FEASIBILITY STUDY
ON
NEW INTERNATIONAL AIRPORT CONSTRUCTION PROJECT
IN
EL SALVADOR

June, 1973

OVERSEAS TECHNICAL COOPERATION AGENCY
TOKYO, JAPAN

PREFACE

The Government of Japan, acting upon a request from the Government of El Salvador, took steps to cooperate in the survey and research for a new international airport construction project and commissioned the actual work to the overseas Technical Cooperation Agency. Aware of the importance of the proposed international airport construction project, the Agency organized an Airport Survey Team of twelve members with Akira Takeda, Deputy Director-General of the Civil Aviation Bureau, Ministry of Transport, as its Leader. On November 6, 1972 the Survey Team was despatched to El Salvador.

For fourty days the group conducted field surveys to select a suitable site for the new airport as well as area studies to gather data for a basic airport design. The following report brings together the results of this investigative work.

In presenting this report, we would like to express our hope that it may be of some assistance to the economic development of El Salvador and also serve as a positive contribution to amicable and fruitful ties between our two nations. Our most profound thanks and appreciation are due to the many agencies of the Salvadorian Government which so generously cooperated in the execution of our investigations, to the personnel of the Japanese Embassy in El Salvador who tirelessly assisted in the domestic arrangements, and to Japan's Ministry of Foreign Affairs and Ministry of Transport as well as to the Japan Airport Consultants, Inc. and Japan Air Lines Company, Ltd. which made the despatching of the Survey Team possible.

Overseas Technical Cooperation
Agency

Kei-ichi Tatsuke
Director General


NORTH AMERICA
CANADA
UNITED STATES
ATLANTIC
OCEAN
Newfoundland
Vancouver
Calgary
Seattle
Portland
Salt Lake City
San Francisco
Los Angeles
San Diego
Denver
Dallas
Houston
San Antonio
St. Louis
Chicago
Minneapolis
Milwaukee
Detroit
Montreal
Ottawa
Quebec
Boston
New York
Philadelphia
Washington
Atlanta
New Orleans
Bermudas I
Bahama Is
Havana
Tampico
Vera Cruz
Mexico City
Guadalajara
I. Socorro
Kingston
HAITI
Puerto Rico
Virgin Is
Dominica
Caribbean Sea
EL SALVADOR
NICARAGUA
HONDURAS
COSTA RICA
PANAMA
Caracas
VENEZUELA
Georgetown
Port of Spain
Bogota
COLOMBIA
Equator
Galapagos Is.
ECUADOR
SOUTH AMERICA
BRAZIL
Salvador
Fortaleza
Belem
S. Luis
La Paz
BOLIVIA
Brasilia
S. Paulo
Rio de Janeiro
Antofagasta
St. Felix
Tropic of Capricorn
Easter I.
Sala y Gomez
Juan Fernandez
Valparaiso
Santiago
Mendoza
Rosario
Buenos Aires
Montevideo
URUGUAY
Porto Alegre
Bahia Blanca
Comodoro Rivadavia
Falkland Is
Str. of Magellan
Tierra del Fuego
Cape Horn
South Georgia
South Sandwich
C. Farewell

Executive Summary

Executive Summary

To evaluate the feasibility of the project for the construction of a new international airport in the coastal area of Astoria, El Salvador, capable of handling flight operations of wide-bodied jet aircraft, Overseas Technical Cooperation Association of Japan dispatched a Survey Team to the country. This section summarizes the report of the Survey Team compiled on the basis of the findings of its on-the-spot survey and detailed analyses of these findings.

1.. Economic and Social Conditions

Situated in the center of the five Central American countries, El Salvador of late has been making steady progress, political, economic and cultural, under conditions of economic stability, and now occupies an important terminal point connecting North and South American countries. The development of her economy has been tied primarily to agriculture (cotton, coffee and sugar cane), but emphases have been shifting gradually to light industries. And the development of the manufacturing industry helped her achieve vigorous growth at an annual rate of 7%.

According to the CONAPLAN, a five-year economic development program, further efforts will be devoted to the improvement of her national income through increased production of agriculture, acceleration of industrialization and development of tourism, and it is foreseen that her economy will advance at an average annual rate of 10% and that the deficit in her balance of payments will be eliminated by the final year of the program.

Looking ahead, the volume of her export is expected to grow through introduction of techniques of processing her agricultural products,the level of her involvement in the Central American Common Market will rise and her fishery industry modrnized. Technological development increasingly oriented toward heavier industries, as foreseen under the CONAPLAN, will enable her to make greater contribution to the Central America's region-wide economy and help her build up a growth momentum in her economy.

2. Civil Aviation, Present and Outlook

The air transportation industry of El Salvador has developed as a center of the Central American network of air routes, and at present, seven carriers (COPA,TACA, AVIATECA, LACSA, LANICA, SAM and PAA) operating on medium and short haul routes serve the Ilopango International Airport. All landing operations are visual, weather permitting, therefore, schedules tended to be less dependable.

In 1971, the Ilopango International Airport handled 666,000 passengers and this represents a 1.38-fold increase over the figure of 1966. The number of operations on a peak day was 30 flights and the number of passengers during a peak hour was 130 (both arrivals and departures), of which 65 were in-transit passengers. In terms of their origin, the number of passengers originating from the Central American countries was the largest, 52,827 out of the total of 78,497, or 67.3% and that from North American countries was 23,959.

As is evident from the peak-hour figures mentioned above, in-transit passengers accounted for one half of the total, and this suggests the necessity of terminal facilities exclusively devoted to serving them.

A large percentage of general aviation aircraft is employed for aerial spray of agricultural chemicals, and statistics show that its number is steadily on the rise. In the interest of safety of aircraft in the area, the existing airstrips on which these light aircraft are based must be discarded and their function integrated into the new airport, and this calls for a cross-wind runway.

Looking ahead over the next twenty years, with the round-the-clock operation of the new airport coming into existence, long-haul international flights based on, and those passing through, the airport will increase and the size and speed of the aircraft serving these new routes will grow, with resulting increase in the number of air passengers utilizing the airport. By 1980, the volume of passenger traffic is expected to grow to a minimum of 541,000 of which approximately 160,000 will be accounted for by those originating from North American countries. By 1990, they are expected to grow, respectively, to 1,420,000 and 420,000.

These forecasts do not include the connecting passengers originating from the Far East, Southeast Asis, Europe, North and South America. They are estimated at 150,000 in 1980 and 430,000 in 1990.

As for the aircraft mix serving the new airport, bulk of the operations will include B-747, B-707, BAC-III and DC-8. By 1990, B-747 (1,000-seat) is expected to come into service and STOL or QSH may be commissioned to serve the inter-Central American routes.

3. Location and Scale of the New International Airport

Under instructions given by the Government of El Salvador, search for candidate sites was confined to the coastal area of Astoria. Before proceeding to the designated area, the Survey Team selected eight candidate sites on the basis of available data (air space, meteorology, topography, geology, aircraft noise, access, local community development programs, etc.). Further analyses of the data reduced the number of candidate sites to five, and on the basis of on-the-spot surveys the three sites of Astoria, Carrizal and San Juan were selected. The Survey Team concluded that any one of these three sites meets the geographical and physical requirements of the proposed new international airport. And the plan calls for an area of 877 hectares.

Proposed Airport Facilities

Location		Astoria
Reference Point	Latitude Longitude Elavation	N 13° 33' 29" W 89° 09' 07" 26m
Runway Orientation		(A) N 70° E (B) N 0° E
Airport Surface Area		877 ha
Landing Strip		(A) 3,320 x 300=996,000m^2 (B) 2,020 x 150=303,000m^2
Runway		(A) 3,200 x 60 =192,000m^2 (B) 1,900 x 45 = 88,500m^2
Over-Run		(A) 60 x 60 = 5,400m^2 (B) 60 x 45 = 5,400m^2
Apron		Passenger Loading 8 berths (61,800m^2) Cargo, Maintenance 3 berths (31,200m^2) General Aviation 70 berths (21,560m^2)
Nav-Aids ATC Facilities		Comm. Facilities New ILS System Air Ground Comm. Facilities VHF Comm. Equipments HF Comm. Equipments

4. Construction Schedule

In working out a construction schedule which is economical as well as adequate, three progressive construction stages are envisaged so as to keep pace with the projected growth in transport demand.

Stage 1: Scale commensurate with the transport demand forecasted for 1980.

Stage 2: Scale commensurate with the transport demand forecasted for 1985.

Stage 3: Scale commensurate with the transport demand forecasted for 1990.

The construction schedule we drew up for Stage 1 of the present project foresees a period of approximately four years including those for basic designing, detailed designing and construction work and a period of six months is allowed for administrative and procedural work in between the segments of the work, that is, six months between basic designing and detailed designing and another six months between detailed designing and construction work. However, the period can be accelerated by about six months by, for instance, simultaneously placing orders for basic designs and detailed designs and/or by simultaneously placing orders for different sections of the civil engineering work.

5. Cost Estimate

Costs are estimated under five headings: Civil engineering, terminal facilities, navigation aid facilivies, lighting facilities and land acquisition. Estimates given under each of these headings do no include freight, insurance, import duty and contingency allowances,which are estimated at about ¥1,467,000,000. It must be noted, at this point, that these amounts are subject to change depending on the final outcome of quantitative analyses to be made on the basis of detailed designs. This is particularly true in the case of estimates for terminal buildings, navigation aid facilities and contingency allowances as they are subject to change if and when there occurs any change in the selection of material or in designs. Accordingly, the cost estimate given below should be reviewed in light of the finalized detailed designs.

Costs estimated on the basis of the data currently available are as follows:

in millions yen

Item	Construction Cost	Design, Engineering and unforeseen Expenditures	Total
Civil Engineering	4,104	492	4,596
Terminal Facilities	1,886	189	2,075
Lighting Facilities	830	99	929
Navigation Aid Facilities	500	50	550
Land Acquisition	324		324
Total	7,644	830	8,474 (68,894,000 colons)

Note: Cost estimate is based on the prices in 1972

6. Cost-Benefit Analysis of an airport Project

It has become an established practice among many countries that a decision on such a large-scale investment as the construction of an international airport is preceded by, and based on, an extensive cost-benefit analysis. The Roskill Report of Great Britain and the Cost-Benefit Analysis Report of the Kansai International Airport of Japan are good examples.

The necessity of a cost-benefit analysis in planning the construction of an airport is rooted in the very nature of airport. Firstly, an airport is a facility for the exchange of perople among countries, and as such, has an important role to play in the promotion of foreign trade. Given the increasing level of interdependence among nation's of today's world, economic, political and cultural exchange is bound to become even more pronounced in the future. An overwhelming majority of international travellers, both in-and out-bound passengers, are airborne, and the first point of contact of these vast number of visitors with the receiving country is an airport. The quality and appearance of the facilities and service one meets at such an initial point of contact, that is, an airport, play a decisive role in impressing him, good or bad, so much so that the Roskill Report called what is at stake, aptly enough, as "national dignity."

Secondly, unlike in the case of other types of transportation facilities, an airport induces industrial development in neighboring areas. The sheer volume of infinitely varied kinds of service which an airport requires create new opportunities for commercial and industrial activities. And joint development of surrounding communities is another possibility. If certain types of export product can be manufactured in nearby plants, the economic role of the airport can be greatly enhanced. There are many successful attempts made along this line - and with good results.

Thirdly, as in the case of other types of transportation facilities, construction of an airport provides important stimulus to the construction and related industries. Installation of necessary terminal and navigation facilities requires a wide-ranging variety of products and materials - basic raw materials, electric power and all sorts of machinery and equipment. The needs an airport create bring a series of impetus to the local industries.

Benefits derivable from the construction of an airport are more than financial. In fact, many airports are built with these long-term and wide-ranging benefits in mind.

Benefits Derived from the Construction of an Airport

Matters taken into consideration in measuring benefits

derivable from the construction of an airport include:

1) Primary Effects
   a. User benefits
   b. Construction effects
   c. Development effects

2) Secondary Effects
   a. Effects on foreign trade
   b. Effects on international exchange
   c. Effects on industrial structure

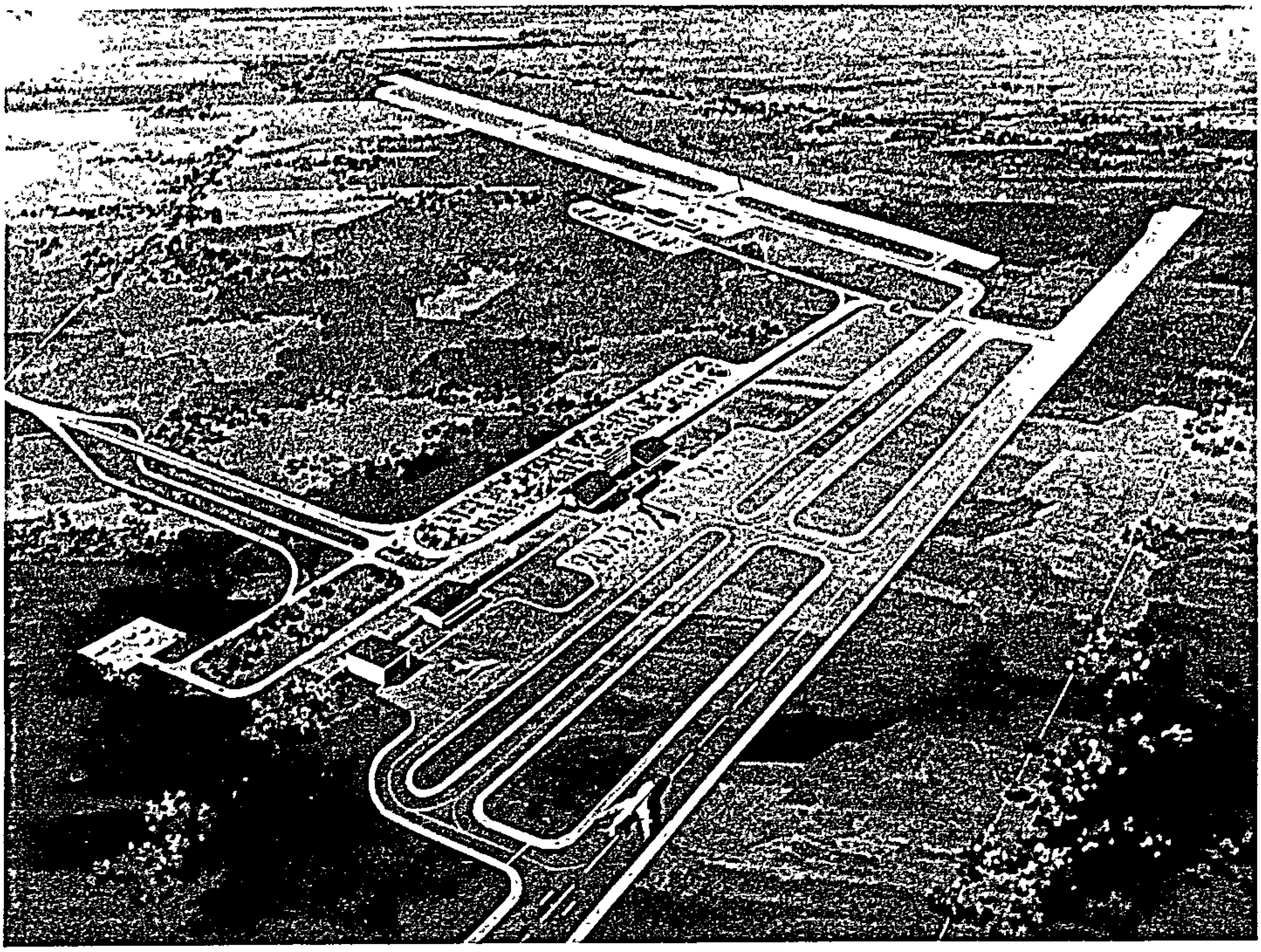
In analyzing the cost/benefit relationships involved in the construction of the proposed international airport in El Salvador, we felt that it was necessary to analyze these effects. In analyzing them, we are faced with two major difficulties: one is the difficulty of representing the benefits in money terms, and the other is the difficulty of measuring with any objectively measurable accuracy the benefits, especially those of secondary effects, while they are admittedly large.

Cost-Benefit Analysis of the proposed new international airport project has revealed that, based on the assumed project life of 30 years, the internal rate of return is projected to be in the environs of 9.5%, which is considered high enough to term the project justifiable.

To do justice to the overall economic evaluation of the proposed project, this rate of return should be understood in the light of the particular nature of a new airport construction project in general, major points of consideration being as follows: Firstly, the overall benefits to be created by the construction of a new airport comprise a great portion of unmeasurable benefits to be derived from the various economic repercussion effects. Based on the theoretical assumption that all these benefits of repercussion effects are properly measured in a tangible form, the projected internal rate of return of the proposed project may well show a considerably higher figure than herein projected. Secondly, from the financial point of view, it may be noted that this rate of return does not necessarily reflect a very high monetary rate of return. This, however, is due to the fact that the secondary or indirect benefits which, as stated above, constitutes a significant portion of the overall benefits of the project of this nature, are to be derived over a long period of time through vast variety of economic and social activities of the nation, and that for this very reason, it is next to impossible to identify with reasonable degree of accuracy the potential payers of the money to constitute the secondary benefits.

In other words, it may be concluded that the proposed new international airport project is one of the typical examples of the projects that may not show a seemingly high profitability in terms of direct monetary rate of return but hold great potentiality of producing desirable effects on the economic and social life of the nation.

EL SALVADOR NEW INTERNATIONAL AIRPORT



Feasibility Study
on
New International Airport Construction Project
in
El Salvador

Table of Contents

List of Tables

List of Figures

1. Introduction

1. Introduction

1.1 Background

The Government of El Salvador has for some time past been giving careful consideration to various studies on the improvement and expansion of the present Ilopango Airport as well as on the construction of a new international airport. On February 4, 1972 a special ministerial conference of air transport-related agencies was convened to review the situation. The outcome of the conference was an official decision to promote the construction of a new international airport and to ask the Japanese Government, through the good offices of the Japanese Embassy in El Salvador, to make a feasibility study.

Upon acceptance of this request, the Japanese Government commissioned a feasibility study to the Overseas Technical Cooperation Agency, and on November 6, 1972 the official Japanese Airport Survey Team which had been organized for the project was despatched to El Salvador.

1.2 Feasibility Study Objective

The objective of the feasibility study was to collect data relevant to the construction of a new international airport on the coast of El Salvador.

1.3 The Survey Team

Team Leader: Akira TAKEDA
(Airport Planner)
Deputy Director-General of the Civil Aviation Bureau Ministry of Transport

Deputy Team Leader: Hiroshi IMAMURA
(Economist)
Deputy Director-General of the Secretariat to the Minister
Ministry of Transport

Team Members: Shoichiro MAEDA

(Flight Operation and Air Traffic Control Specialist)

Special Assistant to the Director of Flight Standards Division
Engineering Department, Civil Aviation Bureau
Ministry of Transport

Kiyoshi KATANO

(Radio Engineer and Communications Specialist)

Special Assistant to the Director of the Radio Engineering Division
Air Traffic Services Department, Civil Aviation Bureau
Ministry of Transport

Captain Masao KIMURA

(Flight Operations Specialist Senior Flight Crew)

Japan Air Lines

Yoshihisa ISHIGAMI

(Airport Systems Specialist)

Executive Director
Japan Airport Consultants, Inc.

Shigeru SHIBATA

(Architect)

Director, Planning Department
Japan Airport Consultants, Inc.

Etsuji KAMIJO

(Transport Economist)

Economist
Japan Airport Consultants, Inc.

Genichiro KAYASHIMA

(Geologist)

Deputy Director, Planning Department
Japan Airport Consultants, Inc.

Minoru MAEDA

(Civil Engineer)

Assistant to the Director, Planning Department
Japan Airport Consultants, Inc.

Dr. Yoshiro TANIGUCHI

(Advisor)

Professor Emeritus
Tokyo Institute of Technology
Advisor
Japan Airport Consultants, Inc.

Eiichi MUTSURO

Staff

Overseas Technical Cooperation Agency

1.4 Survey Team Itinerary

November	6	Departed from Tokyo
	7	Arrived in San Salvador
	8	Visited the Japanese Ambassador and schedule liaison; called on officials of the Salvadorian Government
	9	Began area surface inspection
	10	First aerial survey
	13	Visited the Foreign Minister of Foreign Affairs; data collection at the National Council of Planning
	14	Surveying measurement began
	15	Second aerial survey
	20	Data collection at the Department of Tourism
	21	Third aerial survey; interim report on progress to the Salvadorian Government
	22 - 24	Data collection and liaison with the Civil Aviation Bureau, Institute of National Geography, etc.
	26	Evaluation work for site selection
	28	Inspection tour of Ilopango Airport; soil sampling began
	29	Visited the President Molina; inspection of various construction sites

	30	Studies began on airspace, air transport, and radio communications; inspection tour of PanAmerican Highway construction site
December	3	Tour through the eastern region for tourism and regional development planning
	4	Drafting of interim report began
	9	Consultation with the Japanese Ambassador
	11	Further discussion on interim report with the Salvadorian Government; called on the President
	13	Departed from San Salvador
	15	Arrived in Tokyo

Note: The period of the survey was 40 days, but some of the team members participated only for such duration when their presence was required.

2. The Economy and Society of E1 Salvador

2. The Economy and Society of El Salvador

2.1 Present State of her Economy and Society

2.1.1 Population

The total population of El Salvador stands at 3,647,000 in 1971--a 3.2% increase over the previous year. With her total area of about 21,393 square kilometers, her population density is as high as 170 persons per square kilometer, which is among the highest in Latin America. The population grew about 1.4 times during the past decade, with an annual average growth rate of 3.8%.

The population of San Salvador accounts for 21% of the nation's total, or a density of 839 persons per square kilometer. This compares with the 18% or 543 persons per square kilometer a decade ago showing an accelerating concentration of population in the capital. While the nationwide age distribution is 46.2% for 0 to 14 years of age, 50.4% for 15 to 64 years (roughly equaling the working population), and 3.7% for over 65 years of age, the figures for the capital are 40.8% for the first age group (smaller than the national average) and 55.6% for the second age group (greater than the national average). These differences are due to greater employment opportunities in the capital than in other cities, and contributes to advancing population concentration in San Salvador.

2.1.2 Employment

The total number of those gainfully employed in 1970 was 992,000, or 64.8% of the total labor force. About one half of the total employed, 51.2%, are engaged in agriculture and fishery, followed by manufacturing (19.6%), various service industries (15.0%), and commerce (7.4%). Total employment is increasing yearly, and showed a 1.228-fold increase in 1970 over 1962. Among various sectors of the economy, manufacturing showed the greatest rate of increase, or

1.682, followed by commerce (1.411) and service industries (1.256). We note, however, a low 1.083-fold increase for the main occupations of this country, agriculture and fishing.

In terms of regional classification, San Salvador shows the highest employment rate, 85.2% in 1971, while the national average is about 80%.

The break-down of the employment as of 1971 into industries and occupations region by region is as follows: In terms of industries, agriculture, forestry and fishery occupy the greatest share, 46.7%, followed by service industries with 13.0%, manufacturing 8.2%, and commerce 7.3%. But in the capital of San Salvador, the share of the primary sector is smaller (12.0%), and this is followed by commerce (15.1%), and manufacturing (16.9%). In particular, San Salvador accounts for 73.2% of the total of those employed in civil service. In manufacturing also, close to one half of the nation's total, or 43.2%, is concentrated in the capital. In this we see that the development of San Salvador is directed at creating more employment opportunities.

Occupational classifications: The largest percentage is seen in agriculture, forestry and fishery, amounting to 46.4%. The second and third largest occupational categories are transportation and communications, amounting to 14.5%, and services, amounting to 7.1%. But for San Salvador, those employed in transportation and communications amounted to 29.0%, and in services 16.6%, in retail trade 12.9%, with only 11.8% in agriculture, forestry and fishery. Extraordinary concentration of professional, managerial employees and those engaged in various stages of manufacturing is seen in the capital, representing 50.1%, 66.0% and 59.8% of the nation's total respectively.

2.1.3 Incomes

The 1971 Gross National Product was 2,681 million colones up 21% above the 2,216 million colones in 1967. Agriculture weighs the heaviest, amounting to 27.1% of the total (or 726 million colones). Main items of agricultural production are cotton and coffee. The next biggest industry is commerce, occupying 21.7% , or 581 million colones, followed by manufacturing or 19.2%, 516 million colones. Combined together, these three biggest categories occupy 68% of the G.N.P. There is hardly any difference in terms of rate of increase among various industries, all being in the neighborhood of 20% over 1967.

The 1971 per capital product amounted to 635 colones (or about US$25), only 1.04 times the 1967 figure, or almost no change during the period.

2.1.4 Industry

The Salvadorian economy has been growing at an annual rate of 5 to 7 per cent. But in 1971 the growth rate remained as low as 3.5% over the previous year, due partly to a decrease in incomes from coffee, which had tended to be overproduced. In 1971, agriculture, the nation's principal industry, occupies as much as 27.7% of the total production, followed by commerce 22% and industry 19%.

(a) Agriculture, Forestry and Fishery

The 1970 production of this category was 691 million colones, occupying 28% of the G.N.P. The breakdown: agriculture 75.5% or 521.7 million colones, livestock 13.5%, and poultry 4.2%. Coffee is the principal item of production of the entire country, occupying 53.2% of the total agricultural production. Production of cotton accounted for 10.7% and corn 9.9% in order of importance.

In terms of areas under cultivation, coffee again ranked first as of 1971, claiming 146,172 hectares. Cotton claimed 72,552 ha, sugar cane 29,209 ha, and vegetables 8,902 ha.

(b) Manufacturing

For the data on principal items of manufacturing and their performance, see Table 1.1.12. The total manufacturing production reached 491.6 million colones in 1970, amounting to 19% of the country's G.N.P. It increased 5.4% in 1970 over the previous year. The biggest item of production is foodstuffs, amounting to 135 million colones or 27.5% in 1970. Next in order are leather goods 64.4 million colones (13.1%, cotton fabrics 56.3 million colones (11.5%), soft drinks 48 million colones (9.8%), and chemicals 35.8 million colones (7.3%).

Industrial development with an annual growth rate of 5 to 6 per cent is being promoted to grow out of heavy dependency on agriculture.

2.1.5 Foreign Trade

The 1971 total exports amounted to 569.5 million colones while the total imports stood at 618.3 million colones, thus incurring a trade deficit of 48.8 million colones. Exports are increasing yearly, to 1.67 times the 1962 exports. But imports also are expanding: in 1971 total imports were 1.98 times the 1962 figure, or a double in a decade.

The principal exports items of El Salvador are coffee and cotton, occupying 53.1% of her total exports (or 302 million colones). Due to overproduction, the coffee market has been rather unstable, resulting in a 12% decrease in 1971 over 1970. On the other hand, cotton production has been growing rapidly, showing a 1.26-fold increase over the previous year.

Table 2-1-1 Import, Export

	Cargo metric ton			Value unit: 1000 colones		
	Import	Export	Balance	Import	Export	Balance
1962	595,366	276,916	318,450	311,986	340,750	+28,764
63	971,072	517,206	453,866	379,365	384,609	+ 5,244
64	1,189,097	550,688	638,409	477,808	445,238	-32,570
65	1,042,807	515,793	527,014	501,396	471,771	-29,625
66	1,129,639	516,060	613,579	550,010	472.316	-77,694
67	1,205,754	566,383	639,371	559,818	518,080	-41,738
68	1,277,956	639,504	638,452	533,785	529,264	- 4,521
69	1,137,019	583,697	553,322	523,125	505,272	-17,853
1970	869,313	436,705	432,608	533,953	570,792	+36,839
71	1,268,065	490,992	777,073	618,317	569,492	-48,825

Table 2-1-2 Main Export Products

volume: metric ton.
value: million colones

	coffee		cotton		other products
	volume	value	volume	value	value
1962	105	189	60	81	-
63	101	186	72	94	-
64	109	232	70	93	-
65	100	239	73	94	-
66	97	223	51	61	189
67	121	243	34	42	233
68	118	230	28	36	263
69	112	218	41	49	240
1970	111	278	50	58	235
71	98	229	56	73	201

2.1.6 Tourism

Blessed with 'sun and ocean', El Salvador had an influx of as many as 167,000 visitors from abroad in 1971, or a 1.4-fold increase over 1967. Central American countries are the most important origin of these tourists, accounting for 68.6% of the total foreign tourists visiting El Salvador. The United States follows with 15.7%.

Among Central American countries, Guatemala leads the rest contributing 64.9% of the total visitors to El Salvador, followed by Nicaragua, contributing 20.9%, and Costa Rica with 12.0%. In terms of rate of increase over 1968, Nicaragua comes first with 1.85, followed by Costa Rica with 1.71, and Guatemala with 1.44 times. In terms of months, December and January are the heaviest in tourist traffic from Central America, accounting for 11.5% and 10.3% respectively of the total annual in-bound tourists. The third most popular month is April, with 10.2% of the total.

Table 2-1-3 Incoming Tourist Passengers

unit: person

	1967	1968	1969	1970	1971	1971/1967
Central America	75,419	91,911	84,279	93,978	114,711	1.521
U.S.A.	20,664	25,808	25,396	22,303	26,290	1,272
Canada	1,011	1,110	1,872	1,256	1,521	1.504
South America	4,689	4,780	4,899	4,525	5,431	1.158
Mexico	6,230	6,581	6,208	5,938	7,456	1.197
Espana	1,792	1,991	1,492	1,637	1,888	1.054
Germany	2,064	2,379	2,203	1,883	2,418	1.172
Other parts of Europe	4,941	4,902	5,699	4,221	4,957	1,003
San Andres	515	600	440	301	351	0.612
Asia	676	995	1,142	1,113	1,331	1.969
Others	432	522	530	649	875	2.025
Total	118,433	141,579	134,160	137,804	167,229	1,412

Table 2-1-4 Tourist Passengers of Central America

	1968		1970		1971		1971/1968
	tourist pass	ratio	tourist pass.	ratio	tourist pass	ratio	
Guatemala	51,615	56.1	58,839	62.6	74,472	64.9	1.443
Honduras	17,515	19.1	7,518	0.1	82	0.1	0.005
Nicaragua	12,993	14.1	22,968	24.4	23,980	20.9	1.846
Costa Rica	8,058	8.8	10,291	11.0	13,752	12.0	1.707
Panama	1,720	1.9	1,757	1.9	2,378	2.1	1.383
Belize	20	0.0	47	0.0	47	0.0	2.350
Total	91,911	100.0	93,978	100.0	114,711	100.0	1.248

Table 2-1-5 Tourist Passengers of Central America (by month)

	1968		1971	
	tourist pass.	ratio	tourist pass.	ratio
1	8,429	9.17	11,802	10.29
2	5,150	5.60	9,216	8.03
3	9,970	10.84	8,788	7.66
4	7,814	8.50	11,639	10.15
5	6,827	7.42	7,047	6.14
6	7,048	7.66	8,129	7.08
7	8,010	8.71	9,472	8.26
8	7,018	7.63	8,567	7.47
9	6,385	6.94	7,853	6.85
10	6,436	7.00	8,757	7.64
11	10,228	11.12	10,232	8.92
12	8,596	9.35	13,209	11.51
Total	91,911	100.00	114,711	100.00

Table 2-1-6 Gross Domestic Products by Class

output: unit: million colon
ratio: %

	1967		1968		1969		1970		1971	
	output	ratio	output	ratio	output	ratio	output	ratio	output	ratio
Agriculture	600	27.1	603	26.3	607	25.5	725	28.3	726	27.1
Manufacture	422	19.0	448	19.6	466	19.6	485	18.9	516	19.2
Commerce	528	23.8	540	23.6	542	22.7	543	21.2	581	21.7
Others	666	30.5	701	30.5	767	32.2	812	31.6	858	32.0
Total	2,216	100.0	2.292	100.0	2,382	100.0	2,565	100.0	2,681	100.0
	1,000		1,034		1,075		1,157		1,210	

Table 2-1-7 Gross Domestic Products

	Gross Domestic Products	Population	Per Capita	
	million colon	thousand	colon	(US$)
1967	2,197	3,151	610	(244)
1968	2,274	3,266	616	(246)
1969	2,362	3,390	614	(245)
1970	2,544	3,534	629	(252)
1971	2,656	3,647	635	(254)

2.2 Economic Position of E1 Salvador in Central America

Among the five Central American states, El Salvador is most densely populated and has the highest population growth rate. Let us review the economic relations of El Salvador with the rest of Central America, in terms of trade relations with her Central American trading partners (except Honduras, with whom diplomatic relations have not been resumed since 1970).

With Nicaragua and Costa Rica, El Salvador has enjoyed a favorable trade relation ever since 1966: in

1971 exports to Nicaragua were 39 million colones, her imports from Nicaragua 26.4 million colones, with a resulting favorable trade balance of 12.6 million colones. To Costa Rica, El Salvador exports amounted to 52.3 million colones, while imports totaled 27.7 million colones, or a shortfall of 24.6 million colones less. El Salvador maintained a favorable balance of trade with Guatemala in 1971 (exporting 110.8 million colones and importing 104.6 million, a gain of 6.2 million colones), but in 1969 it incurred a deficit of 57 million colones and in 1970 another deficit of 21.3 million colones.

While her trade with the rest of the world has been unfavorable, those with Central America have remained favorable. She enjoys a leading position among Central American countries in economic terms.

2.3 Transportation Demand in the Past

2.3.1 Passenger Transportation Demand

The number of people travelling to and from El Salvador was 666,000 in 1971, or 1.375 times the volume of five years earlier, in 1966. In 1971, the number of in-bound passengers and that of out-bound ones were quite close to each other.

For the number of in-coming and out-going air passengers, see Table 2-3-1. In 1971, 23.9% (159,000) of the total number of travelers to and from El Salvador were air-borne which was 1.243 times those in 1966. What this means is that the general increase in those traveling to and from this country is steeper than the increase in those by air, and more and more passengers are utilizing transportation other than planes for traveling to and from this country.

Tables 2.3.1 and 2.3.2 show how air transportation demand changed. As for in-coming passengers, nationals of neighboring Central American countries account for the largest portion, 66.5% in 1969 and 67.3% in 1971. Guatemala, Managua, San Jose, and Panama are particularly important points of origin of passengers, all of which lie to the south of El Salvador. Passengers from North America also maintain their percentage share on the order of 30%. But in 1971 it fell slightly to 30.5% from 32.3% in 1969. Passengers originating from Miami, Washington, D.C., and New York account for more than half the total of North American visitors.

The same trend can be seen also for out-going travelers; i.e., the importance of Central America is growing (62.3% in 1969 and 65.4% in 1971), while the position of North America as destination of passengers from El Salvador is sinking, from 36.9% in 1969 to 32.2% in 1971.

Table 2-3-1 Total International Passengers

Year	Incoming	Outgoing	Total
1962	171,972	175,342	347,314
1963	188,130	188,773	376,903
1964	209,681	208,644	418,325
1965	227,491	229,331	456,829
1966	244,542	240,060	484,602
1967	271,259	267,225	538,484
1968	311,421	308,348	619,769
1969	315,258	268,573	583,831
1970	296,703	295,444	592,147
1971	332,761	333,643	666,404

Table 2-3-2 Arrival and Departure Passengers
At Ilopango International Airport

unit: person

	Arrival Passengers			Departure Passengers		
	1969	1970	1971	1969	1970	1971
North America	20,293	24,164	23,959	24,053	28,141	26,231
Miami *1	11,176	12,975	13,163	13,284	15,835	15,030
New Orleans *2	2,874	3,502	3,196	3,792	4,079	3,687
Los Angeles *3	6,243	7,687	7,600	6,977	8,227	7,514
Central America	41,879	49,169	52,827	40,515	49,811	52,900
Mexico	7,407	9,198	8,316	8,459	10,134	9,671
Guatemala	16,997	18,066	19,089	15,709	17,589	18,475
Managua *4	17,475	21,905	25,422	16,347	22,088	24,754
Others *5	751	227	1,711	446	119	1,709
Total	62,923	73,560	78,497	65,034	78,071	80,840

Note: *1. includes Washington,D.C., New York and Belize.
*2. includes Merida.
*3. includes San Francisco and Houston.
*4. includes San Jose and Panama.
*5. includes Haiti, Jamaica and San Andres.

Total Arrival and Departure Passengers

	1969	1970	1971
Arrival	62,923	73,560	78,497
Departure	65,034	78,071	80,840
Total	127,957	151,631	159,337
Rate of Increase	1.000	1.185	1.2452

2.3.2 Cargo Transportation Demand

As has already been mentioned, El Salvador runs a trade deficit, meaning greater amounts of cargo arriving than leaving. In 1971, the total cargo, both ways, amounted to 1,410,000 metric tons, of which 77.3% was brought into El Salvador. Five years earlier in 1966, the total cargo handled had been of a greater volume of 1,545,700 metric tons decreasing in 1971 by about 10% to 0.91 times the 1966 figure. This is due to the decrease in outgoing cargo (exports) from 495,500 metric tons in 1966 to 319,600 metric tons in 1971, or by about 35%, although arriving cargo (imports) showed a slight increase during the five-year period, from 1,050,200 metric tons in 1966 to 1,090,600 metric tons, or an increase of about 3.8%.

Air transportation of cargo is rather limited in volume: in 1971, it represented only 0.56% of the total. In 1971 the arrivals amounted to 4,210 metric tons and out-bound cargo (exports) to 3,800 metric tons. In comparison with the respective 1966 figures of 3,610 metric tons and 1,300 metric tons, the rate of increase during the five years was 1.166 for imports and 2.857 for exports (See Tables 2.3.3, and 2.3.4).

The volume of arriving air cargo amounted to 4,210 tons in 1971, 61.7% and 38.2% of which was from North America and Central America respectively. In 1969, it was 3,546 tons, with the percentage of North and Central Americas 61.1% and 38.2% respectively. While the total volume increased by 15% during the five-year period, the percentage shares of the two regions as origins of the cargo underwent little change. Turning to out-bound cargoes, the total volume amounted to 3,797 tons in 1971, 1.176 times the 2,956 tons in 1969. In 1971, North and Central Americas contributed 28.0% and 70.6% respectively,

Table 2-3-3 Ship Cargo

Unit: metric tons

Year	In	Out	Total
1962	475,858	178,837	654,695
1963	726,474	393,475	1,119,949
1964	1,060,139	492,337	1,552,476
1965	903,901	485,517	1,389,418
1966	1,050,194	495,517	1,545,711
1967	994,601	376,715	1,371,316
1968	1,133,680	447,611	1,581,291
1969	1,086,993	417,672	1,504,665
1970	1,090,075	356,989	1,447,064
1971	1,090,600	319,555	1,410,155

Table 2-3-4 Air Cargo

Unit: metric tons

Year	In	Out	Total
1962	3,555	1,382	4,937
1963	3,235	1,523	4,758
1964	3,992	1,512	5,504
1965	3,905	1,373	5,278
1966	3,613	1,327	4,940
1967	3,570	1,165	4,735
1968	3,188	1,554	4,742
1969	3,546	2,956	6,502
1970	3,988	5,729	9,717
1971	4,210	3,797	8,007

while for the preceding five years the rates were 31% for North America and 67% for Central America, the former declining and the latter rising in their percentage shares.

2.4 Tourism Development Plans

Along with the policy of industrialization of the economy, El Salvador should naturally embark on measures to promote tourism as part of her long-term development strategy. It definitely constitutes an essential aspect of the country's development to improve various facilities catering to tourists, who flock to this country for the 'sun, ocean, and nature,' and add to the national incomes through tourism. At present the following three programs are in progress: 1) Making the La Union region an international tourist site; 2) making the Astoria region a national tourist site; and 3) improvement of excursion tour routes around Santa Ana.

2.4.1 La Union Region

This region has excellent potentials as a tourist site for visitors from abroad. The following measures are recommended:

a. It is desirable that the Government improve the infrastructure and other basic features (lard procurement, electricity, water, etc.), and that private capital is induced to establish other facilities, such as hotels and restaurants;

b. It will entail a public investment amounting to about 20 million dollars.

c. Private capital should be improved to improve 3.2 square kilometers of land (after the land having been purchased by the Government) and construct hotels with an accommation capacity of 5,000.

d. Transportation should not be limited to roads; instead light planes will also be employed for transportation from the international airport.

2.4.2 Astoria Region

This region may be improved as a recreation park for the local population.

a. Salvadorians could enjoy 'sun, ocean, and nature' for about 10 colones a day.

b. Private capital may be utilized to furnish simple lodging (hotels).

2.4.3 Santa Ana Region

This region could be developed as a place for tourist excursion routes.

a. An excursion route from San Salvador to Lake Coatepeque, to Cerro Verde, to Santa Ana, etc., is being planned.

b. On top of Cerro Verde a hotel will be constructed. housing about 100 persons a day.

3. Air Traffic Today

3. Air Traffic Today

3.1 Air Traffic in Central America

3.1.1 Air Traffic in Central America

Means of transportation connecting various Central American countries are both air and road,(except railways, which do not now connect all these countries).

Table 3.1.1 shows the network of roads connecting the Central American countries. However, the Pan American Highway is just about the only trunk road, but this is neither completed not has satisfactory conditions throughout.

Table 3-1-1 Inter-State Road Distances in Central America (km)

	Guatemala	Managua	Mexico	Panama	San Jose	San Salvador	Tegucigalpa
Guatemala		849	1648	2125	1304	259	618
Managua			2497	1276	455	590	469
Mexico				3773	2952	1907	2266
Panama					821	1866	1745
San Jose						1045	924
San Salvador							359
Tegucigalpa							

It therefore follows that the air transport connecting the countries assumes a particular importance. Heavier weight placed on air transport can be seen from Table 3.1.2 showing 1965 - 71 movements of the number of passengers served by air routes connecting Ilopango Airport. Since about 50% of air passengers here are transit passengers, the importance of the air routes directly connecting other countries around El Salvador can be easily perceived.

Table 3-1-2 Passenger Traffic at Ilopango Airport

year	Arrival	Departure	transit	total
1965	47573	50936	55411	153920
66	62837	65378	72119	200334
67	61247	66692	71966	199905
68	70506	74084	85508	230098
69	67057	71069	82596	222722
70	74560	78071	82579	235210
71	78497	80840	84435	243772

3.1.2 Air Traffic in El Salvador

Located near the center of all the Central American countries, El Salvador naturally has the possibility of becoming a hub of air traffic in this region. Table3.1.3 shows the number of landings and take-offs at Ilopango Airport.

Table 3-1-3 Annual Aircraft Movements at Ilopango Airport

	Total	General Aviation & Military	Commercial		
			Total	Pax	Freighter
1964	21648	15099	6549	5894	655
65	27737	19918	7819	7037	782
66	24979	15659	9320	8388	932
67	24561	15940	8621	7759	862
68	25561	16281	9280	8352	928
69	26688	16576	10112	9101	1011
70	34505	24635	9870	8883	987
71	35588	25074	10509	9458	1051

The number of landings and takeoffs at the airport increased to about 1.42 times the 1966 figure (25,000 times) in 1971 (35,600 times). The ratio of general aviation to scheduled air traffic increased from 63:37 in 1966 to 70:30 in 1971.

3.2 Past Annual Performance in Number of Air Passengers

Table 3-2-1 Annual Passenger Movements

	Arrival (A)	Departure (B)	Total (C)	Transit (D)	Ratio of Transit Passengers		Total (C+D)	A+D	B+D
					D/A+D	D/B+D			
1963	37,152	39,501	76,653	43,117	53.71	52.14	119,770	[illegible]	[illegible]
64	42,270	44,288	86,558	48,689	53.52	52.36	135,247	90,959	92,977
65	47,573	50,936	98,509	55,411	53.80	52.10	153,920	102,984	106,347
66	62,837	65,378	128,215	72,119	53.43	52.45	200,334	134,956	137,497
67	61,247	66,692	127,939	71,966	54.02	51.90	199,905	133,213	138,658
68	70,506	74,084	144,590	85,508	[illegible]	53.57	230,098	156,014	159,592
69	67,057	71,069	138,126	82,596	55.19	53.75	222,722	149,653	153,665
70	74,560	78,071	152,631	[illegible]	52.55	51.40	235,210	157,139	160,650
71	78,497	80,840	159,337	[illegible]	51.82	51.09	[illegible]	162,932	165,275

3.3 Past Performance in Air Cargo

Table 3-3-1 Cargo Traffic

Unit: kilogram

Region		1969			1970			1971		
		Export	Import	Total	Export	Import	Total	Export	Import	Total
North America	Washington	1,655	7,224	8,879	8,694	20,161	28,855	3,745	8,904	12,649
	New York	1,978	36,225	38,203	12,158	181,865	194,023	12,273	106,352	118,625
	Miami	705,541	1,464,146	2,169,687	725,709	1,598,913	2,324,622	659,746	1,730,997	2,390,743
	New Orleans	22,992	385,678	408,670	107,509	380,627	488,136	62,122	401,970	464,092
	Houston	44,870	107,630	152,500	33,274	87,047	100,321	6,335	99,089	105,424
	San Francisco	74,107	82,882	156,989	89,421	101,132	190,553	85,604	81,246	166,850
	Los Angeles	69,495	79,434	148,929	58,416	98,000	156,416	133,146	75,256	208,402
	Sub Total	920,638	2,163,219	3,083,857	1,015,181	2,467,745	3,482,926	962,971	2,503,814	3,466,785
Central America	Merida	979	1,329	2,308	53	153	206	76	1,615	1,691
	Mexico	43,273	365,072	408,345	75,515	316,678	392,193	49,899	400,063	449,962
	Belize	6,783	742	7,525	21,141	251	21,392	11,534	10,947	22,481
	Guatemala	14,059	115,924	189,983	60,624	94,954	155,578	57,190	193,953	251,143
	Tegucigalpa	23,202	6,495	29,697	-	-	-	-	-	-
	San Pedro Sula	24,434	18,706	43,140	-	-	-	-	-	-
	Managua	1,114,626	62,321	1,176,947	2,102,868	161,813	2,264,681	1,203,415	96,700	1,300,115
	San José	677,439	155,617	833,056	2,124,046	298,181	2,422,227	955,446	261,234	1,216,680
	Panama	71,287	656,523	727,810	129,045	639,471	768,516	188,639	607,592	796,231
	Sub Total	2,026,082	1,392,729	3,418,811	4,713,292	1,511,501	6,224,793	2,466,199	1,572,104	4,038,303
South America	Caracas	-	-	-	64	-	64	-	-	-
	Guayaquil	-	-	-	-	2,994	2,994	-	-	-
	Colombia	-	-	-	-	5,500	5,500	-	-	-
	Jamaica	-	-	-	-	-	-	4,408	326	4,734
	Puerto Rico	-	-	-	-	-	-	15,419	-	15,419
	San Andrés	-	-	-	-	-	-	27,272	-	27,272
	Sub Total	-	-	-	64	8,494	8,558	47,099	326	47,425
Total		[illegible]	[illegible]	[illegible]	5,728,537	3,987,740	9,716,277	3,476,269	4,076,244	7,552,513

4. Present Condition at the Existing Airport

4. Present Condition at the Existing Airport

4.1 Location and Access

The Ilopango Airport is located about 8.5 km east of central San Salvador, connected by a paved 4-lane road, a quarter of an hour drive by car.

The location of the airport beacon, airport elevation and its temperature are as follows:

Location of the Beacon Latitude 13° 42' N
Longitude 89° 07' W

Elevation 612 m (MSL)

Temperature 27°C

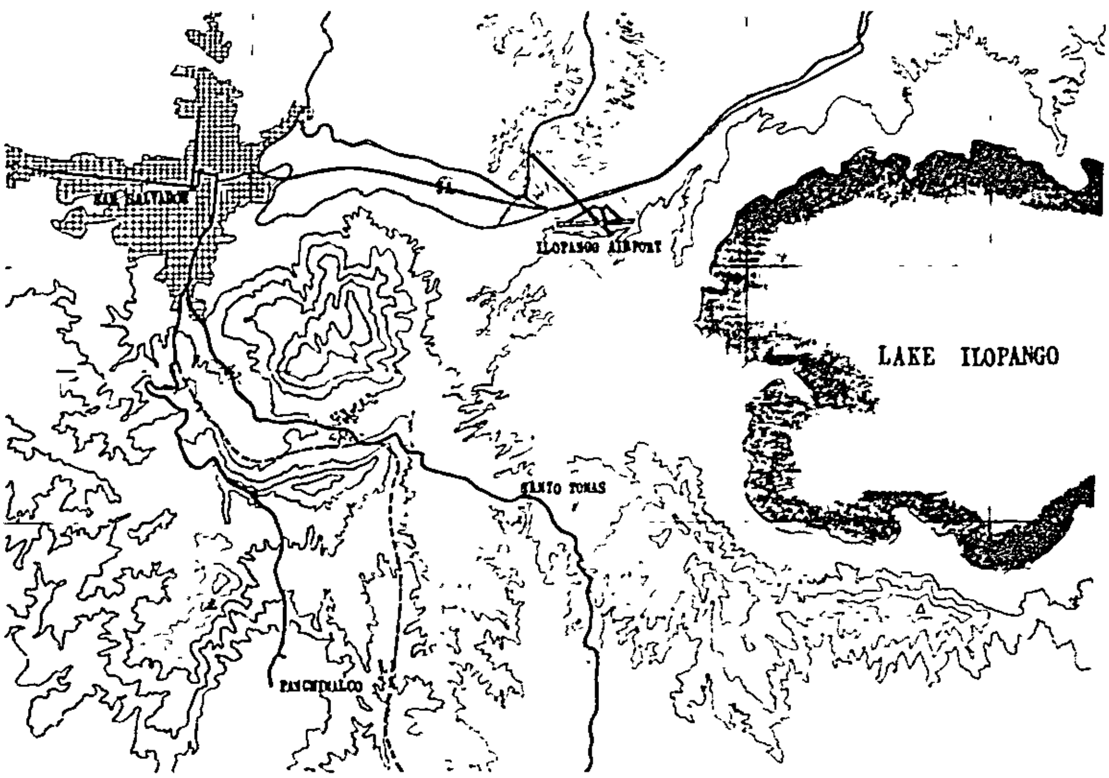


Fig. 4-1-1 Existing Airport Location

4.2 Runway, Taxiway, Apron, etc.

(1) Runway: 2,240 m long and 45 m wide, with a pavement of asphalt concrete

31.8 cm thick, with the subsoil CBR value of 25%, and in the direction of true bearing 152° - 332°.

(2) Landing Strip: 2,300 m long and 150 m wide.

(3) Taxiway: 675 m long and 23 m wide, with the pavement of asphalt concrete.

(4) Apron: 62,000 square meters paved by asphalt concrete.

4.3 Airport Lighting Facilities

The airport is equipped with the following lighting facilities: high intensity runway light, runway-end light, runway threshold light, VASIS light, taxiway light, aerodrome beacon, obstruction light, and hazard beacon on top of the mountain to the west of the airport.

(1) High intensity runway light: one series circuit, for 74 lights of 6.6 A and 200 W, to be supplied by CCR of 30 kW, and adjustable in five stages of lightness.

(2) Runway-end light: the same circuit as with the runway, 12 lights of 6.6 A and 200 W.

(3) Runway threshold light: on both sides of the both ends of the runway are flashing lights.

(4) VASIS light: regular VASIS lights are installed at 15 points on both sides of the runway. The CCR is placed near the up wind wing bar,

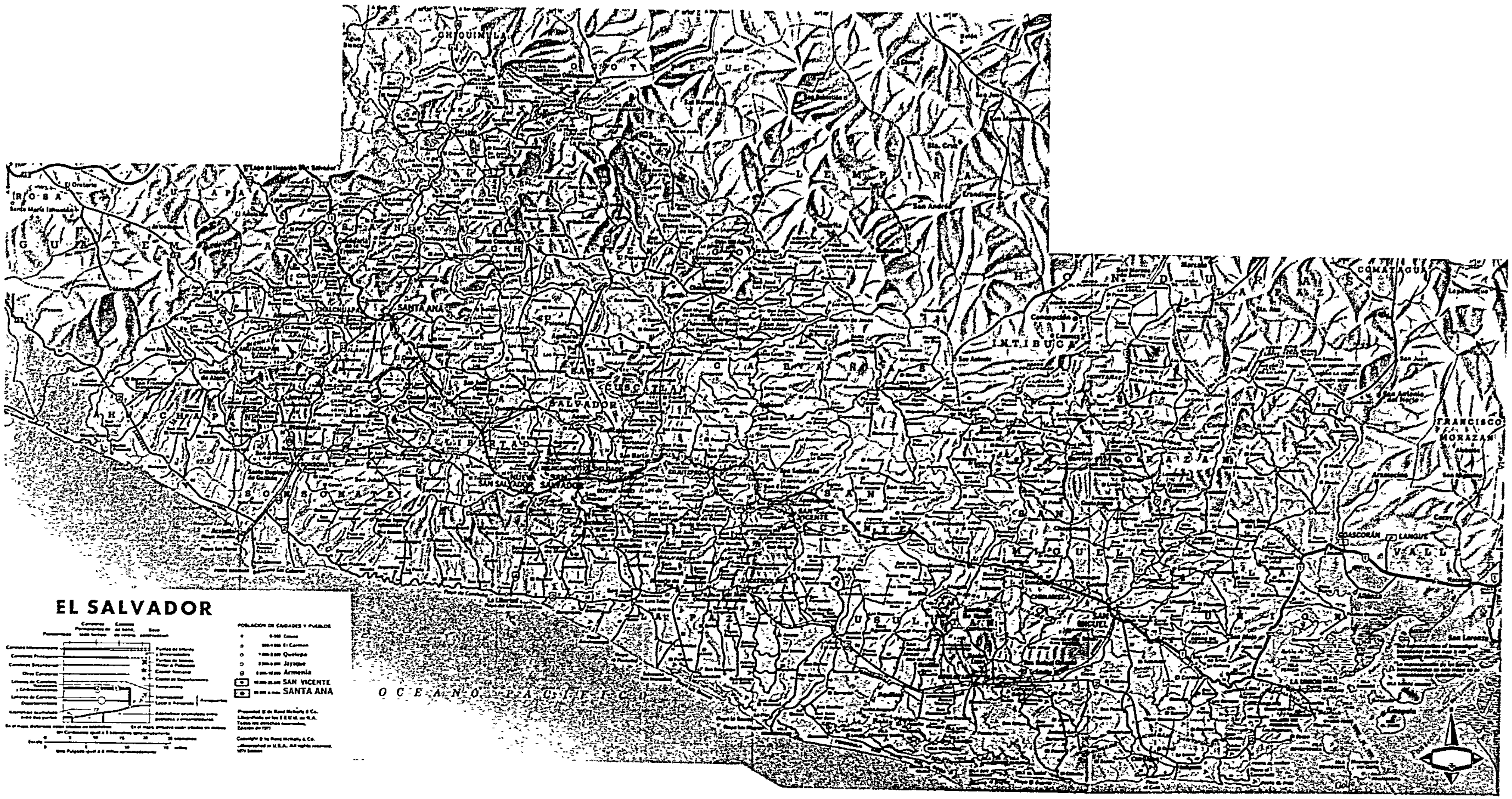
(5) Taxiway light: 2 series circuits, 94 lights of 6.6 A, 30 W on a corn-type base, not adjustable for degrees of lightness.

(6) Aerodrome beacon: a revolving aerodrome beacon is installed on the roof of the Control Tower.

(7) Obstruction light: installed at such places as the radio antenna and the house of PAR station.

(8) Hazard beacon: two chord beacons of 300 W, 300 mm type on top of the mountain to the west of the airport.

(9) Electric Power Facilities: The power is received at 3ϕ, 3 W, 4,160 V; its voltage is lowered


EL SALVADOR
Quelepa
Jayaque
Armenia
SAN VICENTE
SANTA ANA
SANTA ANA
SAN SALVADOR
SAN VICENTE
SAN MIGUEL
CUSCATLAN
INTIBUCA
FRANCISCO MORAZAN
COMAYAGUA
OCEANO PACIFICO

to 2,400 V by a transformer of 3ϕ, 150 kVA, and is then supplied to the CCR and other places. In the case of a failure of commercial power, a reserve generator of 3ϕ, 440 V, 150 kVA will be activated to produce power which subsequently is transformed into 2,400 V currency for use by the airport facilities. Control of lighting facilities can be exercised through the Control Tower.

In the case of landing or taking off at night, using night lighting facilities, general aircraft are to pay US$10 and agricultural planes and those belonging to flying clubs US$4 in fees, irrespective of their weight. This is according to the airport regulations.

4.4 Navigation Aids

To handle radio communication and navigational aid services in Central America, the Central American Cooperation of Navigation Service (COCESNA) has been formed under agreement by the five Central American states plus British Honduras, and it is charged with the task of operation, maintenance, and control of communications facilities and maintenance and control of control facilities and navigation aid facilities throughout Central America. This organization is due to the need in international air transportation for providing uniform navigational aid services to aircraft flying in this region, which is made up of a number of different countries. The COCESNA thus provides integrated navigational aid and communications services based on ICAO regional flight plans.

(1) Air Traffic Control Facilities

The Air Traffic Control Facilities consist of those for air-ground communications necessary for control service (flight control and landing control) and the control console, special telephones for communications with control units, weather stations, and fire departments, supervision facilities for such safety facilities as the omnidirectional range-beacon, and other related equipment such as tape recorders. Most of the facilities are housed in the Control Tower on the airport and in the mechanical room in the basement of the tower, except the air-ground radio facilities for landing control, which are placed at the Boqueron relay station on a volcano at 1,800 meters above the sea level northwest of the airport in order to cover a wider area. Ilopango Airport presently has no circuits for radio communication with cars operating within the premises of the airport; light-guns are used instead for communication with the tower.

Ilopango Airport air traffic control facilities are summarized as follows:

(a) Air-Ground Communication Facilities

Table 4-4-1 Ilopango Airport Air Traffic Control Facilities

Purpose	Frequency	Equipments		Location
Tower (local)	118.3MHZ	transmitter receiver	MARC ITT Model CT - 1 50W 2 units " CR - 7B 2 "	Tower
	3023.5KHZ	transmitter receiver	Communications Associates Inc. Model CT-11 " " CR-2	Tower "
Approach	119.5MHZ	transmitter receiver	Collins Model 242 F-2 200W 1 unit " " 51M8 1 "	Boqueron "
		transmitter receiver	MARC ITT Model CT-1 50W 2 " " " CR-7B 2 "	Tower "
Ground Control	121.9MHZ	transmitter receiver	MARC ITT Model CT-1 50W 1 " " " CR-7B 1 "	" "
Emergency	121.5MHZ	transmitter receiver	MARC ITT Model CT-1 50W 1 " " " CR-7B 1 "	" "

Other: One set of VHF Transceiver in ATC Console

In addition, a pair of emergency VHF tranceivers are located in the control console.

(b) Air Traffic Control Console

It is made up of tables for local control, approach control, ground control, and flight progress, with the following instruments:

Local Control: speaker, volume control, clock panel, weather instrument panel, transmitter/ receiver control panel, amplifier rack x 2, equipment rack

Approach Control: aeronautical chart frame, telephone set, intercom unit, speaker, volume control, clock panel, power supply, amplifier rack, equipment rack

Flight Progress: flight progress board x 2

Ground Control: speaker, volume control, clock panel, transmitter/receiver control panel, VOR remote control panel, recorder and NDB monitor panel, amplifier rack x 2, equipment rack

(c) Others

Tape recorder Model 5CA
Tape recorder Model 5CB
Time signal generator Model DCTA

(2) Communication Facilities

Ilopango Airport has the following communication facilities at the moment.

(a) Air Traffic Fixed Communication Facilities

To all aircraft flying over Central America, uniform navigation aid and communication service is provided based on the ICAO regional flight plans, and all communication for flight planning and aerial weather is handled by the VHF/UHF FM multiplex circuit operated by COCESNA at the moment.

Ilopango Airport in particular utilizes the branch circuit from the Relay Station of the main circuit (the Boqueron Relay Station on top of volcano 1,800 meters above the sea level about 15 kilometers northwest of Ilopango Airport).

The Boqueron Relay Station is equipped with a reserve generator to start functioning in the case of failure of commercial electric power.

(b) Teletype Facilities

The teletype and related instruments for the purpose of fixed aerial communication, aerial weather communication and drop circuits to various airlines are housed in the COCESNA communications room on the third floor of the terminal building, and are used for AFTN circuits service, ATS circuits service and circuits services for different airlines. The teletype facilities are of the old type (50 baud), such as the M-15 printers (made by the Teletype Corporation).

(c) Aeronautical Mobile Service Facilities

In order to insure safe and smooth flight by all aircraft flying in Central American FIR, necessary facilities for such air traffic mobile service as position report and weather report are located in the flight information office in each country. Ilopango Airport in particular is equipped with a 126.9 MHz tranceiver for use by Salvador Radio.

The Table shows the outline of the facility:

Table 4-4-2 Transceiver

Purpose	Frequency	Transceiver	Location
FIS	126.9MHZ	transmitter Collis Model 242F-2 200W 1 unit receiver " " 51N8 1 "	Tower "

(3) Radio Navigational Aid Facilities

The Radio Navigational Aid Facilities (VOR/DME, NDB) of Ilopango Airport are as shown in Table 4.4.3 below.

The NDB is placed in Apopa town, about 6.5 nm away from the Airport, and is also used for the Airway.

All the facilities are equipped with reserve generators at their sites, whose operation is supervised by the monitor at the Control Tower.

Table 4-4-3 Air Navigation Aids

Facilities	Identi-fication	Freq.	Equipment	Location
VOR (Ilopango)	YSV	114.7MHZ	WILCOX Model 485A 200W 1 set	Airport
DME		94X	AEROCOM Model 5350 20W 1 set	VOR and COLOCATE
NDB (Apopa)	YSX	215KHZ	ITT Model CB-3 1000W 1 set	R/W 15 aprox. 6.5nm

Facilities are provided with Stand-by generator and monitored at the control tower site.

4.5 Electrical Power Facilities

Electric power is supplied mainly by CEL (Comision Ejectiva Hidroelectrica del Rio Lempa), a government agency The National rural electrification plan, introduced by CEL in 1965, has progressed smoothly, and it is expected that the entire Salvador Region will be supplied with electric power in a near future. Rural electrification is accompanied by industrialization at the same time and the annual power generation registered a 2.9-fold increase during the period from 1961 (213,000 MKWH) to 1969 (624,152 MKWH). The supply capacities have been ample, 89,200 KW in 1961 and 206,800 KW in 1971, and there are plans for a 33,000 KW gas turbine generator, due in 1975.

El Salvador has abundant water resources, such as Rio Lempa, and hydroelectricity accounts for 60% of the total power generated in the country, with the rest generated by thermal power stations. Its frequency is 60 Hz throughout the country. The voltages used in transmitting and distributing the power range from 115 KV, 69 KV, 44 KV, 35 KV, 22 KV, 13.2 KV to 4.2 KV.

Ilopango Airport receives power at 4,160 V. There is one reserve generator of 150 KVA for lighting facilities and there are two reserve generators of 106 KVA for other facilities such as the terminal building.

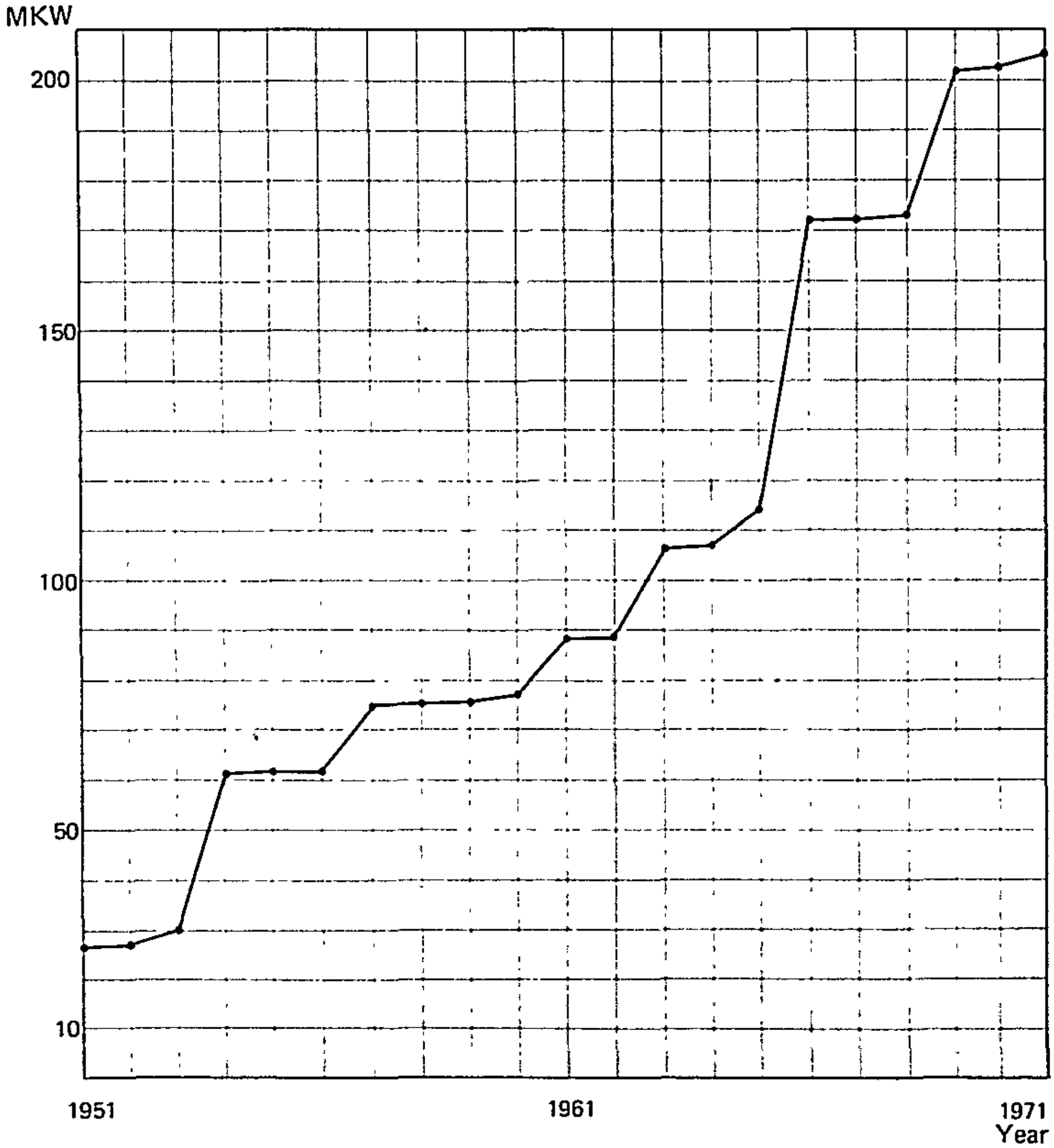


Fig. 4-5-1 Power Generating Plant Capacity of E1 Salvador

4.6 Buildings

(1) Passenger terminal building: built of reinforced concrete, 9,950 m^2

(2) Cargo terminal building:
No. 1 and 2 Warehouses 3,274 m^2

No. 3 and 4 Warehouses	2,047 m^2
Through-cargo Warehouse	522 m^2
Disposable cargo Warehouse	207 m^2
Total	6,050 m^2

(3) Hangars for small craft, work house, etc. 4,100 m^2

(4) Fire department 200 m^2

(5) Other buildings: Weather Station, emergency power plant, and Armed Forces facilities

5. Air Traffic Forecast

5. Air Traffic Forecast

5.1 Given Factors in Air Traffic Forecast

Various methods are conceivable for forecasting an air traffic, among which the one of time series analysis is the most popular. Such analyses should take into account the trend of the world economy if they are to be relevant to forecasting international air traffic. Since, however, it is extremely difficult to make accurate forecast of the world economy in terms of its structure and future performance, we will have to take certain factors as 'given' rather boldly in pursing this analysis. In our present study we take the entire world economy as 'given', and forecast future air traffic demand by time series analysis. The given factors in this air traffic forecast are as follows:

(i) The current trend of the world economy and society will be maintained;

(ii) The Central American Common Market will function normally and the Salvadorian economy will continue to move in the direction of growth, or at least the CONAPLAN's New 5-Year Plan will be successfully executed;

(iii) The Salvadorian national plans for tourism development will be completed by 1980: A hotel of 5,000 persons/day capacity will be completed in La Union Region, the National Natural Park will be completed in Astoria Region, and the excursion routes in and around Santa Ana Region will completed;

(iv) A Central American international tourist route will be developed.

5.2 Passenger Development

5.2.1 Forecast Method

With the above-listed given factors in operation, we may now assume that air passengers will increase as time progresses and obtain the following formula to effect forecast.

$$Pax, i(t) = Pax, i(0)\ (1 + t.gi) \ ......[1]$$

with Pax, i(t) standing for the number of passengers from country "i" in the "t" year, Pax, i(0) for the number of passengers from country "i" in the base year, and gi for the annual average growth rate of the number of passengers from country "i".

This formula will be applicable to airports already completed and operating. If past experience is any guide, construction of a new airport will induce some additional number of passengers. We must now take into account those induced passengers, and change formula [1] to

$$Pax, i(t) = Pax, i(0)(1 + t.gi)(1 + d) \ .....[2]$$

with d standing for the rate of induced passengers, or the rate of induced tourism, which can be determined by tourism development in connection with the domestic tourism development plans. From the past movements of tourists and tourist facilities in El Salvador this rate may be assumed to be 5 - 15% for our study. We only take this factor into account for the first year following the opening of the airport.

We then take formula [2] as providing forecast figures of air passengers. In the following table we give base figures for our forecast.

Table 5-2-1 Passenger Increase Co-efficient

Origin/Destination	Average Annual Increase Rate (%) (1967 - 1971)	$\frac{1980}{1971}$ *	$\frac{1990}{1980}$ **
North America	25.32	3.771	2.643
Central America	23.98	3.317	2.619
Others	20.18	3.098	2.412

Notes: *Includes new airport-induced tourists component of 15% for North America, 5% for Central America and 10% for others.

**Does not include induced tourists.

5.2.2 Result of Calculation

The resulting forecast figures are given in Table 5.2.2. We also assumed for this analysis that those passengers arriving by air will also leave by air, making the total passengers twice as many as arriving passengers.

Table 5-2-2 Projection of Arriving and Departing Passengers for the Proposed Airport

Origin/Destination	1980	1990	1980/1971	1990/1980
North America	180,682	477,568	3.771	2.643
Miami *1	92,460	232,090	3.512	2.510
New Orleans *2	23,110	58,052	3.615	2.512
Los Angeles *3	65,112	187,426	4.284	2.879
Central America	350,458	917,686	3.317	2.619
Mexico	50,458	101,546	3.034	2.012
Guatemala	115,080	308,556	3.014	2.681
Managua *4	184,920	507,584	3.637	2.745
Others *5	10,600	25,568	3.098	2.412
Total	541,740	1,420,822	3.400	2.623

Note: *1. includes Washington,D.C., New York and Belice.
*2. includes Merida.
*3. includes San Francisco and Houston.
*4. includes San Jose and Panama.
*5. includes Haiti, Jamaica and San Andres.

In 1971 the number of arriving passengers from North America was 24,000, and it will increase approximately 3.8 times to 90,000 arriving passengers in 1980 (multiply by 2 to obtain the total number of passengers handled by the airport). In 1990 the number will be about ten times the 1971 figure, amounting to 239,000 for arrivals only. Passengers from Central American countries amount to 65% of the total, totaling 53,000 in 1971 (arrivals only), and to about 3.3 times the 1971 figure in 1980, or 175,000 (arrivals only), and to about 8.7 times the base figure in 1990, or 459,000 arriving passengers. Taking passengers from other areas all together, the total number of air passengers into and out of El Salvador using this airport will increase from 159,000 in 1971 to 542,000 in 1980 (a 3.4-fold increase), and to 1,421,000 in 1990(8.9-fold increase).

5.3 Air Cargo Forecast

5.3.1 Forecast Method

Air Cargo Forecast must be made separately for arrivals and departures, because they are drastically different due to El Salvador's economic features. Since we again assume the continuation of the present trend of the world economy, we take it that air cargo traffic will increase with the passage of time. Therefore,

$$Q, i(t)\ Qi(0)\ (1 + t.gi) \quad ......[3]$$

with Qi(t) standing for air cargo traffic from country"i" in the t year, Qi(0) for air cargo traffic from country "i" in the base year, and gi for the rate of increase of air cargo from country "i".

Since the birth of a new airport is not expected to induce discernible additional air cargo demand, our formula [3] will suffice in this case.

The following is the base figures for our forecast.

(a) Arriving Cargo

Table 5-3-1 Incoming Cargo Increase Co-efficient

Origin	Average Annual Increase Rate (%) (1969 - 1971)	1980/1971	1990/1980
North America			
Miami *1	11.6	2.044	1.567
New Orleans *2	2.2	1.198	1.184
Los Angeles *3	2.5	1.230	1.149
Central America			
Mexico	1.1	1.103	1.147
Guatemala	3.1	1.278	1.484
Managua *4	9.6	1.862	1.481

Note: *1. includes Washington,D.C., New York and Belice.

*2. includes Merida.

*3. includes San Francisco and Houston.

*4. includes San Jose and Panama.

(b) Departing Cargo

Table 5-3-2 Outgoing Cargo Increase Co-efficient

Destination	Average Annual Increase Rate (%) (1969 - 1971)	1980/1971	1990/1980
<u>North America</u>			
Miami *1	3.1	1.278	1.218
New Orleans *2	4.8	1.435	1.213
Los Angeles *3	1.5	1.133	1.224
<u>Central America</u>			
Mexico	0.2	1.020	1.176
Guatemala	9.9	1.895	1.583
Managua *4	12.2	2.094	1.579
<u>Others</u> *5	0.7	1.064	1.060

Note: *1. includes Washington,D.C., New York and Belice.

*2. includes Merida.

*3. includes San Francisco and Houston.

*4. includes San Jose and Panama.

*5. includes Haiti, Jamaica and San Andres.

5.3.2 Result of Calculations

We see the resulting figures in Table 5.3.3.

Table 5-3-3 Projection of Cargo for the Proposed Airport

	Origin/Destination	1971	1980	1990	1980/1971	1990/1980
Incoming Cargo	North America	ton 2,517	ton 4,595	ton 6,885	1.826	1.498
	Maiami *1	1,857	3,796	5,950	2.044	1.567
	New Orleans *2	404	484	573	1.198	1.184
	Los Angeles *3	256	315	362	1.230	1.149
	Central America	1,560	2,488	3,539	1.595	1.422
	Mexico	400	441	506	1.703	1.147
	Guatemala	194	248	368	1.278	1.484
	Managua *4	966	1,799	2,665	1.862	1.481
	Others *5	-	-	-	-	-
	Total	4,077	7,083	10,424	1.737	1.472
Outgoing Cargo	North America	ton 974	ton 1,222	ton 1,489	1.255	1.226
	Maiami *1	687	878	1,069	1.278	1.218
	New Orleans *2	62	89	108	1.435	1.213
	Los Angeles *3	225	255	312	1.133	1.224
	Central America	2,455	5,075	7,994	2.067	1.575
	Mexico	50	51	60	1.020	1.176
	Guatemala	57	108	171	1.895	1.583
	Managua *4	2,348	4,916	7,763	2.094	1.579
	Others *5	47	50	53	1.064	1.060
	Total	3,476	6,347	9,536	1.826	1.502

Note: *1. includes Washington,D.C., New York and Belice.

*2. includes Merida.

*3. includes San Francisco and Houston.

*4. includes San Jose and Panama.

*5. includes Haiti, Jamaica and San Andres.

a. Arriving Cargo

It is expected that air cargo from North America will increase from 2,500 tons in 1971 (62% of the total arriving air cargo) to 4,600 tons in 1980, about 1.8 times as much as in 1971, and to 6,900 tons in 1990, a 2.7-fold increase over 1971. Incoming cargo from Central American countries will increase from 1,560 tons in 1971 to 2,500 tons in 1980, about 60% increase and to 3,500 tons in 1990, showing a 2.3-fold increase.

b. Departing Cargo

Outgoing air cargo to North America will rise from 970 tons in 1971 to 1,200 tons in 1980, and to 1,500 tons in 1990, showing 1.25- and 1.53-fold increases respectively. Our forecast depicts an increase of departing air cargo with destinations in other Central American countries from 2,500 tons in 1971 (occupying 71% of the total outgoing air cargo) to 5,080 tons in 1980 and to 8,000 tons in 1990, changing by about 110% and 230% respectively. In 1990 the share of Central America-distined air cargo will occupy 84% of the total departing cargo.

6. Basic Figures in Airport Planning

6. Basic Figures in Airport Planning

6.1 Aircraft Mix and Passenger Projection by Route

Although it is extremely difficult to forecast the types of aircraft to be in use in 1980 and 1990, we have made the following tentative postulation by route after taking note of the air traffic passenger forecast and the world trend for bigger aircraft. It is given air route by air route.

Table 6-1-1 Aircraft Mix and Passenger Projection by Route

Route	1980		1990	
	Annual Number of Passengers	Type of Aircraft	Annual Number of Passengers	Type of Aircraft
New York Washington Miami	92,460	B-747(360 Seats)Class, and B-707(145 Seats)Class	232,090	B-747(360 Seats)Class
San Francisco Los Angeles	65,112	Same as above	187,426	Same as above
New Orleans Houston	23,110	B-707(145 Seats)Class and BAC-111 Class	58,052	B-707(145 Seats)Class
Central America & Others	361,058	Same as above	943,254	B-707(145 Seats)Class and STOL(120 Seats)
Total	541,740		1,420,822	

6.2 Number of Landings and Take-offs per Year

The Salvadorian international airports will have about the same number of transit passengers as those terminating in this country or those flying out of the country because of her geographical location in Central America. If we assume a seat occupancy rate of 50% and a 1:1 ratio for transit passengers and in-bound (or out-bound) passengers, the number of passengers for each aircraft of various types and of in-bound (or out-bound) passengers are as follows:

Table 6-2-1 Number of Passengers per Aircraft by Type

Class	Seats	Load Factor	Passenger per Aircraft	Dept(Arr)Passengers per Aircraft
BAC-111 Class	100	50%	50	25
B-707 Class	145	50%	72	36
B-747 Class	360	50%	180	90
STOL(SQH)Class	120	50%	60	30

The number of landings and take-offs per year can be obtained through the following formula, with the results in Table 6-2-2.

$$N_1 = \frac{P_1}{P'}$$

N_1: Annual Aircraft Operations
P_1: Annual Number of Passengers
P': Number of Departing (Arriving) Passengers per Aircraft

Table 6-2-2 Annual Landing and Take-off Aircraft Operations by Type

Route	1980		1990	
	Type of Aircraft	Annual Aircraft Operations	Type of Aircraft	Annual Aircraft Operations
New York·Washington· Miami·San Francisco · Los Angeles	B-747 Class & B-707 Class	4,377 times	B-747 Class	4,662 times
New Orleans · Houston · Central America & Others	B-707 Class & BAC-111 Class	15,368 times	B-707 Class & STOL(SQH)	33,377 times
Total		19,745 times		38,039 times

6.3 Calculation of Peak Hour Passengers

The number of passengers in peak month at Ilopango International Airport is estimated at 1.2 times the average figure for ordinary months, based on monthly survey materials from 1969 to 1971. The rate of concentration during the peak-hour is estimated at 1/4 from Table 6-3-2. If we assume the validity of these figures for 1980 and 1990, the number of air passengers during peak-hour can be obtained from the following formula:

$$P_2 = \frac{P_1}{365} \times A \times B$$

P_2: Number of Passengers during Peak-hour

P_1: Annual Number of Passengers

A : Peak Season Coefficient

B : Peak-hour Concentration Rates

Table 6-3-1 Number of Passengers during Peak-hour

Route	1980	1990
New York, Washington, Miami, San Francisco & Los Angeles	130	345
New Orleans, Houston, Central America & Others	316	823
Total	446	1,168

Table 6-3-2 Past Performance of Peak-hour Concentration Rates

Day		7.00–8:00	8:00–9 00	9 00–10:00	10:00–11:00	11:00–12 00	12 00–13:00	13:00–14.00	14.00–15 00	15 00–16 00	16 00–17 00	17 00–18 00	18 00–19 00	19 00–20·00	Total
Sun.	Arrival		4	1	2		(2) 1		(3) 2		3	1	1		(17) 15
	Departure			4	4			1	(2) 1	(2) 1	2		2		(17) 15
	Total		4	5	6		(2) 1	1	(5) 3	(2) 1	5	1	3		(34) 30
Mon.	Arrival		2	(3) 2	2				1			3			(11) 10
	Departure			2	5	(1)				1		2	1		(12) 11
	Total		2	(5) 4	7	(1)			1	1		5	1		(23) 21
Tue.	Arrival		(3) 2	3	2	(1)			1	1	1	1	1		(14) 12
	Departure			2	5	1		(1)	(1)	1	2		2		(15) 13
	Total		(3) 2	5	7	(2) 1		(1)	(2) 1	2	3	1	3		(29) 25
Wed.	Arrival	1	2	2	(1) 2		(1)				1	3			(13) 11
	Departure		1	2	4		(1)				1	1	1		(11) 10
	Total	1	3	4	(7) 6		(2)				2	4	1		(24) 21
Thu.	Arrival	1	2	2	(3) 2		1		1	1	1	1	1		(14) 13
	Departure	(1)	1	2	4	1	(1)	1		1	2		2		(16) 14
	Total	(2) 1	3	4	(7) 6	1	(2) 1	1	1	2	3	1	3		(30) 27
Fri.	Arrival		3	2	(2) 1			(1)	1		1	4			(14) 12
	Departure			3	3				(2)	1		2	1		(12) 10
	Total		3	5	(5) 4			(1)	(3) 1	1	1	6	1		(26) 22
Sat.	Arrival		2	2	(3) 2	(1)				5		1	1		(15) 13
	Departure			5	2	1		(1)		(3) 2	2		1	1	(16) 14
	Total		2	7	(5) 4	(2) 1		(1)		(8) 7	2	1	2	1	(31) 27

Peak-hour Concentration Rates of Passenger Aircraft.

Sunday : 6 flight/30 flight = 1/5.0
Monday : 7 flight/21 flight = 1/3.0
Tuesday : 7 flight/25 flight = 1/3.57
Wednesday : 6 flight/21 flight = 1/3.50
Thursday : 6 flight/27 flight = 1/4.50
Friday : 6 flight/22 flight = 1/3.66
Saturday : 7 flight/27 flight = 1/3.85

6.4 Landings and Take-offs by Aircraft Type during Peak-hour

The number of landings and take-offs expected during peak-hour can be derived from the following formula, with the results as shown in Table 6-4-1:

$$N_2 = \frac{N_1}{365} \times A \times B$$

N_2 : Number of Operations during Peak-hour
N_1 : Annual Number of Operations
A : Peak Season Coefficient
B : Peak-hour Concentration Rate

Table 6-4-1 Number of Operations During Peak-Hour

	Aircraft Type	Number of Operations	Total
1980	B-707 Class	4	17
	BAC-111 Class	13	
1990	B-747 Class	4	32
	B-707 Class	28	

6.5 Number of Berths Necessary

6.5.1 Berths for Passenger Aircraft Parking

Assuming the necessary parking time for B-747's as 60 minutes and that for B-707's as 40 minutes, the following formula will give the number of berths necessary for passenger aircraft:

$$S = \frac{N_2}{365} \times \frac{T}{60}$$

S: Number of Berths Required

N_2: Number of Aircraft Operations during peak-hour

T: Aircraft Parking Time

(B-747: 60 min., Others: 40 min.)

Table 6-5-1 Number of Berths for Passenger Aircraft

1980				1990			
Aircraft Type	Number of berths required	Spare berth	Berths planned	Aircraft Type	Number of berths required	Spare berth	Berths planned
B-707 Class	2	0	2 for B-747 Class	B-747 Class	2	0	2 for B-747 Class
BAC-111 Class	5	1	6 for B-707 Class	B-707 Class	10	1	11 for B-707 Class
Total	7	1	8		12	1	13

6.5.2 Berths for Cargo Aircraft Parking

Estimates for the number of berths required for cargo aircraft are extremely difficult to obtain at the present moment. In view of the fact, however, that TACA and PAA are the only airlines that are expected to cargo aircraft at the proposed airport we have estimated that only two cargo planes are to be parked simultaneously during the peak-hour based on the flight schedule of November 1972. The plan, therefore, calls for two berths for the initial construction to be completed by 1978. Which should satisfy demand of up to 1980, while 3 berths may be planned to satisfy demand of up to 1990.

7. Site Selection

7. Site Selection

7.1 Surveyed Area

The area covered by the field survey for the site selection study of the proposed airport is in the Pacific coastal region about 30 to 40 km to the south of San Salvador (Fig.7-1-1). It is a triangular area of about 200 km^2 bounded by the sea coast on the south, Rio Jiboa on the east, and the road from La Libertad to Zacatecoluca.

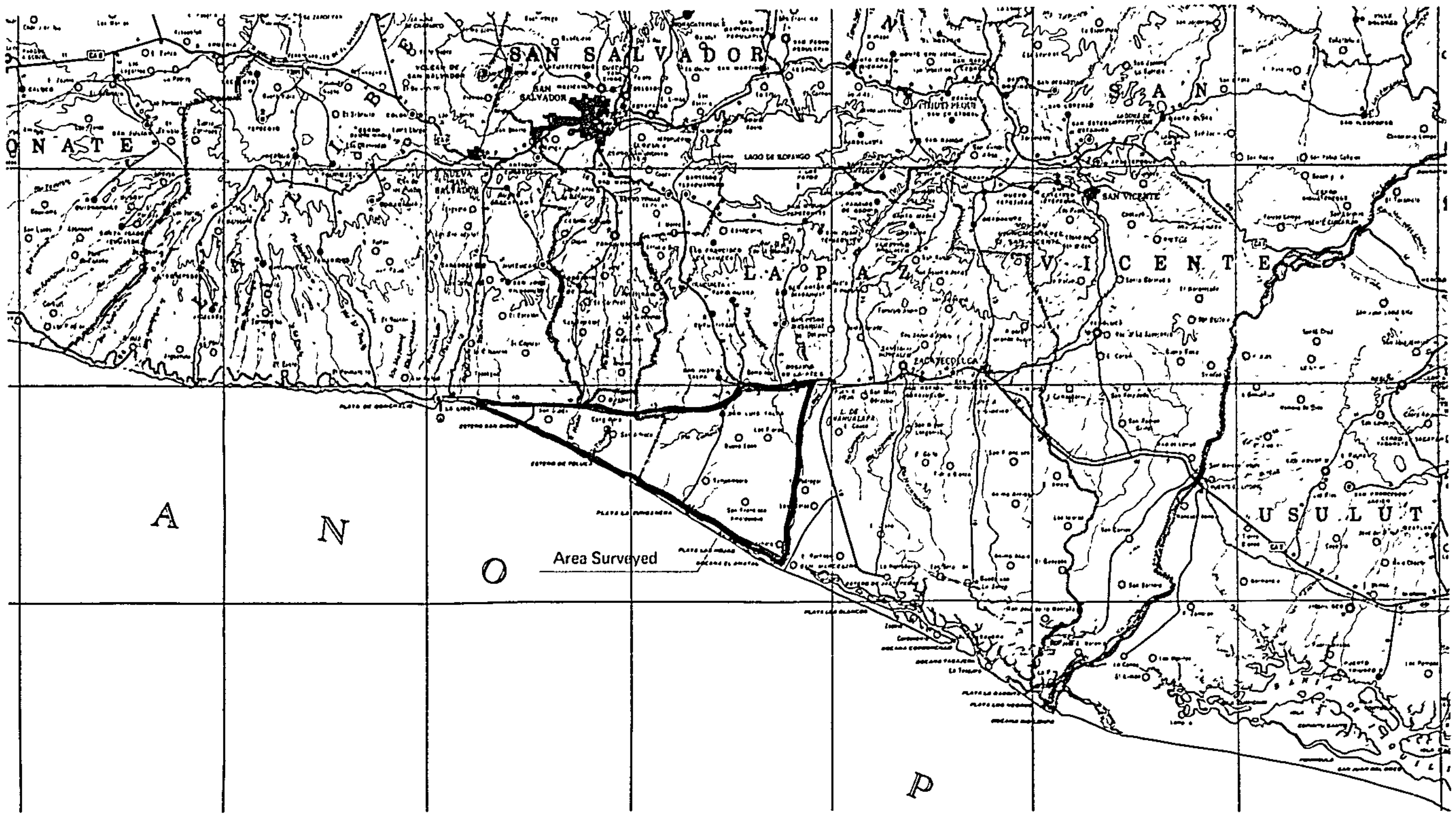


Fig. 7-1-1 Site Selection Study Survey Area

7.2 Approximate Area Requirements of the Proposed Airport

(i) Runway 3,200 m x 60 m
Alternate Runway 2,300 m x 45 m

(ii) Landing Strip 3,300 m x 300 m

(iii) Parallel Taxiway 3,200 m x 30 m
Parallel Taxiway for the Alternate Runway
2,300 m x 23 m

(iv) Apron 15 parking positions (8 for B-747, 5 for B-737 and 2 for reserve)

(v) Terminal Area

Note: The above is based on the preliminary survey report by Japan Airport Consultants, Inc.

7.3 Selection of Possible Sites

7.3.1 Preliminary Selection by Available Documentation

Previous to the field survey, we searched for possible appropriate airport sites on the map based on the topographical map of the area, aerial photos, and meteorological data, with the following results: (Table 7-3-1)

Table 7-3-1 Desk-selected Sites

Items \ Possible Site		A	B	C	D
Location	longitude latitude	N 13'26'21" W 89°03'05"	N 13°23'50" W 89°03'00"	N 13°26'28" W 89°07'42"	N 13°25'41" W 89°08'00"
Elevation		21.7m	10.7m	10.0m	6.0m
Runway Orientation		N 70'E	N 45°E	N 14°30'E	N 76°E
Rough estimate of earth movement	cutting	350,000m^3	440,000m^3	-	240,000m^3
	banking	300,000m^3	360,000m^3	-	150,000m^3
Others				restriction on northside approach area	

(A) is near the site proposed by the Hellman Report and the JAC Report, and the rest are newly selected possible sites. Judging from wind direction and wind velocity both (A) and (D), having the wind coverage of less than 95%, should require a cross-wind runway to raise operational efficiency. (B) will barely pass without a cross-wind runway, but is close to the coast to avoid airspace obstruction by mountains in the north. (C) offers the most desirable orientation of the runway in terms of wind direction and wind velocity, but will face airspace obstruction of the hills and mountains in the north.

During the phase of desk selection, no candidate sites were given preference over others, leaving further consideration to post-field trip study.

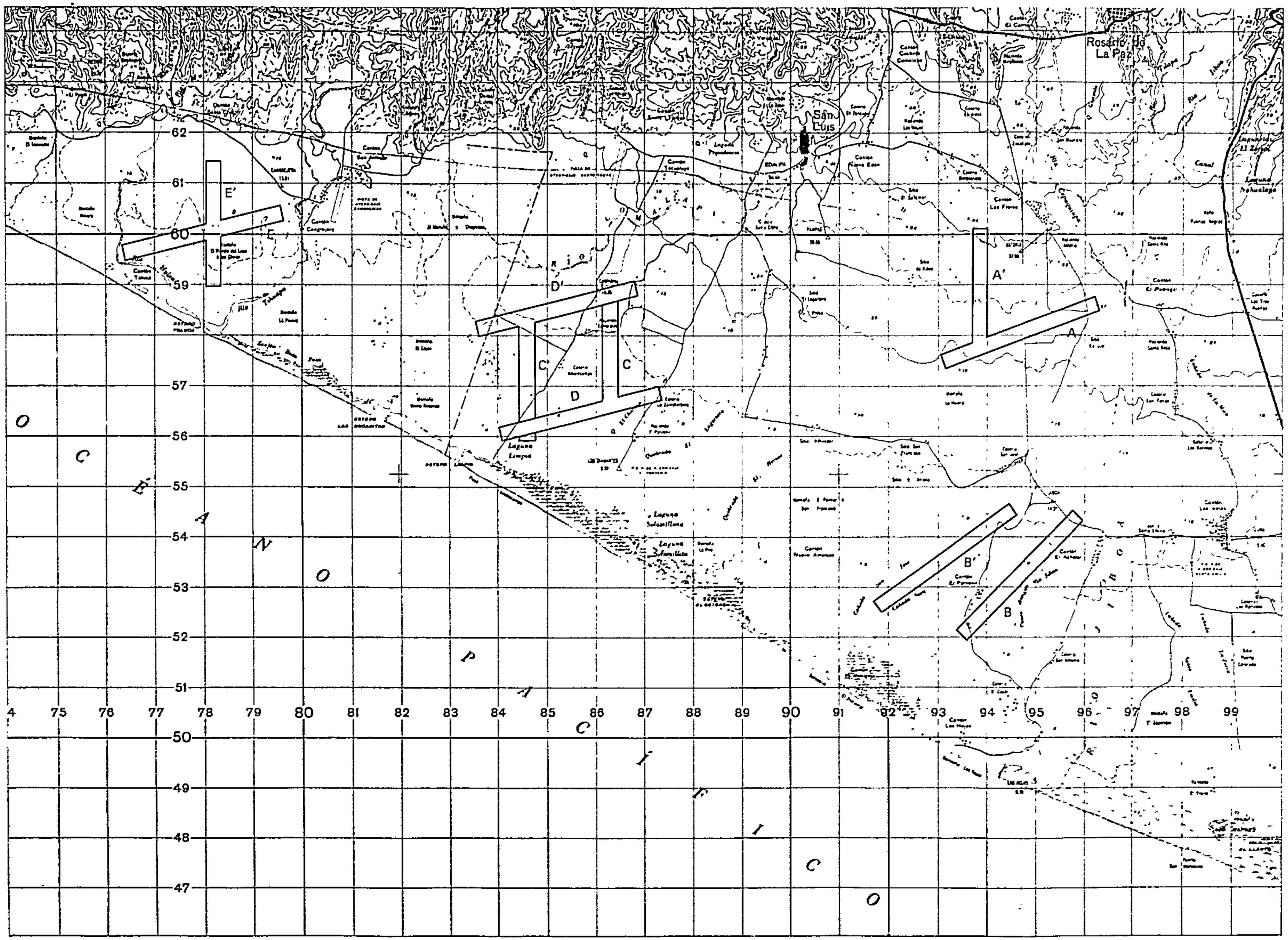


Fig. 7-3-1 Possible Sites Selected on Paper

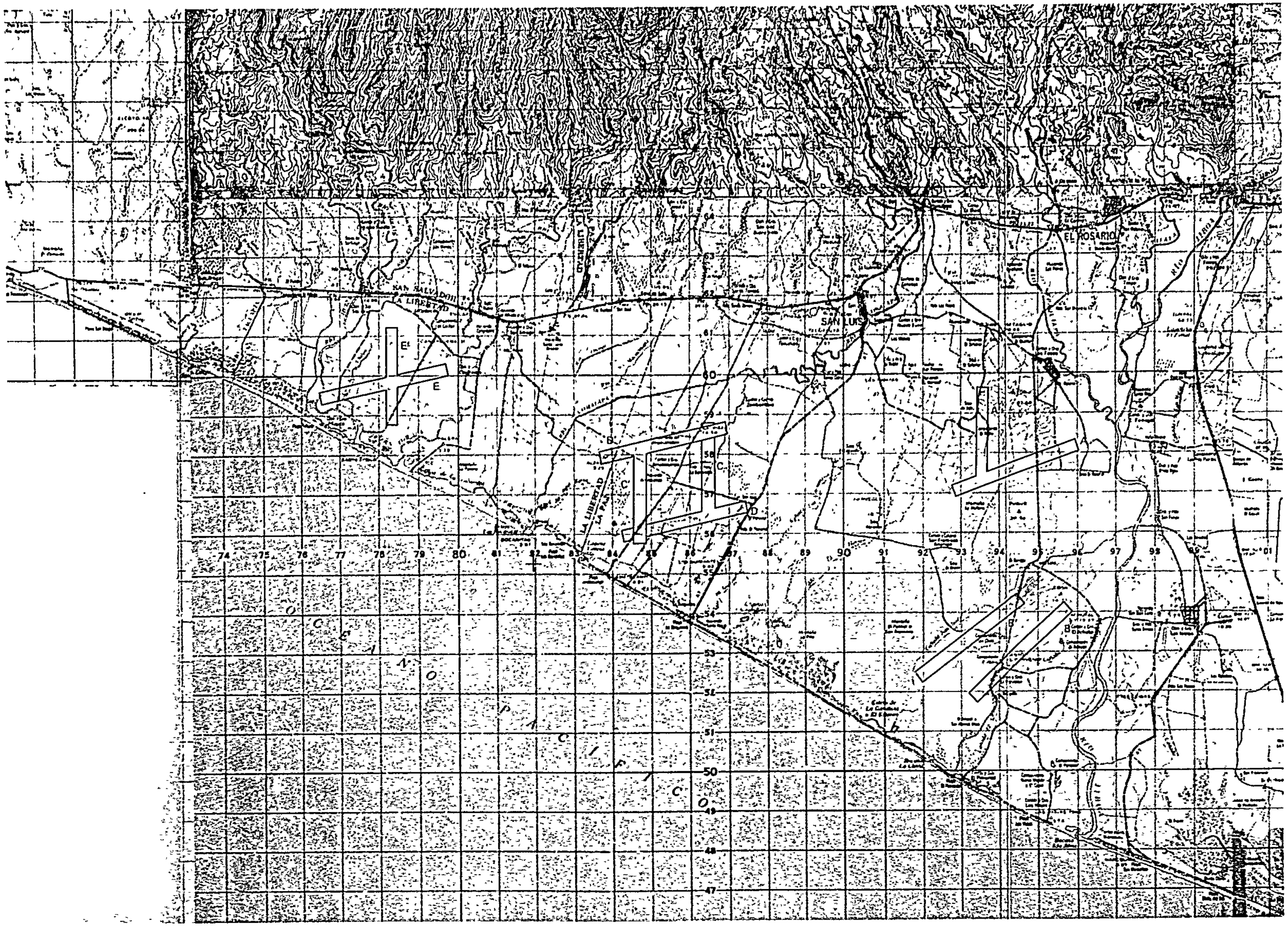


Fig. 7-3-2 Field Surveyed Possible Sites

7.3.2 Selection by Field Survey

(i) Selection of Candidate Sites

As a result of the field surveys the possible sites are determined with the runways as follows: (Fig. 7-3-2)

Site (A) maintains its main runway and the cross-wind runway is added... A + A'

Site (B) having a small village within its area, moves its B' runway to about 1 km to the north of the village... B → B'

Sites (C) and (D) are to be combined, to result in the (D + C) runways. and the (D' + C') runways... D + C and D' + C'

Site (E) is additionally established closer to Liberta Town... E + E'

(ii) Determination of Orientation of Runway by Wind Direction Distribution Chart

The Orientation of main runway should be so selected as to have at least 95% wind coverage in accordance with ICAO Recommendations. According to the data obtained at Santa Cruz Porrillo the orientation should be 025° - 205° to secure 95% wind coverage with a wind velocity of 13 knots, and according to the data obtained at Astoria it should be 045° - 225°, inclined more to the east-west direction.

Both at desk selection and field surveys the candidate sites of A, D, D', and E were to have coss-wind runways of A', C, C', and E' respectively, as a result of the rough examination as above.

7.4 Geological and Topographical Study of the Possible Sites

(1) General

The area surveyed was the so-called La Paz coastal plain extending between the rivers Rio Huiza and Rio Jiboa. Topographically, the plain presents a number of alluvial fans formed from the detrital deposits of such waterways as the

Rio Jiboa and the Rio Comalapa. The overall terrain slopes down toward the south, and the Pacific coastline is composed of sand dunes backed by marshes in the hinterland. As no particular watercontrol work has been undertaken on the rivers in the area, flooding appears to occur after heavy rains, a hypothesis that can be inferred from a comparison of topographic maps from different years as well as from aerial photographs. Additional support for this hypothesis was uncovered along a belt of the northeastern sector of the surveyed area where overturned rocks of 20 cm - 50 cm in diameter lay exposed on the earth's surface, attesting to recent flooding.

The characteristic soil within the area is, near the surface, a thick layer of such alluvial deposits as gravel, sand, and clay, which are spread by flooding and become finer in grain, generally speaking, the lower the terrain.
The source of the detritus deposited by the rivers is the relatively new andesite, tuffacious breccia, tuff, terrace gravel, volcanic ash, etc. which are found throughout the hills and mountains to the north (Fig. 7-4-1). Although the ground surface layer (within 3 m of the surface) presents variations caused by flooding, in general terms sandy soil characterizes the region around the Rio Jiboa and the Rio Comalapa, and this turns to clayey soil as one approaches the coast and to soft earth in the hinterland of the sand dunes.

(2) Topographic Features (Table 7-4-1)

Table 7-4-1 Topographic Features of the Possible Sites

Sites / Subjects	ASTORIA A + A'	EL PORVENIR B, B'	EL CARRIZAL C + D	SAN JUAN C' + D'	CANGREJERA E + E'
Topographic Features	Flood Plain	Flood Plain	Flood Plain	Formerly Flood Plain	Plain
Undulation	Easy-grade slope with little undulation.	Very easy-grade slope with slight undulations in places	Very easy-grade slope.	Flat	Flat
Elevation	18m(West) - 28m(East)	6.5m(W) - 18m(E)	8.0m(W) - 14.5m(E)	2.5m(W) - 8.0m(E)	5.0m(W) - 12.5m(E)
Present land usage	Cotton fields Pasture Waste land	Cotton fields Waste land (B') Dwelling area (B)	Cotton fields Pasture Dwelling area	Cotton fields Waste land Air field	Cotton fields
Roads, Rivers, Irrigation or Drainage Canals, etc.	,Road crossing *A small canal crossing (unsupported, 3-5m width, 1-2m depth) *Maximum height of trees in waste land is 20 m.	*50-70 houses in dwelling area(B), some made of blocks. *The height of virgin forest is less than 20 m. *Both B and B' are former rivers or ruins of flooded RIO JIBOA	*Road crossing *Irrigation and drainage canals crossing. (4m width, 1 - 2m depth) *Ruins of flooded RIO COMALAPA. *15 - 20 houses.	*Road crossing *About 20 houses *Formerly river channel.	*Ruins of river channel

(3) Geological Features (Table 7-4-2)

Table 7-4-2 Geological Features of the Possible Sites

Sites / Subjects	ASTORIA A + A'	EL PORVENIR B, B'	EL CARRIZAL C + D	SAN JUAN C' + D'	CANGREJERA E + E'
Surface soil types (0-3m depth)	*Almost sand. *Large stones laied in some places. *Partly sandy clay.	*Sand or silt	*Almost clayey, partly sanded.	*Tuffacious clay and silt.	*Sandy clay
Geological distribution	*Sandy soil lays in the depth of 0.2-0.5m, and under it is sand seam.	*Sand and silt seam mutually.	Cohesive soil (1.0-1.5m depth)	Cohesive soil (1.0-2.0m depth)	*Almost sandy clay.
Soil types (more 3 m depth)	Midium - coarse sand and silt.	Uncertain	*Sandy silt	*Silt or sandy silt and sand seam.	Uncertain
Geological Characteristics	*Sedimentary soil of the flooded area of the RIO JIBOA, RIO SEPA QUIAPA is composed of sand seam and sandy clay and their grain size are irregular. *Pervious	*Sedimentary soil of the flooded area of the RIO JIBOA, the grain size are irrégular. *Pervious	*Cohesive soil with mixture of sand, pervious is comperatively good.	*Clay with high degree of sensitivity. *Poor trafficability *Impervious.	*Poor trafficability. *Impervious.
Ground water table, etc.	*Ground water table ; GL-1.0 m - 2.0m	*Ground water table ; GL-2.0 m more or less	*Ground water table ; GL-1.5 m - 3.0 m *Ground water appeares to be flowing in the RIO COMALAPA flooded area.	*Ground water table ; GL-1.0 m - 1.5 m *Generally the water level is high due to the surrounding elevation being low and close to the swampy area.	*Ground water table ; GL-1.0 m more or less

(4) Soil Mechanics Features (Table 7-4-3)

Table 7-4-3 Soil Mechanics Features of the Possible Sites

Sites / Subjects	ASTORIA	EL PORVENIR	El Carrizal	SAN JUAN	CANGREJERA
	A + A'	B, B'	C + D	C' + D'	E + E'
The items of Investigations and Laboratory tests.	•Percussion boring (20 meters depth) •Test pit+Auger boring (3-points, 3 m depth) •Physical tests 17 pcs. •Compaction tests 8 pcs •Laboratory CBR tests 8 pcs.	•Investigation at sites.	•Boring (Depth 19m) •Test pit+Auger boring(3-points, 3 meters depth) •Physical tests 18 pcs. •Compaction tests 6 pcs. •Laboratory CBR tests 6 pcs.	•Boring(Depth 20 m) •Test pit+Auger boring (3-points, 3 m depth) •Physical tests 18 pcs. •Compaction tests 5 pcs. •Laboratory CBR tests 5 pcs.	•Investigation at site.
Conclusions of Main investigation	•Class of Soil;ML,SM •Moisture content ML 34 - 63% SM 9 - 56% •Liquid limit 17.6-33% •Specific gravity 2.52-2.62 •CBR 8 - 29% •N-value 0-7 m depth : 10 ± 7-10 m depth: 20 - 30	——	•Class of Soil.ML,SM •Moisture content ML 27 - 63% SM 15 - 49% •Liquid limit 20-44% •Plastic limit 31-36% •Specific gravity 2.36-2.56 •CBR 13-34% •N-value 0 - 5 m depth: 0-10 5 - 19m depth: 10-38	•Class of Soil, ML,SM •Moisture content ML 39 - 203% SM 33 - 59% •Liquid limit 39-49% •Plastic limit 34-38% •Specific gravity 2.25 - 2.38 •CBR 4.4 - 22.5% •N-value 0 - 4m depth:0-10, 10-20 m: 20-45 4 - 10m depth: 10-20	——
Geological Problems	•Soil judged from boring tests is almost silty sand till 20 m depth, and N valves are less than 30. •Pile foundation needs 10-12 m long friction piles for structure and more than 20 m long piles for special structures.	•Geological condition is notas good as Astoria.	•The layer with enough bearing strength for pile foundation is more than 15 m deep.	•The layer with enough bearing strength for pile foundation is more than 14 m deep	•Foundation condition is better than that of SAN JUAN.

Note. 1) The items of Physical tests: Moisture content, Liquid limit, Plastic limit, Grading analysis.
2) ML, SM: Class of soil in the method of Unified Soil Classification; ML are *inorganic silt and very fine grainded sand*, fine grainded rock, poor plastic silty sand, or clayey sand, SM are silty sand, poor graded sand and silts mixture.

(5) Evaluation

Comparing the various sites in terms of topographic and geological features, several factors make Astoria stand out as the best alternative.

a. In topographic terms, the site is centrally situated to the plain at a relatively high elevation, and variation in the relief is at a minimum.

b. The area which would be affected by flooding is small; the slope of the terrain is steeper than elsewhere; past flooding has slightly raised the elevation of the site.

c. The runway bed layer, that is, the surface soil, is more suitable to paving than at the other sites. The existing foundation is adequate for the bed of a runway.

d. Such water engineering conditions as surface water drainage and ground water circulation are favorable.

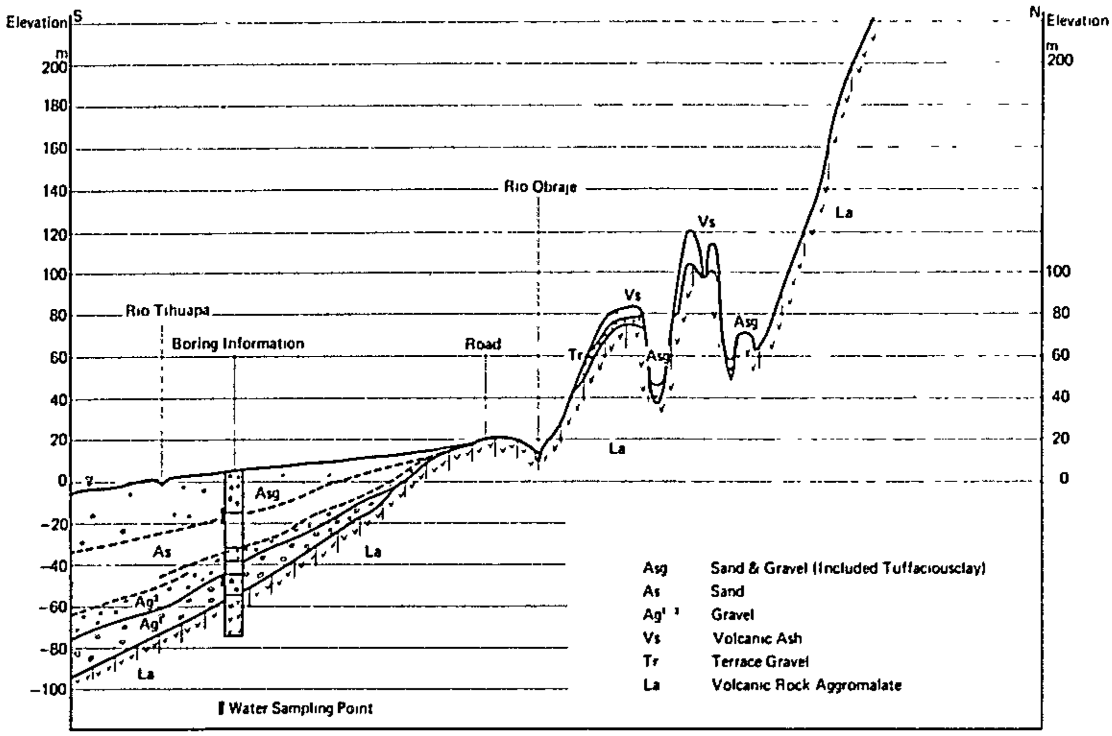


Fig. 7-4-1 Geological Cross-Section of Surveyed Area

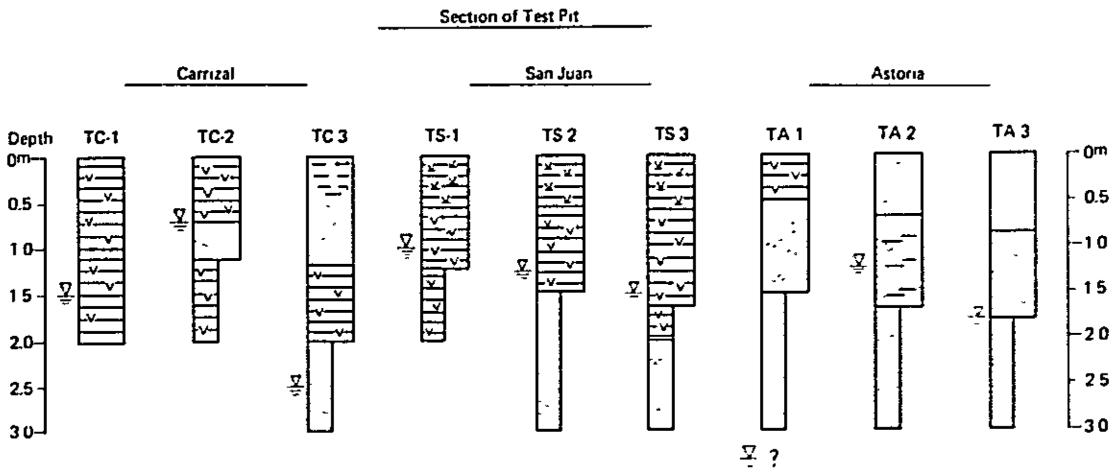


Fig. 7-4-2 Column Section of Test Pit

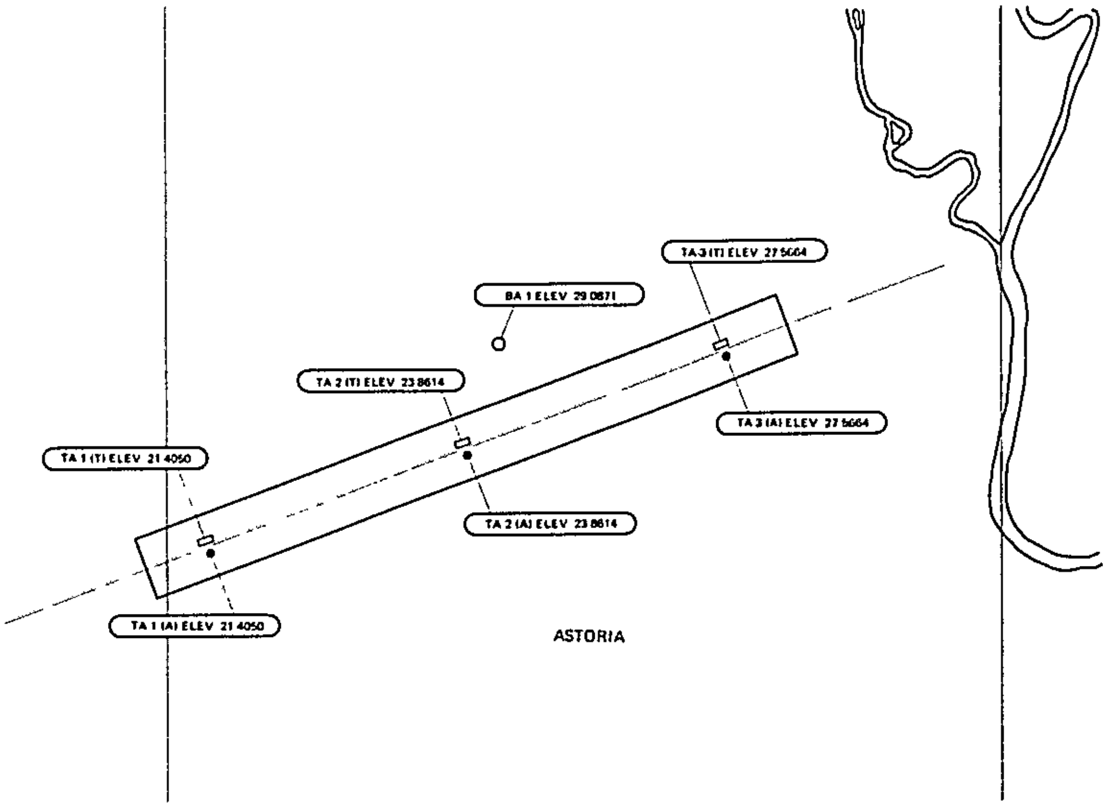


Fig. 7-4-3 Soil Test Locations (Astoria)

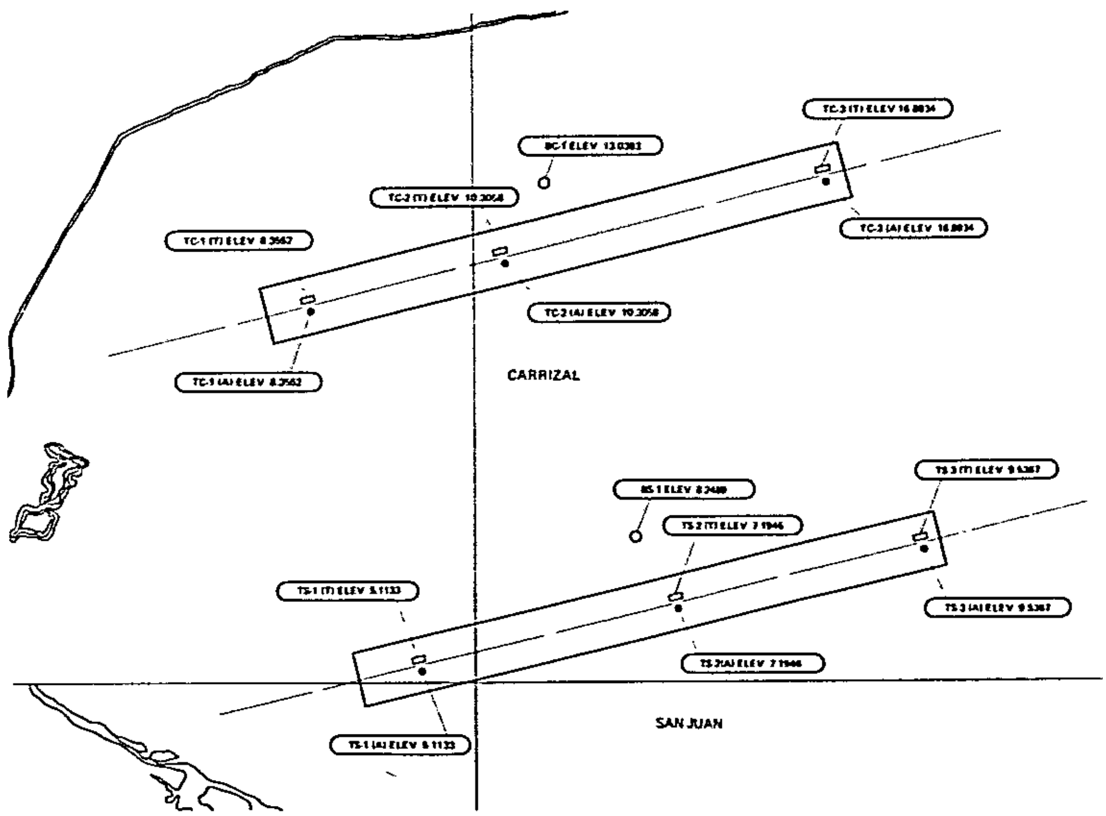


Fig. 7-4-4 Soil Test Locations (San Juan)

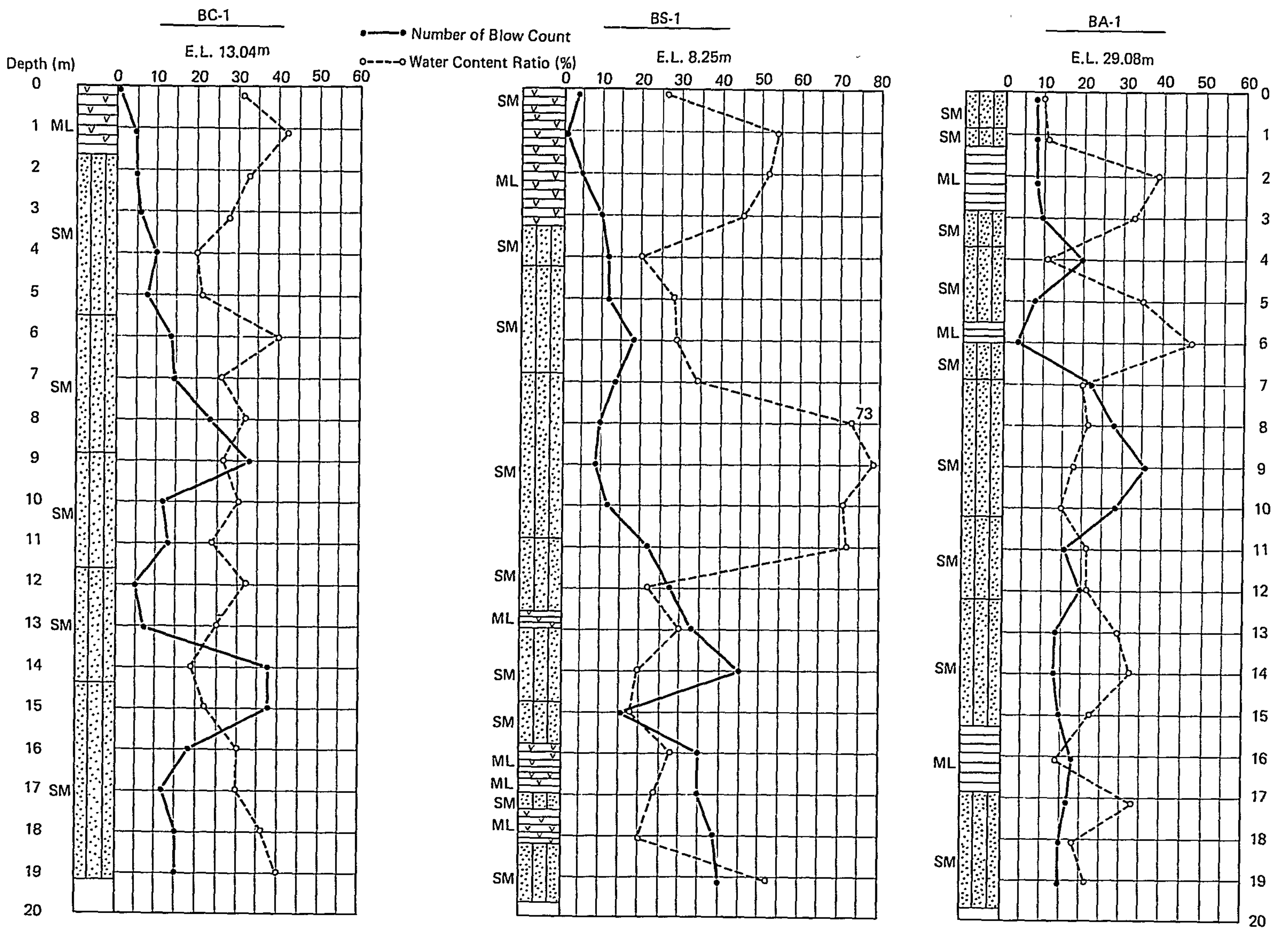


Fig. 7-4-5 Boring Results

7.5.1 Operational Requirements

(1) Runway usability of new airport should be more than 95%

(2) Airspace serving the airport should be large enough for safe jet operation such as B747s.

(3) Orientation of main runway should meet the direction of flight of small airstrips in the vicinity of new airport to the extent possible.

7.5.2 Basic Data

(1) Major Obstacle

a. Cerro Taburete...........1,110m
b. Volcan de Usulutan.......1,450m
c. Volcan de Tecapa.........1,594m
d. Cerro el Tigre...........1,550m

(2) Desirable Runway Orientations

a. N-S direction is desirable judging from wind rose at Astoria and the orientations of airstrips in the plain.

b. Limit of runway orientation which gives wind coverage of more than 95% is 055-235 deg.. Any clockwise change reduces the wind coverage.

c. Limit of runway orientation which gives wind coverage of more than 90% is 080-260 deg.. Any clockwise change reduces the wind coverage.

7.5.3 Suitable Area for Airport Site

(1) There is no suitable area where enable south landing ILS approach procedure for N-S oriented runway.

(2) Airport site area where enable south landing ILS approach procedure for main runway with wind coverage of more than 95% is limited in the vicinity of El Porvenir.

(3) Airport site area where enable south landing ILS approach procedure for main runway with wind coverage of more than 90% extends eastwards from Cangrejera.

7.5.4 Five Airport Sites for Evaluation

After field investigations, we selected following five airport sites.

a. Astoria.....Main runway; 070-250 deg./cross wind runway. 360-180 deg.

b. El Porvenir.Main runways; 045-225 deg. and 055-235 deg.

c. San Juan....Main runway; 076-256 deg./cross wind runway; 005-185 deg.

d. Carrizal....Main runway; 076-256 deg./cross wind runway; 005-185 deg.

e. Cangrejera..Main runway; 080-260 deg./cross wind runway; 360-180 deg.

7.5.5 Evaluation of Each Site

(i) Astoria

(1) Main runway (A)...070-250 deg.

a. ILS approach

ILS approach procedures are available for either direction of runway.

b. VOR approach

Straight-in approach procedures are available for either direction of runway

c. Take-off

There is enough airspace for either direction of runway.

(2) Cross-wind runway (A')...360-180 deg.

a. ILS approach

South landing from north ILS approach procedure can not be established due to terrain obstructions.

Decision height of north landing ILS approach may be higher than minimum of

CAT I due to terrain obstructions in missed approach area.

b. VOR approach
Straight-in approach procedure can not be established for south landing from north due to terrain obstructions.

c. Take-off
Limited instrument departure procedures are necessary for north take-off due to terrain obstructions.

(ii) El Porvenir

(1) Main runway (B)...045-225 deg.

a. ILS approach
ILS approach procedures are available for either direction of runway.
Outer marker can not be placed on land for north landing ILS approach because runway is very close to coast line: DME on ILS is needed.

b. VOR approach
Straight-in approach procedure can not be established for south landing due to terrain obstructions.

c. Take-off
There is enough airspace for either direction of runway.

(2) Main runway (B')...055-256 deg.

a. ILS approach
ILS approach procedures are available for either direction of runway. Outer marker can not be placed on land for north landing ILS approach because runway is very close to coast line: DME on ILS is needed.

b. VOR approach
Straight-in approach procedure can not be established for south landing due to terrain obstructions.

c. Take-off
There is enough airspace for either direction of runway

(iii) San Juan

(1) Main runway (D)...076-256 deg.

a. ILS approach
ILS approach procedures are available for either direction of runway

b. VOR approach
Straight-in approach procedures are available for either direction of runway.

c. Take-off
There is enough airspace for either direction of runway.

(2) Cross wind runway (C)...005-185 deg.

a. ILS approach
South landing from north ILS approach procedure can not be established due to terrain obstructions.

Decision height of north landing ILS approach may be higher than minimum of CAT I due to terrain obstructions in missed approach area, and outer marker can not be placed on land because runway is very close to coast line: DME on ILS is needed.

b. VOR approach
Straight-in approach procedure can not be established for south landing from north due to terrain obstructions.

c. Take-off
Limited instrument departure procedures are necessary for north take-off due to terrain obstructions.

(iv) El Carrizal

(1) Main runway (D)...076-256 deg.

a. ILS approach
ILS approach procedures are available for

either direction of runway.

b. VOR approach

Straight-in approach procedures are available for either direction of runway.

c. Take-off

There is enough airspace for either direction of runway.

(2) Cross wind runway (C')...005-185 deg.

a. ILS approach

South landing from north ILS approach procedure can not be established due to terrain obstructions.

Decision height of north landing ILS approach may be higher than minimum of CAT I due to terrain obstructions in missed approach area, and outer marker can not be placed on land because runway is very close to coast line: DME on ILS is needed.

b. VOR approach

Straight-in approach procedure can not be established for south landing from north due to terrain obstructions.

c. Take-off

Limited instrument departure procedures are necessary for north take-off due to terrain obstructions.

Note: Generally Speaking Carrizar is slightly inferior to Astoria.

(v) Cangrejera

(1) Main runway (E)...080-250 deg.

a. ILS approach

ILS approach procedures are available for either direction of runway, however, DME on ILS is needed for east landing ILS.

b. VOR approach

Straight-in approach procedure can not be established for west landing due to terrain obstructions.

c. Take-off

There is enough airspace for either direction of runway.

(2) Cross wind runway (E')...360-180 deg.

a. ILS approach

ILS approach procedure can not be established for south landing due to terrain obstructions.

Decision height of north landing ILS approach may be higher than minimum of CAT I due to terrain obstructions in missed approach area and DME on ILS is needed.

b. VOR approach

Straight-in approach procedure cannot be established for south landing due to terrain obstructions.

c. Take-off

Limited instrument departure procedures are necessary for north take-off.

7.5.6 Comparative Evaluation of Sites

	Astoria	El Porvenir	Carrizal	San Juan	Cangrejera
Main Runway	4	3	4	5	3
Cross Wind Runway	4	(5)*	4	4	4
Wind Coverage (Main Runway)	4	5	3	3	2
Total Points	12	13	11	12	9
As Translated into Evaluation Symbols of Table 7-13-1	5	5	4	5	3

Note: *...Both runway B and runway B' being self sufficient do not require a cross-wind runway. However, since this fact constitutes a significant merit, it has been translated in terms of comparable numerical symbol.

7.6 Meteorological Conditions

(1) The meteorological data available from sources around the surveyed area include:

a. Las Flores (Astoria)--wind direction and velocity (6/70 - 6/72)

b. Rosario de La Paz--rainfall ('67 - 6/72)

c. La Herradura--rainfall ('67 - 6/72)

d. Santa Cruz Porrillo--temperature; no. of clear days; humidity; no. of rainy days; rainfall

(2) Below is a summary of the meteorological conditions for the surveyed area.

a. Temperature: The temperature over the period where data was available reached a low of 17.6°C in January of 1972, a high of 37.2°C in January of 1968, and showed a monthly average from 1967 to 1972 of 25.1°C (February, 1968) to 28.8°C (April, 1970). The months from January through April show striking temperature variation while in other months the temperature is fairly constant.

b. Clear days: There are not many clear days. The average annual number of days with a cloud amount under 2/10 is from 6 to 16, and most of these days come in the dry season from November through March.

c. Humidity: The average annual humidity falls between 70% - 75% and the most humid months, with humidity around 80%, come in the rainy season from June through October.

d. Rainy days: The average annual number of days when rain falls is between 100 - 130, comprising about 1/3 of the days in the year. From May through October rain falls on more than half of the days of each month.

e. Rainfall: The annual rainfall is 1,163 mm - 2,110 mm. The greatest rainfall recorded in a single month was 750 mm at La Herradura in September of 1971. The months from May through October all register more than 100 mm rainfall and in many months the amount comes to around 300 mm.

(3) Wind coverage

The wind rose introduced as Fig.7-6-1 was prepared from observations spanning two years from June, 1970 to June, 1972. This figure shows that the prevailing heavy winds, those over a velocity of 20 knots, come from the north and northeast, and that the prevailing wind under 20 knots is a southerly wind, although the predominance of such a southerly wind is not striking.

Table 7-6-1 introduces wind coverage data compiled on a monthly and annual basis for each proposed runway alignment under cross winds of 10, 13, and 20 knots. All the runway alignments show better than 98% coverage for almost all months with a maximum permissible cross-wind component of 20 knots. With a permissible cross wind of 13 knots coverage falls below 80% in some cases in the first quater of the year for alignments of N70°E and N76°E, and with a permissible cross wind of 10% alignments of N56°E, N70°E, and N76°E all show several months between December and May with coverage under 80%. This means that in order to meet the ICAO regulation concerning light aircraft, which stipulates runway usability better than 95% at a maximum permissible cross-wind component of 10 knots, an attached runway close to north-south in alignment will be a necessary addition if the main runway is aligned close to east-west.

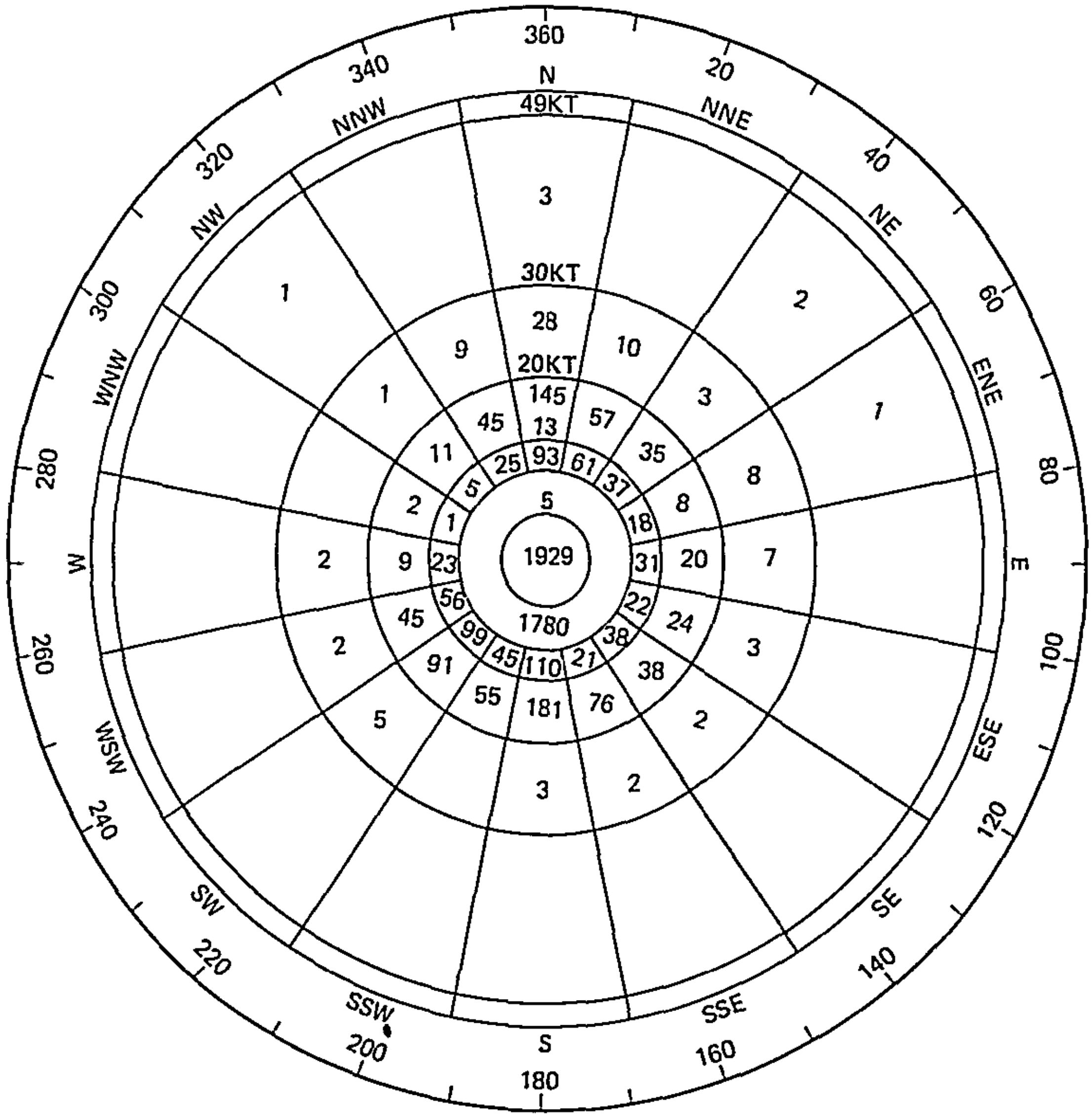


Fig. 7-6-1 Wind Rose Based on Meteorological Data of June 1970 - June 1972

Table 7-6-1 Monthly Wind Coverage

R/W Alignment		Cross Wind Component (Knots)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Average
A' C	N0E	10	94.32	93.79	92.45	90.30	88.66	88.83	90.81	91.83	91.46	92.07	94.42	95.06	91.90
		13	98.30	98.21	97.46	95.24	94.45	94.28	95.35	95.71	95.86	96.81	98.00	97.54	96.55
		20	99.83	100	99.76	99.42	99.04	98.60	99.28	99.21	99.17	99.55	100	99.78	99.54
B	N45E	10	89.68	79.35	81.53	84.66	84.05	93.74	88.87	91.13	91.02	93.59	88.76	84.36	87.45
		13	95.63	88.44	92.29	90.84	91.64	99.69	95.17	95.31	95.23	96.78	94.56	92.06	94.01
		20	99.83	98.13	99.71	98.74	99.42	99.66	99.57	99.21	99.76	99.84	99.64	99.32	99.49
B'	N56E	10	85.53	73.54	74.93	81.87	81.00	93.54	88.09	90.87	90.88	93.08	86.21	78.80	84.33
		13	92.61	83.01	84.81	87.98	89.48	96.89	94.42	95.33	95.13	96.68	92.46	88.56	91.52
		20	99.79	97.28	99.48	98.13	99.34	99.84	99.58	99.59	99.86	99.87	99.42	86.76	99.32
A	N70E	10	79.88	68.91	71.10	79.08	79.74	92.73	87.29	89.75	89.94	92.68	82.46	75.77	82.42
		13	89.79	78.89	79.46	85.45	80.86	96.76	93.31	94.88	95.24	96.91	90.62	85.62	89.66
		20	99.66	95.53	98.81	99.40	99.78	99.91	99.61	99.34	99.97	99.79	99.24	98.67	99.00
D D' E	N76E	10	78.40	67.24	69.86	78.15	86.35	92.30	88.39	89.55	90.12	92.52	80.96	71.15	81.52
		13	88.37	76.13	76.96	84.06	87.65	96.62	92.84	94.81	95.24	97.18	89.69	84.26	88.77
		20	99.67	95.62	98.84	97.40	99.81	99.52	99.64	99.26	99.98	99.79	99.14	98.70	99.01

Observation Period : June 1970 - June 1972 (two years)
Observation Time : 00:00 03:00 06:00 09:00 12:00 15:00 18:00 21:00 hours
Location : ASTORIA, EL SALVADOR
Total Number of Observations: 5,328 times
Non-Observation Rate : 8.9% (520 times)

10 Knots = 5.14 m/s
13 Knots = 6.68 m/s
20 Knots =10.28 m/s

7.7 Airport Ground Access Considerations

Road distance from San Salvador to the various possible sites via La Libertad and Comalapa are shown. in Table 7-12-1, but in general terms all sites lie within 40 km of the capital San Salvador and no site is clearly in an unfavorable position in terms of transportation time. If a choice has to be made, probably the greatest difference among the sites would be in the length of the access road necessary to link the airport to existing state roadways, and in this respect Cangrejera is in the best location, El Porvenir, requiring road longer than 10 km, is in the worst, and the others fall in between with road lengths within 4-6 km.

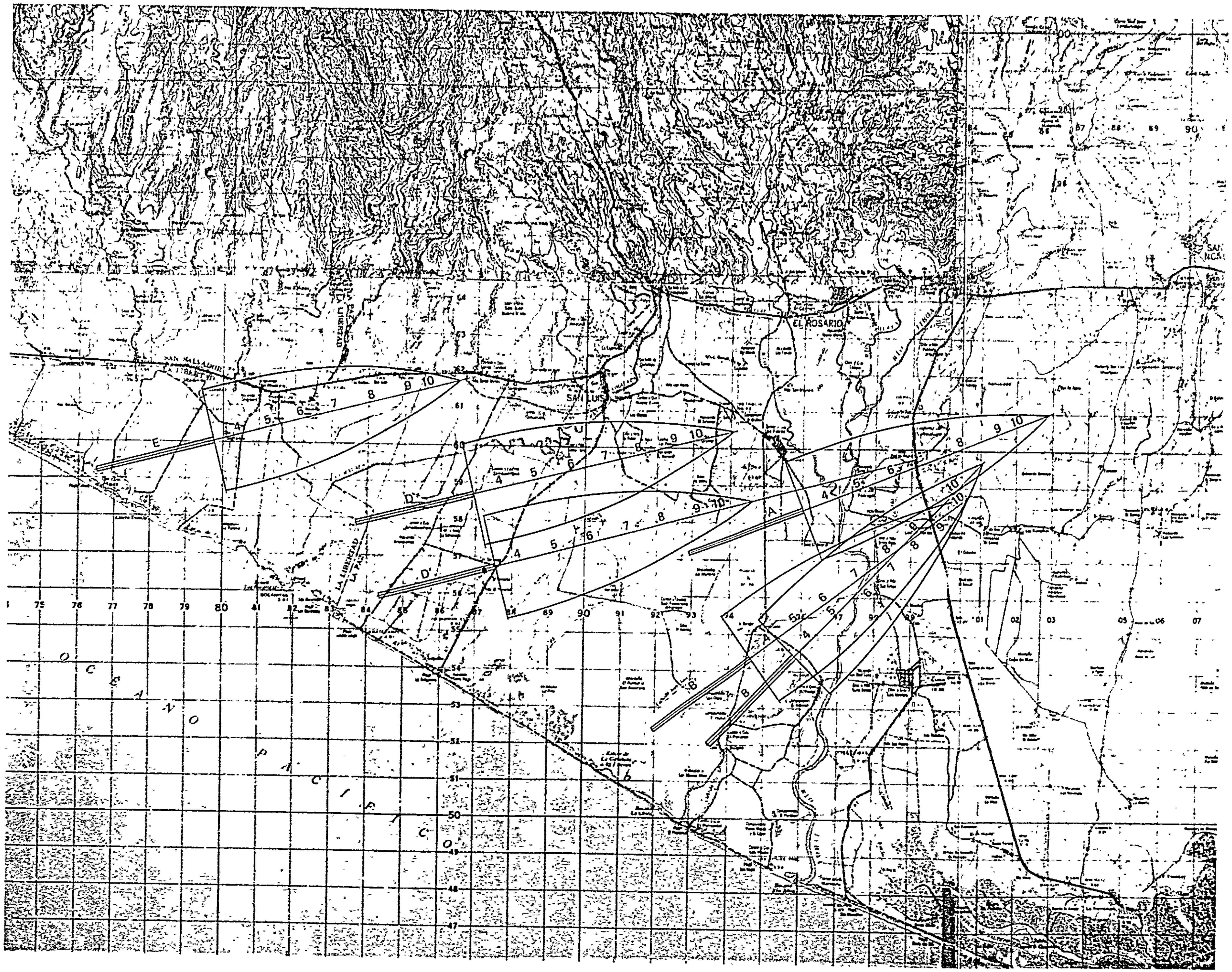


Fig. 7-7-1 B-747 Standard Noise Contour—80 dB (A)

7.8.1 Construction Conditions at Each Site

Table 7-8-1 List of Construction Conditions

Sites / Items	Astoria A+A'	El Porvenir B,B'	El Carrizal C+D	San Juan C'+D'	Cangrejera E + E'
Land Procurement and Compensation	pasture and cotton field	dwelling area and cotton field	dwelling area and cotton field	airfield and cotton field	cotten field
Earth Works	little work on stripping	little work on stripping	large amount of top soil stripping	large amount of top soil stripping	large amount of top soil stripping
Drainage Construction (Slope and Co-efficient of Flow)	easily planned	easily planned	little difficult	difficult	difficult
Pavement Construction (subgrade CBR)	18 - 23.5%	-	14.7 - 23.0%	18.4 - 22.0%	-
Structure Foundation (depth of layer)	10 - 12m or less than 20m	-	15m	14m	-
Transportation of Materials (distance from N.R.)	6km	10km	4km	5km	2km
Influence of Construction	village 2km N.E.	ground water pollution	ground water pollution	ground water pollution	-
Others	restriction to use of the northside airport		restriction to the use of surrounding airfield	restriction to the use of surrounding airfield	

7.8.2 Evaluation

There are no significant differences in physical condition from the viewpoint of construction that would weigh heavily for or against any of the sites. The relative scale of construction necessary at each site (such as for earth moving) was not computed, so that quantitative comparison is not possible, but several comments follow from a consideration of such important components of the construction cost as soft earth treatment, the possibility of diverting unearthed dirt for use elsewhere, the required pavement thickness, etc. In short, Astoria site, with its firm surface soil (CBR value 18.0% - 23.5%), and El Carrizal site, with its fairly hard surface soil (CBR value 14.7% - 23.0%), stand out as favorable sites in terms of the earth. In terms of water engineering for surface and subsurface water Astoria is again a superior site, for the tilt of the terrain can be used to advantage in planning for water drainage which can handle the voluminous runoff after heavy rainfall in the rainy season.

7.9 Aircraft Noise Considerations

The sites were compared in terms of distribution of homes which would fall within a B-747 standard noise contour of 80dB(A), and the result, in order of descending disturbance, was Cangrejera, El Carrizal, Astoria, El Porvenir B, El Provenir B', and San Juan. As the prevalent construction material for homes is wood, which has little sound-proofing efficacy, relocation and other such countermeasures would have to be adopted to minimize the noise disturbance.

Note: The B-747 standard noise contour was computed for takeoff with a 0 - 2,500 nm range. The selection of the 80dB(A) contour as an index for noise disturbance was an arbitrary choice, but for several reasons this countour seems preferable to a 70dB(A) contour or some other decibel level as an appropriate index. Not only is 80dB a good indicator for the threshold when noise becomes annoying and an appropriate choice in view of the projected frequency of takeoffs, but also the 70dB(A) contour would include practically all of the surveyed area--up to 24 km from the runway end--and thus would have little value for comparative analysis.

7.10 Regional Development Planning Factor

El Salvador Government has yet to finalize any specific policy for guiding the course of regional development within the surveyed area, but in view of the features of the area the most obvious direction would be toward seaside tourism development taking advantage of the proximity to the ocean. In this case, among the first choices for development along the coastline from La Libertad to El Porvenir area would be the regions of Amatecampo, Las Hojas, San Marcelino due to the relative absence of marshes in their hinterland. The airport sites closest to these possible development regions and hence most favorably situated in terms of future regional development are San Juan, El Carrizal, and El Porvenir. In the event of a larger scale of regional development, however, more proximity to the coast would not be an outstanding advantage, while the distribution of marshes in the airport vicinity and other factors with a bearing on water control engineering would become more important. In this sense, although the development policy adopted will influence the outcome, the availability of surplus land in the vicinity and the excellence of soil and water conditions make, once again Astoria another suitable site in respect to regional development.

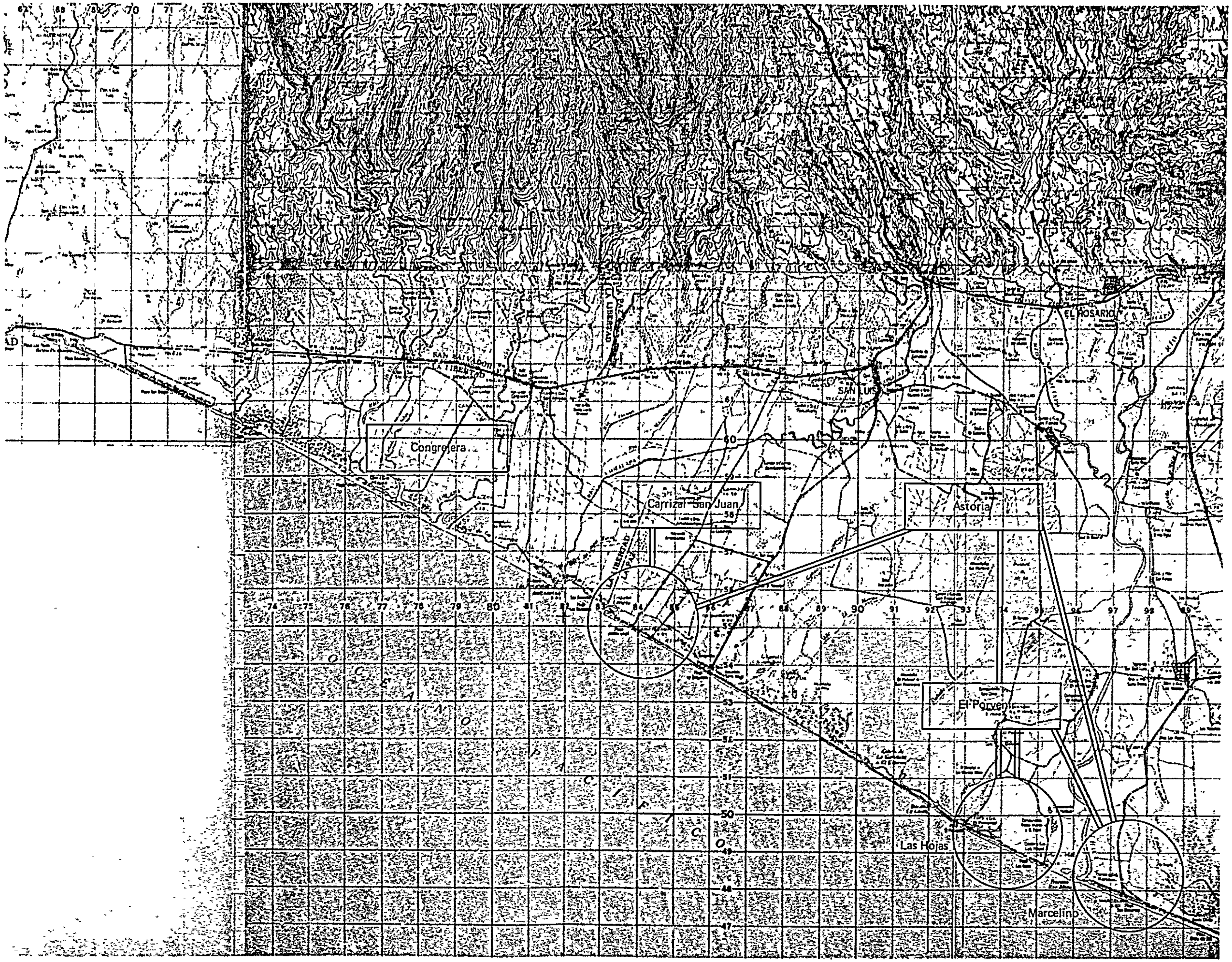


Fig. 7-10-1 Distances from the Pacific Coast of the Possible Regional Development Area

7.11 Aerial Survey

With the cooperation of the Salvadorian Civil Aviation Bureau three VFR flights by Twin-engine Beech and Twin-engine Piper were made to examine the candidate sites and their surrounding areas, with the findings summarized as follows:

Summary of the Aerial Survey Findings

(1) Cerro Rosario seemes to be obstructive for low visibility flight.

(2) Volcan de San Vicente would be mental obstruction for take-off direct climb to north-east from site A.

(3) Cerro Tabulete and Volcan de San Vicente should be taken into sufficient consideration in establishing arrival route from east to site A.

(4) Take-off climb turn toward mountain area should be avoided.

(5) Instrument approach from north seems difficult.

(6) Montana el Palmer jungle area should not be included in airport construction area; considerable amount of extra expenditure seems to be necessary.

(7) Aircraft noise abatement procedures should be concidered for east take-off from site A.

(8) Approach course west to site E is excelent.

(9) Approach course from east to site A is excellent

(10) Approach course from west to site A is excellent

(11) Cerro Rosario is not an obstruction for take-off direct climb from site D to the east.

(12) No obstructive constructions in particular in the plain area of La Paz.

7.12 Features of the Possible Sites Surveyed

Table 7-12-1 below shows the features of the possible sites surveyed.

Table 7-12-1 Features of the Possible Sites Surveyed

Item / Sites		Location of the Sites: latitude	longitude	elevation	runway direction	topographical condition	direct route from Libertad	direct route from Comalapa	Present Land Usage	Topographical and Geological features: surface soil	Aircraft Operation	Wind Coverage: maximum crosswind component (knots)	%	(Distance from San Salvador) via La Libertad (Km.)	via Comalapa (Km.)	Construction Conditions: topographic features	geology	ground water level (meter)	existence of river channel drainage	e
A + A'	A	13°26'21"	89°03'05"	22	N 70° E	easy-grade slope	28.6	7.2	cotton field forest	sand, sandy clay	ILS/VOR straight-in approach available for both side	10 13 20	82.42 89.66 99.00	36	9	field A' gradient is steeper than A	sandy soil	-1.2	open channel	gr ci st re to
	A'				N S					large gravels on surface ground	No ILS/VOR straight-in approach available for North side	10 13 20	91.90 96.55 99.54					-3.50		
B	B	13°23'52"	89°02'02"	_9	N 45° E	very easy-grade slope	30.0	11.5	cotton field	sand, silt	ILS/VOR straight-in approach available for both side	10 13 20	87.45 94.01 99.49	40	12	relative height 12m	sand or silt	-	none	gr ci st re to
B'	B'	13°24'02"	89°03'42"	11	N 56° E	very easy-grade slope	28.6	11.0	cotton field forest	sedimentary soils of flooded area of Rio Jiboa the grain size irregular	ILS/VOR straight-in approach available for both side	10 13 20	84.33 91.52 99.32	39	13	field relative height 10m	sand or silt	-	none	sa
C'+ D'	C'	13°26'39"	89°08'07"	12	N S	very easy-grade slope	19.6	8.8	cotton field pasture	cohesive soil, sandy silt	No ILS/VOR straight-in approach available for North side	10 13 20	91.90 96.55 99.54	23	10	relative height 4-5m	sandy silt	-0.5	open channel	to su su re 1.(so
	D'				N 76° E						ILS/VOR straight-in approach available for both side	10 13 20	81.52 88.77 99.01					-2.5		
C + D	C	13°25'35"	89°07'48"	5	N S	very easy-grade slope	20.8	9.8	cotton field	tuffacious clay and silt	No ILS/VOR straight-in approach available for North side	10 13 20	91.90 96.55 99.54	25	12	field relative height 6-7m	tuffacious clay and silt	-1.0	former river channel	to su su re of im
	D				N 76° E						ILS/VOR straight-in approach available for both side	10 13 20	81.52 88.77 99.01					-2.5		
E +E'	E	13°27'35"	89°10'03"	12	N 76° E	flat	13.0	13.5	cotton field	sandy clay soft ground	ILS/VOR straight-in approach available for both side	10 13 20	81.52 88.77 99.01	15	16	relative height 6-7m	sandy clay	-	river	to su so ne
	E'				N S						No ILS/VOR straight-in approach available for North side	10 13 20	91.90 96.55 99.54							

Table 7-12-1 Features of the Possible Sites Surveyed

Present Land Usage	Topographical and Geological features	Aircraft Operation	Wind Coverage		(Distance from San Salvador)		Construction Conditions						Regional Development	Remarks
	surface soil		maximum crosswind component		via La Libertad	via Comalapa	topographic features	geology	ground water level	existence of river channel drainage	earth works	houses within 80dB (A) noise contour of B-747	distance to the possible nearby regional development area	
			knots	%	Km.	Km.			meter					
cotton field forest	sand, sandy clay large gravels on surface ground	ILS/VOR straight-in approach available for both side No ILS/VOR straight-in approach available for North side	10 13 20 10 13 20	82.42 89.66 99.00 91.90 96.55 99.54	36	9	field A' gradient is steeper than A	sandy soil	-1.2 -3.50	open channel	ground has sufficient bearing strength remove 10-15cm of top soil	some houses	to Amate-campo about 7.5km to Las Hojas about 8 km to San Marcelino about 9.5km	none
cotton field	sand, silt	ILS/VOR straight-in approach available for both side	10 13 20	87.45 94.01 99.49	40	12	relative height 12m	sand or silt	-	none	ground has sufficient bearing strength remove 20-50cm of top soil	a few houses	to Las Hojas about 2.5km to San Marcelino about 4.5km	none
cotton field forest	sedimentary soils of flooded area of Rio Jiboa the grain size irregular	ILS/VOR straight-in approach available for both side	10 13 20	84.33 91.52 99.32	39	13	field relative height 10m	sand or silt	-	none	same as above	a few houses	to Las Hojas about 2.5km to San Marcelino about 4.5km	none
cotton field pasture	cohesive soil, sandy silt	No ILS/VOR straight-in approach available for North side ILS/VOR straight-in approach available for both side	10 13 20 10 13 20	91.90 96.55 99.54 81.52 88.77 99.01	23	10	relative height 4-5m	sandy silt	-0.5 -2.5	open channel	top soil is not suitable for subgrade remove about 1.0m of top soil	some houses	to Amate-campo about 2.5km	none
cotton field	tuffacious clay and silt	No ILS/VOR straight-in approach available for North side ILS/VOR straight-in approach available for both side	10 13 20 10 13 20	91.90 96.55 99.54 81.52 88.77 99.01	25	12	field relative height 6-7m	tuffacious clay and silt	-1.0 -2.5	former river channel	top soil is not suitable for subgrade remove 1.0m-1.5m of top soil or soil improvement	a few houses	to Amate-campo about 2.5km	none
cotton field	sandy clay soft ground	ILS/VOR straight-in approach available for both side No ILS/VOR straight-in approach available for North side	10 13 20 10 13 20	81.52 88.77 99.01 91.90 96.55 99.54	15	16	relative height 6-7m	sandy clay	-	river	top soil is not suitable soil improvement necessary	village	no possible development plan	none

7.13 Overall Evaluation of Possible Sites

Table 7-13-1 below shows comparative evaluation of all possible sites surveyed, expressed in terms of the numerals 1 to 5, with increasing desirability as the number increases, i.e., 1 denoting "poor", 2 "fair", 3 "good", 4 "very good", and 5 "excellent". In the study of this report, we made no weighting of each evaluation criteria and recommend that a further detailed site selection study be made before the engineering design according to the method, for example, recently developed and published by Louisville and Jefferson County Air Board under the title of "An Innovative Process with a Multi Interest Team of Experts and Citizens."

Within the scope of this report, however, we have narrowed the 5 possible sites surveyed down to 3, i.e., Astoria, EL CARRIZAL, and San Juan, as the proposed sites for the new international airport.

Table 7-13-1 Overall Evaluation of Possible Sites

	Sites / Evaluation Criteria	ASTORIA A + A'	EL PORVENIR B, B'	EL CARRIZAL C'+ D'	SAN JUAN C + D	CANGREJERA E + E'
1.	Operational Evaluation	5	5	4	5	3
2.	Meteorological Conditions	5	2	4	4	1
3.	Topographical & Geological Conditions	5	2	4	3	1
4.	Construction Suitability	5	3	4	3	2
5.	Aircraft Noise Considerations	3	4	2	5	1
6.	Accessibility & Surface Transportation	3	1	4	3	5
7.	Conditions relating to Regional Development	5	4	3	3	2
	Overall Evaluation	31	21	25	26	15

8. Layout Plan

8. Layout Plan

8.1 Method of Layout Planning

After determining the scope of necessary facilities, their capacities and the runway orientations, as well as examination of air space navigation, the stage is set for the layout of the entire airport. In our task of determining the plan for airport layout, we must take into account various factors with their mutual relations to one another in order to enhance the total efficiency of the site. We must refrain from making easy, one-dimensional decisions. Such a consideration forced us to go through the following processes of examination to come to the final version of the airport layout.

(1) Proper Location of Runways

It is no exaggeration that the location of runways will determine the layout of the rest of the airport. Other points of consideration arise as subordinate issues to this principal aspect. The location of runways, then, is to be hypothesized in view of the estimated air traffic based on the examination of air space navigation, its safety, its capacities, etc.

(2) Apron, Terminal Building and other Principal Facilities

Based on the location of the runways thus determined, the apron, the terminal building, the cargo building, access roads, location of curb side, etc., may be considered, always bearing in mind the efficiency of ground operation of aircraft, smooth flow of passengers and cargo, approach to the airport by visitors, and other factors.

(3) Taxiways

Taxiways must be so designed as to facilitate organic and efficient functioning of runways and aprons because of the very nature of their purpose, which is to connect these two basic facilities of the airport. Economic movement of aircraft within the airport is another factor to be taken into consideration here.

(4) Location of Control Tower

In determining the location of the Control Tower, serving as the nerve-center of air traffic control, its siting requirements should be given ample consideration and the Eye Level Determination of the Tower Cab should be made with utmost care. The orientation of the Tower should be so determined as to secure sufficient visibility under all conditions (including weather and daylight situation among others), and for this purpose traffic patterns and ground operation must be taken well into consideration.

8.2 Layout Plan

Determination of runway layout will ultimately lie in the selection of the crossing point of the two runways, and two such points are conceivable: one at the east end of the main runway and the other at the west end of it. The corresponding layout plans are shown in Figures 8.2.1-8.2.2.

8.2.1 Plan A: The crosswind runway crosses the main runway at the east end of the latter, and the terminal complex and the access road system are to be located together in the area surrounded by the runways crossing at the angle of 110°. The Control Tower is to be located within this same area due to consideration of its accessibility and visibility.

8.2.2 Plan B: The crosswind runway is to cross the main runway at the west end of the latter, and the terminal complex and the access road system are to be located within the area surrounded by the two runways crossing at 70°. The Control Tower is to be constructed in the same area.

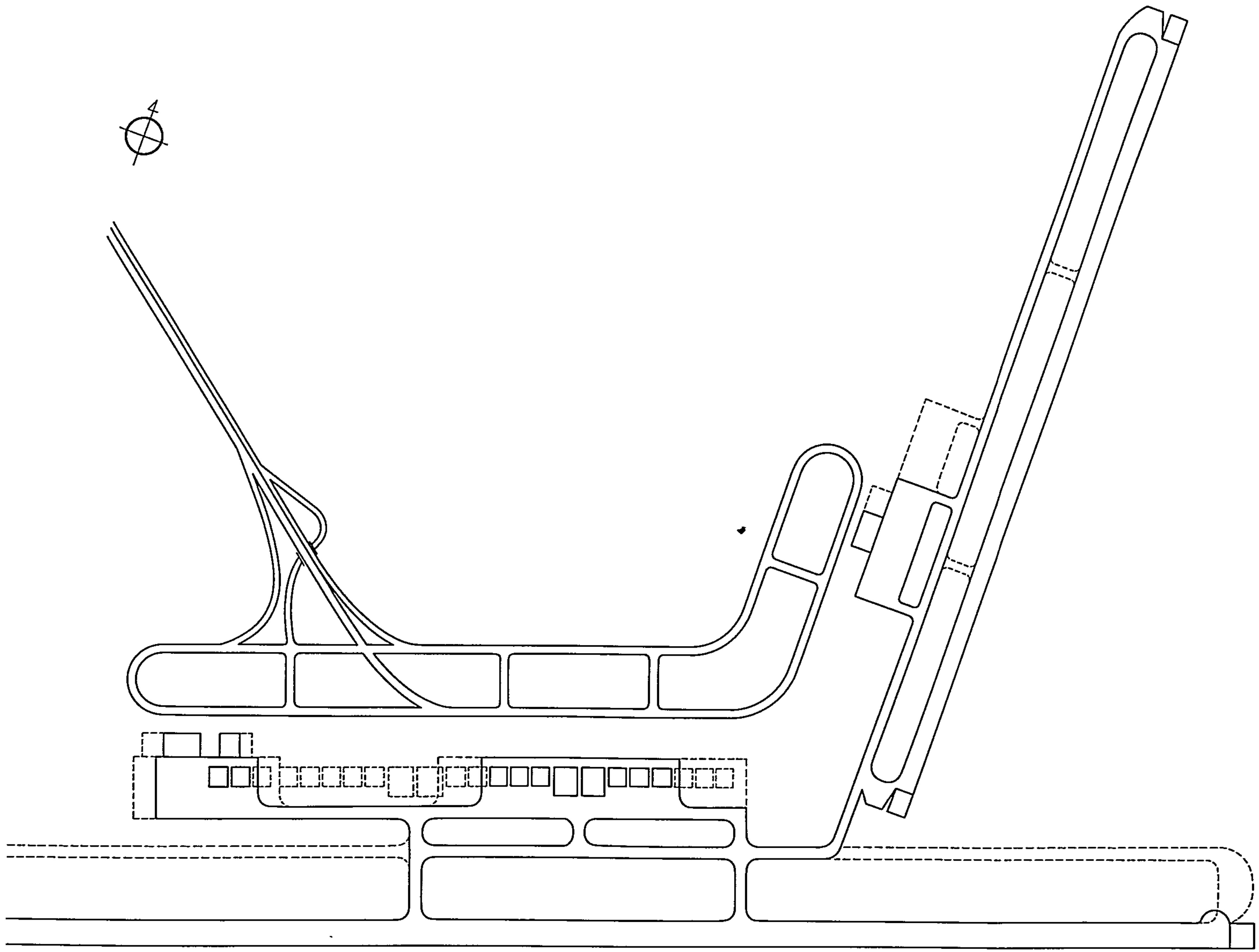


Fig. 8-2-1 Runway Layout Plan (A)

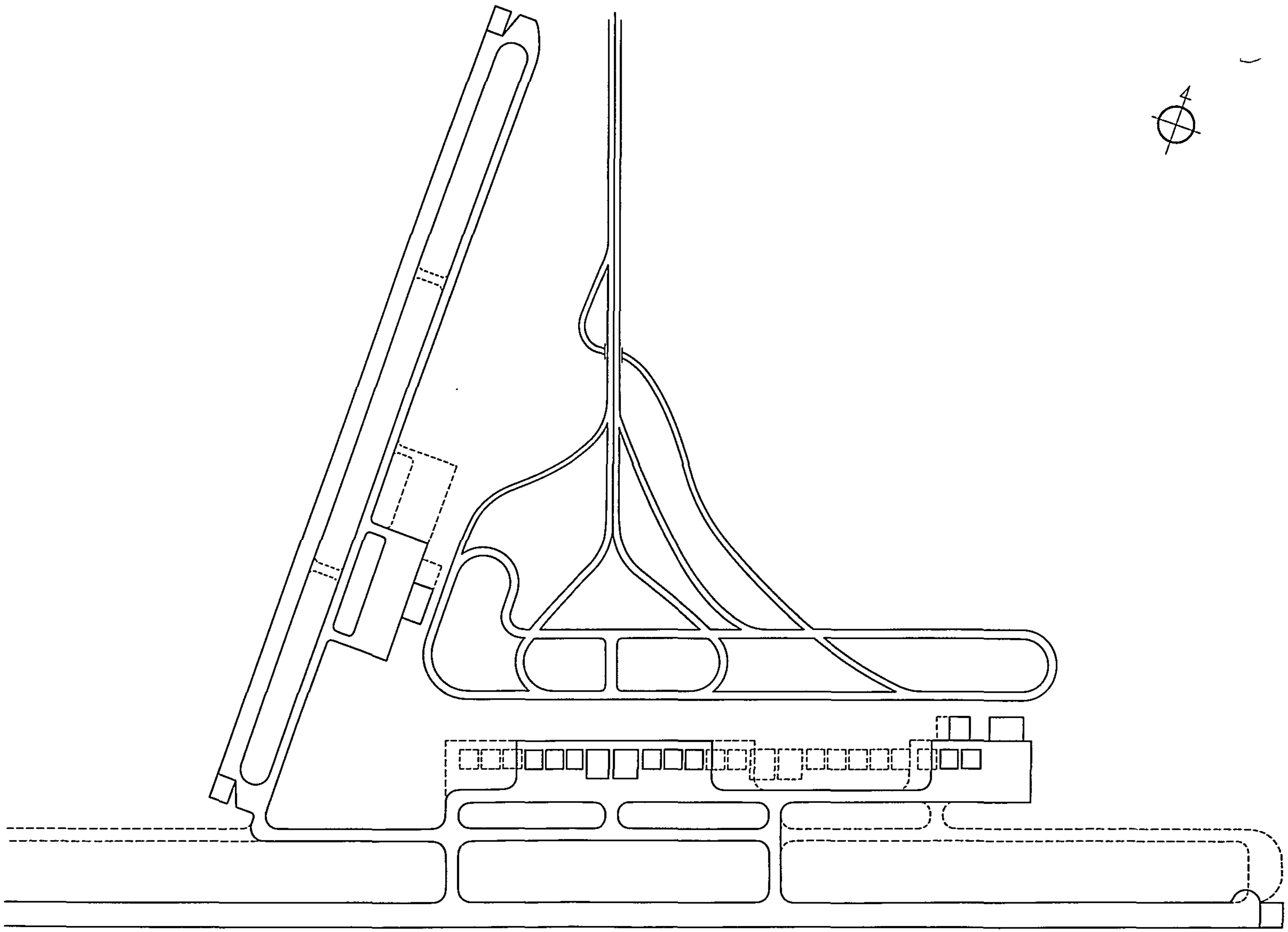


Fig. 8-2-2 Runway Layout Plan (B)

8.3 Airport Layout

Neither of the two plans described above shows conspicuous advantages over the other in terms of runway capabilities and smooth ground operation of aircraft. But in terms of Control Tower functioning, access road system, and possible future extention feasibilities, some differences are observable between the two. In all respects Plan A is preferable to Plan B.

Table 8-3-1 Comparison of A Plan and B Plan

	A Plan	B Plan
Control Tower Function	Little interference from the setting sun	Big interference from the setting sun
Access Road System	Approach to the airport is easy and economical	Approach to the airport is complicated and uneconomical
Future Expansion Possibility	Access road system in the terminal area has flexibility for future land usage	Land usage is comparatively limited and has less flexibility

We subsequently came to the conclusion that Plan A should be adopted, and proceeded to determine the rest of the airport layout.

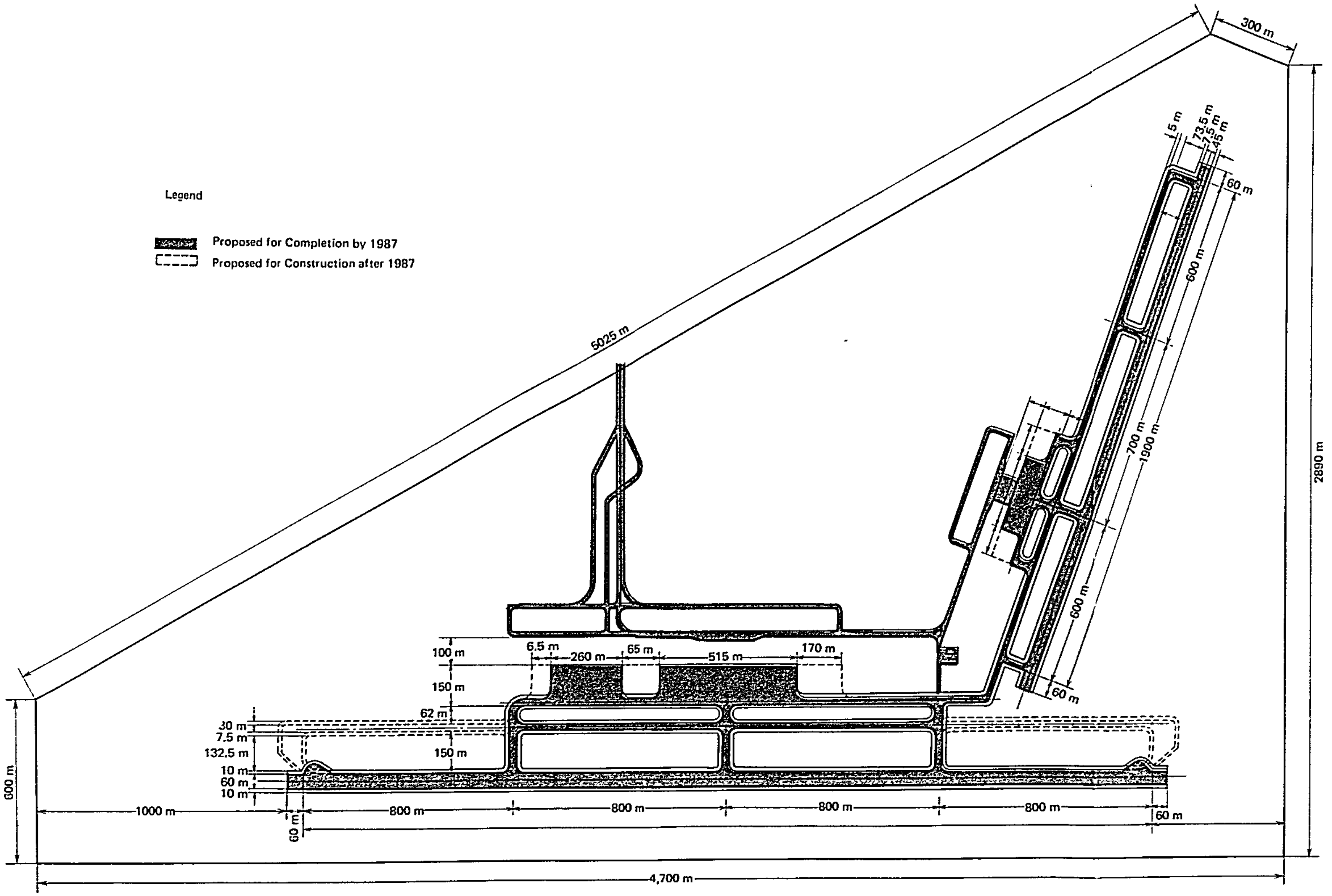


Fig. 8-3-1 Airport Layout Plan

9. Airspace Utilization Concept

9. Airspace Utilization Concept

9.1. IFR Operation

9.1.1. ILS Approach

(1) ILS Runway

ILS may only set for runway 06 for the first stage of airport constructions. Because it appeares to cover 73% of all jet operation with 5 Knots tail wind component.

(2) Approach Procedures

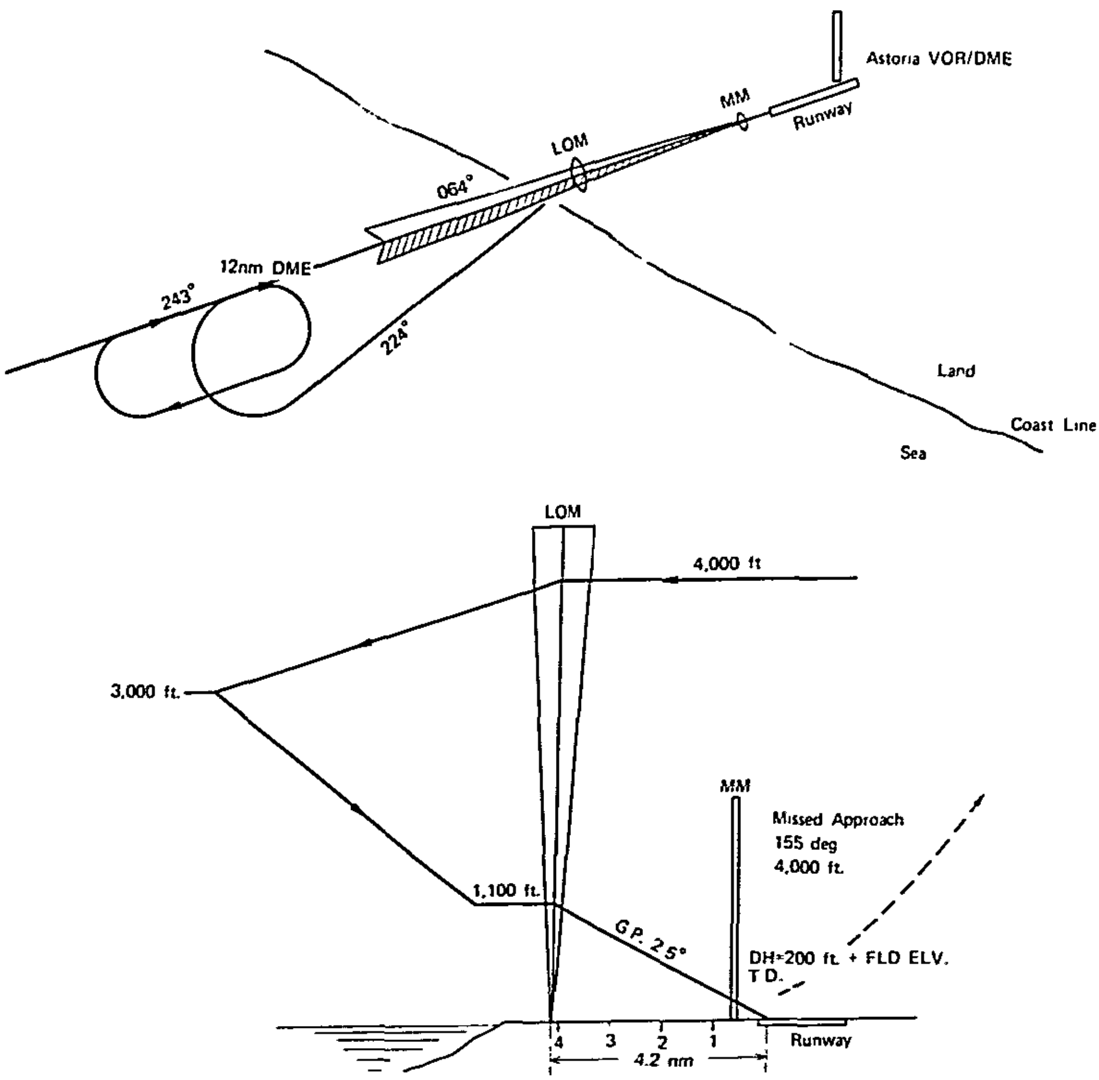


Fig. 9-1-1 ILS Approach Procedure Planview & Profile

(3) Missed Approach

Turn right and climb on radial 155 Astoria VOR/DME, maintain 4000 ft., and hold at 12nm DME.

(4) Holding

Hold on radial 243 Astoria VOR/DME at 12nm.

9.1.2. <u>VOR Approach</u>

(1) *Number of procedures*

Three approach procedures are recommendable, which allow straight-in approach to three directions of two runways respectively.

(2) Approach Procedures

Fig. 9-1-2 VOR Procedures Plan View

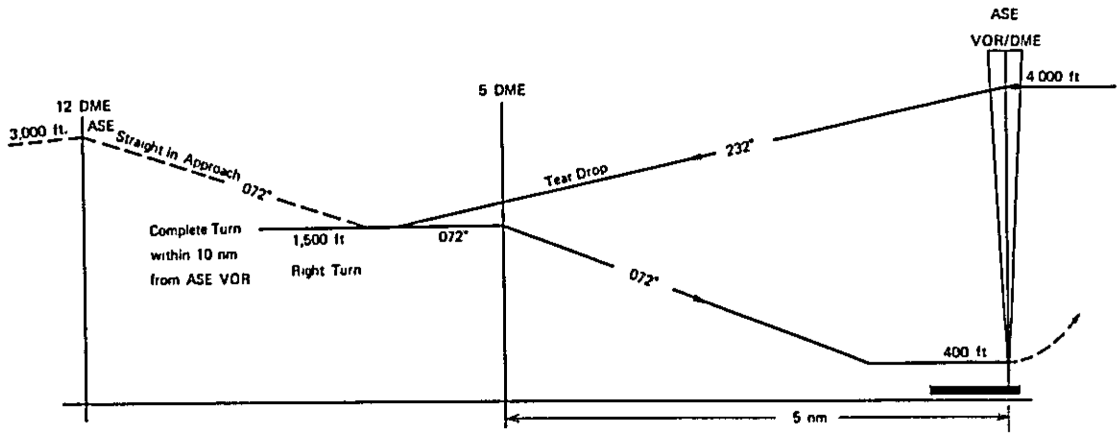


Fig. 9-1-3 VOR Approach Procedure, No. 1 Profile

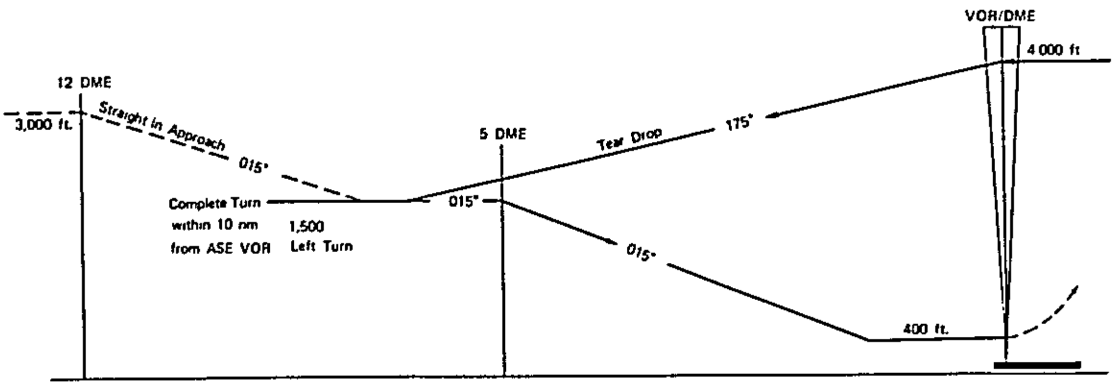


Fig. 9-1-4 VOR Approach Procedure, No. 2 Profile

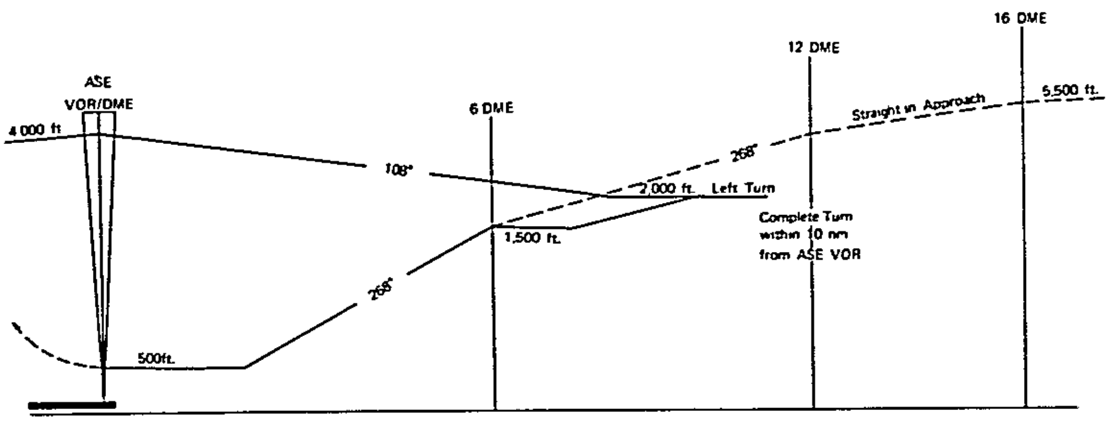


Fig. 9-1-5 VOR Approach Procedure, No. 3 Profile

(3) Missed Approach

a. VOR No.1; Turn right and climb on radial 155 Astoria VOR/DME, maintain 4000 ft., and hold at 9 nm DME.

b. VOR No.2; Turn left and climb on radial 155 Astoria VOR/DME, maintain 4000 ft., and hold at 9 nm DME.

c. VOR No.3; Turn left and climb on radial 155 Astoria VOR/DME, maintain 4000 ft., and hold at 9nm DME.

9.1.3. Departures

Concept of Instrument Departure Routes are shown in Fig.9-1-6 and Fig.9-1-7.

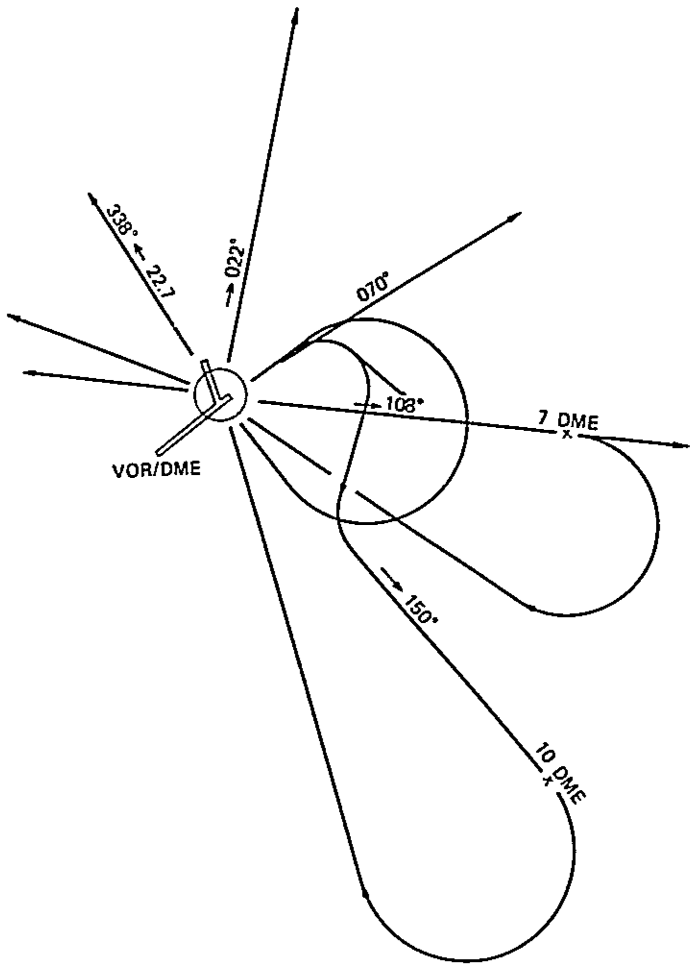


Fig. 9-1-6 Instrument Departure Routes for Runway 24

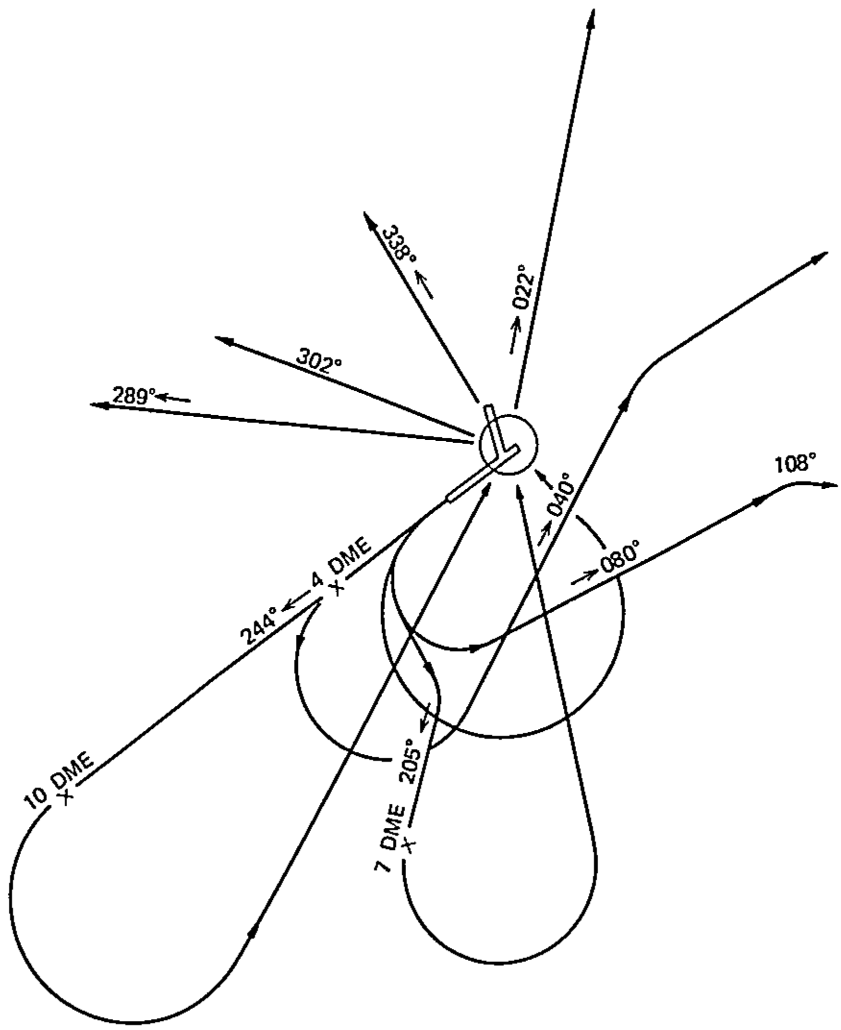


Fig. 9-1-7 Instrument Departure Routes for Runway 06

9.2. VFR Operation

9.2.1. Small Airstrips in the Vicinity of Astoria. Aircraft operations shall be controlled by Astoria ATC.

9.2.2. Positive Control Area. When traffic increased "Positive Control Area" should be established to protect IFR operations.

10. Runways, Taxiways and Aprons

10. Runways, Taxiways and Aprons

10.1 Runways

10.1.1 Runway Length

(i) Runway A (main)

For the purpose of our investigation, we assumed cases involving the longest flights, an aircraft mix to be in service, and the maximum cruising range of aircraft as criteria for determining the runway length of the Salvadorian airport. Also taken into account include runway gradients and elevation, meteorological conditions, and other relevant factors.

(1) Longest flight range

As possible flights that may be scheduled in the future from the airport, we arbitrarily selected Los Angeles International Airport, and as an alternate, San Francisco International Airport, as the longest flight destinations.

El Salvador - Los Angeles:	2,029 nm
Los Angeles - San Francisco:	292 nm

(2) Aircraft mix to be in service

An accurate prediction of the types of aircraft which will be in service in the future is a near impossibility, but as a general rule it is safe to assume that aircraft performance will continue to improve in respect to the required length of the runway. Accordingly, for the purpose of our study we selected representative types among the aircraft that are currently in service today: the B-747 B, the DC-8-62, and the B-727-200 (JT8D-15).

Runway gradient:	0.3%
Runway elevation:	+28.8 m
Reference temp:	31.0°C

(a) The B-747 B

Max. landing weight	564,000 lb.
Max. takeoff weight	774,000 lb.
Operating empty weight	365,800 lb.
Zero fuel weight	526,500 lb.

Runway length required for landing

Le == 2,400 m (wet condition)

(From the Boeing manual)

Runway length required for takeoff

Takeoff weight

Operating empty weight	365,800 lb.
Payload (374 passengers & full cargo)	120,000 lb.
Burnoff fuel (cruise alt. 31,000 ft; wind factor -50 kn.)	123,000 lb.
Alternate fuel	23,000 lb.
Holding fuel	10,000 lb.
Contingency	10,000 lb.
Total	651,800 lb.

Accordingly, Lt' == 2,400 m (standard condition), and correcting for gradient and temperature,

Lt == 2,900 m.

(b) The DC-8-62

Max. landing weight	240,000 lb.
Max. takeoff weight	350,000 lb.
Operating empty weight	143,255 lb.
Zero fuel weight	195,000 lb.

Runway length required for landing

Le == 2,100 m (wet condition)

(From the DC-8 characteristics)

Runway length required for takeoff

Takeoff weight	
Operating empty weight	143,255 lb.
Payload (full capacity)	47,335 lb.
Burnoff fuel (cruise alt. 31,000 ft; wind factor -50 kn.)	65,000 lb.
Alternate fuel	10,000 lb.
Holding fuel	5,000 lb.
Contingency	4,000 lb.
Total	274,590 lb.

Accordingly, Lt' == 2,200 m (standard condition), and correcting for gradient and temperature,

Lt == 2,700 m.

(c) The B-727-200 (JT8D-15)

Max. landing weight	142,500 lb.
Max. takeoff weight	190,500 lb.

Runway length required for landing

Le == 1,750 m (wet condition)

(From the Boeing manual)

Runway length required for takeoff

As at maximum takeoff weight Lt' == 2,607 m, correcting for gradient and temperature,

Lt == 3,200 m.

We thus concluded that a runway with a length of 3,200 m would be appropriate, and this length is also sufficient for other classes of aircraft than the ones studied.

(2) Runway A' (crosswind)

The ICAO regulations stipulate a runway appropriate to aircraft requiring less than 1,500 m in runway length at a maximum permissible crosswind component of 13 kn./hr. Thus, L' = 1,500 m, and correcting for gradient and temperature,

L == 1,900 m.

10.1.2 Runway Width

The ICAO regulations prescribe a minimum width of 45 m and recommend an increase of this figure if large aircraft are to be accommodated. The FAA regulations call for a width from 45 m to 60 m, with 60 m as the necessary width for the B-747 and other large carriers anticipated in the future. As the B-747 also tends to undergo marked nose swing in a crosswind, it is said that pilots psycologically feel greater confidence in landing on a runway closer to 60 m. From such considerations it is suggested that runway width be:

Runway A	60 m
Runway A'	45 m

10.1.3 Runway Shoulder Width

In view of the aircraft to be accommodated under the given meteorological conditions, shoulder width is suggested as:

Runway A	10 m (3.5 m paved + 6.5 m turfed)

Runway A' 7.5 m (3.5 m paved + 4.0 m turfed)

10.1.4 Turning Pad

The proposed plan is based on the turning radius of B-747 B commencing at the runway center line.

10.2 Taxiways

10.2.1 Taxiway Width

(1) Area A

Taxiways C & D	30 m
Right angle taxiways	35 m
Turning sections (fillet)	

(2) Area A'

Taxiways E, F, & G	23 m
Right angle taxiways	27 m
Turning sections (fillet)	

10.2.2 Taxiway Shoulders

a. Area A (C, D, & right angle taxiways): 7.5 m (all paved)

b. Area A' (E, F, G & right angle taxiways): 5.0 m (3.5 m paved + 1.5 m with turf)

10.2.3 Holding Bays

Holding bays would be established at either end of runway A with a sufficient capacity for accommodating B-747.

10.3 Aprons

10.3.1 Passenger Loading Apron

Scale and clearance corresponding to the number of berths found necessary for the proposed facility are illustrated in Figure 10.3.1.

10.3.2 Cargo Loading Apron

Shown in Figure 10.3.2.

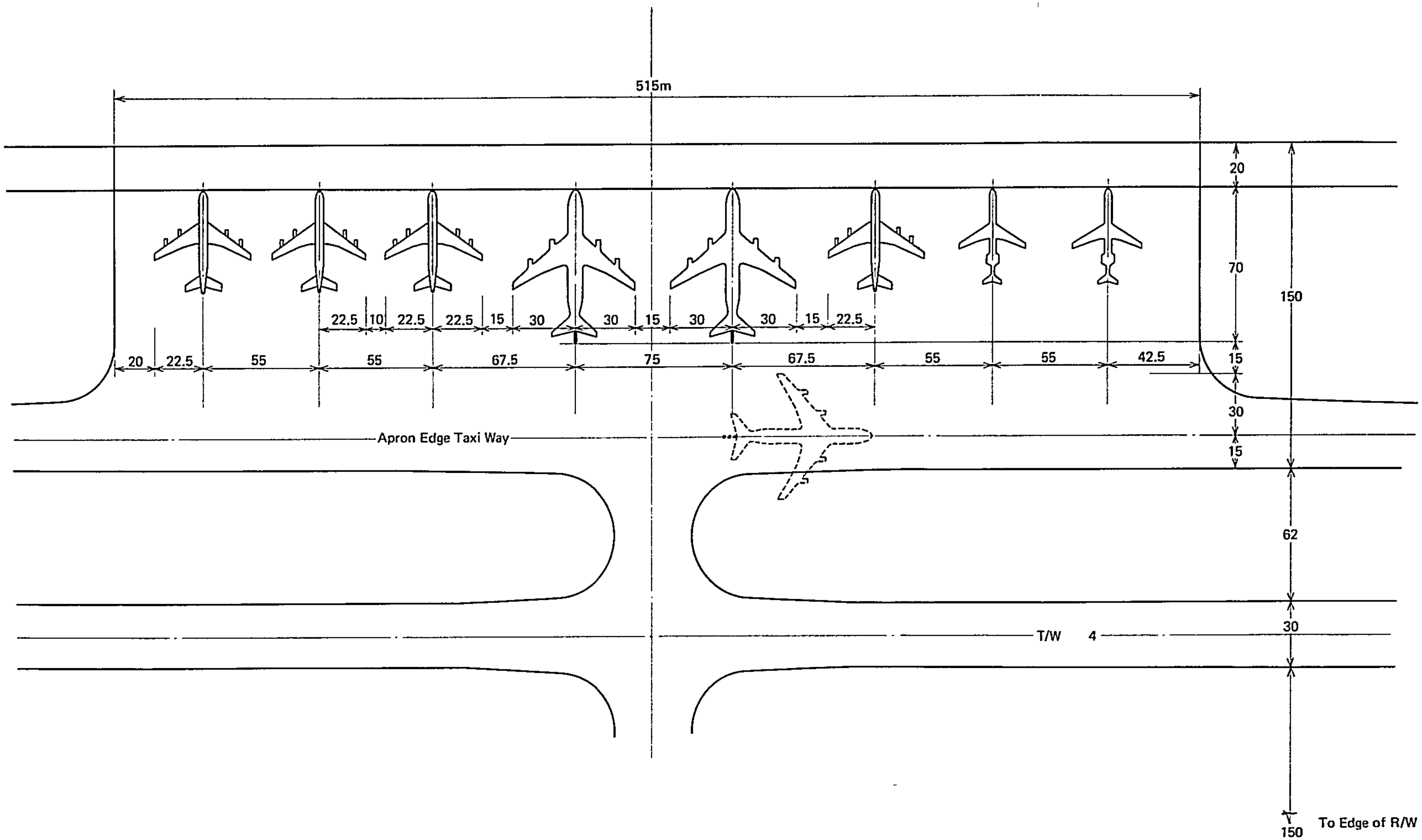


Fig. 10-3-1 Passenger Loading Apron

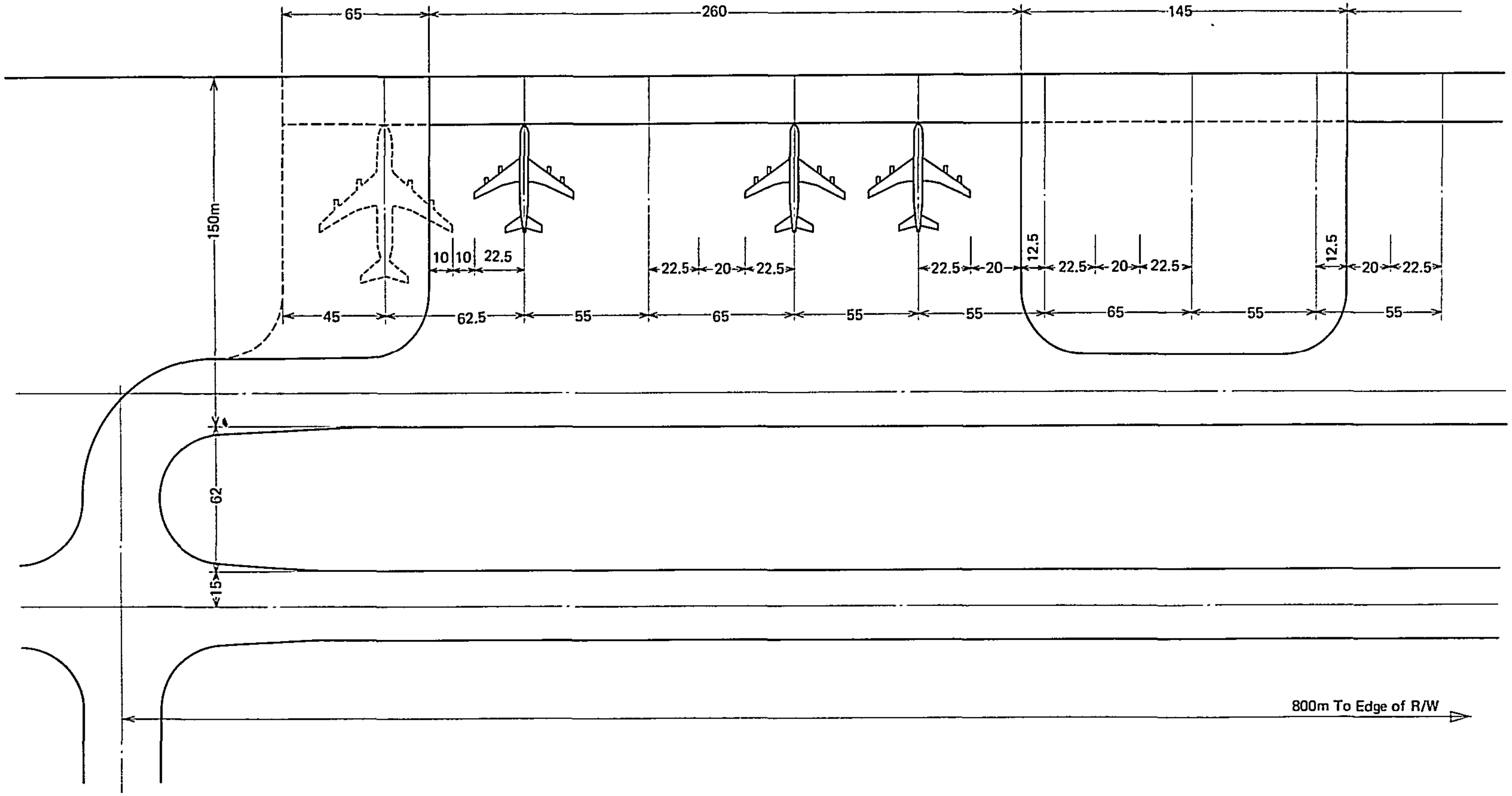


Fig. 10-3-2 Cargo and Maintenance Area Apron

10.3.3 Maintenance Apron

Shown in Figure 10.3.2

10.3.4 Private Plane Apron

The classes of planes to be accommodated cannot be accurately foretold, but the area requirements can be set from the average figure of 300 m^2 necessary per plane.

Figure 10.3.1 Passenger Loading Apron

11. Air Navigation and Control Facilities

11. Air Navigation and Control Facilities

The air traffic control, telecommunication, and radionavigation facilities of the new airport should be based on the facilities and operational modes employed at Ilopango Airport with the addition of rennovations made possible by technological progress and which reflect the trends of aeronautical development. The facility design that follows, prepared with careful heed to the ICAO recommendations and with full emphasis on a smooth inaguration of operations at the airport, has the twin goal of assuring a high level of air traffic safety while giving full play to the functions that can be performed by a new Central American airport.

In Central America at present, aeronautical telecommunication and radionavigation services are operated on standardized basis under COCESNA(The Central American Cooperation of Air Navigation Service) in order to unify the provision of services to the aircraft of other countries. It is accordingly necessary to maintain consistency with COCESNA in designing the air traffic control, telecommunication, and radionavigation facilities.

11.1 Air Traffic Control Facilities

In order to cope with growing volumes of air traffic and a diversifying variety of aircraft in the terminal control area, it is necessary that there be improvement in the reliability of air-ground telecommunications and thus that more sophisticated instruments be employed. All of the functions existing at the present Ilopango Airport will be necessary for the new airport, and to avoid confusion during the transfer of operations, all of the equipment at the new airport will have to be newly installed, with the exception of some of the Boqueron Relay Station facilities.

(1) Air-ground telecommunication facilities

VHF and HF radio-telephony transceivers, as detailed below, need to be installed for the purpose of executing approach control, local control, and ground control over aircraft within the terminal positive control area. It is felt that for some time to come a full operational program can be handled with the same frequency bands used at Ilopango Airport. It thus will be unnecessary to isolate the transmitting and receiving equipment in the Transmission Station; instead, it can all be installed in the same equipment room at a site near the Control Tower, and each channel will be integrated into duplex operation. Figures 11.1.1/2 indicate the effective VHF coverage for local control (Control Tower) and approach control(Boqueron site).

i. VHF radio-telephony transceivers

For local control	50W	2units	(Cont.Tower)
For approach control	50W	2units	(Boqueron)
For ground control	50W	2units	(Cont.Tower)
For emergency	50W	2units	(Cont.Tower)

In addition, one portable VHF transceiver for emergency use will be integrated with the air traffic control console set.

ii. HF radio-telephony

transmitter	500W	2 units
receiver		2 units
console		1 unit

(2) Air traffic control consoles

For the telephones, interphones, flight progress boards, etc. utilized in controlling the air-ground telecommunication facilities and for relaying communications among the concerned quarters, a set of consoles should be installed which embodies the same functions as the console set at Ilopango Airport. Full consideration of human engineering and of functionability should be exercized in the placement of send-receive control switches, main-standby select switches, interphones, local phone switches, wind direction and velocity indicators, digital clocks, etc.

To ensure unobstructed execution of the air traffic control operation and to enhance a rational layout of the maintenance system, equipment and amplifier racks as well as interface equipment for the flight information consoles should be allocated to the equipment room. However, monitor and control panels for the ILS and VOR installations should be incorporated into the air traffic control console set along with the battery-operated VHF transceiver for emergency back-up operation.

i. Air traffic control consoles	1 set	(Cont.Tower)
ii. Equipment racks for the above	1 set	(Equip.Room)
iii. Multichannel tape-recorders (16 channels, 24 hrs operation)	1 set	(Equip.Room)

(3) Other facilities

The electric power system supplying the terminal air traffic control facilities must be designed with the finest quality components for guaranteed reliability in monitoring air safety and in efficient operations. The system must incorporate a large size, high quality power generator for immediate back-up operation of the air traffic control facilities in the event of a failure in the commercial power supply.

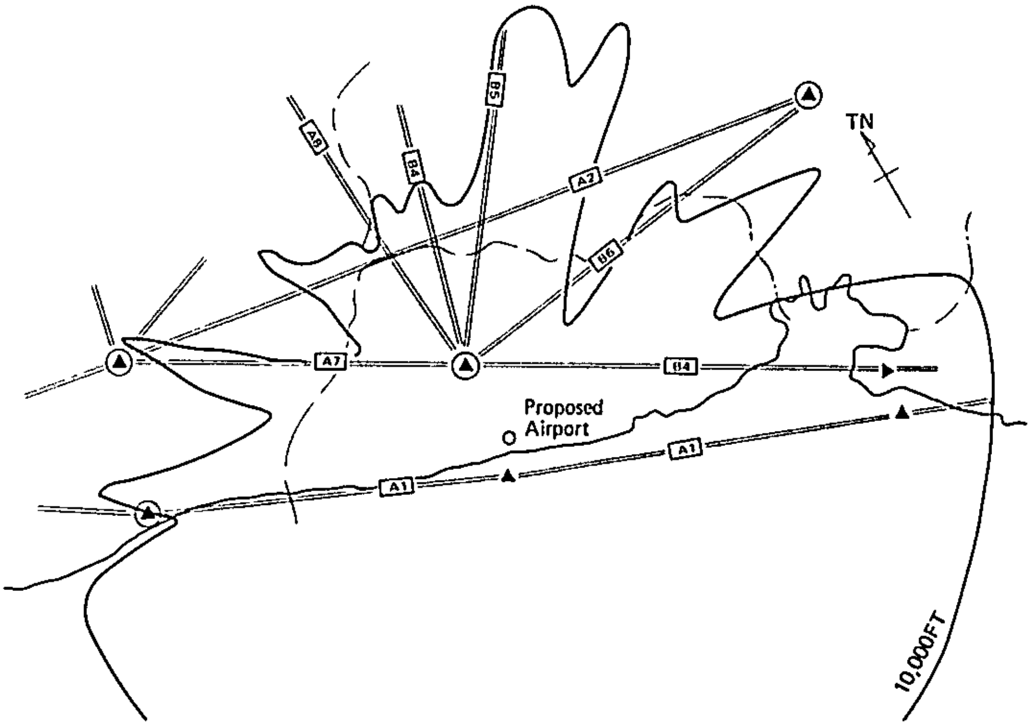


Fig. 11-1-1 Proposed Airport VHF Coverage

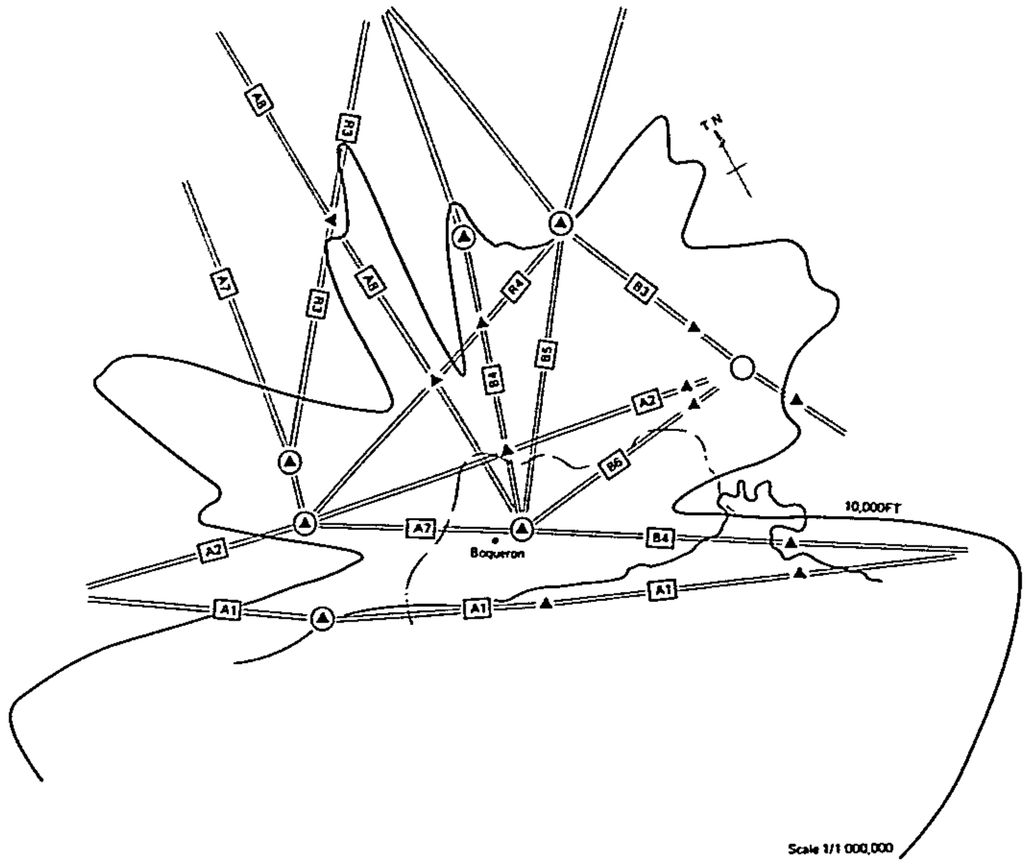


Fig. 11-1-2 Boqueron Site VHF Coverage

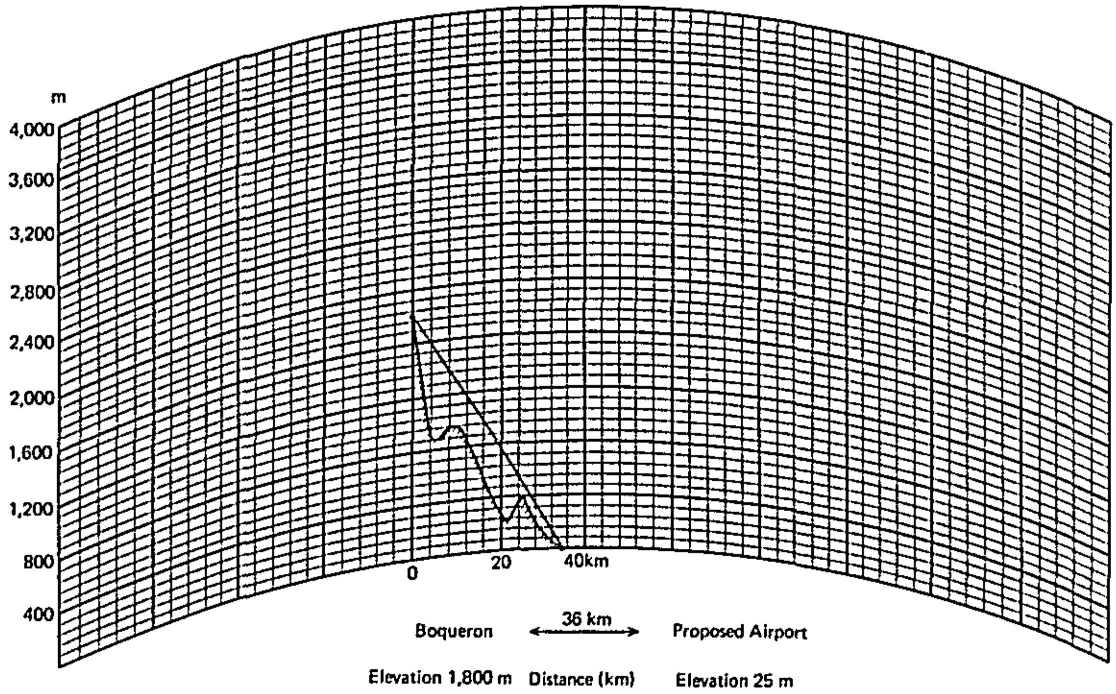


Fig. 11-1-3 VHF Link Profile

11.2 Aeronautical Telecommunication Facilities

All of the telecommunication functions performed at Ilopango Airport should be provided at the new airport both in the interest of supplying effective radionavigation and telecommunication services to aircraft using the new airport as well as in support of safe and smooth operation of aircraft within the Central American Flight Information Region(FIR). Furthermore, the Air Navigation Plan recommended by ICAO should be observed and HF radio-telephony equipment for the en-route network should be newly installed.

(1) Aeronautical fixed telecommunication facilities

The VHF and UHF multiplex channel repeating equipment at Boqueron Relay Station will need to be supplemented and a single span to the new airport established. The propagation path from Boqueron to the new airport, shown in Figure 11.1.4, appears to have adequate clearance with only one span, but in the actual designing stage further study in detail would be necessary. As the new relay equipment will be linked up with existing equipment presently in operation at Boqueron, sophisticated technical coordination will be essential with respect to compatibility of circuitry levels and carrier quality to avoid impaired operation of the interface equipment.

UHF FM multiplex circuit repeaters	1 set	(Cont.Twr.& Boqueron)
UHF FM multiplex circuit terminals	1 set	(Cont.Twr.& Boqueron)

(2) Teletype facilities

For the new airport's El Salvador International Aeronautical Communication Station, one set of teletype units will need to be installed, as currently exists at Ilopango Airport, to carry out service for the circuits of the Aeronautical Fixed Telecommunication Network (AFTN), of the Air Traffic Service(ATS), and for data distribution to the airlines, etc.

(3) Aeronautical mobile service facilities

i. VHF facilities

Ilopango Airport currently has an air-ground telecommunications installation of Salvador Radio supplying radionavigation services to aircraft flying over El Salvador airspace, and the information provided includes traffic control information, position reports, and meteorological bulletins. Transmission from the proposed airport, however, would have a restricted coverage due to the low elevation of the La Paz plain site--only 25 meters or so above sea level--and the interference of surrounding mountains, so it is suggested that the transmission equipment be installed at the Boqueron Relay Station with its elevation of about 1,800 meters above sea level. As indicated in Figure 11.1.2 showing the area that can be served from Boqueron, it is apparent that high quality telecommunication services could be supplied over an expansive region.

VHF radio-telephony transceivers	50W	2 units	(Boqueron)

ii. HF facilities

The ICAO Air Navigation Plan of April, 1972 recom-

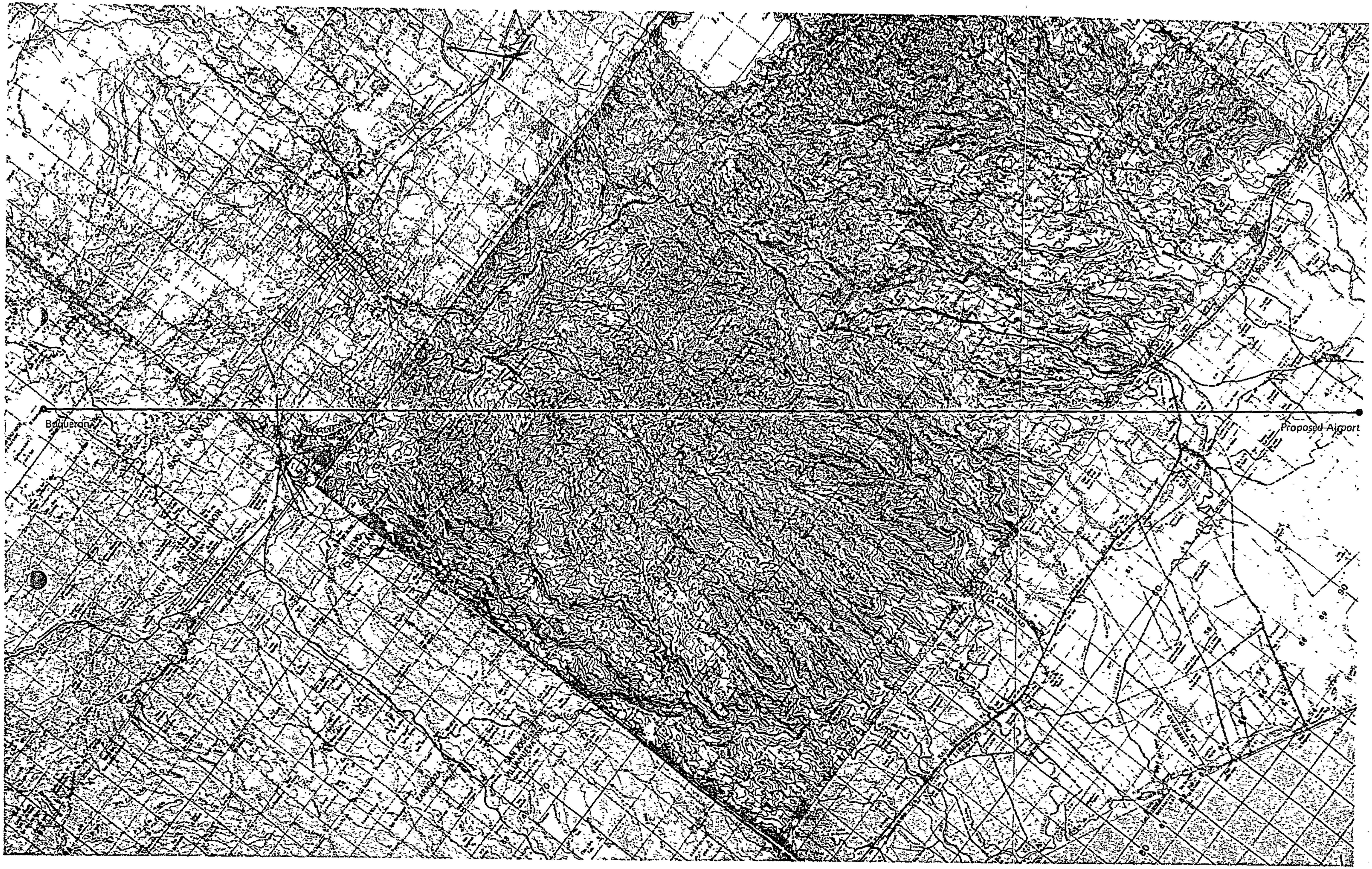


Fig. 11-1-4 VHF Link Route

mends the services of the West Caribbean HF En-route Radio-telephony Network, and accordingly it would be wise to take the opportunity of the new airport construction for incorporating a full complement of equipment for this Network. Further, to reduce the work load of pilots, a selective calling system(SELCAL) might be profitably added to the equipment.

HF air-ground radio-telephony transmitter (5 channels)	2 sets	(XMIT site)
HF air-ground radio-telephony receiver (5 channels)	2 sets	(Cont.Tower)

iii. An air-ground communications console set, equipped with telephones, interphones, a SELCAL control panel, etc. for Air Traffic Service and for control of VHF and HF air-ground facilities, should be located in the communications room of the Terminal Control Building, and the information relayed should be recorded by multi-channel taperecorders.

Air-ground communications consoles	1 set	(Com.Room)
SELCAL equipment	1 set	(Com.Room)

(4) Automatic terminal information service (ATIS)

The automatic terminal information service is a facility designed to relay tape playbacks on meteorological conditions, the aerodrome status, aeronautical maintenance system status,etc. to aircraft flying through the airport area or scheduled to land or take off. As this facility automatically feeds certain information to the pilot whenever he needs it, it reduces the call frequency to the air traffic control section and thus lightens the communication work load.

The proposed airport is centrally positioned both in respect to El Salvador itself and to Central America as a whole, and it is also well located for access to information from every quarter of the Aeronautical Fixed Telecommunication Network which traverses Central America. Accordingly, an ATIS facility at the airport site would serve effectively as a Central American aeronautical information transmission center. The ATIS hardware would include a set of taperecorders installed within the Control Tower to record essential information on altimeter settings, runway inuse, aeronautical maintenance system status, etc. and to transmit information from the VOR facility.

11.3 Radio Navigation Facilities

Navigation aids recommended for the new airport include both a VOR/DME facility as well as an ILS facility for landing under a low visibility ceiling or as a landing aid for aircraft equipped with the necessary instruments.

(1) VOR/DME

A standard model VOR/DME station approved under ICAO international specifications as a short-range NAVAID could be installed to assist the navigation of aircraft approaching, departing, or flying along the air routes of the new airport. This unit enables aircraft navigators to determine their bearing (θ) with reference to the VOR beacon and their range (ℓ) with reference to the distance measuring equipment signals (DME), and thus makes the approach and departure vis-a-vis the aerodrome possible according to preset directions, and also facilitates piloting along the air routes, by reference to high-precision readings from the VOR/DME station.

The optimum site for installing the VOR/DME station would be one permitting a straight-in approach procedure as prescribed in the FAA Terminal Instrument Procedures (TERPS) to both the main and the attached runways. In view of the limitations imposed by obstructions, the suggested site has been selected close to the intersection of the two runways. Within this area there may be some concern as to reflection of the VOR radio wave against buildings and trees in the neighborhood, thus disturbing the set course, so adequate care needs to be taken in assuring clearance over the terminal buildings, the hangars, and so forth. The proposed airport site lies on a coastal plain relatively distant from the maountainous region to the north, and for this reason it should be possible to freely design a set of VOR course.

Remote controls for the VOR/DME station would be established within the Control Tower for monitoring and control over the equipment. The area of effective coverage from the VOR site is shown in Figure 11.1.1.

VOR unit	200W	1 set
DME unit	3KW	1 set

(2) ILS

Installation of an instrument landing system(ILS) is a recommended requirement for an international airport, a point also endorsed in the ICAO Annex 10. Such a landing system could be utilized safely and effectively by jet aircraft almost regardless of the meteorological conditions, and accordingly its adoption is proposed for the new airport. Although at the outset ILS operation need only be guided by category I procedures, the system design should permit a shift to category II procedures at some later date. For this reason the reliability of the ILS facility would need to meet the category II requirements.

An ILS setup operates as an aid to landing by flashing signals to a plane while it approaches for landing which indicate the plane's glide path as well as its arrival at designated distances from the runway threshold. The system components include the localizer course to the airport the glide path, and the markers located along the extended runway center line (compass locator, outer marker, and middle marker).

The localizer course provides lateral guidance along the line of the extended landing runway while the glide path provides vertical guidance down the course of descent (at a standard elevation of 2.5° from the runway surface). The compass locator is a power-conserving non directional beacon (NDB) installed at the start of the localizer course which guides aircraft to that point, and the outer and middle markers are installed at specified points along the localizer course to flash a signal to the aircraft as it passes above.

According to the operational qualifications of the ILS facility, the ICAO regulations provide for a classification in three categories of I,II, and III.

Table 11-3-1 ILS Standard Facility Category I, II, III

	Landing Minima		Standard Facility		
	Decision Height	Visibility	Radio Facility	Visual Facility	Others
CAT-I ILS	200 ft.	1/2 mile	LOC,GP,OM,MM	MALSR SALSR or ALSF	-
CAT-II ILS	100 ft.	1,200 ft.RVR	LOC,GP,OM,MM,IM	ALSF, TDZ/CL HIRL	RVR
CAT-III ILS	0	0	LOC,GP,OM,MM,IM ASDE,PAR,Runway DME,Surface Routing	Improvements to items required for CAT II	RVR

The main direction of approach to an airport should be determined by data analysis of such factors as the topography, the local obstacles, and the preveiling wind directions and strengths, with reference to other considerations such as aircraft noise pollution, etc. For determining the direction of ILS approach, further data analysis on wind coverage under Instrument Meteorological Conditions must be combined with the above data to assure the effectiveness of ILS when the visibility and/or the ceiling is low. The suggested direction of ILS approach to the main runway is from the west over the sea. Before the final design stage, however, the detailed meteorological observation under Instrument Meteorological Conditions and data analysis should be made to reconfirm the feasibility of the ILS approach plan.

The compass locator for runway A would have to be installed together with the outer marker. It could also be used as an approach NDB for aircraft which are navigated with an automatic direction finder (ADF).

(1) Airport surveillance radar

Airport surveillance radar (ASR) and an air traffic control radar beacon system (ATCRBS) might be introduced to the air traffic control system whenever an increase in traffic volume required their adoption. Both systems are visual methods for accurately and continuously conveying onto a radar scope the status of air traffic in crowded airspace regions, and their purpose is to facilitate faultless operation of air traffic control.

To further augment the effectiveness of a terminal radar control system, video mapping techniques can be applied to the scope image for the display of such data as aircraft targets and routes, fixes, and relative position to adjacent airports, and by adding secondary radar units, identification as well as altitude information can be fed into the air traffic control. Another effective tool is the use of "bright display". This allows better illumination within the Control Tower and accurate apprehension of the navigational status of aircraft in the near vicinity. All these facilities help in the provision of aid to aircraft and in sequencing and thus enhancing a smoother flow of air traffic.

The Federal Aviation Agency of the U.S. stipulates that airport surveillance radar, radar beacon system, and bright display be installed whenever the average average annual traffic volume is 50,000 or above with at least 10,000 representing scheduled flights. Judging from the traffic demand forecast for the new airport, a terminal radar control system will become necessary by the FAA standard during the next plan period. Looking further into the future, the air traffic control system will at some date need the additional function of automatic tracking and display of radar targets by means of computer processing. Such a system, known as an automatic radar tracking system (ARTS), uses tagged display in alphanumeric code for aircraft identification and altitde information.

(2) Radio direction finder

Judging from the frequency of light plane movement in and out of Ilopango Airport, a large number of small aircraft can also be anticipated at the proposed airport. The installation of a direction finder would accordingly be a necessary addition to the navigation aids to inform pilots who have lost their bearing or position the direction they can proceed in to reach the airport.

(3) Mobile radiophones and SELCAL units for vehicles

The numerous vehicles moving within the landing site will include firetrucks, patrol cars guiding aircraft and inspecting the runways, and service cars checking the safety facilities such as the VOR site and the lighting systems, and this fleet of vehicles will increase in number together with any expansion of terminal scale. In order to implement ground traffic safety, radiophones will need to be installed in these vehicles and a liaison circuit to the Control Tower will need to be provided.

(4) Automatic teletype relay

The present teletype relay at Ilopango is a manual relay using paper tape, but the introduction of automated technology will be advisable to accelerate the processing of information as the reports become more numerous and more diverse in type.

(5) New instrument landing systems

The conventional ILS procedure has a number of operational constraints such as the lack of course freedom, the fixed glide path angle, and the locating limitations, especially when viewed in light of noise pollution and of the vertical and short takeoff and landing aircraft (V.STOL aircraft) expected in the future. Such factors make it likely that new landing system will be developed and produced which can both satisfy operational safety in airports with complex air patterns and be economically adopted even at relatively small airports. One such system currently under study, which would permit a free combination of approach courses and also enable a curving approach, is the scanning beam microwave ILS. A further advantage of this system is that installation would be made relatively easy by the relaxation of constraints on site selection. Under the projected development schedule for this equipment, the stage of systems selection will be completed in 1975 and the equipment will be ready for production by 1977.

The ILS system proposed for the new airport is a single system for the main runway, but at some date in the future it may be possible to introduce economical instrument landing systems for all approaches to all of the runways.

11.5 Other Facilities

(1) Maintenance system

Support and maintenance operations for air traffic control, telecommunications, and radionavigational services are standardized under COCESNA in the five nations of Central America, and Ilopango Airport is one link within the overall maintenance system. Accordingly, for all aspects of the Central American maintenance system,such as the training of maintenance personnel, the supply of parts, and the implementing of aeronautical operational modes, the new airport too will naturally be expected to execute its services under the currently effective COCESNA framework.

The ILS system of the new airport represents a new category of instruments, and maintenance personnel will have to be specially trained. This fostering of personnel can be facilitated, however, by on-the-job training during the instrument installation, adjusting, and coordinate plotting. The VOR and DME facilities will be of the same type as utilized at Ilopango Airport, but here too on-the-job training during the instrument installation and adjusting can be a significant aid to the acquisition of maintenance techniques.

Most of the installations of Ilopango Airport are located within the airport compound and serviced regularly under a routine maintenance schedule. The approach NDB and the UHF/VHF relay station, however, are located elsewhere, the former 6.5 nm away in Apopa town and the latter 10 nm to the northwest on the top of a 1,800 m volcano. The permanent structures at each site include an instrument shed and an engine house, but without living quarters. Work tools, replacement parts, instruction manuals, and other supplies are kept on hand at the sites, while a resident of the vicinity is employed to watch over the installations. Maintenance is carried out by personnel from the airport who arrive via a special service jeep on regular checkout rounds to look after the equipment.

For the new airport, such a maintenance system could be duplicated in general outline, but because the proposed sites are much further from the airport than in the case of Ilopango Airport, a good plan for raising work efficiency would be to install a two-way radio in the service jeep.

(2) Supplies

Most kinds of parts for radios, televisions, and other general electrical appliances can be easily procured in El Salvador, but the special electronic appliances and instruments for radionavigation and telecommunication will have to be ordered from outside and imported. Accordingly, the time delay between order and delivery will have to be kept in mind in setting up an inventory schedule and accumulating a supply stockpile.

(3) Considerations for the actual designing

i. The choice of electronic instruments should be weighted in favor of transistorized items of low power consumption and high reliability in light of the parts and supplies situation and of the calibre of the maintenance technicians. Furthermore, as the locality of the proposed airport is a coastal plain deep in the tropics where environmental conditions are necessarily severe, a well-balanced systems design approach, which contrives to introduce heat-reflecting, ventilation, and other special techniques into structure design, will be of essence to the overall plan success.

ii. The nation has enacted legislation concerning radio wave equipment and electrical installations, and technical standards have been set up on this basis. A familiarity with such provisions will thus be important in the detailed studies if a decision is reached to begin the actual designing.

12. Airport Lighting

12. Airport Lighting

12.1 Runway A (Main Runway)

(1) Approach lights

West Side: CATI Precision Approach Facility; ALPA Formula 900 m; two 6.6A series circuits. With the excellent meteorological conditions of the airport site and no other misleading lights existing in the area, sequenced flashing lights will not be necessary. A constant current regulator can be used for either the east or the west side by switching.

East Side: Simple Formula 420 m; one 6.6A series circuit.

(2) Approach Beacons

Two approach beacons should be installed at 600m and 400 m from the end of the runway to provide guidance for circling aircraft and also to serve as additional extended approach lights (aircraft is to adopt a circling approach on the east side).

(3) Visual Approach Slope Indicators

A 3-bar VASIS to be planned and installed in both directions of approach; 6.6A series circuit to be installed in each direction of approach; constant current regular to be equipped with switching capabilities.

(4) Runway Edge Lights

High intensity lights; two 6.6A series circuits alternating along runway edge.

(5) Runway Threshold Lights

High intensity flashing lights to be installed at intervals of less than 3 m between the runway edge lights; a 6.6A series circuit at each end of the lines of these lights.

(6) Additional Runway Threshold Lights

Use the same circuits as the approach lights.

(7) Runway Threshold Lights

Runway threshold lights to be equipped with red filters on their inner side and to use also as additional runway threshold lights.

(8) Runway Center Line Lights
One 6.6A series circuit and filters to show remaining distance of the runway.

12.2 Runway A'

(1) Runway Edge Lights
High intensity lights; one 6.6A series circuit.

(2) Runway Threshold Lights
High intensity flashing lights; one 6.6A series circuit.

(3) Runway End Identification Lights
Flashing lights to be installed at both edges of the runway end line, to be planned so that they will light only in the direction of approach.

(4) Runway End Lights
The same as with Runway A

(5) Visual Approach Slope Indicator(VASIS)
A VASIS to be installed in both approach directions; the rest is the same as with Runway A.

12.3 Taxiway

Taxiway Edge Lights; medium intensity lights to be installed along the edges of the taxiways and of the apron; four to five 6.6A series circuits.

12.4 Others

(1) Aerodrome Beacon

Rotating beam to be installed at a place where it will not obstruct either the Control Tower or approaching aircraft.

(2) Wind Direction Indicator Lights

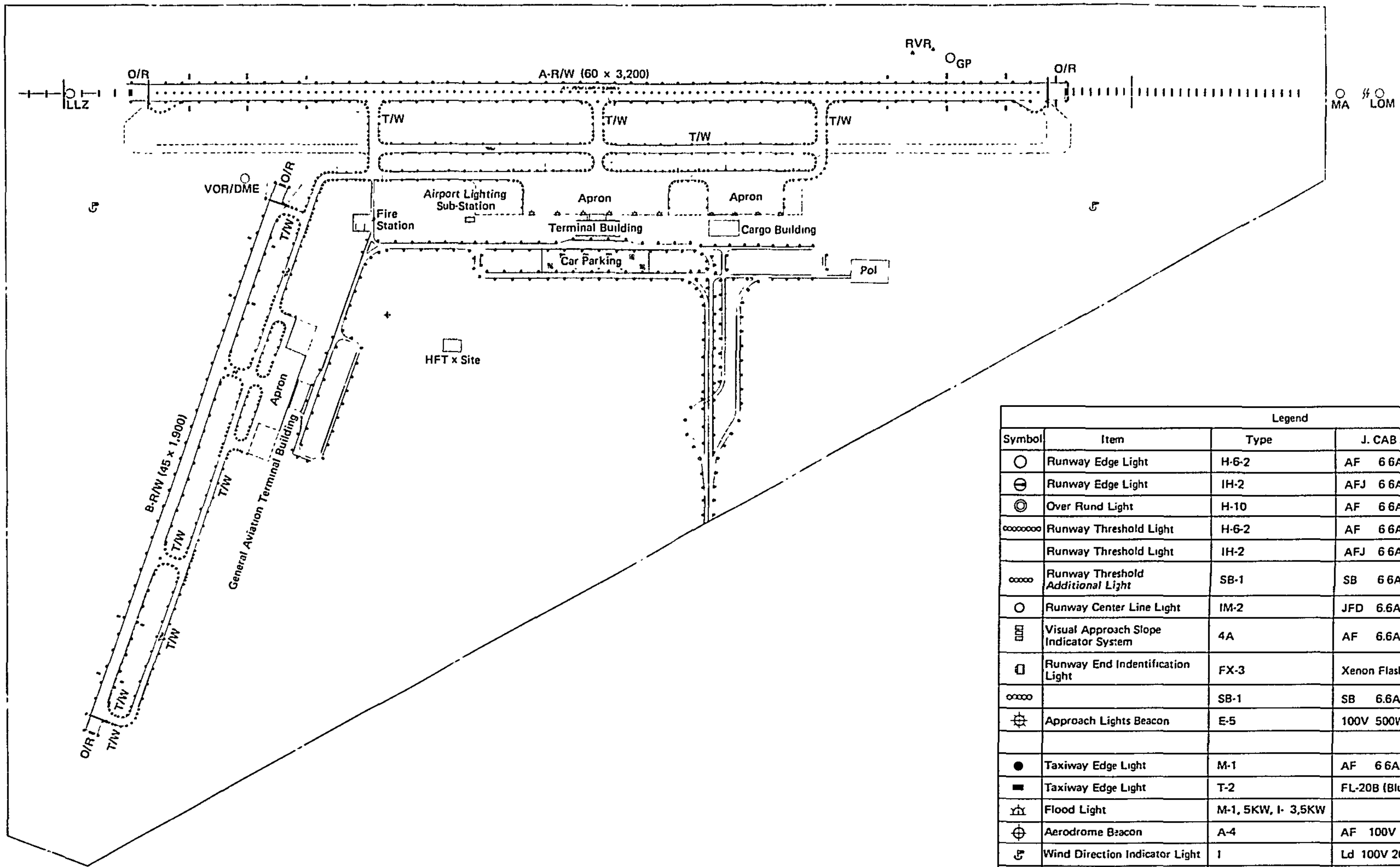
Three wind direction indicator lights to be installed between or around the ends of the runways and landing points but not interfering with the transitional.

(3) Obstruction Lights

To be installed on top of tall objects within the airport.

(4) Apron Flood Lights

To be installed at the passenger apron and cargo apron, using high poles and quarts iodine lamp and metal halide lamps.



Legend				
Symbol	Item	Type	J. CAB Standard	Units
○	Runway Edge Light	H-6-2	AF 6 6A 200W	159
⊖	Runway Edge Light	IH-2	AFJ 6 6A 200W	9
◎	Over Rund Light	H-10	AF 6 6A 200W	20
ooooooo	Runway Threshold Light	H-6-2	AF 6 6A 200W	8
	Runway Threshold Light	IH-2	AFJ 6 6A 200W	70
ooooo	Runway Threshold *Additional Light*	SB-1	SB 6 6A 200W	20
○	Runway Center Line Light	IM-2	JFD 6.6A 200W	100
▯	Visual Approach Slope Indicator System	4A	AF 6.6A 200WGV	48
▯	Runway End Indentification Light	FX-3	Xenon Flashing	4
ooooo		SB-1	SB 6.6A 200W	228
⊕	Approach Lights Beacon	E-5	100V 500W	2
●	Taxiway Edge Light	M-1	AF 6 6A 30W	480
▬	Taxiway Edge Light	T-2	FL-20B (Blue)	30
	Flood Light	M-1, 5KW, I- 3,5KW		10
⊕	Aerodrome Beacon	A-4	AF 100V 2,500W	1
	Wind Direction Indicator Light	I	Ld 100V 200W x 4	3
⬭	*Street Light*	*HF 400, HF 700*		*227*

Fig. 12-1-1 Proposed Airport Navigational Aid Facility Plan Scale 1/5,000

13. Terminal Facilities

13. Terminal Facilities

13.1 Passenger Terminal Building

13.1.1 Plan of the Passenger Terminal Building

Since El Salvador's new international airport will serve as the gateway to this country, the Terminal Building should be a most attractive building not only for visitors from abroad but also for local residents.

In both meteorological and topographical aspects, the projected airport site is a tropical area, whose characteristic features should be well used in architectual tasks connected with the airport construction. Buildings should be open and desirably should have broad canopies to provide protection from strong sunshine, and west side walls should be protected from strong afternoon sun by means of louver and/or hollow block material.

Care should be taken to place ample tropical plants in and around the building. An aquarium with colorful tropical fish in the terminal building could be an added attraction to travelers and visitors.

Even though the building is rather open, necessary areas should be treated as the core of the building and should be sufficiently air-conditioned.

The terminal building should be not only functional but also appealing to the eye. It should also be designed for low-cost future building management, which purpose can be accomplished by fully utilizing local materials. Such a method of construction should also further enhance the attractiveness of the building to visitors.

We recommend here a plan for a terminal building which will not only be the best terminal building in Central America but which will also acquire a worldwide reputation as an example of efficient functionalism, pleasant beauty, and low cost.

13.1.2 Size of the Passenger Terminal Building

The size and scope of the Terminal Building is calculated for a CAB and CIQ area per peak-hour passenger of 15 m^2/Peak Hour Passenger, and for other areas, 24 m^2/Peak Hour Passenger, based upon the standards of the Federal Aviation Agency and IATA as well as on research materials at Japan Airport Consultants. The size of each room is computed, taking into consideration such factors as its respective functions, conditions, number of employees, and capacities.

Table 13-1-1 Total Area of Passenger Terminal

	1980	1990	Unit: m^2
CAB, CIQ	6,700	17,600	15 m^2/PH.PAX
Lobby and Others	10,700	28,100	24 m^2/PH.PAX
Concourse	600	7,000	
Total	18,000	52,700	

Table 13-1-2 Area Breakdown

	Area	Remarks
Ticket Lobby	600 m^2	Length of Ticket Counter 75 m
Departure Lobby	1,400	2.5 m^2 per person, Number of Well-Wishers = 1.5 peak-hour departure passenger.
Departure Lounge	500	
Airlines Office	1,300	
Telecommunication Room	500	
Government Office	1,400	
CIQ Facilities		
Dep. Customs	300	
Dep. Immigration	300	
Arr. Immigration	300	
Baggage Claim	500	
Arr. Customs	600	
Arrival Lobby	600	
Restaurant	650	
VIP Room	200	
Machine Room	1,300	
Storage	1,000	
Dep. Baggage Sorting Room	700	
Arr. Baggage Handling Room	700	

13.1.3 Layout of the Passenger Terminal Building

The most essential aspects of the passenger terminal building are a simple and easy-to-understand layout and an absence of unnecessary ups and downs. Owing to the projected equality in number between inbound or outbound passengers and transit passengers, our present plan calls for the Arrival and Departure Lounges on either side of the Depature Lobby which includes the Transit Room. On the curb side of the Arrival Lobby will be the 6-storied administration building which embrances the Control Tower, Government offices, restaurant, concessions, and other facilities.

Due to the grading of the entire airport site, the curb side of the terminal building is elevated one floor above the apron level, and this higher level is to constitute the first floor of the building. The Baggage Handling Area, Ramp Service Employees Office, Machine Room, and Bonded Warehouse are to be housed on the apron level, the first basement. On this floor is also a corridor running lengthwise through the building which serves as service road.

A mezzanine is also planned for the center of both departure and arrival lounges, above the ticket counter and above the arrival customs inspection counter, to be used as office space.

A concourse is to be built in the future between the Departure Lounge and the aircraft so that passengers may board the plane directly through the Boarding Bridge. For the 1980 plan, however, sloping corridors and moving sidewalks are to serve the purpose.

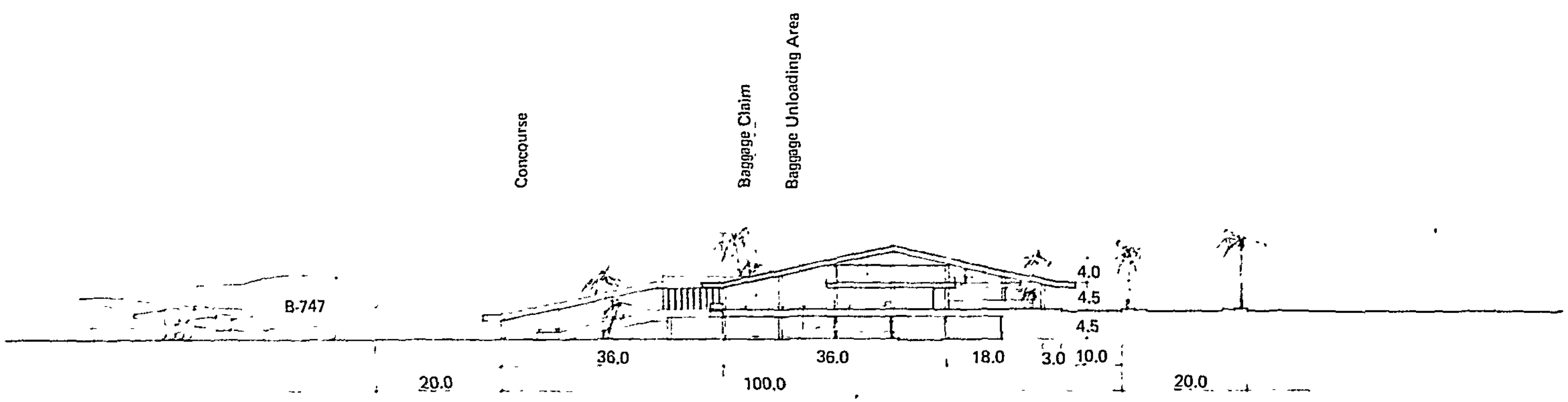


Fig. 13-1-1 Proposed International Airport Terminal Building Section

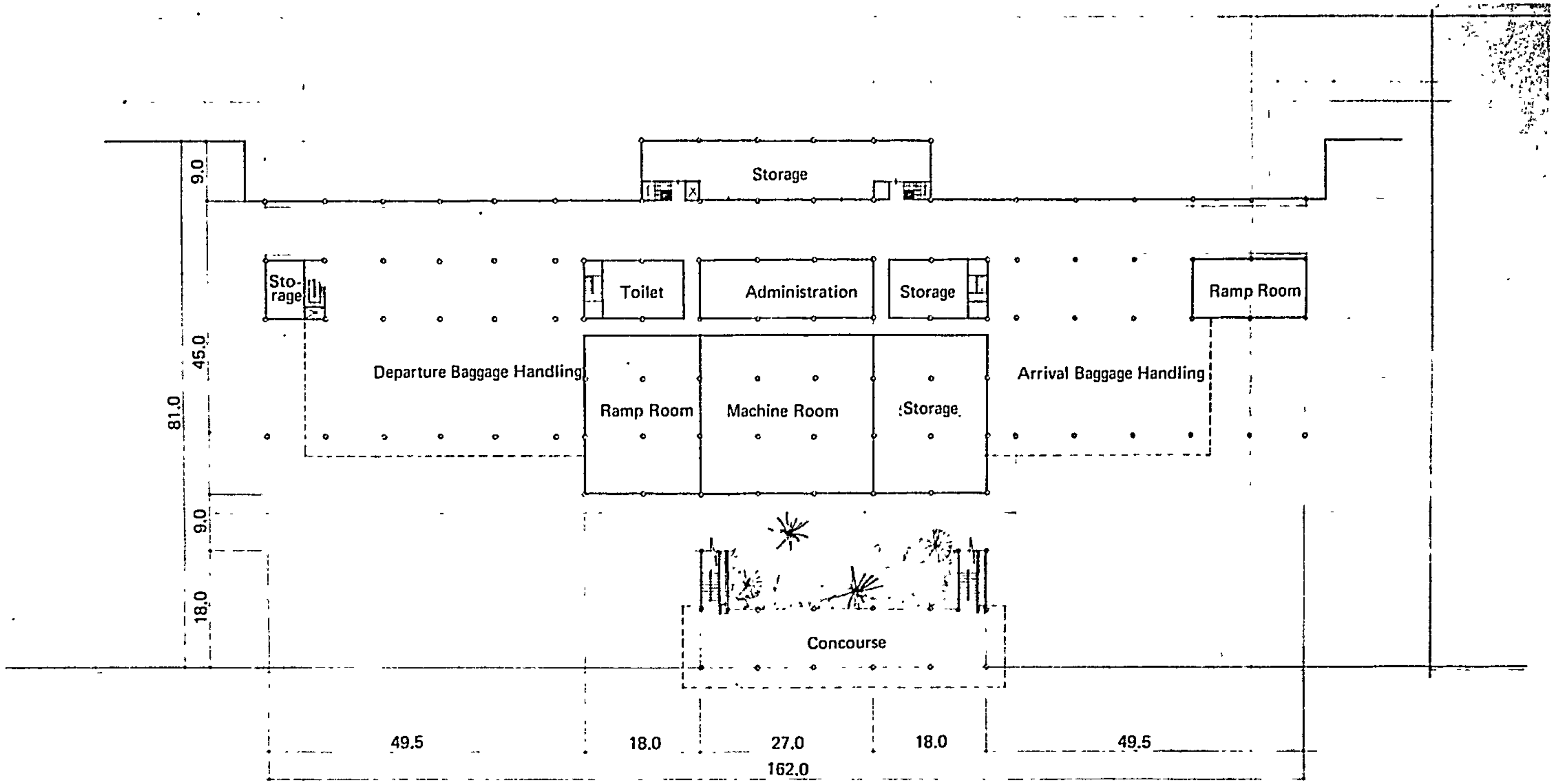


Fig. 13-1-2 Proposed International Airport Terminal Building Basement Floor Plan

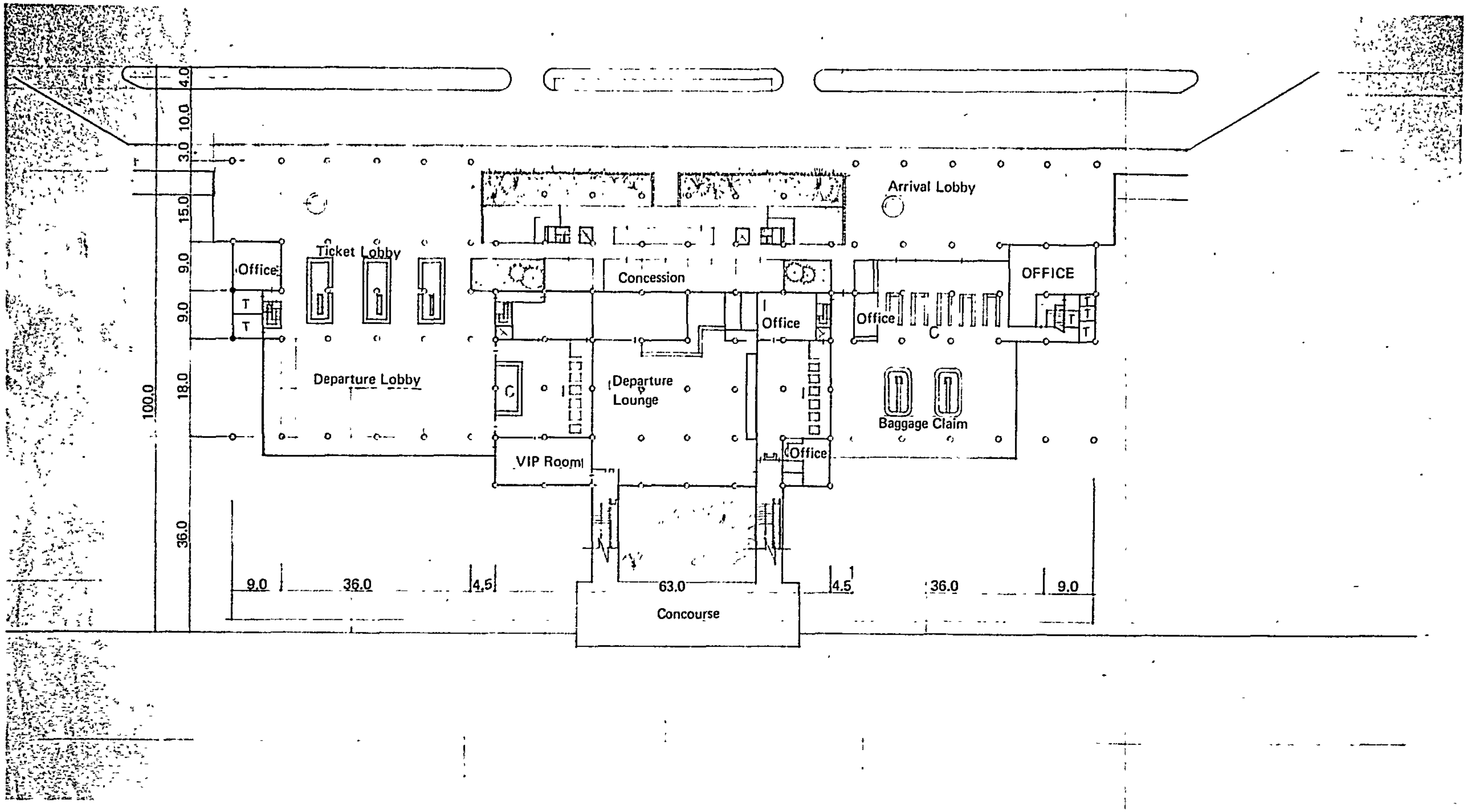


Fig. 13-1-3 Proposed International Airport Terminal Building 1st Floor Plan

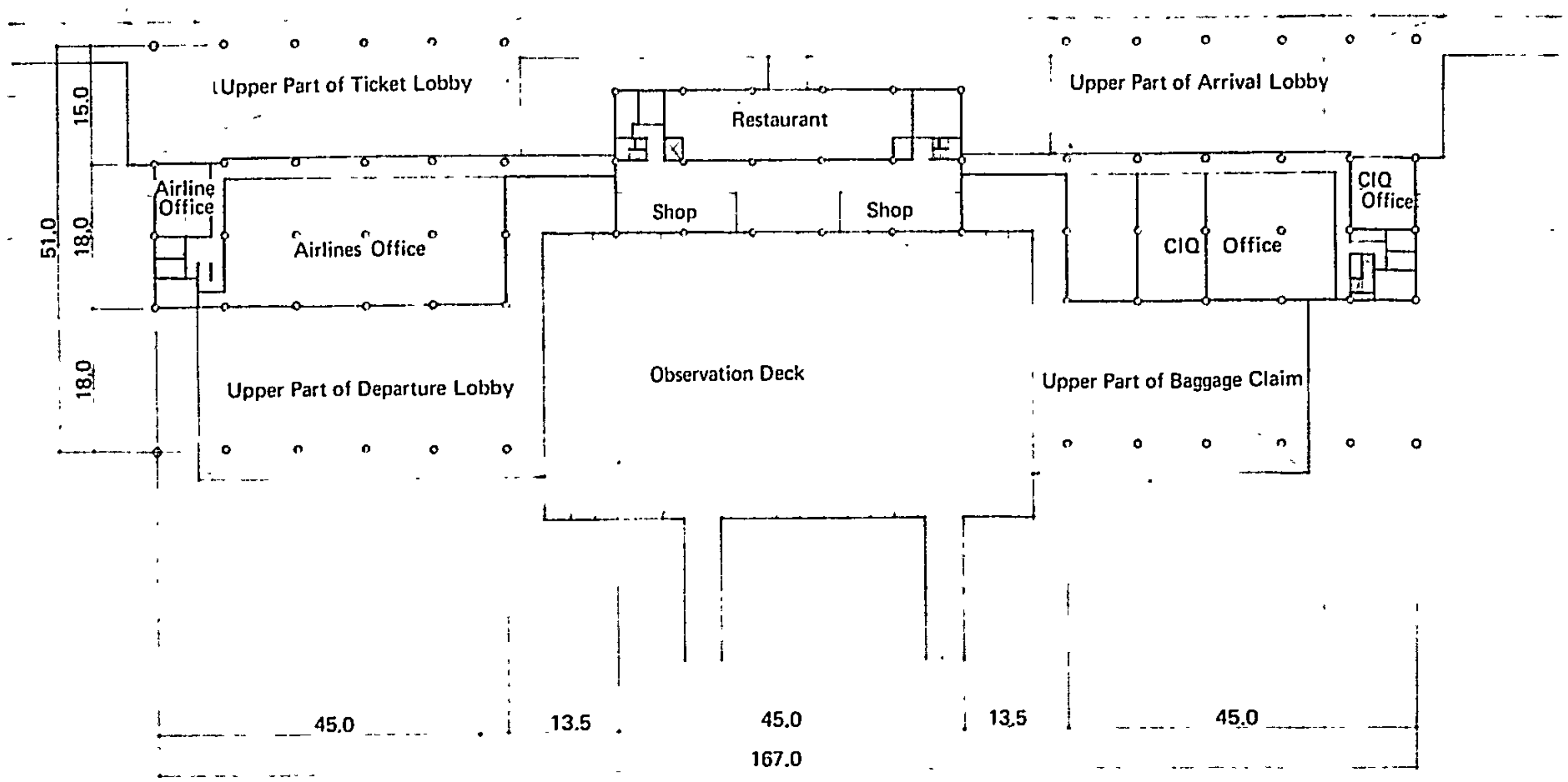


Fig. 13-1-4 . Proposed International Airport Terminal Building 2nd Floor Plan

13.2 Cargo Terminal Building

The existing airport handles, as of 1971, 7,600 tons of cargo annually and has the following cargo handling facilities:

Warehouses No. 1, 2	3,274m^2
Warehouses No. 3, 4	2,047
Transit Warehouse	552
Bad Condition Warehouse	207
Total;	6,080m^2

The present Transit Warehouse will need to be Expanded to approximately 2,000m^2 in future. Warehouse No. 4 presently has a 50m^3 freezer which also is to be expanded by 100m^3.

The 1971 handling capacity per square meter of the Warehouses at existing Ilopango Airport is calculated to be 1.5 tons annually. The standard cargo handling capacity in Japan at the moment is around 4 t/m^2 with manual operation, which can be raised to 15 t/m^2 through mechanization. In many airports of the world, a handling capacity of 10 t/m^2 is used as a base figure for planning and operations. The extremely low handling capacity of the existing Ilopango Airport seems to be due to long storage time in the bonded warehouse in addition to its dependency on manual handling. In our present plan for the new airport, we have calculated the space requirement on the basis of 1.5 t/m^2.

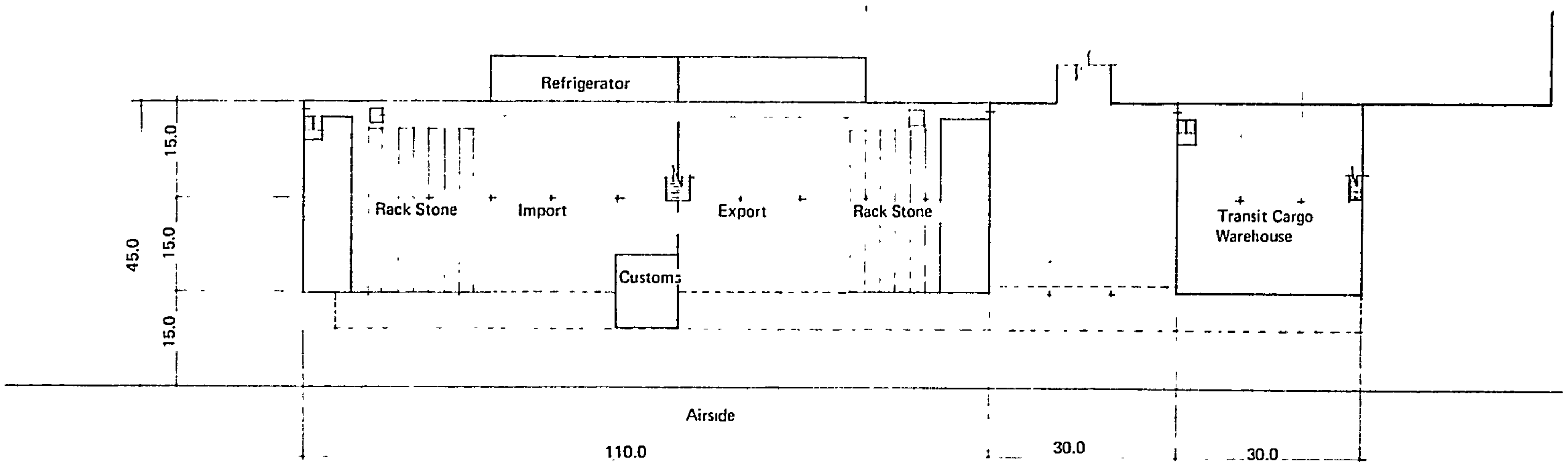


Fig. 13-2-1 Proposed Cargo Terminal Bldg. 1st Floor Plan

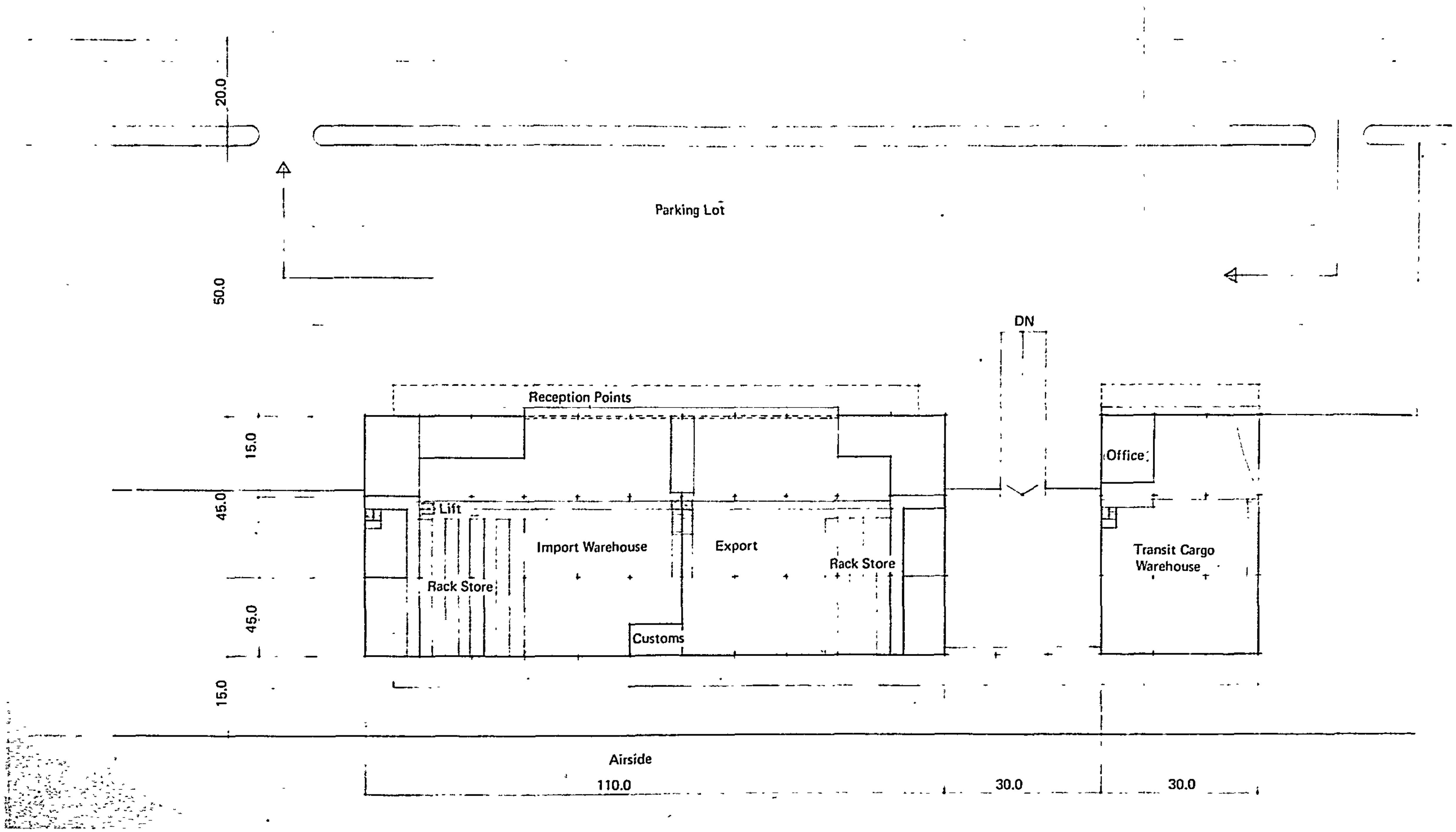


Fig. 13-2-2 Proposed Cargo Terminal Bldg. Basement Floor Plan

13.3 Flight Information System

(1) Introduction

The Flight Information System is a system to provide airport users at the terminal building, mainly air passengers, with a variety of compiled and digested information in connection with aircraft arrivals and departures, to allow rational and economical operation of the terminal building.

(2) Operation Method

There are two conceivable methods of operation of this system, one the central control method to effect the control collectively from one centralized unit, and the other the local control method to effect the control in each locality. The former not only is economically advantageous in case more than one airline jointly operate the terminal building, but also enables uniform information service to passengers. The building administration itself, or a special organization established for this purpose, will be put in charge if the central control method is adopted. The other method is appropriate for unilateral operation of the terminal building by one specific airline on a small scale. The operating airline naturally will manage the system alone in this case.

In view of the number of airlines using the new airport, the expected flight schedule, anticipated number of users, and the scale of the terminal building, along with expected future development, a plan incorporating the central control method seems to cater more efficiently to the needs of the projected airport.

(3) Composition of the System

The central control method as described above consists of three principal elements: An information cneter to compile air traffic information and transmit it to various places; a visual display system as the principal part of the flight information desplay system, displaying flight information visually; and a public address system to communicate flight information through auditory means. In planning these systems, introduction of computers to deal with an increasing amount of information in future should be given due consideration.

(i) Information Center

In providing information through the central control method, communications equipment necessary for compilation of information should be given ample consideration. The Center will be able to function fully away from public access areas if communications equipment is well provided. It will need at most an area of about 35 to 45 m^2 after taking into account future increases in both equipment and work load. The Announcing room, the Information Room, and the Machine Room will be housed within this space.

(ii) Flight Information Display System

This system consists of display equipment at strategic points along passenger movement routes for providing flight information. If this new airport is to adopt the central control system, the following functional requirements must be met:

1) sufficient capacity for display
2) sufficient display speed
3) easy handling of the equipment
4) sufficient visual distance
5) excellent designing
6) bi-lingual capacity for simultaneous display
7) low cost of the equipment and maintenance
8) easy administration and supervision

For areas which need relatively little central control, partial adoption of the local control system may be advisable. After considering a mixture of the various factors mentioned above, the most appropriate system may be the flap type display system, which is in use in various airports throughout the world.

The present system naturally needs to take into consideration monitoring equipment to keep track of the display situation. A popular method is to employ ITV.

(iii) Public Address System

This is to provide the users, primarily air passengers, with audible information. If the new airport is to adopt a central control method for its flight information display system with partial application of a local control system, the entire public space must be divided into several announcement areas, with arrangement to be determined the nature of information to be relayed. It is also necessary to maintain a constant proper level of volume and tone quality.

It is desirable in general to use both the mother tongue of the country (Spanish) and the more common international language of English.

In addition to this central announcement system, some local announcement facilities may be considered so that particular local needs may be better met.

In addition to the above general announcement services, emergency announcements should also be made possible as one of the necessary functions of the terminal building. A background music system should also be considered for its relaxing effect upon airport users.

14. Construction Estimate and Schedule

14. Construction Estimate and Schedule

14.1 Basis for Estimate of Major Construction

(1) Scope of Grading Work Plan

Figure 14.1.1 shows the areas to be covered by grading work under this plan, including the main runways, the alternate runways, the taxiways, aprons, parking areas, and part of the roads.

(2) Longitudinal Gradient of Runways and Taxiways

(i) Runways

Runway A: A slope of 0 - 0.45% adopted (See Figure 14.1.2)

Runway B: Gradient of 0.7% - 0.83% - 0.4% adopted

(ii) Taxiways

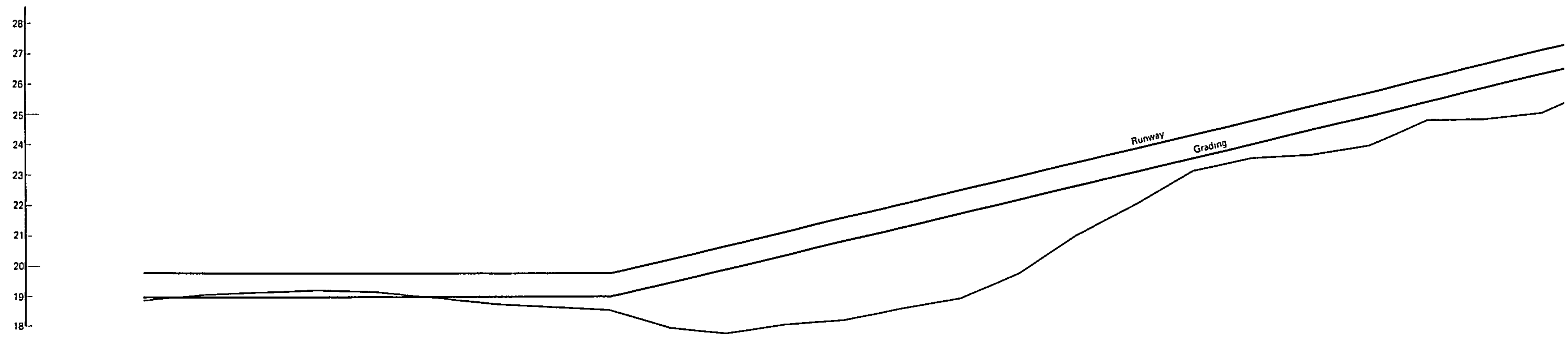
Taxiway C:	Gradient of	0 - 0.45%
S:	"	S
G:	"	0.1%

(3) Transversal Cross Section of Landing Strip (See Figure 14.1.3)

Grading formation is determined so as to equalize as much as possible the amount of earth to be excavated and banked to form the subgrade of pavement.

(4) Rainfall Intensity

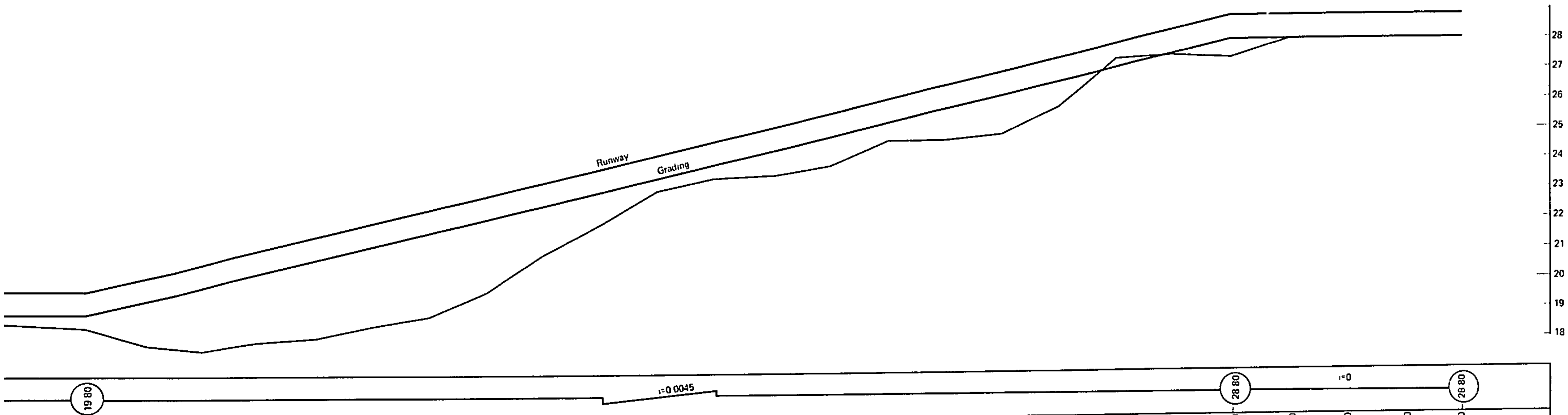
Fig. 14-1-1 Grading Area Plan



Point	Interval	Cumulative Distance	Ground Level	Formation	Elevation of R/W Pavement Surface
A 0		0	18.90	19.00	19.80
A 1	100	100	19.10	19.00	19.80
A 2	100	200	19.20	19.00	19.80
A 3	100	300	19.25	19.00	19.80
A 4	100	400	19.20	19.00	19.80
A 5	100	500	19.00	19.00	19.80
A 6	100	600	18.80	19.00	19.80
A 6 + 50	50	650	18.75	19.00 (19.05)	19.80
A 7	50	700	18.70	19.05	19.80
A 8	100	800	18.60	19.05	19.80
A 9	100	900	18.00	19.50	20.25
A 10	100	1,000	17.80	19.95	20.70
A 11	100	1,100	18.10	20.60	21.15
A 12	100	1,200	18.20	20.85	21.60
A 13	100	1,300	18.60	21.30	22.05
A 14	100	1,400	18.90	21.75	22.50
A 15	100	1,500	19.75	22.20	22.95
A 16	100	1,600	21.00	22.65	23.40
A 17	100	1,700	22.00	23.10	23.85
A 18	100	1,800	23.10	23.55	24.30
A 19	100	1,900	23.50	24.00	24.75
A 20	100	2,000	23.60	24.45	25.20
A 21	100	2,100	23.90	24.90	25.65
A 22	100	2,200	24.70	25.35	26.10
A 23	100	2,300	24.70	25.80	26.55
A 24	100	2,400	24.90	26.25	27.00

Gradient of R/W: (19.80) i=0 (19.80) i=0.0045

Fig. 14-1-2 Longitudinal Section along Center Line of Runway A



	19 80	19.80	20.25	20 70	21 15	21 60	22.05	22 50	22 95	23.40	23 85	24.30	24.75
(19 05)	19 05	19 05	19.50	19 95	20 60	20 85	21.30	21 75	22 20	22.65	23 10	23 55	24 00
	18 70	18 60	18 00	17 80	18 10	18.20	18 60	18 90	19 75	21 00	22 00	23 10	23 50
	700	800	900	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,800	1,900
	50	100	100	100	100	100	100	100	100	100	100	100	100
+50	A 7	A 8	A 9	A 10	A 11	A 12	A 13	A14	A 15	A 16	A 17	A 18	A 19

25 20	25 65	26.10	26 55	27.00	27.45	27.72	27 00	28.35	28 80	28 80	28 80	28 80	28 80
24 45	24 90	25 35	25 80	26 25	26 70	(26 97) 26 92	27 10	27.55	28 00	28 00	28 00	28 00	28 00
23 60	23.90	24 70	24 70	24 90	25 80	26.70	27 40	27.50	27 40	28 00	28.00	28 00	28 00
2,000	2,100	2,200	2,300	2,400	2,500	2,560	2,600	2,700	2,800	2,900	3,000	3,100	3,200
100	100	100	100	100	100	60	40	100	100	100	100	100	100
A 20	A 21	A 22	A 23	A 24	A 25	A 25 + 60	A 26	A 27	A 28	A 29	A 30	A 31	A32

Fig. 14-1-2 Longitudinal Section along Center Line of Runway A

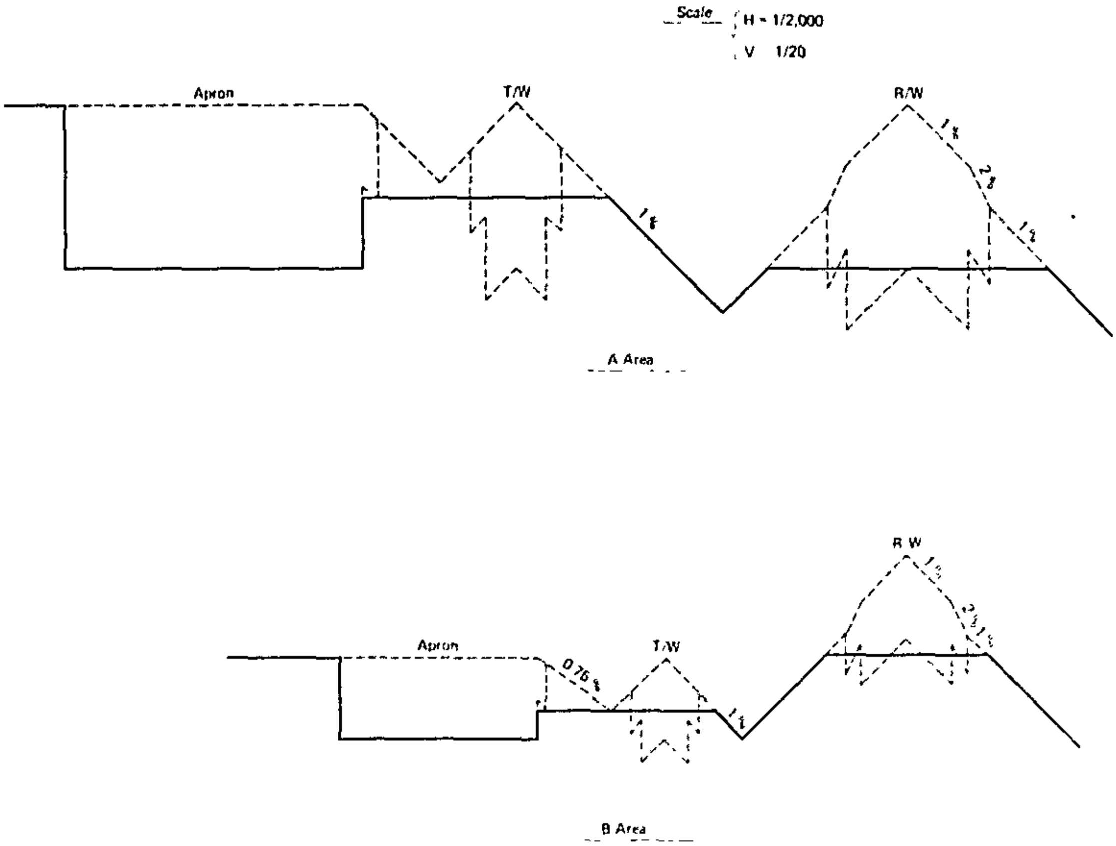


Fig. 14-1-3 Grading Standard Cross Section

Although we should deal with rainfall intensity that might occur once in three to five years (once in five years for the Federal Aviation Agency), it is extremely difficult to give accurate estimates due to lack of detailed meteorological data concerning the site of our study. We assume the following after considering annual rainfalls, monthly rainfalls, and the number of rainy days in the neighboring areas, as well as certain general features:

with hourly rainfall taken as 30 mm,

$$i = \frac{3,600}{t + 60}$$

(i = rainfall intensity in mm/h, and t = duration in minutes).

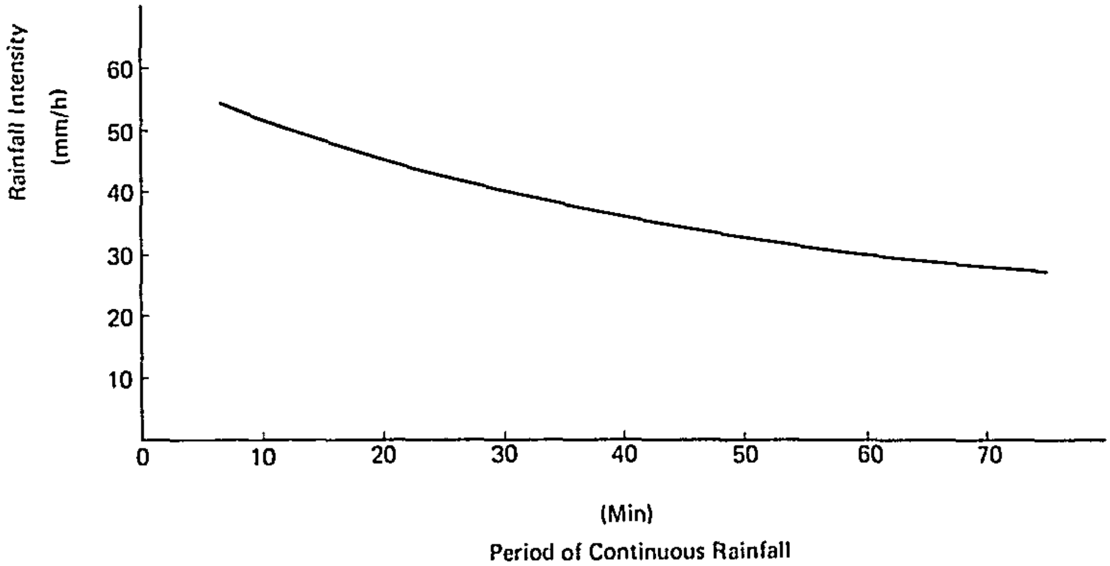


Fig. 14-1-4 Rainfall Intensity Curve

(5) Drainage System

The airport site projected here forms a general downward slope from northeast to southwest, and there is no river within or around the site with the potential to be used as the drainage system for the airport. It is not possible to effect drainage to Rio Jiboa, flowing to the east of the site, because of the relatively high elevation of that river. We therefore propose construction of open ditches around the landing strips to prevent water in-flow from surrounding areas, and to collect all the drainage to be led away to the swamp in the southeast of the airport. In proposing this, we have taken into account the fact that the ground water level around the site is high.

(6) Basis for Runoff Computation

(1) Runoff Coefficient

asphalt pavement surface	0.9
turfed surface	0.3
natural ground surface	0.1

(2) Surface Slope

Assumed to be 0.5% throughout

(3) Surface Flow Times

Based upon the Surface Flow Time Curves of the Federal Aviation Agency

(4) Slope of Pipe

Assumed to be 0.3% throughout

14.2 Estimated Construction Costs

Table 14-2-1 Breakdown of Project Costs

Unit: Million Yen

Exchange Rate: 1 colon = ¥ 123

	Construction Cost	Design, Engineering and Unforeseen Expenditure	Total	Domestic Portion	Foreign Portion
Civil Engineering	4,104	492	4,596	2,561	2,035
Terminal Facilities	1,886	189	2,075	653	1,400
Lighting	830	99	929	202	727
Nav-Aid Facilities	500	50	550	47	503
Sub Total	7,320 *	830	8,150	3,463	4,687
Land Acquisition Cost	324	-	324	-	-
Total	7,644 (62,146 thousand colon)	830 (6,747 thousand colon)	8,474 (68,894 thousand colon)	3,463 (28,154 thousand colon) [42.5%]	4,687 (38,106 thousand colon) [57.5%]

Note: * Does not include freight, insurance, import duty, and contingency allowance, which amount to 1,309 million yen.

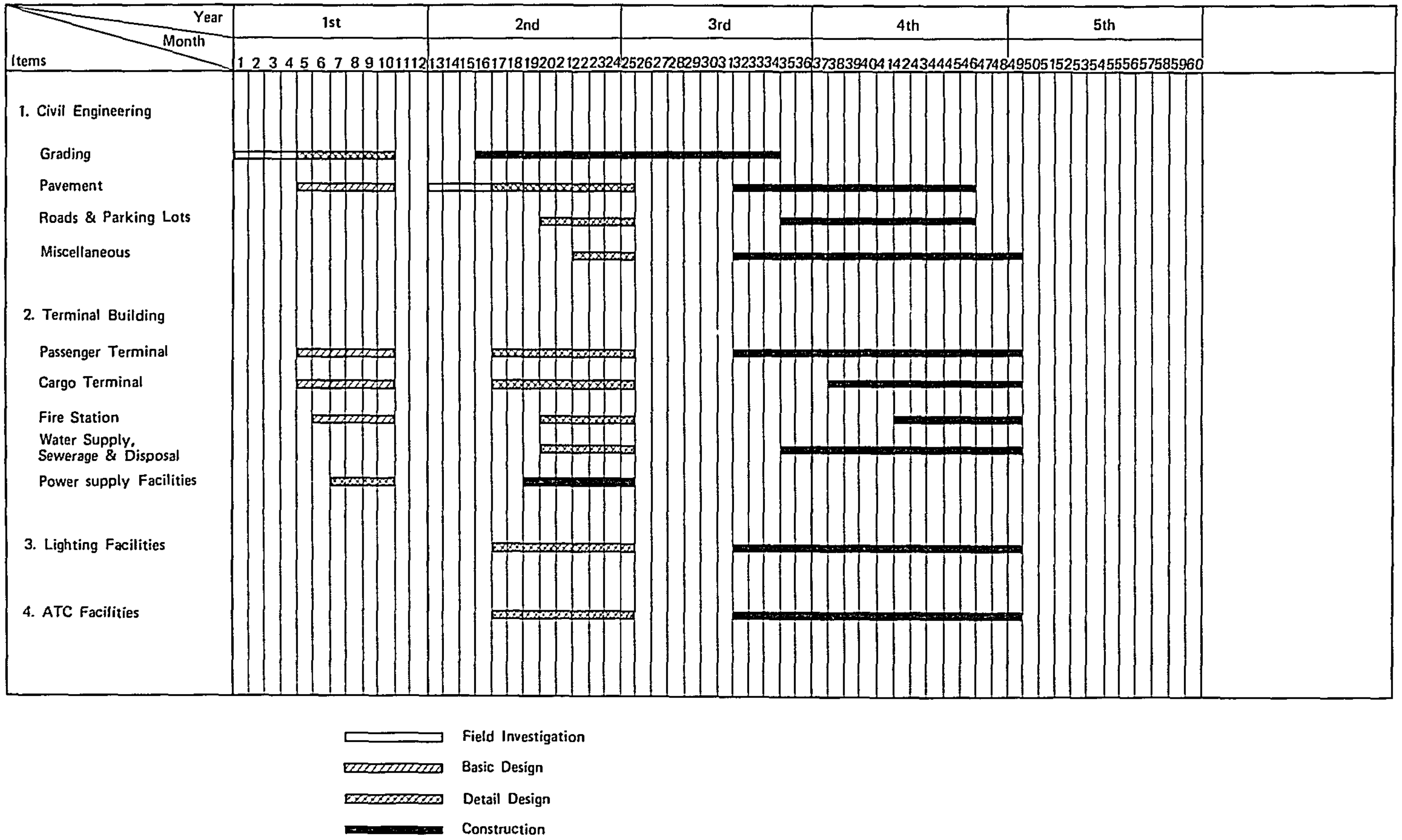


Fig. 14-3-1 Construction Schedule for the New Proposed Airport

14.3 Construction Schedule

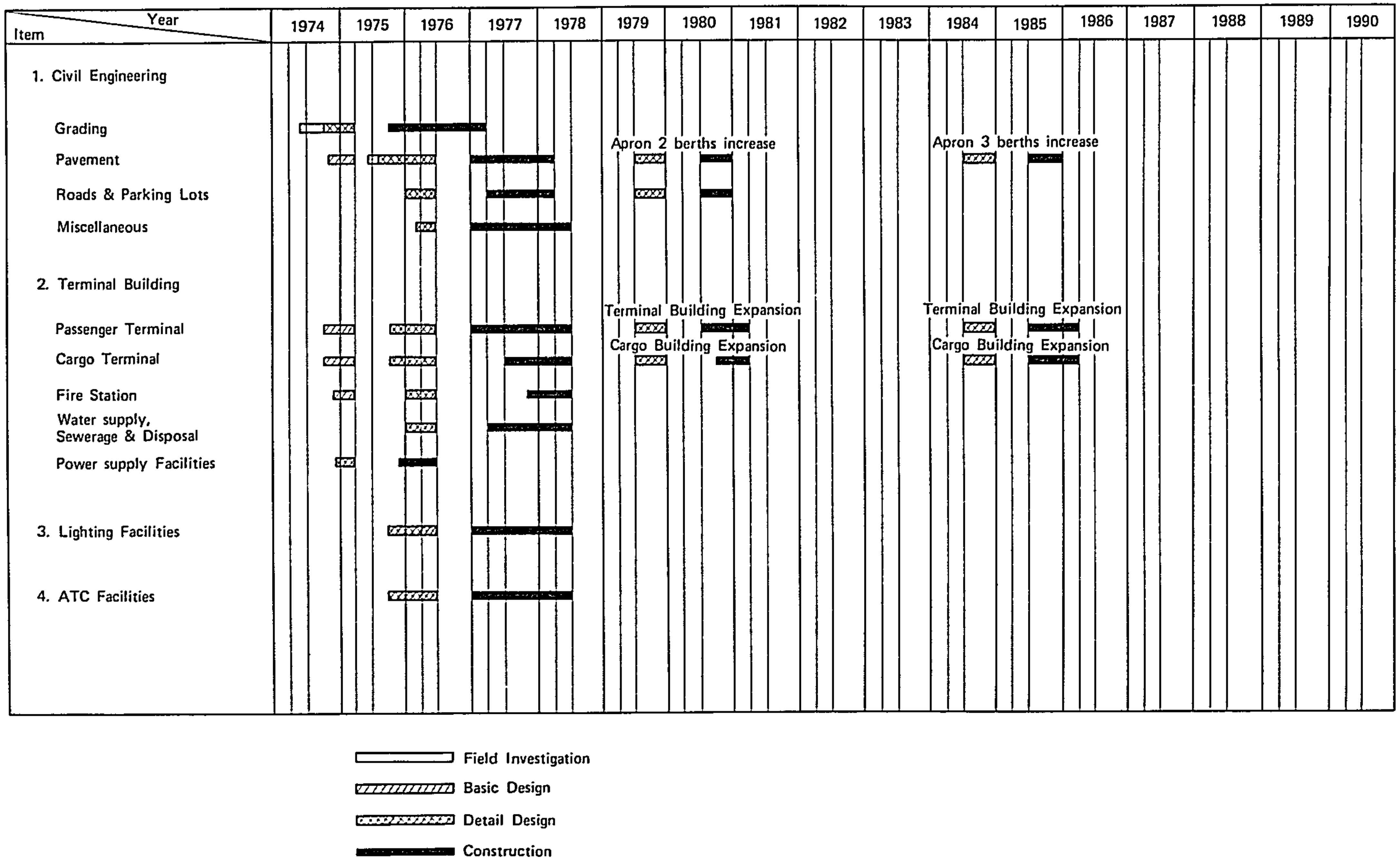


Fig. 14-3-2 Construction Schedule for the Proposed Airport

14.4 Summary Table of Facilities

Table 14-4-1 (1) List of Facilities

Item			1980	1990
Location			Astoria	Same as left
Reference Point		Latitude Longitude Elavation	N 13° 33' 29" W 89° 09' 07" 26 m	"
Runway Orientation			(A) N 70° E (B) N 0° E	"
Airport Surface Area			876.6 ha	"
Basic Facilities	Landing Strip		(A)3,320 x 300=996,000m^2 (B)2,020 x 150=303,000m^2	"
	Runway		(A)3,200 x 60 =192,000m^2 (B)1,900 x 45 = 88,500m^2	
	Over-Run		(A) 60 x 60 = 7,200 m^2 (B) 60 x 45 = 5,400 m^2	"
	Turning Pad		(A) 4,812.2 x 2 = 9,825m^2	"
	Runway Shoulder		(A) width 10m 44,472m^2 (B) " 7.5m 26,545m^2	"
	Taxiway		(A) width 30~35m 126,486m^2 (B) " 23~27m 84,067m^2	(A) 175,237 m^2 (B) 84,067 m^2
	Holding Bay			(A) 12,578.2 x 2 = 25,157 m^2
	Taxiway Shoulder		(A) width 7.5m 49,470m^2 (B) " 5.0m 27,133m^2	(A) 72,896 m^2 (B) 27,133 m^2
	Apron		Passenger Loading 8 berths (61,800 m^2)	13 berths 95,400m^2
			Cargo, Maintenance 3 berths (31,200 m^2)	5 berths 43,800m^2
			General Aviation 70 berths (21,560 m^2)	130 berths 38,500m^2
	Apron Shoulder		(A) width 20 m (B) " 5 m	Same as left "

Table 14-4-1 (2) List of Facilities - continued

	Item	1980	1990
Airport Lighting Facilities	(A) Runway		
	(1) Approach Lights	1 set	
	(2) Approach Light Beacons	1 "	
	(3) Visual Approach Slope Indicator	1 "	
	(4) Runway Edge Lights	1 "	
	(5) Runway Threshold Lights	1 "	
	(6) Runway Threshold Addition Lights	1 "	
	(7) Runway End Lights	1 "	
	(8) Runway Centerline Lights	1 "	
	(B) Runway		
	(1) Runway Edge Lights	1 "	
	(2) Runway Threshold Lights	1 "	
	(3) Runway End Identification Lights	1 "	
	(4) Runway End Lights	1 "	
	(5) Visual Approach Slope Indicator	1 "	
	Taxiway		
	Taxiway Edge Lights	1 "	
	Aerodrome Beacon	1 "	
	Wind Direction Indicator Lights	1 "	
	Obstruction Lights	1 "	
	Apron Flood Lights	1 "	
	Power Facilities	1 "	
ATC Relating Facilities	ATC Facilities	1 set	
	Air Ground Communication Facilities	1 "	
	VHF Communication Equipments	1 "	
	H F Communication Equipments	1 "	
	ATC Console	1 "	
	Others(Engine Generated)	1 "	

Table 14-4-1 (3) List of Facilities

Item		1980	1990
	Communication Facilities	1 set	
	Aeronautical Fix Telecommunication Facilities	1 "	
	Teletype Facilities	1 "	
	Aeronautical Mobile Service Facilities	1 "	
	VHF Facilities	1 "	
	H F Facilities	1 "	
	ATS Facilities	1 "	
	Radio Navigational Facilities		
	VOR/DME		
	ILS		
	ASR		1 set
	DF		1 "
	Ground Mobile Communication Facilities and SELCAL		1 "
	Automatic Teletype Relay System		1 "
	New Instrument Landing System		1 "
Terminal Facilities	Passenger Terminal	20,000 m^2	
	Cargo Terminal	10,000 m^2	
	Hanger	500 m^2	
	Crash Fire Station	1,500 m^2	
	Fueling Facilities	1 set	
	Water Supply Facilities	1 "	
	Sewage Disposal Facilities	1 "	
	General Aviation Facilities	5,000 m^2	
	Road and Parking Lots		
Others	Other Facilities	1 set	

15 Cost-Benefit Analysis

15 Cost-Benefit Analysis

15.1 General

15.1.1 Cost-Benefit Analysis of Investments in Transportation Facilities

Investments in transportation facilities - roads, railways, ports and harbors, and airports - constitute an important part of infrastructure of the nation's economy; for transportation facilities provide a network of veins through which the life blood of an economy circulates. An efficient system of transportation serving the vast multitude of economic units scattered across the country therefore is essential for a viable growth of the economy. It connects and integrates the various sectors of the economy, and expansion of transportation system itself creates substantial demands for other sectors of the economy.

In considering a given investment plan for the construction of transportation facilities, decision should be made not merely on the basis of the projected rates of return on the investment but on the basis of the extent to which the investment is expected to contribute to the growth of the economy as a whole. In this context, the benefits derivable from an investment in transportation facilities cannot be measured in money terms alone. It therefore follows that the decision on an investment in transportation facilities should be based on long-term and wide-ranging benefits that can be reasonably expected from it, not on short-term and measurable monetary returns. Preoccupation with short-term monetary returns may mislead the decision to an investment in more quick-return oriented projects at the expense of long-term social interests which otherwise could have been gained. This is all the more the reason why most sophisticated and scientific studies must be made to measure as much as possible the social benefits of a long-term project, and this is particularly true of longer-term projects.

But it must be admitted that even a most scientific study cannot wholly grasp the social benefits that can be derived from a long-term investment. Therefore, utmost care should be taken to seek out every possible benefit which a project is potentially capable of giving. A technique designed to supplement such deficiency in the measurement of future benefits is the cost-benefit analysis.

As we have seen above, the cost-benefit analysis technique is not primarily designed to show the effects of an investment in money terms; its primary aim is to measure the long-term and wide-ranging social and economic benefits of a given investment. Incidentally, the cost-benefit analysis is a tool widely used all over the world in the analyses of large, long-term projects involving transportation facilities, development of water resources and urban renewal, etc.

It is conceivable that the effects of an investment in transportation facilities can be particularly large and far-reaching in countries where the transportation system is in incipient stage simply because a system of improved transportation system plays the vital role of an infrastructure.

15.1.2 Cost-Benefit Analysis of an Airport Project

It has become an established practice among many countries that a decision on such a large-scale investment as the construction of an international airport is preceded by, and based on, an extensive cost-benefit analysis. The Roskill Report of Great Britain and the Cost-Benefit Analysis Report of the Kansai International Airport of Japan are good examples.

The necessity of a cost-benefit analysis in planning the construction of an airport is rooted in the very nature of airport. Firstly, an airport is a facility for the exchange of people among countries, and as such, has an important role to play in the promotion of foreign trade. Given the increasing level of interdependence among nation's of today's world, economic, political and cultural exchange is bound to become even more pronounced in the future. An overwhelming majority of international travellers, both in-and out-bound passengers, are airborne, and the first point of contact of these vast number of visitors with the receiving country is an airport. The quality and appearance of the facilities and service one meets at such an initial point of contact, that is, an airport, play a decisive role in impressing him, good or bad, so much so that the Roskill Report called what is at stake, aptly enough, as "national dignity."

Secondly, unlike in the case of other types of transportation facilities, an airport induces industrial development in neighboring areas. The sheer volume of infinitely varied kinds of service which an airport requires create new opportunities for commerical and industrial activities. And joint development of surrounding communities is another possibility. If certain types of export product can be manufactured in nearby plants, the economic role of the airport can be greatly enhanced. There are many successful attempts made along this line - and with good results.

Thirdly, as in the case of other types of transportation facilities, construction of an airport provides important stimulus to the construction and related industries. Installation of necessary terminal and navigation facilities requires a wide-ranging variety of products and materials - basic raw materails, electric power and all sorts of machinery and equipment. The needs an airport create bring a series of impetus to the local industries.

Benefits derivable from the construction of an airport are more than financial. In fact, many airports are built with these long-term and wide-ranging benefits in mind.

15.1.3 Benefits Derived from the Construction of an Airport

Matters taken into consideration in measuring benefits derivable from the construction of an airport include:

1) Primary Effects

a. User benefits
b. Construction effects
c. Development effects

2) Secondary Effects

a. Effects on foreign trade
b. Effects on international exchange
c. Effects on industrial structure

In analyzing the cost/benefit relationships involved in the construction of the proposed international airport in El Salvador, we felt that it was necessary to analyze these effects. In analyzing them, we are faced with two major difficulties: one is the difficulty of representing the benefits in money terms, and the other is the difficulty of measuring with any objectively measurable accuracy the benefits, especially those of secondary effects, while they are admittedly large. Nevertheless, we shall examine specific items of benefits in the following pages.

15.2 Classification of Benefits and Costs

Table 15.2.1 Classification of Benefits and Costs

Benefits	Primary Effects	a. User benefits a-1 Benefits to air passengers: reduced travel time, improved comfort of travel, enhanced safety, increased convenience a-2 Benefits to airport management (revenues) b. Construction effects c. Development effects
	Secondary Effects	a. Effects on foreign trade b. Effects on international exchange c. Effects on industrial structure
Costs	Direct Costs	a. Airport construction costs b. Airport expenditures c. Development costs for surrounding areas d. Noise control costs e. Compensation for fishery and agricultural interests
		a. Loss of benefits which otherwise could have been derived from displaced projects b. Loss in the form of destruction of natural environment c. Loss of opportunity due to delay in construction d. Increased level of costs attendant upon a developed industrial structure

15.2.1 Classification of Benefits

In this section, we shall examine the substances of benefits derivable from the construction of an airport, dividing them into six items mentioned above.

1) Primary Effects

a. User Benefits

a.1 Benefits to air passengers

Reduced travel time: Compared with other means of transportation, travel by air helps passengers save tremendous amont of travel time. Given the emphasis on the improvement of productivity, time is bound to increase its value and the travel time reduced by air travel will make a profound contribution to increasing the production of goods and services of an economy. The benefits of reduced travel time can be measured by representing the value of unit time in money terms.

Improved comfort of travel: Of late, technological improvement in aircraft engineering has been simply remarkable. Sound-proofing is so complete that the B-747s and air buses are virtually free from noise and the excellent in-flight service and comfort enable passengers to enjoy their pleasant trip. The efficient service one receives at a modern airport enhances the pleasure of air travel.

Enhanced Safety: It is a proven fact that the per-mile rate of accident of aircraft is the lowest of all means of transportation. And thanks to a number of latest technological innovations, the safety of aircraft has been improving still further with the years. In veiw of the fact that 80% of accidents occurred at the time of landing or take-off, most up-to-date navigation aids are planned for the new airport to insure vastly improved safety of aricraft operations at the airport, and the benefits which passengers stand to receive from such installation will be greatly enhanced.

Increased convenience: The scale and quality of the facilities of the new airport will be sufficient to accommodate any known wide-bodied aircraft, and the number of seats and flights they offer will serve the convenience of passengers using the airport.

a.2 Benefits to Airport Management

Revenues generated by the management from the operation of the airport are clearly identifiable benefits accruing to the management, and they can be measured by simply adding those of various items of business.

b. Construction effects

The construction work of the airport increases demand for construction materials and employment, skilled as well as unskilled, which in turn raise the level of income, adding to the private consumption expenditures. While it is difficult to accurately measure the overall effects of such benefits, it is generally agreed that they are of substantial proportion.

c. Development effects

When an airport is constructed in an area, industries catering to the needs of the airport are concentrated in surrounding areas, and the effects the airport has on the nation's economy are profound and far-reaching. Industries that may conceivably gather around the airport include those directly catering to the needs of the airport and those which benefit from ready access to the airport in the way of increased added value to their products. And they can be classified into the following three types:

(1) Industries catering to the functional and maintenance needs of the airport

(2) Industries which use aircraft for the shipment of their products

(3) Industries siting in the neighboring towns to serve their needs

Industries of Category (1) include aircraft maintenance plants, fueling business, banks, insurance companies, airleines agents, hotels, government office, cargo forwarding agents, warehouses, taxi and bus companies, in-flight service companies, gift shops, restaurants and travel agents catering to air passengers, sightseeing visitors and well-wishers.

Those of Category (2) consist of businesses supplying aircraft maintenance parts and related facilities and those which frequently utilize aircraft for the shipment of their products. However, due to the highly sophisticated level of technology involved in the former type of business, majority of this category may, for the time being, be those of the latter type.

With respect to industries of Category (3), they are not usually induced by the needs of an airport itself. As seen in other countries, however, many airports are followed by the development of what is konwn as airport town. Improved access roads and transit facilities which usually accompany an airport attract population around the airport, and the increasing availability of labor in such communities in turn attracts industrial plants.

2) Secondary Effects

a. Effects on Foreign Trade

Construction of an airport creates new routes of distribution of goods by aircraft, connecting many markets. An efficient and quicker delivery of goods serves to expand the market for domestic products, creating further demands which are translated into an increased volume of external trade of the country.

b. Effects on International Exchange

An easy and safe access of foreigners to the country would mean increased number of tourists and business visitors. The hard currency which these visitors expend while in the country can be an important source of foreign exchange earnings. They also stimulate the development of tourism-related industries, e.g., construction of hotels,and improved tourist facilities will further attract foreign tourists.

c. Effects on Industrial Structure

Construction of an airport represents a large-scale public investment. Economists are generally agreed that public spending of a scale involved in such a project creates multiple effects which means an increase in national incomes by more than the effects normally expected from an isolated individual expenditure. When investment is represented by I and the national incomes by Y, the above multiple effect relationship is shown as dY=kdI. In other words, an increase in investment (dI) brings about a multiple (k) increase in the national incomes (dY). Generally, k is a positive number larger than one. Therefore, it is assumed that the effects on the increase of national incomes are larger than the amount of investments sunk in the construction of an airport. Its effects do not end there; construction of an airport triggers the concentration of population in neighboring cities, which increases the weight of the secondary and tertiary industries of the area, and thus the industrial structure of the country becomes accentuated by the manufacturing and service industries.

15.2.2 Classification of Costs

Costs involved in the construction of an airport are divided into two categories: direct and indirect costs.

1) Direct Costs

a. Airport Construction Costs: They consist of the costs for the construction of airport, including the land price of the site.

b. Airport Expenditures: They represent the costs for operating and managing the airport.

c. Development Costs for Surrounding Areas: These go to the development of environment in surrounding areas.

d. Noise Control Costs: Noise-proofing facilities must be installed on residences and public facilities that are located within a certain level of noise contour.

e. Compensation for Fishery and Agricultural Interests: When the fisheries and agriculture in the vicinity of an airport suffer damage on account of the construction of the airport, their damage must be compensated for.

2) Indirect Costs

a. Loss of Benefits which Otherwise Could Have Been Derived from Displaced Projects: These represent the losses incurred on account of the postponement or discontinuation of other public projects which were put off or shelved due to the construction of an airport on the site.

b. Loss in the Form of Destruction of Natural Environment: They include damage to the ecology of the surrounding area resulting from the land development of the site or aircraft noise.

c. Loss of Opportunity due to Delay in Construction: A delay in the construction of an airport means a serious loss to other projects.

d. Increased Level of Costs Attendant Upon a Developed Industrial Structure: Construction of an airport attracts concentration of population in the surrounding communities and the level of their industrialization advances. Such development entails the construction of roads, city water and swerage system, which increase the social costs.

15.3 Measurement of Benefits and Costs

15.3.1 Measurement of Benefits

Of the various items discussed under 15.2.1 measurement will be taken of those which are amenable to relatively accurate grasping.

1) Reduced Travel Time

a. The benefits which passengers stand to gain by the use of air transportation can be measured in terms of the differences in fares between air and surface travel by introducing the concept of the value of time spent and represent them in money terms. In the case of El Salvador, an overwhelming majority of international travellors travel either by air or by car. Accordingly, the time-reduced benefits per passenger can be shown in the following equation:

$$B = (C_R + vT_R) - (C_A + vT_A)$$

B: benefits gained from reduced travel time

C_R: car fares

T_R: time required by car

C_A: air fares

T_A: time required by air

v : value of time

b. Value of Time

The coefficient used in the computation of money value of time expended is called the value of time, and it varies from one traveller to another. Of the various methods of determining the value of time, such as incomes approach or cost approach, we decided to take the incomes approach for the measurement of the value of time. Under this method, the total incomes derived from the production of all industries are divided by the number of man-hour required to achieve such incomes, and the resulting coefficient represents the average value of hour.

According to statistics for 1971, the total incomes of El Salvador's industries were 2,681-million colons and the total number of persons employed for the production was 1,314,857. Accordingly, the per-capita production income was 2,039 colons. Assuming that each of them worked a total of 260 days, seven hours a day, the average per-capita hourly production income works out at 1.12 colons. In other words, the average value of an hour in 1971 was 1.12 colons. However, a large percentage of those who travelled by air conceivably came from those belonging to brackets of higher incomes, whose time should appropriately be considered worth three to five times the above-mentioned average value of an hour. Further, taking into consideration the projected rate of increase in the national income of El Salvador till 1978, the year in which the new airport is to be completed (this being estimated at 3% a year), the value of an hour for each air passenger in 1978 is estimated at 5.5 colons.

c. Air Routes

The air routes foreseen in the present measurement include:

To the United States:

San Salvador - Miami (including New York and Washington, D.C.)
- Los Angeles (including San Francisco)
- New Orleans (including Houston)

To Central American countries:

San Salvador - Mexico
- Guatemala
- Managua

If and when the airport in El Salvador was rendered incapable of accommodating flights, travellers who otherwise would have used aircraft may elect to travel by car as far as Guatemala and from that point on, travel by air. And to Central American destinations, it would be more economical to travel by car.

d. Measurement

Benefits gainable during the first year of operation of the new airport, computed on the above-mentioned premise, are shown in Table 15.3.1. Assuming the proejct life of the new airport to be 30 years and the value of time to increase at an annual rate of 3%, the gross benefits foreseen during the life of the airport as discounted in terms of 1972 value would be as shown in Table 15.3.2.

Note: This measurement includes benefits which are attributable to the existing Ilopango Airport.

Table 15.3.1 Measurement of Benefits Gained from Reduced Travel Time (1978)

Route	By Car								By Air					(B)	(A)-(B)	Nr.of passengers	Gross Benefits
	C_R			UT_R				(A)	C_A	UT_A							
	C_R	$C_{A'}$	C_R+C_A		T_R		V	C_R+UT_R		T_A			V	C_A+UT_A			
	colon	colon	colon	TR (H)	TA' (H)	TH+TA' (H)	colon	colon	colon	Access Time (H)	TA (H)	Access Time+T_A (H)	colon	colon	colon		colon
San Salvador-Miami	16	230	246	4.23	2.33	6.56	5.5	282	230	0.60	2.25	2.85	5.5	246	36	30.556	1,100.016
San Salvador-Los Angeles	16	390	406	4.23	4.75	8.98	5.5	455	413	0.60	5.17	5.77	5.5	445	10	20.443	214.430
San Salvador-New Orleans	16	220	236	4.23	2.42	6.65	5.5	273	230	0.60	2.50	3.10	5.5	247	26	7.684	199.784
San Salvador-Mexico	101	-	101	26.42	-	26.42	5.5	246	203	0.60	1.75	2.35	5.5	216	30	21.800	654.000
San Salvador-Guatemala	16	-	16	4.23	-	4.23	5.5	39	43	0.60	0.50	1.10	5.5	49	▲10	43.422	434.220
San Salvador-Mangua	39	-	39	10.08	-	10.08	5.5	94	83	0.60	0.67	1.27	5.5	90	4	51.999	207.996

Note: 1. The number of passengers represents passengers resident in El Salvador. With respect to the ratio between resident passengers and non-resident passengers, the data of Ilopango Airport were used for the first year, or 4 to 6. It is assumed that the ratio of resident passengers will subsequently increase, reaching 6 to 4 in the 30th year.

2. Under the heading "By Car", it is assumed that travellers to Central and South American destinations will use cars and those destined to North America will travel by car as far as Guatemala in case the airport in El Salvador is rendered out of commission.

3. It is assumed that the car will travel at an average speed of 60 km/hr at the cost of 0.064 colon per km.

4. The distance between San Salvador and the airport is 36 km and cars will be used.

5. $C_{A'}$ and $T_{A'}$ represent the fares and time needed in case passengers use the airport of Guatemala.

(2) Airport Revenues

Airport revenues are generated from two sources: airport operating revenues and tax revenues. Airport operating revenues consist of landing charges, parking charges, passenger terminal building rentals, cargo terminal rentals, car parking charges, restaurants, observation deck admission fees and public address system charges, while tax revenues are derived from air passenger service charges, fuel tax and ticket tax. Details of computation of these charges are discussed under 15.4 below.

As in the case of airport expenditure, computation of airport revenues for the first 15 years was done by simple addition, and those from the 16th year and afterward were computed at an annual rate of increase of 8.5%.

15.3.2 Measurement of Expenditures

In this section, only those items of the expenditures listed under 15.2.1 which can be measured are included.

(1) Airport Construction Costs

As mentioned under 14.2 (estimated construction costs), the construction costs for Phase One (ending in May, 1978) including the cost of land are estimated at 68,447,000 colones. Their breakdown is as follows:

Civil engineering	37,366,000	colones
Terminal construction	16,691,000	"
Lighing	7,553,000	"
Radio communications	4,203,000	"
Land cost	2,634,000	"
Total	68,447,000	colones

The plan calls for additional work under Phase Two starting in the third year and those under Phase Three starting in the eighth year, and the estimated costs for each of these phase are 12,195,000 colones.

(2) Airport Expenditures

Expenditures are divided into two categories: operating expenses (maintenance cost, personal expenses and nonpersonal expenses) and capital cost (depreciation cost). The capital does not include service charges of the capital investment (interest or returns on the capital) or repayment of loans.

For the first 15 years, expenditures represent a simple addition of each item of expenditure, and those from the 16th year and afterward were computed at an annual rate of increase of 4.9%, this being the average growth rate of the 7-year period that starts from the 9th year.

15.3.3 Findings of Cost-Benefit Analysis

Findings of the cost-benefit analysis are as shown in Table 15-3-2. The discount rate is a device by which the value of future benefits is represented in terms of current value. In the present analysis, three discount rates were used. The 8% discount rate is one which is used for analyzing benefits of large-scale projects in advanced countries, the 6% discount rate represents average official discount rate, and the 4% discount rate having the highest probability is often used for analyzing benefits of public investments.

Table 15.3.2 Cost-Benefit Analysis

Unit: 1,000 colon

	Item	Discount Rate		
		8%	6%	4%
Benefits (B)	Benefits from Reduced Time *	73,401	[illegible]	[illegible]
	Operating Revenues of Airport	143,468	[illegible]	[illegible]
	Sub-total **	216,869	328,373	505,211
Cost (C)	Airport Construction Costs	92,837	92,837	[illegible]
	Airport Expenditures	91,134	127,761	[illegible]
	Sub-total	183,971	220,598	282,145
Net Benefits (B - C)		32,898	107,775	[illegible]
Cost-Benefit Ratio (B/C)		1,179	[illegible]	1,791

Note * Includes benefits attributable to the existing Ilopango Airport.

** Internal rate of return of the total benefits is projected at 9.5%.

15.4 Expected Revenue and Expenditure

15.4.1 General

The following is a statement of expected revenue and expenditure of the proposed international airport for the first fifteen years of operation following the opening expected in June, 1978. In determining the items of accounts and such computation factors as the unit prices, etc., we have taken into account the proposed facility requirements of the new airport, and consulted available reference documents including that of the Ilopango Airport and international airports, as well as materials published by the ICAO and the AOCI. To provide enough buffer to absorb any unforeseeable deficits, we have also been conservative in our estimates and have accounted for no increases in the unit rates of revenues, which in actuality will likely be realized.

For revenues, we have applied all of the items currently used at the existing Ilopango Airport, i.e., landing charges, parking charges, passenger and cargo terminal rentals, auto parking fees, ticket tax, and fuel tax, and to these we have newly added air passenger service charges, restaurant and shop income, admission fee to the observation deck, and PA system service charges, in order to help increase the airport revenue.

As shown in Table 15-4-1, the total expected revenue stands at 6,870,648 colones for the first year of operation and 22,377,417 colones for the fifteenth year. A breakdown of the revenues shows that direct operating revenue of the airport will be 3,578,303 colones (52%), while tax revenue will amount to 3,292,345 colones (48%) for the first year of operation. Tax revenue is not, properly speaking, a direct source of revenue to the airport operator, and accordingly should not be accounted for in the evaluation of the financial position expected of the proposed airport operations. But since tax revenue arises concomitant with the operation of the airport, we have included the entire tax revenue in this report as one item of the overall operating income.

For expenditures, we have included 1)maintenance costs which include repair work, utility, and cleaning, 2) personnel expenses as well as 3) non-personnel expenses necessary in the operation of the airport facilities, and 4) depreciation, but have not included property tax, nor interest on the invested capital. As to the amortization of the invested capital, a separate financial plan should be established along with the interest rate to be decided. Additional maintenance costs and depreciation cost arising from airport expansion expected in the third and eighth years of operation are accounted for in Section 15.4.4.

It is projected that the airport will yield a revenue-expenditure balance in credit of 594,787 colones in the first year, 8,424,119 colones in the fifteenth year, resulting in the accumulated balnce over the first fifteen years of 50,751,481 colones without interest. To achieve this expected performance and to further improve the airport revenue in the interest of further improve the airport revenue in the interest of sound airport management and operation, is essential to have well-experienced airport administration specialist.

Table 15-4-1 Expected Revenue and Expenditure

(in colon)

Fiscal Year *	1st **	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
REVENUE	6,870,648	7,387,082	8,387,828	9,013,879	9,702,885	10,461,655	11,297,616	12,621,580	13,637,591	14,758,486	15,995,446	17,361,143	18,869,536	20,535,826	22,377,417
Landing Charges	1,901,682	2,125,510	2,375,704	2,655,348	2,967,909	3,317,262	3,707,737	4,144,175	4,631,986	5,177,217	5,786,627	6,467,771	7,229,115	8,079,982	9,030,996
Parking Charges	34,301	38,571	43,373	48,772	54,843	61,670	69,347	77,979	87,686	98,601	110,875	124,677	140,197	157,649	177,273
Terminal Bldg. Rental	249,349	249,349	374,035	374,035	374,035	374,035	374,035	498,697	498,697	498,697	498,697	498,697	498,697	498,697	498,697
Cargo Terminal Rental	800,000	800,000	1,042,100	1,042,100	1,042,100	1,042,100	1,042,100	1,320,000	1,320,000	1,320,000	1,370,000	1,320,000	1,320,000	1,320,000	1,320,000
Auto Parking	70,929	74,442	78,175	82,128	86,190	90,473	94,974	99,695	104,636	109,907	115,396	121,216	127,254	133,623	140,320
Restaurants, Shops & Other Services	312,473	344,102	378,932	417,287	459,525	506,038	557,259	613,665	675,780	744,182	819,508	902,476	993,825	1,094,420	1,205,197
Observation Deck	21,791	23,997	26,426	29,101	32,047	35,291	38,863	42,797	47,129	51,899	57,152	62,937	69,308	76,323	84,048
Public Address Service Charges	187,778	194,245	267,203	275,877	285,227	295,312	306,191	317,932	330,609	344,300	359,092	375,079	392,364	411,060	431,287
Air Passenger Service Charges	1,246,364	1,372,521	1,511,451	1,664,443	1,832,921	2,018,452	2,222,764	2,447,757	2,695,524	2,968,370	3,268,834	3,599,711	3,964,095	4,365,349	4,807,218
Fuel Tax	259,187	288,211	320,488	356,350	396,228	440,569	489,870	544,683	605,634	673,407	748,764	832,553	925,854	1,029,455	1,144,650
Ticket Tax	1,786,794	1,876,134	1,969,941	2,068,438	2,171,860	2,280,453	2,394,476	2,514,200	2,639,910	2,771,906	2,910,501	3,056,026	3,208,827	3,369,268	3,537,731
EXPENDITURE	6,275,862	6,495,521	7,615,750	7,899,011	8,211,291	8,535,240	8,891,914	10,001,297	10,440,819	10,923,482	11,441,453	11,997,591	12,595,014	13,249,595	13,953,298
Maintenance Cost	1,575,079	1,691,208	2,172,004	2,342,182	2,526,749	2,726,998	2,944,337	3,500,231	3,787,545	4,100,080	4,440,158	4,810,326	5,213,375	5,652,360	6,130,631
Personnel Cost	1,000,000	1,060,900	1,124,555	1,191,074	1,266,199	1,338,964	1,420,926	1,506,599	1,596,133	1,696,208	1,800,851	1,910,245	2,024,583	2,151,404	2,284,011
Non-personnel Cost	700,000	742,630	787,188	833,752	886,340	937,275	994,648	1,054,619	1,117,293	1,187,346	1,260,596	1,337,172	1,417,208	1,505,983	1,598,808
Depreciation Cost	3,000,783	3,000,783	3,532,003	3,532,003	3,532,003	3,532,003	3,532,003	3,939,848	3,939,848	3,939,848	3,939,848	3,939,848	3,939,848	3,939,848	3,939,848
BALANCE	594,787	891,561	772,078	1,114,868	1,491,594	1,926,415	2,405,702	2,620,283	3,196,772	3,835,004	4,553,993	5,363,552	6,274,522	7,286,231	8,424,119
Value at 1972 (6% discount Rate)	409,301	592,939	484,411	659,888	832,898	1,014,812	1,195,559	1,228,491	1,413,935	1,600,213	1,792,709	1,991,831	2,198,241	2,408,194	2,626,683
Value at 1972 (4% discount Rate)	470,068	677,514	564,150	783,292	1,007,667	1,251,362	1,502,594	1,573,674	1,846,056	2,129,444	2,431,414	2,753,503	3,097,279	3,458,220	3,844,658

* June to May
** Opening of airport expected in June 1978

15.4.2 Computation Factors

In preparing this estimate of revenue and expenditure, we have decided the relevant factors as outlined below, based on the planned facility requirements of the new international airport, and taking into consideration the past performance of Ilopango Airport and other international airports, data put out by such international air transport organizations as the ICAO and the AOCI, and the general economic outlook for El Salvador.

(1) Wage and price increase rates

Wages	3.0%
Other items	2.4%

(2) Unit rates

a. Income

Landing charges	₡3.75 (¥461) per ton
Parking charges	₡0.625 (¥77) per ton
Terminal building rental	
Ticket counter spaces	₡250.00 (¥30,750) per m^2/yr.
Office spaces	₡187.50 (¥23,060) per m^2/yr.
Cargo terminal rental	₡100.00 (¥12,300) per m^2/yr.
Auto parking	₡0.20 (¥25) per car/hour

Restaurants, shops, and other services (Net revenue to the airport operator per embarking passenger)

Dining room	₡0.489	(¥60.12)
Baggage & parcel lockers	₡0.002	(¥ 0.31)
Telephones	₡0.005	(¥ 0.65)
Souvenir shop	₡0.316	(¥38.90)
Duty free shop	₡0.459	(¥56.40)
Insurance counters	₡0.128	(¥15.69)
Total	₡1.399	(¥172.07)

Observation deck admission fee	₡0.1 (¥12) per head
PA system service charges	--Half of the PA system operating cost is to be covered by the airlines

Air passenger service charges
¢9.00 (¥1,107)
per nonresident embarking passenger

Fuel tax ¢8.13 (¥1,000) per kiloliter

Tickets tax --10% of air tickets purchased in El Salvador

b. Expenditure

Maintenance costs

Runways, taxiways and aprons
--1.5% of the initial investment (excluding management expenses)

Terminal complex
--3.7% of the initial investment (excluding management expenses)

Navigation aids
--5.0% of the initial investment (excluding management expenses)

Personnel expenses
(200 employees) ¢5,000 (¥615,000) per head/yr.

Non-personnel expenses
--70% of personnel expenses

Depreciation Cost
--Straight-line depreciation with service life of 15 to 25 years (except for the PA system, which is to be written off in 6 years)

15.4.3 Computation of Revenues

(1) Landing charges

Landing charges are the most important airport revenue item. In this report we assume that BAC-111 and B-727 class aircraft will be in use for the first half of the 1980's, and B-707 and B-747 class aircraft in the latter half of the 1980's. According to the landing charges schedule adopted at present by Ilopango Airport, as the maximum take off weight of all these aircraft exceeds 10 tons, the landing charge per ton is US$1.30 (₡3.25). If we assume here a landing charge per ton of $1.50 for the expected 1978 opening and extrapolate from the forecasted landing/takeoff frequency for 1980 and 1990, total landing charge revenue will amount to ₡1,901,682 for the first year, ₡9,030,996 for the fifteenth year, and the revenues for the years in between are interporated at an equal increase rate, of these which is calculated retrospectively as 11.77% (Table 15-4-1).

As a reference we computed the average landing charges per ton at eight major Latin American international airports using data from the ICAO Manual of Airport and Air Navigational Facility Tariffs,1972, as shown in the following table, and the average per ton charge works out to about US$2.00.

Country - Airport		Average Landing Charges per ton	Weight Basis
Argentiana	- Buenos Aires	US$2.41	Maximum Takeoff Weight
Bolivia	- La Paz	1.82	Gross Weight
Brazil	- All 1st Class Airports	1.47	Maximum Takeoff Weight
Chile	- San Tiago	1.21	Maximum Takeoff Weight
Colombia	- Burrangilla	2.54	Maximum Gross Operating Weight
Mexico	- All 1st Class Airports	3.30	Maximum Operating Weight
Panama	- Tocumen	1.00	Actual Takeoff Weight or Maximum Weight
Venezuela	- Maiquetia	2.27	Maximum Takeoff Weight

(2) Parking charges

The schedule used at Ilopango Airport was used as the calculation base (no charge for less than one hour; ₡0.625 per ton per hour). Starting from a basis of the monthly parking statistics collected in November, 1972, annual averages were estimated for the number of planes parking longer than an hour and for the number of parked hours per plane. These estimates were then adjusted according to the forecasted takeoff/landing frequency for 1980 and 1990 to derive the annual income from parking for the respective years. Using straight-line extrapolation, the income was projected as ₡34,301 for the first year, ₡177,273 for the fifteenth year, and as increasing at a rate of 12.45% over the intervening years as shown in the Table 15-4-1.

(3) Terminal building rental

Conventionally, rental of building space is determined under a costs approach where construction and operating costs are divided by the available space for rental. With this figure as a reference, the rental schedule is modified according to the floor number and the use that can be made of each unit. Per unit rent of an airport terminal building, however, cannot be calculated under this approach for at least two reasons: First, the space available for rental amounts to less than 50% of the total establishment, and second, compared to an ordinary building, operating costs are very high. Accordingly, in the light of practices common at other airports, a price approach has been adopted wherein ticket counter spaces are rented at a yearly rate of ₡250 (¥30,750) per square meter and office spaces at ₡187.50 (¥23,060) per square meter.

Another factor that has to be included is the planned expansion of the building to 1.99 times the original size (or 35,700 m^2) in the second construction stage and to 2.93 times the original size (or 52,700 m^2) in the third construction stage. Thus the rental space can be increased by 1.5 times the original figure for the duration of five years starting from the third year of operation and by 2 times the original figure for the remaining eight years starting from the eighth year of operation. We thus have calculated in Table 15-4-2 the space and revenue by construction stage for ticket counter and office spaces.

Table 15-4-2 Passenger Terminal Building Rental

(in Colon)

Fiscal Year	Ticket Counter		Office		Total
	Rental Space	Yearly Rental	Rental Space	Yearly Rental	
1st - 2nd	22.5m^2	5,625	1,300m^2	243,724	249,349
3rd - 7th	33.8	8,450	1,950	365,585	374,035
8th - 15th	45.0	11,250	2,600	487,447	498,697

(4) Cargo terminal building rental

The cargo terminal building rental was determined by assuming that 80% of the entire space would be rented for calculation, at ₡100 (¥12,300) per square meter per annum. Needless to say, this rental rate takes into consideration rental rates at other international airports as well as the above-mentioned rentals for the terminal building. The stage 2 and stage 3 expansion programs will again enlarge the space available for rental, by 1.32 times (or 10,421 m^2) from the third to the seventh year, and by 1.65 times (or 13,200 m^2) from the eighth to the fifteenth year. The following table details the space for rental and the resulting annual income for the airport.

Table 15-4-3 Cargo Terminal Building Rental

Fiscal Year	Rental Space m^2	$ Yearly Rental
1st - 2nd	8,000	800,000
3rd - 7th	10,421	1,042,100
8th - 15th	13,200	1,320,000

(5) Auto parking

In October, 1972 the number of cars which parked at Ilopango Airport was 14,951. Calculating the average daily number of parked cars from this figure and assuming an annual increase rate of 5% (which reflects the projected 10.12% increase rate for passengers), the number of cars parked daily by 1980 will work out to 712, and by 1990 to 1,159. The average parking fee per auto was found by dividing the October, 1972 parking revenue (¢4,086.20) by the number of cars (14,951) with the result of ¢0.3 (¥37) per car. On this basis, the first year revenue from parking comes to ¢70,929 and the fifteenth year to ¢140,320.

Both direct management by the airport authority and indirect management through a private agency are common methods among the world's international airports in managing parking lots. Due to the relatively easy management conditions and also to the rather high profit rate, direct management by the airport itself may be the more desirable format for the new airport.

(6) Restaurants, shops, and other services

The net revenue to airport operator per each embarking passenger through restaurants, shops, and other services was estimated at 1.399 colones (¥172.07) through an analysis of income statistics from Tokyo International Airport and from other international airports of a similar size to the proposed airport. Using this figure as the basis, the airport revenue in this category was projected to be ¢312,473 in the first year of operation and ¢1,205,197 in the fifteenth year, with an average growth rate of 10.12% per annum over the intervening years on a straight-line basis.

(7) Observation deck admission fee

In calculating the revenue from this source, we assumed that an average of two well-wishers and/or excursionists would be present at the airport for each passenger, and that one out of four, or 0.5 persons per passenger, would use the observation deck. The admission fee, ¢0.1 (¥12), was fixed in view of Salvadorian national income and other factors. The total projected revenue from this source comes to ¢26,426 in 1980 and ¢69,308 in 1990.

(8) Public address system service fee

As has been mentioned in an earlier section 13.3, it is recommended that a centrally controlled system be adopted. With such a system, the airport authority customarily handles the entire airport information service, and airlines are expected to cover about half of the operating cost. That is, one half of the total of maintenance cost, personnel expenses, non-personnel expenses, and depreciation costs for the PA system represents a revenue item for the airport. In calculating the revenue, the following personnel were assumed necessary for operation and management of the PA system.

Managing and programming employees	4
Technicians	3
Terminal information Services personnel	10
Total	17

Note: 1. Yearly salary per employee...₡5,000 (¥615,000)
2. Personnel expense increase...6% yearly

The projected additional investment for the third year of operation is subsumed in terms of increasing maintenance costs and depreciation costs. (The method of calculation is outlined below with the item of depreciation.) Projecteddrevenue from the PA system is shown in the table below.

Table 15-4-4 Operating and Depreciation Cost of the Public Address System and Charges to Airlines

(in Colon)

Fiscal Year	Maintenance Cost	Personnel Expenses (17)	Non-Personnel Expenses	Repreciation Cost	Total Cost	Charges to Airlines) (1/2 of Cost)
1st	42,114	85,000	59,500	188,943	375,557	187,778
2nd	46,377	90,100	63,070	188,943	388,490	194,245
3rd	75,136	95,506	66,854	296,911	534,407	267,203
4th	82,741	101,236	70,865	296,911	551,753	275,877
5th	91,116	107,311	75,117	296,911	570,455	285,227
6th	100,339	113,749	79,624	296,911	590,623	295,312
7th	110,495	120,574	84,402	296,911	612,382	306,191
8th	121,680	127,808	89,466	296,911	635,865	317,932
9th	133,996	135,477	94,834	296,911	661,218	330,609
10th	147,559	143,606	100,524	296,911	688,600	344,300
11th	162,495	152,222	106,555	296,911	718,183	359,092
12th	178,943	161,355	112,949	296,911	750,158	375,079
13th	197,055	171,037	119,726	296,911	784,729	392,364
14th	217,001	181,299	126,909	296,911	822,120	411,060
15th	238,966	192,176	134,523	296,911	862,576	431,287

Note: Maintenance Cost for the 1st year is calculated as 3.7% of the initial investment, amounting to $1,138,000.

(9) Air passenger service charges

After considering practices common among other international airports, an air passenger service charge of ₡9.00 (¥1,107) was assumed for each non-resident international passenger. Statistics compiled for Ilopango Airport show a resident/non-resident ratio of 40:60 approximately. Combined with the passenger forecast, the number of non-resident passengers embarking comes to 167,939 in 1980 and 440,455 in 1990. It follows that the prospective airport income from this source will be ₡1,246,364 in the first year and ₡4,807,218 in the fifteenth year, with a yearly straight-line growth rate of 10.12%.

(10) Fuel tax

Based on the records of Ilopango Airport in November, 1972, the following analysis was made to project fuel tax revenue:

a. Average flight range per plane was obtained by aircraft class by averaging the distance from the new airport to the first stop for all departing flights recorded in one month.
b. Average fuel consumption per plane by aircraft class was then computed for the average flight range.
c. The daily number of departing flights for 1980 and 1990 was next obtained.
d. The daily fuel consumption was calculated.
e. Finally, daily fuel consumption was converted to an annual basis.

Table 15-4-5 Expected Yearly Fuel Requirement

Fiscal Year	Yearly Volume (kilo-liter)
1978	31,880 kl.
1979	35,450
1980	39,420
1981	43,831
1982	48,736
1983	54,190
1984	60,254
1985	66,996
1986	74,493
1987	82,829
1988	92,098
1989	102,404
1990	113,880
1991	126,623
1992	140,792

The per kiloliter fuel tax, ₡8.13 (¥1,000), was assessed by considering the current tax at Ilopango Airport and modifying this for price rises. Annual fuel tax revenue was projected as 259,187 colones in the first year and 1,144,650 colones in the fifteenth year. Again, the revenues for the years in between are interporated at an increase rate of 11.19% as detailed in Table 15-4-1.

(11) Tickets tax

The tickets tax revenue at Ilopango Airport amounted to 1,400,000 colones (¥172,200,000) in 1972, constituting the most important item of revenue for that airport. Since the average annual increase of embarking passengers is projected as about 10% between 1972 and 1990, we assume a yearly tickets tax revenue increase of 5% for each year following 1972. The revenue at the expected time of opening (1978) can then be estimated as 1,786,794 colones, and this sum will increase to 3,537,731 colones for the fifteenth year of operation (Table 15-4-1).

15.4.4 Computation of Expenditure

Ordinary airport operation principally requires maintenance costs (for repair work, utility and cleaning), personnel expenses to run the facilities, non-personnel expenses related to personnel expenses, and depreciation cost. Interest payments on the initial investment, real estate taxes due, fire insurance premium, etc. are excluded. A separate financial plan should be drawn up for determining the method of investment amortization and its interest rate.

(1) Maintenance cost

The cost of maintenance at the new airport is expected in the following table.

Table 15-4-6 Detailed Maintenance Cost

(in Colon)

Fiscal Year	R/W,T/W,Apron	Terminal Complex	Nav. Aids	Total
1st	485,307	561,317	528,455	1,575,079
2nd	518,196	618,134	554,878	1,691,208
3rd	592,827	996,555	582,622	2,172,004
4th	633,003	1,097,426	611,753	2,342,182
5th	675,901	1,208,507	642,341	2,526,749
6th	721,707	1,330,833	674,458	2,726,998
7th	770,617	1,465,539	708,181	2,944,337
8th	863,756	1,892,885	743,590	3,500,231
9th	922,293	2,084,483	780,769	3,787,545
10th	984,797	2,295,475	819,808	4,100,080
11th	1,051,537	2,527,823	860,798	4,440,158
12th	1,122,799	2,783,689	903,838	4,810,326
13th	1,198,891	3,065,454	949,030	5,213,375
14th	1,280,140	3,375,739	996,481	5,652,360
15th	1,366,895	3,717,431	1,046,305	6,130,631

a. Maintenance of runways, taxiways and aprons

World's major international airports allocate about

1.5% of the investment for maintenance of runways,taxiways and aprons excluding the expenditure for management personnel and related non-personnel expenses. Since the maintenance cost will vary according to the volume of air traffic, we set an annual expenditure increase of 6.78% taking account of increases in the takeoff/landing frequency as well as of the rising price trend. In order to compensate for the planned airport expansion, which will include an additional investment in taxiways, aprons, and berths in the third year and the eighth year, we have proportionately rescaled the expenses for these years using the same calculation formula as for the initial investment total.

b. Maintenance of terminal facilities

The total investment/maintenance ratio for terminal facilities (including the cargo terminal building) was set at 3.7% in light of budgeting practices common among the world's major international airports. The maintenance cost of passenger terminal building in particular vary greatly according to the number of passengers handled. In setting an expenditure increase rate, therefore, we weighted the rate by the passenger increase rate as well as by the general Salvadorian price increase trend (2.4% per annum over the past several years) to arrive at an annual growth rate of 10 12%. Planned expansion investments for stage 2 and stage 3 are also met by increased maintenance cost calculated by the same method as with the initial investment.

c. Maintenance cost of navigation aids

Judging from the experience of major international airports of the world, about 5% of the investment is necessary for maintaining navigational aids facilities. After taking into account the country's commodity price increase trend of 2.4% as well as the likelihood that precision instruments of these facilities will require increasing repair work as the years go by, we adopted a figure of 5% for the annual increase rate for Nav. Aids maintenance. No additional investment is proposed in stage 2 and 3 for this category of facilities.

(2) Personnel expenses

The most important operating cost of an airport is the personnel expenses. The expenditure statistics published by El Salvadorian Government tell us that the total personnel expenditure for the 101 employees of Ilopango Airport Authority was 280,380 colones in fiscal 1972, or 2,804 colones (¥344,892) per head. Taking the recent personnel expense growth rate of 3% into consideration, we assumed an annual average expenditure per head of 5,000 colones (¥615,000) and a 3% yearly increase.

At the proposed opening of the new airport (1978), the number of employees necessary can be calculated as at least 200 which is double the Ilopango Airport figure. The number of employees will naturally increase along with the increase in the size of the airport but once it reaches a certain number, the rate of increase will become moderate. Considering the above, as well as the projected yearly increase of passengers, we assumed on the increase rate of employee requirements of 3% per annum. The personnel expenses thus calculated amounted to 1,000,000 colones for the first year and 2,284,011 colones for the fifteenth year, as shown in Table 15-4-1.

(3) Non-personnel expenses

Averaging the statistics compiled at Ilopango Airport for the 1969-73 period, the ratio of non-personnel expenses to personnel expenses was 67.55%. We accordingly took 70% as a generally valid average percentage which gave some leeway for variation up and down. The resulting annual non-personnel expenses, shown in Table 15-4-1, stand at 700,000 colones for the first year and 1,598,808 colones for the fifteenth year.

(4) Depreciation cost

Straight-line depreciation was adopted in the analysis. The depreciation factors detailed in the following table were selected after referring to practices adopted by the world's major airports.

Table 15-4-7 Depreciation Factors

Facilities	Service Life (years)	Depreciation Rate	Undepreciated Value (%)
1. Site Improvements	30	0.034	20
2. R/W, T/W & Apron	20	0.050	0
3. Passenger Terminal Bldg. and other Buildings	25	0.040	10
4. Sewage & Drainage	15	0.060	10
5. Power Supply, Nav. Aids, etc.	15	0.060	0
6. Public Address System	6	0.166	0

The same depreciation factors are also applied to the expansion of facilities in the third and the eighth years of operation. An exception is the public address system, whose service life vary between 6 and 10 years depending on the items of the facilities. For the sake of conservative estimation, however, we have adopted a uniform service life of 6 years for all items involved. Replacement cost at the 6-year mark for the part of the PA system which will have been depreciated (about 60% of the total system) is to be accommodated out of the maintenance cost. For this reason, the equal amount of the depreciation cost has been accounted for both before and after the 6th year.