New Chitose Airport. A similar idea is proposed by other regional governments such as Oita, Nagasaki and Hiroshima.

As background, two factors could be cited: limited cargo handling capacity of New Tokyo International Airport at present and in the future and an increasing air cargo traffic in recent years. New Tokyo International Airport handled about 1.2 million tons or 86% of all international cargo traffic in Japan in 1988. Its capacity has already reached the limit and it is said that it alone or even with New Kansai International Airport in the west planned to open in 1994 will not be able to meet demand anticipated to grow rapidly. In this context, regional airports are expected to play a larger role in handling domestic and international air cargo. International air cargo handled in Japan has been increasing at 12.4% per year between 1980 and 1989 reaching 1.5 million tons in 1989. The major air cargo in recent years are fresh groceries such as vegetables, fruits and fish for which speed in transport is essential and high-technology manufacturing products that generate high value added and are able to bear high transport cost.

3) Strategy for Tokua Airpot

Strategy for linking Tokua Airport development with regional development should be worked out in due consideration of the socio-economic and geographical conditions of Tokua and surrounding areas. The examples given above are all those in developed countries where economic levels are high enough to create sufficient demand for air transportation and technological levels are matured. While direct application of those examples to Tokua is inappropriate, some of the ideas could be adjusted to Tokua's case. The following is a summary of a preliminary assessment of the possibilities for Tokua Airport to spearhead regional development.

a) Tourism would be the prospective sector that could be promoted in parallel with Tokua Airport development. With improved access, especially toward foreign countries, the area has high potential for attracting foreign tourists.

b) Industries related with tourism such as agriculture and light manufacturing could be promoted. Tourism growth in the region will lead to creating new demand for commodities in the area.

While import of some commodities is inevitable at an early stage, efforts should be made to increase the share of local commodities in the total supply of commodities. Food stuff for hotel guests and souvenirs for tourists are appropriate examples of localising tourism-related production. As the quality of products is improved by the initial efforts, it might become possible later on to export some of the products that grew competitive in overseas markets.

c) Two possibilities are considered for Tokua Airport to increase its air cargo handling: export of groceries such as fresh fruits and marine products and Tokua's increased role as the hub of regional air cargo flows for the Islands region.

Development of agriculture and marine products that could take advantage of improved access is worthy of a detailed study. There are some examples in other countries that might be relevant to Tokua such as export by air from Thailand and tuna transported by air to Japan.

At present most air cargo for import and export are transported through Port Moresby. As the new international airport, Tokua will take over some part of the gateway role played by Port Moresby and handle an increased volume of air cargo for East New Britain Province and other provinces in the Islands region such as West New Britain, New Ireland, Manus and North Solomons.

The international air cargo gateway function is a future possibility. As Tokua is situated in between East Asia/Southeast Asia region and South Pacific region, there is a possibility that Tokua will become an air cargo transhipment point, especially for the areas within a short range (about 2,000 km from Tokua)* to midium range (about 3,000 km from Tokua)** destinations.

* Solomon (Honiara), Nauru, Kiribati, Marshall Islands, Caroline Islands (Ponape, Truk Island)

** Vanuatu, West Samoa, Manila, Guam

d) Development of airport/aviation-related training center is a possibility for Tokua. Air Niugini has the largest training facility of all airline companies in South Pacific. DCA also operates a training college for air traffic controller and airport staff for national needs. These existing resources in training could be developed to a South Pacific regional training center receiving trainees from other South Pacific countries. Attractive natural environment and abundance of airspace resources of the Tokua region are favorable conditions to promote this concept.

6.2 Tourism

1) Background

Tourism is one of the most important sectors that would affect the basic characteristics of an airport under planning. The Study Team found out during the first survey in PNG that there is high expectation on the role of tourism development in relation with Tokua Airport development, both at national and provincial levels. It was pointed out that Tokua Airport with an international status could trigger tourism development in the region, thus contributing to economic growth of the province and the country. With this background in mind, the Study Team made a preliminary analysis on tourism development potential of the Rabaul-Kokopo-Tokua region and tried to find some implications for planning of Tokua Airport, especially air traffic forecast.

2) Tourism Resources in the Region

The northeastern part of the Gazelle Peninsula in East New Britain Province encompassing Rabaul, Tokua and Kokopo is one of the areas with the richest touristic resources in PNG. Vying with Madang in Madang Province, the provincial capital of Rabaul is said to be one of the most beautiful towns in PNG or even in South Pacific. Rabaul itself is characterized by wide and clean streets in a grid pattern and having dramatic volcanoes towering over it on all sides and beautiful Simpson Harbour. The Rabaul-Kokopo-Tokua area is endowed with a combination of different types of touristic resources related with natural beauty, historical relics and local human activities. The following part lists the major touristic resources in the region.

(Natural resources)

- beautiful beaches and sea with coral reefs left untapped
- magnificent scenery with volcanoes and harbour
- beautiful scenery with rich green in contrast with blue sky and sea water and accentuated by colorful flowers and pretty churches located along roads
- beautiful off-shore islands (e.g. Duke of York Islands, Credner Islands, Watom Island)
- hot spring

(Historical resources)

- World War II relics
- legendary Queen Emma-related attractions

(Human activities-related resources)

- vigourous Rabaul market
- small but cozy town of Rabaul
- friendly local people

Figure 6.2-1 presents the major touristic attractions in the Rabaul-Kokopo-Tokua region.

3) Constraints in Tourism Development

"Papua New Guinea Five Year Tourism Development Plan 1990 - 1994" identifies the following aspects as the problems affecting the tourism industry in Papua New Guinea.

a) law and order situation reflected by a high crime rate, (It is often pointed out, though, that there is almost no law and order problem in East New Britain Province).

b) high cost of accommodation, meals and domestic transport

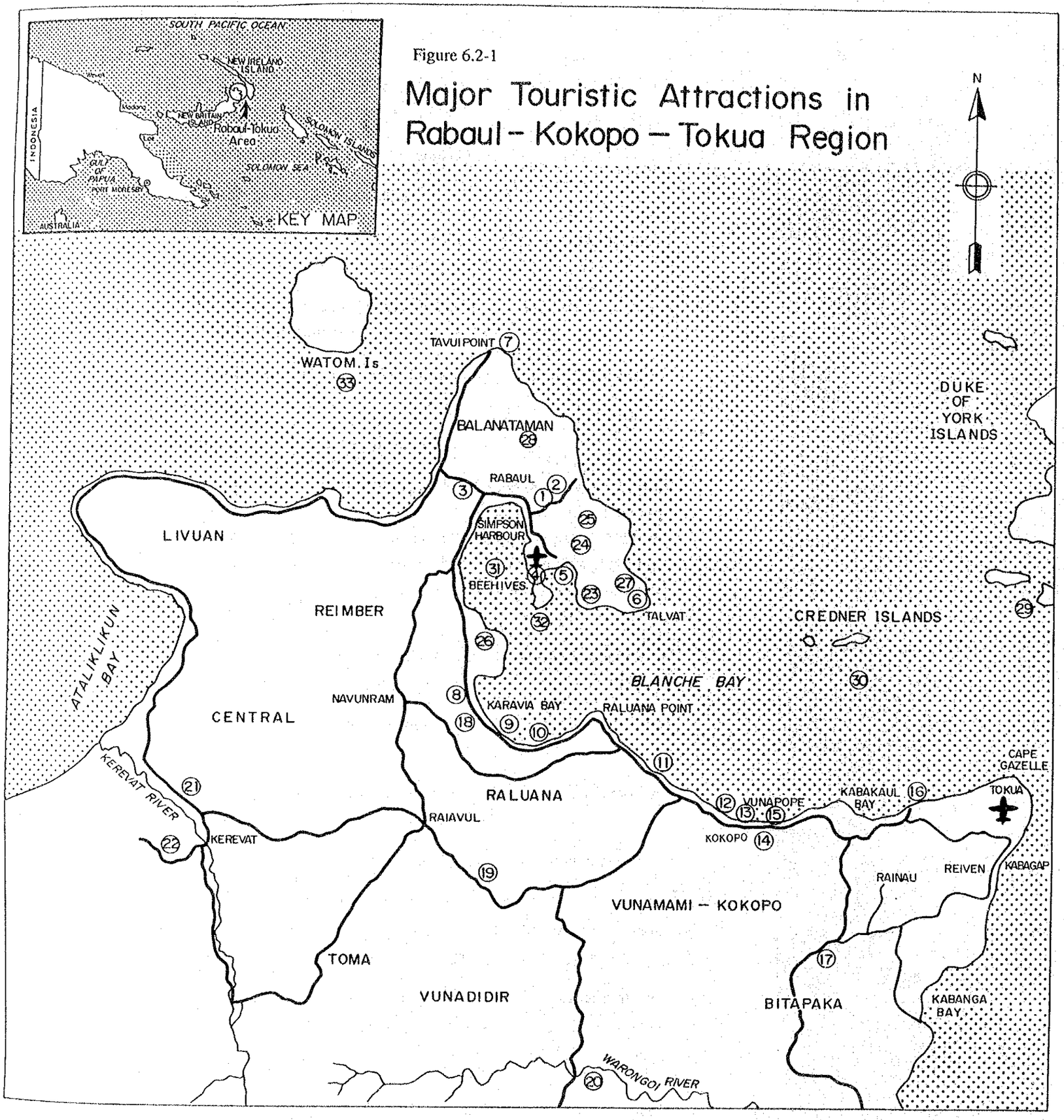
c) inadequate access transport to PNG and high airfares

d) inconsistency and lack of continuity in government policy in tourism development

e) inadequate budgetary allocation for tourism promotional activities

Figure 6.2-1

Major Touristic Attractions in Rabaul - Kokopo - Tokua Region



LEGEND

- Major Road
- River
- Airport

MAJOR TOURISTIC ATTRACTIONS

1 Orchid Park (orchids indegenous to PNG)
2 Mamanula Lookout (magnificent panoramic view)
3 Tunnel-Hill Road (wartime tunnels)
4 Aircraft Wreckage (Japanese aircraft wrecks)
5 Hot Spring (beach with hot spring seawater)
6 Pread Point (Australian big guns at the wartime)
7 Submarine Base (wartime Japanese submarine base, good diving spot)
8 Japanese Barges at Karavia (5 Japanese barges in a tunnel)
9 Floating Crane
10 Japanese Tunnels (7 large tunnels dug by the Japanese)
11 Queen Emma's Grave (remains of her grave)
12 Queen Emma's Steps (overlooking the Duke of York Islands)
13 Kokopo (German headquarters between 1890 and 1910)
14 German Cemetary
15 Vunapope Mission (headquarters of the Sacred Heart Missionaries)
16 Ulaveo Museum (historical records, arts and crafts)
17 Bitapaka War Cemetary(for Australian soldiers killed during WWI)
18 Malmaluan Lookout (Extensive view of Rabaul)
19 Toma Road (magnificent view of the Baining Mountains)
20 Warongoi Hydro-Electric Project
21 Lowlands Agricultural Experiment Station(largest in the South Pacific)
22 Vudal Agricultural College
23 Mt. Tavurvur (active volcano)
24 Mt. Rabalanakaia (active volcano)
25 Mt. Kombiu (highest extinct volcano called "Mother")
26 Mt. Vulcan (erupted in 1937 and grew to 225 meters in a few days)
27 Mt. Turagunan (extinct volcano called "South Daughter)
28 Mt. Tovanubatir (A Volcanology Observatory is located.)
29 Duke of York Islands (tourist resort)
30 Crender Islands (good snorkelling spot, called "the Pigeons")
31 The Dawapia Rocks(good for swimming, snorkelling, "called Beehives")
32 Matupit Island
33 Watom Island (good for snorkelling, diving & walking treck)

SCALE

2 10 20km
0 1 5 15

f) keen competition from other countries in the region such as Fiji, Guam, Australia and New Zealand

g) lack of entertainment facilities after dark

h) health fears, especially malaria

In addition to these constraints for PNG, the Rabaul-Kokopo-Tokua region has the following constraints.

a) inadequate accommodation facilities, in contrast with the region's rich touristic resources

b) limited access to the region from the origins in overseas source markets

4) Government Standing in Tourism Development

As an important sector contributing to the creation of job opportunities and foreign currency earning, the government of PNG has granted top priority to the development of tourism. The government set the target of 60,000 international visitor arrivals in 1994, equivalent to a growth of 10.2% per year since 1990 (international visitor arrivals amounting to 40,742 in 1990).

The major points of the government's policy and strategies in promoting tourism could be summarized as follows.

a) to promote PNG as a desirable holiday destination in the main international source markets

b) to develop tourism industry for the benefit of the greatest possible number of citizens

c) to utilize local commodities to the extent possible, thus enhancing inter-sectoral linkages

d) to attract national and foreign investments in tourism through providing investors' incentive packages

e) to minimize adverse impacts of tourism development on environment and local culture and communities

The Tourism Development Corporation of PNG (TDC) adopts a concept of "strategic area development". According to this concept, public funds for tourism development will be concentrated on selected strategic areas namely: Islands Region including East New Britain Province and the Sepik region. According to TDC, the Islands region should attract tourists from source markets along the north - south line such as Japan, South Korea and Taiwan, while the Sepik region should be geared to origins along the east - west line such as Singapore, Hong Kong and Indonesia.

East New Britain Province has been proposing "model tourism development" concept, which is similar to the TDC's "strategic area development" concept. To promote this idea for promoting tourism development of East New Britain Province, the provincial government scheduled to convene a seminar inviting people from government (e.g. Prime Minister, Minister of Tourism, DCA etc.) and the private sector (e.g. hoteliers, tour operators, airline companies etc.)

5) Direction of Tourism Development in the Region

Tourism development of the region almost entirely hinges upon the improvement of access from overseas origins. Easier access to the region through Tokua Airport with an international status would be one of the vital conditions required for promoting international tourism of the region. It should be understood that the objective of giving an international status to Tokua Airport, if so decided, would be to create new tourist demand for regional development promotion rather than the airport meets existing international tourism demand in the region.

The issue of according Tokua Airport an international airport status, however, should be analyzed looking into all relevant matters including national air transport policy and regional development aspect. In the following part, an analysis on tourism is presented and preliminary proposals made with the assumption that Tokua Airport be accorded an international airport status.

Regarding the goal of tourism development in the region, it would be more strategic and realistic to set a target at a moderate level than unrealistically high level. In other words, "Quality Tourism" rather than

"Mass Tourism" should be aimed at. The following are the considerations;

a) Tourism in PNG is still at an infant stage (International tourist arrivals in 1989 was about 49,000, only 7th in the South and Central Pacific region.) It would be too early to set a high target assuming competition with other major touristic destinations in the region such as Guam, Fiji and Australia. It would not be too late to consider a possibility of "mass tourism" for the region after a constant increase in tourist arrivals is realized over some years.

b) As represented by "Eco-tourism" concept proposed by the Tourism Development Corporation, harmony should be maintained between tourism development and environment, both natural and social. This consideration is especially essential for the Rabaul-Kokopo-Tokua region characterized by beautiful nature as the important touristic resource and relative homogeneity of the local community. A low density development in environmentally justifiable areas would be the appropriate direction in stead of urban marine resort type development such as Waikiki in Hawaii or Pattaya in Thailand.

c) Good balance should be sought between the magnitude of tourism growth and the size of local community that would be the main body to cater for tourism growth. Moderate level tourism growth will be appropriate considering the economic size and manpower resources of the region. Rapid and massive tourism growth, if realized, is possible to bring about a number of adverse impacts on local community such as prices rise, shortage of manpower, environmental destruction etc.

d) In relation with marketing aspect, PNG's image in foreign potential markets is somewhat negative (e.g. linked with security and crime problem, a wild place etc.) With this reality, it would be more strategic to focus marketing efforts on specialised group rather than general mass at the initial stage. An example of possible strategy might be to emphasise marine sports and war relics or aim at diverting part of tourists visiting Cairns, Australia or Guam/Saipan. By starting with tapping specialised groups, it might become possible later on to broaden the target for marketing

as the region becomes more familiar to the potential tourists in the overseas markets through initial efforts.

6) Implications to Air Traffic Forecast

Analyzing all the aspects mentioned so far, the Study made a preliminary analysis on potential and desirable magnitude of tourism growth in the Rabaul-Kokopo-Tokua region. This assessment should be taken as a planning framework or policy target to be integrated into airport planning, especially air traffic forecast, rather than an objective forecast of visitor arrivals to the region.

The findings presented so far could be summarized as follows.

a) The region is endowed with rich touristic resources.

b) The region as part of PNG, however, has a number of constraints in promoting tourism.

c) Attitudes of both the central and provincial governments are very active in promoting tourism. It could be expected that some of the constraints be overcome or reduced to some extent over years by measures being taken or to be taken by the government (e.g. reduction of accommodation prices by the introduction of investors' incentive packages).

d) Moderate level growth of tourism would be possible and desirable in the region with the assumption that an international status be given to Tokua Airport.

Based on these findings, the Study Team considers a development of hotel accommodations not exceeding 200 to 300 guest rooms in total would be desirable and possible to be attained by the year 2000 or so. In presenting this figure, it is assumed that low density development takes place in a number of areas along the Rabaul-Kokopo-Tokua: Kokopo or the areas around the airport site, for example. From the landscape and environmental perspectives, low story architectures that would match and mingle with the surroundings would be favorable and recommended.

7) Other Issues Related with Tourism

The objective of analyzing tourism aspect as presented so far is to provide a basic input for Tokua Airport planning. Development of tourism itself should be planned and promoted in parallel with Tokua Airport development in the subsequent stage. The following summarizes some of the findings related with tourism which are not directly related with air traffic forecast for Tokua Airport, but would be useful for tourism planning and promotion in the Rabaul-Kokopo-Tokua region.

a) The Study Team found during the first survey in Rabaul that the East New Britain Tourist Board plans to start preparing a five year tourism development plan of the province soon. This five year plan should be able to serve as the framework for tourism development in the region and all tourism development projects and activities in the coming years should be guided according to the set framework. A consolidated approach in this manner would be the "must" in successfully promoting sound tourism development in the region.

b) An important component of the tourism development framework would be to select priority areas in the region to effectively and successfully attract and encourage potential tourism-related investors to investment. It is preliminarily considered Kokopo and the areas around the Tokua Airport site are advantageous for investment at the early stage of tourism growth. Some part of these areas provide favorable environment for hotel development with nice beaches and sufficient space. Above all, these areas will be provided anyway with basic infrastructure and utility facilities in parallel with new township program in Kokopo and airport development in Tokua. Availability of these facilities would be a big advantage in attracting investors.

c) With regard to Kokopo for tourism development, revitalization of the "Queen Emma Palace" project could become a viable first step in promoting tourism of the region. The project was originally planned by the Tourism Council of the South Pacific with fund provided by European Community (EC). The hotel was originally scheduled to open in 1991, but suspended in 1988. With the

Tokua Airport project proceeding, this is a good chance for the provincial government and Tourism Development Corporation to make an effort in revitalizing the "Queen Emma Palace" project that could become a trigger in attracting further investments to the region.

d) It was pointed out during the first survey in PNG that viable international links with Tokua would be places like Cairns, Australia and Guam and direct connection of Tokua with such places as Tokyo, Singapore and Hong Kong would be a future possibility. It would be possible to link this idea with a marketing strategy aiming at promoting diversion of tourists from Cairns and Guam to the region. A combination of air link and marine transport ("fly and cruise") would be a possibility worthy of further analysis, particularly considering Rabaul's experience in receiving cruising passengers (c.f. The number of cruise passengers visiting Rabaul was 2,500 in 1990.)

6.3 Mining

During the first survey in PNG it was often pointed out that there is a possibility that the Lihir gold mine on the Lihir island, New Ireland Province, would create certain level of demand for Tokua Airport. The Study Team, however, found out through an interview survey with Kennekot Explorations (Australia) Ltd., the mining company, that the impact of the Lihir gold mine on Tokua's air traffic would be limited.

The development of the Lihir gold mine is scheduled to start in 1993 and the operation to start in 1995. It is confirmed that the mine's gold deposit is of largest in the world outside South Africa, though the grade is low. At an operational stage, the total workforce of about 1,400 is planned to be working at the mine, out of which 350, 350 and 700 each are expatriates, non-Lihir workers and Lihir workers respectively. Expatriates will be working on a 15-day duty and 5-day off shift. Since the island will not provide any recreational facilities except drinking places after dark, most expatriate workers are expected to fly out of the island for days-off to places like Cairns, Australia and Guam.

It is estimated that about 6,400 trips, both outbound and inbound, will be made annually by expatriate workers with the shift schedule and the number of

expatriate workers assumed as mentioned above. According to the mining company, transportation of these expatriate workers to outside the island or PNG will be made mainly by chartered direct flights to Cairns or Guam by an aircraft like DHC8 or equivalent. It is judged by the mining company that direct flight on a chartered basis is more economical than using commercial flights through Rabaul or Tokua. With this prospect, the mining project contains the development of a 1,200 m airstrip (to be expanded to 1,500 m later on) to accommodate the direct flights to/from the Lihir island.

While most of international air traffic to be generated by the Lihir gold mine will be catered for on its own, it would also be true that the Lihir gold mine would impose a certain level of impact on Tokua Airport in some aspects such as follows.

- Much of daily commodities such as food and materials necessary for daily operation of the mine will be supplied by East New Britain Province, thus creating a certain level of air cargo traffic from Tokua to the Lihir island.
- Company's executives are likely to fly by commercial flights for visiting the Lihir island through Tokua.
- With tourism development in the Rabaul-Kokopo-Tokua region, certain portion of expatriate workers would visit and stay in the region flying in through Tokua.

6.4 Kokopo New Township Project

In response to the point made during the first survey in PNG, the Study Team looked into possible relationship of the Tokua Airport project and the Kohopo New Township project. The Study Team considers that the impact of the Kokopo project on the Tokua project, especially air traffic through Tokua, would be minimum.

The regional development policy of East New Britain Province is to promote the decentralization of social services and economic development to the rural areas of the province. The provincial government adopts "A Growth Center Hierachy" approach to promote this policy. The strategy of adopting this approach is to promote the development of rural areas through strengthening the social and economic functions of the selected growth centers, thus avoiding an over-concentration or too wide a spread of development funds.

Under the proposed hierachy, Rabaul is planned to remain as the provincial and regional center of the province. Kokopo and Palmalmal are designated as the sub-regional centers for the Gazelle and Pomio sub-regions respectively. District centers and local centers will constitute lower levels of the hierachy for smaller settlements. The province's policy regarding the role of Rabaul is to retain its existing population and economic activities, while promoting a balanced growth of the province through encouraging the growth of the areas outside Rabaul through strengthening sub-regional centers such as Kokopo.

To promote the growth of Kokopo, the provincial government plans to move its headquarters functions from Rabaul to Kokopo step by step. The provincial government has prepared a zoning plan of Kokopo, which has been approved by the central government. The following shows land area for each zone in the planned 123 hectar area in Kokopo.

- open space	:	2.06	ha
- residential area	:	19.05	ha
- commercial area	:	8.41	ha
- light-industrial area	:	13.39	ha
- public/institutional area	:	79.98	ha
- total	:	122.89	ha

In the public and institutional area, the provincial government has secured a land of 4 hectar for the development of government buildings. The Department of Land of the central government plans to establish an office at this site and move in 1992. For the provincial government, a bidding is planned soon for hiring consultant for designing provincial government buildings.

Planned scale of the provincial government in Kokopo will be in the order of not exceeding 100 officers at the managerial level including Provincial Premier. Most of the public servants engaged in administrative services for Rabaul's social and economic activities will remain in Rabaul. A possibility for the private sector activities would be the location of new offices or expansion in Kokopo rather than total relocation of the existing facilities in Rabaul to Kokopo.

Regarding the anticipated relationship between the Kokopo New Township Project and the Tokua Airport Project, the provincial government's initiative to move part of its function to Kokopo would contribute to attracting certain level of economic activities and population to Kokopo, thus helping to cancel out to some extent a disadvantage of the Tokua site being distant from the present main regional center,

Rabaul. It is also expected that the Kokopo New Township Project will to some extent attract commodities and people flying in through Tokua during the construction of the Kokopo new town. After the construction, no major impacts are foreseen.

7. ENVIRONMENT

7.1 Environmental Impacts of the Project

7.1.1 Responsible Agency and Present System

Environmental issues in Papua New Guinea is administered by the Department of Environment and Conservation within the framework of "the Environmental Planning Act 1978." The act is at present under amendment to add it more specificness. The amendment is planned to be finalized by 1992. The "General Guidelines for the Preparation and Content of Environmental Plans" provide general guidelines for environmental considerations required in implementing development projects.

Under the present system, an environmental plan is submitted, either voluntarily or upon requirement, for the projects that are foreseen to create major environmental impacts. For the projects with minimum environmental impacts anticipated, an exemption could be granted for submitting an environmental plan. It is recommended that DCA, the executing agency of the Tokua Airport project, will keep close contact with the Department of Environment and Conservation such that the environmental issues regarding the project, be properly taken cared of in the process of promoting the project to implementation. The following descriptions on the environmental aspect of the Tokua Airport project could be used as a basis of the discussion between DCA and the Department of Environment and Conservation.

7.1.2 Natural Environment

On the land Tokua Airport site is surrounded primarily by cocoa and coconut plantations, no rare or precious species have been identified according to the Department of Environment and Conservation.

The Tokua site is located at Cape Gazelle facing the sea toward north and southeast. The aerial photos taken during the first survey indicate that coral reefs are found along the shorelines around the Tokua site. Since coral reefs are an important resource for tourism growth of the region, any impact to be caused by the airport construction and operations should be minimized. To collect data on the existing coral reefs and use them as a basis of analyzing protective measures, it is desirable that an environmental survey focusing on coral reefs be conducted prior to proceeding to the implementation of the project and clarify the following items.

- size and area of coral community
- species composition
- general aquatic condition
- planktonic population of the coral area
- forecast of impacts of the project on the coral reefs
- identification and recommendation of measures

To minimize adverse impacts on coral reefs, drain water during construction and wastewater to be generated by operations should be properly treated before being discharged into the sea. The Bureau of Water Resources, Department of Mining and Energy, requires the following wastewater quality standards to be observed.

BOD	:	less than 20 ppm
suspended soils	:	less than 150 ppm
fecal coliforms	:	less than 200 fc/100 mls

A wastewater facility and drainage system plan should be prepared in due consideration of these wastewater standards.

7.1.3 Social Environment

From the social environmental viewpoint, aircraft noise is often the most severe problem to be considered in the development of airport facilities. The following three aspects are important in minimizing noise problem.

- site selection
- land use in the surrounding areas
- noise abatement measures

The Tokua site is almost an ideal location for airport development in that it is situated in a fairly undeveloped area facing the sea on the two sides and surrounded mostly by plantations, while access to the existing infrastructures such as water supply and road systems could be secured at a relatively low cost. The location stands on a good balance of minimizing adverse impacts on the social environment and readiness for development.

The preparation of a land use plan in the surrounding areas of the Tokua site is an issue to be considered in the subsequent stage of the project promotion. The necessity of an appropriate land use plan stems from the two reasons, namely:

- It would be necessary to develop a land use pattern that would minimize the noise problem for residents in and visitors to the area. A land use plan from the environmental perspective could be prepared based on a forecast of noise level and allocation of activities allowed in each zone classified according to the forecast noise levels. Noise contour in and around the Tokua site is prepared later in 7.2.

- To create an attractive environment for tourism in the area, it would be necessary for the government to control land use through guiding each private investment project in a desirable direction according to a master land use plan of the area.

As far as the issues mentioned above are properly taken into consideration, noise issue could be prevented from becoming a major problem. In the unexpected event that the noise issue becomes a problem, it would become necessary to take a number of noise abatement measures such as the improvement in operating methods, restrictions on flight departures and landings and aircraft improvement. A more detailed analysis on the noise aspect is given in the following sub-section 7.2.

During the first survey by the Study Team in PNG, it was pointed out that the customary land adjacent to the airport site needs careful consideration in case of planning additional land acquisition. The Study found so far that no acquisition of the customary land is needed for the airport development.

The development of Tokua Airport, however, would likely make it necessary to cut trees in some part of the plantations bordering the runway portion of the airport to clear the ICAO standard for the short term development in 2000 and for the master plan in 2010. The necessity to acquire additional plantation land for the secondary runway is subject to further analysis and discussion. According to the provincial government, there has not been any problem in acquiring land in the province in the past and no problem is foreseen in case of cutting trees acquiring additional or plantation land adjacent to the Tokua Airport site through taking appropriate compensation measures.

The Study Team would like to propose that both the national and provincial governments pay due attention to the land issue from the planning stage so as to prevent land disputes regarding the project. Since the project could become a trigger in the development of the entire area surrounding the airport site, it would be desirable if the governments to take an open attitude such as actively providing project-related

information to the public from the planning stage or even promoting local communities' participation in the planning process. This kind of open approach by the government would contribute to preventing or minimizing not only the land problem but also any other problems associated with social conflicts that could be caused by the implementation of the project.

7.2 Noise Impacts

7.2.1 Environmental Aspect

Noise is the major environmental consideration associated with the airport operations. The orientation of the proposed runway at Tokua, combined with the prevailing wind conditions, results in as follows:

Runway 28 : Operationability be 52% of landings and take-offs for westerly wind annually

Runway 10 : Operationability be 48% of landings and take-offs for easterly wind annually

Hence, the preferential runway is RWY 28. This implies that more taking off flights (less landings) over the area west from the airport and more landing flights (less take-offs) over the area east from the airport.

Note: Operationabilities (52% and 48%) mentioned above will become different (i.e. 80% and 20%) when many take-offs are executed with tail wind component under calm wind condition at pilot's discretion in conformity to ATC's suggestion.

7.2.2 Noise Level Measurement

Various measures have been developed to evaluate aircraft noise effect by noise level and frequency. Weighted Equivalent Continuous Perceived Noise Level (WECPNL) method is currently used in Japan, and it appears to be best applicable as a noise evaluation measure in this Study. WECPNL is a modified version of Effective Perceived Noise Level (EPNL) defined by ICAO, and it reflects the perceived severeness of flight noise with larger weights on night flights than daytime flights. WECPNL is given by the following formula:

$$WECPNL\ (i) = 10 \log 10 \left[\sum_{j} \text{anti log } (EPNL\ ij)/j \right] + 10 \log 10N - 39.4$$

where, j : Type of aircraft and type of flight patterns

N : Total weighted number of flights at "I" point
(= N1 + 3N2 + 10N3)

N1 : Number of flights from 7 am to 7 pm

N2 : Number of flights from 7 pm to 10 pm

N3 : Number of flights from 10 pm to 7 am

i : Any selected point

Since the formula presented above is, however, actually very hard to use for calculating each configuration of a number of flights, the simplified version of the formula, which is more practical for calculation, is recommended hereunder:

$$WECPNL = dB\ (A) + 10 \log N - 27$$

where, dB (A) : A weighted sound pressure level

N : Number of flight
$(= N_1 + 3\ N_2 + 10\ N_3)$

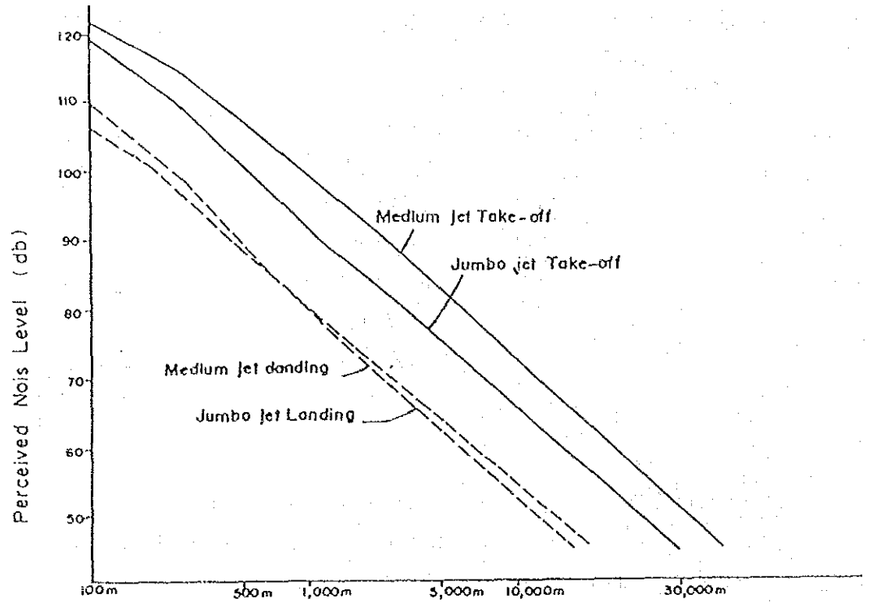
N_1 = Number of flights from 7 am to 7 pm

N_2 = Number of flights from 7 pm to 10 pm

N_3 = Number of flights from 10 pm to 7 am

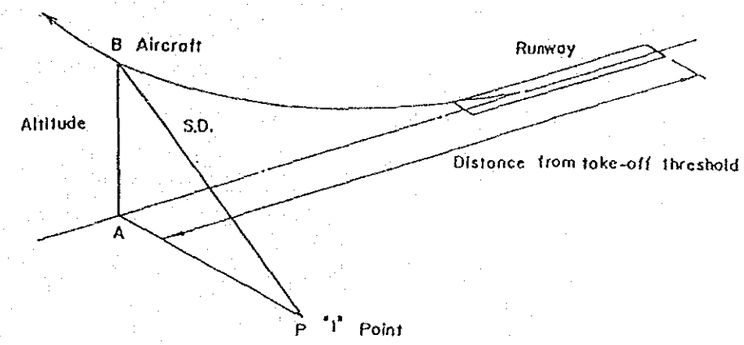
The take-off profile is determined to be a function of distance to destination and type of aircraft. Hence, the distance to aircraft from any point, or the so called "Slant Distance" is calculated. Since EPNL (Effective Perceived Noise Level) for every aircraft has been obtained as a function of the slant distance, EPNLij at "j" point can be calculated based on each aircraft type and flight pattern. (Refer to Figure 7.2-1)

The aircraft noise contours will be worked out on the basis of the estimated number of daily flights.

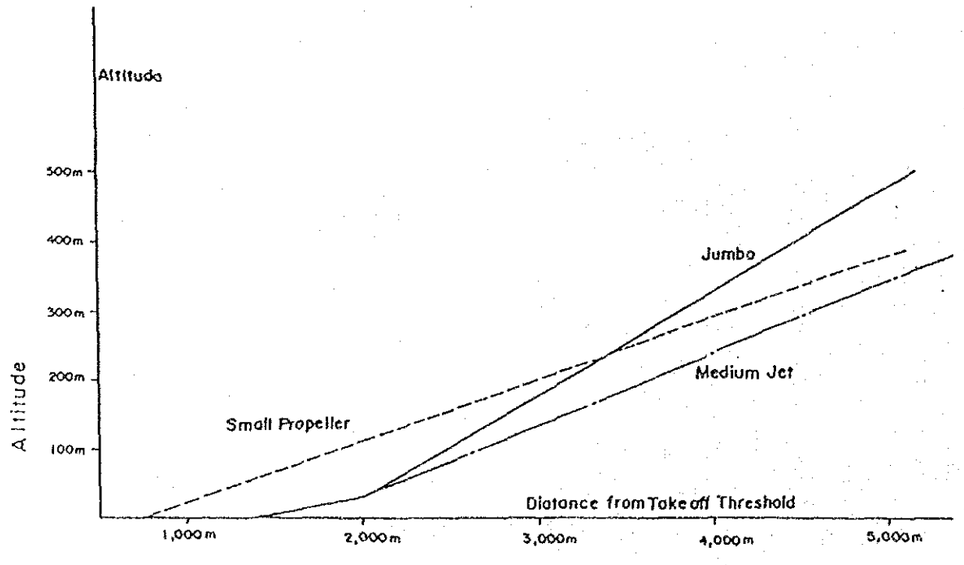


PNL AND DISTANCE FROM AIRCRAFT

Slant Distance (S.D.) = $\sqrt{AP^2 + AB^2}$



SLANT DISTANCE



TAKE OFF PROFILE

Figure 7.2-1 Calculation of WECPNL

The traffic pattern and other basic conditions at Tokua are assumed as follows:

Traffic	:	As shown in Figure 7.2-2	
Daily Flight	:	As shown in Table 7.2-1	
Runway Length	:	2,200 m	
Ratio of Runway Use	:	RWY 28	: 80%
		RWY 10	: 20%
Descent Gradient	:	RWY 28	: 2.50°
		RWY 10	: 2.50°
Climb Gradient	:	300 ft/NM	
Background Sound	:	0 dB	

The scale of WECPNL applied in the evaluation will be 70 WECPNL up to 95 WECPNL in 5 WECPNL increments. It is also noted that the traffic patterns, shown in Figure 7.2-2, represent a straight-out climb for departure and a straight-in approach for landing, both on Runway 28 and 10.

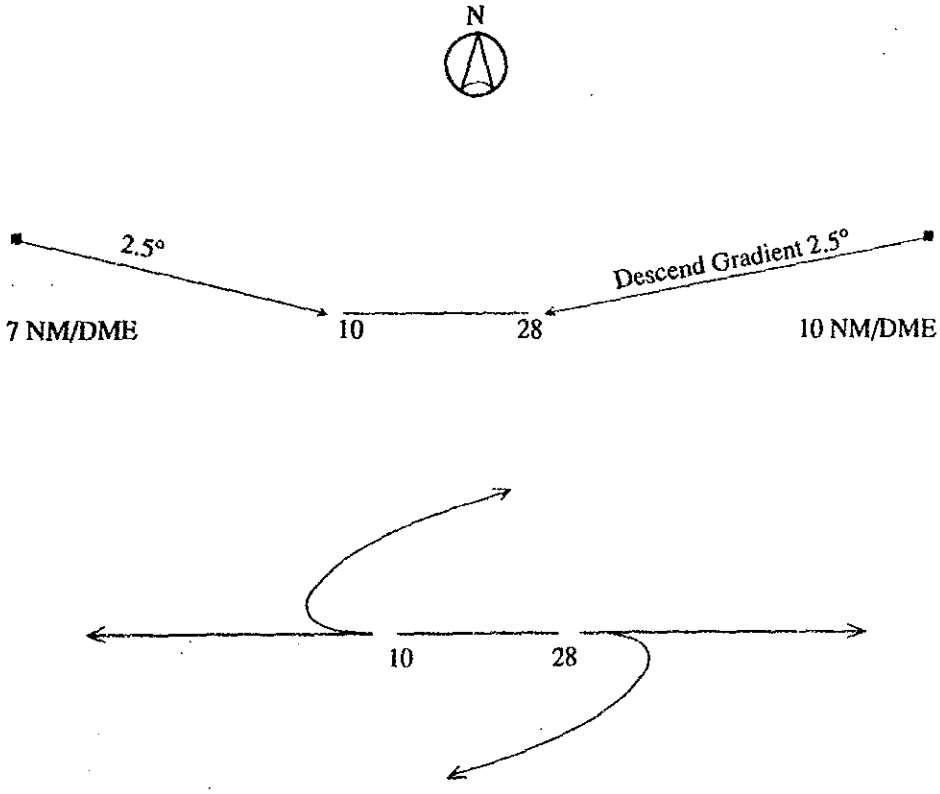


Figure 7.2-2 Traffic Pattern for Noise Contour Calculation

The aircraft noise contours will be worked out on the basis of the estimated number of daily flights. Based on Attachment 9-2 "Table: Projected Annual Aircraft Movements by Routes" and taking account the operational hour tendency shown in Attachment 9-2 "Table: Schedule Operations at Rabaul Airport", number of daily flights at Tokua Airport to be applied for WECPNL noise level is tentatively estimated, as shown in Table 7.2-1.

Table 7.2-1 Number of Daily Flights at Tokua applied for WECPNL Noise Level

Year	Aircraft Type	Time			Total
		07:00 - 19:00	19:00 - 22:00	22:00 - 07:00	
2000	MJ (A310, B767)	1.0	0.0	0.0	1.0
	SJ (B737, MD87)	5.0	1.0	1.0	7.0
	TP (F28)	4.0	1.0	1.0	6.0
	G. A.	13.0	2.0	1.0	16.0
	Total	23.0	4.0	3.0	30.0
2010	LJ (B747)	1.0	1.0	0.0	2.0
	MJ (A310, B767)	2.0	1.0	1.0	4.0
	SJ (B737, MD87)	10.0	2.0	3.0	15.0
	G. A.	25.0	3.0	3.0	31.0
	Total	38.0	7.0	7.0	52.0

Note 1: Flight number of 19:00 - 22:00 is equivalent to 3 times the number of 07:00 - 19:00 and that of 2200 - 07:00 is equivalent to 10 times that of 07:00 - 19:00. (For instance, the total flights of 19:00 - 22:00 of the year 2000; 4.0 x 3 = 12.0 and the total flights of 22:00 - 07:00 of the year 2010; 7.0 x 10 = 70.0).

Note 2: LJ: Large Jet, MJ: Medium Jet, SJ: Small Jet, TP: Turbo-Prop Aircraft in ( ) are representative aircraft types.

7.2.3 Noise Levels of 2000 and 2010 Operations (Refer to Figure 7.2-3)

The traffic pattern, as well as descent and climb gradients, will not be modified in evaluating the noise level of operations in 2000 for reasons explained above. On the other hand, the number of daily flights in specific hours has been estimated as shown in Table 7.2-1. It is anticipated that about 23 flights are operated from 7 am to 7 pm (N1), about 4 flights from 7 pm to 10 pm (N2) and about 3 flights from 10 pm to 7 am

(N3). Although it is desirable to introduce aircraft of quieter engines as noted above, the noise contours have been prepared by applying the aircraft types expected in 2000 and 2010 at Tokua Airport, Figure 7.2-3 indicates the WECPNL noise contours anticipated for operations in 2000 and 2010. By reviewing the 2000 noise contours, it will be possible to observe the following: The noise level would not be aggravated substantially even though the daily traffic in 2010 will be 1.7 times the traffic in 2000. It is primarily attributable to the fact that the flight schedule will continue to concentrate in the time range of 07:00 - 10:00 and 16:00 - 20:00 when less effect is expected on the weight noise level.

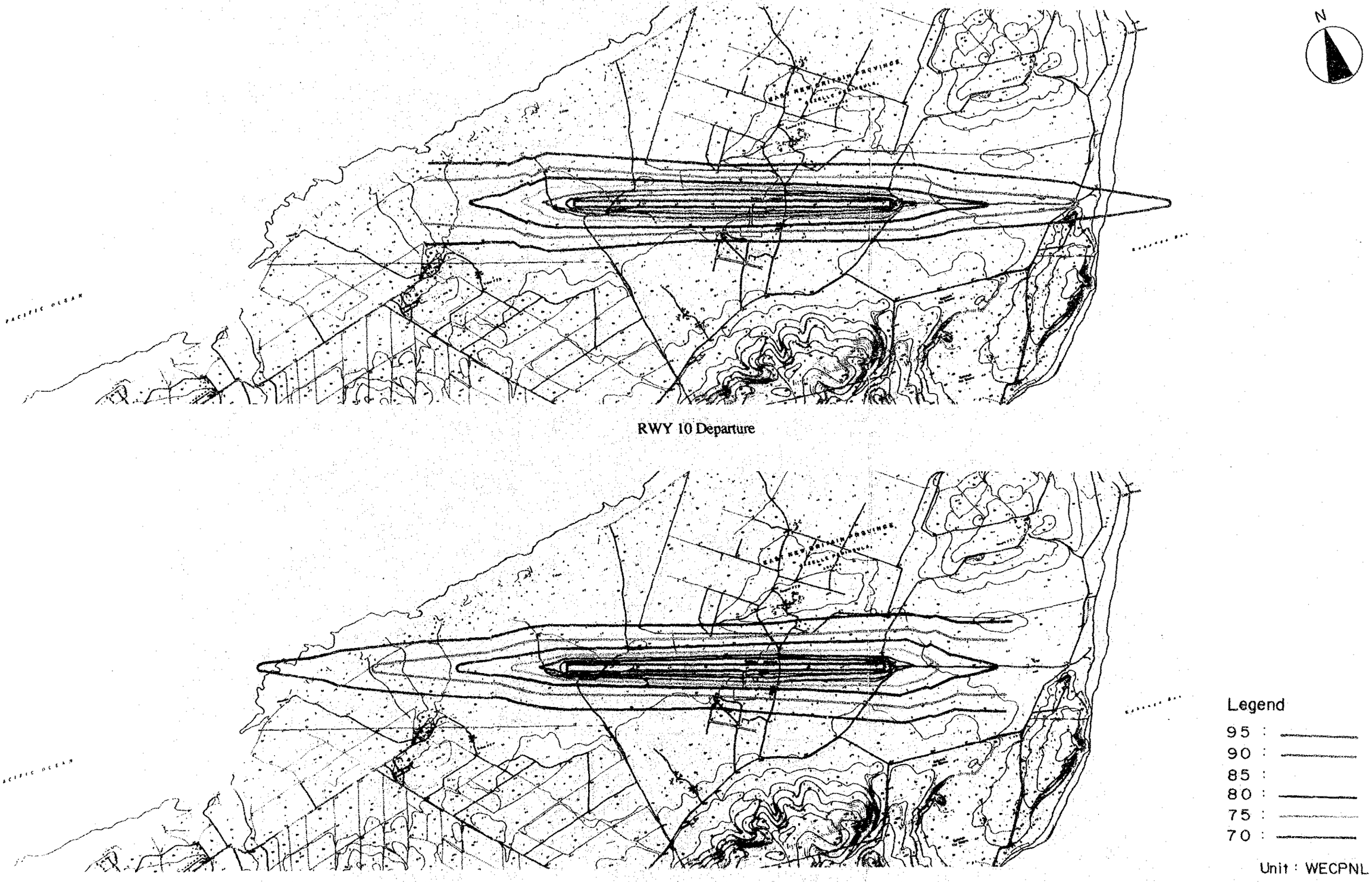
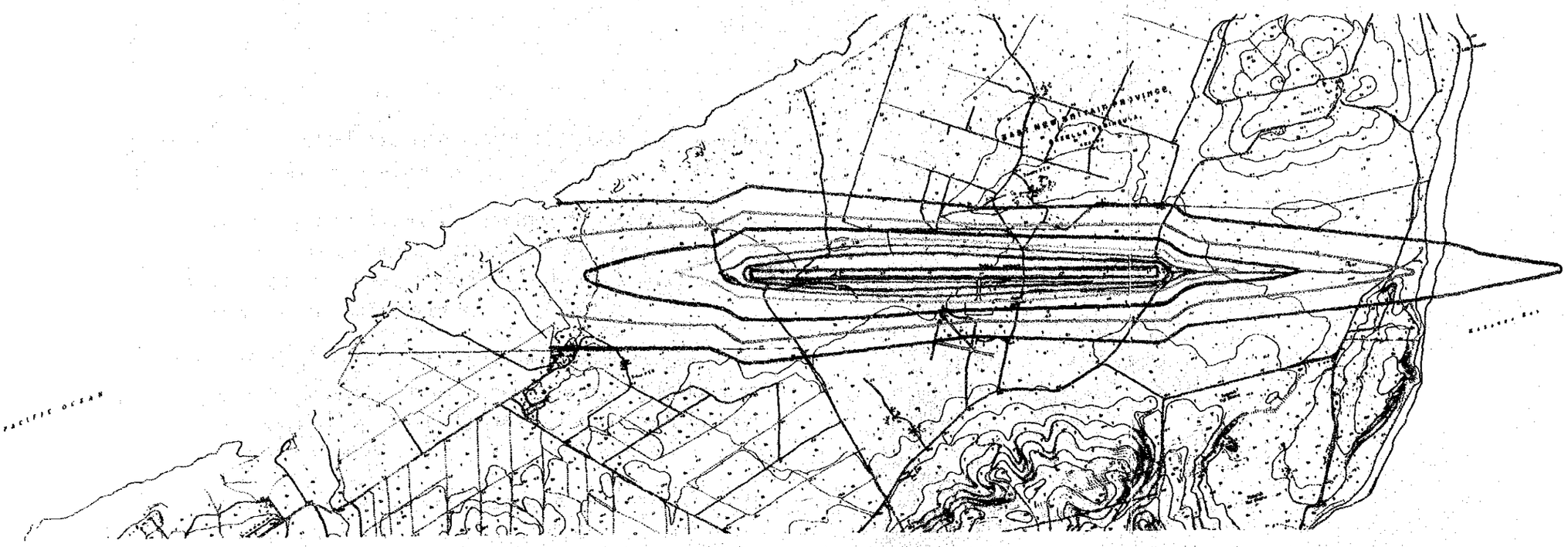
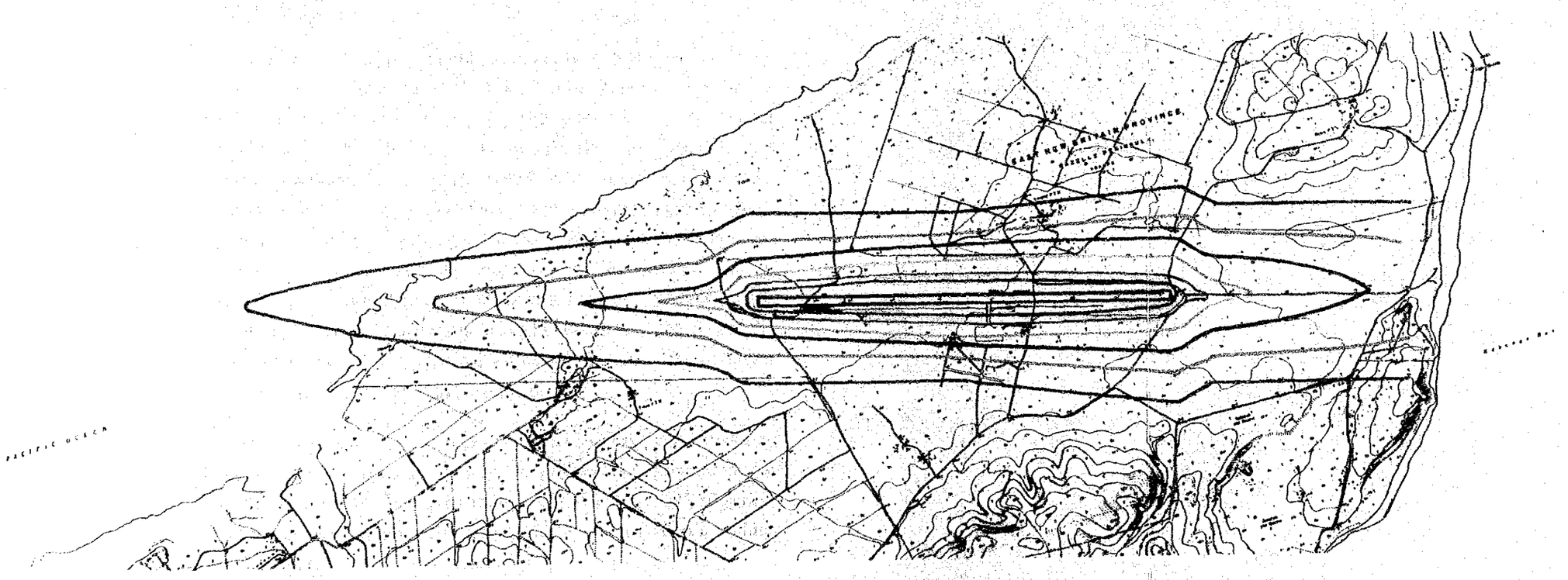


Figure 7.2-3 (1) WECPNL Noise Counter (2000)



RWY 10 Departure



RWY 28 Departure

SCALE
0 500 1000

Figure 7.2-3 (2) WECPNL Noise Counter (2010)

7.2.4 Measures to Reduce Noise Level

Three types of procedures are primarily considered to either reduce noise or to limit its impact on the environment, including:

1) Suppression of noise at its sources-primarily with the quieter engines; significant attention has been paid by aircraft manufacturers and government officials to reduce aircraft engine noise as a way of reducing aviation noise levels at their sources.

2) Modification of airport and aircraft procedures-such as engine power settings; modification of aircraft operating procedures would also be effective to reduce the perceived noise levels or to reduce the noise impacts on the airport vicinity.

3) Development of land uses more compatible with the noise levels associated with the airport operations; the control of land use development in areas of high noise intensity will be applied to bring about less impacts.

The procedure 2) above could be usually put into practice by combinations of various methods. For instance, reduced engine power settings on take-offs or landings would reduce the noise intensity being emitted from the aircraft engines. On the other hand, steeper approaches on landing and steeper take-offs would result in smaller area noise exposure with higher noise emissions, while low engine power settings require aircraft to fly over a longer distance at lower altitudes with much larger areas for noise exposure. For the proposed airport at Tokua, however, application of these procedures are considered to be easier, since the airport is geographically located between Namalili Bay to the east and Kabakaul Bay to the west with Cape Gazelle to the northeast where inhabitants to be affected are limited.

Technology of suppression of aircraft engine noise has been remarkably developed in recent years and such quieter engines have been introduced in the recent aircraft types as B737, B767, A310, A320, MD80 series, etc. From a viewpoint of noise abatement, it is desirable to introduce such types of aircraft for the service in future.

7.2.5 Future Land Use Restriction

The following consideration may be applicable to the future land use in the area surrounding the airport.

Table 7.2-2 Future Land Use Restriction

Land Use	WECPNL
No schools, hospitals and the others sensible to noise.	More than 70
No new residences are basically permitted. Continuation of the existing agricultural use is recommended.	More than 75
Prohibited area for new residences. Further agricultural land use is recommended.	More than 85

7.2.6 Noise Abatement Procedures

Table 7.2-3 shows the content of noise abatement procedures, as a reference to be applicable to aircraft operations in future, though the area around the airport would not come to the extent that these procedures have to be applied.

Table 7.2-3 Outline of Noise Abatement Operating Procedures

Production		Outline of system	Effect	Actual Use in Japan	Applicability for Tokua
Takeoff System	Steepest Climb	In normal take-off, upon reaching a safe altitude, aircraft slow down the climb rate and accelerate the speed. Under the dooming system, however, the aircraft continue zooming until reaching an altitude of 1,000 m to reduce noises.	In the case of B727, the noise level is -1.5 to -3 dB(A) at a point 5 to 3 km away from the starting point of taxiing.	The system is employed by jet planes at almost all airports, except where the cutback climb-system is used.	Applicable. (when inhabitant increase under climb path)
	Thrust Cutback Climb	Upon reaching a safe altitude after take-off, aircraft fly over residential areas adjacent to the airport at a low noise level by throttling down engine thrust to 3 maximum extent permissible in terms of safety. After passing the residential areas, the aircraft increase engine thrust and return to normal climb.	With B727 and B737, the noise level in the cutback zone is -5 to -10 dB(A)	The system is used by B727, B737 and DC-9 at Fukuoka and Kumamoto Airports.	Applicable. Climb rate of this procedure is low.
Landing System	Delayed Approach System	This system involve delaying the lowering of under-carriage and flaps as much as practically possible during approach to runway. When approaching with under-carriage and flaps kept in flight condition, aircraft receive smaller air resistance which decrease necessary thrust and in turn reduce engine noises.	Noise level -2 to -3 dB(A).	This system is adopted by jet aircraft at nearly all airports.	Applicable. However, this procedure concentrate noise in the area under final segment.
	Reduced Flap Setting	Until touchdown, aircraft navigate with as low flap angle as possible so as to lessen air resistance and thus decrease engine thrust with a resulting noise reduction. This system, however, involve higher touchdown speed and thus limit in terms of safety.	Noise level -2 to -3 dB(A).	All jetliners except DC8 and A300 use this landing system at almost all airports.	Applicable. 2500 m runway length is short for this procedure. Must be 3000 m in length
Other Systems	Preferential Runway	When no dwelling houses are located near one end of the runway, landing and take-off are executed in that direction whenever possible	Highly effective in preventing noise pollution	This system is used at airports of Tokyo International, Kochi, Sendai, Hiroshima and Matsuyama.	Applicable.
	Preferential Route	Aircraft fly a path clear of dwelling houses by circling.	Highly effective in preventive noise pollution.	This system is used at airports of Tokyo International, New Tokyo International, Osaka International, Fukuoka, Nagoya and Sendai.	Applicable.

8. AIR TRAFFIC DEMAND FORECAST

8.1 Economic Background (1984 ~1990)

8.1.1 Air Passengers

For an average growth rate, real GDP is 1.93%, and air passengers for Rabaul Airport is 3.89% during the period from 1983 to 1989 (6 years). Peak year of annual growth rate for real GDP was 1986 as 4.03%, while that for air passengers was 1988 as 19.46%. In 1984, both annual growth rates for real GDP and air passengers showed negative.

Some economic depression seems to have given impacts to trip activity of air passengers. But in 1985 and 1986, only the annual growth rates for air passengers presented negative. It can be imagined that some factors inherent to air transportation, for example, raising up the level of air fare and some accidents for flights or some airports etc., seem to have given effects on decrease of air passengers.

In 1989, the growth rate of real GDP was negative at - 1.47%, while air passengers showed an increase of 10.11%. But this growth rate itself is less than 19.46% of the previous year, 1988, which seems to have been influenced by the economic recession.

The economy of PNG in 1989 was adversely affected by two major factors: the closure of the Bougainville Copper Limited mine; and the significant decline in world market prices of PNG's major agricultural exports commodities, in particular coffee and cocoa.

8.1.2 Air Cargo

An average growth rate of air cargo handled at Rabaul Airport is 11.53% for 6 years. As already mentioned above, peak year of annual growth rate for real GDP is 1986 at 4.03%, while that for air cargo is also the same year of 1984 at 54.63%.

In spite of negative annual growth rate of real GDP in 1984 at -1.31%, air cargo showed a drastic increase in this year. It can be said that air cargo in 1984 was not influenced at all by economic recession. In the next year of 1985, on the contrary, negative annual growth rate of air cargo was recorded at -12.06% and simultaneously air passengers decreased by -3.07%.

As same as for air passengers, transportation of air cargo seems to have been influenced by some peculiar reasons in transportation side. Unlike air passengers, the annual growth rate of air cargo turned to be positive in the next year of 1986.

As already referred, in 1989, the growth rate of real GDP was negative at -1.47%, while air cargo showed an increase of 3.63%. But the growth rate itself in this year is less than 12.32% of previous year, 1988 which seems to have been influenced by economic recession.

Table 8.1-1 Annual Growth Rate of GDP and Air Traffic for Rabaul Airport

(Unit: %)

	Real GDP at 1983 price	Air Passengers	Air Cargo
1984	-1.31	-3.07	54.63
1985	3.93	-3.07	-12.06
1986	4.03	-6.95	20.09
1987	3.61	9.32	0.56
1988	2.96	19.46	12.32
1989	-1.47	10.11	3.63
Average Annual Growth Rate	1.93	3.89	11.53

8.2 Socio-Economic Framework

8.2.1 Population

According to national census, population of PNG is 2.9 million in 1980 and 3.74 million in 1990 respectively. The average annual growth rate is approximately 2.29% during the period of these ten years. But the estimated population in the year of 1988 is 3.56 million, and the average annual growth rate from 1988 to 1990 is about 2.43%. The Study Team considers that the population of PNG will annually increase at 2.4% in the future. It will reach about 4.21 million in 1995, 4.74 million in 2000, 5.33 million in 2005, and 6.00 million in 2010.

On the other hand, population of East New Britain Province (ENBP) shows the increase 133.20 thousand in 1980 to 184.41 thousand in 1990 with an average

annual growth rate of 3.31%. The share of ENBP in PNG has changed from 4.48% to 4.94%, showing a gradual increase. If the growth rate of 4.9% of population of ENBP were applied to the future, population of ENBP will reach about 234.24 thousand (with the share of 5.56% in PNG) in 1995, 197.53 thousand (6.28%) in 2000, 377.93 thousand (7.09%) in 2005, and 480.05 thousand (8.00%) in 2010.

8.2.2 Gross Domestic Product

1) GDP in PNG

During ten years since 1980, Papua New Guinea's gross domestic product (GDP) has grown from 2,098 million Kina to 2,317 million Kina in real terms at constant price of 1983. An annual average growth rate of GDP during the same period is about 1%.

In 1989, real GDP decreased by 1.5% in contrast with the average growth rate over the previous four years of 3.4%. The performance of PNG economy in 1989 was adversely affected by two major factors: the closure of the Bougainville Copper Limited mine on 15 May due to militant activity; and the significant decline in world market prices of PNG's major agricultural export commodities, in particular coffee and cocoa.

Table 8.2-1 Population and GDP in PNG

Year	Population	Annual Growth Rate (%)	GDP (Million Kina) Current Price	Annual Growth Rate (%)	Constant Price at 1983	Annual Growth Rate (%)
1980	1,987,057		1,566.2		2,098.1	
1981	3,039,058	2.0	1,556.0	0.7	2,128.8	1.5
1982	3,101,386	2.1	1,618.1	4.0	2,124.9	0.2
1983	3,165,074	10.2	2,145.4	32.6	2,145.4	1.0
1984	3,230.152	2.1	2,282.2	6.4	2,117.4	1.3
1985	3,297.985	2.1	2,402.6	5.3	2,200.7	3.9
1986	3,400,000	3.1	2,555.0	6.3	2,289.3	4.0
1987	3,479,400	2.3	2,831.1	10.8	2,372.0	3.6
1988	3,561,000	2.3	3,140.9	10.9	2,442.1	3.0
1989	3,644,600	2.3	3,013.7	4.0	2,406.1	-1.5
1990	3,736,391	2.5	3,134.2	4.0	2,317.1	-3.7
1995	4,206,802	2.4	5,140.1	10.4	3,100.8	6.0
2000	4,736,438	2.4	8,429.8	10.4	4,149.6	6.0
2005	5,332,755	2.4	13,824.9	10.4	5,553.1	6.0
2010	6,004,149	2.4	22,673.0	10.4	7,431.3	6.0

Source : 1. 1980~1990

(1) GDP

Quarterly Economic Bulletin published by Bank of Papua New Guinea. But figure for 1990 are estimated by the Study Team

(2) Population

National Statistical Office. The figures for 1986~1988 are officially estimated.

2. The figures for 1995~2010 were projected by the Study Team.

The closure of Bougainville Mine was a major setback for the economy. "the Development Outlook 1991", was released in May 1991. This report says that mining and petroleum exports are expected to play a major role in boosting PNG's economic growth, as measured by gross domestic product, by a dramatic 17.7% in 1992.

Prepared by a team of economists from the Bank of PNG Economics and Development Resources Centre, the report presents PNG as a far better performer than its Pacific Island neighbors in the Developing Member Country (DMC) group of countries.

The report has also supported the government's projection of a 7.8% growth in GDP for this year. "Under the influence of a marked upsurge in mining and petroleum investment and the coming into full production

of recently developed mines, economic activity is expected to strongly recover in 1991 from the depressed levels of the previous two years", the report said.

2) Development Program

According to "Economic Policies (Volume 2)" presented by The Honorable Paul Pora, MBE, MP, Minister for Finance and Planning on the occasion of the 1990 Budget, real GDP is expected to grow at an average annual rate of 6.5% over the period 1991 to 1994, with growth rates in individual years ranging from 4.7% in 1992 to 9.9% in 1993.

In May of 1991, the Government of Papua New Guinea presented the medium term macro-economic framework from 1993 to 1996 which is complemented by a discussion on the policy measures stressing that it would be necessary to ensure that the limited resources generated by the mineral and petroleum developments, and donor support, are productively and efficiently utilized.

In this way, employment and income generation, rural development, internal security (law and order), education and training (human resource development), health, physical infrastructure and industrial development, in the private and public sectors, will be maximized given the resources available.

This Government's projections to 1996 indicate that macro-economic developments will be favorable, but the economy will continue to be overcome to secure widespread development and benefit the majority of the population.

This projections during the period 1993 to 1996 take into consideration the full implementation of the initiatives taken during the 1990 to 1992 period. These include the deregulation of private sector activity, privatization, civil, service reform, the support of export cash crop industries, including the improvement of research and extension, the fisheries industry development plan, the forestry action plan, the higher education plan, the national training policy an recently approved population policy.

These initiatives, combined with developments in the mineral and petroleum industries, will create a stable macro-economic environment.

In addition, some significant improvements in those industries most important for employment and income generation in the short term will occur. This will give the authorities breathing space to develop an integrate adjustment program for the 1993 to 1996 period.

This projection indicates that economic activity, as measured by the real growth in GDP, will increase on the average by 4.8% per annum between 1993 to 1996. This rate of growth is high relative to previous periods. However, it will not offer a solution to the most passing problem, employment and income generation for the existing unemployed and new entrants to the labor force.

Taking into consideration the above mentioned medium term macro-economic framework, the Study Team sets the three range of framework for GDP of PNG. The Study Team assumes that most probable average annual growth rate of GDP as 6% for "medium", minimum one as 3% for "low range" and maximum one as 9% for "high range".

Table 8.2-2 Projections of GDP in PNG
(constant price at 1983)

(Unit: million Kina)

	Low Range	Medium	High Range
1995	2,686.2	3,100.8	3,565.1
2000	3,114.0	4,149.6	5,485.4
2005	3,610.0	5,553.1	8,440.0
2010	4,184.9	7,431.3	12,986.0
Average Annual Growth Rate	3.0%	6.0%	9.0%

8.3 Forecast of Traffic Volumes at Rabaul Airport

8.3.1 Basis of Forecast for Air Passengers

1) Forecast of Total Air Passenger Traffic Volume

"Total air passengers" means all of the accumulated number of air passengers for arrivals and departures of 23 key airports in PNG which include the domestic and international passengers. The forecasted traffic volume of total air passengers is very important because it will function

as a control total of air passengers in PNG. The outline of process for forecasting total air passengers is explained as follows.

(1) Model Building for Forecasting

a) Analysis for Suitable Explanatory Variables for Forecasting

(a) Analysis of Co-relation

Firstly, to build a model formula for forecasting the total air passengers, the co-relation analysis is conducted with regard to some socio-economic indicators such as population of PNG, nominal GDP of PNG, real GDP of PNG, nominal GDP per capita, real GDP per capita etc. which are considered to be explanatory variables for air passengers.

(b) Selection of Explanatory Variable

As a result of correlation analysis, real GDP of PNG is selected as the suitable variable to explain air passengers traffic volume.

b) Estimation of Coefficients of Parameter

To estimate coefficients of parameters in model formula, the "least-squares analysis" is applied. This analysis is conducted using the observed data of total air passengers and real GDP of PNG in constant price at 1983 during the period from 1983 to 1989.

The model formulas for forecasting traffic demand of total air passengers is acquired as follows.

APPNG = 25.425 + 0.75152 GDPR,

(-0.16) (2.19)

(R = 0.69919 S.D. = 109.51 D.W. = 1.375)

where;

APPNG stands for total air passengers in PNG (thousand persons)

GDPR stands for real GDP in PNG in constant price at 1983. (million Kina)

The figures in parenthesis under the coefficients are "t" value. "R" is correlation coefficient, S.D. is standard deviation and D.W. is Darvin Watson ratio. These figures are indicators for judging appropriateness of coefficients of variables from the statistical point of view.

The Study Team considered that above estimated coefficients in formula ("25.425" as a constant and "0.75152" as a parameter of GDPR) are suitable from the statistical point of view and applicable to the model for forecasting the total air passenger traffic demand.

(2) Forecast of Total Air Passenger Traffic Volume

Three levels of total air passengers traffic volume are forecasted corresponding to the level of real GDP already projected as a framework for socio-economy.

By substituting the projected values of real GDP in future for the explanatory variable of GDPR in the formula for forecasting above, low, medium and high of three ranges of the explained variable of PPNG which stands for total air passengers are forecasted as shown in the following table.

Table 8.3-1 Projections of Total Air Passengers in PNG

(Unit: '000 persons)

	Low	Medium	High
1995	2,004.2	2,355.7	2,704.7
2000	2,365.7	3,144.0	4,147.8
2005	2,738.4	4,198.7	6,368.3
2010	3,170.5	5,610.2	9,784.7

2) Forecast of Generated and Attracted Traffic Volume by Key Airport

(1) Model Building of Generated and Attracted Traffic Volume by Key Airport

Model building for forecasting of generated and attracted traffic volume is usually carried out using the data of regional socio-economic indicators such as gross regional domestic product based on zoning of areas centering airports and traffic volume of each zone.

The Study Team, however found out that enough data and information for the purpose of the ordinary model building were not available.

The Study Team, therefore, applied the second best alternative: the trend formulas (straight regression lines) by key airport and international air passengers are built by the method of least-squares by using the time series data of generated and attracted passenger traffic volume of each key airport during the period from 1983 to 1989. All of the explanatory variables of trend lines are "TIME" from 1983 to 1989.

The trend lines of key airports and international passengers are shown as follows.

a) International Air Passengers (APIPNG)

$$APIPNG = -1.20632 \times 10^7 + 6{,}127.43 \cdot TIME$$

b) Domestic Air Passengers

(a) Port Moresby Airport (APPOM)

$$APPOM = -2.63357 \times 10^7 + 13{,}528.3 \cdot TIME$$

(b) Lae Airport (APLAE)

$$APLAE = -1.24345 \times 10^7 + 6{,}462.82 \cdot TIME$$

(c) Rabaul Airport (APRAB)

$$APRAB = -9.16496 \times 10^6 + 4{,}674.54 \cdot TIME$$

(d) Mt. Hagen Airport (APMH)

$$APMH = -1.5274 \times 10^7 + 7{,}736.36 \cdot TIME$$

(e) Goroka Airport (APGOR)

$$APGOR = -5.55323 \times 10^6 + 2{,}830.93 \cdot TIME$$

(f) Madang Airport (APMAD)

$$APMAD = -1.21297 \times 10^6 + 647.857 \cdot TIME$$

(g) Kieta Airport (APKIE)

$$APKIE = -2.61223 \times 10^6 + 1{,}351 \cdot TIME$$

(h) Wewak Airport (APWE)

$$APWE = -317{,}933 + 191.857 \cdot TIME$$

(i) Popondetta Airport (APPOP)

$$APPOP = -1.80261 \times 10^6 + 925.786 \cdot TIME$$

(j) Hoskins Airport (APHK)

$$APHK = -1.7983 \times 10^6 + 922.321 \cdot TIME$$

(k) Gurney Airport (APGUR)

$$APGUR = -3.74775 \times 10^6 + 1{,}901.36 \cdot TIME$$

(l) Tabubil Airport (APTAB)

$$APTAB = -875{,}187 + 453.357 \cdot TIME$$

(m) Daru Airport (APDAR)

$$APDAR = -2.04395 \times 10^6 + 1{,}037.79 \cdot TIME$$

(n) Kavieng Airport (APKAV)

$$APKAV = -2.53039 \times 10^6 + 1{,}283.54 \cdot TIME$$

(o) Tari Airport (APTAR)

$$APTAR = -5.71292 \times 10^6 + 2{,}882.18 \cdot TIME$$

(p) Vanimo Airport (APVAN)

$$APVAN = -2.06722 \times 10^6 + 1{,}049.36 \cdot TIME$$

(q) Chimbu (Kundiawa) Airport (APCHI)

$$APCHI = -2.30772 \times 10^6 + 1{,}169.89 \cdot TIME$$

(r) Manus Airport (APMAN)

$$APMAN = -1.24005 \times 10^6 + 632.071 \cdot TIME$$

(s) Kiunga Airport (APKIU)

$$APKIU = 2.27453 \times 10^7 - 1{,}137.25 \cdot TIME$$

(t) Mendi Airport (APMEN)

$$APMEN = -1.80828 \times 10^6 + 916.357 \cdot TIME$$

(u) Misima Airport (APMIS)

$$APMIS = -1.76043 \times 10^6 + 888.179 \cdot TIME$$

(v) Lousuia Airport (APLOU)

$$APLOU = -210{,}529 \times 10^7 + 108.464 \cdot TIME$$

(w) Buka Airport (APBUK)

$$APBUK = 3.48317 \times 10^6 - 1{,}750.18 \cdot TIME$$

The time series data of air passenger traffic by key airport for forecasting are shown in Attachment 8-1.

Table 8.3-2 Forecast of Air Passenger Traffic Demand at Rabaul

(Unit: Persons)

		Low	Medium	High
1995	Without	163,000	188,000	216,000
	With	180,000	208,000	240,000
2000	Without	188,000	251,000	332,000
	With	209,000	278,000	368,000
2005	Without	218,000	335,000	510,000
	With	242,000	372,000	566,000
2010	Without	252,000	448,000	785,000
	With	280,000	497,000	870,000
2020	Without	323,000	731,000	1,650,000
	With	358,000	811,000	1,830,000

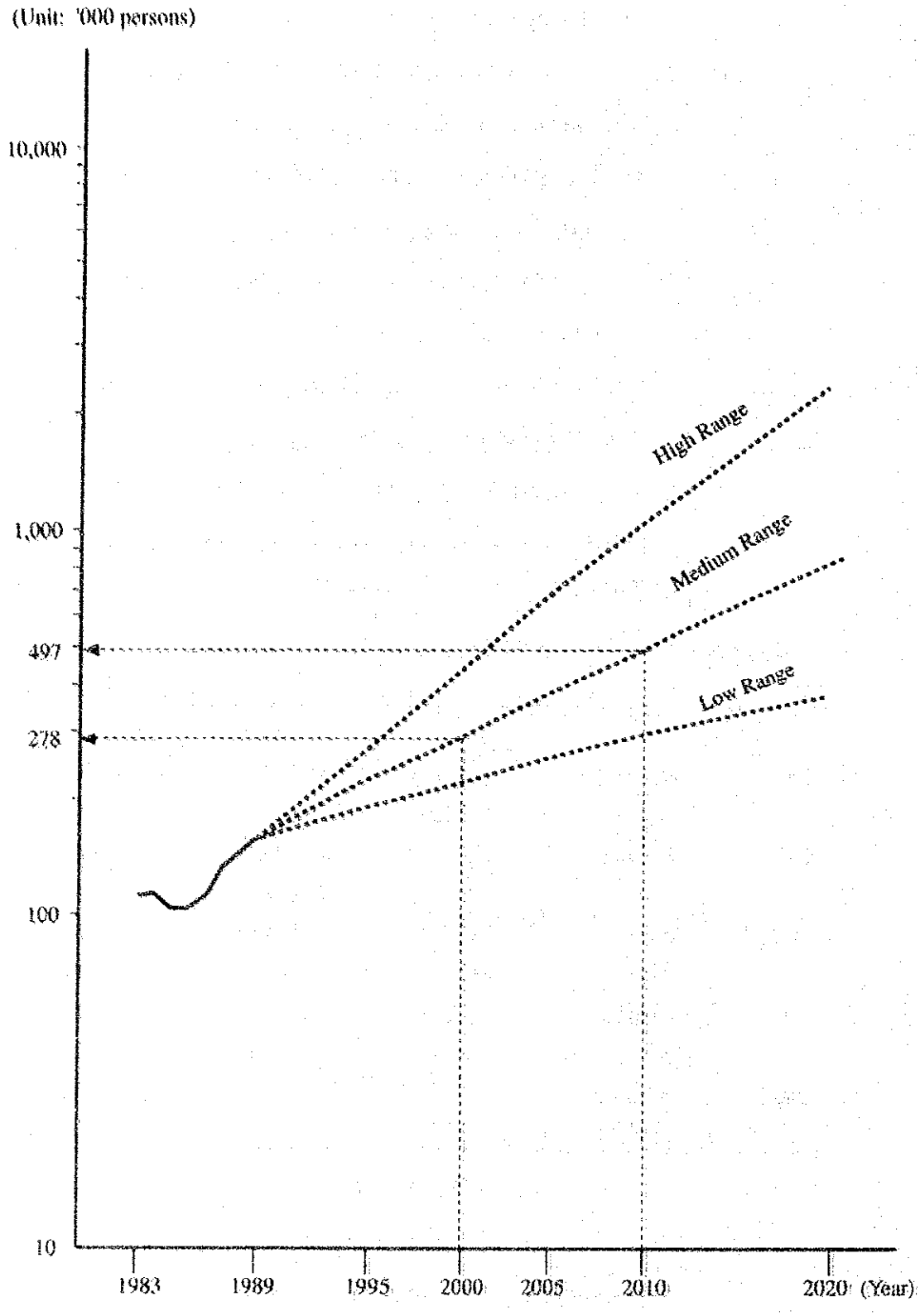


Figure 8.3-1 Projections of Air Passengers Traffic Demand (With the Project: Tokua Airport)

(2) Forecast of Generated and Attracted Traffic Volume by Key Airport

The first forecasted volume for the generated and attracted traffic is calculated by substituting the figures of forecasting years (1995, 2000, 2005 and 2010) for the explanatory variable of "TIME" in the trend formulas of domestic air passengers for the key airports and international air passengers.

Usually the accumulated forecasted value estimated by these trend formulas for domestic air passengers of the key airports and international air passengers does not coincide with the already forecasted total air passenger traffic by the model mentioned above as a control total.

It is, therefore, necessary for these forecasted value firstly calculated by trend formulas to be coordinated or modified so that the accumulated traffic volume of domestic air passengers and international air passengers would coincide with the total air passengers as a control total.

(3) Forecast of Rabaul Airport (Without The Project)

a) Normal Traffic

As shown in the Table 8.3-3, the forecasted domestic air passenger traffic volumes for Rabaul Airport are 188,000 in 1995, 251,000 in 2000, 336,000 in 2005, 449,000 in 2010 and 731,000 in 2020 respectively. The forecasted value in 2020 is calculated by applying the annual average growth rate of 5% from 2010 which is less than that of 6% during the period from 2005 to 2010.

These forecasted traffic volume is called "Normal Traffic" which would have taken place on the existing facility in any case, even without the new investment.

b) Estimate of Transit Passengers Via Port Moresby

There are two kinds of transit passengers which are the domestic and the international. Unfortunately available

information was not provided for both of them at Rabaul Airport. As a result of traffic survey conducted by the Study Team on the 11th and 12th of July in 1991 at Port Moresby and Rabaul Airport, the international transit passengers to Rabaul Airport via Port Moresby could be estimated as approximately 5% of all arrival passengers from Port Moresby Airport to Rabaul Airport.

The Study Team assumes that about 7% more than 5% of all arrivals from Port Moresby Airport to Rabaul Airport would probably be transit passengers in the future. This percentage is taken into consideration for the estimation of the future international air passengers for Takua Airport which could be referred to as "Diverted Traffic" from Port Moresby to Tokua Airport.

Table 8.3-3 Forecast of Passenger Traffic Demand

[Medium] (Unit: Persons)

			1995	2000	2005	2010	2020
Without	Normal Traffic		188,000	251,000	335,000	448,000	731,000
(Rabaul)	(Domestic)						
	(Potential Demand)		(20,000)	(27,000)	(37,000)	(49,000)	(80,000)
	Total		188,000	251,000	335,000	448,000	731,000
With		Domestic	188,000	233,000	310,000	414,000	660,000
(Tokua)	Normal Traffic	International		18,000	25,000	34,000	71,000
		(Diverted from POM)					
		Sub total	188,000	251,000	335,000	448,000	731,000
	Induced Traffic	Domestic	20,000	25,000	34,000	45,000	72,000
	(Revealed Traffic of Potential Demand)	International	-	2,000	3,000	4,000	8,000
		Sub total	20,000	27,000	37,000	49,000	80,000
	Total	Domestic	208,000	258,000	344,000	459,000	732,000
		International	-	20,000	28,000	38,000	79,000
		Total	208,000	278,000	372,000	497,000	811,000

c) Estimate of Potential Demand

In this study, the "Potential Demand" is estimated. In this study, it is assumed that there always exists potential demand in addition to actually carried passengers, and this potential demand is estimated by three factors of the number of supplied seats, load factor and the number of actually carried passengers.

This methodology is based on the experience of trip that the potential demand drastically increases when load factor is more than 60%.

The outline of methodology for estimation of potential demand is explained in Attachment 8-2.

3) OD Matrix of Domestic Air Passengers between Key Airports

(1) Estimation of Domestic Air Passenger between Key Airports in Base Year

In this Study, a base for forecasting is set in 1989, because air passenger traffic in 1990 is strongly effected by the closure of the Bougenville Limited mine, especially Kieta Airport.

Using the data of generated and attracted traffic volume by key airport and OD matrix of Air Niugini and Tal Air between key airports as shown in Attachment 8-3, the domestic air passengers between key airports (OD matrix) are estimated by the iteration of "Fratar Method" which is known as "Present Pattern Method". (Refer to Attachment 8-4).

(2) Forecast of the Domestic Air Passenger Traffic Volume between Key Airports

Given the OD matrix of air passengers between key airports in base year (1989) and the generated and attracted air passengers by key airport in forecasting years of 1995, 2000, 2005 and 2010 mentioned above, the domestic air passenger traffic demand is forecasted by the iteration of "Fratar Method" for these forecasting years. (Refer to Attachment 8-5)

8.3.2 Basis of Forecast for Air Cargo

1) Forecast of Total Air Cargo Traffic Volume

(1) Model Building for Forecasting

a) Analysis for Suitable Explanatory Variables for Forecasting

As a result of correlation analysis already carried out for air passengers mentioned above, real GDP of PNG is also selected for a suitable variable to explain air cargo as the same as for that of air passengers.

b) Estimation of Coefficients of Parameter

In the same way as for air passengers, to estimate coefficients of parameters in model formula, the "least-squares analysis" is applied. This analysis is conducted using the observed data of total air cargo and real GDP of PNG in constant price at 1983 during the period from 1983 to 1989.

The model formula for forecasting traffic demand of total air cargo is acquired as follows.

$$ACPNG = -3{,}246.7 + 13.9939\ GDPR,$$
$$(-0.10) \qquad (1.45)$$

$(R = 0.64474 \quad S.D. = 3{,}070.17 \quad D.W. = 1.400)$

where,

- ACPNG stands for total air cargo in PNG (tons)
- GDPR stands for real GDP in PNG in constant price at 1983. (million Kina)

The Study Team considers that the above estimated coefficients in formula ("3,246.7" as a constant and "13.9939" as a parameter of GDPR) are appropriate from the statistical point of view and applicable to the model for forecasting the total air cargo traffic demand.

(2) Forecast of Total Air Cargo Traffic Volume

Three levels of total air cargo traffic volume are forecasted corresponding to the level of real GDP already projected as a framework for socio-economy.

By substituting the projected values of real GDP in future for the explanatory variable of GDPR in the formula for forecasting above, low, medium and high of three ranges of the explained variable of PPNG which stands for total air cargo are forecasted as shown in the following table.

Table 8.3-4 Projections of Total Air Cargo in PNG

(Unit: Tons)

	Low	Medium	High
1995	34,344	40,146	46,643
2000	40,300	54,822	73,515
2005	47,271	74,463	118,862
2010	55,316	100,746	178,478

2) Forecast of Generated and Attracted Traffic Volume by Key Airport

(1) Model Building of Generated and Attracted Traffic Volume by Key Airport

The same methodology as air passengers is applied to air cargo.

The trend formulas (straight regression lines) by the domestic air cargo by key airport and international air cargo are built by the method of least-squares by using the time series data of generated and attracted air cargo traffic volume of each key airport during the period from 1983 to 1989. All of the explanatory variables of trend lines are "TIME" from 1983 to 1989.

The trend lines of domestic air cargo by key airport and international cargo are shown as follows.

a) International Air Cargo (ACIPNG)

ACIPNG = -537,714 + 272.143·TIME

b) Domestic Air Passengers

(a) Port Moresby Airport (ACPOM)

ACPOB = 925,991 + 471.25·TIME

(b) Lae Airport (ACLAE)

ACLAE = 275,110 - 136.143·TIME

(c) Rabaul Airport (ACRAB)

ACRAB = -196,633 + 99.60711·TIME

(d) Mr. Hagen Airport (ACMH)

ACMH = -319,474 + 161.571·TIME

(e) Goroka Airport (ACGOR)

ACGOR = 36,237.4 - 17.5357·TIME

(f) Madang Airport (ACMAD)

ACMAD = 107,304 - 53.3214·TIME

(g) Kieta Airport (ACKIE)

ACKIE = -23,445.3 + 12.2143·TIME

(h) Wewak Airport (ACWE)

ACWE = -153,466 + 77.6429·TIME

(i) Popondetta Airport (ACPOP)

ACPOP = 122,767 - 61.5357·TIME

(j) Hoskins Airport (ACHK)

ACHK = -28,358.6 + 14.4643·TIME

(k) Gurney Airport (ACGUR)

ACGUR = -60,974.6 + 30.8571·TIME

(l) Tabubil Airport (ACTAB)

ACTAB = -297,644 + 150.429·TIME

(m) Daru Airport (ACDAR)

ACDAR = 7,408.21 - 3.60714·TIME

(n) Kavieng Airport (ACKAV)

ACKAV = -26,377.4 + 13.3571·TIME

(o) Tari Airport (ACTAR)

ACTAR = -8,268.3 + 41.7143·TIME

(p) Vanimo Airport (ACVAN)

ACVAN = 19,065.3 - 9.21429·TIME

(q) Chimbu (Kundiawa) Airport (ACCHI)

ACCHI = -43,683.1 + 22.1071·TIME

(r) Manus airport (ACMAN)

ACMAN = -18,922.7 + 9.57143·TIME

(s) Kiunga Airport (ACKIU)

ACKIU = 303,496 - 152.357·TIME

(t) Mendi Airport (ACMEN)

ACMEN = -102,379 + 51.7143·TIME

(u) Misima Airport (ACMIS)

ACMIS = -43,285.2 + 21.8214·TIME

(v) Lousuia Airport (ACLOU)

ACLOU = -5,511 + 2.78571·TIME

(w) Buka Airport (ACBUK)

ACBUK = 33,553.7 - 16.8571·TIME

The time series data of air cargo traffic by key airport for forecasting are shown in Attachment 8-6.

(2) Forecast of Air Cargo Traffic Volume by Key Airport

The first forecasted volume for air cargo traffic is calculated by substituting the figures of forecasting years (1995, 2000, 2005 and 2010) for the explanatory variable of "TIME" in the trend formulas of domestic air cargo for key airports and international air cargo.

In the same way and reason as for air passengers, the modified cargo traffic volume of the domestic air cargo for key airports and international air cargo is calculated.

Table 8.3-5 Forecast of Air Cargo Traffic Demand

(Unit: Tons)

		Low	Medium	High
1995	Without	1,720	2,110	2,540
	With	1,770	2,150	2,600
2000	Without	2,120	3,090	4,340
	With	2,280	3,320	4,670
2005	Without	2,570	4,400	7,140
	With	2,770	4,700	7,670
2010	Without	3,110	6,170	11,450
	With	3,330	6,650	12,310
2020	Without	4,160	11,000	27,110
	With	4,470	12,000	29,150

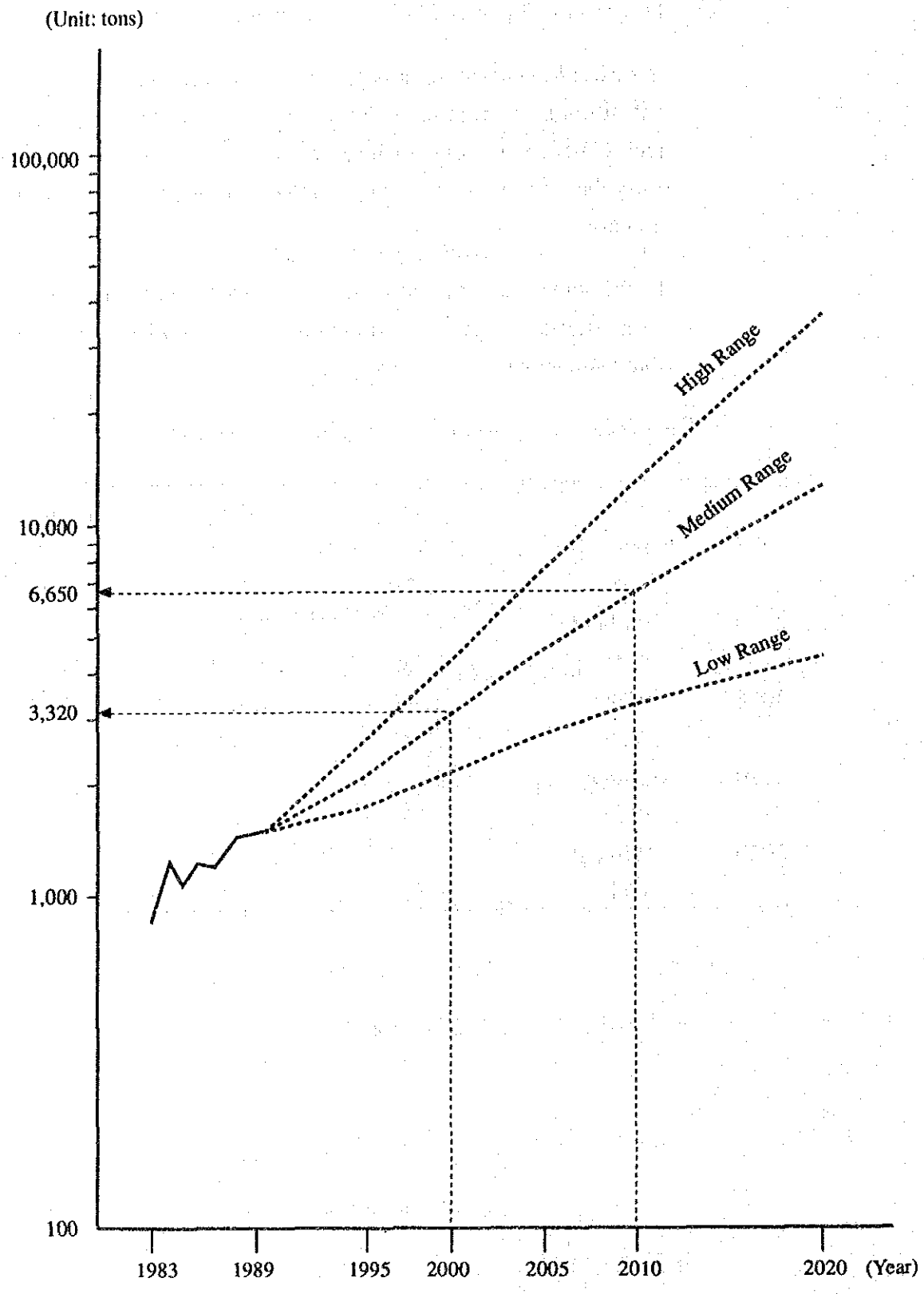


Figure 8.3-2 Projections of Air Cargo Traffic Demand
(With the Project: Tokua Airport)

(3) Forecast of Rabaul Airport (Without the Project)

a) Normal Traffic

As shown in the Table 8.3-6, the normal forecasted domestic air cargo traffic volumes for Rabaul Airport are 2,100 tons in 1995, 3,100 tons in 2000, 4,400 tons in 2005, 6,200 tons in 2010 and 111,000 tons in 2020 respectively. The forecasted value in 2020 is calculated by applying the annual average growth rate of 6% from 2010 which is less than that of 7% during the period from 2005 to 2010.

b) Estimate of Exported and Imported Cargo

It is difficult to get accurate information concerning transit cargo at Rabaul Airport which can be considered as the exported or imported cargo.

The Study Team, therefore, assumes that about 10% of all cargo handled at Rabaul Airport be imported and 5% of them could be exported via Port Moresby Airport. It is assumed that international air cargo will increase to these levels as Tokua becomes an international airport.

Table 8.3-6 Forecast of Freight Traffic Demand

[Medium] (Unit: Tons)

			1995	2000	2005	2010	2020
Without (Rabaul)	Normal Traffic (Domestic)		2,100	3,100	4,400	6,200	11,000
	(Potential Demand)		-	-	-	-	-
	Total		2,100	3,100	4,400	6,200	11,000
With (Tokua)	Normal Traffic	Domestic	2,100	2,600	3,700	5,200	9,400
		International (Diverted from POM)	-	500	700	1,000	1,700
		Sub total	2,100	3,100	4,400	6,200	11,000
	Increased Traffic by Development	Domestic	50	70	100	150	300
		International	-	150	220	300	600
		Sub total	50	220	330	450	900
	Total	Domestic	2,150	2,670	3,800	5,350	9,700
		International	-	650	920	1,300	2,300
		Total	2,150	3,320	4,720	6,650	12,000

8.4 Forecast of Traffic Volumes at Tokua Airport

8.4.1 Basis of Forecast for Air Passengers

1) Forecast of Generated and Attracted Traffic Volume by Key Airport

The total air passenger traffic as a control total and generated and attracted traffic volume by key airport in the future are based on the results of the forecasts in "without the project" mentioned above except for Port Moresby Airport and Tokua Airport.

As explained in detail in the following section, the generated and attracted traffic volume of Port Moresby Airport (POM) is subtracted by diverted traffic from POM to Tokua Airport as international air passengers which are now transit passengers via POM to Rabaul Airport.

This diverted traffic from POM to Tokua Airport and revealed traffic demand of potential demand are added to the generated and attracted traffic volume of Tokua Airport.

2) Forecast of Tokua Airport (With the Project)

a) Normal Traffic

The normal traffic volume forecasted in case of "without the Project" is divided into two categories: domestic and international. The international air passenger traffic volume is estimated by applying the ratio of foreign transit passengers via POM to Rabaul Airport of all domestic air passengers for POM, "8%", as already mentioned above.

In case of medium level, the international air passenger traffic volumes are projected as 18,000 in 2000, 34,000 in 2010, 71,000 in 2020 respectively.

Domestic traffic volume of Tokua Airport is subtracted by the above international air passengers to be diverted from POM. The projected traffic volumes for the domestic air passengers are 188,000 in 1995, 233,000 in 2000, 310,000 in 2005, 414,000 in 2010, 660,000 in 2020 respectively.

b) Induced traffic

In this Study, the induced traffic demand stands for "revealed traffic demand" of potential demand already estimated in case of "without the Project". It is assumed that all of the potential demand would be revealed because of the expansion of the capacity not only of airport but of aircraft when Tokua Airport would be opened.

The revealed traffic volumes of potential demand are estimated to be 20,000, 27,000 37,000, 49,000 and 80,000 for each forecasting year.

This revealed traffic demand is broken down into the domestic and the international by the same ratio as that of the normal traffic.

The share of the international air passengers of all air passenger traffic volume for Tokua Airport could go up from 7.8% in 2000 to 9.7% in 2020.

The Study Team studied the regional development conditions and prospect of East New Britain Province as already mentioned in Chapter 6. The Study Team took account of maintaining consistency of air traffic volume forecasting and regional development of East New Britain Province, and considered that the result of forecasting reflected suitably the results of the analysis on regional development aspect.

3) OD Matrix of Domestic Air Passengers between Key Airports

Using the estimated OD matrix of air passengers between key airports in the base year (1989) and the generated and attracted air passengers by key airport in forecasting years of 1995, 2000, 2005 and 2010 mentioned above, the domestic air passenger traffic demand is forecasted by the iteration of "Fratar Method" for these forecasting years. (Refer to Attachment 8-7)

8.4.2 Basis of Forecast for Air Cargo

1) Forecast of Cargo Volume Handled by Key Airport

Based on the same approach, the total air cargo traffic as a control total and cargo volume handled by the key airports in the future are based on the results of the forecasts in "without the project" mentioned above except for Port Moresby Airport and Tokua Airport .

Cargo volume handled at POM is subtracted by diverted traffic from POM to Tokua Airport as international air cargo which are now transit cargo via POM to Rabaul Airport.

This diverted traffic from POM to Tokua Airport and increased traffic demand by regional development such as cash crops and coconut products etc. are added to the cargo volume of Tokua Airport which is considered to be the cargo volume of Rabaul Airport in case of "without the Project".

2) Forecast of Tokua Airport (With the Project)

a) Normal Traffic

The normal traffic volume forecasted in case of "without the Project" is divided into two categories of the domestic and the international in case of "with the Project". The international air cargo traffic volume is estimated by applying the ratios of foreign transit cargo via POM to Rabaul Airport of all domestic air cargo for POM. The ratio of imported cargo is "10%" and that of the exported cargo is "5%" as already mentioned above.

In case of medium level, the international air cargo traffic volumes are projected as 500 tons in 2000, 700 tons in 2005, 1,000 persons in 2010 and 1,700 tons in 2020 respectively.

Domestic traffic volume of Tokua Airport is subtracted by the above international air passengers to be diverted from POM. The projected traffic volumes for the domestic air passengers are 2,100 tons in 1995, 2,600 tons in 2000, 3,700 tons in 2005, 5,200 tons in 2010, 9,400 tons in 2010 respectively.

b) Increased Traffic by Development

There is no detail impact analysis to development for surrounded area of Tokua Airport. The Study Team assumes that not only the domestic cargo but also international cargo would increase by regional development and internationalization of the airports.

The ratios of the domestic and the international (the exported) of all the cargo volume in case of "without the Project" for all the cargo volume in case of "without the Project" for Rabaul Airport are applied by "2.5%" and "5.0%" to estimate the domestic and the international cargo traffic volume at Tokua Airport by regional development.

The domestic traffic volumes by regional development are projected as 50 tons in 1995, 70 tons in 2000, 100 tons, in 2005, 150 tons in 2010, and 300 tons in 2010 respectively.

On the other hand, the international traffic volume by regional development would be forecasted to increase by 150 tons in 2000, 220 tons in 2005, 300 tons in 2010 and 600 tons in 2020.

Flow charts of traffic demand forecast for passengers and cargo are shown in Figure 8.4-1 and Figure 8.4-2.

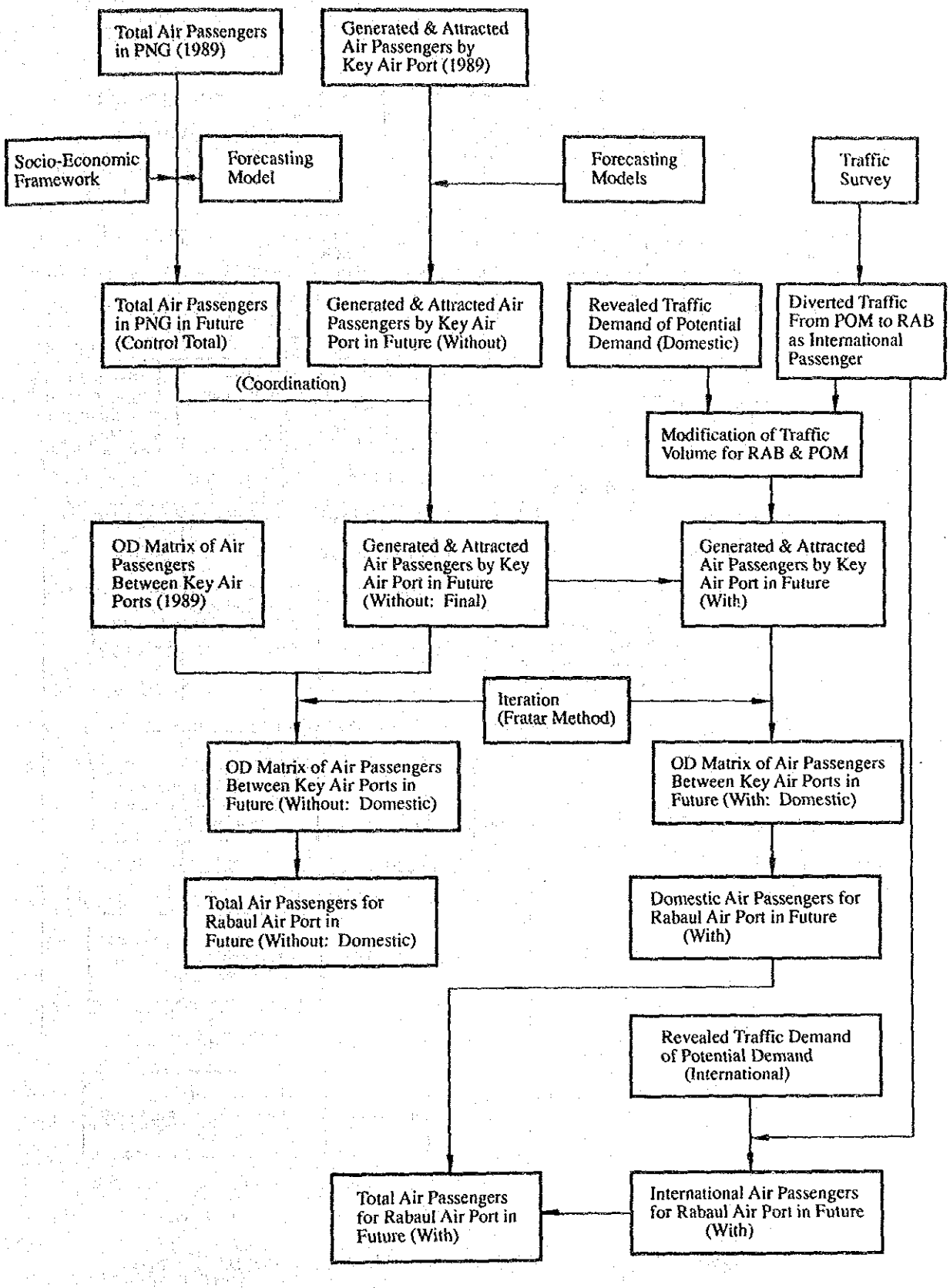


Figure 8.4-1 Flow Chart for Traffic Demand Forecast (Passengers)

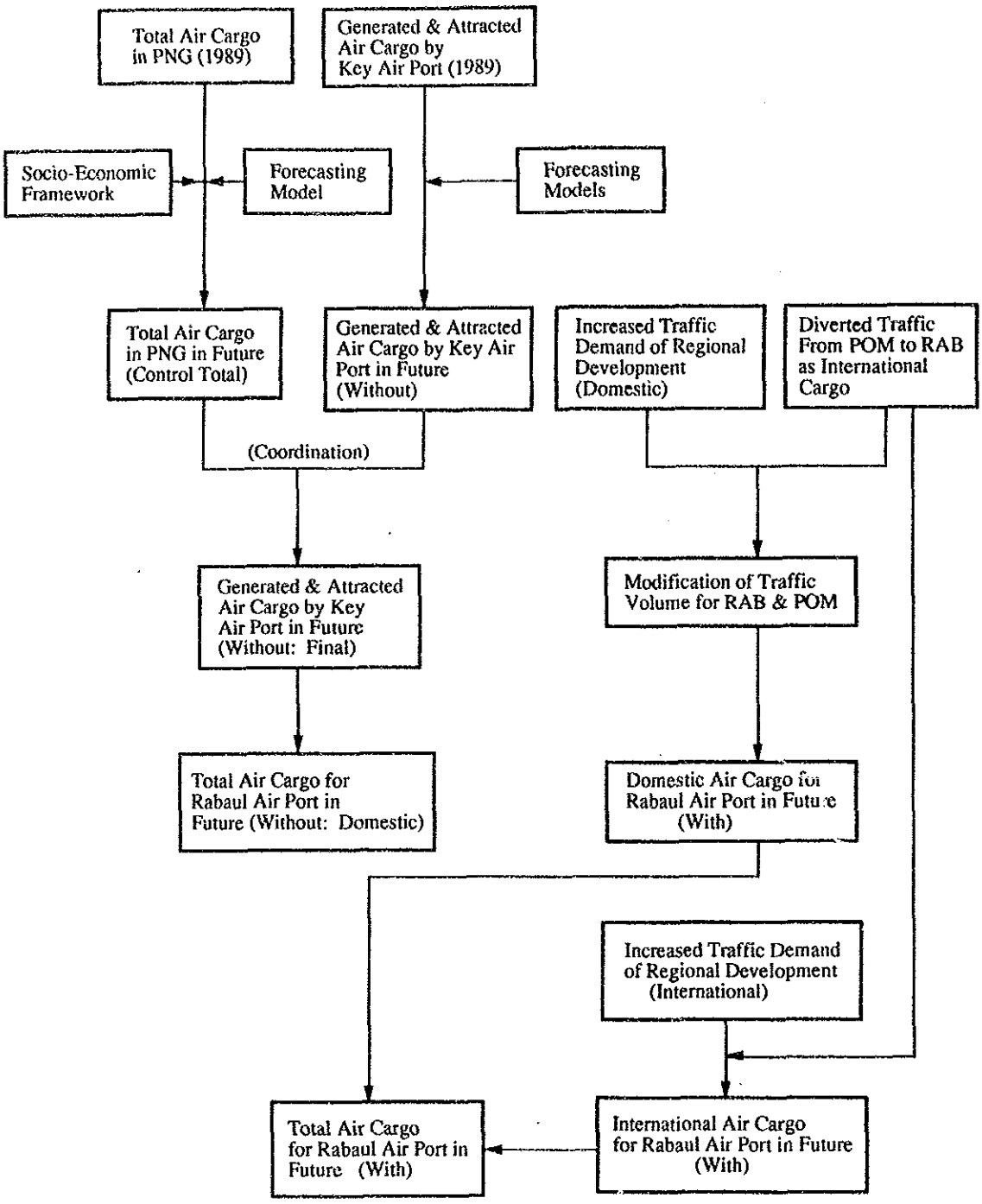


Figure 8.4-2 Flow Chart for Traffic Demand Forecast (Cargo)

8.5 Forecast of Peak Hour

For the purpose of preparing design concepts of recommended new facilities, it is necessary to start with peak hour data-both passenger flows and aircraft operations.

The congestion and delay and the justification for facility expansion tend to occur at peak hour periods. Actually, peak data are usually the starting point for design. It is generally agreed that designing so as to eliminate all congestion at peak periods is too ambitious and too costly an effort.

Developing peak hour data for Tokua Airport also involved a highly judgmental effort. The basic data were provided by DCA, Air Niugini and Air Links. Air Niugini gave the Study Team the daily detail document for inbound and outbound traffic and operational data outputted by computer during one year of 1990, and Air Links provided the Study Team with daily documents for traffic and operational information during one year of also 1990.

Peak hour was not observed during the study period but busy hour was supposed to be 16:00 hour period of every day of week, except Sunday. Hence, peak hour for commercial operations was estimated for those months which were considered - on a judgement basis - to be most likely to contain annual peaks.

The Study Team observed in details the daily traffic data provided by Air Niugini during some one week in a year of 1990, and the peak day ratio and peak hour ratio were estimated as 1/260, and 15% respectively.

Table 8.5-1 Peak Hour and Selected Data, 1990 at Tokua Airport

Items	1990	1995	2000	2010
Total Passengers	160,000	208,000	278,000	497,000
Total Commercial Ops	4,554	3,782	4,402	7,835
Total Gen Aviation Ops	6,826	7,800	11,287	16,065
Total Operations	11,380	11,582	15,689	23,900
Total Peak Hr Passengers (including transit)	92	220	257	355
Total Peak Hour Com Ops	7	11	15	17
Peak Hr Pass, % in Pass/Day (including transit)	15	26	25	20
Peak Day Pass, % in Pass/Year (including transit)	1/260	1/265	1/270	1/280
Average Pass per Ops	14	18	18	21

Note: "Total Passengers in 1990" were estimated from the trend formula by the Study Team

Applying these ratios, total peak hour passengers were estimated as 92 including transit passengers.

Table 8.5-1 shows peak hour passengers including transit, for 1990 and for forecasting years 1995, 2000, 2005, 2010. Peak hour commercial operations are also shown for the same period. Other selected data on airport activity at Tokua Airport are included in the table as well.

According to the analysis for the relationships between total passenger traffic and peak hour traffic in a variety of airports around the world, it is universally true that as airport total passenger volume rose, the peak hour passenger flow tended to fall as a percent of total passenger volume.

As volumes rise, the resulting congestion tends to cause a spreading out of peak hour passenger flows as well as aircraft operations. This principle is expected to occur in Tokua Airport. The modest relative declines are anticipated in peak activities at Tokua Airport, as indicated in the Tale 8.5-1.

8.6 Air Traffic Route and Aircraft Type

8.6.1 Domestic Air Passengers

It is assumed that the basic pattern of traffic route of domestic air passengers to/from Tokua Airport would be almost the same as that of Rabaul Airport.

Based on the statistical data of Air Niugini, Tal Air and DCA, the ratios of traffic volume of commercial aviation and general aviation in future are assumed as 65% and 35% respectively. By applying the ratio for commercial aviation, 65%, the forecasted passengers of commercial aviation are estimated as 167,000 in 2000, 224,000 in 2005 and 299,000 in 2010.

By taking account of traffic pattern by route for Air Niugini in 1990, the above traffic volume of commercial aviation is split into each route. Traffic volume of routes for Tokua-Port Moresby, Tokua-Madang, and Tokua-Kieta are projected to increase in share for future, but the shares of traffic volume of other routes except Tokua-Wewak seems to decrease in future. The changes of these shares by route are estimated by referring to the results of forecasts by route of Air Niugini.

The changes of these shares by route are also based on the results of forecasts by route of Air Niugini.

The Study Team obtained the information by hearing from Air Niugini and Tal Air with regard to a plan for the introduction of aircraft type in future. Based on the result of hearing, aircraft types by route are projected by taking into account navigation and traffic volume by route etc. The Study Team projected the aircraft type by route to be NJ (Non Jetplane: for general aviation) and SJ (Small Jetplane). The specified air craft type would be explained in more details in later Chapter. (Refer to Table 8.6-1)

8.6.2 International Air Passengers

For the purpose of dividing the international air passengers for Tokua Airport into each route, it is assumed that Tokua Airport would take almost the same pattern of traffic passengers by route as that of Port Moresby Airport.

By taking account of international traffic pattern by route for Air Niugini in 1990, the already projected traffic volume of international passengers is split into each route. The shares of traffic volume by route for Tokua-Cairns and Tokua-Singapore would be kept at around by 20%, and those for Tokua-Brisbane and Tokua-Sydney around 13~14%. These shares are projected to be decreased gradually year by year except those of routes of Tokua-Europe and Tokua-America.

The changes of these shares by route are also based on the results of forecasts by route of Air Niugini.

Aircraft type by route is projected by taking into consideration the same factors as the domestic aircraft type. For the routes of which distance for navigation is less than 5,000 kilometers, the aircraft type of these routes is predicted as SJ (Small Sized Jet), and for the routes with navigation distance of more than 5,000 kilometers, their aircraft types are supposed as MJ (Medium Sized Jet) and LJ (Large Sized Jet). (Refer to Table 8.6-2)

Table 8.6-1 Domestic Air Passengers by Route in Future for Tokua Airport

(Unit: Persons)

Route		1990 Traffic	1990 (%)	1990 A.C. Type	2000 Traffic	2000 (%)	2000 A.C. Type	2005 Traffic	2005 (%)	2005 A.C. Type	2010 Traffic	2010 (%)	2010 A.C. Type
Tokua	- Port M.	46,800	29.2	NJ&SJ	75,100	29.1	NJ&SJ	102,700	29.9	NJ&SJ	141,800	30.9	NJ&SJ
(Rabaul: only	- Lae	14,700	9.2	NJ&SJ	22,800	8.8	NJ&SJ	30,400	8.8	NJ&SJ	39,700	8.7	NJ&SJ
for 1990)	- Hoskins	8,800	5.5	NJ&SJ	13,600	5.3	NJ&SJ	17,900	5.2	NJ&SJ	23,000	5.0	NJ&SJ
	- Kavieng & Others	16,600	10.4	NJ&SJ	24,300	9.4	NJ&SJ	29,900	8.7	NJ&SJ	36,400	7.9	NJ&SJ
	- Kieta	20,100	12.6	NJ&SJ	31,900	12.4	NJ&SJ	42,700	12.4	NJ&SJ	57,450	12.5	NJ&SJ
	- Others	53,000	33.1	NJ&SJ	90,300	35.0	NJ&SJ	120,400	35.0	NJ&SJ	160,650	35.0	NJ&SJ
	Total	160,000	100.0		258,000	100.0		344,000	100.0		459,000	100.0	

Table 8.6-2 International Air Passengers by Route and Aircraft in Future for Tokua Airport

(Unit: Persons)

Route		1990 Traffic	1990 (%)	1990 A.C. Type	2000 Traffic	2000 (%)	2000 A.C. Type	2005 Traffic	2005 (%)	2005 A.C. Type	2010 Traffic	2010 (%)	2010 A.C. Type
Tokua	- Oceania	61,400	58.8	SJ&MJ	11,600	58.0	SJ&MJ	15,600	55.7	SJ&MJ	19,000	50.0	SJ&MJ
(Port Moresby	- S. E. Asia	43,100	41.2	LJ&MJ	8,400	42.0	LJ&MJ	11,000	39.3	LJ&MJ	13,300	35.0	LJ&MJ
only for 1990)	- America	-	-		-	-		1,400	5.0	LJ	3,800	10.0	LJ
	- Europe	-	-		-	-		-	-		1,900	5.0	LJ
	TOTAL	104,500	100.0		20,000	100.0		28,000	100.0		38,000	100.0	

9. ESTABLISHMENT OF REQUIRED SCALES

9.1 General

In response to the request to the Government of Japan (GOJ) from the Government of Papua New Guinea (GOP) to conduct the study on the development of the proposed airport at Tokua, GOJ decided to perform the Study through JICA. JICA and GOP agreed on the Scope of Work for the Study on November 28, 1990.

Based on the Scope of Work and as set forth in the Inception Report, the frame of the airport development study is executed in stagewise, as noted as the following.

1) Master Plan Study on the development (Stage-I Study)

   Stage-I Study will work out a comprehensive airport master plan by establishing a phase development plan toward the year 2010.

2) Feasibility Study on intermediate development (Stage-II Study)

   Stage II Study will be conducted to carry out a feasibility study on a short term development plan for the year 2000, which will be phased out of the master plan.

The results of the succeeded Studies reported in the Progress Report and the Interim Report were revised as shown in this Final Report from a point of view of construction cost, to the extent that traffic demand can fit in the implementation of the Project.

Facilities in all phases in an airport have been recently amplified at the most airports in the world, in line with aircraft becoming larger and heavier coping with airport magnitude.

In order to work out the airport master plan, the basic scales required for the master plan are established hereunder, deriving from the results of the preceding Studies. The basic scales should conform with the international standards and recommended practices, as specified by ICAO. If there are no appropriate standards and recommended practices in ICAO, the Standards of FAA (USA) and/or JCAB (Japan) are applied in due course.

9.2 Fundamental Facilities

Fundamental facilities at an airport are runway, taxiway and apron. All these facilities are closely related with each other to maintain the airport operation in a proper manner. The following factors should be taken into account to make up the required scales.

9.2.1 Runway Length and Width

A runway length is calculated under the factors such as air-route stage distance, categories of aircraft, standard temperature, elevation and average runway slope of the airport. These conditions are set up as follows:

1) Air-Route Stage Length

As of 1991, there are 7 airliners of foreign and domestic operating in the airports in PNG. The major international routes are for Sydney, Brisbane and Cairns of Australia. As for the international routes, the study was made on the assumed routes connecting PNG with such regions as Oceanic, South East Asia, USA and Europe, based on the analysis of survey sheet for passengers conducted by the Study Team.

The routes for the new airport were assumed as shown in Table 9.2-1. The maximum route stage distance for the year 2000 is estimated to be 798 km (431 nm) via Port Moresby, presuming the air-routes connecting Tokua with various areas of Oceania, Asia, etc.

For the future (2010), the route between Tokua and Singapore of 5,112 km (2,760 nm) is assumed to be the maximum stage distance, judging from the routes in service up to date by Air Niugini.

2) Categories of Aircraft (Refer to Table 9.2-1)

Taking into account the aircraft types such as A310, followed by B767, B737, F28 and DHC7 presently used, with their number owned by the airliners and a prospect of aircraft types for future, the aircraft envisaged to be in service for the target year 2000 are assumed to be A310, B767, B737 and F100 types, taking into consideration a change trend of aircraft for service and the airlines' policies, etc.

Thus, maximum sized aircraft type for the year 2000 is estimated to be Medium Jet A310 type, and large Jet B747 for the year 2010. The Aerodrome Classification Number for the proposed aerodrome will be classified as 4D for the year 2000 and 4E for the year 2010.

Note: Refer to Aircraft classification by code number and letter, ICAO Aerodrome Design Manual (DOC 9157).

Table 9.2-1 Representative Air-routes and Aircraft Types

[Domestic]		Route	Range (km)	Serviceable Aircraft		
Medium Range:	①	– POM	798 (431 nm)	F100,	MD80s,	B737
	②	– MADANG	700 (380 nm)	F100,	MD80s,	B737
	②	– LAE	639 (345 nm)	F100,	MD80s,	B737
	②	– MANUS	600 (324 nm)	F100,	MD80s,	B737
	③	– KIETA	452 (244 nm)	F100,	MD80s,	B737
	④	– BUKA	385 (208 nm)	DHC6	DHC8	
Short Range:	⑤	– HOSKINS	240 (130 nm)	DHC6,	DHC7,	F28
	⑤	– KAVIENG	240 (130 nm)	DHC6,	DHC7,	F28
	⑥	– MANGA, LONDOLOVIT, TOL, LIHIR NAMATAMAI, etc.		DHC6,	DHC7,	F28
[International]	①	– HONOLULU	6,093 (3,340 nm)	B747,	A310,	B767
	②	– SINGAPORE	5,112 (2,760 nm)	B747,	A310,	B767
	②	– TOKYO	5,093 (2,750 nm)	B747,	A310,	B767
	②	– WELLINGTON	5,093 (2,750 nm)	B747,	A310,	B767
	②	– JAKARTA	5,090 (2,750 nm)	B747,	A310,	B767
	③	– KAGOSHIMA	4,912 (2,652 nm)	B747,	A310,	B767
	③	– HONG KONG	4,889 (2,640 nm)	B747,	A310,	B767
	④	– MANILA	3,925 (2,119 nm)	B747,	A310,	B767
	⑤	– SYDNEY	3,611 (1,950 nm)	A310	A300	B767
	⑥	– BRISBANE	2,091 (1,129 nm)	B737	MD80s	B767
	⑦	– CAIRNS	1,640 (885 nm)	F100	MD80s	B737

3) Alternate Airport

This may depend on the size of the aircraft. Port Moresby can be one of the alternate airports for Tokua Airport for the above mentioned aircraft. Kavieng Airport can be also an alternate airport for B737 type.

4) Aerodrome Data

In order to correct the runway length to a required route distance, the following basic aerodrome data will be referred.

Aerodrome Elevation	:	13.85 m
Aerodrome Reference Temperature	:	31.0°C
Temperature in Standard Atmosphere	:	*14.91°C
Average Slope of Runway	:	0.42%

* 15.0 - (13.85 x 0.0065) = 14.91

5) Runway Length

The results calculated from all conditions fore-mentioned come to be that the required length of the runway is necessary to be about 2,200 m for the year 2000 and about 3,000 m for the year 2010. (Refer to Attachment 9-1).

It is noted that the runway of 2,200 m in length can be used by Large Jet B747 with weight reduction penalty for limited routes length.

6) Runway Width and Strength

The runway width for the year 2000 and 2010 is going to be, to cater for operations of Middle Jet and Large Jet, 45 m and the shoulders of 7.5 m in width on the both sides of the runway, conforming to the ICAO Standards.

The runway strength is of pavement structure to cope with the weight of A300 type aircraft which is the heaviest among Middle Jet aircraft, from the view point of pavement performance and economy of the cost as discussed later.

9.2.2 Runway Strip

1) Length

The length of runway strip is to be 2,320 m, including 120 m (60 m x 2) of the over-run areas on the both runway ends, in the case the runway length is 2,200 m. The future plan for the year 2010, being 3,120 m in the case the runway length is then 3,000 m.

2) Width

The width of runway strip should be 300 m to cater for CAT-I operation of ILS.

9.2.3 Taxiways

It is essential to maintain a safe and prompt operation on the runway and to avoid a congestion which may be caused by mix operations with small aircraft sharing 80% of number of aircraft.

1) Number of Taxiways

For the year 2000, 2 conventional taxiways (intersecting with the runway at the angle of 90 degrees) should be provided at an interval of about 500 m from runway center point, and partial taxiway of 650 m in length, parallel to the runway, should be also provided. Turning pads are recommended to be provided at the both ends of the runway. For the year 2010 when the runway length is extended to about 3,000 m, number of conventional taxiways will be accordingly increased to 5 taxiways. The parallel taxiway length will also be extended to the same length of the runway, about 3,000 m. Holding bays are recommended to be provided at the both ends of the runway.

2) Taxiway width

The taxiway width should be 23 m and the shoulders of 7.5 m for the year 2000 and 10.5 m for the year 2010 in width on the both sides of the taxiway, conforming to the ICAO Standards.

3) Taxiway Strength

The pavement strength of taxiways should be the same as that of the runway.

4) Rapid-Exit Taxiway

Though it is still early to comment if a rapid-exit taxiway is necessary to be provided or not, this question will be subject to further study, taking into consideration the operational situation and procedural capacity between the runway and the taxiway which may occur in future.

5) Separation Distance between Runway and Parallel Taxiway

The separation distance from the runway to the parallel taxiway should conform with the ICAO Standards of 182.5 m at minimum, taking into account the factors such as an introduction of larger aircraft type and operational safety in future, as well as fuel consumption rate of jet aircraft travelling on low level for the distance from the apron.

9.2.4 Apron Area

1) Passenger Terminal Apron

An apron size will be calculated by the procedural flow as shown in Attachment 9-2, based on aircraft type on route service, number of flight, parking procedure, parking time, etc. The apron layout will be designed separately to passenger terminal and general aviation aprons considering the introduction of the Large Jet for the year 2010.

(1) Peak Day and Peak Hour Concentrated Rates

Peak month coefficient is derived from the 2nd peak month of annual passenger, based on an actual growth trend (Refer to Attachment 9-2) and annual passenger demand forecast. And, taking a growth rate of 10% per day, the peak day concentrated rate is set 0.00370 ~0.00357.

Peak hour concentrated rate changes according to route structure, airport operational hour and international flight hour. It tends to become smaller, as number of take-off and landing increase.

Thus, it will be set of 0.25 ~0.20, taking into account the actual result and airlines time tables of the year 1990.

(2) Aircraft Type and Parking Time

A spot occupancy time is set as shown in Table 9.2-2, since an initial parking phase at the airport is deemed to be the one for a relay station, judging from the present operational status at Rabaul Airport. It will be necessary to review it when an international schedule flight comes to be stable in Future.

Though the actual seat load factor at present shows a high rate of 80%, a planned load factor will be designed as 60% for domestic and 50% for international, considering an assumed progress of the airport development and aircraft type presumably becoming larger.

Table 9.2-2 Aircraft Type and Parking Time

Aircraft Types	Aircraft Models	Seat Capacity	Parking Time (Min.)
A–Large Jet	B747–200B	360 ~385	70 (90)
B–Large Jet	B747–SP, DC10	221 ~280	70 (90)
C–Middle Jet	A310, B767	210 ~211	70 (80)
D–Small Jet	B737, F100, MD80s	81 ~110	45 (60)
E–Non Jet	BN Islander, DHC8	6 ~ 36	30

Note: Parking Time ( ) is for future.

(3) Required Apron Spot

Required number of spots for the years of 2000 and 2010 are derived from number of parking aircraft at a peak hour of annual take-offs and landings per aircraft types. As a supplemental spot, one more spot is better added to the required number of spots to cope with parking time prolonged unexpectedly or unavoidable and or temporal parking by a chartered flight, etc. (Refer to Attachment 9-2)

However, a supplementary additional spot is not provided in order to reduce the construction cost for the year 2000. Expandability should be considered for future expansion for 2010.

Table 9.2-3 Required Apron Spot

Year	A and B Types	C Type	D type	E Type	Total
2000	0	1	1	4	6
2010	1	2	2	5	10

Note: Night stay of E type aircraft will be considered separately.

(4) Standard Configuration of Apron

Parking configuration on apron will be that a jet aircraft smaller than middle jet and small aircraft park at an angle of 45 degrees and taxi out of a spot by themselves, so preparing an expandability of parking area for a large jet aircraft such as B747 type to be assumably introduced in future that it can park with nose-in and taxi out through pushing out of a spot by tag-car.

Depth of the apron will be designed to cater for B747, the biggest type of aircraft, and not to infringe into the transitional surface of 1/7 gradient from the edge of the runway strip. Standard dimension for parking of aircraft are as follows.

Table 9.2-4 Required Apron Dimension

Year	No. Of Spots	Dimension	L. Jet	M. Jet	S. Jet	N. Jet	G.A.	Total
2000	6	Width:		95m x 1	60m x 1	50m x 1	28m x 3	289 m
		Length:		105m	85m			
		Area:		9,975m^2	5,100m^2	6,360m^2		21,435m^2
2010	10	Width:	70m x 1	95m x 2	60m x 2	50m x 1	28m x 4	542m
		Length:	190m	105m	85m			
		Area:	13,000m^2	19,950m^2	5,100m^2	12,880m^2		50,930m^2

(5) Dimension of GSE Area

Aircraft on an apron needs a number of support facilities for such as passenger boarding on and disembarking from an aircraft, cargo loading and unloading and fuel supplying to aircraft and the

others, for which GSE facilities area has to be designed. Dimension of GSE area at both passenger terminal and cargo terminal, derived from take-offs and landings per aircraft types, will be 1,500 m^2 in total.

The separation distance between the apron and the terminal building will be 25 m, including the area of GSE vehicle pass strip and of buried pipes.

2) Cargo Apron

The cargo to be handled at the year 2000 is estimated to be 3,200 tons, out of which 85% is for domestic. Since most of them is considered to be belly loading in a passenger aircraft, an apron exclusively used for cargo handling will not be provided but a supplemental spot in the passenger-apron is to be utilized as a cargo apron.

However, since cargo demand is expected to increase and cargo aircraft will come in service in future, an apron area exclusively used for cargo handling should be acquired in advance in the area adjacent to the passenger-apron. The required dimension of cargo area, if it is implemented, is estimated to be about 2,300 m^2 for the year 2000 and about 3,700 m^2 for the year 2010.

9.3 Terminal Area

9.3.1 Passenger Terminal

The requirements for developing the terminal building are discussed herein in the light of the demand as established by the projected traffic forecasts for the master plan target year of 2010.

At present there is no international traffic at Lakunai airport. However, the new Tokua Airport is planned to serve as an international airport as well as a domestic.

1) Annual passengers forecast:

	Year 2000	Year 2010
Total Annual Passengers	278,000	497,000
Domestic Passengers	258,000	459,000
International Passengers	20,000	38,000

2) Peak hour passengers

The number of peak hour passengers is figured out by annual passengers multiplied by concentration rate on peak day and the rate in peak hour.

	Year 2000	Year 2010
	278,000	497,000
Peak Hour Passengers	x 0.000926	x 0.000714
	= 257	= 355

3) Number of services of maximum size aircraft

Year 2000 : A310, once every other day
Year 2010: B747-SP, once a week

As number of services is few, it is anticipated that there would be only one aircraft at a peak hour.

Although, the proportion of the international passengers is much smaller than the domestic one, the aircraft used for the international lines are larger than the one of domestic lines. For instance, departure lounges are a function of the gates they serve and must be planned to accommodate the largest aircraft that will be using that particular gate. It should, therefore, size each lunge based on its largest aircraft type, by incorporating seating capacity with a certain load factor.

Therefore, the passenger terminal building for international lines requires a space to accommodate these passengers carried by a larger aircraft.

4) Unit area for passenger terminal building

The following shows various unit areas applied for acquiring a rough estimation for passenger terminal building area;

Japan	*15(35)	m^2/pax
ICAO	14	m^2/pax
IATA	20-25	m^2/pax
France	20	m^2/pax
FAA	24-32	m^2/pax
Moroco	12-20	m^2/pax

* N.B. 35 m^2/pax including CIQ, 15 m2/pax without CIQ.

5) Area for passenger terminal building

Considering the above the following areas are estimated:

(15 m^2/pax is used for a domestic terminal building and 25 m^2/pax is for international.)

Passenger terminal building area :	2000	5,000 m^2
	2010	8,000 m^2

6) Space Allocation

Various design standards have been analyzed including USA Federal Aviation Administration (FAA), British Airports Authority (BAA) and International Air Transport Association (IATA) as well as International Civil Aviation Organization (ICAO). These standards are compared and listed in Attachment 9-3. However, these standards are not always consistent and are varied enormously. The study team has decided to adopt such standards considered to be the most approximate to the local conditions for the Tokua Airport.

Table 9.3-1 Space Allocation and Processing Time

-	Check-In Hall		
	• International	=	1.75 m^2/Pax
	• Domestic	=	1.30 m^2/Pax
-	Check-In Counters		
	• Passenger frontal area	=	1.30 m^2/Pax
	• Processing time	=	1.5 to 2.0 min./Pax
	• Passengers flow	=	50% of Peak Pax processed in 20 min.
-	Departure Hall		
	• Passengers	=	1.30 m^2/Pax
	• Well wishers	=	1.0 m^2//Pas
-	Emigration		
	• Area	=	1.50 m^2/Pax in line
-	Security (X-ray)	=	45 sec. to 1.0 min./Pax (Floor area flexible according to design)
-	Departure Lounge		
	• With seating	=	1.75 m^2/Pax
	• Without seating	=	1.3 m^2/Pax
-	Baggage Claim		
	• Domestic	=	1.5 m^2/Pax
	• International	=	2.0 m^2/Pax
-	Immigration	=	same as Emigration
-	Baggage per Passenger		
	• Domestic	=	2.0/Pax
	• International	=	2.5 to 3.0/Pax

7) Design Concept

(1) Future Expansion

The design should keep up with the expansion for year 2010 plan. The target year of this master plan for Tokua Airport is 2010. However, the first stage of the construction is 2000. Therefore, the terminal building as well as other facilities should be planned and designed to take into the consideration of the expansion at the outset.

(2) Module

It is conceived from the beginning to apply a module to plan and design the terminal building. The module brings the consistency to the space and help comprehend the space as a whole. Module will give the flexibility to the expansion of the building in future.

Figure 9.3-1 shows the basic unit of a module adopted to the planning of this terminal building. 7.2 m can be divided into several ways, which produces a good human scale. Besides it is a proper span for structure.

Figure 9.3-2 shows a bay frame produced by using this basic unit of module. From the experience it is understood that the good depth of passenger terminal building is about 50 m.

Figure 9.3-3 shows the grand frame of whole structure. This framing enables to preconceive the future expansion of the structure.

8) Block Planning

A block planning contributes to clarify the function of space within the building, which is shown in Figure 9.3-4. Module of human scale and structure merges with functions of the space in block.

Figure 9.3-5 shows a concept of the future expansion according to the modular planning.

9) Common use of the space

The projection of the international passengers shows infrequent use of the international passenger terminal area. Accordingly it is recommended to use space commonly as much as possible between domestic and international passengers. Of course this should not cause any essential inconvenience for both.

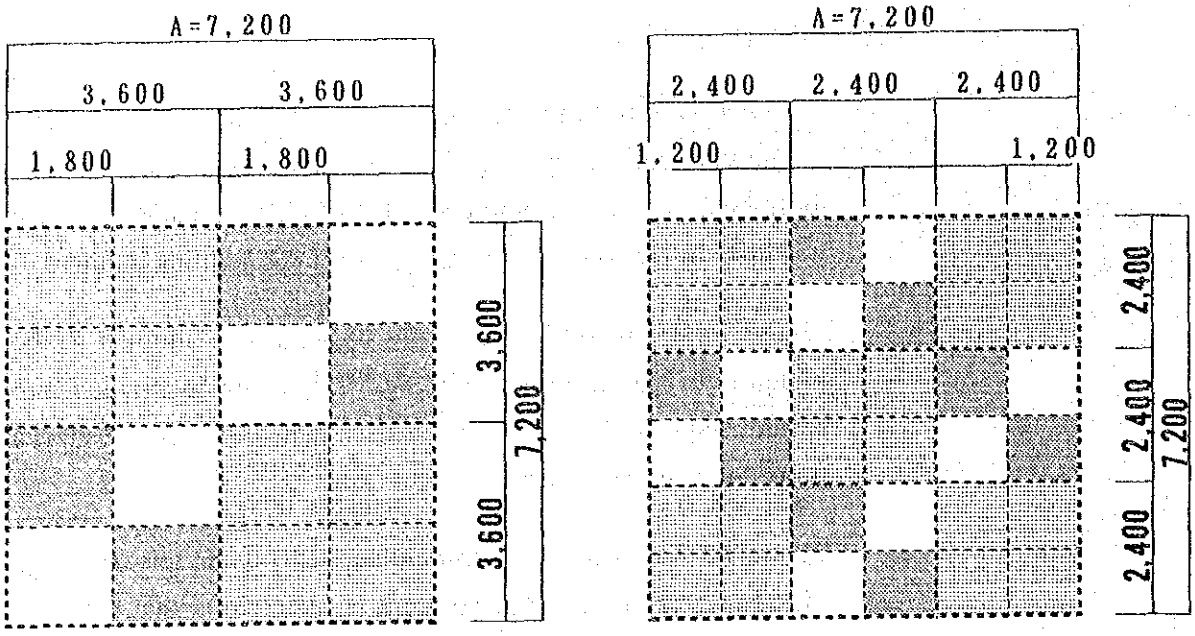


Figure 9.3-1 Unit of Module

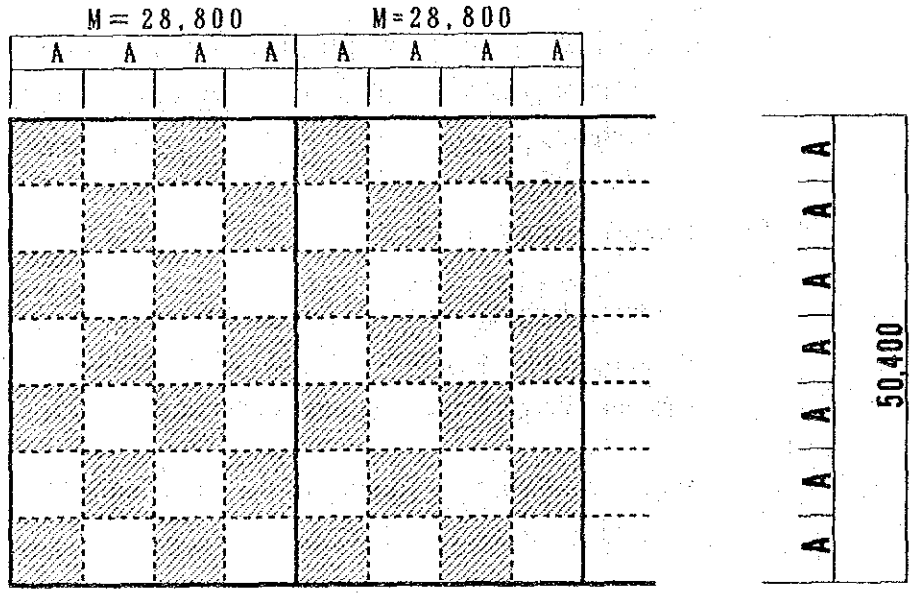


Figure 9.3-2 Bay Frame

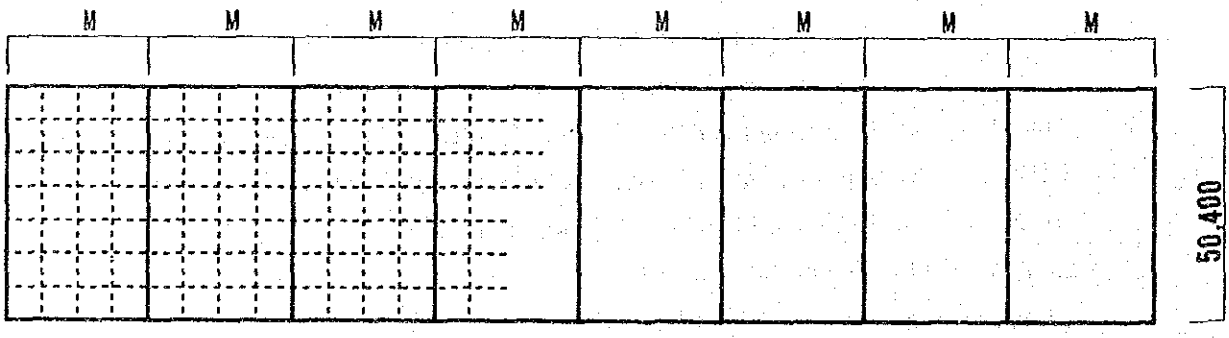


Figure 9.3-3 Grand Frame