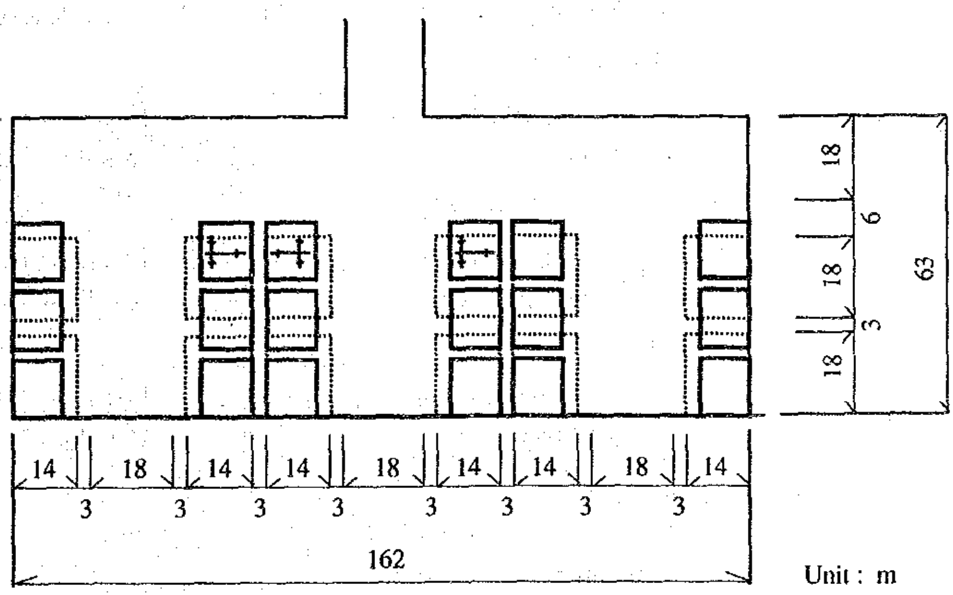


Figure 10.1-9 General Aviation Apron Arrangement for Master Plan

5) GSE

GSE vehicle pass strip and buried pipe space between the apron and the terminal building etc. are planned to be 25 m for passenger terminal area and 20 m for general aviation area.

Ground equipment parking and storage area is planned between passenger terminal apron and general aviation apron.

10.2 Site Preparation and Pavement

10.2.1 Grading Plan

1) Design requirement

Required profile for runway, taxiway and runway strip are specified by the ICAO in accordance with the runway length and the following criteria is used for the grading design.

(1) Runway

- Longitudinal profile average : less than 1.0%
- End 1/4 portion of runway : less than 0.8%
- Grade change : less than 1.5%
- Transverse profile : less than 1.5 % and more than 1.0%
- Runway shoulder : transverse slope : less than 2.5%

(2) Runway strip

- Longitudinal profile : less than 1.5%
- Transverse slope : less than 2.5%

(3) Extended runway safety area

- Longitudinal profile : less than 5%
- Transverse slope : less than 5%

(4) Taxiway

- Longitudinal profile : less than 1.5%
- Transverse slope : less than 1.5%

2) Grading design

(1) Design terms

In the grading design, the following terms and conditions are taken into account.

- Existing runway with 1720 m length should be considered as a part of pavement to minimize the new pavement thickness.

- Embankment height of west end of the site should be 5.0 m to avoid the high tide by Tsunami or earth quake.

- To minimize the height of the structure for approach lighting system, the eastern area should be lowered as much as possible.

- The construction work is planned to be performed in two stages to coincide with the traffic demand. In the first stage, runway of 2200 m in length should be constructed and extension of 800 m in length should be carried out later as the 2nd stage. Excavating volume, therefore, is recommended to be almost equal to the embankment volume at the first construction stage so as to perform the work within the airport area.

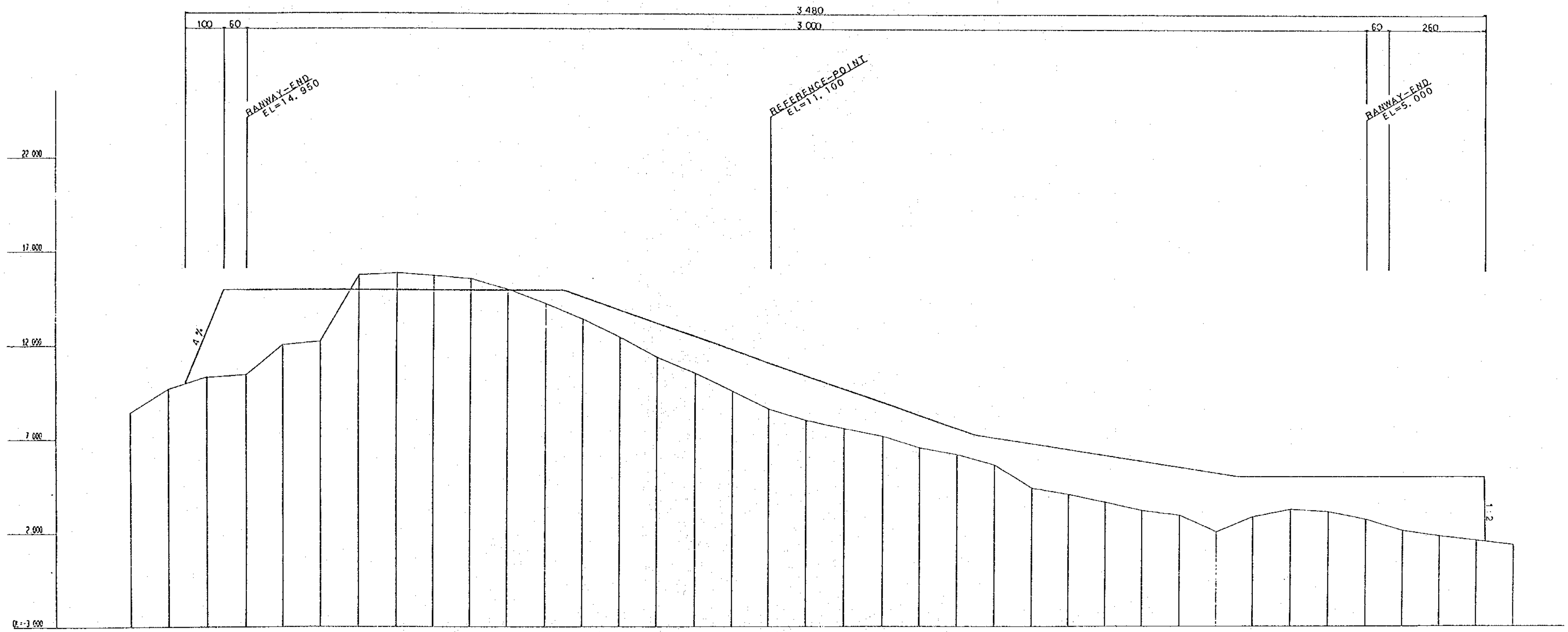
(2) Optional Study

Considering the natural terrain heights, the basic longitudinal profile is to decline toward the west side and to be elevated toward the east. Furthermore point of grade change is determined at the end 1/4 of the runway.

Regarding the transverse slope of the runway strip, 1.3% in the excavation zone and 2.3% in the banking zone were selected in order to minimize the earthwork volume.

Following the longitudinal slope of runway as a result of earth work volume calculation for the first construction stage, the overall longitudinal slope of the runway in 3000 m length was determined as the master plan.

Longitudinal and typical cross section are shown in Figure 10.2-1 and Figure 10.2-2 respectively.



STATION	-NO. 3	-NO. 2	-NO. 1	-60.000	No. 0	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
GRADIENT PITCH					(14.950)				Level L= 0.000		
BANK					4.510	2.910	2.740				
CUT								0.800	0.910	0.770	0.610
PROPOSED HEIGHT					14.950	14.950	14.950	14.950	14.950	14.950	14.950
GROUND HEIGHT	8.400	9.660	10.300		10.440	12.040	12.210	15.750	15.860	15.720	15.560
DISTANCE	-300.000	-200.000	-100.000	-60.000	0.000	100.000	200.000	300.000	400.000	500.000	600.000

STATION	No. 7	No. 8	+50.000	No. 9	No.10	No.11	No.12	No.13	No.14	No.15
GRADIENT PITCH			(14.950)						I=0.700% L=1100.000	
BANK		0.700		1.160	1.440	1.810	1.970	2.210	2.450	2.360
CUT	0.050									
PROPOSED HEIGHT	14.950	14.950	14.950	14.600	13.900	13.200	12.500	11.800	11.100	10.400
GROUND HEIGHT	15.000	14.250		13.440	12.460	11.390	10.530	9.590	8.650	8.040
DISTANCE	700.000	800.000	850.000	900.000	1000.000	1100.000	1200.000	1300.000	1400.000	1500.000

STATION	No.16	No.17	No.18	No.19	+50.000	No.20	No.21	No.22	No.23	No.24	No.25
GRADIENT PITCH					(7.250)				I=0.317% L=710.000		
BANK	2.100	1.820	1.750	1.410		1.462	2.385	2.399	2.501	2.624	2.557
CUT											
PROPOSED HEIGHT	9.700	9.000	8.300	7.600	7.250	7.092	6.775	6.458	6.141	5.824	5.507
GROUND HEIGHT	7.600	7.180	6.550	6.190		5.630	4.390	4.060	3.640	3.200	2.950
DISTANCE	1600.000	1700.000	1800.000	1900.000	1950.000	2000.000	2100.000	2200.000	2300.000	2400.000	2500.000

STATION	No.26	+60.000	No.27	No.28	No.29	No.30	No.31	No.32	No.33	+20.000	No.34
GRADIENT PITCH		(5.000)				Level L=660.000				(5.000)	
BANK	3.120		2.130	1.740	1.870	2.270	2.860	3.150	3.380		
CUT											
PROPOSED HEIGHT	5.190	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	
GROUND HEIGHT	2.070		2.870	3.260	3.130	2.730	2.140	1.850	1.620		1.390
DISTANCE	2600.000	2660.000	2700.000	2800.000	2900.000	3000.000	3100.000	3200.000	3300.000	3320.000	3400.000

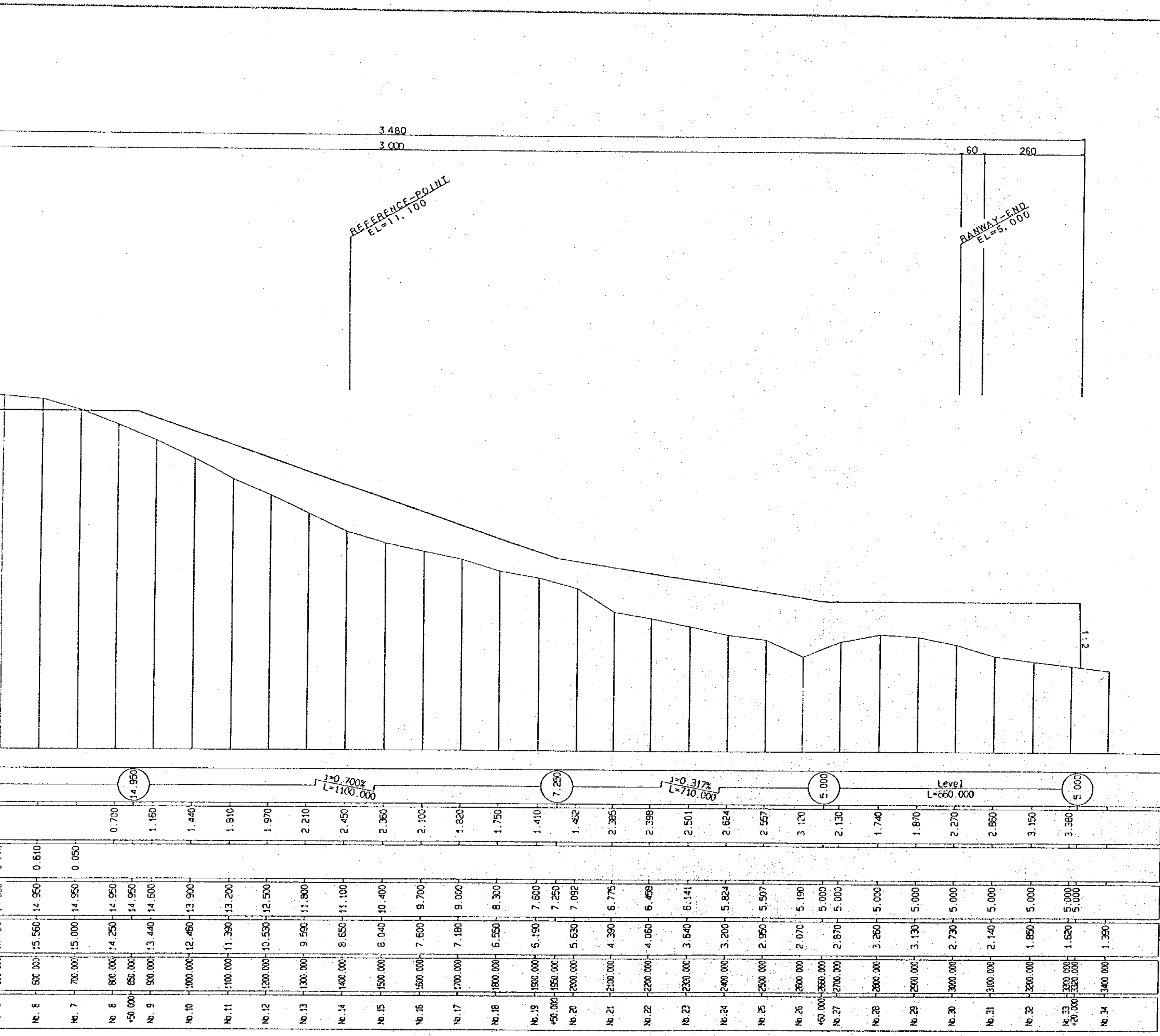
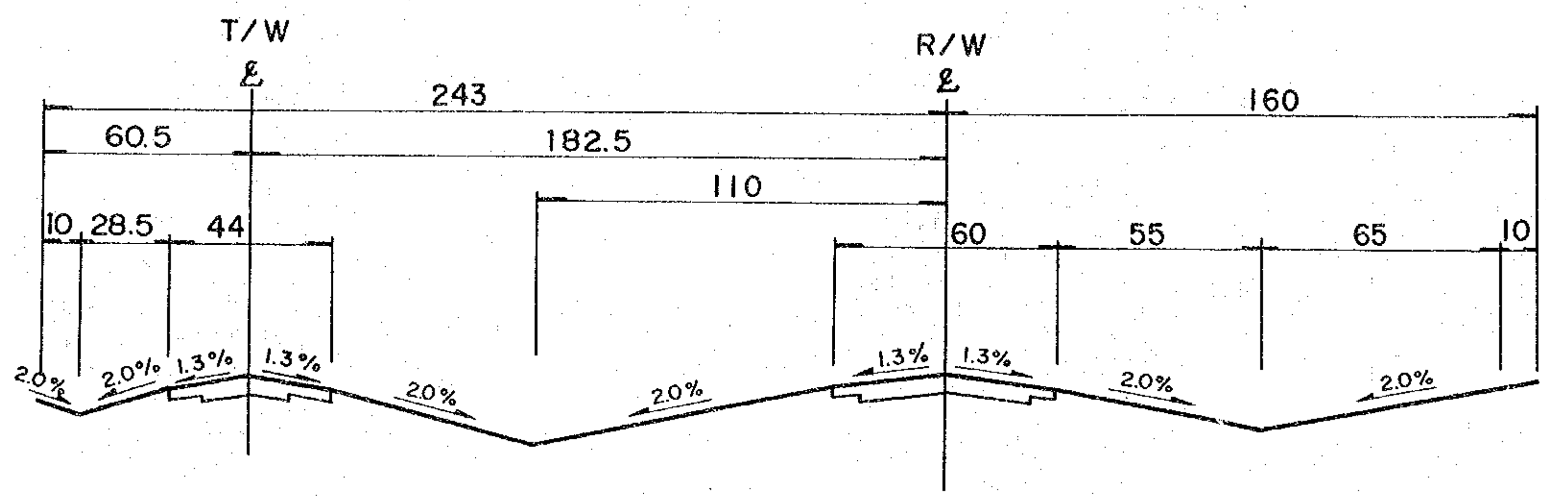


Figure 10.2-1 Longitudinal Section



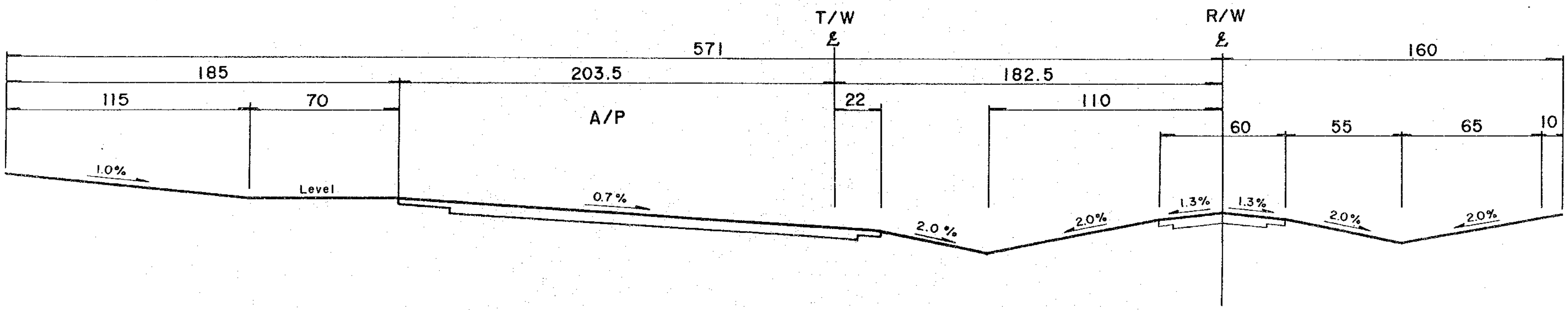


Figure 10.2-2 Typical Cross Section

10.2.2 Airport Drainage System

1) Design Criteria

(1) Amount of Runoff

The airport surface drainage revolves about the solution of the rational method.

$$Q = \frac{1}{360} C \cdot i \cdot A$$

where	Q	:	runoff volume from the given drainage area (m^3/sec.)
	C	:	ratio of runoff to the rainfall
	i	:	rainfall intensity (mm/hr.)
	A	:	drainage area (ha.)

(2) Coefficient of Runoff "C"

Based on the range of values suggested by the FAA indicated in Table 10.2-1, the Study Team determined the coefficient of runoff as follows;

Inside airport	:	turf area	C = 0.30
		pavement area	C = 0.95
Outside airport	:		C = 0.50

Table 10.2-1 Value of Factor "C"

Type of surface	Factor "C"
For all watertight roof surfaces	.75 to .95
For asphalt runway pavements	.80 to .95
For concrete runway pavements	.70 to .90
For gravel or macadam pavements	.35 to .70
For impervious soils (heavy)*	.40 to .65
For impervious soils, with turf*	.30 to .55
For slightly pervious soils*	.15 to .40
For slightly pervious soils, with turf*	.10 to .30
For moderately pervious soils*	.05 to .20
For moderately pervious soils, with turf*	.00 to .10

* For slopes from 1 percent to 2 percent.

For drainage basins consisting of several types of surface with different infiltration characteristics, the weighted runoff coefficient should be computed in accordance with the following expression.

$$\overline{C} = \frac{\Sigma(Ci \bullet Ai)}{\Sigma Ai}$$

where $\overline{C}$: weighted runoff coefficient

Ci : runoff coefficient in an area

Ai : area in a basin

(3) Time of concentration

The time of concentration is composed of two components referred to as the "Inlet time" and "Time of flow". The "Inlet time" is the time required for water to flow overland from the most remote point in the drainage area to the inlet. The "Time of flow" is the time during which water flows through the drainage system to any point.

The "Inlet time" is calculated by the following formula and Figure 10.2-3 provides adequate estimates of the time.

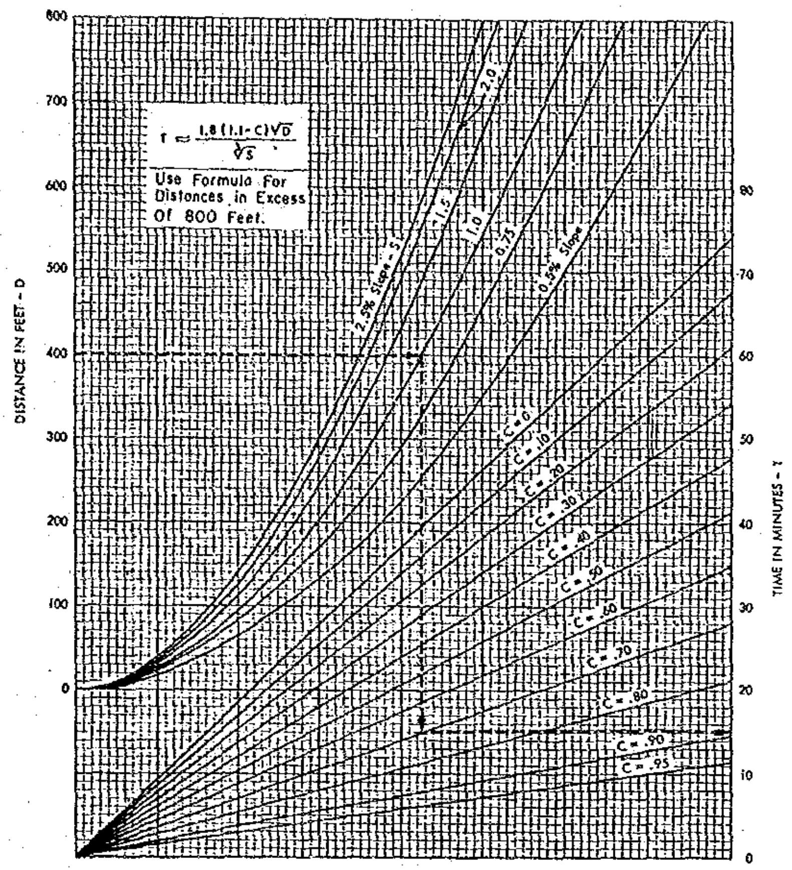
$$T_1 = \frac{3,261(1.1-\overline{C})\sqrt{D}}{\sqrt[3]{S}}$$

where T_1 : inlet time (minutes)

$\overline{C}$: weighted runoff coefficient

D : drainage distance (m)

S : drainage slope (%)



Surface Flow Time Curves

Figure 10.2-3 Surface Flow Time Curve

And the "Time of flow" is calculated based on the following expression.

$T_2 = L/60\,V$

where T_2 : time of flow (minute)

L : length of the drainage system (m)

v : velocity of the water flow (m/sec.)

(4) Velocity of the water flow

The velocity of the water flow in the drainage system shall be calculated by the Manning's formula.

$$V = \frac{1}{n} \cdot R^{2/3} \cdot I^{1/2}$$

where V : velocity of the water flow (m/sec.)

n : coefficient of roughness

I : hydraulic gradient (%)

R : hydraulic mean depth (m)

Table 10.2-2 Coefficient of Roughness

PIPE		Coeffic. 'n"
Clay, concrete, and asbestos cement		0.012
Corrugated metal		
Fully paved		0.012
25% Paved,	$2\frac{2}{3} \times \frac{1}{2}$ inch corr	0.023
	3 x 1 or 6 x 1 inch corr	0.023
	6 x 2 or 9 x $2\frac{1}{2}$ inch corr	0.026
Unpaved,	$2\frac{2}{3} \times \frac{1}{2}$ inch corr	0.024
	3 x 1 or 6 1 inch corr	0.027
	6 x 2 or 9 x $2\frac{1}{2}$ inch corr	0.031
	2 x $\frac{1}{2}$ inch helical corr	
	12 inch diameter	0.012
	18 inch diameter	0.015
	24 inch diameter	0.017
	30 inch diameter to 48 inch diameter	0.018 to 0.021

OPEN CHANNELS	Maximum Permissible Velocity in Feet/Second	Coeffic. "n"
Paved		
Concrete	20 to 30 +	0.011 to 0.020
Asphalt	12 to 15 +	0.013 to 0.017
Rubble or Riprap	20 to 25	0.017 to 0.030
Earth		
Bare, sandy silt, weathered	2.0	0.020
Silt clay or soft shale	3.5	0.020
Clay	6.0	0.020
Soft sandstone	8.0	0.020
Clean gravelly soil	6.0	0.025
Natural earth, with vegetation	6.0	0.030 to 0.150*
Turf		
Shallow flow	6.0	0.06 to 0.08
Depth of flow over 1 foot	6.0	0.04 to 0.06

The required velocity in the drainage system should be more than 0.6 m/sec. and less than 3.5 m/sec., in order to avoid the sedimentation of the soil or sand.

(5) Drainage capacity Q

$$Q = A \cdot V$$

where Q : drainage capacity (m^3)

A : area of cross section of the drainage (m^2)

V : velocity of water flow (m/sec.)

In the case of pipe culvert design drainage capacity Q is calculated based on the full drainage area, whereas 90% of the maximum drainage capacity is selected as a design drainage capacity for the box culvert and open channel.

2) Determination of rainfall intensity

The selection of the severity of the storm which the drainage system should accommodate involves economic consideration. An extremely severe storm occurring very infrequently would undoubtedly cause some damage if the system were designed for some storm of lesser severity. However, if serious interruptions in traffic are not anticipated, a system designed for the larger storm may not be economically justified. Taking these factors into account, the FAA recommends that for civil airports the drainage system be designed for a storm whose probability of occurrence is once in 5 years.

In order to determine the design storm, the following procedures were taken.

(1) Step 1

Based on the rainfall record in 1990 collected at aerodrome site, maximum rainfall intensity in 15 minutes, 30 minutes, 1 hour, 2 hours and 3 hours were read as tabulated in the Table 10.2-3.

Table 10.2-3 Maximum Rainfall Intensity in Short Time

(Unit: mm)

Year	1990												
Month / Hr.	1	2	3	4	5	6	7	8	9	10	11	12	Max.
15 min.	13.0	22.5	12.5	24.0	19.0	13.0	11.0	10.0	5.5	4.5	9.3	29.5	29.5
30 min.	18.0	34.0	16.5	36.0	30.0	13.0	16.0	17.5	10.5	5.8	13.5	31.0	36.0
60 min.	43.0	34.0	23.5	38.5	58.0	13.5	19.5	20.5	12.0	5.8	20.0	33.5	58.0
120 min.	48.0	36.0	24.5	46.0	97.0	16.0	23.0	26.5	13.5	5.8	24.2	43.5	97.0
180 min.	48.0	36.3	25.0	48.5	108.5	19.5	24.5	29.0	13.5	5.8	24.2	48.0	108.5

The formula of rainfall intensity were calculated by the regression method based on the maximum value.

$$i = \frac{175}{t^{1/3}-0.93}$$

where i : rainfall intensity (mm/hr.)

t : duration of rainfall (minute)

(2) Step 2

Based on the monthly rainfall record from 1946 to 1990, the monthly rainfall for 5 years return period was estimated by using the Hazen method as shown in the Figure 10.2-4 and it is to read 450 mm at one fifth.

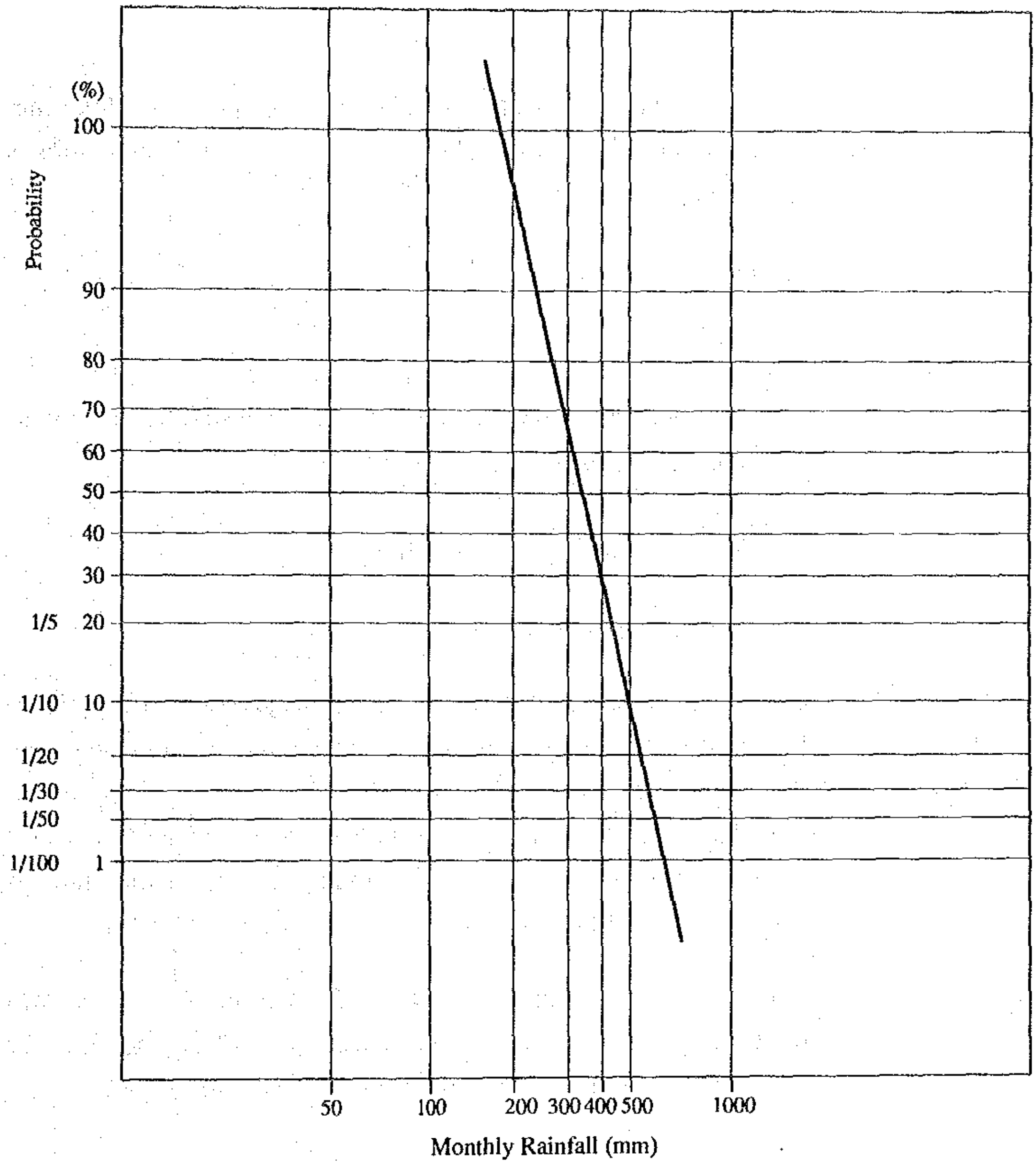


Figure 10.2-4 Probability and Monthly Rainfall by Hazen Method

(3) Step 3

The maximum monthly rainfall in 1990, which was 399.2 mm was compared to the value of the above step 2 and ratio is calculated.

Ratio = 450/399.2 = 1.13

(4) Step 4

The formula mentioned in the step 1 was adjusted by the ratio as rainfall intensity at 5 years' return period.

$$i_5 = 1.13 \times \frac{175}{t^{1/3}-0.93} = \frac{197.75}{t^{1/3}-0.93}$$

3) Calculation of amount of runoff

The airport area was divided into several drainage basins in accordance with planned gradient and existing terrain slope as shown in the Figure 10.2-5. Since the natural flow from the southern area of the airport should be blocked by the airport, outside of the airport was also involved in the calculation of runoff volume as one of the drainage basin. The result of the calculations are as shown in Table 10.2-4.

The runoff volume at the outlet point of whole drainage areas was calculated to be 59 m^3/sec. which is consisted of 18 m^2/sec. from the airport area and 41 m^3/sec. from the southern area of the airport.

Table 10.2-4 Amount of Runoff (Inside of the Airport)

Basin Name	Area (ha)	Coefficient of Runoff "C"	Time of concentration "T" (min.)	Rainfall Intensity "i" (mm/hr.)	Runoff volume "R" (m^3/sec.)
A-1	3.72	0.31	22.2	105.2	0.337
A-2	2.40	0.42	26.0	97.3	0.272
A-3	4.80	0.42	29.6	91.4	0.512
A-4	2.40	0.42	33.5	86.2	0.241
B-1	2.40	0.42	43.1	76.8	0.215
B-2	3.13	0.42	44.2	75.9	0.277
B-3	2.40	0.42	45.3	75.1	0.210
B-3'	2.40	0.42	45.3	75.1	0.210
C-1	3.20	0.42	37.3	82.0	0.306
C-2	3.20	0.42	38.1	81.2	0.303
C-3	2.40	0.42	38.9	80.4	0.225
C-4	2.40	0.42	40.0	79.4	0.222
C-5	3.20	0.42	40.8	78.7	0.294
C-6	2.40	0.42	41.6	78.0	0.218
D-1	3.60	0.39	25.5	98.2	0.382
D-2	3.11	0.39	28.1	93.7	0.316
D-3	2.63	0.41	31.3	89.0	0.266
D-4	3.20	0.42	33.4	86.3	0.322
D-5	2.40	0.42	36.2	83.2	0.233
E-1	1.73	0.62	31.9	88.2	0.263
E-2	2.74	0.49	35.2	84.2	0.314
E-3	4.47	0.52	38.2	81.1	0.524
F-1	2.74	0.60	43.2	76.7	0.350
F-2	2.74	0.49	44.0	76.0	0.283
F-2'	3.65	0.56	44.0	76.0	0.432
G-1	2.74	0.69	40.5	79.0	0.415
G-2	2.74	0.49	41.2	78.4	0.292
G-3	3.65	0.54	42.3	77.4	0.424
H-1	5.95	0.78	43.3	76.6	0.989
H-2	5.96	0.74	44.0	76.0	0.931
H-3	7.95	0.63	44.9	75.4	1.049
I-1	1.83	0.60	39.1	80.3	0.245
I-2	2.74	0.49	41.6	78.0	0.291
I-3	8.74	0.54	42.6	77.2	1.012
J-1	1.66	0.64	31.3	89.0	0.263
J-2	2.74	0.49	33.9	85.7	0.320
J-3	4.57	0.54	37.0	82.3	0.564
K-1	2.85	0.30	27.9	94.0	0.223
K-2	3.59	0.59	34.5	85.0	0.500
K-3	2.97	0.54	46.3	74.3	0.331
L	2.69	0.54	20.7	108.9	0.439
M	1.93	0.54	16.0	124.4	0.360
N-1	15.01	0.30	34.6	84.9	1.062
N-2	0.72	0.30	34.7	84.8	0.051
N-3	2.73	0.51	37.9	81.4	0.315
N-4	0.00	0.00	39.8	79.6	0.000
O-1	2.54	0.54	23.7	101.8	0.388
O-2	1.76	0.54	30.4	90.3	0.238
O-3	0.00	0.00	33.1	86.7	0.000
P-1	2.84	0.72	16.2	123.6	0.702
P-2	3.81	0.30	19.5	112.3	0.357