社会開発調査部報告書

PEOPLE'S REPUBLIC OF CHINA

FEASIBILITY STUDY ON THE CONSTRUCTION PROJECT OF WUHAN／TIANHE AIRPORT

FINAL REPORT

MARCH 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the People's Republic of China, the Japanese Government decided to conduct a study on the Construction Project of Wuhan Tianhe Airport and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the People's Republic of China a survey team headed by Hiraku Moriguchi, Japan Airport Consultants, Inc. on several occasions between December 1988 and March 1990.

The team held discussions with concerned officials of the Government of the People's Republic of China, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the People's Republic of China for their close cooperation extended to the team.

March 1990

柳谷謙介

Kensuke Yanagiya
President
Japan International Cooperation Agency

March 1990

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

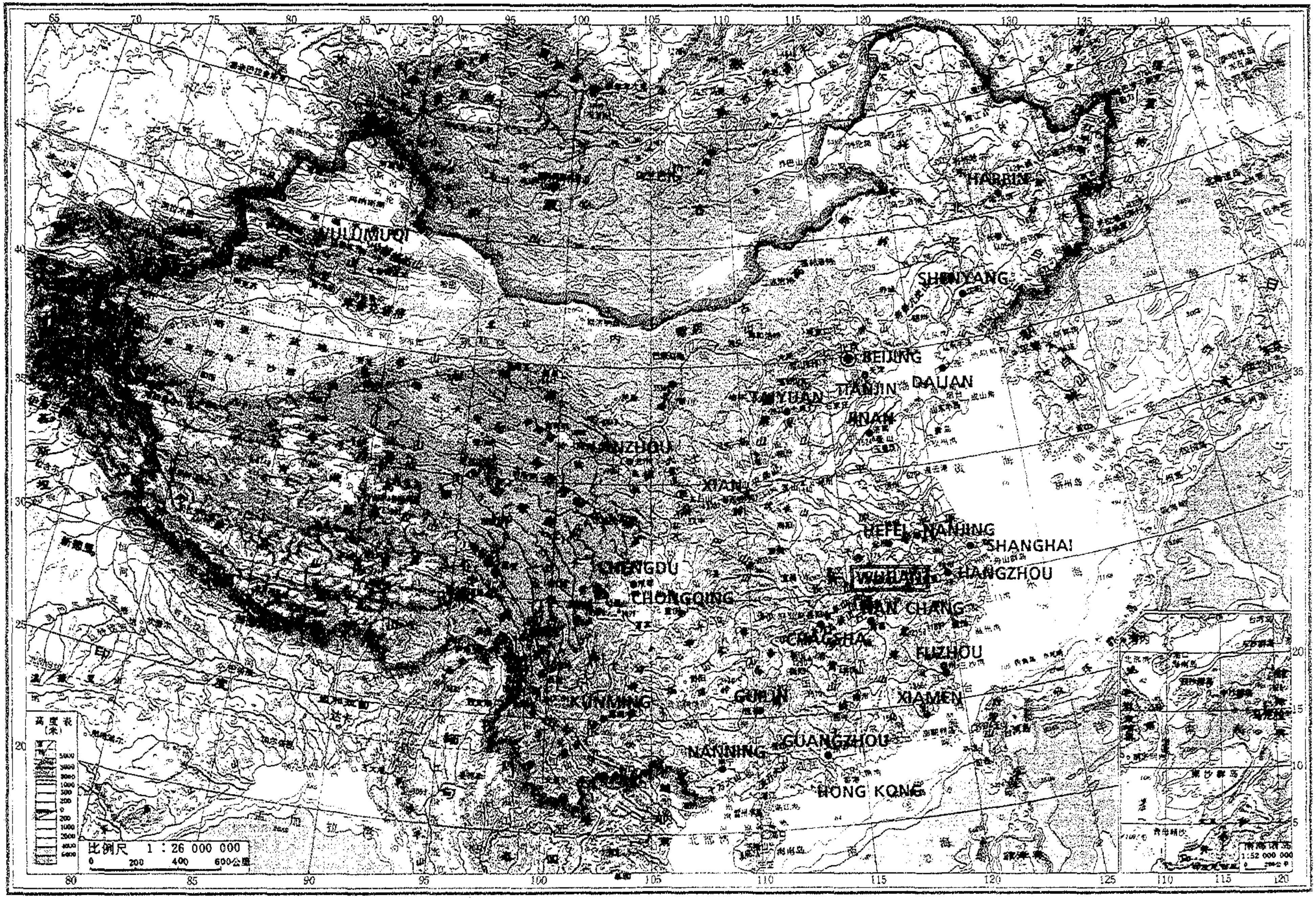
We have pleasure in submitting to you herewith the final report of the Feasibility Study on the Construction Project of Wuhan/Tianhe Airport in the People's Republic of China. The Study was made during the period from December 1988 to March 1990 to examine the technical, economic and financial feasibility of the Project as well as to pursue technology transfer to Chinese government experts during the Study period.

The final report was prepared based on the draft final report, duly reflecting the official comments of the Chinese Government thereon.

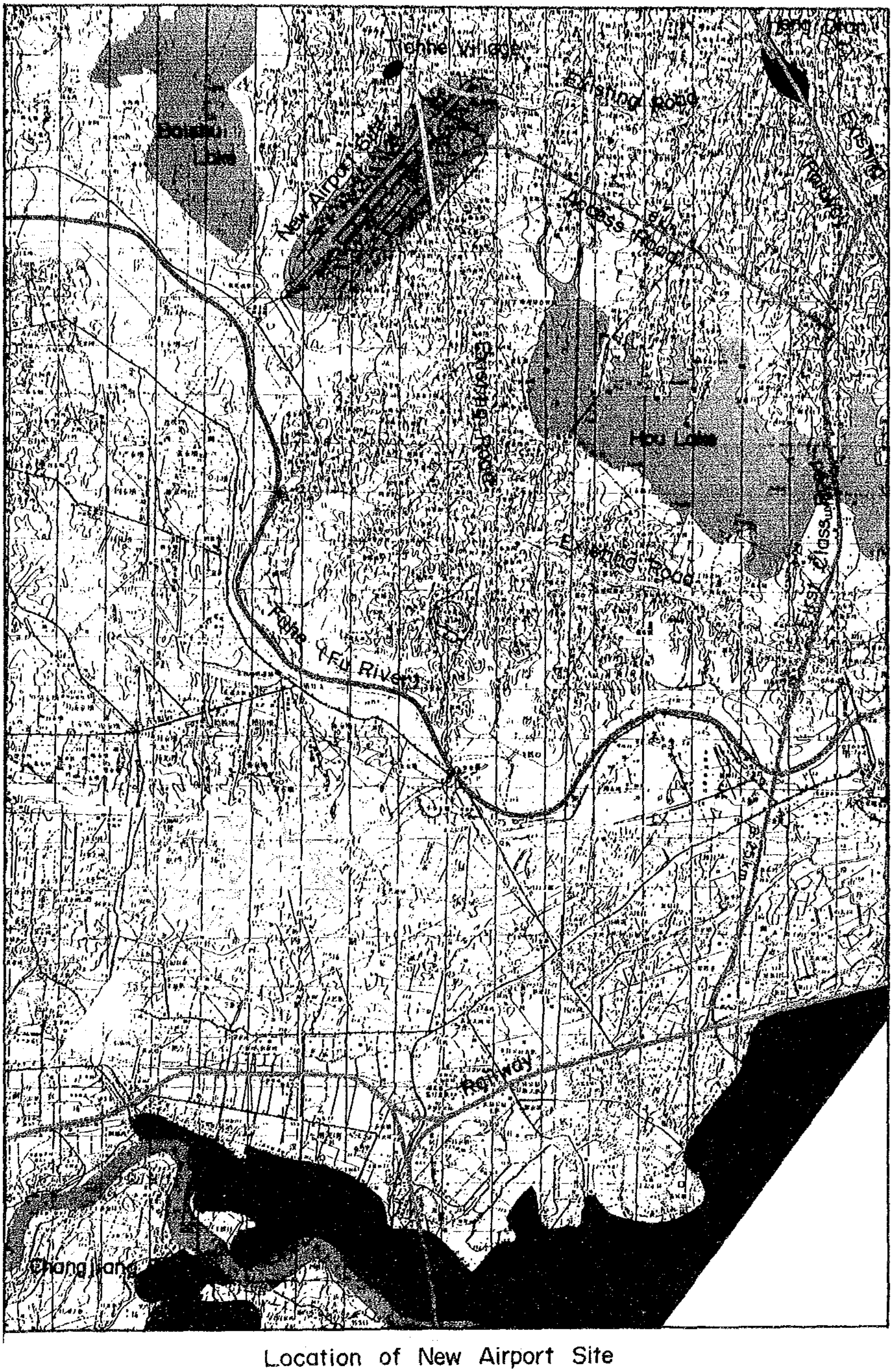
We wish to take this opportunity of expressing our sincere gratitude to the officials concerned of your Agency, Advisory Committee, as well as the Embassy of Japan in China, and last but not least to those of the Government of People's Republic of China and the People's Government of Wuhan City for the kind assistance and cooperation extended to us throughout the period of the Study.

Yours faithfully,

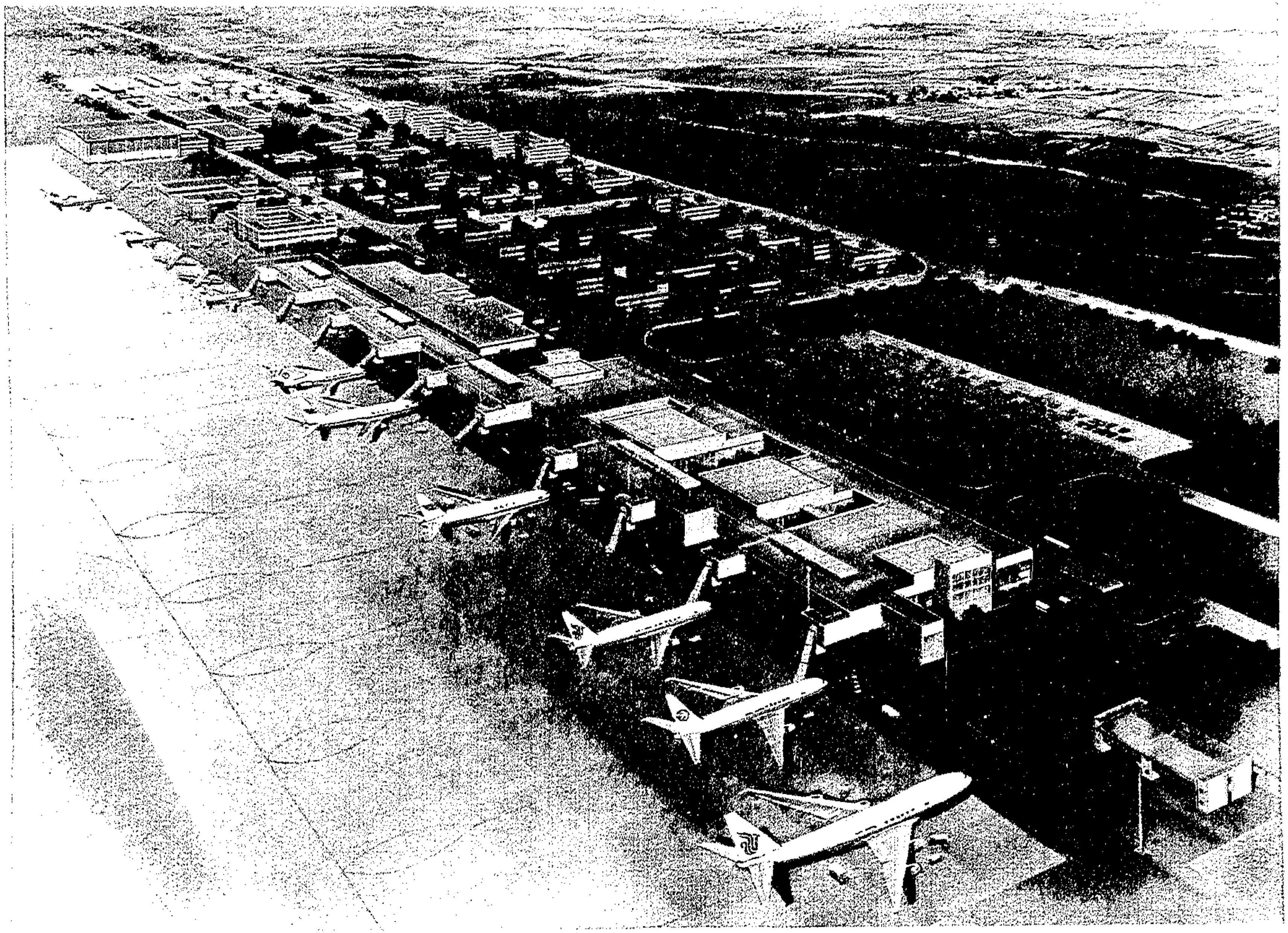
Hiraku Moriguchi
Project Manager
Japan Airport Consultants, Inc.



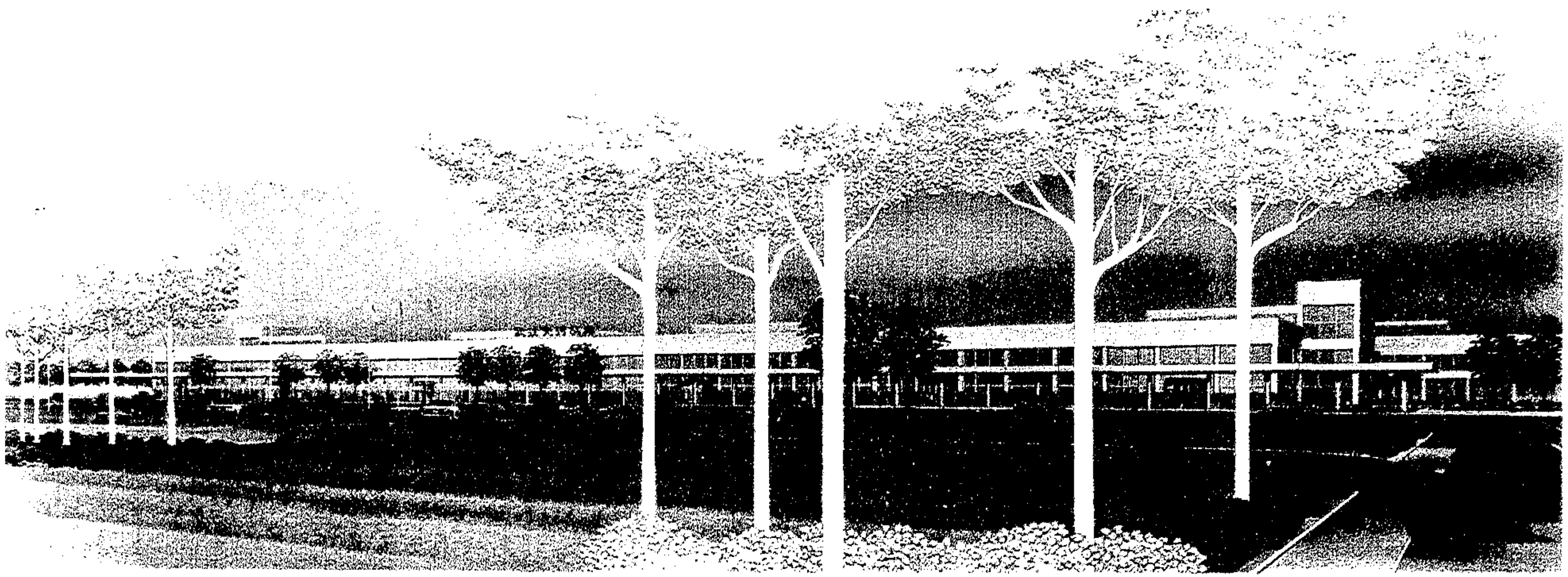
MAP OF THE PEOPLE'S REPUBLIC OF CHINA



Location of New Airport Site



PEOPLE'S REPUBLIC OF CHINA / FEASIBILITY STUDY ON THE CONSTRUCTION PROJECT OF WUHAN/TIANHE AIRPORT
BIRD'S EYE-VIEW PERSPECTIVE FROM THE AIRSIDE / JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)MAR.1990



PEOPLE'S REPUBLIC OF CHINA / FEASIBILITY STUDY ON THE CONSTRUCTION PROJECT OF WUHAN/TIANHE AIRPORT
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ABBREVIATION

ABBREVIATIONS

A/A	Airport Authority
A/C	Aircraft
ACC	Area Control Center
AFL	Apron Flood Light
AFTN	Aeronautical Fixed Telecommunication Network
A/G	Air to Ground Communication
AIS	Aeronautical Information Services
A/L	Airlines
ALS	Approach Light System
AMS	Aeronautical Mobile Service
APP	Approach Control
ARR	Arrival
ASR	Automatic Send and Receive Teletypewriter
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
BOD	Bio-chemical Oxygen Demand
B/S	Brick Structure
CAAC	Civil Aviation Administration of China
CBR	California Bearing Ratio
CCR	Constant Current Regulator
CCU	Communication Control Unit
CGO	Cargo
CIF	Cost, Insurance and Freight
CIQ	Customs, Immigrations and Quarantine
dB	Decibel
DEP	Departure
DME	Distance Measuring Equipment
DPS	Data Processing system
EIRR	Economic Internal Rate of Return
EPS	Electric Pipe Shaft
EQ	Equipment
ER	Extended Range
FAA	Federal Aviation Administration (U.S.)
FAX	Facsimile
FIR	Flight Information Region
FIRR	Financial Internal Rate of Return

GDP	Gross Domestic Products
GP	Glidepath (a component of ILS)
GS	Glide Slope
GSE	Ground Support Equipment
HF	High Frequency
HIALS	High Intensity Approach Light System
HIRL	High Intensity Runway Edge Lights
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
JCAB	Civil Aviation Bureau(Ministry of Transport), Japan
JICA	Japan International Cooperation Agency
LCN	Load Classification Number
LLZ	Localizer
LMM	Middle Marker Collocated with Compass Locator (a component of ILS)
LO	Compass Locator
LOM	Outer Marker Collocated with Compass Locator (a component of ILS)
LPG	Liquefied Petroleum Gas
LTF	Landline Telephone
LTT	Landline Teletypewriter
MLS	Microwave Landing System
NDB	Non-directional Radio Beacon
NPV	Net Present Value
OM	Outer Marker(a component of ILS)
PAPI	Precision Approach Path Indicator
PAX	Passenger
PBB	Passenger Boarding Bridge
POL	Petroleum, Oil and Lubricant
PPM	Parts Per Million
PSR	Primary Surveillance Radar
PTB	Passenger Terminal Building

RC	Reinforced Concrete
RO	Receive Only Teletypewriter
RTF	Radiotelephony
RTT	Radioteletypewriter
RVR	Runway Visual Range
RWY	Runway
RWCL	Runway Centre Line Lights
RWYL	Runway Edge Lights
RX	Receiver
S	Steel
SALS	Simplified Approach Light System
SELCAL	Selective Calling System (of Air to Ground Communication)
SIWL	Single Isolated Wheel Load
SS	Suspended Solid
SSB	Single Side Band
SSR	Secondary Surveillance Radar
STN	Station
SUPV	Supervisor
TGS	Taxiway Guidance Signs
TDZ	Touchdown Zone Lights
TRCV	Transceiver
TRDPS	Terminal Radar Data Processing System
TTY	Teletypewriter
TWCL	Taxiway Centerline Lights
TWR	Airport Traffic Control Tower
TWY	Taxiway
TWYL	Taxiway Lights
TX	Transmitter
UHF	Ultra High Frequency
UPS	Uninterruptible Power Supply System
VFR	Visual Flight Rules
VHF	Very High Frequency
VIP	Very Important Person
VOR	VHF Omnidirectional Radio Range
WDI	Wind Direction Indicator
WDIL	Illuminated Wind Direction Indicator
WX	Weather

CONCLUSION AND SUMMARY

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1. Necessity of the Project

The construction project of Wuhan/Tianhe Airport is urgently needed because of the impossibility of expansion of the existing Wuhan/Nanhu Airport which is approaching its capacity limitation, and also because of the vital role the air transport plays in Wuhan City and its surrounding area.

2. Technical Feasibility

No significant technical difficulty is anticipated in the implementation of the Project at the Tianhe site.

3. Financial Feasibility

The Project is financially feasible since the financial internal rate of return is 7.8% on condition that the Airport is to be run on a self-supporting accounting principle and that the foreign portion of the construction costs is to be financed by foreign soft loans of which the average interest rate is understood to be below 7%.

4. Economic Feasibility

The Project is economically feasible since the economic internal rate of return (EIRR) is 12.1% from the viewpoint of the national economy of China where the social discount rate is said to be 12%. If the intangible benefits are taken into consideration, then the Project will show a much better EIRR figure.

5. Managerial Feasibility

The Project is managerially feasible because the Project Implementation Office has already been established and the Wuhan/Tianhe Airport Authority is going to be organized in time for the completion of the Airport, mostly consisting of the personnel experienced at the existing Wuhan/Nanhu Airport.

SUMMARY

1. Objective and Scope of the Study

1.1 Objective

The objectives of the Study are:

(1) to examine the technical, economic and financial feasibility of the construction project of Wuhan/Tianhe Airport at the selected new airport site of Tianhe; and

(2) to pursue technology transfer to the experts of the Chinese side participating in the Study during the Study period.

1.2 Scope

The scope of the Study covers the following items:

(1) Evaluation of the new airport site;
(2) Supplemental meteorological survey;
(3) Air transport demand forecast;
(4) Airport master planning;
(5) Preliminary design;
(6) Construction schedule;
(7) Preliminary cost estimate;
(8) Economic analysis;
(9) Financial analysis; and
(10) Forecast of aircraft noise contour.

2. Background of Project

2.1 Wuhan City

The Wuhan City is situated in the central region of China along the Chang Jiang River with the total urban population of 3,525 thousand in 1987 and the gross industrial product of 13.8 billion Yuan in 1985, ranked fifth and fourth in the country, respectively.

2.2 Existing Wuhan/Nanhu Airport

The existing Wuhan/Nanhu Airport opened in 1954 is located just 4 km southeast of the centre of the City and has the runway length of 1,812 m. with the annual passengers of 492 thousand in 1987. The airport, however, has reached the limit of expansion due to the environmental problems, necessitating a new airport in order to meet the increasing air transport demand in Wuhan City.

3. Site Selection

Decision of the Chinese side on the selection of Tianhe among the 6 (six) candidate sites as the site for construction of a new Wuhan airport can be justified for the following reasons:

(1) No operational impacts are foreseen upon the existing Hankou Airfield (military airport).
(2) No large buildings exist around the site that need to be relocated.
(3) Enough land area is available to enable the construction of open parallel runways in future.
(4) Good airspace usability and favourable wind conditions are ascertained.
(5) The first-class road is being constructed nearby from the centre of Wuhan City to facilitate airport access.
(6) No adverse influence is foreseen upon the city planning of Wuhan.
(7) No problem is anticipated in construction conditions.

4. Air Transport Demand Forecast

4.1 Premises

Premises of the forecast are summarized as follows:

(1) Target Year : 2000

(2) Roles of Wuhan/Nanhu Airport and Wuhan/Tianhe Airport

a. Wuhan/Nanhu Airport : to be used for small aircraft operation.
b. Wuhan/Tianhe Airport : to be used for all the scheduled aircraft operation.

(3) Socio-economic Conditions

Items	The Year 2000	Average Annual Growth Rate(%) (1987 - 2000)
a. Population of China (million)	1,250	1.13
b. Gross Social Product of China (billion Yuan in 1980 price)		
(High case) :	4,028	6.20
(Low case) :	3,674	5.45
c. Population of Wuhan City (thousand)	7,482	1.34
d. Gross Social Product of Wuhan City (million Yuan in 1980 price)	79,170	9.29

Source : (a and b) Civil Aviation Administration of China
(c and d) The People's Government of Wuhan City

4.2 Forecast Results

Forecast results are summarized as follows:

(1) Forecast of Passenger and Cargo Transport Demand at Wuhan/Tianhe Airport for the year 2000

	Arriving and Departing Passengers		Loaded and Unloaded Cargo	
Case	Number (thousand)	Average Growth Rate(%) (1987 - 2000)	Tonnage (thousand tons)	Average Growth Rate(%) (1987 - 2000)
High Case	5,000	20	60	16
Middle Case	4,100	18	45	13
Low Case	3,400	16	25	8

(2) Forecast of Annual Aircraft Movements at Wuhan/Tianhe Airport for the year 2000

Aircraft Type	Annual Aircraft Movements	Share(%)
50-Seater	3,404	10.7
100-Seater	2,814	8.9
150-Seater	10,634	33.6
200-Seater	14,812	46.8
Total	31,664	100

(3) Forecast of Peak-Hour Traffic at Wuhan/Tianhe Airport for the year 2000

		Domestic Route	Regional Route	Compound Total
Aircraft Movement	Take-offs	6	1	6
	Landings	6	1	6
	Compound Total	9	1	10
Passenger	Departure	730	130	740
	Arrival	810	160	810
	Compound Total	1,530	240	1,550

5. Facility Requirements

Major facility requirements determined on the basis of the Middle Case of air transport demand forecast are summarized as follows:

(1) Airfield Facilities

a. Runway Dimensions : 3,000 m x 45 m

b. Runway Strip Dimensions : 3,120 m x 300 m

c. Taxiway to be constructed : One parallel taxiway and two rapid-exit taxiways, etc.

d. Apron (Number of Aircraft Stand): 19

(2) Terminal Facilities

a. Passenger Terminal Building (Required Area) : 29,035 m^2

b. Cargo Terminal Building (Required Area) : 4,980 m^2

c. Aircraft Maintenance Hangar (Required Area) : 9,000 m^2

d. Car Park (Required Area) : 15,600 m^2

(3) Air Navigation Facilities

a. Radio Nav-aids to be installed : ILS,LLZ,GP,MM,OM,VOR/DME, NDB,etc.

b. Visual Aids to be installed : ALS,SALS,RWCL,RWYL,TWCL, TWYL,AFL,etc.

c. ATC Facility to be installed : Control Tower,IFR Room, ASR/SSR,etc.

d. Aeronautical Telecom. Facility to be installed : VHF/UHF equipment,Tele-typewriters for AFTN,etc.

e. Meteorological Facility to be installed : Weather Radar,Wind Direction/ Speed Indicator, Satellite Receiver,etc.

(4) Airport-Related Facilities

a. Drainage Facility to be constructed : for runway,taxiways,apron and terminal area.

b. Water Supply Facility (Annual Water Consumption): 690,000m^3

c. Sewage Disposal Facility (Annual Waste Water Quantity): 621,000m^3

d. Electric Power Supply Facility (Total Demand for Airport Facilities) : 8,500 KVA

e. Fuel Supply Facility (Annual Fuel Consumption): 126,000 kl

f. Air-conditioning Facility
(Cooling Load Capacity) : 6,700 Mcal/H
(Heating Load Capacity) : 7,500 Mcal/H

g. Rescue and Fire-fighting Facility to be installed : In accordance with Category 8 of ICAO Recommendations.

h. Guard Facility (Required area) : 3,000 m^2

i. Related Buildings to be constructed : Administration Buildings,Catering Facilities,Staff Housings,etc.

j. Related Roads (Access Road Length) : 9.7 km from the interchange of Dai Huang Road

K. Exclusive Railway (Total Length) : 900 m from the end of the freight platforms of Heng Dian Station.

6. New Airport Master Plan

6.1 Location of Runway

The following has been decided by the Chinese side:

(1) Direction : N43° 50'E(MN)
(2) Airport Reference Point;
Latitude : 30° 47'01"N
Longitude : 114° 12'27"E

6.2 Basic Concept for Terminal Building

Considering the forecast annual passenger demand and the peak-hour traffic at Wuhan/Tianhe Airport, the following concepts are adopted in this Study:

(1) Centralized concept
(2) One-and-a-half-level system
(3) Central check-in system
(4) Frontal linear concept

6.3 Overall Airport Layout Plan

Fig. S-1 shows the Overall Layout Plan of the Airport Facilities for the design year of 2000, on which the preliminary design and cost estimate are based. Plan also shows the second runway to be constructed in future.

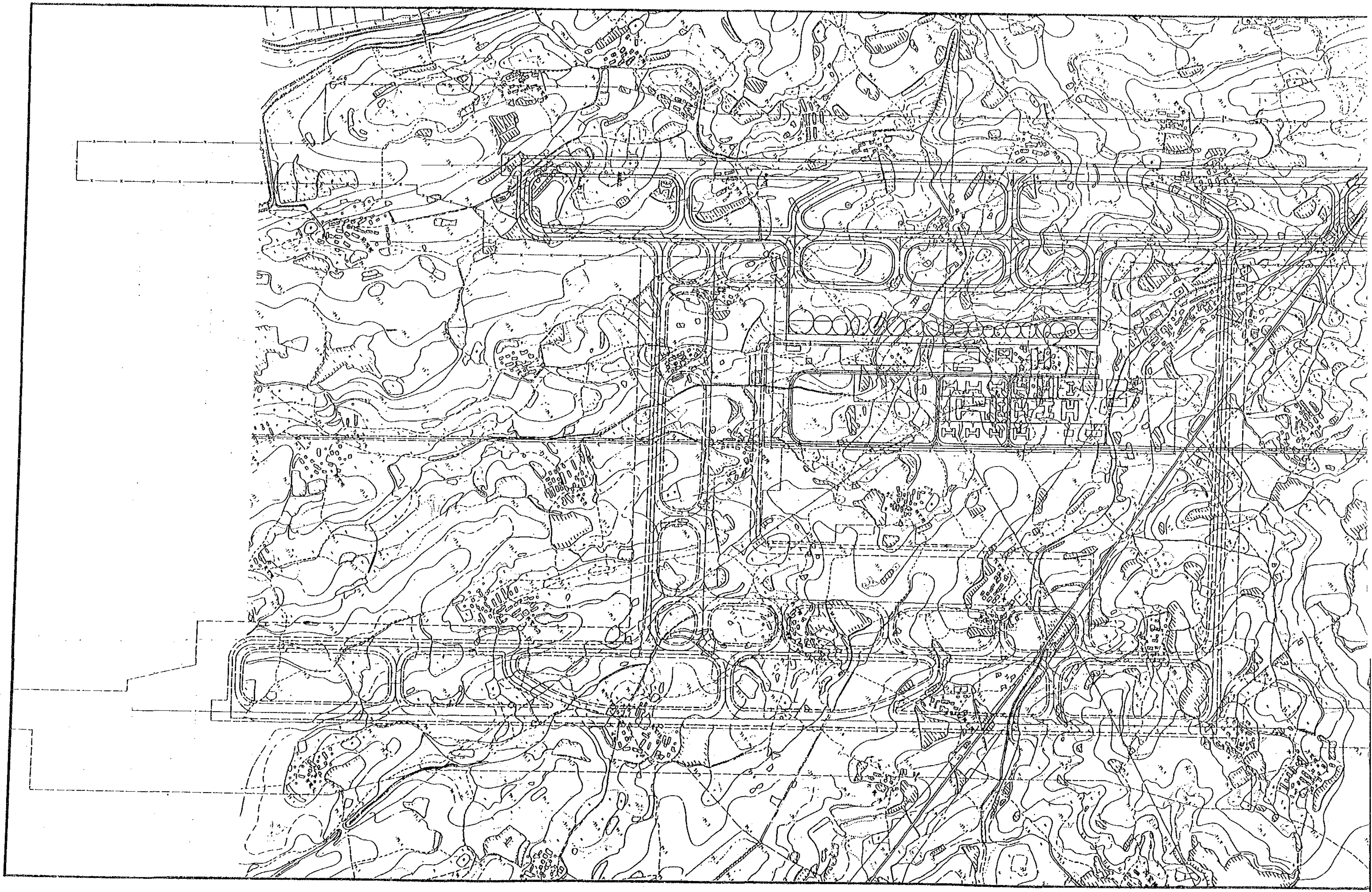
7. Construction Schedule and Cost Estimate

7.1 Construction Schedule

The construction schedule for the Airport made on the basis of the construction conditions surveyed in 1989 is shown in Table S-1.

7.2 Cost Estimate

The cost estimate of the construction of the Airport made based on the preliminary design as well as on the data and information collected in 1989 is shown in Table S-2.



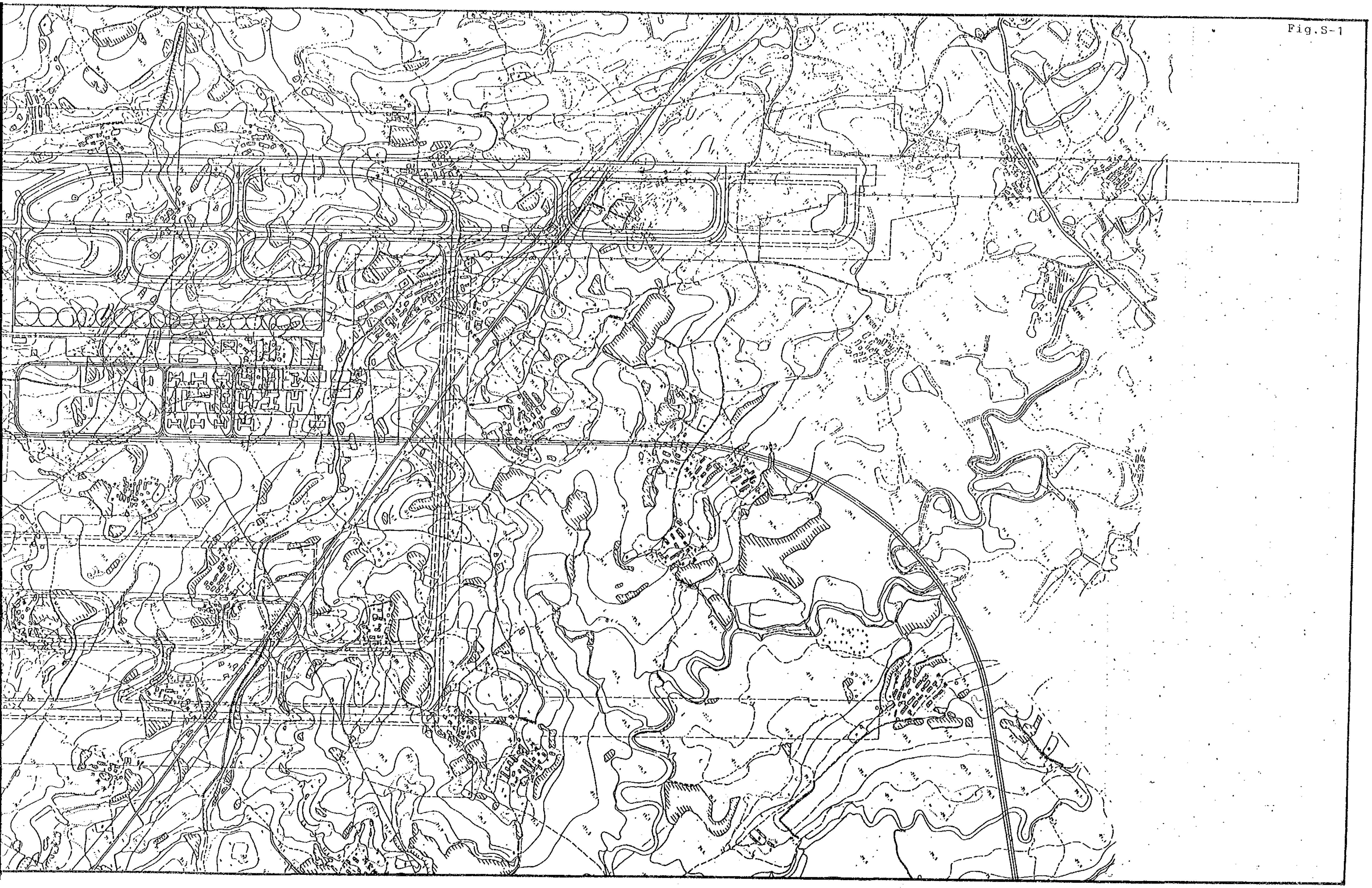


Fig.S-1 Overall Layout Plan of Airport Facilities

Table S-1 Construction Schedule for Wuhan/Tianhe Airport

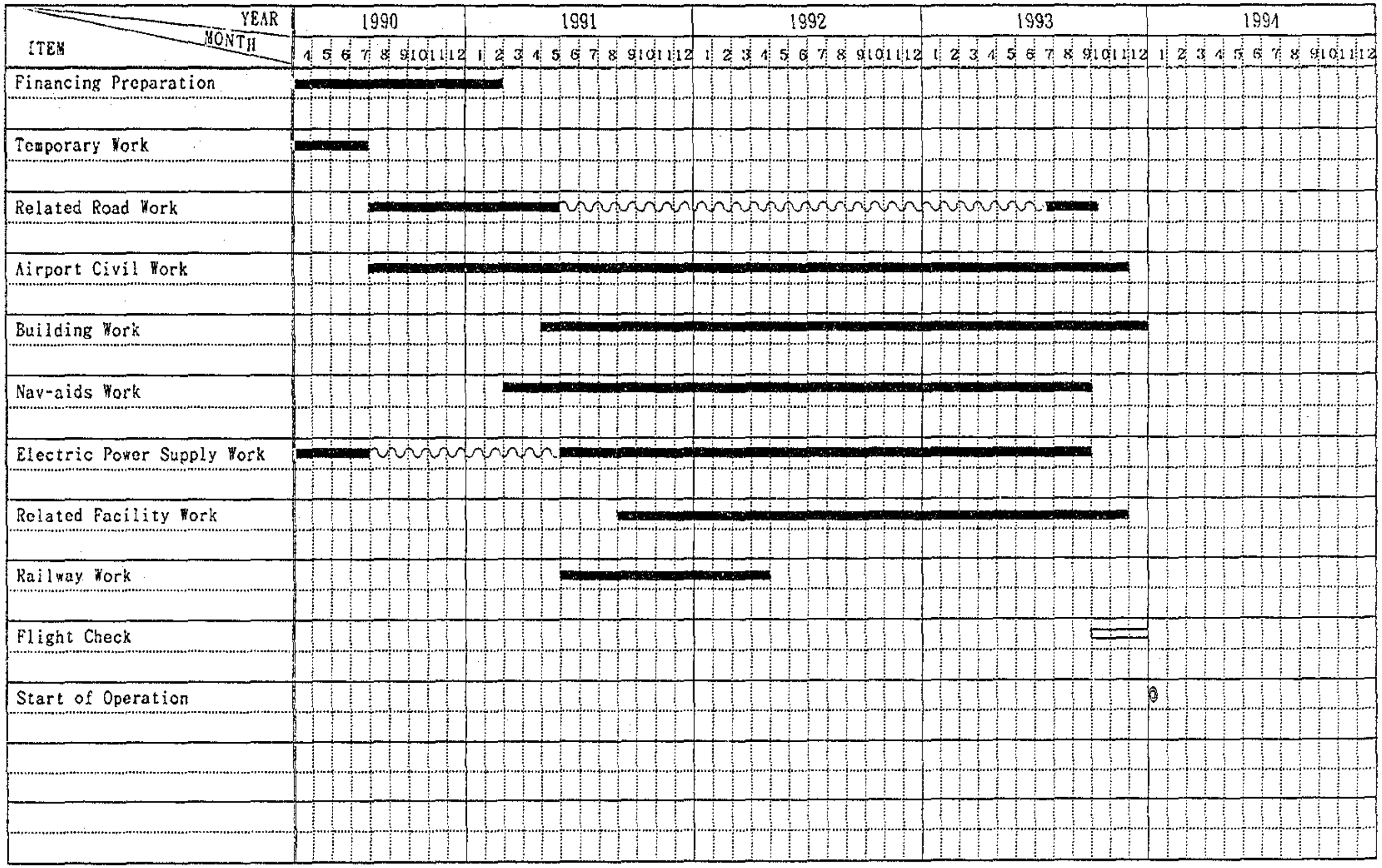


Table S-2 Construction Cost Estimate for Wuhan/Tianhe Airport

(in 1989 price)

Item	Local Portion		Foreign Portion		Total
	Thousand Yuan		Thousand Yuan	Thousand Yen▲	Thousand Yuan
Land Acquisition Cost	30,143		0	(0)	30,143
Airfield Facility	73,389	<19,637>*	0	(0)	73,389
Terminal Facility	53,228	<10,645>*	29,516	(1,121,608)	82,744
Passenger Terminal Building	32,195	< 5,351>*	29,516	(1,121,608)	61,711
Cargo Terminal Building	2,876	< 477>*	0	(0)	2,876
Aircraft Maintenance Facility	13,598	< 4,082>*	0	(0)	13,598
G.S.E. Facility	1,155	< 192>*	0	(0)	1,155
Roads and Car Park	3,404	< 543>*	0	(0)	3,404
Air Navigation Facility	7,455		77,072	(2,928,736)	84,527
Airport-Related Facility	141,545	<16,802>*	30,925	(1,175,150)	172,470
Drainage Facility	11,851	< 816>*	0	(0)	11,851
Water Supply Facility	2,266		0	(0)	2,266
Sewage Disposal Facility	3,765		0	(0)	3,765
Electric Power Supply Facility	20,171		9,578	(363,964)	29,749
Fuel Supply Facility	23,238		21,209	(805,942)	44,447
Air-conditioning Facility	1,484		0	(0)	1,484
Rescue and Fire-fighting Facility	1,378	< 227>*	0	(0)	1,378
Control Tower	2,571	< 530>*	138	(5,244)	2,709
Related Buildings	58,209	<12,013>*	0	(0)	58,209
Downtown Staff Housing *	37,000	< 7,636>*	0	(0)	37,000
Downtown Ticketing office*	5,000	< 1,032>*	0	(0)	5,000
Another Related Buildings	16,209	< 3,345>*	0	(0)	16,209
Related Road	14,842	< 3,216>*	0	(0)	14,842
Exclusive Railway	1,770		0	(0)	1,770
Sub Total of Construction Work	275,617	<47,084>*	137,513	(5,255,494)	413,130
Engineering	13,781		6,876	(261,288)	20,657
G.S.E/Rescue and Fire-fighting Vehicles	0		18,158	(690,004)	18,158
Sub Total	319,541	<47,084>*	162,547	(6,176,786)	482,088
Contingency	31,954	< 4,708>*	16,255	(617,690)	48,209
Total Airport Construction Cost	351,495	<51,792>*	178,802	(6,794,476)	530,297
Construction Cost of Bridge* across Fuhe River	40,000		0	0	40,000
Grand Total	391,495		178,802	(6,794,476)	570,297

* Based on the estimation by the Chinese side.
< >* Cost of locally procured but restrictedly supplied materials.
▲ 1Yuan=0.268U.S.Dollar=38Yen

8. Financial Analysis

The purpose of the financial analysis is to examine the financial viability of the Project in which the Airport will be administered by the Airport Authority on the basis of a self-supporting accounting principle.

The financial internal rate of return (FIRR) of the Project shows 7.8%, which is made with the cash flow of the financial costs and the financial benefits of the Project for the assumed project life of 20 years and the construction period of 4 years.

It is concluded, therefore, that the Project is financially feasible on condition that the foreign portion of the construction costs of the Project are to be financed by foreign soft loans, of which the average interest rate is understood to be below 7%.

9. Economic Analysis

The purpose of the economic analysis is to make a comprehensive evaluation of the economic worth brought about in the People's Republic of China by the implementation of the Project. It is a general practice to make cost-benefit analysis on the "with-and-without principle", that is to say, comparing the case where the project is implemented with the case where the project is not implemented.

The economic internal rate of return (EIRR) of the Project shows 12.1% based on the cash flow of the economic costs and the direct and tangible economic benefits of the Project in monetary terms. It is concluded, therefore, that the Project is economically feasible from the viewpoint of the national economy of China where the social discount rate is said to be 12%. If the intangible benefits are taken into consideration, then the Project will show a much better EIRR figure.

10. Forecast of Aircraft Noise Contour

According to the Chinese Standard of Aircraft Noise of Area Around Airport established in June 1987, the noise contours are forecast by Weighted Equivalent Continuous Perceived Noise Level (WECPNL) method based on units of Decibel (dB) around the area of Wuhan/Tianhe Airport for the year 2000, with the size of the land area to be affected by different levels of aircraft noise as shown below:

WECPNL	70	75	80	85	90	95
Area (km^2)	20.89	9.50	3.95	1.75	0.86	0.41

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 History of Study

The city of Wuhan belonging to Hubei Province is situated in the central part of China where the Chang Jiang River and the Jing Guang Railway Line cross each other and is sited as the economic hub of the inner part of the central China region.

The existing Wuhan/Nanhu Airport is located just 4 km from the centre of Wuhan City with a runway length of 1,800m, accommodating only up to the B737 type of aircraft. However, it cannot be easily expanded because of the environmental situations.

Under the circumstances, the People's Government of Hubei Province and the Civil Aviation Administration of China (hereinafter referred to as CAAC) have long since 1958 been studying possible sites for a new airport needed for the development of the City. The Government of the People's Republic of China finally approved the construction project of a new Wuhan airport at Tianhe in 1985.

In response to the request of the Chinese Government for technical assistance for the Project, the Government of Japan decided to conduct a feasibility study in 1988. The Japan International Cooperation Agency (hereinafter referred to as JICA) sent a preliminary survey mission to China in August 1988 in order to identify the Project, and the Scope of Work for the feasibility study was agreed upon between CAAC and the JICA Mission as attached hereto in Appendix 1-1.

1.2 Objective and Scope of Study

The objectives of the Study are:

(1) to examine the technical, economic and financial feasibility of construction project of Wuhan/Tianhe Airport at the selected new airport site; and

(2) to pursue technology transfer to the experts of the Chinese side participating in the Study during the Study period.

In order to achieve the above-mentioned objectives, the Study will cover the following items:

(1) Evaluation of the new airport site;
(2) Supplemental meteorological survey;
(3) Air transport demand forecast;
(4) Airport master planning;
(5) Preliminary design;
(6) Construction schedule;
(7) Preliminary cost estimate;
(8) Economic analysis;
(9) Financial analysis; and
(10) Forecast of aircraft noise contour.

1.3 Organization of Study

The Study is conducted by the JICA Study Team under the direction of JICA with the advice of the Advisory Committee and also with the cooperation of the Chinese side. The Study organization is shown in Fig.1-1, with the lists of the persons concerned as shown in Appendix 1-2.

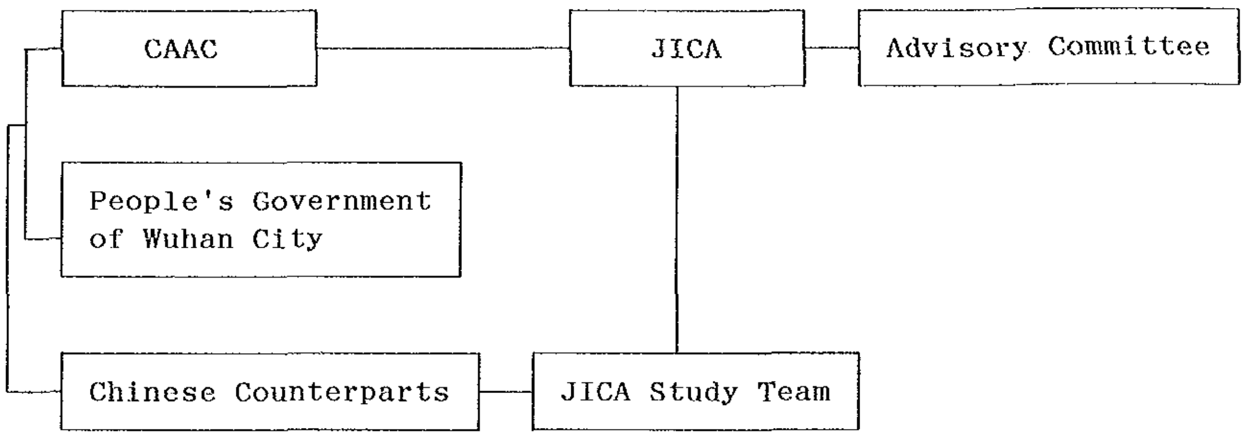


Fig.1-1 Study Organization Chart

CHAPTER 2 BACKGROUND OF PROJECT

CHAPTER 2 BACKGROUND OF PROJECT

2.1 Wuhan City

Geographically, the central China region is considered to consist of Shanghai City, Jiangsu Province, Zhejiang Province, Anhui Province, Jiangxi Province, Hunan Province and Hubei Province all located along the Chang Jiang River. Hubei Province which recorded the total population of 50,581 thousand in 1987 comprises 8 (eight) cities including Wuhan City, 7 (seven) districts and 1 (one) autonomous county.

Wuhan City recorded the urban population of 3,525 thousand in 1987 and recorded the gross industrial product of 13.8 billion Yuan in 1985, ranking fifth and fourth in the country, respectively.

Wuhan, integrating three cities of Wuchang, Hanyang and Hankou and including 4 (four) counties, is an industrial city of having a total population of 6,294 thousand and producing gross social products of 24,959 million Yuan (in 1980 price) in 1987 of which the industrial product accounts for 77% as shown in Table 2-1.

The City is featured by such industries as iron and steel, automobile, shipbuilding, machines, electronics, spinning, food and chemicals, etc. as well as by the fishery producing Wuchang fish and soft-shelled turtle.

Table 2-1 Socio-economic Indicators of China

(1987)

Items	Unit	China[*1]	Hubei Province[*2]	Wuhan City[*3]
Land Area	(km^2)	9,600,000	180,590	8,392
Total Population	(thousand)	1,080,730	50,581	6,294
Urban Population	"	503,620	11,108	3,525
Non-Urban Population	"	577,110	39,473	2,769
Gross Social Products	(Million Yuan in 1980 price)	1,842,900	110,037	24,959
Industrial Products	"	1,198,600	58,641	19,271
Agricultural Products	"	311,800	17,252	1,341
Other Products	"	332,500	34,144	4,347
Composition of Agricultural and Industrial Products				
Agriculture	(%)	20.7	22.7	6.5
Light Industry	(%)	38.2	38.6	43.2
Heavy Industry	(%)	41.1	38.7	50.3
Total	(%)	100	100	100
Transport Traffic				
Railway	(thousand)	1,124,790	29,100	...
Road	"	7,014,580	275,750	...
Inner Waterway	"	457,790	29,420	...
Air	"	13,100	260	...
Total	"	8,610,260	334,530	...

Source: *1 Statistical Year Book of China,1988
*2 Statistical Year Book of Hubei,1988
*3 Socio-Economic Development of Wuhan City,1987

2.2 Present Transport System

The present transport system to and from Wuhan City consists of railway, road, inner waterway and air, with the network maps as shown in Figs. 2-1, 2-2, 2-3 and 2-4, respectively.

Air transport plays a vital role in intercity transport, especially in long distance routes; however, its share in the total passenger transport demand in Hubei Province only accounted for 0.08% in 1987, although increasing year by year as shown in Table 2-2.

Table 2-2 Passenger Transport Demand by Mode in Hubei Province

(thousand)

Transport Mode	1985	1986	1987
Railway	33,530 (11.96%)	29,050 (9.20%)	29,100 (8.70%)
Road	223,780 (79.82%)	255,970 (81.07%)	275,750 (82.43%)
Inner Waterway	22,900 (8.17%)	30,546 (9.67%)	29,420 (8.79%)
Air	140 (0.05%)	195 (0.06%)	260 (0.08%)
Total	280,350 (100%)	315,761 (100%)	334,530 (100%)

Source : Statistical Yearbook of Hubei, 1988

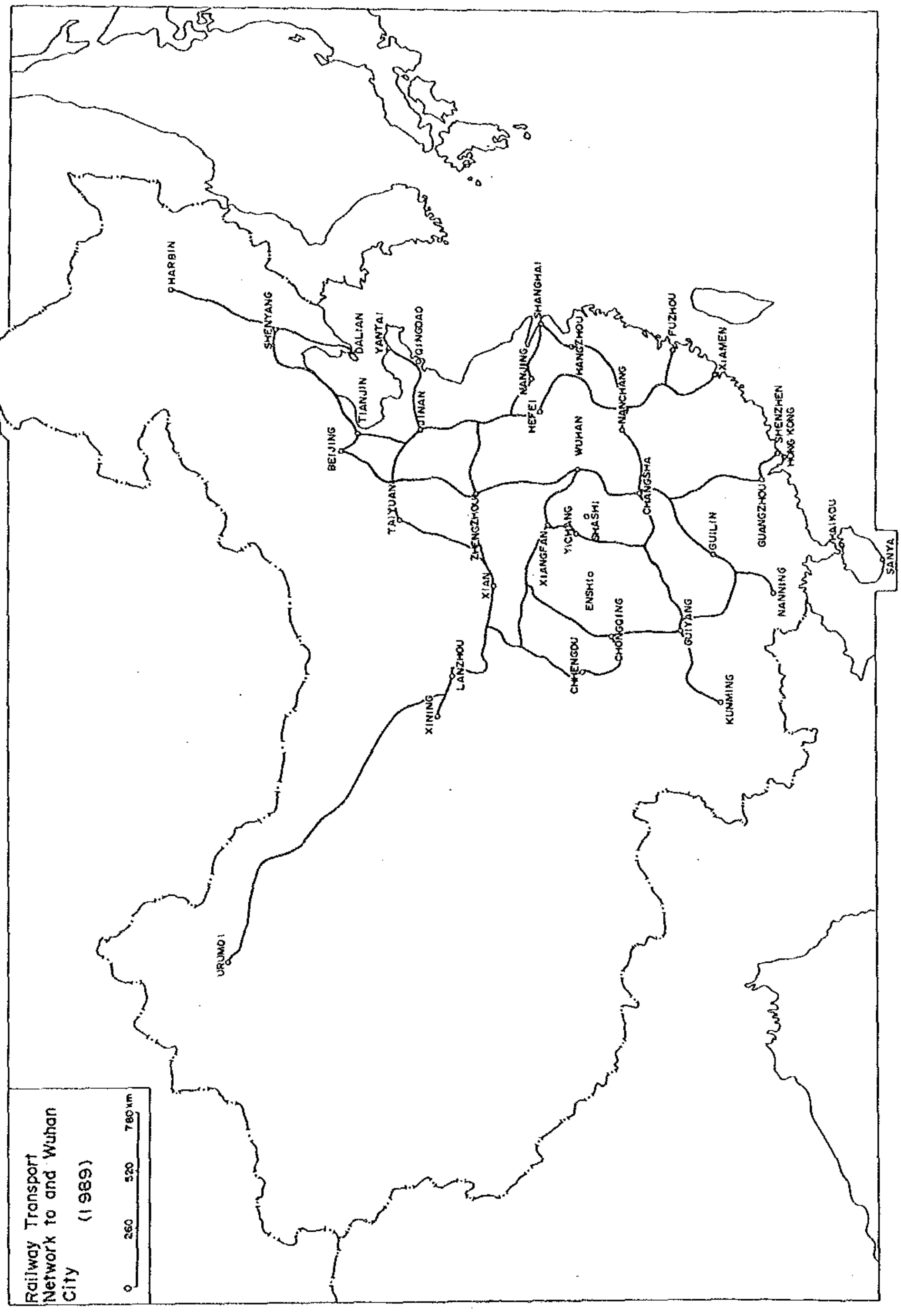


Fig.2-1 Present Railway Transport Network to and from Wuhan City

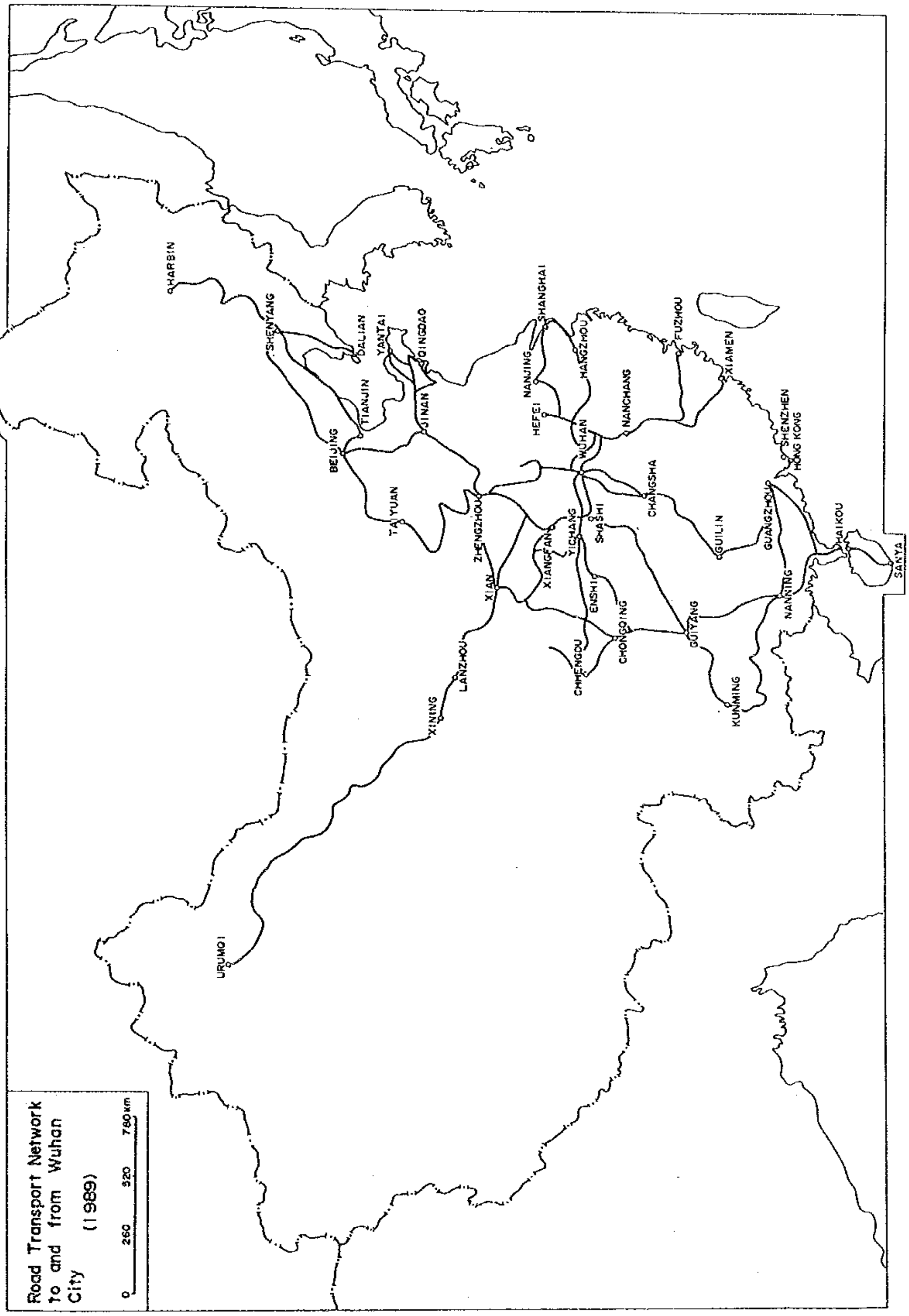


Fig.2-2 Present Road Transport Network to and from Wuhan City

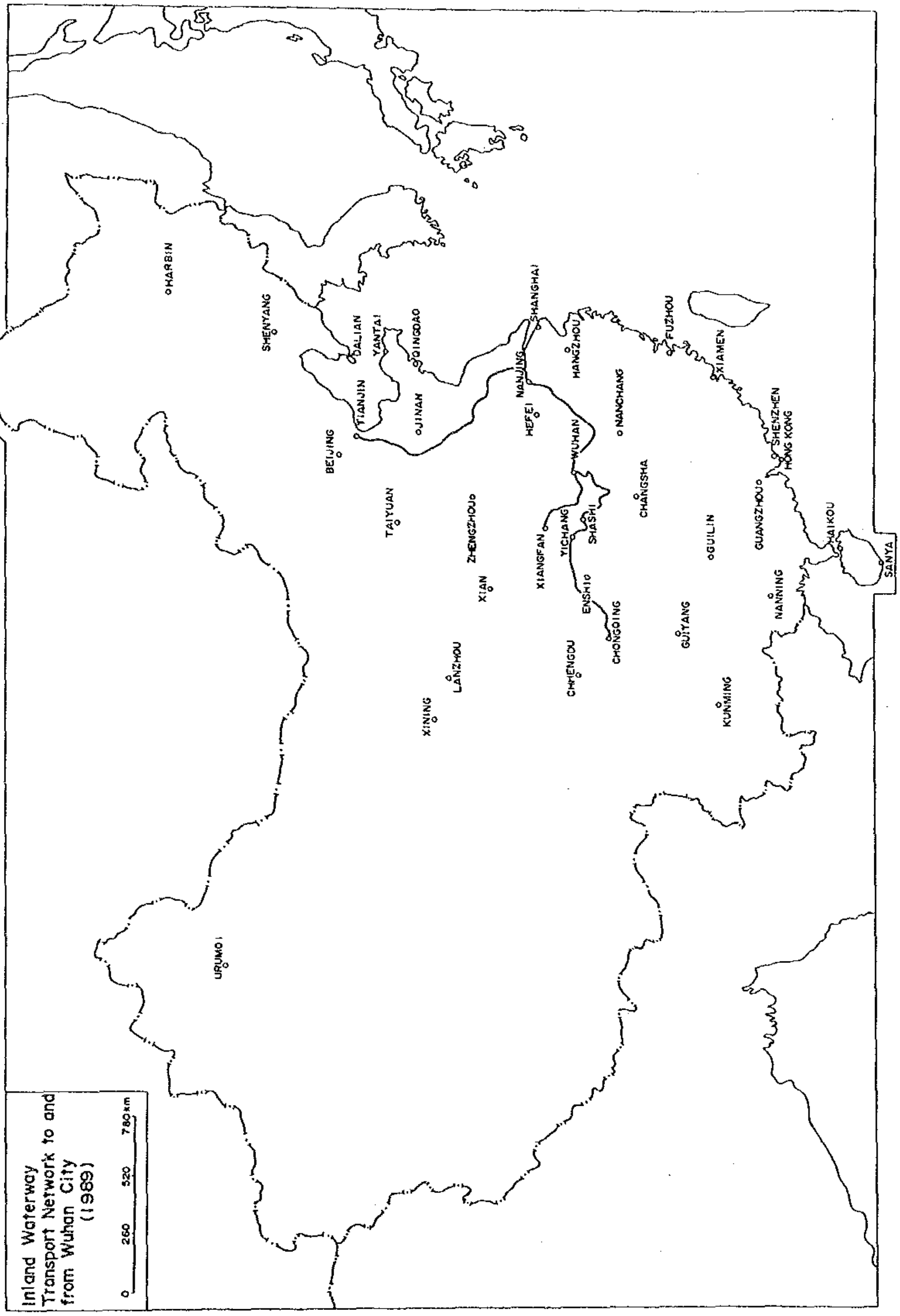


Fig.2-3 Present Inner Waterway Transport Network to and from Wuhan City

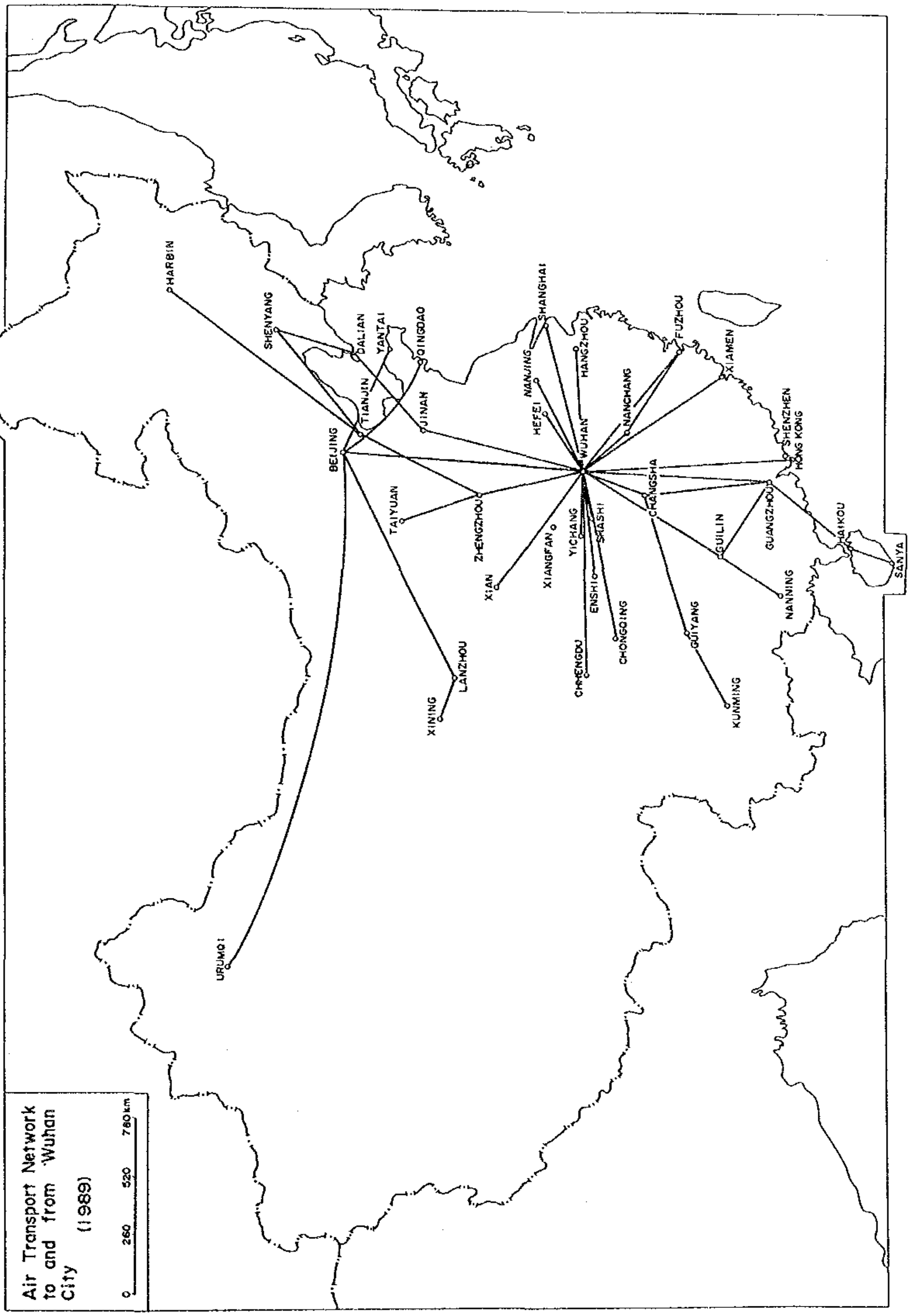


Fig.2-4 Present Air Transport Network to and from Wuhan City

2.3 Existing Wuhan/Nanhu Airport

2.3.1 Existing Facility Conditions

The existing facility conditions of Wuhan/Nanhu Airport as of January 1989 are summarized below.

(1) Airfield Facilities

Table 2-3 Existing Facility Conditions
-- Airfield Facilities --

Facility	Description	Condition
Runway Strips	Dimension: 1812m x 150m	The width is insufficient for precision approach, but cannot be extended.
Runway	Dimension: 1812m x 50m Operating Length: 36 Approach: 1552m 18 Approach: 1752m 36 Departure: 1812m 18 Departure: 1612m Surface:Cement concrete Concrete slab thickness: Overlaid section: 22-31cm Extended section: 25cm Direction:184°-04°	Operating length is limited due to the obstacles. Longest route:to Beijing by B737. Surface is in good condition.
Taxiway	Length: No.1: about 110m No.2: about 100m No.3: about 100m Width: 18m Surface: Cement concrete Concrete slab thickness: No.1: 22-31cm No.2 & No.3: 25cm	Not parallel. Distance between the runway centreline and the apron taxiway is too short to construct a parallel taxiway.
Apron	Dimension:80m x 600m Area:about 42,000m^2 Aircraft stand:total 10 2 for B737 4 for YN7 4 for SH6 Distance from the runway centreline : 115m Surface: Cement concrete Concrete slab thickness: 22-31cm or 25cm	Depth of the apron and distance from the runway centreline is too short for aircraft bigger than B737.

(2) Terminal Facilities

Table 2-4 Existing Facility Conditions
-- Terminal Facilities --

Facility	Description	Condition
Passenger Terminal Building	Structure: RC 1F Floor area: 3,000m^2	In poor condition. One level operation.
Cargo Terminal Building	Structure: RC 1F Floor area: 1,600m^2	In good condition.
Hangar Facility	Structure: S/RC 2F Floor area: 4,900m^2	No frontal door. C check operation for YN-7 or B737.
Control Tower Building	Structure: RC 3F Floor area: 1,400m^2	In operation. Eye level is approx. 15 m height. Situated in Passenger Terminal Building.
Meteorological Building	Structure: RC 3F Floor area: 700m^2	In operation. Situated in Passenger Terminal Building.
Fire Station Terminal	Structure: RC 2F Floor area: 1,300m^2	In good condition.
Administration Building	Structure: RC 2F Floor area: 1,900m^2	In good condition.
G.S.E. Facility	Structure: RC 1F Floor area: 600m^2	In good condition.
Guard Building	Structure: RC 4F Floor area: 3,000m^2	In good condition.
Staff houses for married people	Structure: RC 3F Floor area: 30,000m^2	In good condition.
Staff houses for unmarried people	Structure: RC 3F Floor area: 8,000m^2	In good condition.
Staff houses for unmarried people of Airport Authority	Structure: RC 4F Floor area: 1,800m^2	In good condition.
Guest House	Structure: RC 3F Floor area: 2,500m^2	Two buildings in good condition.
Accessory Storages	Structure: RC 1F to 2F Floor area: 4,500m^2	Five buildings
Roads and Car Park	Area: 10,000m^2 Car stands: 100 Surface: Cement concrete	Pavement is in good condition.

(3) Air Navigation Facilities

Table 2-5 Existing Facility Conditions - Air Navigation Facilities

Facility	Description	Condition
Radio Navaids	VOR: 115.1MHZ, 50W(1974)	In operation.
	DME: 1,250MHZ, 1KW, Thompson(1985)	In operation.
	LLZ(RWY36): Frequency unknown, made in China(1987)	Awaiting flight check.
	GP(RWY36): Frequency unknown, made in China(1987)	Awaiting flight check.
	LMM: Locator 303KHZ, RACAL	In operation.
	MM, made in China	Not in operation.
	LOM: Locator 242KHZ, RACAL	In operation.
	OM	In operation.
Visual Aids	ALS(RWY36): Constant current series circuit of 200W, made in China	In operation.
	SALS(RWY18): - ditto -	In operation.
	RWY Thr/End LIghts: - ditto -	In operation.
	RWYL : - ditto -	In operation.
	T-Lights: Parallel circuit 100W x 21, made in China	In operation.
	TWYL: Parallel circuit of 100W, made in China	In operation.
	Apron Flood Light: Parallel circuit, made in China	In operation.
ATC Facility	ACC: 118.9MHZ TX 50W Park Air Electronics	In operation.
	TWR: 130.0MHZ TX 25W Park Air Electronics	In operation.
	Radar: ASR; Coverage r=270-400km, made in China	Not in operation.
	SSR; TOSHIBA (1986)	In operation.
Communi-cations Facility	AFTN: Teletypewriters SIMENS, SAGEME	In operation.
	HF radio: made in China	In operation.
Meteoro-logical Facility	Observation Instruments: Wind Direction/ Speed Indicator Wind Socks	In operation.
	Communications: Teletypewriters SIMENS	In operation.
	WX Radar: made in China	Not in operation.
	WX Satellite Receiver	Will be operative in 1989.

2.3.2 Possibility of Expansion

The existing Wuhan/Nanhu Airport is located in Wuchang district just 4 km to the southeast of the centre of Wuhan City. The Airport was opened in 1954 with the runway length of 1,300 m, which has been extended to 1,812 m to meet the increasing traffic demand since then as shown in Fig.2-5.

However, there are distinct operational difficulties caused by obstructions existing near the Airport, resulting in higher airport operating minima; the current visibility minima for the instrument approach to Runway 36 is 2,800 m. Furthermore, the Airport is surrounded by buildings, houses, railway, river, farm land and so on, as shown in Fig.2-6.

Therefore, it can be said that the Airport has reached the limit of extension, if it was to be extended to cater for bigger aircraft than B737, due to the following measures being required for obstacle clearance and environmental protection.

(The south of the runway end)

1. Removal of the route of the river
2. Removal of the Institute of Shipbuilding
3. Removal of the Hubei Engineering Institute
4. Compensation for agricultural land
5. Compensation for fishery
6. Removal of electric wire
7. Removal of the road
8. Removal of houses

(The north of the runway end)

1. Removal of the route of the railway
2. Removal of houses
3. Compensation for agricultural land
4. Removal of the Wuchang Station
5. Change of the construction plan for new railway
6. Removal of high buildings

Moreover, if the second runway was to be constructed to the east of the existing runway at the distance of 1,500 m between the centrelines, the following objects would have to be relocated.

1. The Agriculture Institute
2. The Wuchang Boiler Factory
3. The power transmission line

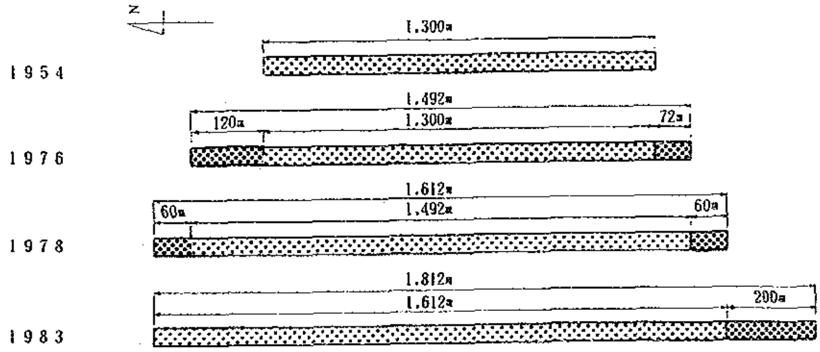


Fig.2-5 History of Runway Extension at Wuhan/Nanhu Airport

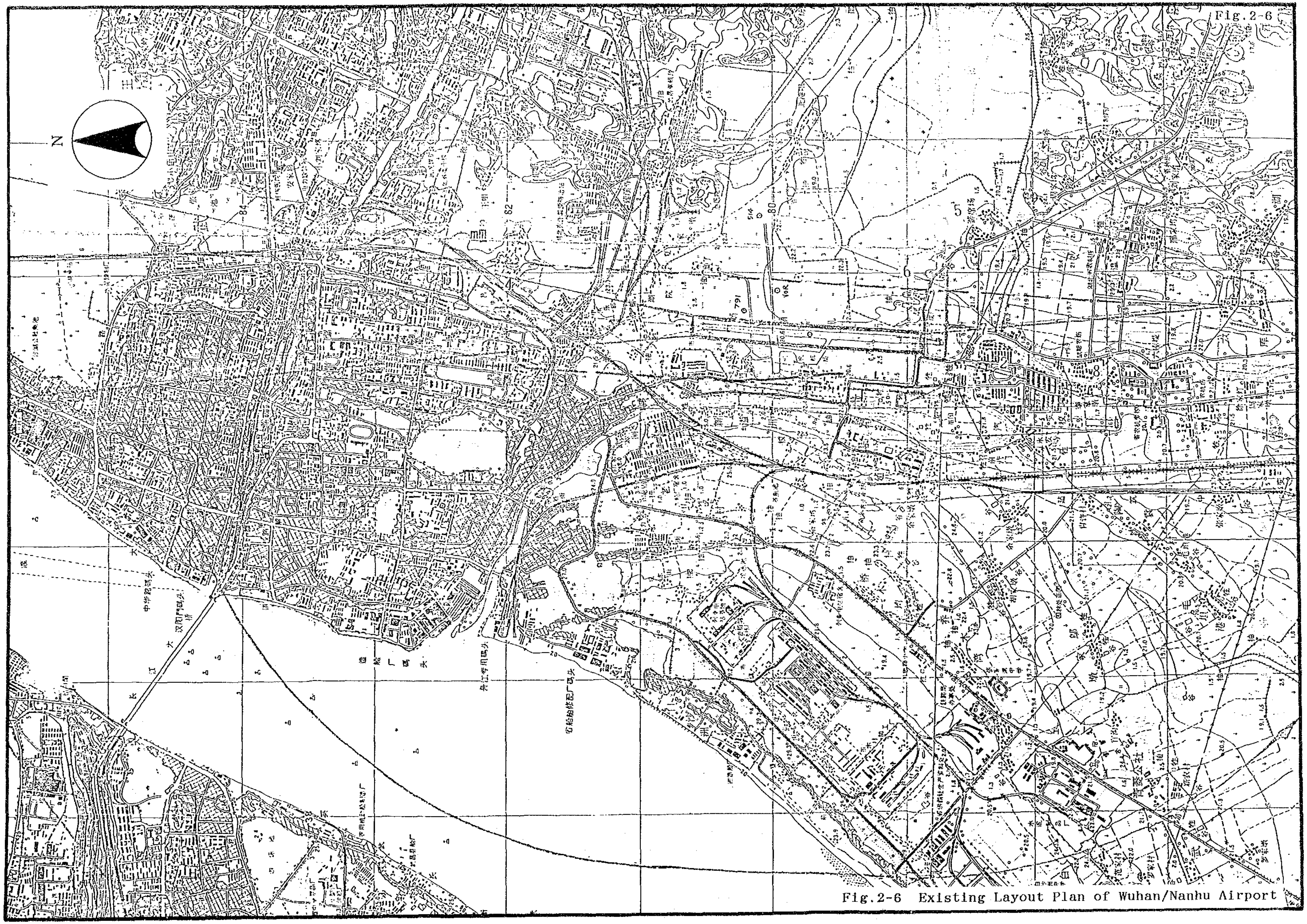


Fig.2-6 Existing Layout Plan of Wuhan/Nanhu Airport

CHAPTER 3 SITE SELECTION STUDY

CHAPTER 3 SITE SELECTION STUDY

3.1 Candidate Sites

The site selection study for a new Wuhan airport was carried out by the Chinese side in 1984 as regards several candidate sites as well as the existing airport. The locations of the candidate sites studied are shown in Fig.3-1, all being located in the outskirts of Wuhan City except the existing airport.

The general situations of all the candidate sites are shown in Table 3-1.

Based on the site selection study, Tianhe was selected as the site for the construction of a new Wuhan airport by the Chinese Government in 1985.

Fig. 3-1 Location of Candidate Sites

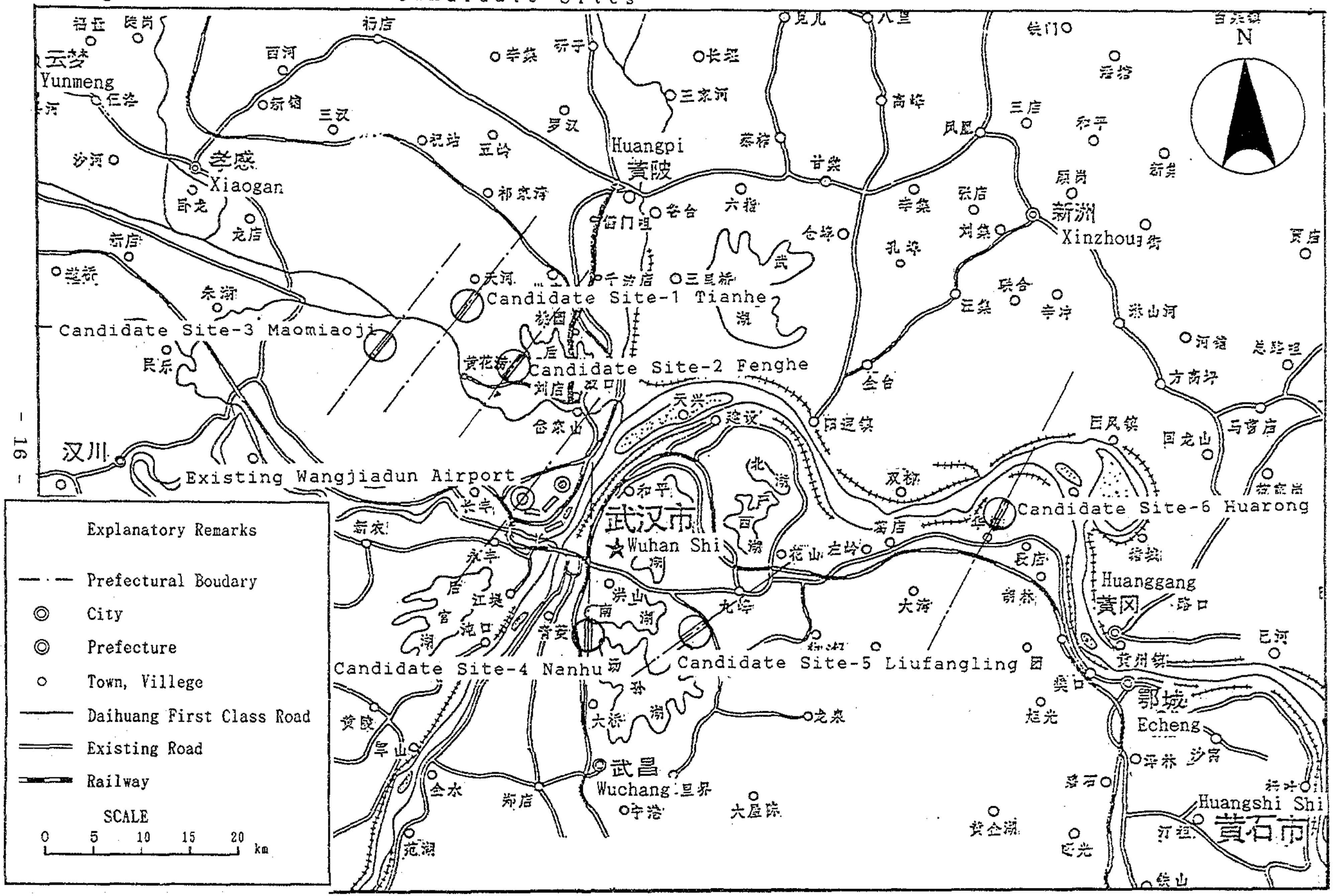


Table3-1 General Situation of Candidate Sites

	Tianhe	Fenghe	Maomiaoji	Nanhu	Liufang Ling	Huarong
1. Location	Northeast of Wuhan. Distance from the center of the city(assumed Changjiang Bridge)is 27km. Near by Tianhe Town, Huanpi Prefecture.	North of Wuhan. Distance from the center of the city is 20km 2 km west from Mt. Fenghe, Huanpi Pre.	Northwest of Wuhan. Distance from the center of the city is 28km. In the Hankou Dongxihu Farm, Hongshan Ward.	Southeast of Wuhan. Distance from the center of the city is 7km. Nanhu, Wuchang Ward. Near by the city area.	Southeast of Wuhan. Distance from the center of the city is 18km. Near by Liufangling Town, Wuchang Pref.	East of Wuhan. Distance from the center of the city is 48km. Near by Huarong Town. Far from Wuhan City.
2. Direction of the runway	N45°E	N45°E	N45°E	N 4 °E	N65°E	N30°E
3. Wind condition	Relatively good	Relatively good	Relatively good	Good	Relatively Wrong	Relatively good
4. Relation to Wangjiadun Airport (the military aerodrome)	Distance between planning runway center line and runway center line of Wangjiadun Airport is 16km	Near by Wangjiadun Airport Distance between the runway center lines is 12km. The concerned authorities appointed the problem. Expected overlapping of control zone and holding pattern airspace area.	Distance to Wangjiadun Airport is 22km. No problem.	Distance to Wangjiadun Airport is 22km. No problem.	Distance to Wangjiadun Airport is 26km. No problem.	Distance to Wangjiadun Airport is 51km. No problem.
5. Airspace condition	There is not obstacle. Condition is good.	There is not obstacle. However the overlapping of control zone mentioned above is problem.	There is not obstacle Condition is good	There are many obstacles. Buildings in the adjacent city arer. Sheshan and Hongshan are also problem. Condition is wrong.	There are several mountains higher than limitting height. Baogaifeng and Baozishan are problem. Condition is relatively wrong.	There are high mountain at 35km north. But it is not problem. Condition is good.
6. Problem of runway arrangement.	It is possible to arrange the opened parallel runways. No problem.	As same as Tianhe.	It is possible to arrange the opened parallel runways. But the elevation of second runway will be lower than the flood level due to the lay of The land.	It is necessary to remove the large factory and railway yard for construction of second runways. And reclaiming the lake is also necessary. The construction cost will be high.	Due to the problem of topography, it is difficult to arrange the opened parallel runway. Maximum feasible runway separation is 1400m.	As same as Tianhe.
7. Topography	The site is low hilly districts. The unevenness of the land is small.	As same as Tianhe.	As same as Tianhe.	The lay of the land is flat. But it is necessary to reclam the lake.	As same as Tianhe.	As same as Tianhe.

Table3－1 (Continued)

	Tianhe	Fenghe	Maomiaoji	Nanhu	Liufang Ling	Huarong
8. Geologic condition	Geologic structure is simple. There is not a geologic dislocation. Bearing strength of the ground is expected over $20t/m^2$. Geologic condition is good. Under ground water is poor.	As same as Tianhe.	As same as Tianhe.	Expected bearing strength of the ground is relatively low. It is $10\sim15T/m^2$. Geologic condition is relatively wrong. Under ground water is rich.	Geologic condition is good. Expected bearing strength of the ground is relatively high. It is $20\sim25t/m^2$	Geologic structure is complicated. Two geologic dislocations are crossing. Rock layer expose, and expected bearing strength is high.
9. Accessability	The construction of 10km new accessroad from planning 1st. class road is necessary. After the completion of Dai-Huang Road, good road condition will be expected.	As same as Tianhe.	The construction of 16 km new access road from existing Han-Sha road. The road condition of that existing road is not so good.	It is necessary to improve the existing access road. Extention of width and overcrossing the rail way are necessary. It will be expensive.	The construction of 6km new access road from existing Han-Huang Road. The road condition of that existing road is wrong.	The construction of 7km new access road from existing Han-Huang Road. The road condition of that existing road is wrong.
10. Land use	Mainly farmland. The fields is not so fertile. Compensation cost of the fields is 10,000 Yuan/Mu (1Mu=666.7m²)	As same as Tianhe.	Mainly farmland. The fields is fertile. This site is important point for Wuhan agleculture. Compensation cost of the fields is 20,000~30,000 Yuan/Mu.	Extend area is mainly farmland. But large factory, rail way yard, college and another institutions are adjacent. The fields is fertile. Compensation cost of the fields is 40,000~50,000 Yuan/Mu.	Mainly farmland. The fields is fertile. Compensation cost of the fields is 10,000~20,000 Yuan/Mu.	As same as Liufangling.
11. Objects to be removed	Farm houses. The electric power line (35kV) Telephone line. Road. The cost is low.	As same as Tianhe.	Maomiaoji Town, Baiquan Farm (100,000m²) Anothe objects is as same as Tianhe. The cost is higher than Tianhe.	Large factory, Rail way yard, river, road and other buildings. The cost is very high.	A part of Liufangling Town. Two high voltage electric power lines (110kV) The cost is higher than Tianhe.	The 1st. class road. Another objects is as same as Tianhe.

Table 3 − 1 (Continued)

	Tianhe	Fenghe	Naomiaoji	Nanhu	Liufang Ling	Huarong
12. Relation to city planning.	There is not relation to city planning. No problem.	As same as Tianhe.	As same as Tianhe.	Near by the city area. Airport prevents the development of the city area.	Approach and diparture rout of aircrafts pass over the Hubei Institute of Technology.	As same as Tianhe.
13. General	There is no especial problem for airport construction.	Relation to Wangjiadun Airport is the most critical problem. The concerned authorities don't agree to this site.	In this site housings and factory are increasing now. Removal objects gradually increase.	The most critical problem is adjacency to the city area. Following problems are pointed out. i The cost of removing objects. ii Noise iii Prevention to city planning. The obstacles in approach and departure area are also problem.	The most critical problem is impossibility of setting the opened parallel runways. And the airspase condition is also problem.	The most critical problem is the distance from the city. The road condition of existing road is unexpected.

3.2 Evaluation of the Tianhe site

Evaluation was conducted on the Tianhe site by the JICA Study team with the results as presented hereinafter.

3.2.1 Airspace Usability

(1) Airspace Environment

Dimensions of obstacle limitation surfaces, i.e., conical, inner horizontal, approach and transitional surfaces, at the Site are calculated according to the ICAO Annex 14, as shown in Fig.3-2. Furthermore, dimensions of inner approach, inner transitional and balked landing surfaces are also calculated for a precision approach runway Category I, as shown in Fig. 3-3.

No significant objects restricting the planning of instrument approach and departure procedures are observed around the site. The steel tower for micro-wave relay station of 132m height (MSL), located at a distance of 7,800m ENE from the airport reference point, is not considered to be an obstacle for air navigation according to the obstacle clearance criteria as specified in the ICAO PANS-OPS. However, it is recommended that the tower be appropriately marked and lighted for safety operation of low flying aircraft.

(2) Wind Condition

Based on the analyses of the observations conducted at Tianhe for 41 days from December 22, 1988 to January 31, 1989, and on the records for the past three years (1986-1988) of both Nanhu Airport and Huangpi Meteorological Observation Station, similarities of wind roses for all the observation points are observed as shown in Fig. 3-4, and, therefore, the wind condition at the site can be summarized as follows:

a. Prevailing direction of wind: N-NNE
b. Average wind velocity: 2.5 knot
c. Wind coverage for planned runway direction:
100% with 20 knot crosswind limitation as shown in Table 3-2 and Fig. 3-5.

Accordingly, it is considered that there exists no problem on the planned runway direction as far as the wind is concerned.

Table 3-2 Wind Coverage for Planned Runway Direction

Month	15knot (%)	20knot (%)
January	100.0	100.0
February	100.0	100.0
March	99.6	100.0
April	99.8	100.0
May	99.6	100.0
June	99.7	100.0
July	99.8	100.0
August	99.8	100.0
September	99.9	100.0
October	99.2	99.9
November	100.0	100.0
December	100.0	100.0
Annual Average	99.8	100.0

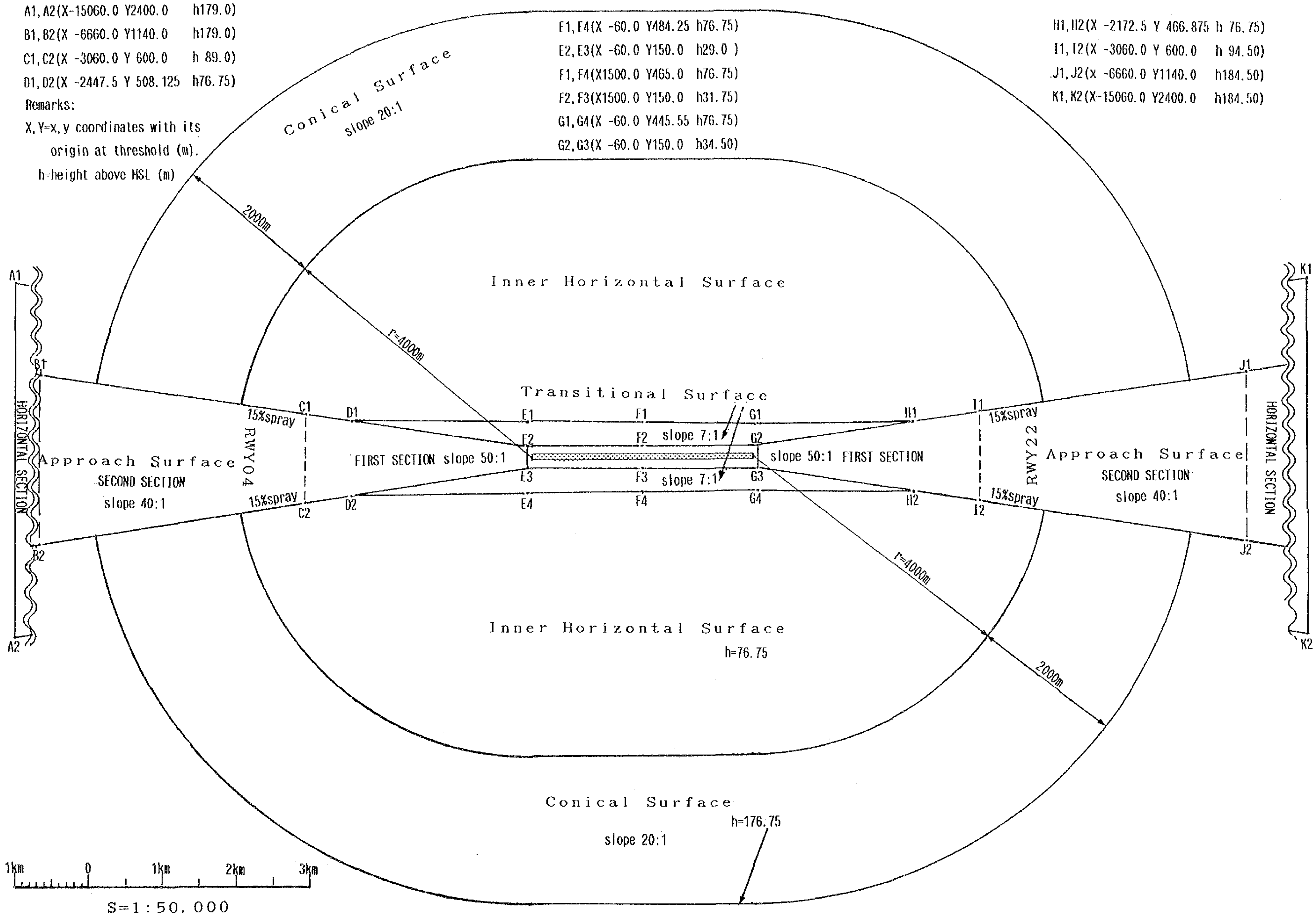


Fig.3-2 Obstacle Limitation Surfaces

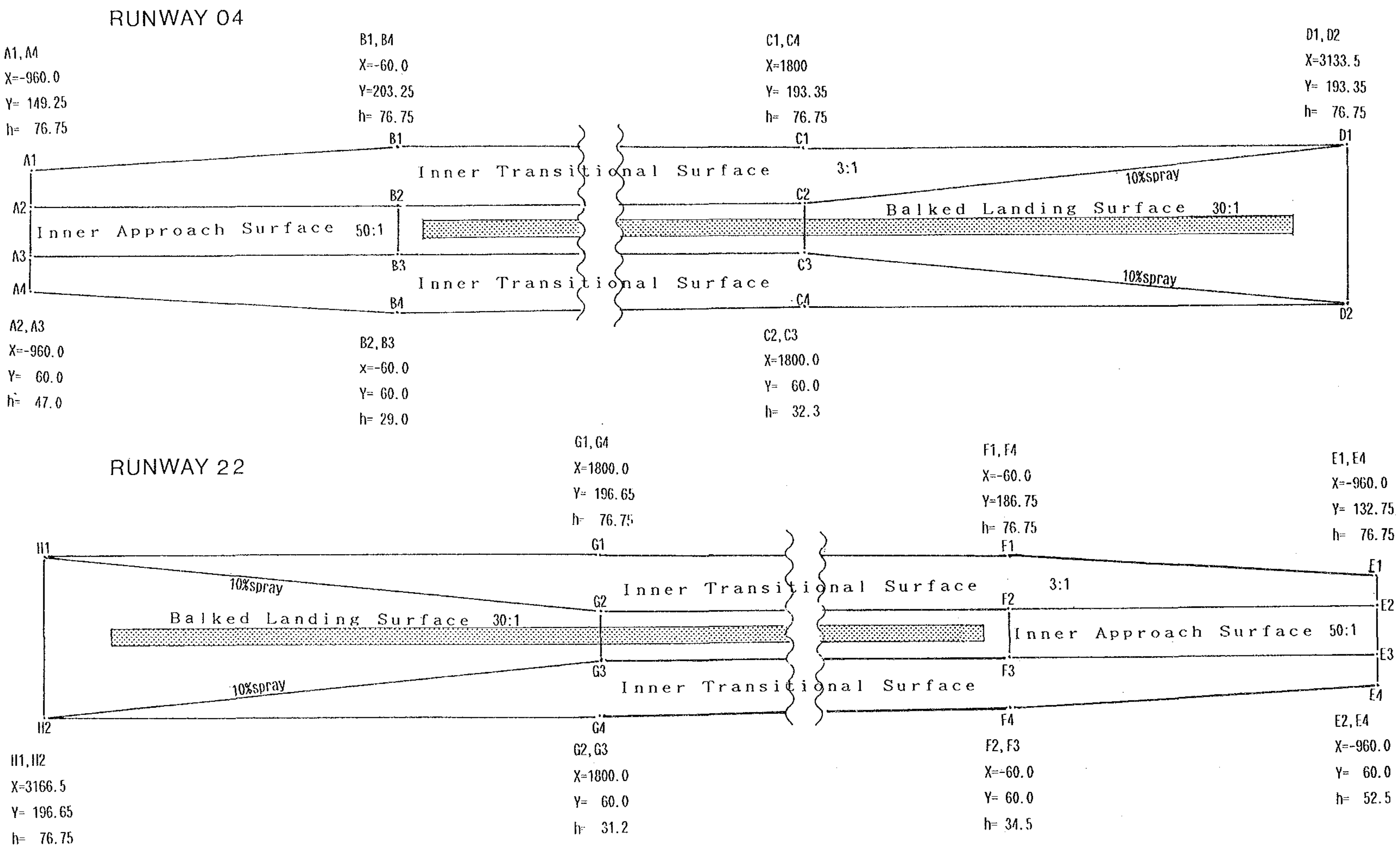
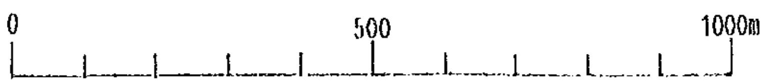


Fig.3-3 Inner Approach/Inner Transitional
and Balked Landing Surfaces



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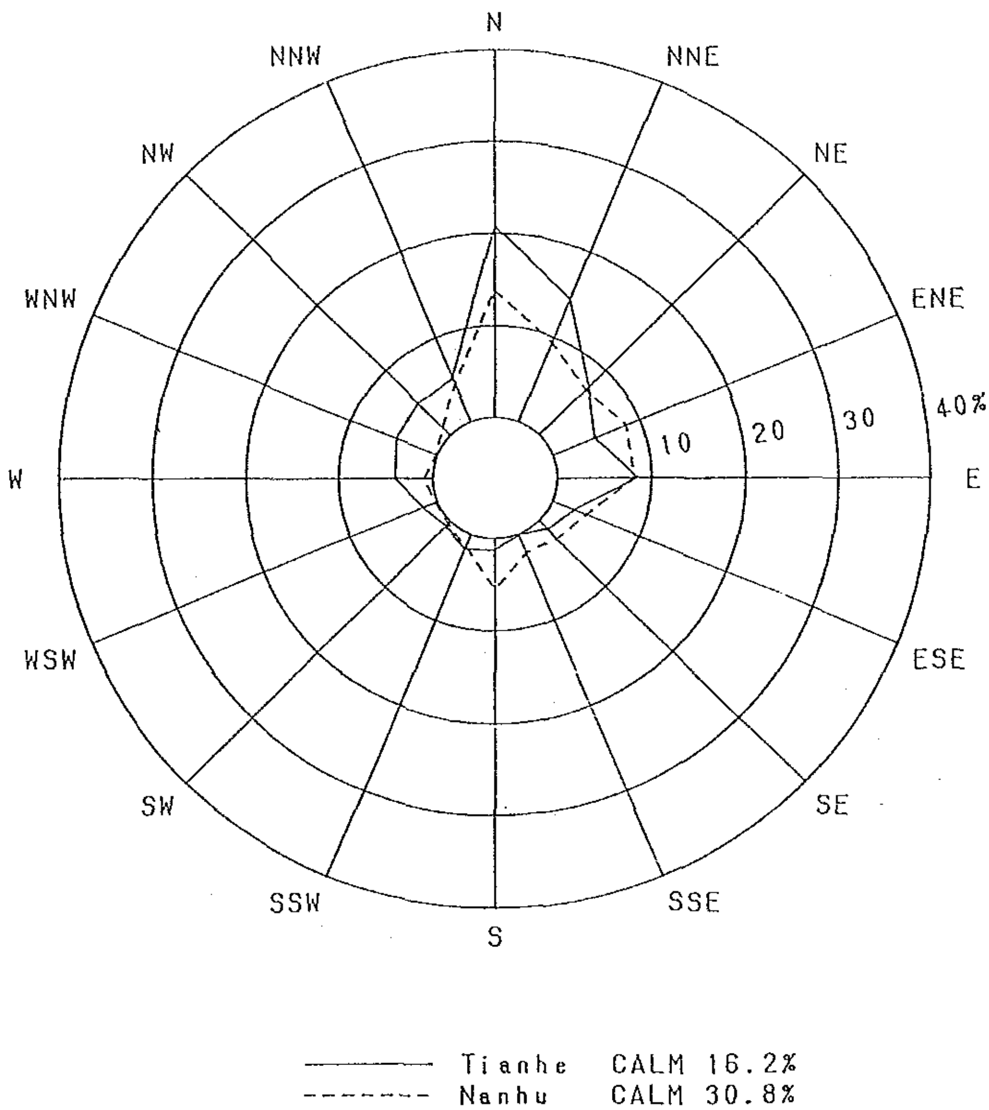
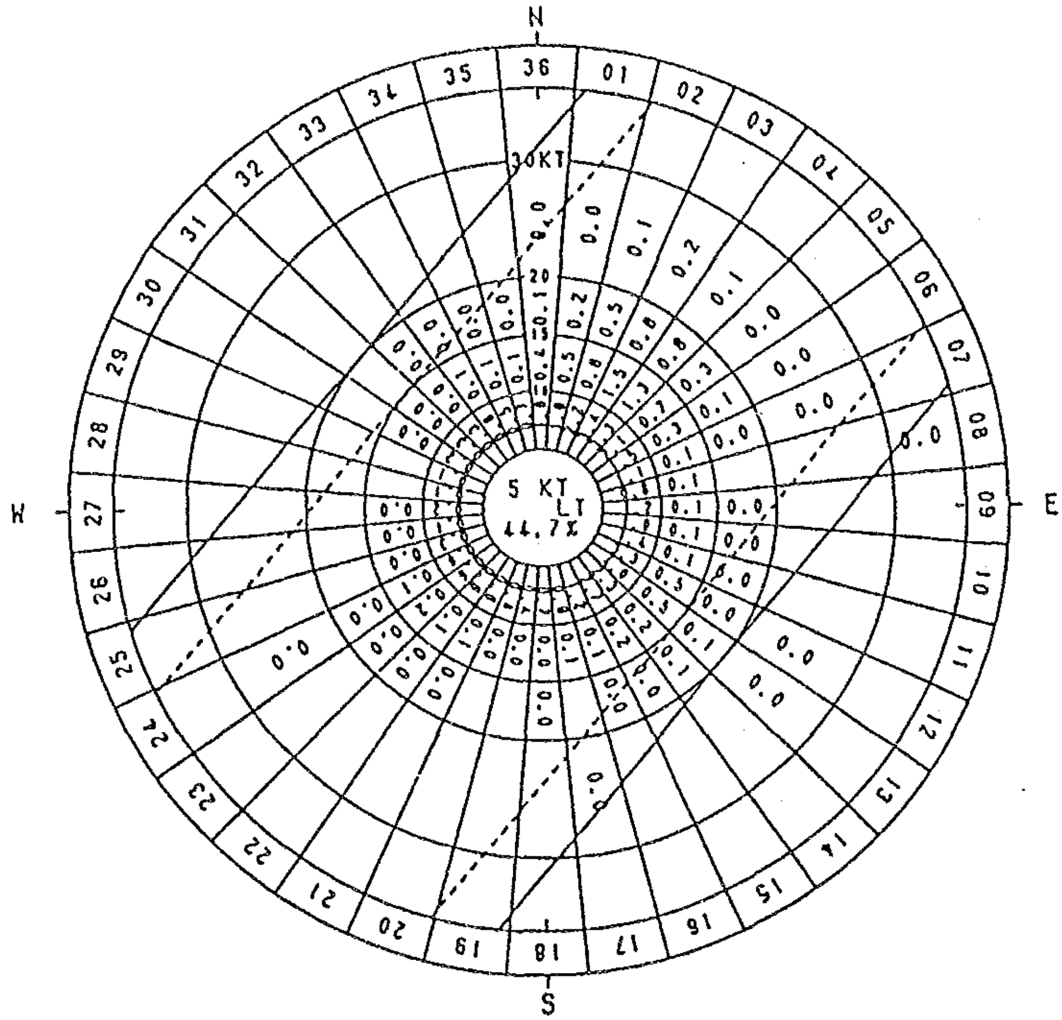


Fig.3-4 Comparison of Wind Rose
(Tianhe and Nanhu, January 1-31, 1989)

Runway Direction : N 40° E



--------- Cross Wind Limit 15kT (P=99.8%)

———— Cross Wind Limit 20kT (P=100.0%)

Fig.3-5 Wind Coverage Chart
(Nanhu, Jan 1986 - Dec. 1988)

(3) Visibility and Ceiling

Analyses are made on visibility and ceiling data recorded at Wuhan/Nanhu Airport for the 3 (three) years from 1986 to 1988 as follows:

a. Low visibility less than 800m (below ILS Category I minimum): 0.7% at annual average. However, attention should be paid to the fact that low the visibility conditions prevail in January, April, November and December as shown in Table 3-3.

b. Low visibility less than 400m (below ILS Category II minimum): 0.5% at annual average. Attention should also be paid to the fact that the very poor visibility conditions occur mainly due to dense fog caused by lakes and rivers nearby especially in the early mornings in January, April and November.

c. Low ceiling less than 200ft (below ILS Category I Decision Heights: Observed only 7 (seven) times during the three years from 1986 to 1988 and no problem is anticipated.

Table 3-3 Low Visibility Conditions at Wuhan/Nanhu Airport

Month	Visibility (%)	
	Less than 400m	Less than 800m
January	1.4	2.3
February	0.6	0.8
March	0.0	0.1
April	1.3	1.6
May	0.1	0.2
June	-	-
July	-	-
August	-	0.0
September	-	-
October	0.6	0.8
November	1.1	1.4
December	0.6	1.1
Annual Average	0.5	0.7

(4) Usability Factor

Estimation is made on usability factors for the following two cases based on visibility and ceiling values at Wuhan/Tianhe Airport.

Case 1: ILS Category II Approach for Runway 04 and Category I for Runway 22; and

Case 2: ILS Category I Approach for Runways 04 and 22.

High usability factors are obtained for both cases as shown in Table 3-4. However, Case 1 is more appropriate at Wuhan/Tianhe Airport in terms of operational regularity in winter season, taking into consideration the differences of conditions in January and December.

Table 3-4 Estimation of Usability Factor

(%)

Month	Case 1	Case 2
January	98.6	97.7
February	99.4	99.1
March	99.6	99.6
April	98.6	98.2
May	99.5	99.4
June	99.7	99.7
July	99.8	99.8
August	99.8	99.8
September	99.9	99.9
October	98.6	98.4
November	98.9	98.6
December	99.3	98.8
Annual Average	99.3	99.1

3.2.2 Construction Conditions

(1) Topography

The Tianhe site is situated in the hilly area of agricultural land with the elevation of 20m to 40m above the sea level, and the runway is planned at less undulated area. According to the preliminary study on runway elevation, it is expected that the height and depth of cuts and fills are about 6m and 8m, respectively, and there is no problem on slope stability.

The ground elevation of the area beyond both ends of the planned runway is almost equal to or lower than that of the airport area. Thus, there is no need for cutting the ground to secure the obstacle limitation surfaces.

The planned airport area is adjacent to the waterway flowing to the Fu River as well as to the Ho Lake. Therefore, there is no problem both on the disposal of rain and treated sewage and on the source of water supply.

(2) Geological Condition

The constitution of geological layers is shown below.

Q_4	2m - 3m	Q_3
Q_3		
Q_2		Q_2
At the lower portion		At the higher portion

The Q_2 to Q_4 layer is mainly of clay, a part of which being sandy or silty clay and the base layer Q_1 is of clay with gravel.

The soil strength is estimated below.

Layer	Cohesion ($C:kg/cm^2$)	Internal Friction Angle (°)	Strength of Uniaxial Compression Test ($Qu:kg/cm^2$)*1	Consistency*2
Q_4	0.16	27	0.51	Medium
Q_3	0.29 - 0.44	29 - 35	0.98 - 1.69	Stiff
Q_2	0.23 - 0.54	29 - 38	0.78 - 2.2	Stiff/Very Stiff

Notes: *1 Qu is calculated by the following formula.

$$Qu = 2C/\tan(45^\circ - \phi/2)$$

*2 Consistency is estimated by the following table quoted from "Soil Mechanics in Engineering Practice" by Terzaghi-Peck, 1948.

Consistency	Very Soft	Soft	Medium	Stiff	Very Stiff	Hard
N-value	under 2	2 - 4	4 - 8	8 - 15	15 - 30	over 30
$Qu(kg/cm^2)$	under 0.25	0.25-0.5	0.5-1.0	1.0-2.0	2.0-4.0	over 4.0

The suitability of these soils as the fill material cannot be estimated accurately because the soil test for moisture-density relations has not been carried out. In this Study, the suitability is estimated based on the physical properties of the soils as shown in the following table.

Soil	Natural Moisture Content (Wn)	Liquid Limit (Wl)	Plasticity Index (Ip)	Wl - Wn
Q4	25.3%	30.4%	13	5.1%
Q3	21.3%	37.0%	16.5	15.7%
Q2	22.7%	39.9%	18.6	17.2%

Based on the above data, the soils are classified as CL (Clay with low compressibility).

The natural moisture content of Q3 and Q2 is lower than the liquid limit and it is considered that there is no problem on the trafficability in the construction work.

According to the above conditions, it is considered that there is no problem in the strength and trafficability except Q4, the amount of which is very small and the thickness is very thin.

(3) Supply of Construction Materials

No problem is seen for supply of construction materials because there are production areas or factories of such material as gravel, sand and cement, etc. around Wuhan City. However, the access road to the site must be improved for the transport of construction materials.

3.2.3 Overall Evaluation

In conclusion, the selection of Tianhe as the site for construction of a new Wuhan airport can be justified due to the following reasons:

a. No operational influence upon the existing Hankou Airfield (military airport).
b. No large buildings around the site to be relocated.
c. Enough land area enabling the construction of open parallel runways in future.
d. Good airspace usability and wind condition.
e. The first class road being constructed nearby from the centre of Wuhan City.
f. No adverse influence upon the city planning of Wuhan.
g. No problem in construction conditions.

3.3 Airspace Planning at the Tianhe Site

3.3.1 Existing Airspace Configuration

(1) Airways in Wuhan FIR

Airways penetrating Wuhan Flight Information Region (FIR) are as follows (Refer to Fig.3-6):

A81 (Beijing - Wuhan - Kunming - Rangoon);
A461 (Beijing - Wuhan - Hong Kong); and
ATS Route (Wuhan - Nanning).

The width of these airways is normally 20km (10.8NM) except in the Hekou - Wuhan - Longkou segments of 8km (4.3NM). Overflying traffic on these airways is controlled by the Wuhan ACC at Wuhan/Nanhu Airport.

(2) Arrival and Departure Routes

There are four arrival and departure routes with the width of 8km (4.3NM) each for arriving and departing aircraft to and from Wuhan/Nanhu Airport and Hankou Airfield as shown in Fig.3-7.

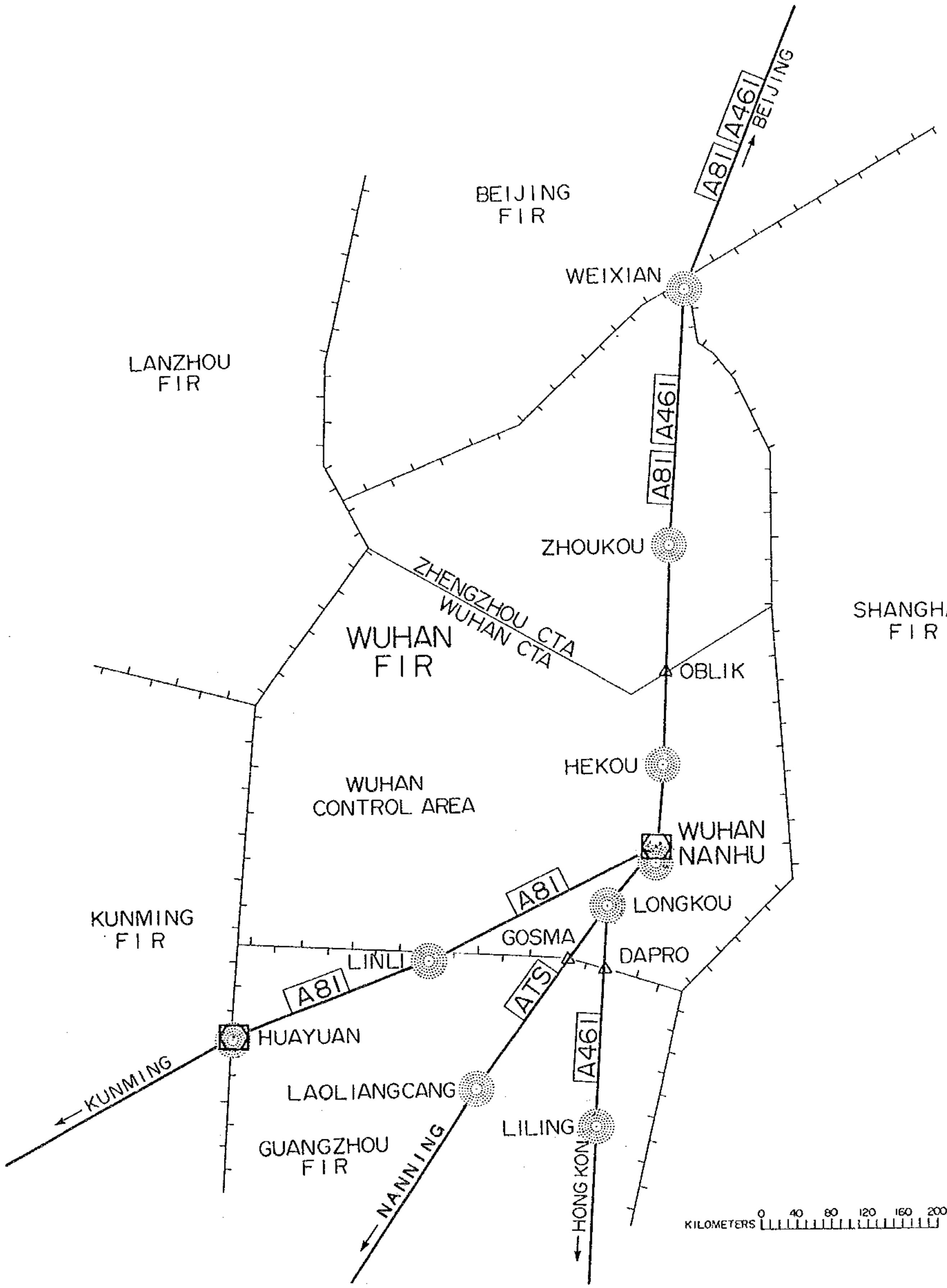


Fig.3-6 Airways in Wuhan FIR

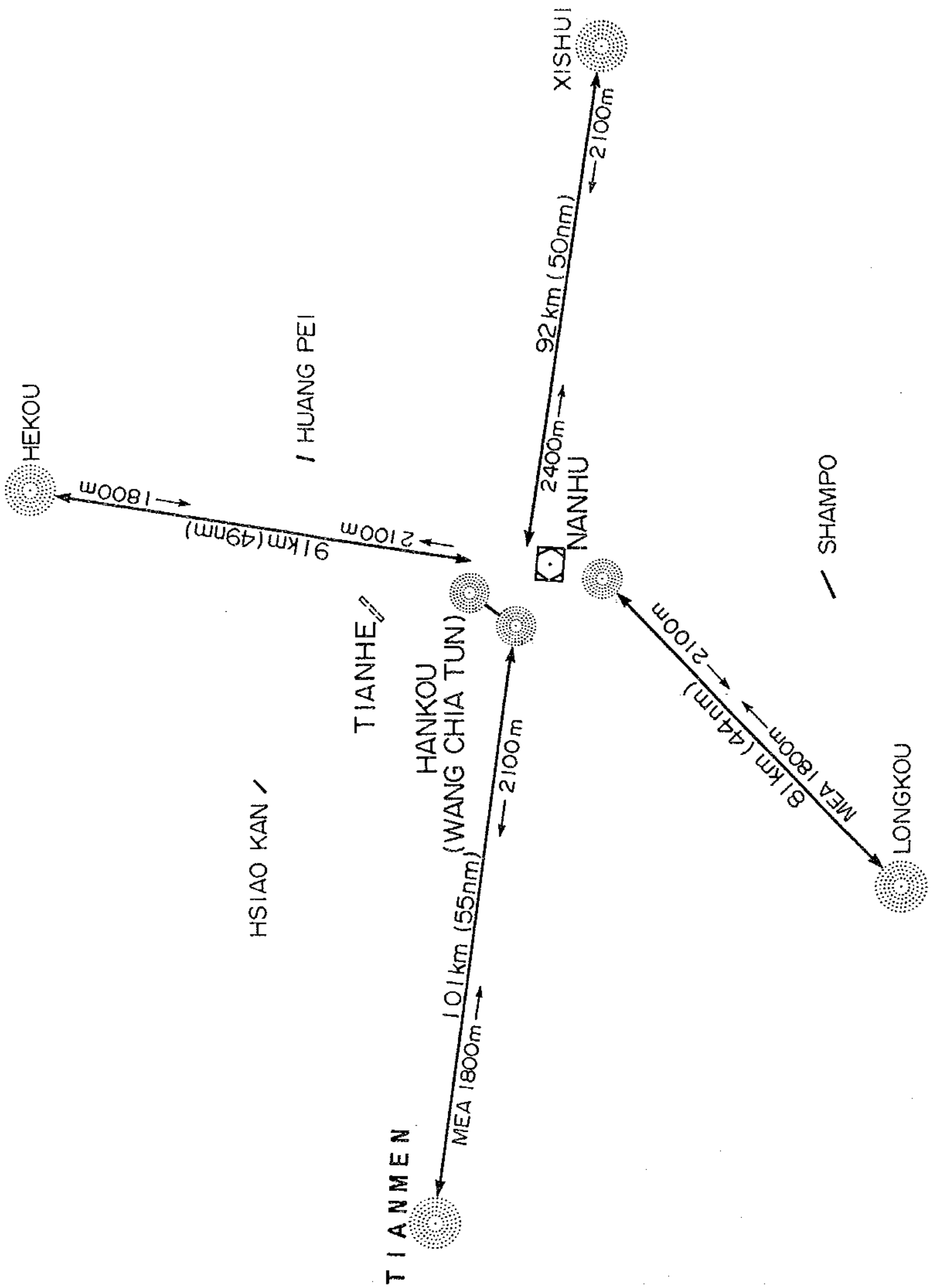


Fig.3-7 Existing Arrival and Departure Routes at Nanhu Airport and Hankou Military Aerodrome