Japan International Cooperation Agency
Ministry of Public Works and Urban Planning, Angola

Establishment of Comprehensive Geographic Database System
for
The National Rehabilitation and Development
in
The Republic of Angola

Final Report

March 2002

Pasco Corporation, Japan

Exchange Rate

US Dollar(US$)	Japanese Yen(¥)	Date
1.00	131.45	Dec. 1997
1.00	144.30	Jun. 1998
1.00	108.15	Sep. 2000
1.00	126.35	July 2001
1.00	123.91	Sep. 2001

PREFACE

In response to the request from the Government of the Republic of Angola, the Government of Japan decided to conduct the Development Study on the Establishment of Comprehensive Geographic Database System for the National Rehabilitation and Development in the Republic of Angola and entrusted the study to Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Takeshi Hirai of Pasco Corporation to Angola, six times between November 1997 and March 2002.

The team held discussions with the officials concerned of the Government of the Republic of Angola and conducted the field surveys in the planned study area. Upon return to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation of the officials concerned of the Government of Angola for their close cooperation extended to the Team.

March 2002

Takao Kawakami

President

Japan International Cooperation Agency

Letter of Transmittal

March 2002

Mr. Takao Kawakami
President
Japan International Cooperation Agency

Dear Sir,

It is a great honor for me to submit herewith the Final Report on the Study of Establishment of Comprehensive Geographic Database System for the National Rehabilitation and Development in the Republic of Angola.

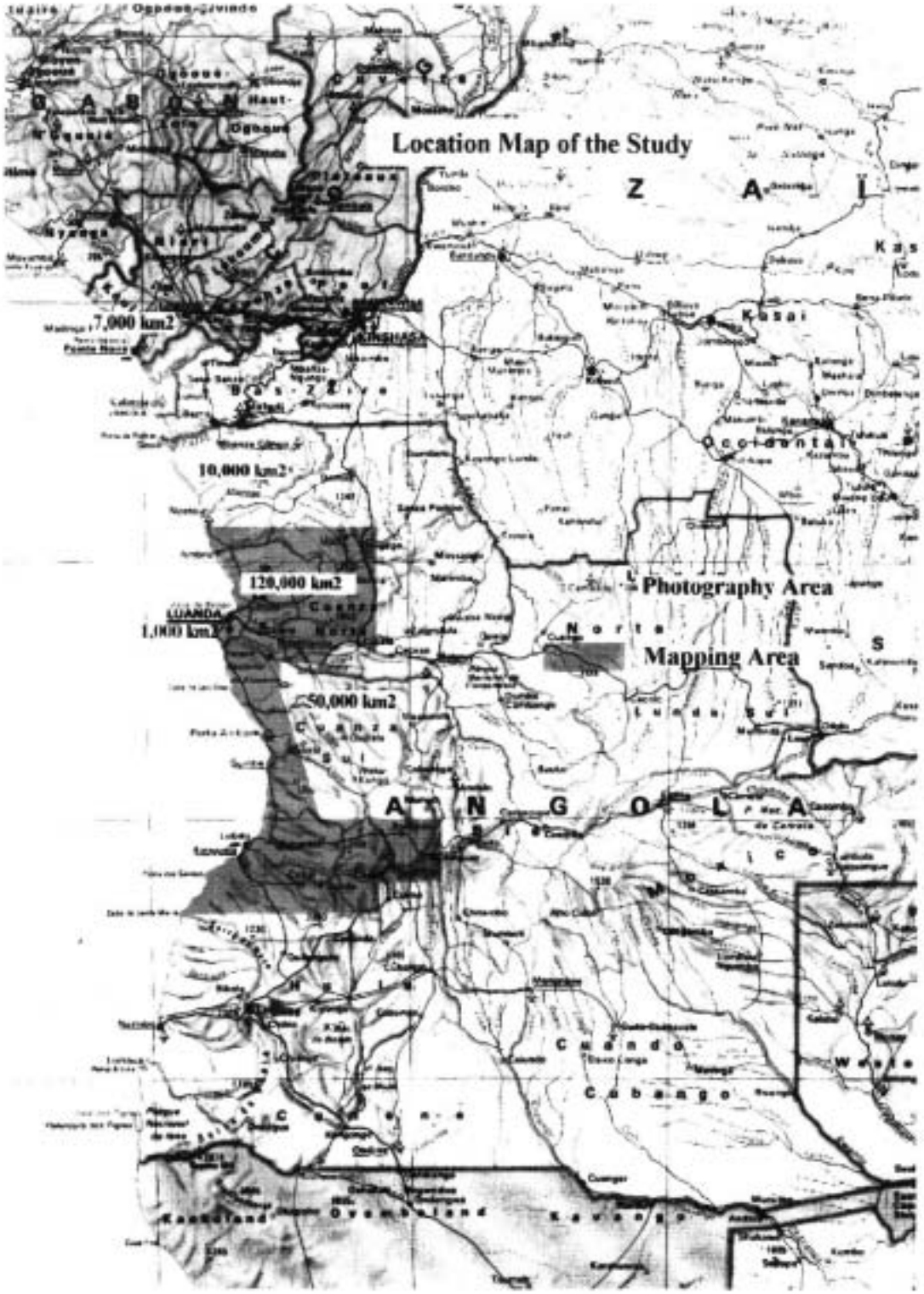
The Study Team, which was organized by Pasco International Inc. and headed by myself, was dispatched to Angola six times from November 1997 to March 2002 to conduct the study works for development of digital topographic mapping database with the cooperation of the counterparts in Angola under the contract for implementation of the said Study with Japan International Cooperation Agency (JICA) and to arrange for subcontracting the work of aerial photography and make the presentation on the digital topographic map data. In the meanwhile, the Study Team also conducted the works of digital plotting and compilation and creating GIS data in Japan and wrapped up the results of these works in this Report.

On behalf of the Study Team, I would express my sincere appreciation of the unsparing favor and close cooperation that the Government of the Republic of Angola and its related agencies extended to all the Team members during their stay in Angola.

I also wish to express our deepest gratitude to JICA, Ministry of Foreign Affairs, Ministry of Land, Infrastructure and Transport, Embassy of Japan in Zimbabwe and other related governmental authorities for their invaluable advice and supports.

Yours faithfully,

Takeshi Hirai, Team Leader
The Study for Establishment of Comprehensive Geographic Database System
for the National Rehabilitation and Development in the Republic of Angola


Location Map of the Study
7,000 km2
10,000 km2
120,000 km2
1,000 km2
50,000 km2
Photography Area
Mapping Area
A N G O L A
Z A I R E
Kasai
Occidental
Cuando
Cubango
Ovamboland
Kavango

INTRODUCTION

The Republic of Angola was affected by the civil war lasting over 40 years, and several millions of domestic refugees flowed into the urban areas, where they settled down disorderly with little firm guidance by the administrative side. As a result, the public facilities and other various types of social infrastructure in the urban areas were damaged, while some land was abandoned and the conditions of land ownership were largely changed in local areas, resulting in an unstable situation.

In these circumstances, the Government of Angola was exerting urgent efforts for reconstruction of the country. In this national reconstruction, it was important to settle the refugees down, activate the national production operations and promote the effective use of wealthy resources.

Angola is originally rich in mineral resources including oil and diamonds and has a broad, fertile land suited for agriculture, so that it has a high possibility of reconstructon to a wealthier country. In order to formulate an appropriate reconstruction plan to bring this possibility to reality, it was essential to accurately grasp the recent land use conditions, and to investigate the actual conditions and define various problems in each stage of reconstruction making use of a geographic information system.

Nevertheless, the maps available to formulate the national land reconstruction plan in Angola were only the 1/100,000-scale topographic maps covering the entire land and the 1/25,000-scale topographic maps for the capital city of Luanda, which were made up under the assistance of the former Soviet Union around 1986 and taken in charge by the Institute of Geodesy and Cartography, Ministry of Defense of Angola (Ministério da Defesa, Instituto de Geodesa e Cartografia de Angola, hereinafter “IGCA”). These topographic maps involved large secular changes due to damage of the urban areas, refugees’ camps gathered in the environs of some cities and the lands abandoned by local residents, so that these maps were inadequate to formulate the precise reconstruction plan.

In the consideration of theses actual conditions of Angola, the Government of Angola made a request for the creation of geographic data and land use data and building of the comprehensive geographic database (GIS) through the Ministry of Public Works and Urban Planning (Ministério das Obras Públicas e Urbanismo, hereinafter “MINOPU”) to the Government of Japan.

In response to this request, the Japanese Government dispatched the Preparatory Study Team in December 1996 and the Preliminary Study Team to Angola for the period of the end of February to the beginning of March 1997. The Preliminary Study Team made many repeated meetings with the MINOPU until the agreement (hereinafter “S/W”) for this Study Project was reached between both parties.

The “Study of the Establishment of Comprehensive Geographic Database System for the National Rehabilitation and Development in the Republic of Angola” was planned to be implemented under the S/W from the first year beginning in fiscal 1997 in Japan to the fourth year (for a period of 35 months).

In implementation of the Study, however, it was very difficult to carry out the aerial photography work having the important function among all the study works in the study area for the climatic conditions, limitations in flight of the photographing aircraft and other various reasons. In addition, the movements of an anti-governmental organization became so active in the surrounding area of Luanda for a certain time duration of the study period that the Japanese Study Team was interrupted to enter into Angola.

1. OUTLINE OF THE STUDY

1.1 Objectives of the Study

This Study had the following objectives:

① To create the data equivalent to the 1/100,000-scale topographic maps to cover the area of approximately 120,000km^2 in the western coastal area using the satellite images and create the data equivalent to the 1/25,000-scale topographic maps and the land use data to cover the area of 1,000km^2 in the capital city of Luanda using aerial photos, as well as to digitize the existing 1/1,000,000-scale maps to cover the entire national land and build the comprehensive geographic database based on this data.

② To take aerial photos to cover the area of about 67,000km^2 in the agricultural production zone in the central part of the western coastal area from which food is supplied to Cabinda Province and the western part of Zaire Province that are the oil production bases, and to the capital city of Luanda.

③ To transfer the technology to the counterparts in Angola through the works of this Study.

1.2 Study Areas

The areas for the study items under this Study as shown in the Location Map first herein are as follows:

① Creation of the data equivalent to the 1/100,000-scale topographic maps
About 120,000km^2 of the central part of the western coastal area including the south of Zaire Province, the west of Uige Province, Cuanza-Norte Province, the west of Cuanza-Sul Province, Luanda Province, the central area of Huambo Province and Benguela Province

② Creation of the data equivalent to the 1/25,000-scale topographic maps and land use data
About 1,000km^2 in the central part of the capital city of Luanda

③ Creation of 1/1,000,000-scale topographic map data
About 1,250,000km^2 of the entire national land of Angola

④ Aerial photography and satellite image acquisition
1) 1/30,000 scale (black/white)
About 68,000km^2 including Cabinda Province, the west of Zaire Province, the southwest of Malanje Province, the east of Cuanza-Sul Province and Luanda area (1,000km^2).
2) 1/10,000 scale (color)
1,000km^2 of the capital city of Luanda

1.3 **Outline of the Study**

The contents of the Study will be outlined below.

1.3.1 Creation of digital data equivalent to the 1/100,000 topographic maps

The western coastal area of Angola had a concentrated population and it was an area for which it is urgently needed to make a decision on the development policy. Thus, it was necessary to make appropriate management of various types of geographic information and to grasp the actual conditions. For this purpose, the digital data of the 1/100,000-scale topographic maps was created as the base data for the Geographic Information System (GIS) to make concentrated management and use of the geographic information of the national land. In considering that no field survey was made and the urgency of data creation, the digital data was created by the following method:

- The existing 1/100,000-scale topographic maps were digitized to create the digital topographic map data.
- Digital compilation was made on the secular changes including planimetric features and vegetation using latest satellite (SPOT) images.
- Interpretation keys were created as the interpretation criteria necessary to acquire the information on planimetric features, vegetation and others in comparison between the existing topographic maps and the aerial photos.

1.3.2 Creation of digital data equivalent to 1/25,000-scale topographic maps

Especially, the capital city of Luanda and its surrounding area had a heavily concentrated population and it was urgently needed to execute the concrete rehabilitation and development plan for this Luanda area. For this purpose, the topographic map database was developed to serve for the concrete programs to execute the rehabilitation and development plan.

In the Luanda area, the elevation control points associated with the existing bench marks and the horizontal control points measured by GPS survey were newly set up, at which the signals for aerial photography were installed and pricking of those points was made on aerial photos. Mapping data acquisition was made through digital mapping based on the newly taken aerial photos for which aerial triangulation was conducted and referring to the materials made available from the Angola side (IGCA) and the results of the field surveys.

1.3.3 Creation of digital land-use data equivalent to 1/25,000 topographic maps

To grasp the present and actual conditions of the Luanda area, the digital land-use data as the most basic thematic map information was created in addition to the topographic map data. The items of land-use information conformed to the categorical items as agreed with the Angola side, including the categories of building and premises usage.

The work of categorizing the land-use items was carried out through interpretation of 1/10,000-scale color aerial photos, the 1/30,000-scale black & white aerial photos and "IKONOS" satellite images and the field survey based on these aerial photos was also made.

1.3.4 Production of 1/25,000-scale printed topographic maps

The 1/25,000-scale topographic map digital data was subject to computer-based compilation using Draw Software for 5-color printing and the proof output maps in each color separation were outputted by means of an image setter, from which 1000 copies of each printed map sheet were produced.

1.3.5 Creation of digital data for 1/1,000,000-scale topographic maps

The 1/1,000,000-scale topographic map digital data was created to ensure the counterparts on the Angola side to easily master the knowledge and techniques in the GIS and to manage various types of geographical information independently. This digital data was created by extracting the data on the water systems in Angola from the "Digital Chart of the World" prepared by US Department of Defense, and reediting and combining the digitized data from the existing 1/1,000,000-scale road maps and the existing Angola administration maps as well as the vegetation data prepared by US Institute of Geology as acquired on Internet.

1.3.6 1/30,000-scale aerial photography and satellite image acquisition

The 1/30,000-scale black & white aerial photography for the Luanda area were completed as planned, but the 1/30,000-scale aerial photography for the other areas (approx. 67,000km^2) were not completed as planned because of unfavorable climate conditions and also the untimely permission for the photo taking.

For the areas except the Luanda area, the image data with a resolution of 10m were acquired from the resources exploration satellite "SPOT" of France to prepare the images of those areas.

1.3.7 1/10,000-scale aerial photography and satellite image acquisition

The 1/10,000-scale aerial photography was conducted to take color aerial photos for acquisition of land-use information in the Luanda area. However, one-third part of the area was not photographed in color as well as in black and white during the study period.

For the area part of which aerial photography was not made, the image data with a resolution of 1m was acquired from the US reconnaissance satellite "IKONOS" to prepare the images of that area part.

1.3.8 Building of GIS

To ensure the Angola side to make effective use and independent maintenance and operation of the digital data of topographic maps, maps and land-use maps as created in this Study, the equipment, GIS software and consumables such as output paper forms necessary for these works were procured and installed in the GIS operation room at the MINOPU as the counterpart agency in Angola, and the GIS software and digital data were also installed in the equipment. The items of the equipment were as follows:

• Desk-top computer	Dell Precision 220 (with APC UPS)	10 sets
• Laptop computer	Dell Latitude Laptop	1 set
• Color scanner (A0 size)	Contex FSC36	1 set
• Color scanner (A3/A4 size)	Epson EXPRESSION 1640XL	1 set
• Ink-jet color plotter (A0 size)	HP DesignJet 1050C	1 set
• Laser printer (A4 size)	HP LaserJet 4100N	1 set
• Ink-jet color printer (A2 size)	Epson Stylus Colour 3000	1 set

In installation of the equipment, the GIS operation room in which the above system was installed was provided with an emergency-use auxiliary diesel generator and the cabling work was conducted.

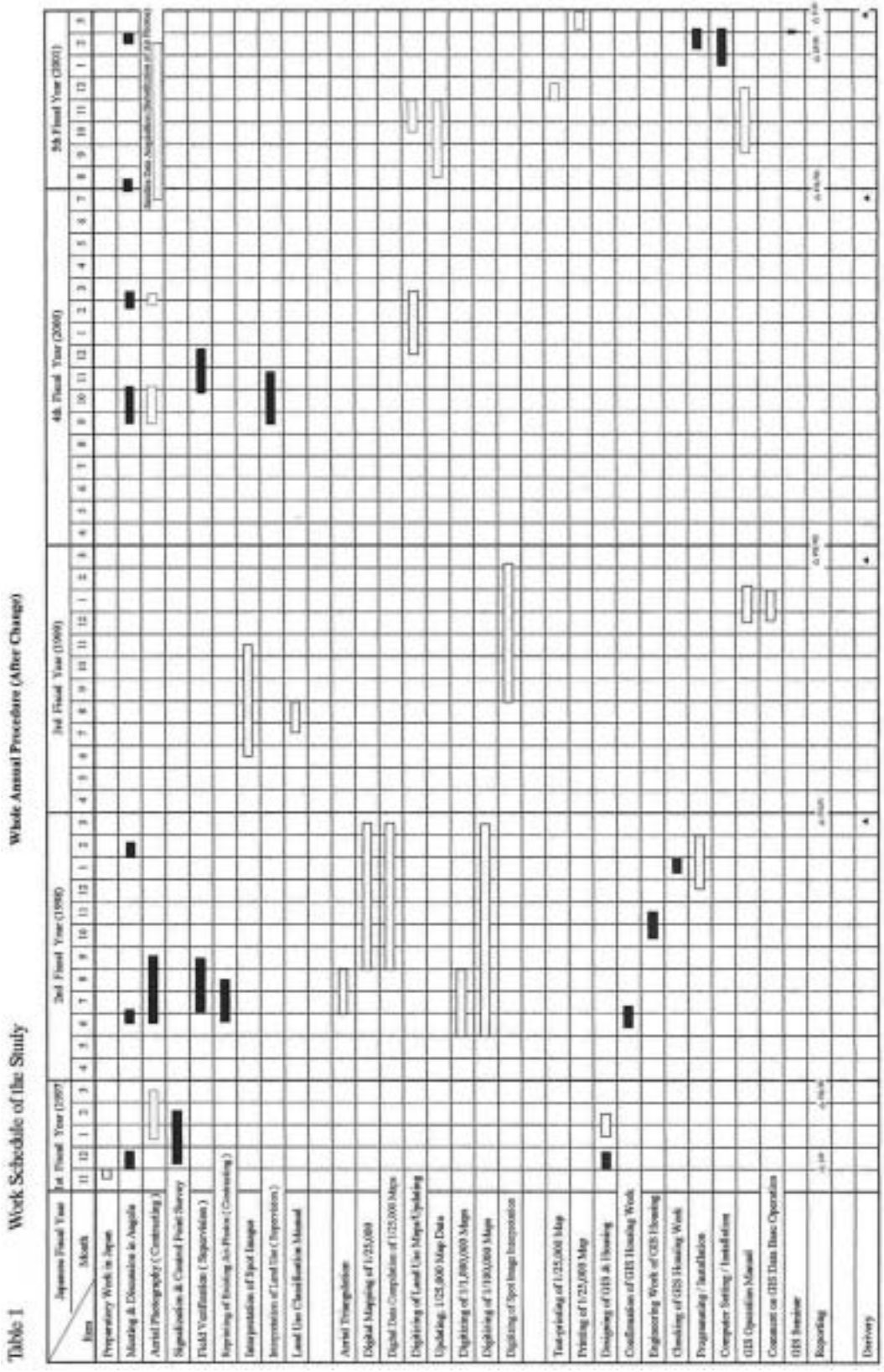
1.3.9 Technology transfer

The cooperative work with the counterparts in Angola was carried out through the processes of data creation from the first year work of the Study before introduction of the final system in order to ensure the counterparts to use the GIS in the early stage. In addition, the training in Japan was provided for the counterparts, so that they had master the GIS technology.

1.3.10 Study period

This Study was started at the end of November 1997 as the first year. The study period from the start to the completion of this Study was scheduled to be about 35 months, but in practice, it required about 52 months for the reason of the unfavorable climate condition over the objective areas and the suspension of JICA Study team's delegation in certain period for the safety control by JICA.

Table 1 Work Schedule of the Study



2. BASIC SPECIFICATIONS OF THE STUDY

This Study was implemented in accordance with the specifications as agreed in the "Scope of Work" and the technical specifications conformed to the agreements with the counterpart agency of Angola. For the other matters as not agreed between both sides of Japan and Angola, the JICA Overseas Work Specifications applied to those matters. (See Table 2.)

Table 2 Basic Specifications of the Study

Item	Description	Application
Products	Aerial photos: 1/30,000-scale panchromatic Approx. 68,000 km^2 1/10,000-scale color Approx. 1,000 km^2 Contact photos 5 copies each Satellite images: SPOT / IKONOS Aerial photo reproductions: Areas as follows: Southeastern Area of Malanje Province Eastern Area of Cuanza-Sul Province 1/1,000,000-scale digital map data: Area as follows: Entire national land of Angola Approx. 1,250,000 km^2 1/100,000-scale digital map data: Approx. 120,000 km^2 1/25,000-scale digital topographic map data: Approx. 1,000 km^2 1/25,000-scale land-use map data: Same area as above Each type of digital data: (CD-ROM form) 1/25,000-scale topographic map printed sheets: 1,000 copies each GIS Operation Manual: One set	S/W and Work Instructions
Symbols	In accordance with the symbol specifications as discussed and agreed with the MINOPU of Angola on the basis of the former Soviet Union's symbols in the existing topographic maps.	S/W and Work Instructions
Survey Standards	Reference ellipsoid: Clark 1880 Projection: UTM Neat lines: 30' x 30' (1/100,000 scale) 7.5' x 7.5' (1/25,000 scale)	S/W and Work Instructions
Accuracy	Overseas Survey Work Standards of JICA	Work Instructions
Type Approval of Products	The type approval certificate issued by the MINOPU is attached to the Products.	Work Instructions
Particulars	The following annotation was attached to each sheet of the digital topographic map data as marginal information: "This Map was prepared jointly by Japan International Cooperation Agency (JICA) under the Japanese Government Technical Cooperation Program and the Government of Angola." To the 1/100,000-scale topographic map data, the following annotation was attached: "This Map was created for urgent recovery of Angola based on SPOT images without making a field survey."	Work Instructions

3. COMPOSITION OF STUDY WORKS

3.1 Study Implementing Organizations

This Study was implemented by Pasco Corporation under contract with Japan International Cooperation Agency (JICA) and the study works were conducted by the JICA Study Team organized by Pasco Corporation under the work instructions of JICA. The work contract for each single fiscal year of Japan (12 months beginning in April) was entered into between JICA and Pasco International Inc.(the ancestor of Pasco Corporation)

The Infrastructure Development Institute – Japan executed the technical assessment in each work process in this Study under the contract awarded by JICA.

3.2 Yearly Study Items

The yearly study items instructed by JICA to Pasco Corporation for this Study were as follows:

(1) First-year Study

Study period (November 25, 1997 to March 31, 1998)

1) Preliminary study in Japan
   - ① Collection and arrangement of related materials
   - ② Preparation of Inception Report
2) Work in Angola
   - ① Explanation and discussions on Inception Report
   - ② Review of basic concept of Geographic Information System (GIS)
   - ③ Check on existing aerial photos
   - ④ Conceptual design of GIS
   - ⑤ Review of GIS operational environment
   - ⑥ Signal installation for aerial photography
   - ⑦ Survey of control points
   - ⑧ Check on survey standards
   - ⑨ Check on map symbols
   - ⑩ Survey in circular flight
3) Work in Japan
   - ① GIS physical design
   - ② Design of GIS operational environment
   - ③ Preparation of Progress Report

(2) Second-year Study

Study period (June 1, 1998 to March 31, 1999)

1) First work in Angola
   - ① Explanation and discussions on Progress Report
   - ② Supervision of field survey
   - ③ Design 2 of GIS operational environment
   - ④ Reproduction of existing aerial photos
   - ⑤ Aerial photography

2) First work in Japan
   - ① Digitization of 1/100,000-scale topographic maps
   - ② Digitization of 1/1,000,000-scale topographic maps
   - ③ Aerial triangulation
   - ④ Digital plotting
   - ⑤ Digital compilation
   - ⑥ GIS programming

3) Second work in Angola
   - ① Installation of peripheral instruments for GIS operation

4) Third work in Angola
   - ① Check on completion of installation of peripheral instruments for GIS operation

5) Second work in Japan
   - ① Preparation of Progress Report 2

(3) Third-year Study

Study period (August 16, 1999 to March 31, 2000)

1) Work in Japan
   - ① Preparation of land-use interpretation manual
   - ② Creation of interpretation keys
   - ③ Interpretation of satellite images
   - ④ Creation of orthographic satellite images (ortho-photo images)
   - ⑤ Digitization of interpreted data
   - ⑥ Recommendations on comprehensive geographic database
   - ⑦ Preparation of GIS operation manual
   - ⑧ Preparation of progress Report 3

(4) Fourth-year Study

Study period (September 7, 2000 to July 30, 2001)

1) Work in Angola

① Explanation of Progress Reports 2 and 3

② Supervision of preliminary interpretation for land use

③ Supervision of land-use field survey

2) Work in Japan

① Digitization of land-use data

② Preparation of Progress Report 4

③ Preparation of Study Progress Report

④ Purchase of satellite image data

(5) Fifth-year Study

Study period (July 13, 2001 to March 31, 2002)

1) First Work in Japan

① Editing of topographic map data

② Purchase of satellite image data

③ Creation of satellite images

2) First work in Angola

① Explanation of progress Report 4

3) Second work in Japan

① Preparation of trial-print maps

② Preparation of Draft Final Report

③ Preparation of GIS operation manual

④ Inspection of edited maps

4) Second work in Angola

① Installation

② Training of operation

③ Explanation of GIS operation manual

④ Explanation of Draft Final Report

5) Third work in Japan

① Preparation of Final Report

② Production of 1/25,000-scale topographic maps

3.3 Dispatched Personnel for Works in Angola

The members of the Study Team and their periods dispatched from Japan to Angola for this Study are as follows:

(1) First-year Study in Angola

Member of Study Team	Assignment	Period of Dispatch
Takeshi Hirai	Team leader	1 Dec. 1997 ~ 21 Dec. 1997
Yoshiaki Otoku	Aerial photography	11 Jan. 1998 ~ 16 Mar. 1998
Plews Rease Williams	GIS design	1 Dec. 1997 ~ 21 Dec. 1997
Mamoru Araseki	Facility design	1 Dec. 1997 ~ 21 Dec. 1997
Yutaka Kyakuno	Control point survey 1	7 Dec. 1997 ~ 20 Feb. 1998
Tsuyoshi Seino	Control point survey 2	7 Dec. 1997 ~ 20 Feb. 1998
Ryouhei Imaeda	Control point survey 3	7 Dec. 1997 ~ 18 Feb. 1998
Akihiro Sugita	Control point survey 4	7 Dec. 1997 ~ 18 Feb. 1998
Masami Alberto Miyasato	Translator	7 Dec. 1997 ~ 13 Feb. 1998

(2) Second-year Study in Angola

Member of Study Team	Assignment	Period of Dispatch
Takeshi Hirai	Team leader	14 Jun. 1998 ~ 5 July 1998
Yoshiaki Otoku	Aerial photography	14 Jun. 1998 ~ 29 Aug. 1998 1 Feb. 1999 ~ 20 Feb. 1999
Mamoru Araseki	GIS room design	14 Jun. 1998 ~ 29 Aug. 1998 1 Feb. 1999 ~ 20 Feb. 1999
Sadao Matsumoto	Field verification	1 Jun. 1998 ~ 19 Sep. 1998
Carlos Kimura	Translator	1 Jun. 1998 ~ 12 Sep. 1998

(3) Third-year Study in Angola

The study in Angola was suspended in accordance with the instruction by JICA and no study team was dispatched to Angola.

(4) Fourth-year Study in Angola

Member of Study Team	Assignment	Period of Dispatch
Takeshi Hirai	Team leader	22 Oct. 2000 ~ 4 Nov. 2000
Yoshiaki Otoku	Aerial photography	10 Sep. 2000 ~ 8 Nov. 2000 18 Feb. 2001 ~ 10 Mar. 2001
Sadao Matsumoto	Field verification	10 Sep. 2000 ~ 23 Dec. 2000
Carlos Kimura	Translator	10 Sep. 2000 ~ 23 Dec. 2000

(5) Fifth-year Study in Angola

Member of Study Team	Assignment	Period of Dispatch
Takeshi Hirai	Team leader	26 Feb. 2002 ~ 16 Mar. 2002
Yoshiaki Otoku	Deputy leader	29 July 2001 ~ 15 Aug. 2001 19 Feb. 2002 ~ 16 Mar. 2002
Hideaki Umeda	GIS installation	29 Jan. 2002 ~ 18 Mar. 2002
Hidetoshi Kakiuchi	GIS specialist	17 Feb. 2002 ~ 18 Mar. 2002
Carlos Kimura	Translator	29 Jan. 2002 ~ 18 Mar. 2002

3.4 Reception of Trainees in Japan

The trainees of Angola and their period of training in Japan for GIS technology through the entire period of the Study were as follows:

Trainee	Organization	Period of Training
Dr. Manual António Paulo	Coordinator of Technical Group (MINOPU) Director National (MINOPU)	7 Mar. 1998 ~ 29 Mar. 1998
Sr. Domingos Armando	Manager of Technical Group (MINOPU) / Technical Director (IGCA)	27 Nov. 1998 ~ 13 Dec. 1998
Sr. António Guilherm Montenegro	Manager of Technical Group (MINOPU)	20 Nov. 1998 ~ 27 Dec. 1998 13 Mar. 2001 ~ 11 Apr. 2001

MINOPU:Ministério das Obras Públicas e Urbanismo

IGCA: Instituto de Geodesa e Cartografia de Angola

4. STUDY WORK PLANS AND RESULTS

The work plans and the results for the main study items relating to the quantities of products in this Study are shown in Table 3 below.

Table 3 Work Plans and Results

F/Y	Items of Work	Planned Work Volume	Work Result Volume	Remarks
First Year	Signalization for Aerial Photography (Pricking)	Approx. 15 points	4 points 12 points	FY1997
	Control point Survey: GPS Survey Leveling	New: 15 points Existing: 4 points Approx. 150 km	15 points 4 points 165 km	
Second Year	Supervision of Field Survey	Luanda Area 1,000 km^2	Luanda Area 1,000 km^2	
	Reproduction of existing aerial photos	1,000 sheets	982 sheets	
	Aerial photography	① Luanda Area B/W 1,000km^2 Color 1,000km^2 ② Other Areas B/W 67,000km^2	① Luanda Area B/W 1,000km^2 Color 680km^2 ② Other Areas B/W 2,230km^2	
	Digitization of 1/100,000-scale topographic maps	120,000 km^2	120,000 km^2	FY1998
	Digitization of 1/1,000,000-scale maps	Approx. 1,250,000 km^2	Approx. 1,250,000 km^2	
	Aerial Triangulation	Approx. 90 models	Approx. 99 models	
	Digital Plotting (1/25,000-scale)	1,000 km^2	1,000 km^2	
	Digital Compilation (1/25,000-scale)	1,000 km^2	1,000 km^2	
Third Year	Interpretation of Satellite Images	120,000 km^2	120,000 km^2	
	Creation of Ortho-photo images	75 scenes	75 scenes	FY1999
	Digitization of Interpreted Data (1/100,000-scale)	120,000 km^2	120,000 km^2	
Fourth Year	Supervision of Preliminary Interpretation for Land Use	Luanda Area 1,000 km^2	Luanda Area 1,000 km^2	FY2000
	Supervision of Field Survey for Land Use	1,000 km^2	1,000 km^2	
	Aerial Photography	① Luanda Area Color 320km^2 ② Other Areas B/W 2,750km^2	① Luanda Area 0km^2 ② Other Areas 0km^2	
	Acquisition of Satellite Images	① SPOT 22 scenes ② IKONOS 320km^2	① SPOT 22 scenes ② IKONOS 115km^2	
	Digitization of Land-use data	Luanda Area 1,000 km^2	Luanda Area 1,000 km^2	
Fifth Year	Acquisition of Satellite Images	① SPOT 18 scenes ② IKONOS 205km^2	① SPOT 18 scenes ② IKONOS 205km^2	FY2001
	Modifications of Secular Changes in Topographic Maps (1/25,000-scale)	Luanda Area 1,000 km^2	Luanda Area 1,000 km^2	
	Printing of Topographic Maps (1/25,000-scale)	6-color print 11 sheets 1,000 copies per sheet	6-color print 11 sheets 1,000 copies per sheet	

Figure 1 Overall Study Plan Map

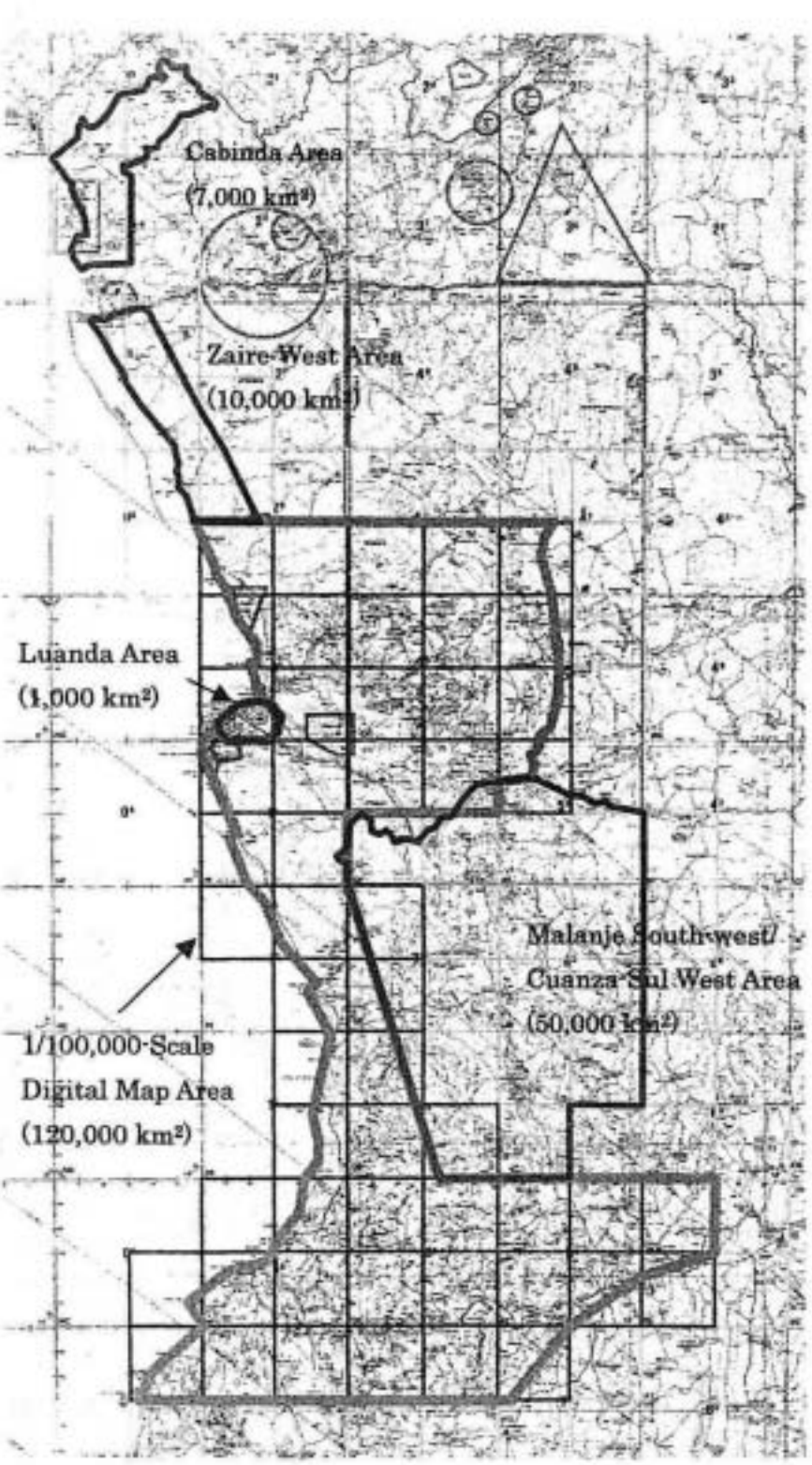
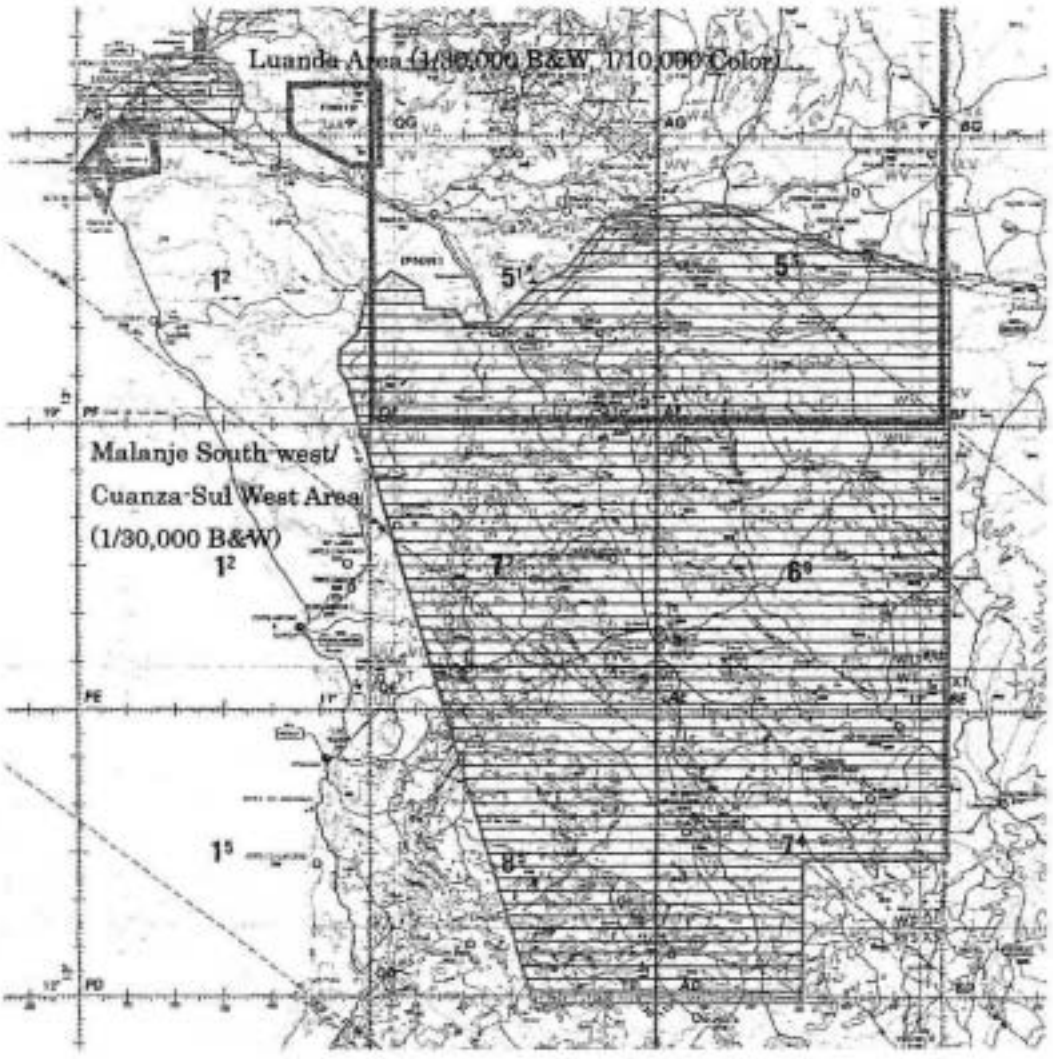


Figure 2 Aerial Photography Plan Map (1)

Figure 3 Aerial Photography Plan Map (2)



5. CONTENTS OF THE STUDY

5.1. The First Year's Work (1997)

5.1.1. Preparatory Work in Japan

(1) Review of reference materials

Materials related to the natural conditions, social conditions, and history of Angola and its neighboring countries that are available in Japan were collected from wide range in addition to the materials rented from JICA so that we could submit a proper proposal.

(2) Inception Report Preparation

Based on the directions of JICA and the collected materials, the attached inception report was formulated and submitted to JICA

5.1.2. The First Phase Work in Angola

(1) Inception Report Discussion

Discussions were held seven times during our stay in Angola with the counter part of Angola, mainly Dr. Paulo, the Director of MINOPU, on the reconfirmation of the S/W and the inception report. The outline of discussions is as follows.

1) The objectives of the Study and the scope of the Study of S/W were reconfirmed as follows.

a. Aerial photography;

- Multi-color aerial photographs of Luanda city area of 1,000 km^2 with the scale of 1:10,000
- Black and white photographs of Luanda city area of 1,000 km^2 and the total of three areas of 67,000 km^2 with scale of 1:30,000

b. Acquisition of digital map data of entire land with 1:1,000,000 standard;
However, the presence of manuscript maps will be reconfirmed with the Survey Department.

c. Acquisition of digital map data of 1:100,000 standard;
Data acquisition of 120,000km^2 area

d. Preparation pf topographic maps and land use maps of Luanda area;
Data acquisition of Luanda city and its surrounding areas of 1,000 km^2
However, it was agreed that emphasis would not be placed on the output of analog drawings, but placed on the preparation of database.

e. Installation of GIS related facilities;

This subject was basically agreed, but details will be discussed further.

f. Technology transfer;

The Angola side that the technology transfer is the most important subject, and the Japan side understood it. Acceptance of trainees was determined to be implemented as soon as possible after examining the schedule and so on.

The objective of the Study and the scope of the Study of S/W were basically understood both parties except for detail discussions.

(2) Examination of the basic concept of geographic information system (GIS)

In order to determine the contents, the level, and the size of the GIS to be prepared by this Study, the following were discussed with the Angola side.

- Presence and type of the existing geographic information available for the moment
- The objectives for use for the moment
- The concept of the information preparation necessary for using the GIS
- The goal of information management for the while

The following were clarified during the discussions.

1) Presence of the existing geographic information

a. Reference point data;

They are properly stored in the form of results table. However, the electronically prepared data is not available.

b. Map data;

As the map data corresponding to the existing base maps, the film manuscript maps are stored at IGCA. However, the data in the form of digital maps is not available. No map data corresponding to the official maps is available. There is no private map data that can be used as the GIS data of national level.

c. Aerial photographs;

The films of the aerial photographs taken by the former USSR from 1985 to 1990, which are same as those taken by the former USSR from 1979 to 1988 and used for updating of 1:100,000 scale map, are stored at IGCA. The films are placed in the air-conditioned room under good storage conditions. However there is no ordinary photo index map. Instead, pictures on which the effective part of stereo model reduced to about one fifth are used as the photo index map. In addition, to retrieve those photo index maps, a from must be used which is difficult to use except for the staff in charge.

d. Attribute (subject) data;

There seems to be no subject data that can be used at present including the census data. For example , they cannot answer to our question on the subject of retrieving the road under the control of the government and can be used for vehicle traffic.

e. Others;

The Ministry of Geology and Mining (Ministério da Geologia e Minas) seems to have a database, but the details are unclear. In addition, a UN organization involved in removing the land mines seems to have the GIS. There is a concept to examine the data to be used by the GIS and to establish a committee consisting to the related departments of the government.

2) Objectives of using the GIS for the while

It is not only impossible but inappropriate to operate a highly advanced GIS in wide range of area under the present situation of Angola.

As a result of discussions, the following were agreed.

- The GIS to be used for this Study will be the one that retrieves and references comparatively simple data such as to display the paved roads in some area and calculate their extension, or to obtain the number of houses in a specified area in the city.
- The system must be able to manage the basic data stored by IGCA.
- The system must be at the practical test stage so that it can be the first step towards the introduction of real GIS that can be totally used by the administration in the future.
- The system must be open so that the data can be provided to the requests from government and private organizations.
- Management of data and system that can be easily linked with the subject data prepared by the government and private organizations will be aimed.

3) Concept of information management necessary for using the GIS

- The map data must be general and open one so that wide range of governmental and private organizations can use them and the meta-data must be disclosed.
- The attribute data must be prepared by the users as a rule.

4) Target of information management for the while

- To proceed to manage the data agreed by the S/W.
- To prepare the data so that the results stores at IGCA can be managed by personal computers.
- To prepare a cooperative system with the organizations such as the Statistics office

(Estatistxa) of the Ministry of Planning (Ministério do Planeamento) or UN organizations.

The system configuration was examined based on the results of the above mentioned discussions. The details will be explained later, but the outline is shown below.

- The place to install the system will be the fourth floor of MINOPU.
- The system will be of a network configuration linking personal computers output device through a Local Area Network (LAN).
- The scale of the system hardware will be as follows.

  For MINOPU:

Deck-top personal computers:	tow (2) data servers, seven (7) clients, and one (1) print server
Lap-top personal computers:	one (1) computer
Portable display projector:	one (1) projector
Digitizer:	one (1) A0 size digitizing table
Scanner:	one (1) A0 size monochromatic scanner, one (1) A3 size color scanner
Printer:	one (1) A0 size color inkjet printer, one (1) A3 size multi-color inkjet printer, one (1) A0 size monochromatic laser printer

  For IGCA: (for data input)

  One (1) personal computer, one (1) A4 size printer, one (1) B4 size scanner

- A generator will be installed for the purpose of stabilizing the power source.
- A portable display projector and necessary lap-top computer will be introduced to promote the wide use of the system.
- As the exclusive staffs this purpose, the following staffs will be assumed: four to five staffs for the preparation and maintenance of data and used services, and two to three staffs for the hardware management.

The GIS desing and the desing of GIS operation facilities will reported in including the results of the discussions made at site.

(3) Confirmation of the maps and materials stored IGCA

The maps and topographic maps stored by IGCA at present are as follows.

1) Administrative division map of 1:1,500,000 scale; 1989
2) Maps of 1:1,000,000 scale; covering the entire land of Angola, 8 sheets altogether, correction was made on three maps on the northern part of latitude 12 degree south (in

1980s)

3) Maps of 1:500,000 scale; covering the entire land of Angola, 32 sheets altogether, correction was made on three maps on the northern part of latitude 12 degree south (in 1980s)
4) Maps of 1:250,000 scale; covering the entire land of Angola, 67 sheets altogether
5) Topographic maps of 1:100,000 scale; covering the entire land of Angola, 472 sheets altogether, prepared between 1956 and 1976, corrected in 1980s.
6) Topographic maps of 1:25,000, covering Luanda state, central Bengo province, a part of Cuanza Norte province, about 90 sheets (latter half of 1980s)
7) Road maps of Luanda city of 1:10,000 scale; central part of the city, 4 sheets altogether (1980s)
8) Topographic maps of 1:50,000 scale; covering the city of Luanda and its surrounding area, approximately 184 sheets (1988 to 1991)
9) Topographic maps of 1:2,000 scale; central part of Luanda city, approximately 250 sheets (1988 to 1991)
10) Others;

Topographic maps of Nabime and Rubango cities with 1:5,000 and 1:2,000 scales
Topographic maps of Cabinda city with 1:2,000 scale
Both are prepared in 1980s.

(4) Confirmation of existing aerial photographs

Existing aerial photographs are necessary to prepare the keys for the interpretation of updated secular changes using the "SPOT" satellite images of the areas, the digital topographic maps of 1:100,000 scale of which are to be made. Preparation of interpretation keys must be based on the comparative interpretation of the existing aerial photographs and the satellite image of the same areas by referring to the existing topographic maps. Therefore, we confirmed the existing aerial photographs for the areas the digital topographic maps of which are to be made (120,000 km^2).

1) Latest aerial photographs

There were relatively new serial photographs taken from 1982 to 1985. However those serial photographs were taken for small areas at large to medium scales. All of them were taken using the cameras manufactured in the former USSR and many had records written in Russian.

For example, aerial photographs of an area of 2,100 km^2 near Maxima located about 70 km Southeast of Luanda were taken at a scale of 1:14,000 in 1982, and those of an area of 560 km^2 at the mouth of Longa River and an area of 241 km^2 close to the mouth of Cuvo ou Queva River, both of which are located about 150 km south of Luanda, were taken at a scale of 1:14,000 in the same year. In addition, in the same 1982, aerial

photographs of an area of 160 km^2 in the central Luanda were taken at a scale of 1:8,000.

In 1983, aerial photographs of an area of 20 km^2 near Ndalatago located about 180 km east of Luanda were taken a scale of 1:15,000 and the photographs of an area of 239 km^2 near Cacuaco in the city of Luanda were taken on a scale of 1:7,000 and those of an area of 1,862 km^2 extending from the northern coast of Luanda city to near Caxito were taken at a scale of 1:10,000.
In the same year, photographs of a fairy large area (approximately 60,000 km^2) extending over the central part of Bengo province including the city of Luanda, northern part of Uige province, and Cuanza prpvince were taken at a scale of 1:40,000.

There were aerial photographs covering the city of Luanda at a 1:6,000 scale, city of Lobito on the southern coast taken at the scales of 1:11,000 and 1:15,000, and the city of Bengera in the south teken at scales of 1:11,000 and 1:15,000 in 1985.

2) Latest aerial photographs

The existing basic aerial photographs were used for the preparation of the existing topographic maps of 1:100,000 scale , which were also taken by the former USSR from 1979 to 1980. These photographs are shown in Figure 5.1.5.
The scales of these aerial photographs were approx. 1:30,000 and 1:60,000 (more precisely, ranging from 1:27,000 to 1:36,000 and 1:58,000 to 1: 73,000 respectively). In taking those photographs, it is assumed that they have used two types of cameras, each having the focal length of 10 cm and the picture size of 18 cm x 18 cm, and the focal length of b20 cm and the picture size of 30 cm x 30 cm.
Those basic aerial photographs were taken from the direction of south to north and the Photographs were organized to match the map sheets.
It can be from Table 5.1.1 that the aerial photographs for each map sheet are similar in amount for all scales.

As the photographs to interpret the satellite images, the above mentioned series are easy to be referenced for each map sheet. We are going to copy photographs by selecting those of the typical areas necessary for the preparation of interpretation keys from the above mentioned list.

3) Sub-contracting of copying of aerial photographs

The original films for coping the existing aerial photographs cannot be taken out of IGCA, which keeps them. Therefore, copying must be sub-contacted to IGCA.

With regard to the photosensitive materials such as photo-printing papers and processing agents necessary for copying, there is a dealer handing these materials in Luanda. If IGCA orders these materials, they can be delivered in about three weeks after the orders are placed.

The photo-processing darkroom in the Survey Department did not seem to have been used for more than ten years, but the pipes for water supply and draining necessary for washing were still alive. There were two contact printers, the equipment necessary for copying, model KG-30 manufactured by Zeiss, which responded normally to power supply.

However portions of the upper lids were slightly damaged, and some of the electric lamps used for exposure were burnt.

In implementing the sub-contracted works, some remedial measures may by necessary for these damages.

(5) Survey standards

The survey standards follow those of the current geodetic controls and the existing topographic maps of 1:100,000 scale.

The existing topographic maps of 1:100,000 scale included fifty to sixty sheets printed in Cuba during the war time of 1990 mainly covering west coast which omitted some geographic information for security reason. These existing maps had notes "USO LIMITADO" outside the neat lines on the upper right portions, established the "CAMACUPA origin" almost at the center of the national land as the origin of coordinates, and were prepared by pseudo-TM (Transverse Mercator) projection method using Clarke 1866 as the spheroid.

The existing official topographic maps of 1:100,000 scale cover the entire national land of Angola and had the notes "SECRET" on upper right portions. These maps used the elements of spheroid of Clarke 1880 and prepared by the UTM projection method.

In the present study, an agreement was made to use the above mentioned Clarke 1880 as the element of spheroid, the UTM projection method, and Zone No.33.

The reference altitude will be at the Marco datum point, which is the tide-watching point of Ponta de Ilha in the city of Luanda.

The existing bench marks are attached to the above mentioned tide-watching point and ranged from class 1 to 4. The new control points used for the preparation of new digital maps of 1:25,000 scale will be determined based on the survey on the existing triangular points and bench marks.

(6) Confirmation of the format of maps

It was agreed that the format used of preparing the digital topographic maps of 1:100,000 and 1:25,000 scales in this Study would follow the "Manual de symbols Conventions-1:100,000 / 1:50,000" by the Department of Survey of Angola which is used for the existing maps as a rule. The existing maps of 1:25,000 scale were prepared in accordance with this manual.

However, the existing format only followed the analog maps. Therefore, when making the computers recognize the boundary of vegetation as the surface information on the digital topographic map, the classification used for these existing maps is too minute and these vegetation boundaries is difficult to be determined many cases.

For example, because the existing format has strong elements with strategic purpose, the format of vegetation is further classified into several categories according to the height of growth. Other than the format of vegetation, there are some other items that the format may need to be changed to simplified one, which is easy to control as the digital information.

In addition, in the existing format, the number of building codes as the symbols very few. Since many of the building codes depend on repeated notes, these symbols must be established to reduce the notes for buildings.

In the discussions for this time, we submitted sample of digitized output maps of the existing maps from Japan in advance and asked IGCA to discuss on them. However, because only the expressions of existing maps were digitized in these maps, they were the output maps far from the specifications of the basic data for the GIS.

IGCA requested us to prepare the pilot output maps based on the actual format closer to the final specifications before discussion. IGCA will examine the omission or addition of format for this Study by confirming the contents of expression on these pilot maps in detail.

The Study Team promised to IGCA that they would prepare the format based on the existing one as soon as possible and prepare the output maps as the GIS data before the next discussion.

(7) Signalization for aerial photographs

1) Outline

Before taking the black and white aerial photographs of 1:30000 scale (1,000 km) of the city of Luanda, new control points necessary for aerial triangulation to digitize the topographic maps of 1:25.000 scale and the existing reference points were determined and aerial signals were installed. In addition, the locations difficult to reach for aeria signalization will be clearly identified from already taken aerial photographs and pricked.

2) Selecting the reconnaissance points

Before taking aerial Photographs, aerial signals and pricking points for fifteen planned points were determined in accordance with the plan. However because coastlines were included in the scope of photographing, survey points were added to maintain the precision of aerial triangulation. The four aerial signals were added to the two existing reference points (Morro da Cruz and Ouibenga) and to the new control points, then other twelve points were selected be pricked (one existing points and eleven new points), making the number of total control points to eighteen.

3) Signalization for aerial photographs

The shape of the aerial signals consists of three wings and the size, the from , and the materials of signals are as follows.

Shape (wings):	150 cm x 50 cm
Materials:	Stone, rock debris, and paint
Color:	Black and white

4) Survey of the eccentric elements of aerial photo signals and the pricking points

Survey of the eccentric elements of aerial photo signals and the pricking points were conducted by the solar observation method at the rate of two sets for each survey point.

5) Arrangement

Because aerial photographs were not taken yet within the Study period, ground photographs were taken and detail sketches made so that the survey points would not become obscure of the future work.

(8) Survey of control points

The control points of location and height necessary for the aerial triangulation and the plotting were installed this time using the global positioning system (GPS) observation and the direct leveling.

1) Control points on level locations

a. Outline;

GPS observation was conducted on the eighteen control points necessary for aerial triangulation (among which four points were existing points) by the static positioning method using four GPS receivers (4000 SSE) manufactured Trimble Co.

b. Selection of points;

For the acquisition of heights by GPS observation, it was impossible to ignore the geoid. However because the geoidal heights had not been observed in the study area

beforehand, it was decided to measure the heights of the new control points by the direct leveling as much as possible. For this purpose, we tried to select the locations of new control points, whose heights could not be measured by the direct leveling, in a way to make it possible to calculate and the same time inside of the existing points (points of direct leveling) where it was easy to prick and conduct the GPS observation.

c. Observation;

Observation was made by the simultaneous observation at four points using four two-frequency GPS receivers. As a result, the number of sessions became eleven.

Observation of the GPS satellite was conducted for more than three satellites at heights of no less than 15 degrees and for a duration of two hours at one time . In doing the observation, one counterpart staff member was assigned to each working group for the purpose of technology transfer through the actual observation.

d. Provisional calculation;

To confirm the accuracy of observation data, provisional calculations were conducted at site after the observation.

As a result of the cheek calculation of the closure errors of each session based on the WGS-84 ellipsoid (long radius of 6,378.137 m and the flatness of 1/298.257223563) and the closure errors of the triangles, the maximum closure error of each session was determined as 6.3 cm (observation precision of 1:422,000). The average side length of a route was approximately 47.9 km.

For the overlapped side where the observation dates differed, a result having sufficient observation accuracy was obtained, where the maximum range of the same side was 3.4 cm by DX value, 3.2 cm by DY value, and 4.8 cm by DZ value. As we have acquired respectable observation accuracy, the observation was approved by IGCA.

e. Network adjustment;

The control points were adjusted at four national reference points in Angola (Sassalenba, Quibenga, Morro da Cruz, and Fortaleza) and a strict simultaneous) network adjustment was made based on Clarke 1880, which was reference ellipsoid of Angola, using the altitudes from direct leveling conducted this time as the existing points.

Because the altitudes of three new control points (GCP16, GCP23, and GCP24) were not obtained by the direct leveling, they were obtained by the interpolation of the difference of the ellipsoidal surface of Clarke 1880 and the geoidal surface. The specifications used for the network adjustment of control points are shown below, which were agreed by the Survey Department of Angola at the time of field verification.

Reference ellipsoid:	Clarke 1880
Geodetic coordinates system:	UTM coordinates (33 zone)
Origin of coordinates:	15 ° 00’00”West of Greenwich
	0 ° 00’00”North
Addend of coordinates:	500,000 m Easting
	10,000,000 m Northing
Scale of the origin of coordinates:	0.9996
Reference height:	Mean sea level (existing bench mark of IGCA)
	Marco Datum Bench Mark

2) Control points for height

a. Outline;

Leveling was conducted for areas where the existing bench marks insufficient for maintaining the specified accuracy of altitudes as the topographic maps of 1:25,000 scale for aerial triangulation and plotting work. The leveling was implemented as agreed, using the existing bench marks as the existing reference points, and the survey was started after the site reconnaissance of the planned lines were conducted in accordance with the plan.

Since aerial photographs had not been taken, detail sketches of points were made and plotted on the existing topographic maps so that the survey points would not become obscure for the future pricking work.

b. Reconnaissance and observation;

The reconnaissance of the planned leveling lines was conducted to investigate road conditions and the observation lines of selected lines in accordance with the existing observation maps and to determine the presence of existing bench marks . At the time of reconnaissance, the fixed points were also investigated. The structures such as the water channels on the road side were used as the fixed points.

Observation was made using the digital level and the bar code scale manufactured by Leica through two-way observations. The planned work load was 150 km, but 165 km was observed.

One counterpart staff member was assigned to each working group for the purpose of technology transfer through actual observation. The work proceeded in a orderly manner and completed as planned. The level lines to which reconnaissance and observation were conducted are shown in Figure 5.1.1.

c. Results of observation

The limitation of observation accuracy was 5 cm S when the leveling was implemented. S is a one-way distance of level (km). The accuracy of leveling was approved by IGCA.

The existing points used for leveling were 19 points as shown below.
2021, 2221, 67, 1130, 1334, 1224, 1326, 259, 1394, 100,
1166, 1377, 1327, 1133, 4238, 1322, 4174, Morro da Cruz, and Quibenga

Some of the comments on the first year work of the Establishment of Comprehensive Geographic Database System for the National Rehabilitation and Development in the Republic of Angola are as follows.

- During the field work, the team members were forced to explain the work by the police and military, despite the fact that the team members were with the counterparts carrying official identification. For the following years of work, police and military need to be notified about the work in advance.
- For the GPS receivers (4000SSE, Trimble, America) worked very well as recognized, the work was implemented and completed efficiently.
- During the leveling the digital levels and the staff (the bar code type) were used. The results from the equipment were better than we expected. Observation using digital levels reduced reading errors, recording errors and stress to the staff.
- A seminar was conducted on January 7th. The participants from MINOPU and IGCA were enthusiastic about learning the survey technology. During the actual field survey, the team members showed the usage of equipment to the counterpart and guided the counterpart staff use the equipment. The willingness of learning was impressive to the team members.

(9) Aerial photographing

New aerial photographing was planned to be implemented as the consigned works as follows.

1) Objectives

a. To prepare digital topographic maps of 1:25,000 scale to supply the geographic database of important areas in the city of Luanda and to take the aerial photographs necessary for the preparation of land use maps of the said areas.
b. To take the aerial photographs of the portion of north-western part of the national land of Angola, which is an important area fir the industrial development of the country and the preparation of maps of which are assumed necessary for the future, as well as the portion of central hilly areas.

2) Contents of the consigned work and the survey period

The contents of the consigned work of photographing were determined as follows.

a. A portion of the city of Luanda:	Extent : 1,000 km^2
	Scale of photographing: 1:10,000
	Multicolor aerial photography:
	About 780 photos
b. Same as above:	Extent : 1,000 km^2
	Scale of photographing: 1:30,000
	Black and white aerial photography:
	About 160 photos
c. Cabinda province:	Extent : 7,000 km^2
	Scale of photographing: 1:30,000
	Black and white aerial photography:
	About 650 photos
d. Western part of Zaire province:	Extent : 10,000 km^2
	Scale of photographing: 1:30,000
	Black and white aerial photography:
	About 830 photos
e. An area extending from the	Extent : 10,000 km^2
western part of Malange province	Scale of photographing: 1:30,000
to the eastern part of Cuanza-	Black and white aerial
Sul province	About 830 photos

The members of the Study Team will supervise the consigned photographing work and the period is set from January 5, 1998 to March 20, 1998.

3) Subcontracting of the works

A subcontractor was determined by the tender. Before subcontracting the work, specifications for subcontracting the photographing were prepared, the contents of which were approved by the JICA in December 1997. Then, the work specifications were sent to three selected companies with the tender documents indicating the deadline for submitting tender documents at the beginning of January 1998. A subcontractor was selected from the short list approved by the Urban Planning Department of MINOPU which is the counterpart department of Angola of the present study because there is no aerial photography company in Angola.

The aerial photography companies indicated in the above mentioned short list were:

a. Aircraft Operation Company (South Africa)

b. Finmap (Finland)
c. Kevron (Australia)

Based on the documents submitted from the above mentioned three companies, their experiences, technical abilities, engineers, and tender amounts were evaluated. As a result, aircraft operation Company of South Africa was determined most suitable, and the request for the consignment was submitted to the JICA with the evaluation report.
It was determined that the subcontract agreement would be concluded with Aircraft Operation Company on March 10, 1998.

4) Submission of request for approval of aerial photographing in Angola
The Study Team of JICA submitted a request for the approval photographing of Angola by airplane for the purpose of taking photographs to the Director of Urban Planning of MINOPU in the middle of January 1998.
These documents were submitted to the National Security Bureau of the Ministry of Defense (Ministério da Defesa) from MINOPU via the National Aircraft Department of the Ministry of Transportation (Ministério dos Transportes) on January 21, 1998.
Separate from the above mentioned. As for the request photographing the boarder area of the neighboring country in Cabinda province, plan documents were submitted from MINOPU to the Ministry of Foreign Affairs, pending the approval of the said request.
Unfortunately, the above mentioned requests were approved during the study period. Thus we have to wait for the approval to be given during the following phase.

5) Meteorological conditions during the present study period
Although the present study period fell on the rainy season when the weather is divided into the dry and the rainy seasons, there were many fine days. However, mists were very thick. and many of the days were not appropriate for taking aerial photographs from the ground altitude of more than 1,000 m.
However, there were six fine days over the city of Luanda during the latter half of January and in the middle of February. Therefore, if we had been able to obtain the approval for photographing, we could have taken the aerial photographs of Luanda.
The present study was agreed between two countries, Japan and Angola, and the progress of works must be accompanied by the provision of conveniences from Angola. However the security supervision for the national defense (under the jurisdiction of the Police Department of the Ministry of Home Affairs) was very strict due to the present domestic situation of Angola, and it was outside of other Ministries jurisdiction.
The fact that the present photographing work could not proceed as planned was unfortunate because we are forced to drastically change the work plan from the following phase.

5.1.3 The First Phase Work in Japan

(1) GIS Desing

1) GIS hardware and software configuration

A number of minor changes have been made since the original proposed hardware and software that was described in the Inception Report. These changes and modifications to the hardware and software specifications have been made during consultation with the Angolan counterpart during the First Period of Work in Angola, in December 1997.

At the end of the First Period of Work in Angola, the Study Team requested that the Angola counterpart obtain initial price quotations from local suppliers for the hardware portion of the GIS center that is to be facilitated in MINOPU by the Study Team.

Although copies of at least two quotations were received, both were incomplete in the some equipment was not listed or not understood or obtainable by the local suppliers for inclusion into the quotations. Due to the complex nature if the hardware and software configuration for the GIS center, it is the recommendation of the Study Team, that foreign based supplier, familiar with such configurations, be chosen to supply the hardware and software for the Project.

a. System base;

The computer hardware which is proposed for installation in Angola is PC-based. These PC systems will be networked, as described in the original proposal. The operating systems of the PCs will be Microsoft Windows-NT 4.0 or greater. In keeping with the original proposal, all computers and output devices will be networked using a common 100/T Ethernet. All of the computers, peripherals, and hardcopy devices will be protected from electrical. Surges and disruptions in power through the use of UPS devices. To further protect the hardware in the GIS center, the installation of a standalone power generator and new wiring is being proposed. The proposed components of the hardware specification represent careful selection based on configuration specifications, adaptability to various electrical and environmental conditions, and quality of design. Due to the duration of the Project, with the hardware and software being installed early in the schedule, the configured systems represent equipment which will retain a very competitive edge beyond the duration of the Project.

b. Addition of a large format scanner;

Originally, three (3) digitizing tablets, devices used to interactively pick positions off paper maps or drawings and convert and register these positions to digital coordinates, were proposed. However, after discussions with the Angolan counterpart and other

members from other Angolan government agencies (which may be involved in the creation, use and operation of the GIS center), it became relevant, that three (3) digitizing tablets were not needed. Based on these discussions, and the observation of other possible source data which other agencies had, the Study Team recommended that a large format monochrome scanner replace two of the digitizer tablets. Appropriate conversion software for the scanned data has also been added to the specification.

c. Addition to support machines;

Prior to the first Period of Work in Angola, the need for an additional computer "Support Machine," used for documentation and general affairs of the GIS center was considered. Then, during discussions with the Angolan counterpart, an additional support machine would be equipped with presentation software, namely laptop computer. This machine would be equipped with presentation software, namely Microsoft Power Point, and an external projection device. This machine would be used by the director of the GIS center for making promotional presentations to other Angolan government agencies and other related organizations. The projection device will also be for training presentations and seminars at the GIS center.

d. Overview of proposed software;

The proposed software for this Project is described in the Proposed GIS Software Specification as shown in Progress Report 1.

The primary GIS software which the Study Team has proposed is Environmental Systems Research Institute's (ESRI) Arc/Info Rev. 7.x for Windows-NT. Two (2) licenses of Arc/Info Rev. 7.x for Win-NT are configure for the GIS Center. Supplemental modules for Arc/Info include (1) license each of TIN and GRID. These modules add additional functionality to Arc/Info for terrain and rater data analysis. Such data types will exist in the base data created for this Study, thus it is important for these modules to exist in the configured system.

Additionally, ESRI's ArcView 3.x.for Window-95/NT software for data editing, Query, and display of spatial data is proposed. The (10), licenses of ArcView 3.x software are configured for the GIS Center. Additional modules for ArcView include on (1) license each of Spatial Analyst, Image Analyst and 3D Analyst.

ScanVec's AccuPrint RIP will be used for output device file preparation. A software RIP is configured with this system because of the large size of plot files routinely generated when making output from GIS or spatial data analysis systems.

Two (2) licenses of Able Software's R2V product will be configured in this system. This package used for the conversion and editing of scanned (raster) data into vector

data, which is then used by the GIS.

Additional, non-GIS related software will also be configured for the GIS center. Such software will include Adobe Photoshop, (one license) for working with scanned raster and image data. Three (3) licenses of Microsoft Office will be configured in the system. This software will be used for general work, documentation writing, presentation preparation, etc.

All of the machines in the GIS center will be configured with an appropriate virus checking and control software.

Additional software, which is bundled with the various peripheral devices, for control and maintenance of each specific device will also be configured. Such soft ware is not specifically listed as a separate item in the software specification.

2) Processing flow

The following section is a working description of the various tasks such as data input, data preparation, maintenance and analysis, data integration management and archiving, and hardcopy output. This is a *working* description, as discussions with the Angolan Counterpart are ongoing and the final processing flow will be determined upon approval of the proposed hardware and software configuration. For this description and also as shown in the Processing Work Flow for Angola GIS center, a certain number of machines within the GIS center are listed as dedicated to a specific group of tasks, however because of the flexibility of the software licensing, such dedication is manly for description only. A short description of the intended role of the support machine is also provided.

a. Data input and editing;

The Data Input and Editing tasks, consists of the creation or digitization and initial editing of various data sources by the GIS center. Here, the A0 scanner, digitizing tablet, desk scanner and digital camera may be used. Presently three computers could be dedicated to supporting these tasks. These systems are arranged in a similar location within the design of the GIS center facilities room. Examples of input data sources may be map color separation films, maps, drawings, aerial photographs and digital images. Examples of tasks may be data preparation and input, data vectorization, transformation and editing , image cataloging and preparation.

b. Data preparation, maintenance and analysis;

The tasks of data preparation, maintenance and analysis can dedicated to three computers within the GIS Center. For these tasks, additional peripheral devices are not needed. These systems are also arranged in a similar location within the design

of the GIS center facilities room. Example of tasks may be attribute association, editing and verification, tabular data preparation, data query and processing quick map generation, minimal system configuration and customization.

c. Data integration management and archiving;

The tasks of data integration, management and archiving are specifically dedicated to two computers within the GIS center because of the specific hardware and software requirements of these tasks. These two computers will be the primary GIS stations within the Center. Example tasks e the integration of newly created or modified data into the master spatial library database, management of the master spatial library database, detailed map production, data archiving and backup, data translation and dissemination.

d. Hardcopy output;

The task of hardcopy output is listed as a primary in the Processing Flow, however hardcopy output is not necessarily a dedicated task. Three types of hardcopy devices have been proposed for the GIS center. The first, an A4/A3 size monochrome laser printer can used for the output of reports, diagrams, charts, system files, images and any maps requiring monochrome printing up to A3 size. The second device, an A3 size color inkjet printer can be used for color output of the same tasks as the laser printer.

Finally, the large format A0 size color inkjet plotter will be used for color or monochrome output over A3 size. The primary use of the A0 inkjet plotter will be for the plotting of check plots and maps produced at the GIS center. Access to these hardcopy devices will be made available over the network for all of the computers. No files will need to be transferred between machines for printing or plotting and no hardcopy devices will need to be moved to produce output. Output for the hardcopy devices is controlled from a computer called the Print Server. This machine is to be used only for the preparation of device files for printing and spooling to the appropriate hardcopy device via the network..

e. Support machines;

The primary uses of the support machines will be for the preparation of reports, documents, charts and presentations. Each machine will also be linked to the GIS Center network and can access the distributed hardcopy resources. Each of the support machines will be able to make use of the proposed projection device. The projection device will facilitate instruction of GIS Center technicians in addition to the presentation of the activities of the GIS Center to other interested organizations.

3) Proposed design of GIS center facility;

During the First Period of Work in Angola, the Angolan counterpart showed the Study Team three rooms within MINOPU that could be used for the GIS center. The Study Team chose the largest (main) of the three rooms to house the main computers and peripherals of the GIS center. Either of the other two rooms can be used as support rooms, presentation or offices, workrooms for use later during the project, and for storage of media (paper) and supplies for the hardcopy devices. The rehabilitation of the main room will be in the form of a new, self contained and self sufficient power supply system, in addition on the procurement of an appropriate number of chairs, tables, drawers and lockers to be used for the staff, computers, supplies, and materials, respectively.

During the design for the placement of the equipment and furniture, care has been taken to consider work flow tasks, so as to minimize repetitive movement of people within the room. Room illumination was also being considered, as it seemed typical that blinds were usually open or seldom utilized in the rooms which the Study Team visited. Such illumination situations effect the positioning of the computer screens. The final layout design may change slightly based on the number of computers and peripheral devices which are approved from the proposed configuration list.

(2) Design of GIS related facilities

1) Items including the estimate for design of GIS related facilities

During the technical discussion, MINOPU disclosed an intention that they would provide three rooms in the building of MINOPU. The contents are as follows.

Name of the room	Use
Coordination room	A room for the administrators who will plan the and operation of the GIS
Support room	A room where the original maps and the output maps are to be edited
GIS operation room	A room to install the GIS computer equipment

2) Allocation plan of the equipment

The results of the discussions on the GIS operation system and the allocation of the GIS computer equipment are shown in the Table below. The design items of the GIS operating facilities to be calculated accompanying the allocation plan are also shown in the Table below.

Location	Number of to be installed	Items to be calculated in the design of the operation facilities
Coordination room	1 set of not-type personal computer	Supply of power source Wiring of LAN cables
Support room	To be used by transferring the equipment from the GIS room	Supply of power source In some cases, wiring of LAN cables may necessary.
GIS-room	9 sets of personal computers 1 set of note-type personal computer	9 Supply of power source Wiring of LAN cables

3) Scope of calculation for the design of the GIS related facilities

	Coordination room	Support room	GIS operation room
A. Computers			9 sets
B. Air-conditioners	Existing items will be used	Existing items will be used	2 new sets
C .Power source equipment	Power supply work	Power supply work	Power supply work
D. Reconstruction of floor	As is	As is	Free access work
E. Furniture and equipment			To be newly arranged

a. Computers;

As required to locations of computers, two types of cable, the power cable of AC220V and the LAN cables will be wired from the GIS operation room to the coordination and support room.

b. Air-conditioners;

Two new air-conditioners will be installed in the GIS operation room.

Other room will use the existing air-conditioners.

c. Power source equipment;

The standard voltage and frequency available for commercial use is AC220V ± 10V /

50Hz, but the measures result was AC208V. Boosting of its voltage and stabilization are necessary. As for the power supply situation, service interruption may occur anytime. Incorporation of the UPS device with boosting and constant-voltage functions as will as installation of private power generator are necessary. The power form private generator will be supplied to the GIS computer equipment and two air-conditioners to be installed in the GIS operation room.

d. Reconstruction of floor;

As a result of examining and selecting the installation method of cables including the power cable for computers and the LAN cables, a free access method was selected. The floor materials will be procured from South Africa or Japan.

e. Furniture and equipment;

The furniture will be mainly procured for the GIS operation room where the GIS computer equipment will be installed.

4) Item that need further adjustment and measures in relation to the estimate of the design of the GIS related facilities.

a. Wiring of computer cables;

- Matters related to the power source

  The electric standard in Angola is the Portuguese standard (NB). However whether the geometric specification of plugs and electric outlets (3-pile with ground) has a standard has been studied yet. It is also necessary to study whether plugs and electric outlets can be procured, which is related to the geometric specification of the plug on the power cable of computer equipment. Therefore, it is necessary to make adjustment so that the geometric specifications will conform to those of South Africa where the computer equipment will be procured.

- Matters related to the LAN cables

  Specifications of the modules to connect the LAN cables differ for each country

  Compatibility between the LAN equipment (HUB) to be procured from South Africa and the LAN cables must be confirmed.

b. Air-conditioners;

Two new air-conditioners' cooling capacity and the power consumption are known.

c. Power source equipment;

Necessary generating capacity of private power generator need be assessed,

distribution boards shall have a non-fuse breaker matching to the number of items to supply power and the number of electric leakage breakers must be designed. A table tap method will be used and five to seven types of cable length will be processed at site.

d. Reconstruction of floor: free access work;

Floor materials are manufactured in South Africa and can be procured. Quality, guideline of work, whether it is possible not to use technical laborers (making the construction work easy) must be studied.

5) List of estimates (Refer to Progress Report 1.)

6) "Requirement of quotation for execution" before starting the construction work

The instruction for execution from JICA has set the starting period of construction related to the design of the GIS related facilities in May to June. However, looking at the present situation, we want to start the construction work after clarifying the following matters not confirmed yet.

a. Specifications and procurement of air-conditioners;

In Japan. window-type air-conditioners have not been manufactured for these ten years.

Therefore, with regard to the locally procured air-conditioners, main specification must be confirmed including the cooling and dehumidifying capacity, power consumption, parts supply, and trouble repair system.

As for the power consumption, the contents indicated from Angola was on the cooling capacity and not the power consumption. Therefore, we cannot determine the specifications of private generator and distribution board at present.

The local estimation, this time, did not calculate the relationship among air-conditioners, capacity of private generator, and the interrupting capacity of distribution board.

b. Examination of the scope to supply electricity from the private generator;

We decided to supply power to the GIS equipment and two air-conditioners. However, we are going to calculate the entire power consumption including the power supply to ceiling lighting and conduct the field verification with the cooperation of MINOPU in the direction to supply electricity while the electricity is interrupted during the night.

c. Determination of power generating capacity of private generator and a method of

delivery;

The required power capacity will be calculated from above items a. and b., and the optimal private generator will be selected and its cost will be estimated in Angola.

How to deliver the private generator (weight of 1 ton) to the installation place (south terrace of the 4th floor) has not been determined yet. A plan we have now is to rent a mobile crane and remove the iron lattice on the cast terrace deliver the generator.

d. Reconstruction of floor;

Floor materials will be procured from South Africa, which seems possible from the catalogue.

We want to confirm the quality, easiness of construction work, and the inclusion of the work instruction, and examine and determine a method of floor reconstruction with the local laborers by avoiding to dispatch engineers from Japan.

e. Furniture and equipment;

The estimates from Angola do not clarify details such as the outside dimensions or the quality of products.

We want to confirm the actual products listed in the written estimation in Angola and will determine whether they can be used or not.

f. Quality and process of the design works of operating facilities

We want to determine the "quality of work", "safety of work", "outline of ordering", "outline of inspection", and "payment conditions" in the above mentioned work, a discuss the estimation of the work process (starting order of the work) and the number of necessary days with the Building and Repair Section of the Ministry of Public Works before starting the work, We will submit the "execution schedule and written execution estimates related to the design of the GIS related facilities" to JICA with the discussed matters mentioned above, and start the work after obtaining the approval of JICA

By summarizing the above mentioned matters, we are going to propose the preliminary requirement of quotation for execution according to the following order.

I. Confirmation of the items not confirmed yet

Specification on the following items will be determined and written execution estimates will be obtained.

a. Cables and connecting instruments (plugs, electric, modules, and table taps)
b. Air-conditioners
c. Private generator
d. Distribution board
e. Free access
f. Furniture and equipment

II. Discussions with MINOPU

Confirmation method of work quality, safe construction method, outline of ordering outline of inspection, implementation schedule (starting order of the work), and estimation of necessary days.

III. Obtaining the approval of JICA

a. To submit to the JICA the work schedule and the work estimation related to the design of the GIS related facilities.
b. To have JICA submit the instruction to start working on the design of the GIS related facilities.

IV. Start of the design of the GIS related facilities and supervision of work.

V. A notice on the completion of inspection of the design of the GIS related facilities

VI. Resultant documents

a. List of works, work log, and pictures recording the work on the design of the GIS related facilities.
b. Design specifications on the design of the GIS related facilities (including Catalogues)
c. Maintenance documents on the design of the GIS related facilities.

VII. Inspection of power source related matters

Whether the normal power supply is possible while all the items of computer equipment are connected and whether the breaking function of that system operates for the short

circuit must be conformed.

The implementation period of the above mentioned inspection will be linked with the time when the computer related items are set up, and the confirmation will be entrusted to the agent that will wire the power source.

It is necessary to confirm the local agent wiring the power source whether they can implement the above mentioned inspection.

But unfortunately, above free access floor system and furniture were not accepted by JICA as the budget for the Study in 1998.

Figure 5.1.1 Ground Control Point Survey Network

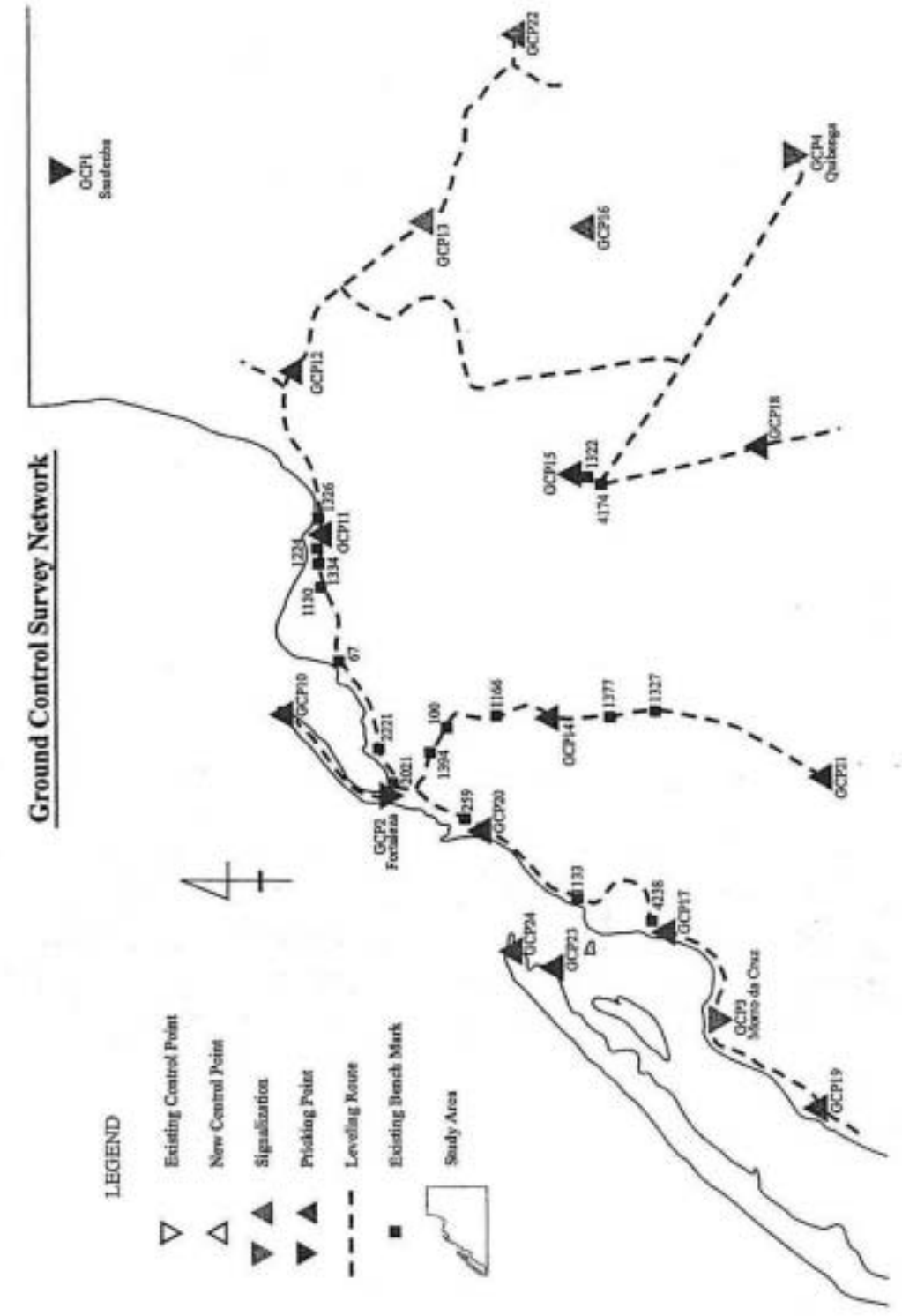


Figure 5.1.2 Observation Net Adjustment

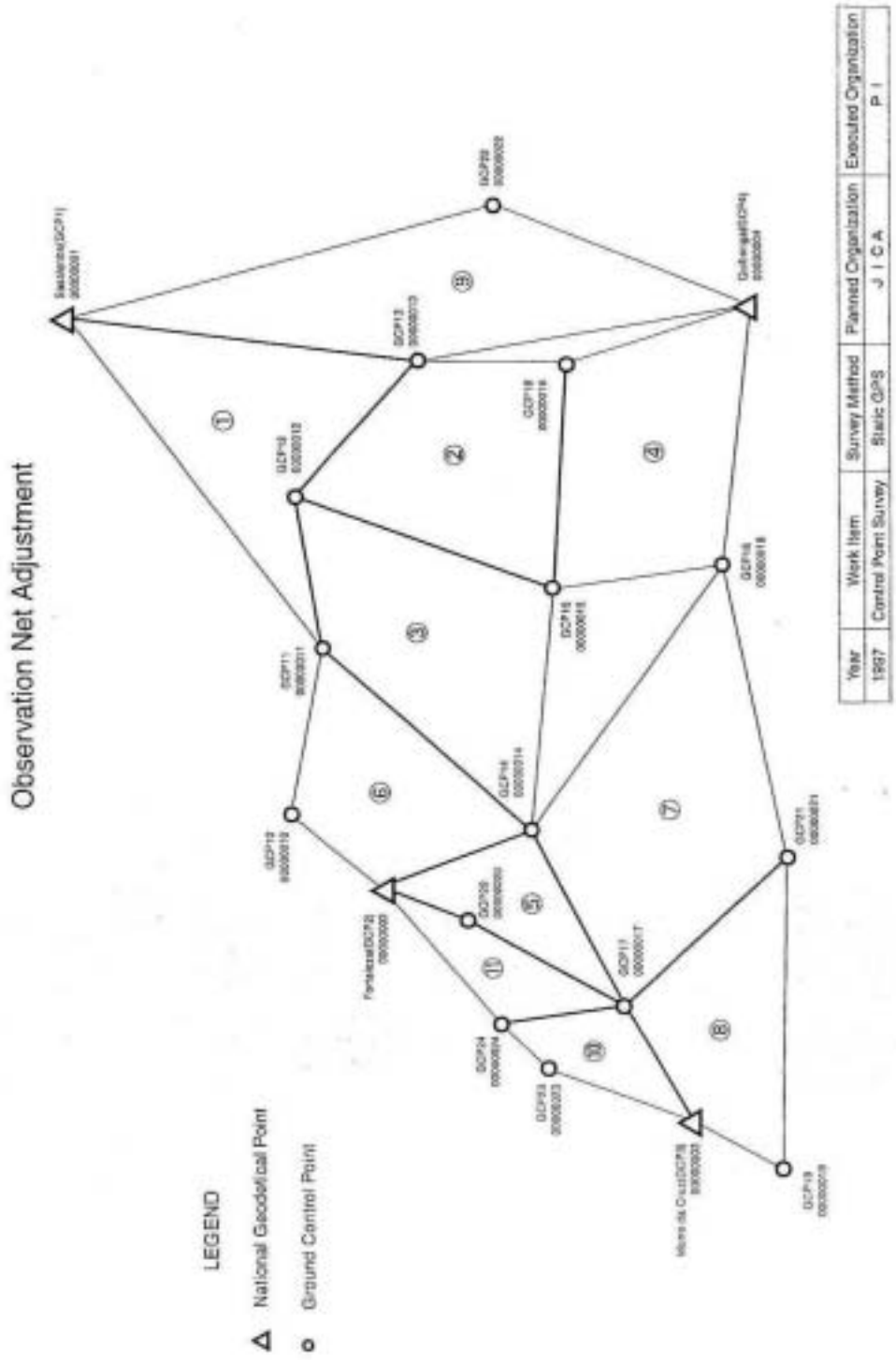


Figure 5.1.3 Results of Final Net Adjustment

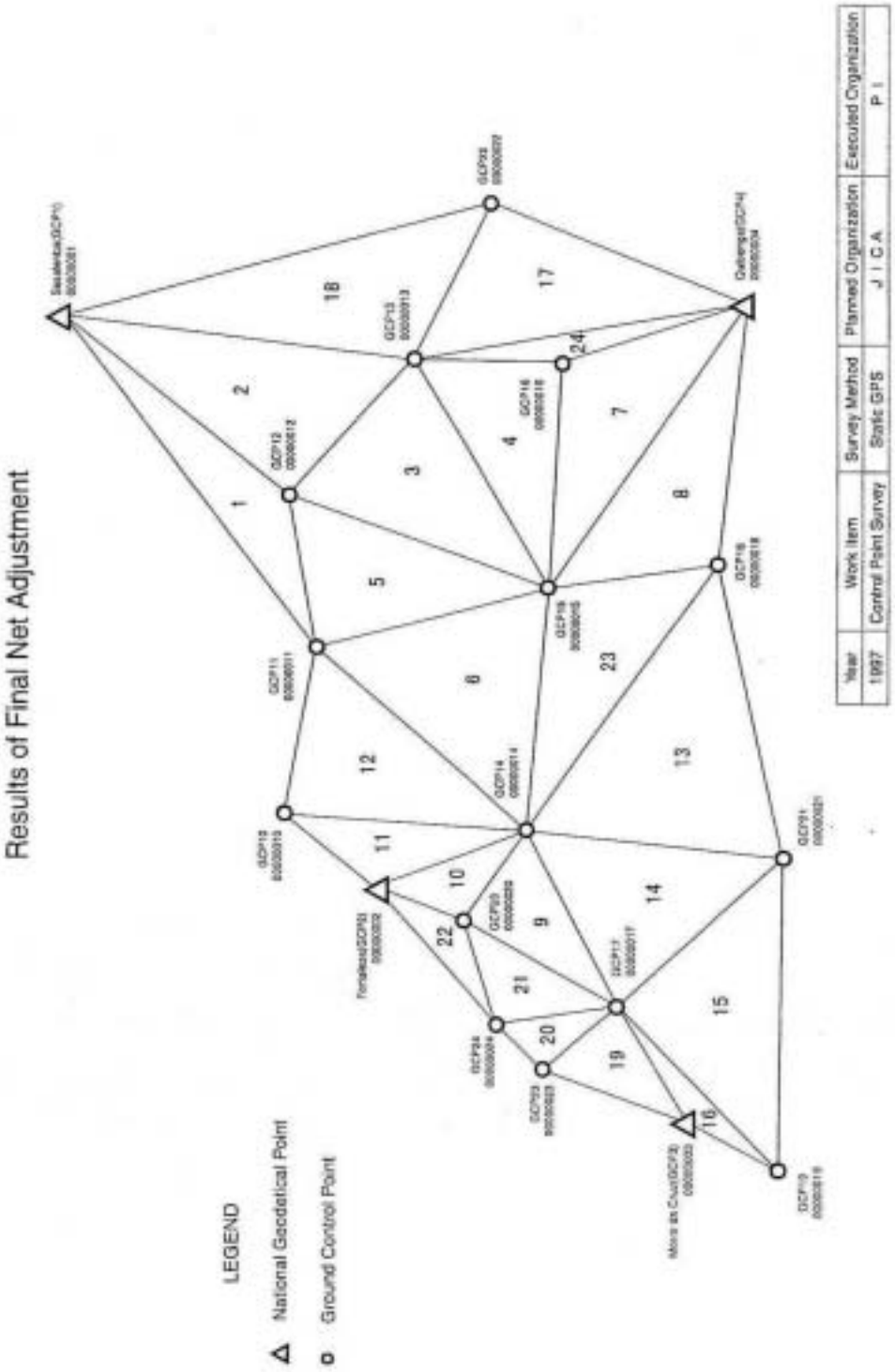


Figure 5.1.4 Accuracy Control Table

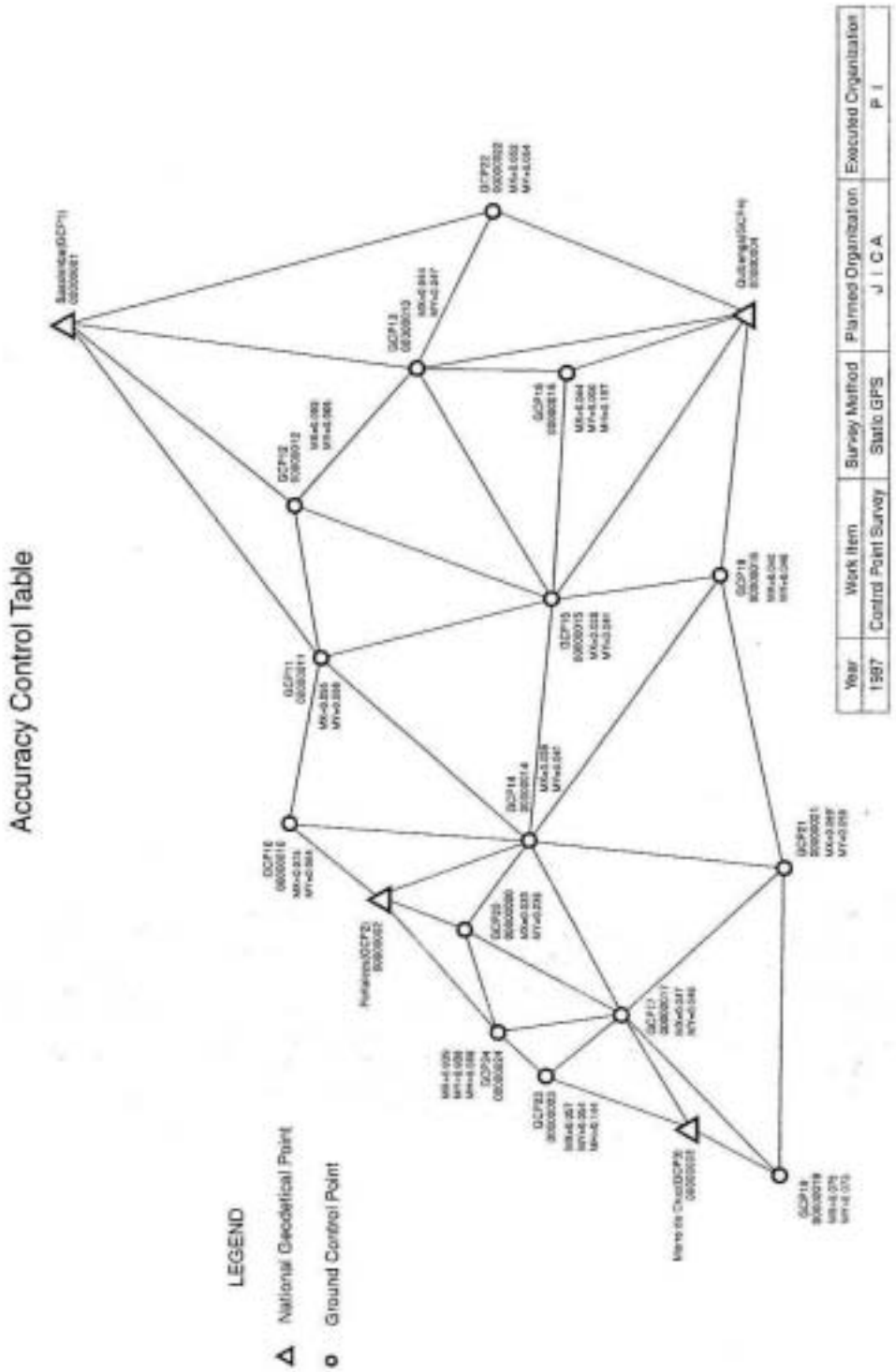


Figure 5.1.5 Aerial Photography (1978 – 1980)

Photo scale 1/30,000 and 1/60,000

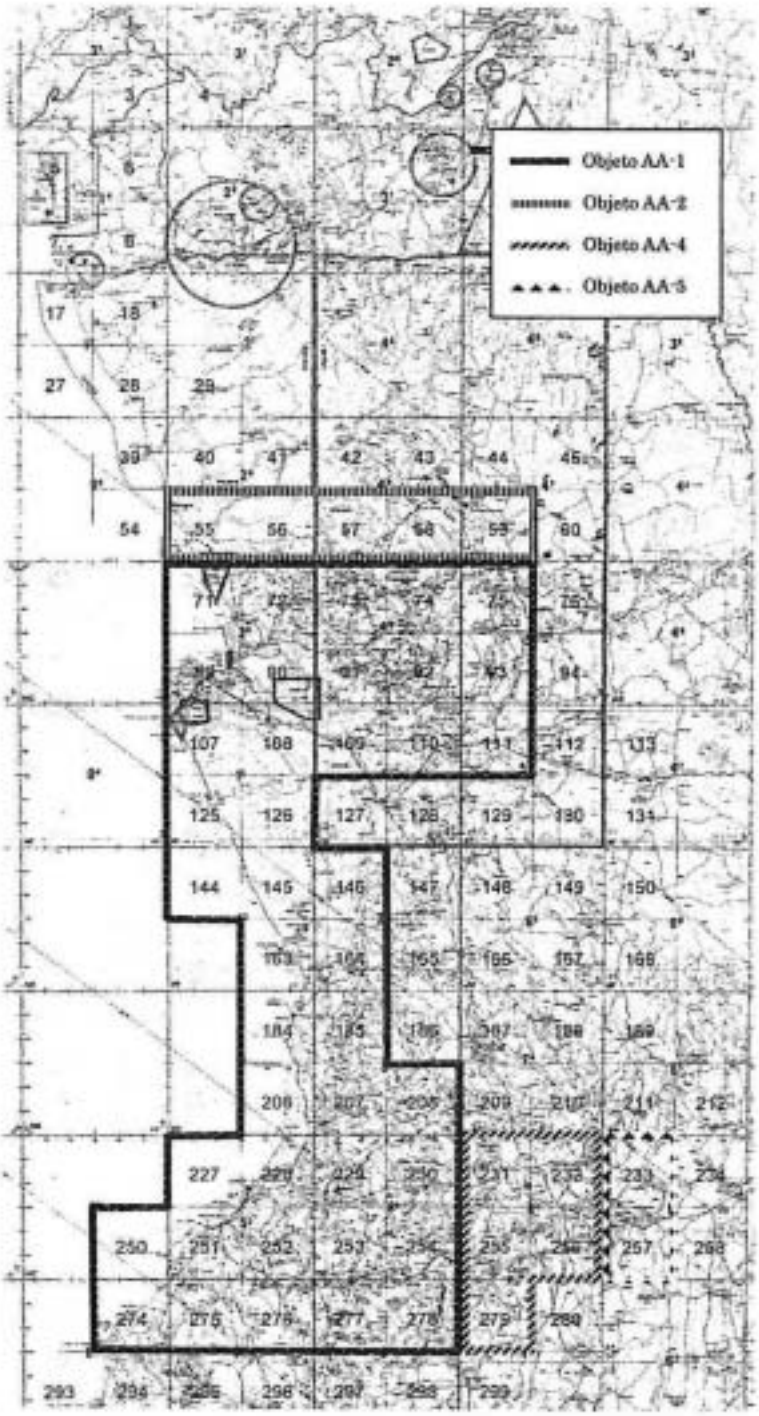


Table 5.1.1 The Number of the Aerial Photographs for Each Sheet

Sheet No.	Photo Scale		Sheet No.	Photo Scale	
	1/30,000	1/60,000		1/30,000	1/60,000
55	131	128	164	143	138
56	133	133	184	64	64
57	156	155	185	169	169
58	159	160	206	79	73
59	166	166	207	150	154
71	72	70	208	178	178
72	153	147	228	124	127
73	145	145	229	205	201
74	148	148	230	233	226
75	175	168	231	218	218
89	71	77	232	199	199
90	134	137	233	191	190
91	153	144	250		
92	132	136	251	144	128
93	177	164	252	146	145
107	76	90	253	199	189
108	136	146	254	228	220
109	158	149	255	208	209
110	159	173	256	211	211
111	177	166	257	191	190
125	67	67	274	107	109
126	139	139	275	173	162
143			276	187	185
144	15	15	277	176	171
145	132	132	278	211	197
146	155	154	279	204	196
163	63	61			