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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
SURVEYS AND MAPPING DEPARTMENT, UGANDA (SMD)

THE TOPOGRAPHIC MAPPING OF KAMPALA AND JINJA BLOCKS, NORTH OF LAKE VICTORIA IN THE REPUBLIC OF UGANDA

GENERAL REPORT

MARCH 1998

INFRASTRUCTURE DEVELOPMENT INSTITUTE
PASCO INTERNATIONAL Inc.

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
SURVEYS AND MAPPING DEPARTMENT, UGANDA(SMD)

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OF
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IN
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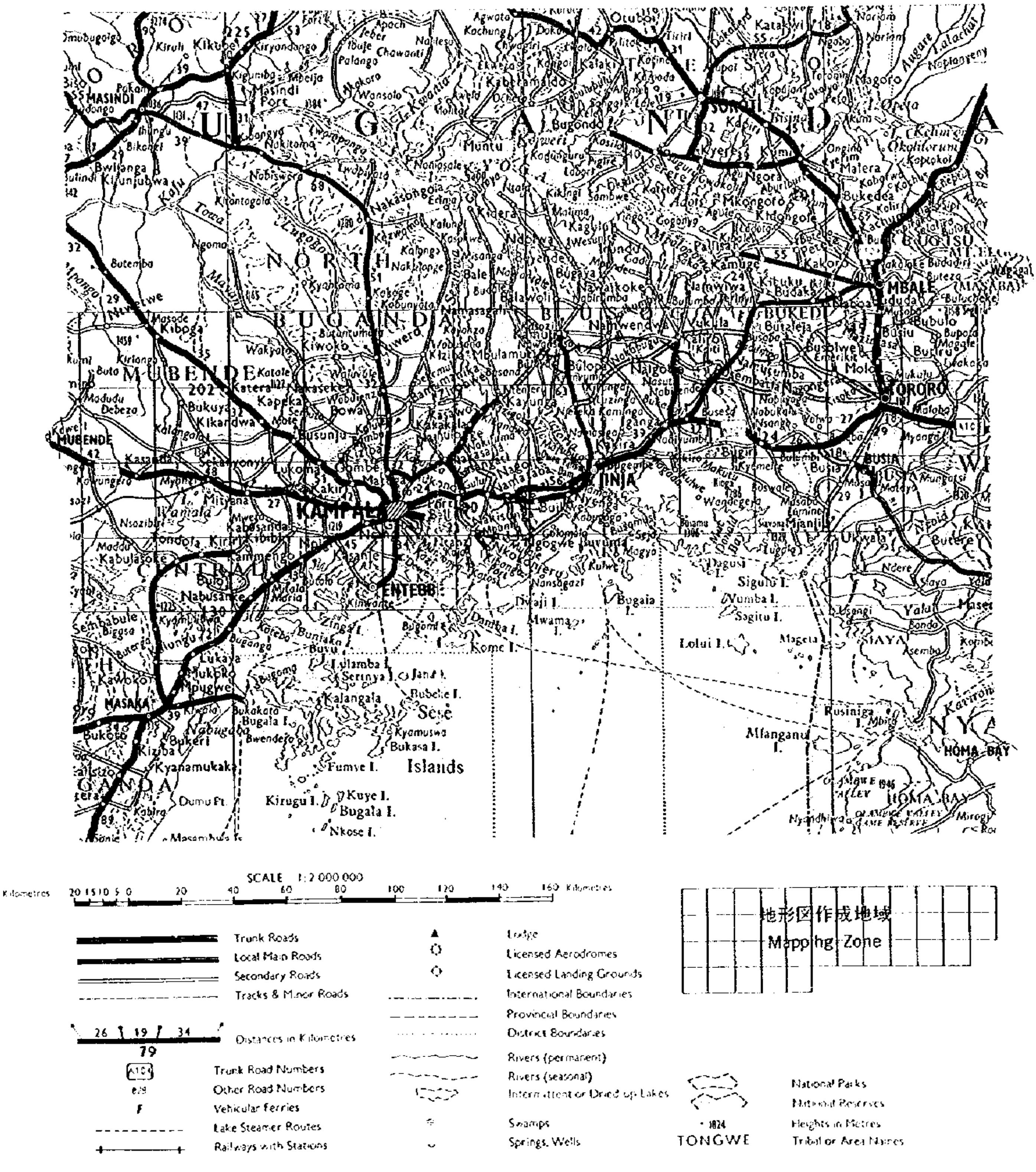
GENERAL REPORT

INFRASTRUCTURE DEVELOPMENT INSTITUTE
PASCO INTERNATIONAL Inc.

ウガンダ共和国
ヴィクトリア湖北部地形図作成
調査対象地域

THE TOPOGRAPHIC MAPPING OF KAMPALA AND JINJA BLOCKS, NORTH OF LAKE VICTORIA IN THE REPUBLIC OF UGANDA



PREFACE

In response to a request from the Government of the Republic of Uganda,the Government of Japan decided to conduct a Topographic Mapping of Kampala and Jinja blocks, north of lake Victoria and entrusted the study to the Japan International Cooperation Agency(JICA).

JICA sent to Uganda a study team headed by Mr.Hiroyuki Matsuda ,Infrastructure Development Institute 3 times between December 1994 and December 1996.

The team held discussions with the officials concerned of the Government of Uganda,and conducted field surveys at the study area. 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 Republic of Uganda for their close cooperation extended to the team.

March 1998

Kimiro Fujita

President

Japan International Cooperation Agency

March 1998

His Excellency Mr.Kimiro FUJITA
President
Japan International Cooperation Agency
Tokyo Japan

Letter of Transmittal

Dear Sir:

In response to your request, we are pleased to formally submit herewith the final report on "Topographic Mapping of KAMPALA AND JINJA BLOCKS,NORTH OF LAKE VICTORIA" which has been conducted since F.Y.1994.

This report generalizes the progress of study and technical aspect. The study was undertaken by Infrastructure Development Institute in a joint-venture with Pasco International Inc. from November 1994 to March 1998.

The outcome of study was 40 sheets at a scale of 1:50,000 topographic map for KAMPALA and JINJA Blocks, North of LAKE VICTORIA on the basis of the 1:60,000 aerial photographs.

We are convinced that the report would, together with study results, be fully utilized as the basic materials for the region and contribute to the future development of Uganda.

We wish to express my sincere appreciation to the officials concerned with the Government of Japan for giving their appropriate direction during the study as well as to the officials concerned with the Government of Uganda and the Japanese Embassy in Kenya for their close cooperation during the study.

Very truly yours,

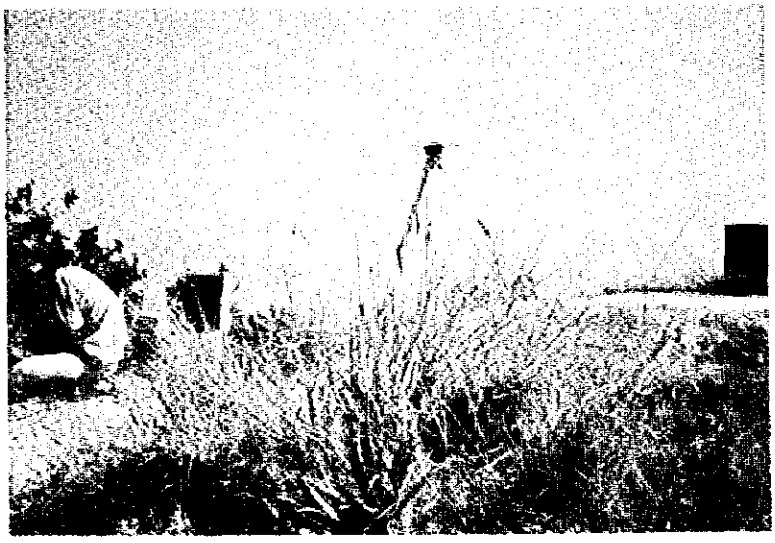
Hiroyuki MATSUDA
Team Leader
Topographic Mapping of
KAMPALA and JINJA Blocks,
North of LAKE VICTORIA
in the Republic of Uganda

Signing on the Minutes of Meeting prior to start of field work.

Courtesy Call at Ministry of Land Housing Urban Development.

Aircraft

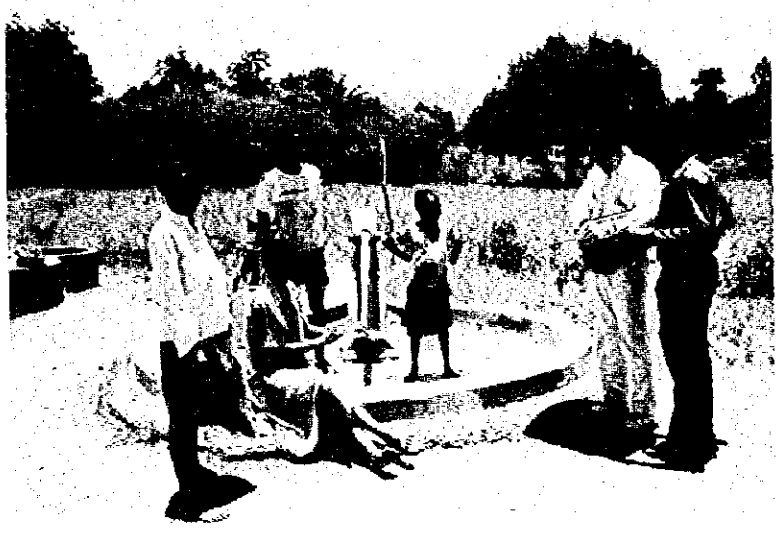
Checking of Aerial photography



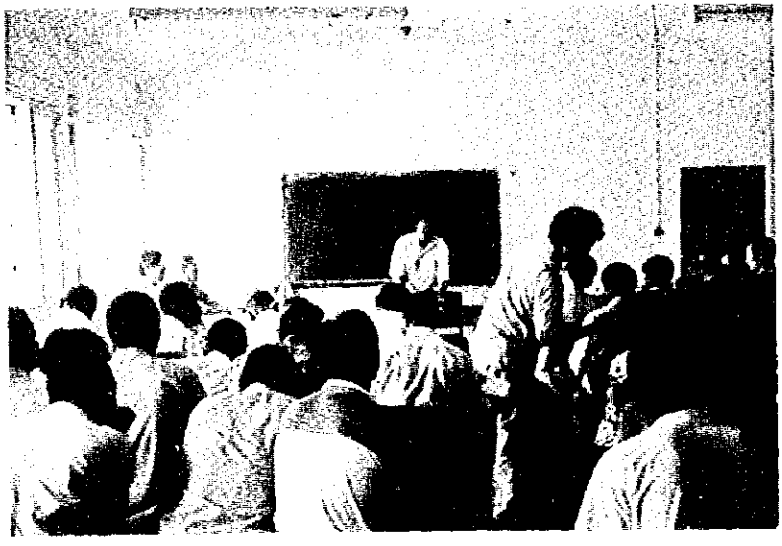
GPS Observation

Signalization

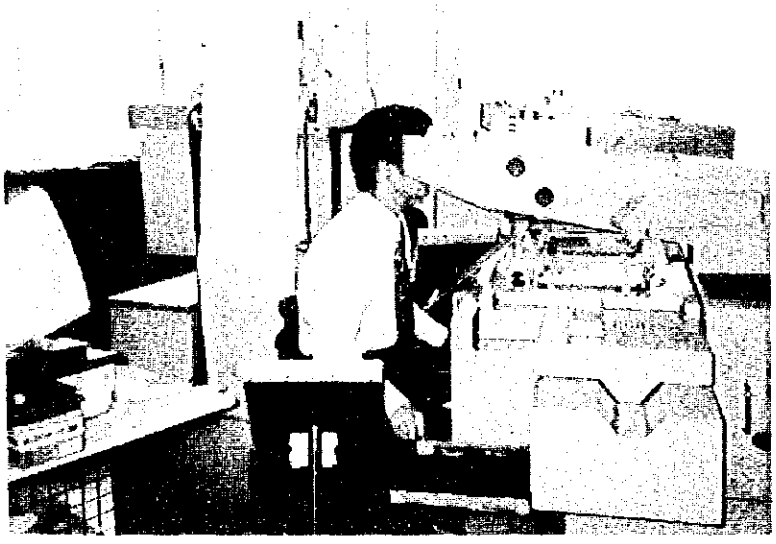
Preparation of field work.



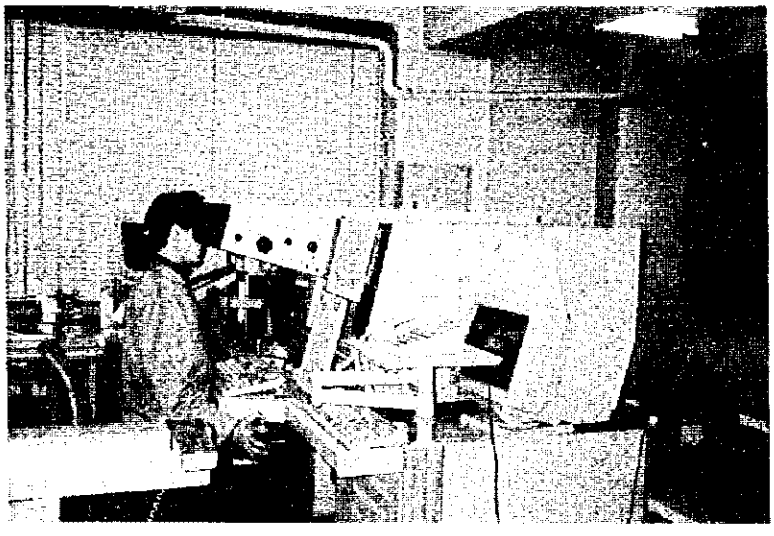
Field identification.



Workshop

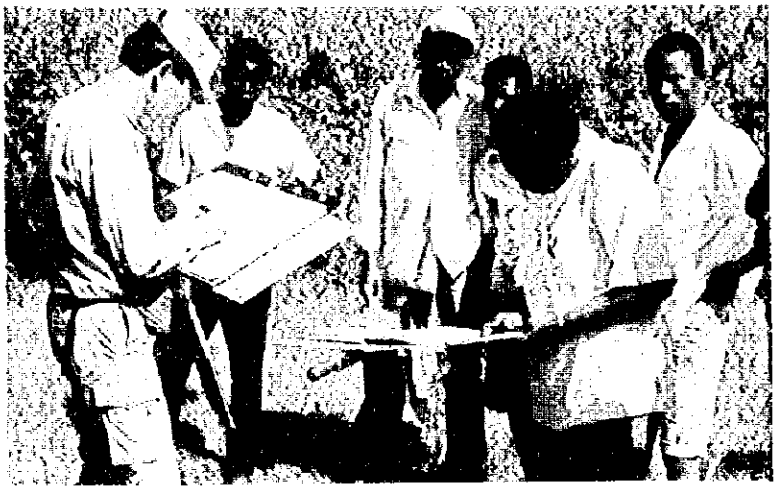


Aerial triangulation.



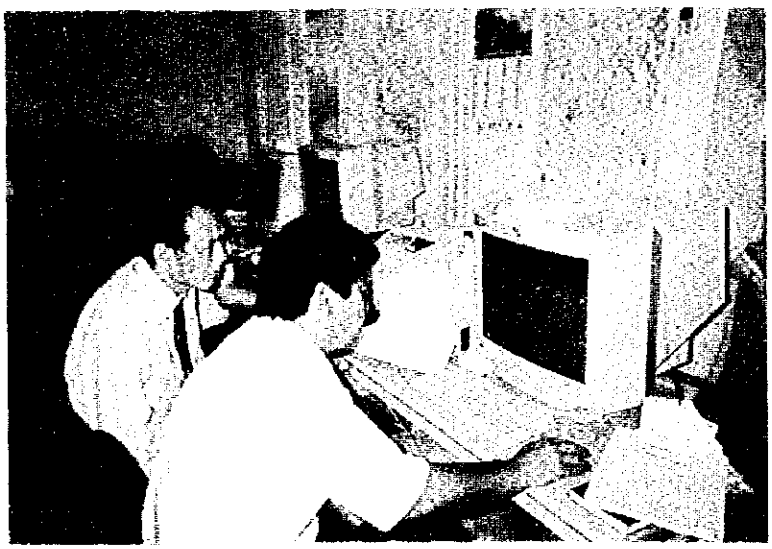
Plotting

Editing



Field completion

Annotation check by SMD



Digital compilation

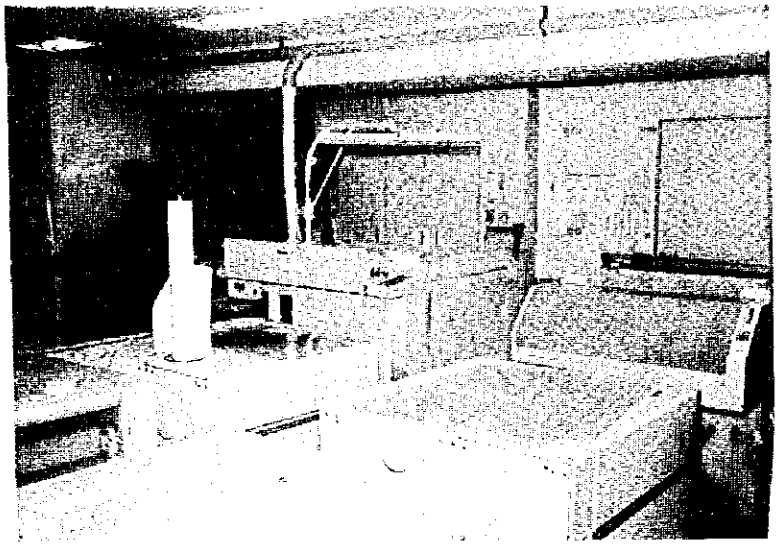


Image setter output device

Platemaking device

Offset printing machine

GENERAL REPORT
ON THE TOPOGRAPHIC MAPPING OF KAMPALA AND JINJA BLOCKS, NORTH OF LAKE VICTORIA IN THE REPUBLIC OF UGANDA

CONTENTS

Attachments

1. Introduction

In response to the request of the government of the Republic of Uganda, the Japan International Cooperation Agency conducted the topographic mapping at a scale of 1/50,000 in the Kampala and Jinja blocks, north of Lake Victoria by using newly produced aerial photographs at a scale of 1/60,000. The four-year work was commenced in November 1994 and completed in March 1998.

The study area has 29,000km^2 ranging in latitudes from 0°0' to 1°00' and longitudes from 31°30' to 34°30'. (c.f. the study area map in the inside cover of this report) It includes the central business district of the nation and the south coast of the Lake Victoria. The area include the capital, Kampala and the second largest city of Jinga, Entebbe where the international airport is located; and other major cites such as Tororo and Bonbo. The climate of the highlands is relatively cool throughout of the year, providing suitable living environment. The area is relatively populated even in the outskirts of cities. The potentiality of commercial and tourism development is high, and the area is expected to grow further.

This report was prepared to explain intermediate outputs during the processes of topographic mapping at a scale of 1/50,000. Topographic maps, aerial photographs, results of control point surveys and other output will be useful for development and conservation of the region and used for other planning and researches. At the same time, we hope that this report will be useful for using the output.

Outline of Work

2 – 1 Ugandan Government Request and Scope of Work

2-1-1 Background of Request

The Government of the Republic of Uganda, considering that the Topographic Mapping is the most important basic study for preparation of social infrastructures related to urban and district developments and for preservation of national lands, requested under the Topographic Mapping of Kampala and Jinja Blocks, North of Lake Victoria to Japan in January,1992, for reasons as follows.

(1) The study area adjoining the northern coast of Lake Victoria is a very important for district economical development, because it includes such major cities as Kampala, Jinja and Tororo, as centers of political activities, and because their surroundings have formed a major agricultural production area in Uganda.
(2) The Government of Uganda has earnestly promoted many kinds of projects related to the urban development plan and the industrial development plan as well as the agricultural rehabilitation plan and the road rehabilitation plan in this area based on "REHABILITATION AND DEVELOPMENT PLAN 1993/94 ~ 1995/96"
(3) The current 1/50,000 topographic maps, which had been prepared 30 years ago by air-photographs taken from 1948 to 1962, were too old to be applied for making plans for recent development or the preservation programs as fundamental planning data for the reason that contents of the maps have remarkably changed by a lapse of the 30 years.

2-1-2 Requested Work and Agreement on Scope of Work

In response to the request, Japan International Cooperation Agency (hereinafter referred to as JICA) dispatched the Preliminary Study Team to Uganda from 20th February to 23rd March 1994. During this time, field survey and technical discussion were carried out with Surveys and Mapping Department, Ministry of Land, Housing and Urban Development which was renamed to Ministry of Land, Housing and Physical Planning (hereinafter referred to as "SMD"), and the Scope of

Work was signed on 16th March, 1994.

The request of the Ugandan Government called for the Topographic mapping of Kampala and Jinja Blocks, North of Lake Victoria (hereinafter referred to as "the study") at a scale of 1/50,000. Consequently, the Japanese mission discussed the scope of work with SMD officials in Uganda specifically in terms of the area to be covered, technical specifications for surveying, flight plans for aerial photography, applicable map symbols, etc. and agreement was made in forms of the Scope of Work and Minutes of Meetings on the Scope of Work. Before the start of the full scale surveying, a preliminary field survey was conducted mainly to study the status of existing control points.(See Attachment-2)

2-2 Work Plan and Implementation

2-2-1 Spesifications

(1) Aerial photography : Scale of 1/60,000 (by super wide angle camera)

(2) Control point survey : 10^{-5} (relative accuracy)

(3) Leveling

a. Limit of reciprocal observation for minor order leveling:

$$5\text{cm}\ \sqrt{S} \qquad S : \text{km}$$

b. Interval of Bench marks for minor order leveling: 2km

(4) Mapping

a. Projection : UTM

b. Ellipsoid : Clarke 1880

c. Sheet lines : 15' X 15' in longitude and latitude

d. Contour interval : 20m

e. Number of color: 5 color

(5) Map accuracy :

Based on the mapping specifications as set forth in the Specifications of Overseas Surveying of JICA.

2--2--2 Work Plans

Based on S/W, the topographic mapping of the Topographic Mapping of Kampala and Jinja Blocks, North of Lake Victoria was planned as a four year project starting from 1994 and the work plans for the respective years are outlined below.

1. First Year

Work in Japan : Planning/preparation
Report writing

Work in Uganda :

Aerial signalization 4 existing control points
Aerial photography 1/60,000 in scale,
approx. 29,000 km^2 in area,
approx. 750 photos
Control point survey 56 newly set points
on land, of which 56 monumented

2. Second Year

Work in Japan : Planning/preparation
Aerial triangulation 720 models
Report writing

Work in Uganda :

Minor order leveling 80 km
Pricking; 56 new control points
existing level routes 272 km
minor order leveling routes 950 km
Field verification 28,000 km^2 (except lakes / swamps)

3. Third Year

Work in Japan : Planning/preparation
Plotting 28,000 km^2 (40 map sheets)
Compilation 28,000 km^2 (34 map sheets)
Report writing

Work in Uganda :

Field completion 28,000 km^2 (except lakes / swamps)

4. Fourth Year

Work in Japan : Planning/preparation

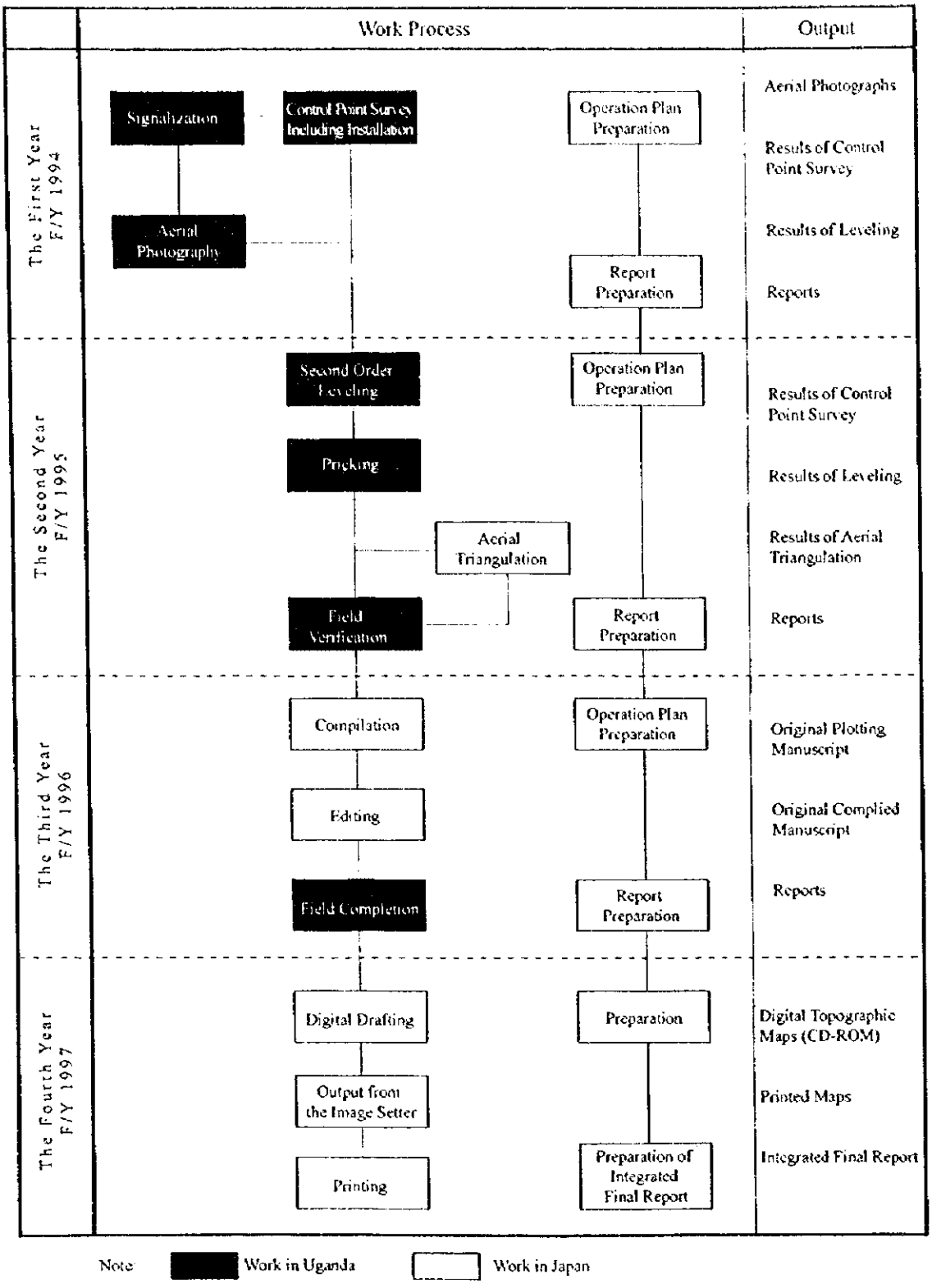
Scribing/drafting 28,000 km^2 (40 sheets)

Printing 5 colors, 1,000 copies each map sheet

Final report writing

The work flow over the four years is shown in Table 1.

Table 1. Flowchart for the Production of Topographic Maps



2 – 2 – 3 Implementation of Work Plans

The Work Plans for each year were implemented respectively as follows.

1. First Year

   1) Work period : From Nov. 28, 1994 to March 28, 1995

   2) Field surveys : From Dec. 6, 1994 to Feb. 18, 1995

   3) Numbers of personnel mobilized in field surveys:

   15 JICA survey team members and

   5 SMD counterparts

   4) Work planned and actually performed

Work Process	Planned	Actual
Signalization	4 points	5 points
Aerial photography	29,000 km^2 750 photos	29,000 km^2 866 photos
Control point survey (monumentation)	56 points 56	57 points 57
Report writing	30 copies	30 copies

2. Second Year

   1) Work period : From Aug. 17, 1995 to Mar. 29, 1996

   2) Field surveys : From Sep. 3, 1995 to Dec.1, 1995

   3) Numbers of personnel mobilized in field surveys:

   16 JICA survey team members and

   8 SMD counterparts

4) Work planned and actually implemented

Work Process	Planned	Actual
Minor order leveling	272 km	320 km
Pricking Control point Existing bench Minor order level	 57 points 272 km 950 km	 57 points 320 km 950 km
Field verification	28,000 km^2	28,000 km^2
Aerial triangulation	720 models	720 models
Report writing	30 copies	30 copies

3. Third Year

1) Work period : From Aug. 22, 1996 to Mar. 28, 1997

2) Field surveys : From Sep. 28, 1996 to Dec. 26, 1996

3) Numbers of personnel mobilized in field surveys:

11 JICA survey team members and

6 SMD counterparts

4) Work planned and actually implemented

Work Process	Planned	Actual
Plotting	28,000 km^2 (40 sheets)	28,000 km^2 (40 sheets)
Compilation	28,000 km^2 (40 sheets)	28,000 km^2 (40 sheets)
Field completion	28,000 km^2	28,000 km^2
Report writing	30 copies	30 copies

4. Fourth Year

1) Work period : From Sep.4, 1997 to Mar. 25, 1998

2) Work planned and actually implemented

Work Process	Planned	Actual
Scribe drawing	28,000 km2	
Digital drawing		28,000 km2
Printing	40 sheets 1,000 copies each	40 sheets 1,000 copies each
Report writing	40 copies	40 copies

2-2-4 Ugandan counterparts' visits in Japan

In the course of this mapping project, the following four Ugandan officials of SMD were in Japan as part of technology transfer program

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Name	Position	Period of Visit
Ms. Nabuma Margaret	Cadastral Section	45 days from Feb.15, 1996 to Mar. 30, 1996
Mr. Bwogi Justin	Asst. Commissioner	40 days from Mar. 5, 1997 to April 13,1997
Mr. Natalima Charles Ms. Kabahuma K. Beatris	Cartography Section Cadastral Section	39 days from Jan. 8, 1998 to Feb. 15, 1998

2 – 3 Outline of Fourth Year Work

While the contents of work performed each year from the First through Third Years are recorded in detail in the Reports submitted for the respective years, the work conducted for the fourth year is outlined below.

The surveys and Mapping Department of the Government of Uganda requested a change of drafting from the analogue scribing to digital drafting. The request was accepted and the work was conducted.

2 – 3 – 1 Outline

The forth-year work, according to the S/W, was supposed to be analogue scribing to produce the five-color printing maps using the original manuscript produced during the previous year. After the commencement of the work, the Surveys and Mapping Department of Uganda initiated an updating project of topographic maps and cadastre data editing project "CAMPUS Project" with a support by French government. As the department was rapidly computerized, the Surveys and Mapping Department requested changes in the specification: the scribing method of drafting was changed to the digital method – the original manuscript is scanned and used as a base map to traced and finalized by using drawing software. The request was accepted and the work was conducted.

2 - 3 - 2 Work Plan

The work for the fourth year was performed as planned as follows.

Work	Period
Preparation (scanning):	Early May, 1997 - Late May, 1997
Digital drawing :	Early June, 1997 - Late September, 1997
Checking of output :	Early October, 1997 - Late October, 1997
Checking by SMD :	Late October, 1997 - Late February, 1997
Checking by trainees :	Middle February, 1998 - Late February, 1998
Printing :	Middle March, 1998 - Late March, 1998
Report writing :	Early March, 1998 - Late March, 1998

2 - 3 - 3 Specifications

1) Map symbols

Map symbols and marginal information were based on the East Africa Specifications in principle as agreed upon with SMD. They were basically the same as applied in the topographic mapping of Southern Kenya and Tanzanian Mapping Project conducted by JICA recently.

2) Number of colors

The number of colors used and color separations were as follows

Black - Marginal information, annotation, grid lines, villages, double-line roads, boundaries, vegetation symbols

Red - Main track, foot paths, paved roads, boundaries

Blue - Rivers, swamps, annotation for water area, water surface Riparian vegetation

Green - Vegetation, forest boundaries

3) Number of map sheets

40 sheets

4) Number of drafting plates

5 color plates

5) Number of printed copies

1,000 copies each of 5- color map sheets.

2 – 3 – 4 Preparation of draft originals

The original plates for printing were prepared not by the color separation conbined negatives, but by using a newly available drawing software and a personal computer which utilized scanned original compilation manuscript. The work was conducted in accordance with the graphic and its application standards, and the base layer was traced as the operator classified color and shapes according to the geographic feature that were organized in separate layers.

Power Macintosh, a desk top personal computer, and Illustrator Ver.5.5, drawing software, were the system used. The work flow is as follows:

1) Contour scribing

For the contour lines, the scribing method was used. This is to eliminate the process of on-screen tracing (digitizing) and to minimize input error. The original compilation manuscript was print on the scribe sheets and the work of scribing was conducted. Diazo sensitive liquid was applied to the scribe sheets and the conventional method of contact print was conducted.

The scribed contour lines were digitally scanned, the raster data was converted to vector data. After the conversion, distortion and other errors were corrected and saved as the contour lines data

2) Preparation of neat-lines and grid data

Latitude / longitude, neat-lines, and UTM grid data for each map were produced using a GIS software (ARC/INFO) separately for accuracy.

3) Preparation of symbols and marginal information

Symbols and marginal information data were produced using drawing software, and thr common marginal data was inserted to the neat-lines and grid data.

4) Annotation data

All annotation data was typed and stored in a text format. During the process of the interactive editing, annotation data was placed in graphic files.

5) Scanning of compilation manuscripts

The compilation manuscripts were scanned and saved as a raster data in the Illustrator EPS format. Electric errors in the scanner and other errors, during the scanning process, such as distortion and scale error, were adjusted and corrected. Only error corrected images were used as the base maps.

6) Interactive Editing

Each data was retrieved as it was classified in layers in a file of the drawing software.

According to the specification of symbols and lines, the raster base maps were traced, digitized, as the data was further separated into finer layer.

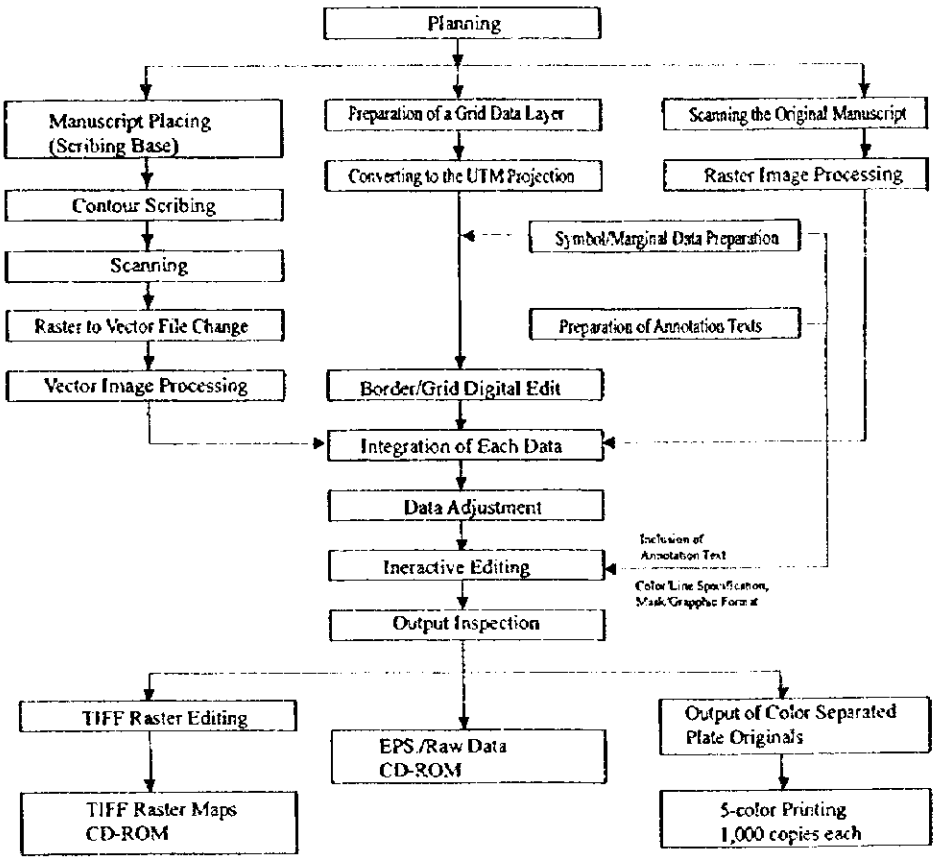
7) Inspection of output

After the interactive editing, the data was printed using color plotter. The contents of the output was inspected. The inspection was conducted during the stay of the trainees from Uganda.

8) Original film output for printing plate making

The film output for final printing plate making was prepared using the inspected and edited maps. The output was to a positive film by an image-setter for high resolution DTP (desk top publishing) with a laser exposure devise at a resolution 3,500 dpi.

Digital Drawing Flow Chart



2－3－5　Printing

Final topographic maps were printed by flat bed offset printing.

1) Preparation of film for plate making

The positive films for plate making were generated 6 sheets for each map sheets. The red mask administrative boundary layer was separated from other red layer plate for its over printing work on same color.

2) Printing Plates

From the positive film, printing plates for the respective colors were made photographically using aluminum PS plates.

3) Proof prints

From the printing plates as made above, proof prints were made by an automatic offset proof printing machine.

4) Proofing

The proof prints were checked for the quality of coloring and matching. Defective sheets in matching were corrected and remade. Colors were checked by test printing sheets by SMD in Uganda.

5) Printing

Printing paper was chosen for physical properties best suited for map printing in terms of representation and endurance. High quality printing ink was used that had good color tones least subject to change.

6) Inspection

Each printed map sheet was checked for any presence of smears from printing, blurs, missing lines, matching, color tones, and all. Those that passed such rigorous inspection alone were adopted as final products.

7) Preparation of integrated positive film

One integrated positive film output each was made for the respective colors for the convenience of future plate making in Uganda.

3. Technical Report

3 - 1 Survey Planning

3 - 1 - 1 Objective

The purpose of the survey was to study the present status of the Topographic Mapping of Kampala and Jinja Blocks, North of Lake Victoria, which was identified as a priority region for development, and to prepare the topographic maps of the region for multiple applications in national development projects and administrative planning. By taking aerial photography of an area of some 29,000 km^2 of the region at a scale of 1/60,000, and based on the aerial photos, topographic maps were to be prepared at a scale of 1/50,000. Namely the required surveys called for:

1. Aerial photography of approx. 29,000 km^2 at scale of 1/60,000.
2. Topographic mapping of approx. 28,000 km^2 at scale of 1/50,000.

Simultaneously, through this project, technology transfer of map making in general to Tanzanian counterparts was to be accomplished to promote close exchange between the two countries.

3 - 1 - 2 Study Area

The study area that includes the northern coast of Lake Victoria, is defined by 0 00'N – 1 00'N in latitude and 31 30'E – 34 30'E in longitude encompassing some 29,000 km^2. The area covers Kampala of captal and the other main cities. And also covers the Districts of Mpigi, Masaka, Mubende, Luwero, Kamuli, Jinja, Iganga, Tororo, and Mubale.

3 - 1 - 3 Survey contents

For the purpose of this project, the following surveys needed to be conducted.

1) Aerial signalization

Prior to the commencement of aerial photography, existing control points were to be signalized to ensure accuracy of locations in aerial triangulation.

2) Aerial photography

By using an aerial camera with a super wide lens of about 9cm in focal length, an area of about 28,000 km^2 that needed to be covered for topographic mapping was to be photographed at a scale of 1/60,000.

3) Control point survey

Control points were to be newly set up as required for aerial triangulation and plotting. Some of them should be monumented to be preserved as permanent national assets. Locations should confirmed on the photos by pricking.

4) Minor order leveling

Minor order leveling was to be conducted along some other existing roads which were lack of existing bench mark to establish additional control for control of aerial triangulation.

5) Pricking

New control points as well as existing and newly set bench marks were to be pricked at their precise locations on enlarged photos.

6) Aerial triangulation

Aerial triangulation of the study area was to be conducted based on independent models and block adjustments.

7) Field verification

Field survey was to be conducted to verify on-site aerial photo interpretations performed in reconnaissance to conform with the specifications. The survey should cover the entire study area to collect data for keys for interpretation, selection of features to be represented, items for annotation, etc.

8) Plotting.

Based on the results and findings of aerial triangulation, field survey, existing control points and minor order leveling, plotting of topographic details was to be conducted in 40 map sheets by using a precise stereo plotter.

9) Compilation

Compilation should produce 1/5000 scale compilation manuscripts for 40 map sheets based on plotted manuscripts.

10) Field completion

Field completion should be conducted in the field for clarification of questions, unclear matters, changes over time that could occur in the course of plotting and compilation, and the findings were to be incorporated to produce correct original maps.

11) Digital drafting

Draft originals were to be made for each color by digital drafting instead of scribing so as to produce 5-color printed sheets on which original maps were to be based.

12) Printing:

Final maps were to be printed in 5 colors by offset printing machine in 1,000 copies for each map sheet.

Work volumes for the respective processes were as listed in Table 2.

Table 2 Yearly Work Schedule and Volumes

Year	Job classification	Work volume	Remarks
First Year			
1994	Signalization	5 existing control points	
	Aerial photography	Scale: 1/60,000 21 courses, approx.3,550 km 866 photos	Super-wide angle camera
	Control point survey	57 points, GPS observation 57 points monumentation	
	Reporting	Yearly report	
Second Year			
1995	Leveling	Minor order leveling: 320 km	
	Pricking	New control points: 57 Existing BM: 950 km Leveling: 320 km	
	Field verification	28,000 km^2	Excluding lake water
	Aerial triangulation	720 models	
	Reporting	Yearly report	
Third Year			
1996	Plotting	28,000 km^2 40 sheets	
	Compilation	- ditto -	
	Field completion	28,000 km^2	
	Reporting	Yearly report	
Fourth Year			
1997	Digital drafting	28,000 km^2 40 sheets	
	Printing	1,000 copies each	
	Reporting	General report	

* The figures of volume shows the actual implementation volumes.

3 - 1 - 4 Outline of Study Area

1) Topography

The study area is surrounded by the East African Rift Valleys which caused the formation of Lake Victoria with an altitude of 1,134 meters. The hilly areas about 1,400 meter high occupies the eastern part of the study area. At the southern border, the Elgon Mountain (4,730 meter), one of the volcanoes, is located. Other than the mountain, the highland area's average altitude is about 1,200 meters.

The Victoria Nile river (the origin of the Nile river) flows to the north from the center of the Lake Victoria through the Rosebery and Buvuma vanals to the Kiyoga lake. The average altitude of the study area is about 1,000 meters. The study area's northern parts are lower than the southern parts.

2) Climate and soil condition

The eastern part of the study area are in the highland climate and others are in the Savanna climate. Despite the fact the area is on the equator, the temperature are relatively low in the morning and evening throughout of the year.

The equatorial-low-pressure front shifts to the north in the summer of the northern hemisphere and to the south in the winter. During the months from March to May, the rainfall is heavy, and the months of November and December, there are some rain due to the south-eastern trade wind. In the highland area around Kampara and Tororo, the cloud development tended to take place and the amount of precipitation is higher than of the inland areas. The trend of rainy seasons is becoming unstable due to the global climate changes.

Land is mostly covered by red-colored ratelite, but in the northeastern region toward the Elgon mountains, soil is black and fertile.

3) Land use

The climate of the coastal area around the Lake Victoria is relatively cool, and land suitable for agriculture is available. Built-up areas and village are concentrated outskirts of capital of the nation, Kampala. The belt of villages spread to the western foot of the Elgon mountain, forming the biggest belt by the largest number of village in the country. It is said that the southern part of the Uganda has relatively high rainfall of about 1,300 mm in a

year; therefore, year-round agricultural production is said to be possible. Agricultural production around village are banana, maize, cassava which are considered as the stable food, and supplementary, sugar canes and peanuts are grown. Cash corps such as coffee and tea also produced. Paddy rice are grown on alluvial deposits, and cotton is grown in the eastern central region. Coffee and tea area grown in highland areas at around 1,500 meters in altitude, and pasture land is recognized.

4) Transportation

The overall level of road development is not high, but the major arterial roads along the coast of the Victoria Lake has been repaired and other major roads have been repaired. Recently, local roads are being improved, and the traffic is becoming heavier.

A railway lline traverse the country from Kenya, an adjacent country, to Tororo expand to Kasese. There is another line from Tororo to northwest to Pakuwachi.

The international airport is located within the study area. There are twelve local airports in the country.

3 - 1 - 5 Work Plans

This survey project was planned as a four year project starting from November 1994 to March 1998 and yearly work volumes were set as shown in Table 2.

1. First Year (fiscal 1994)

(1) Aerial signalization

In order to ensure planimetric accuracy, existing first order control points are to be signalized for aerial photography.

(2) Aerial photography

The entire study area of 29,000 km^2 is to be airily photographed with a super wide lens camera at a scale of 1/60,000.

(3) Control point survey

In order to ensure accurate aerial triangulation, control points are to be newly set up where existing planimetric control is not sufficient. Geodetic coordinates should be determined by differential GPS observations using multiple units of GPS receivers. Some of the new control points should be monumented.

2. Second Year (Fiscal 1995)

(1) Minor order leveling

Insufficient existing bench marks in the study area are, requiring minor order leveling to be performed along other existing roads to set up additional control points.

(2) Pricking

Newly set control points as well as existing and new bench marks should be identified by pricking on enlarged photos.

(3) Aerial triangulation

Based on the pricking results of control points, aerial triangulation is performed covering the entire study area. Block adjustment computations based on independent models are made.

(4) Field verification

Such features, boundaries, and geographical names which need to be represented but not clearly identifiable on the aerial photos are verified on site in accordance with the specifications and the findings are entered on the photos along with other information as they are made in the field.

3. Third Year (Fiscal 1996)

(1) Plotting

Based on the results of control surveys, field verification and aerial triangulation, the 28,000 km^2 study area is plotted by a plotting machine at a scale of 1/50,000.

(2) Compilation

Based on the field survey results and the plotted manuscripts, compilation manuscripts are prepared at a 1/50,000 scale for the 40 map sheets in conformity with the map symbol application rules.

(3) Field completion

Field completion is undertaken to address questions and unclear matters that might arise in the course of detail plotting and compilation as well as to incorporate changes that have taken place after aerial photography. Place names and administrative boundaries to be represented are checked with Tanzanian officials for their approval. Based on the findings of field completion, the compilation manuscripts are corrected accordingly and made into compiled draft maps.

4. Fourth Year (1997)

(1) Digital Drafting

Based on the compiled draft maps, positive films output by digital drafting data are prepared to make printing plates for 5 color printing. The digital drawing method by computer is applied. For the convenience of plate making and printing, original data are integrated in one composite positive film for each color.

(2) Printing

From the composite positive output made by digital map data, printing plates are made photographically. Printing of 40 sheets of 1/50,000 topographic maps in 5 colors is done by offset printing. 1,000 copies are printed for each map sheet.

5. Implementation

The survey work was conducted nearly as planned following the work flow as shown in Table 1 and completed in March 1998.

3 - 2 Aerial Signalization

3 - 2 - 1 Outline

5 existing first and second order control points were selected and signalized for aerial photography.

3 - 2 - 2 Signalization

A total of 5 points including 2 existing first order control points and 3 second order control points were signalized. All signals were identified on the photos. Most of the first order control points that were signalized had their monuments damaged or missing but by referring to data on reference points as listed in the point descriptions, they were signalized nearly at their precise locations. (Figure 1)

3 - 2 - 3 Shape of aerial signals

The shape of aerial signals is 3-winged in principle with each wing being rectangular measuring 5m x 1.5m. Depending on the surrounding situations, the shape was distorted or exposed rocks were used for signal. Some signals are drawn on exposed rocks with white paint and at others, small rocks and timber blocks from felled trees were brought in and laid out on the ground in the specified shape and painted in white.

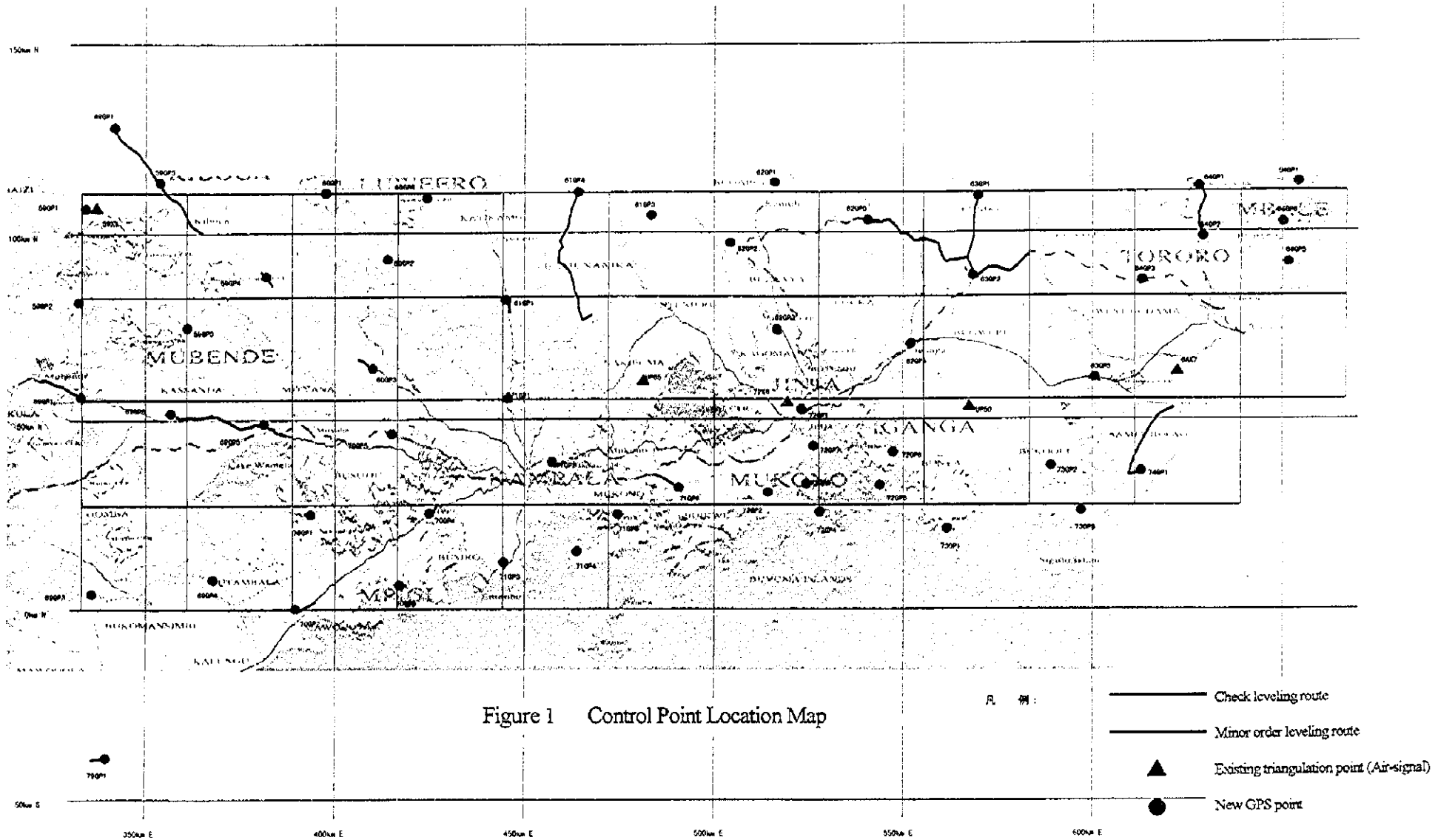


Figure 1 Control Point Location Map

3 - 3 Aerial Photography

3 - 3 - 1 Outline

PHOTOMAP INTERNATIONAL LTD., a Nairobi, Kenya, based air survey company, was contracted to undertake the aerial photography.

3 - 3 - 2 Photographic flights

1) Flight plan

A flight plan was made on the existing map which was originally 1/50,000 in scale but compiled into a 1/200,000 scale. Considering that the study area include the complicate lake shore-lines and the highland area at the foot of Mount Elgon, flight courses were planned partially with 80% overlap to make it easier for selection of better models for this portion, and furthermore, supplementary courses were also planned.

2) Air base

The aircraft was based at Entebbe Airport which is in the central part of the study area.

3) Aircraft and aerial camera

Aircraft :	Piper Navajo PA31 twin engine turbo charged
Aerial camera :	Wild RC-10 with a super-wide angle SAG-II (88mm)

4) Navigation system :

Teledyne Ryan Doppler
Sperry C-12 Compass System

5) Photographic film : Kodak Double X Panchromatic Aerographic Film 2405

6)Printing paper : Kodacrom II RC

7) Implementation

The planned courses were flown at an altitude of 5,400m with the datum plane set at 1,200m during the period of early January 1995 to late January 1995. The period

happened to coincide with a short rainy season but fortunately the clouds were not so much as to hamper photo taking which was made between clouds.

7) Photo processing and checking

Photographed film was taken immediately to photo section in SMD for development and printing. The resulting photos were checked for the following.

a) Adequacy of overlaps and side-laps

b) Cloud volume

c) Deviation from planned courses

d) Tilts of photos

e) Mist volume

Due to frequent occurrences of clouds particular to the rainy season, a planned course sometimes had to be flown in broken segments.

8) Results

The work accomplished the following (see Table 3):

Number of courses flown : 40 courses

Number of photos taken : 866 sheets

The courses were flown nearly on the planned routes, as seen in the Flight Index Map (Figure 2). Only those selected from among the 866 photos taken were actually used for subsequent work processes.

9) Editing of photographed film

In accordance with the instructions from SMD, each film negative was annotated at the bottom (south side) with the name of area covered, photographic scale, date of the photo taken, which along with serial numbers starting from west and going east were printed on the final contact prints.

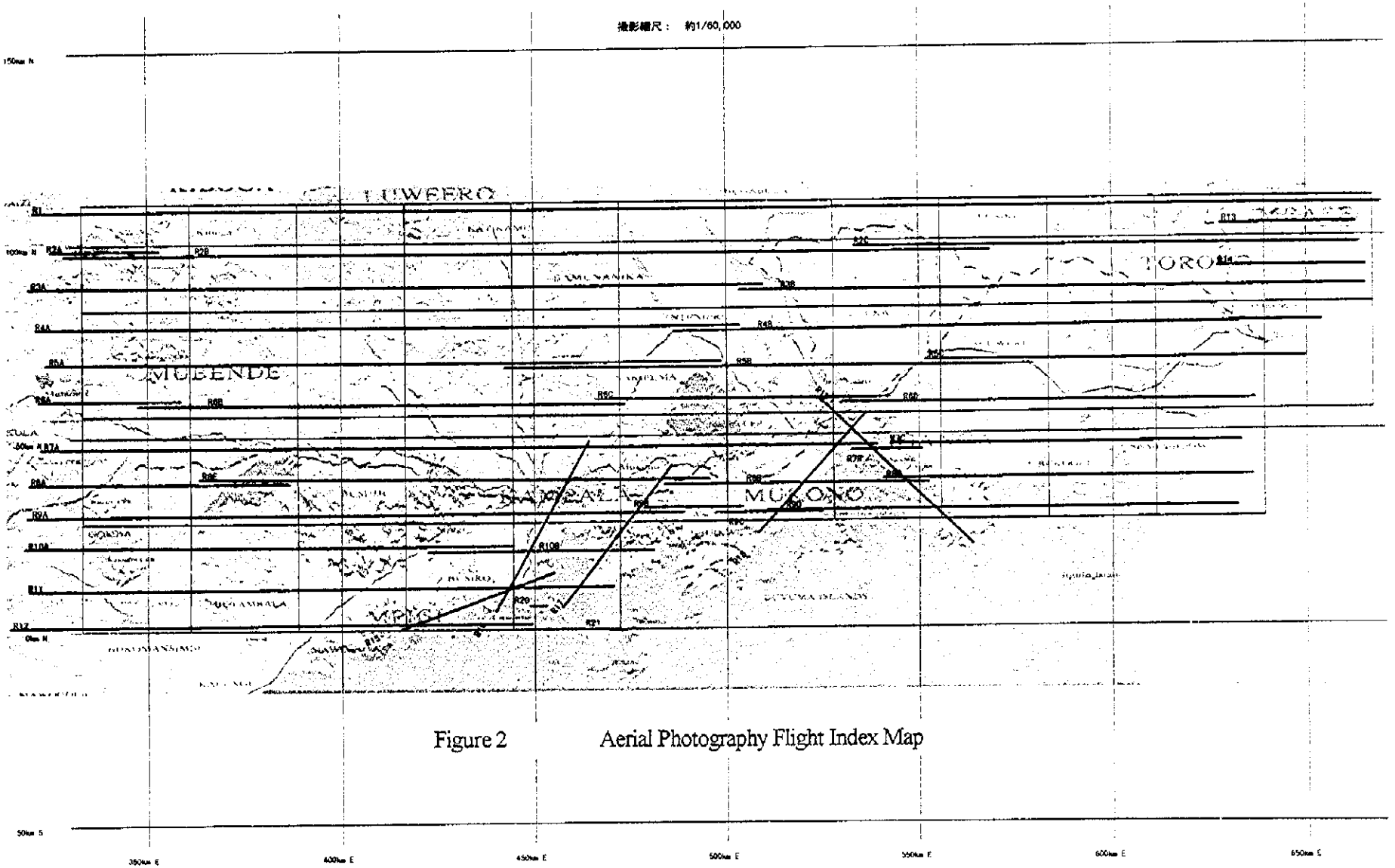


Figure 2 Aerial Photography Flight Index Map

Table 4 Aerial Photograph List

Run No	Date	Counter No.	Photo	Qty	Run No	Date	Counter No.	Photo	Qty
R- 1	Jan. 13	2333 - 2414	1 - 82	82	R- 9A	Jan. 16	2943 - 2975	33 - 1	33
R- 2A	Jan. 13	2470 - 2542	73 - 1	73	R- 9B	Jan. 19	3442 - 3448	1 - 7	7
R- 2B	Jan. 15	2739 - 2744	1 - 6	6	R- 9C	Jan. 22	3507 - 3513	1 - 7	7
R- 2C	Jan. 19	3398 - 2405	1 - 8	8	R- 9D	Jan. 17	3139 - 3162	24 - 1	24
R- 3A	Jan. 15	2747 2784	1 - 38	38	R-10A	Jan. 16	2978 - 3000	1 - 23	23
R- 3B	Jan. 22	3550 - 3582	33 - 1	33	R-10B	Jan. 17	3028 - 3039	12 - 1	12
R- 4A	Jan. 15	2699 - 2734	36 - 1	36	R-11	Jan. 17	3041 - 3069	29 - 1	29
R- 4B	Jan. 14	2579 - 2611	1 - 33	33	R-12	Jan. 17	3073 - 3098	1 - 26	26
R- 5A	Jan. 14	2614 - 2677	64 - 1	64	R-13	Jan. 13	2442 - 2459	1 - 18	18
R- 5B	Jan. 22	3584 - 3595	12 - 1	12	R-14	Jan. 13	2424 - 2440	17 - 1	17
R- 5C	Jan. 19	3407 - 3411	5 - 1	5	R-15	Jan. 19	3352 - 3361	10 - 1	10
R- 6A	Jan. 14	2683 - 2690	1 - 8	8	R-16	Jan. 12	2311 - 2321	1 - 11	11
R- 6B	Jan. 19	3369 - 3395	1 - 27	27	R-17	Jan. 19	3341 - 3350	10 - 1	10
R- 6C	Jan. 22	3603 - 3618	1 - 16	16	R-18	Jan. 22	3496 - 3504	9 - 1	9
R- 6D	Jan. 22	3527 - 3548	1 - 22	22	R-19	Jan. 22	3483 - 3494	12 - 1	12
R- 7A	Jan. 16	2858 - 2900	43 - 1	43	R-20	Jan. 22	3472 - 3475	1 - 4	4
R- 7B	Jan. 15	2792 - 2810	1 - 19	19	R-21	Jan. 21	3461 - 3647	1 - 7	7
R- 7C	Jan. 19	3421 - 3425	1 - 5	5					
R- 8A	Jan. 16	2906 - 2940	1 - 35	35					
R- 8B	Jan. 19	3424 - 3440	14 - 1	14					
R- 8C	Jan. 22	3515 - 3523	9 - 1	9					
R- 8D	Jan. 15	2812 - 2825	14 - 1	14					
R- 8E	Jan. 19	3362 - 3366	5 - 1	5					
				607					259
								Total	866

3 – 4 Control Point Survey

3 - 4 – 1 Outline

Control stations were newly set up at 57 points (see Figure 1) which were clear points on the photographs for observations by static differential GPS and geodetic coordinates necessary for aerial triangulation and plotting were determined from the analysis of vectors derived from the simultaneous observations of the existing first order control points.

3 - 4 - 2 Monumentation

Control points were selected at such locations where they were clearly identifiable and accurately pricked on the aerial photos. The material for monumentation and the size of the monuments were as follows. They were chosen for ease with which they could be handled. The monuments were built with their tops at the ground level so as not to attract too much attention of local people in an attempt to avoid vandalism.

a. Material : Aggregates and concrete reinforced by iron bars at four corners.

b. Size: 25cm X 25cm X 60cm

c. Top: Nailed with a rivet

3 - 4 – 3 GPS observation

Observations were made simultaneously at 4 points using four units of Trimble 4000SSE as receiving devices and connecting to 5 triangulation points. Figure 3 shows the combination of the observation points. These sessions of 4 points were total 31.

1) Observation

At a total of 57 newly set control stations including 5 existing first and second order control points (59X1, UP65, 72X6, UP50, 64X7). The observations took place from December 30, 1994 to January 28, 1995.

Satellites SV2, 4, 5, 7, 14, 15, 16, 18, 19, 24, 26 ,27, 29 and 31 were observed at altitudes of 15° and higher. Observation in each session usually lasted for 2 hours at one time and it was attempted to simultaneously observe 5 or more satellites in each session.

2) Processing of observed data

Satellite orbital data used for analysis were based on the boadcast ephemeris and the

quantity of session data were 1,000 to 1,400 with 30 second interval. Computations for analysis were made according to Trimble's baseline analysis program and the geocentric coordinate system that corresponds to the satellites' reference ellipsoid WGS-84. From the values of four points obtained by simultaneous observation, this analysis program computes coordinate differences between two points, or vectors, and by obtaining and examining closure differences from four side line vectors involving four points, the quality of observations can be judged. The closure differences obtained in this study were as Table 4 and the closure differences of "Block" shown on Figure 3 were as Table 5.

3) Computation

With existing control points (UP50, UP65, 59X1, 64X7, 72X6) as given and also referring leveling data of 29 GPS points, coordinate differences between two adjacent points were computed, and net adjustment was performed simultaneously fixing the coordinates of all the given points. The reference ellipsoid of satellites is WGS-84 whereas the Ugandan's is Clarke 1880. The two ellipsoids, however, have their three spatial axes parallel to each other and therefore WGS-84 based GPS observed values can be strictly dealt with in the geocentric coordinate system referred to Clarke 1880 ellipsoid. Adjustment computations were finalized by Pug-U (Universal Program for Adjustment of Any Geodetic Network), a geodetic network adjustment computation program developed by PASCO Corporation. Heights of other points than the given points were computed relative to the 29 points surveyed by direct leveling in the second year's field work.

Table 6 shows the standard deviations of finalized values for each station.

The before-mentioned two reference ellipsoids have the following dimensions respectively.

WSG-84 :	a=6,378,137.000m	1/f=298.257
Clarke 1880 : (Revised)	a=6,378,249 200m	1/f=293.466

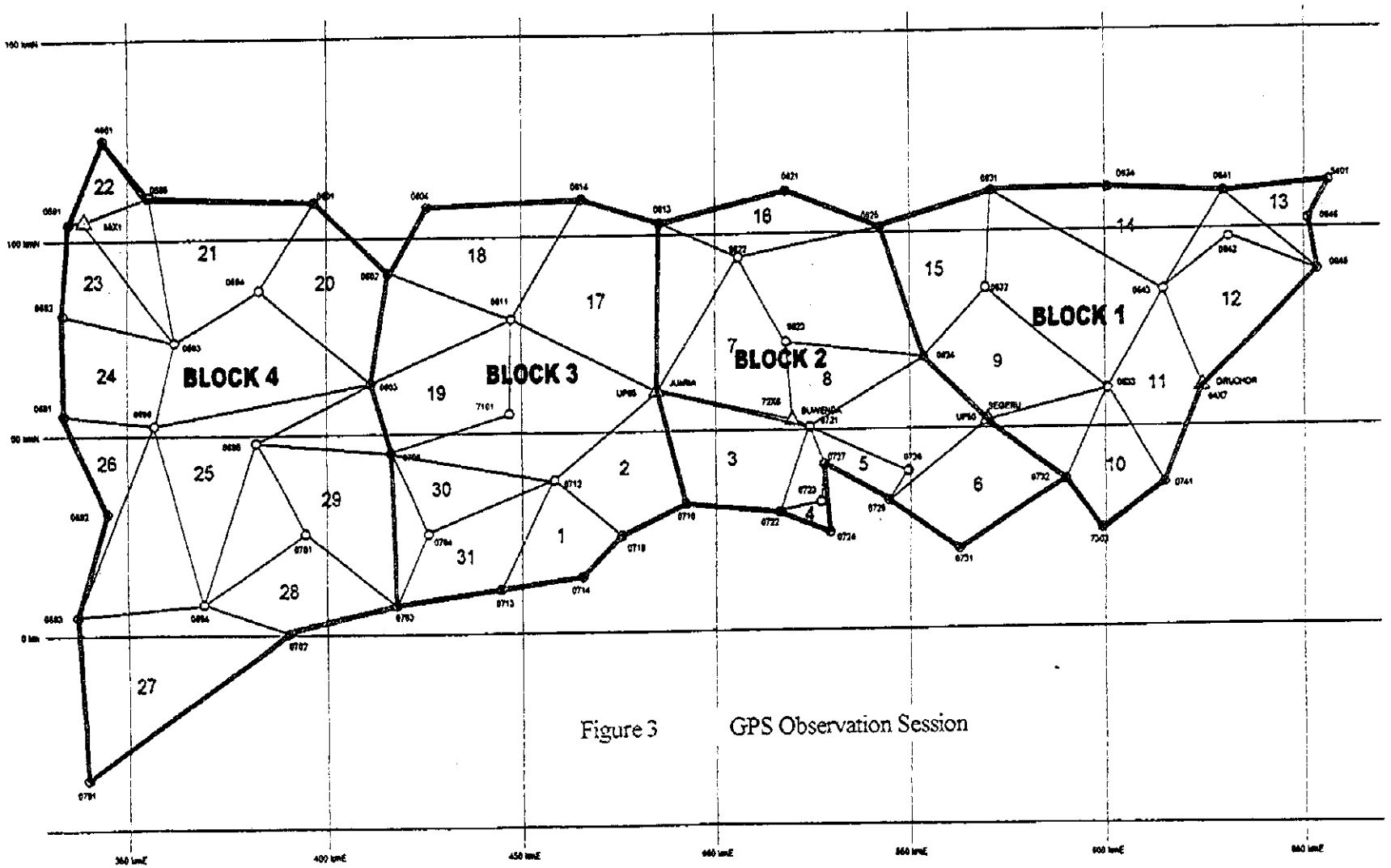


Figure 3 GPS Observation Session

Table 4 Vector Closure of GPS Observation Session

Session	Total site length (m)	Closure ratio(ppm)	Session	Total site length(m)	Closure ratio(ppm)
1	87, 724. 848	1. 8009	17	140, 475. 080	1. 0358
2	104, 817. 383	0. 0114	18	127, 374. 191	0. 0105
3	117, 728. 713	0. 7595	19	115, 012. 866	0. 8175
4	49, 421. 527	0. 0110	20	117, 770. 906	0. 0780
5	65, 880. 344	0. 0019	21	129, 578. 194	0. 6706
6	111, 301. 954	0. 0116	22	61, 725. 983	0. 0192
7	121, 272. 259	0. 0351	23	91, 001. 766	0. 0055
8	95, 105. 610	0. 0121	24	100, 936. 010	0. 0107
9	119, 107. 261	0. 0116	25	177, 293. 626	0. 0210
10	88, 152. 487	0. 0309	26	128, 540. 293	0. 0272
11	109, 913. 243	0. 0179	27	161, 919. 700	0. 3263
12	112, 769. 412	0. 1757	28	111, 312. 301	0. 0314
13	80, 716. 567	0. 0152	29	127, 960. 282	0. 0555
14	137, 693. 309	0. 0238	30	100, 032. 902	1. 0310
15	112, 026. 301	1. 1282	31	111, 809. 838	0. 0382
16	119, 117. 667	0. 0063			

Table 5 Closure of Block Site

Observed sites (BLOCK)	Δx (m)	Δy (m)	Δz (m)	Total site length (m)	Closure (ppm)
BLOCK 1(5401→0611 · · · →5401)	-0. 213	0. 022	-0. 081	323, 699. 053	0. 7083
BLOCK 2(0625→0621 · · · →0625)	0. 117	-0. 128	0. 139	343, 492. 133	0. 6171
BLOCK 3(0613→0614 · · · →0613)	0. 189	0. 255	0. 032	318, 413. 505	1. 0017
BLOCK 4(0602→0601 · · · →0602)	-0. 076	-0. 094	-0. 016	432, 245. 204	0. 2817
All BLOCK(5401→0611 · · →5401)	0. 017	0. 055	0. 074	936, 044. 094	0. 0995

Table 6-1 Standard Deviation of GPS points

St. No.	Standard Deviation			Geoid height (m)	Height above sea level
	SN(m)	WE(m)	H(m)		
59GP1	0.0319	0.0101	0.0910	7.350	1,098.12
59GP2	0.0396	0.0151	0.1102	6.235	1,398.46
59GP3	0.0336	0.0391	0.0808	5.093	1,182.53
59GP4	0.0377	0.0169		4.621	1,238.088
59GP5	0.0265	0.0337		7.122	1,141.540
60GP1	0.0391	0.0173	0.0933	6.068	1,083.42
60GP2	0.0376	0.0161	0.0763	4.671	1,079.18
60GP3	0.0362	0.0130		3.245	1,122.766
60GP4	0.0426	0.0569	0.0883	5.315	1,076.14
61GP1	0.0379	0.0155		3.744	1,137.385
61GP3	0.0383	0.0162	0.1037	3.876	1,088.07
61GP4	0.0425	0.0506		4.474	1,073.650
62GP1	0.0398	0.0181		3.543	1,064.205
62GP2	0.0239	0.0338		3.176	1,074.124
62GP3	0.0206	0.0298	0.0648	1.625	1,124.71
62GP4	0.0361	0.0485		0.573	1,152.180
62GP5	0.0429	0.0516		1.845	1,067.482
63GP1	0.0411	0.0538		1.043	1,086.523
63GP2	0.0331	0.0163		0.168	1,113.291
63GP3	0.0289	0.0385		-1.265	1,087.093
63GP4	0.0408	0.0532	0.0774	1.566	1,113.10
64GP1	0.0387	0.0514		0.759	1,150.769
64GP2	0.0314	0.0152		0.361	1,200.310
64GP3	0.0320	0.0120		-0.452	1,119.228
64GP5	0.0342	0.0183	0.0878	4.933	1,377.20
64GP6	0.0564	0.0723	0.1461	3.869	1,477.95
69GP1	0.0412	0.0174		4.859	1,283.611
69GP2	0.0121	0.0189	0.0729	3.324	1241.30

Table 6-2 Standard Deviation of GPS Points

St. No.	Standard Deviation			Geoid height (m)	Height (m) above sea level
	SN(m)	WE(m)	H(m)		
69GP3	0.0100	0.0160	0.0658	1.334	1,222.51
69GP4	0.0376	0.0434	0.0507	1.456	1,151.61
69GP5	0.0373	0.0433		3.207	1,210.882
69GP6	0.0349	0.0405		2.822	1,255.965
70GP1	0.0100	0.0459	0.0662	2.008	1,248.72
70GP2	0.0410	0.0469		1.251	1,206.045
70GP3	0.0402	0.0460	0.0668	1.091	1,138.36
70GP4	0.0435	0.0524		1.981	1,195.657
70GP5	0.0412	0.0470	0.0848	2.796	1,124.60
71GP2	0.0321	0.0340		1.975	1,155.957
71GP3	0.0463	0.0522		0.744	1,167.365
71GP4	0.0536	0.0509	0.1783	-0.024	1,151.48
71GP5	0.0263	0.0270	0.0785	0.205	1,179.94
71GP6	0.0240	0.0252		-0.046	1,210.309
72GP1	0.0260	0.0314		0.788	1,186.084
72GP2	0.0311	0.0373	0.0743	0.993	1,167.67
72GP3	0.0354	0.0422	0.0873	-1.305	1,137.44
72GP4	0.0357	0.0425	0.0885	-1.053	1,140.54
72GP5	0.0314	0.0402	0.0725	-1.474	1,134.90
72GP6	0.0310	0.0404	0.0619	0.467	1,133.41
72GP7	0.0295	0.0368	0.0589	0.378	1,307.12
73GP1	0.0410	0.0499	0.1174	1.090	1,146.46
73GP2	0.0339	0.0439	0.0676	1.186	1,170.17
74GP1	0.0340	0.0444		1.554	1,179.329
79GP1	0.0555	0.0673		0.000	1,227.798
49GP1	0.0292	0.0379		8.186	1,091.674

Table 6-3 Standard Deviation of GPS Points

St. No.	Standard Deviation			Geoid height (m)	Height above sea level
	SN(m)	WE(m)	H(m)		
54GP1	0.0565	0.0718	0.1485	4.440	1,564.33
71GP1	0.0651	0.0782		2.942	1,172.128
73GP3	0.0109	0.0535	0.0839	1.746	1,148.74
59X1			0.0729	7.277	1,144.60
64X7			0.0783	1.040	1,251.35
72X6			0.0833	0.899	1,253.97
UP50			0.0813	0.818	1,301.19
UP65			0.0472	1.755	1,175.33

Table 7-1 GPS Points Coordinates

St. No.	Latitude	Longitude	N(m)	E(m)	H(m)
59GP1	0° 56' 32"390	31° 31' 08"082	101,181.37	335,192.72	1,098.12
59GP2	0° 44' 22"391	31° 30' 15"764	81,763.47	333,566.64	1,398.47
59GP3	0° 40' 11"972	31° 45' 30"499	74,061.97	361,845.08	1,182.53
59GP4	0° 47' 23"590	31° 56' 53"391	87,312.96	382,959.37	1,238.088
59GP5	1° 00' 01"950	31° 41' 58"422	110,700.63	355,300.67	1,141.540
60GP1	0° 59' 10"772	32° 01' 23"202	109,023.03	396,869.39	1,083.42
60GP2	0° 49' 31"567	32° 14' 31"082	91,235.08	415,654.68	1,079.17
60GP3	0° 34' 08"329	32° 12' 08"833	62,889.77	411,252.94	1,122.766
60GP4	0° 58' 21"738	32° 19' 56"066	107,510.65	425,702.74	1,076.13
61GP1	0° 43' 11"944	32° 31' 39"291	79,575.34	447,434.28	1,137.385
61GP3	0° 55' 52"420	32° 52' 10"244	102,919.51	485,481.63	1,088.08
61GP4	0° 59' 11"509	32° 41' 22"571	109,032.89	465,464.91	1,073.650
62GP1	0° 59' 56"114	33° 09' 48"179	110,401.11	518,178.05	1,064.205
62GP2	0° 51' 06"710	33° 03' 15"075	94,147.99	506,029.17	1,074.124
62GP3	0° 39' 31"163	33° 09' 53"903	72,794.96	518,356.51	1,124.71
62GP4	0° 37' 07"369	33° 28' 53"755	68,382.603	553,588.33	1,152.180
62GP5	0° 51' 58"522	33° 22' 55"586	101,266.85	542,514.64	1,067.482
63GP1	0° 59' 37"794	33° 38' 14"168	109,845.07	570,901.21	1,086.523
63GP2	0° 46' 36"280	33° 37' 25"781	85,850.86	569,412.72	1,113.291
63GP3	0° 32' 27"264	33° 54' 12"283	59,788.42	600,528.63	1,087.093
63GP4	0° 55' 53"731	33° 54' 13"506	110,341.32	600,555.73	1,113.10
64GP1	0° 59' 13"016	34° 09' 57"864	109,100.29	629,746.95	1,150.769
64GP2	0° 53' 03"709	34° 10' 37"590	97,760.59	630,978.79	1,200.310
64GP3	0° 46' 07"339	34° 01' 46"702	84,971.05	614,571.08	1,119.228
64GP5	0° 48' 29"613	34° 22' 38"670	89,351.05	653,278.48	1,377.18
64GP6	0° 55' 24"751	34° 21' 25"952	102,098.63	651,020.76	1,477.94
69GP1	0° 29' 57"978	31° 30' 28"933	55,216.72	333,966.31	1,283.611
69GP2	0° 16' 28"632	31° 36' 21"050	30,360.02	344,849.34	1,241.31

Table 7-2 GPS Points Coordinates

St.No.	Latitude	Longitude	N	E	H
69GP3	0° 02'31"346	31° 32'15"065	4,647.84	337,241.76	1,222.53
69GP4	0° 04' 8"629	31° 49'19"534	7,634.53	368,916.92	1,151.62
69GP5	0° 26' 4"273	31° 56'28"256	48,031.40	382,174.62	1,210.882
69GP6	0° 28'30"086	31° 42'44"016	52,512.95	356,693.29	1,255.965
70GP1	0° 13'37"737	32° 03'07"114	25,107.97	391,502.79	1,248.72
70GP2	0° 00' 9"012	32° 00'48"381	276.70	390,213.07	1,206.015
70GP3	0° 03'49"201	32° 15'38"201	7,037.04	417,720.87	1,138.34
70GP4	0° 13'26"016	32° 20'03"396	24,746.35	425,919.25	1,195.657
70GP5	0° 24'30"747	32° 14'54"147	45,155.79	416,361.08	1,124.60
71GP1	0° 29'48"037	32° 31'19"096	51,891.60	446,807.78	1,172.128
71GP2	0° 20'30"823	32° 37'30"144	37,787.04	458,276.04	1,155.957
71GP3	0° 05'53"270	32° 30'07"034	10,845.79	444,578.33	1,167.365
71GP4	0° 07'31"223	32° 41'25"759	13,852.73	465,558.44	1,151.49
71GP5	0° 12'54"741	32° 46'47"544	23,784.71	475,505.11	1,179.94
71GP6	0° 17'01"858	32° 55'44"942	31,371.02	492,116.18	1,210.309
72GP1	0° 27'30"680	33° 13'06"725	50,676.20	524,317.16	1,186.084
72GP2	0° 15'49"732	33° 08'52"637	29,156.84	516,463.78	1,169.01
72GP3	0° 17'09"143	33° 13'00"421	31,594.87	524,122.76	1,137.44
72GP4	0° 13'07"222	33° 15'52"527	24,167.93	529,442.75	1,140.54
72GP5	0° 17'14"077	33° 24'01"395	31,746.89	544,553.71	1,134.90
72GP6	0° 21'15"755	33° 26'41"865	39,166.82	549,513.61	1,133.40
72GP7	0° 22'21"792	33° 15'06"930	41,193.37	528,032.93	1,307.11
73GP1	0° 10'41"368	33° 33'43"685	19,690.92	562,553.32	1,146.07
73GP2	0° 19'53"675	33° 48'26"922	36,649.44	589,855.20	1,170.17
74GP1	0° 19'19"937	34° 01'51"155	35,615.83	614,717.18	1,179.329
79GP1	-0° 21' 6"068	31° 33'34"122	- 38,880.60	339,689.19	1,227.798
49GP1	1° 07'42"646	31° 35'41"336	124,760.99	343,649.74	1,091.674

Table 7-3 GPS Points Coordinates

St.No.	Latitude	Longitude	N(m)	E(m)	H(m)
54GP1	1° 00'30"076	34° 24' 8"083	111,476.89	656,029.22	1,571.88
73GP3	0° 13'14"367	33° 53'23"869	24,390.00	593,035.68	1,148.74
59X 1	0° 56'52"406	31° 33'14"470	101,794.41	339,100.43	1,144.61
64X 7	0° 32'32"919	34° 07'01"457	59,966.91	624,306.66	1,251.33
72X 6	0° 28'23"708	33° 10'40"917	52,301.04	519,811.18	1,253.96
UP 50	0° 28'08"928	33° 37'38"483	51,853.17	569,809.37	1,301.19
UP 65	0° 32'38"128	32° 51'47"821	60,114.64	484,787.28	1,175.32

3－5 Pricking

The new control points and bench marks established in the first and second years were pricked at their precise locations on the aerial photos to make them serve as control points for aerial triangulation.

1) Control points

Control points were pricked at their precise locations on the 4-time enlarged photos as they were identified on site. At the same time an eccentric point for each principal point was pricked at a point clearly identifiable on the photos and its elements of eccentricity were measured. This eccentricity survey involved measurement of azimuthal angles by summary solar observations and computation of coordinates of eccentric points. Data of both principal points and eccentric points were used in aerial triangulation to ensure accuracy of their locations.

2) Existing bench marks

To provide a reference for the altitude on the topographical map, the bench marks in the district provided by the DOS (British survey body during the colonial era) were confirmed in the field based on the "Point Description" and the photographs were pricked (see Figure 4). The total length of the existing leveling route was about 950 km, but on one part of this route along the railway (approx. 50 km), the railway mile posts which are the basis for the location of the existing bench marks had been reinstalled, so that it was impossible to refer to the point descriptions and the existing bench marks could not be confirmed.

Because almost all existing points are buried approximately 50cm under the ground, it was possible to confirm only 92 existing bench marks in the study area during the field work period (see Table 8).

3－6 Minor Order Levering

To supplement the elevation control, minor order leveling was conducted for three proposed routes spanning some 84 km in total and set up auxiliary bench marks. At the same time, of the 57 GPS control points set up in the previously year, 29 points were surveyed for elevation by minor order leveling based on neighboring existing points (see Table 9), thus making the

total distance of leveling routes about 320 km (see Figure 1).

Minor order leveling was conducted by double running observations starting from an existing point to close at another existing point or the starting point with an allowable closure error set at:

Closure : within $5cm\sqrt{S}$ (S km ; length of observation route)

In addition to the three new routes as above, with respect to the existing points used as the starting points for minor order leveling of relatively long routes in addition to the three new routes as above, leveling was conducted in relation to the neighboring points to ensure their accuracy as given points.

Heights obtained from the minor order leveling were identified approximately every 2 km and pricked on the 2-time enlarged photos.

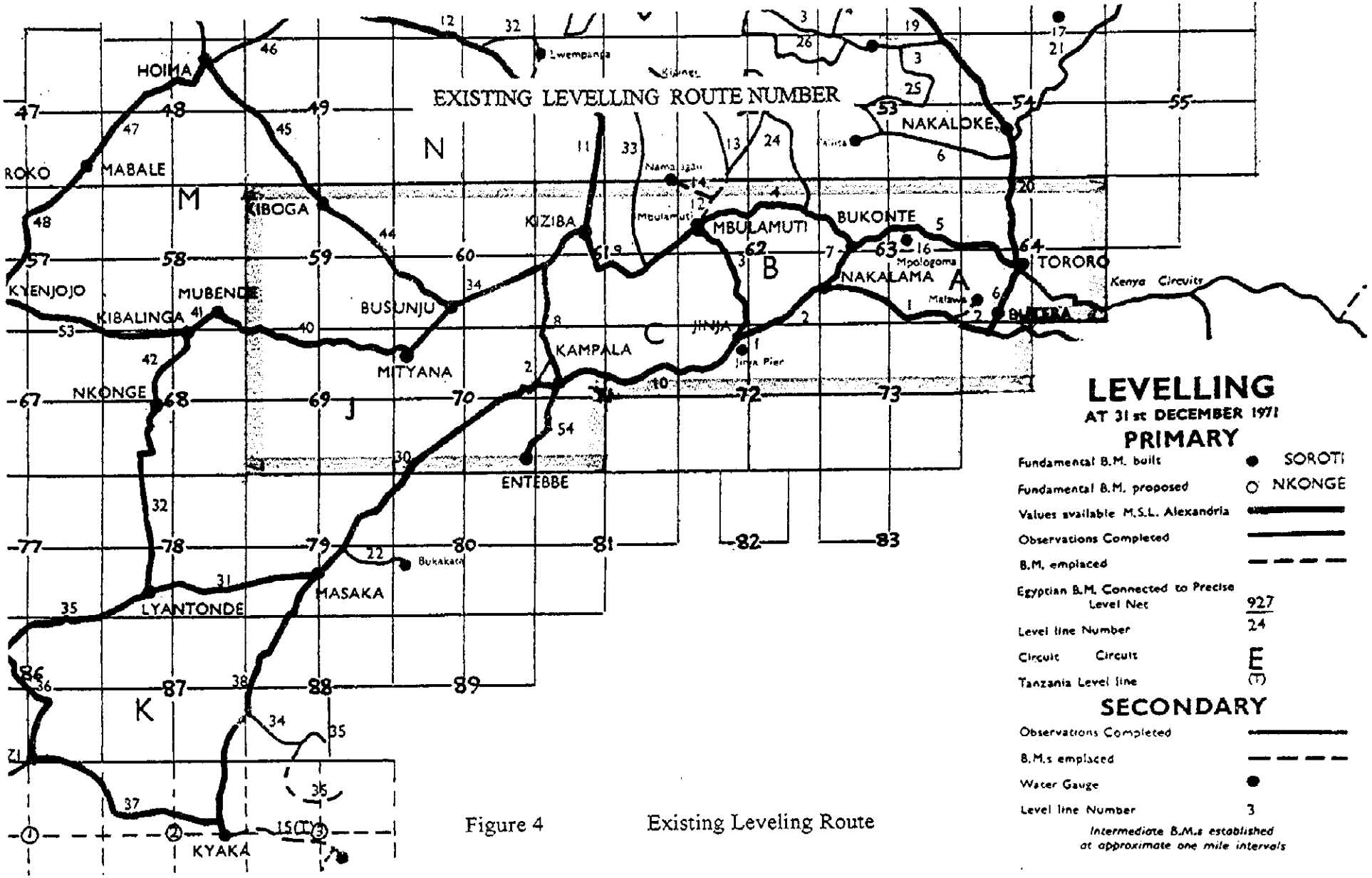


Figure 4 Existing Leveling Route

Table 8-1 Existing Bench Marks Confirmed

BM	Height(m)	BM	Height(m)	BM	Height(m)	BM	Height(m)
1/12	1,157.208	8/29	1,160.186	30/15	1,161.046	34/42	1,167.559
1/29	1,127.380	8/32	1,145.031	30/17	1,175.802	34/43	1,132.264
1/31	1,095.601	9/19	1,073.153	30/18	1,212.086	40/ 3	1,241.743
1/38	1,130.206	9/21	1,065.837	30/21	1,164.502	40/ 9	1,194.207
2/ 3	1,148.678	9/22	1,065.195	30/23	1,197.098	44/ 5	1,111.164
2/24	1,162.235	9/24	1,087.643	30/27	1,179.720	44/ 6	1,125.953
2/27	1,146.027	9/29	1,070.622	30/32	1,183.889	44/17	1,136.252
Nakalama	1,125.530	9/32	1,068.217	30/34	1,160.190	44/18	1,171.219
3/ 1	1,050.249	9/33	1,080.352	30/35	1,183.589	44/22	1,287.356
3/ 8	1,051.473	9/34	1,089.075	30/36	1,156.137	44/23	1,264.360
3/16	1,065.184	9/36	1,100.800	30/41	1,190.885	44/25	1,261.430
3/26	1,091.556	10/ 3	1,151.505	30/42	1,162.703	44/29	1,184.393
3/27	1,097.742	10/10	1,187.026	30/43	1,157.327	44/30	1,138.005
5/16	1,122.586	10/35	1,184.968	30/44	1,149.538	44/31	1,129.383
5/32	1,063.340	10/41	1,182.452	30/45	1,149.921	44/34	1,151.943
5/35A	1,068.433	10/49	1,149.828	30/47	1,166.177	54/12	1,181.067
5/42	1,121.777	Jinja	1,176.064	34/ 1	1,256.934	54/15	1,159.877
6/ 2	1,183.903	J.34	1,171.758	34/11	1,158.206	54/18	1,162.706
Buteba	1,198.895	20/17	1,172.786	34/19	1,127.252	54/19	1,176.868
6/10	1,099.264	20/18	1,176.015	34/22	1,138.706	54/22	1,151.428
6/12	1,158.532	20/20	1,156.859	34/23	1,130.662	54/25	1,147.163
6/20	1,190.692	20/22	1,184.687	34/26	1,195.717	54/26	1,184.180
6/21	1,212.742	30/ 4	1,161.041	34/27	1,169.281		
8/14	1,164.808	30/ 9	1,195.797	34/40	1,213.229		
8/27	1,192.388	30/14	1,197.774	34/41	1,158.978		

Table 8-2 Pricked Points connected with the Existing Bench Marks

Pt. No.	Height(m)	Pt. No.	Height(m)	Pt. No.	Height(m)
1/12-1	1,157.269	9/33-1	1,079.116	34/19-1	1,127.826
1/29-1	1,127.678	9/34-1	1,089.168	34/22-1	1,139.248
1/31-1	1,095.610	9/36-1	1,101.072	34/23-1	1,131.362
1/38-1	1,130.799	10/ 3-1	1,151.555	34/26-1	1,195.628
2/ 3-1	1,148.349	10/10-1	1,186.886	34/40-1	1,214.286
2/24-1	1,163.368	10/35-1	1,185.568	34/41-1	1,158.403
2/27-1	1,145.557	10/41-1	1,182.610	34/42-1	1,167.164
FBM Nakalawa	1,125.530	10/49-1	1,150.660	34/43-1	1,131.920
3/ 1-1	1,019.641	J.34-1	1,170.645	40/ 3-1	1,239.071
3/ 8-1	1,052.780	20/17-1	1,173.130	40/ 9-1	1,195.301
3/16-1	1,067.254	20/18-1	1,176.555	44/ 5-1	1,117.941
3/26-1	1,092.338	20/20-1	1,157.243	44/ 6-1	1,121.913
3/27-1	1,098.585	20/22-1	1,185.695	44/17-1	1,139.182
5/16-1	1,123.672	30/ 4-1	1,161.760	44/18-1	1,173.691
5/32-1	1,063.787	30/ 9-1	1,195.929	44/22-1	1,288.519
5/35A	1,068.433	30/14-1	1,194.140	44/23-1	1,266.873
5/42-1	1,122.591	30/15-1	1,161.626	44/25-1	1,263.924
6/ 2-1	1,183.383	30/17-1	1,176.693	44/29-1	1,183.696
FBM Buteba-1	1,198.974	30/18-1	1,212.785	44/30-1	1,134.119
6/10-1	1,099.522	30/23-1	1,197.215	54/12-1	1,181.028
6/12-1	1,159.166	30/27-1	1,180.466	54/15-1	1,160.977
6/20-1	1,191.809	30/32-1	1,184.387	54/18-1	1,162.838
6/21-1	1,213.191	30/34-1	1,161.004	54/19-1	1,179.092
8/14-1	1,164.070	30/35-1	1,185.796	54/22-1	1,152.486
8/27-1	1,191.854	30/36-1	1,159.202	54/25-1	1,146.672
8/29-1	1,154.050	30/41-1	1,190.952	54/26-1	1,184.095
8/32-1	1,145.474	30/42-1	1,164.631		
9/19-1	1,074.417	30/43-1	1,154.611		
9/21-1	1,066.543	30/44-1	1,148.939		
9/22-1	1,066.805	30/45-1	1,153.599		
9/24-1	1,087.519	30/47-1	1,167.586		
9/29-1	1,070.730	34/ 1-1	1,257.877		
9/32-1	1,068.874	34/11-1	1,159.640		

Table 9 GPS Point Heights by Direct Leveling

GPS Point(levelle	BM(origined)	Route Length(km)	Height(m)	Remarks
59GP4	44/25	2.0	1,238.088	
59GP5	44/34	25.8	1,141.540	
60GP3	44/ 5	8.3	1,122.766	
61GP1	8/14	3.5	1,137.385	
61GP4	9/36	36.1	1,073.650	
62GP1	62GP2	20.6	1,064.205	New leveling route
62GP2	3/ 1	2.7	1,074.124	New leveling route
62GP3	3/16	6.9	1,124.710	
62GP4	2/ 3	0.7	1,152.180	(Lost)
62GP5	632-2	34.4	1,067.482	Lost route of BM
63GP1	63GP2	24.7	1,086.523	New leveling route
63GP2	5/42	10.4	1,113.291	New leveling route
63GP3	1/12	5.0	1,087.093	
64GP1	20/17	7.4	1,150.769	
64GP2	20/20	2.6	1,200.310	
64GP3	5/16	0.1	1,119.228	
69GP1	FBM Mubende	17.3	1,283.611	(Lost)
69GP5	40/ 9	5.4	1,210.882	
70GP2	30/47	5.8	1,206.045	
70GP4	30/21	0.8	1,195.657	
71GP1	8/27	1.0	1,172.128	
71GP2	10/49	6.4	1,155.957	
71GP3	54/19	2.1	1,167.365	(Lost)
71GP6	10/35	11.8	1,210.309	(Lost)
72GP1	2/24	0.4	1,186.084	
74GP1	6/2	25.5	1,179.329	New leveling route
49GP1	59GP5	18.1	1,091.674	
79GP1	31/14	0.4	1,227.798	
69GP6	69GP5	33.2	1,255.965	
Watermark	54/25	0.2	1,134.418	For water level on photos

3 - 7 Aerial Triangulation

3 - 7 - 1 Outline

In aerial triangulation, coordinates of pass points, control points and tie points connecting flight courses, which were to be used for plotting, were measured by a stereo comparator using aerial photos printed on dia-positives, and then by block adjustment computations based on independent models, analytical aerial triangulation was executed to obtain orientation elements as well as the geodetic coordinates of pass points (Figure 5).

3 - 7 - 2 Work contents

1) Specifications

Photo scale :	Approx. 1 : 60,000 (flight altitude above ground : 5,400m)
Number of courses :	19
Number of models:	720
Numbers of control points :	Horizontal ; 58 Elevation ; 118 (Elevation of lake surface at the time of flight also used)
Adjustment computations:	Based on independent models (PAT M-43 program)

2) Instruments used

Pricking device :	PUG-4 (Wild)
Stereo-comparator :	Stecometer (Zeiss Jena)
Computer :	FACOM 1600/2 (Fujitsu)

3) Specifications of aerial camera

Model :	Wild-RC10
Focal length :	88mm
Lens :	SAG-11 No.2147

ウガンダ国・ヴィクトリア湖北部地形図(1:50,000)作成調査

簡易水準測量網図及び既設水準点刺針配点図

撮影縮尺　1：60,000
撮影年月　1995年1月

縮尺 1：400,000

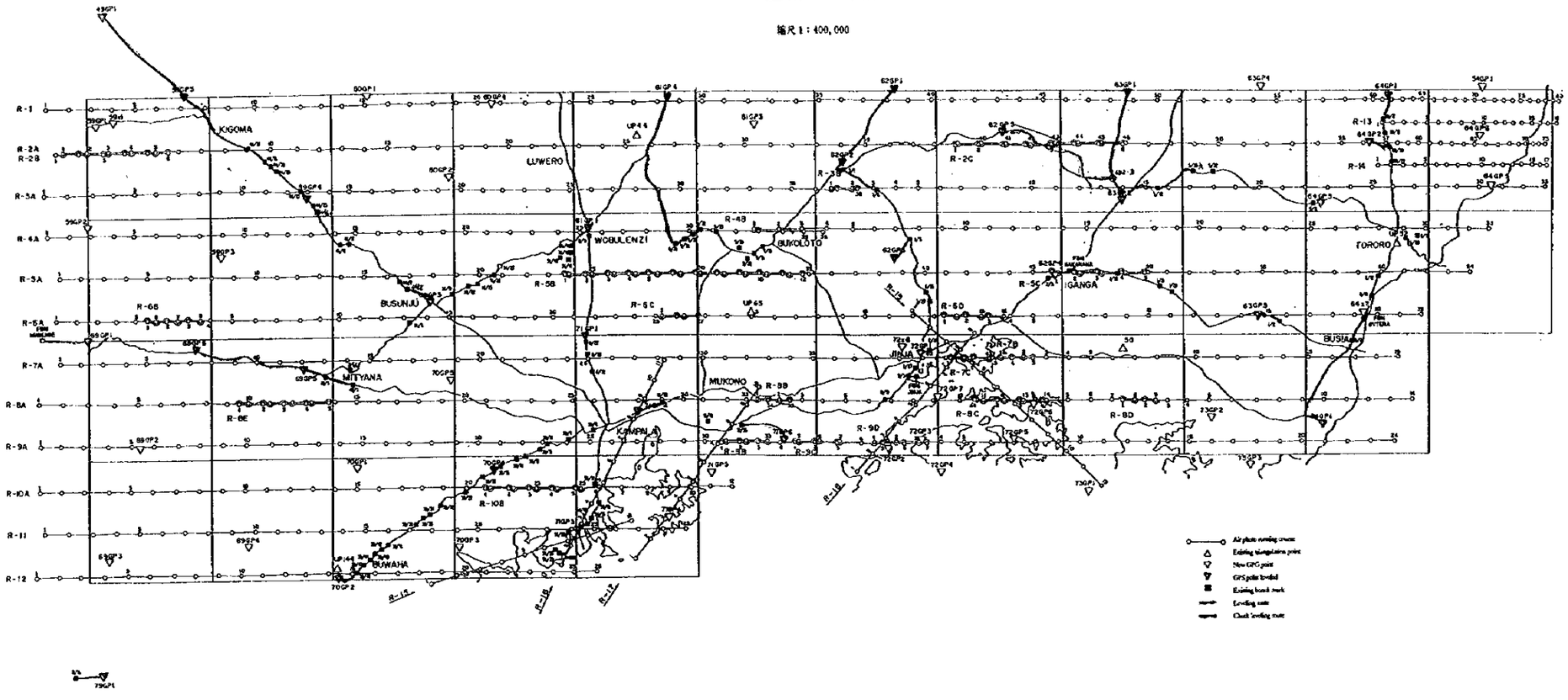
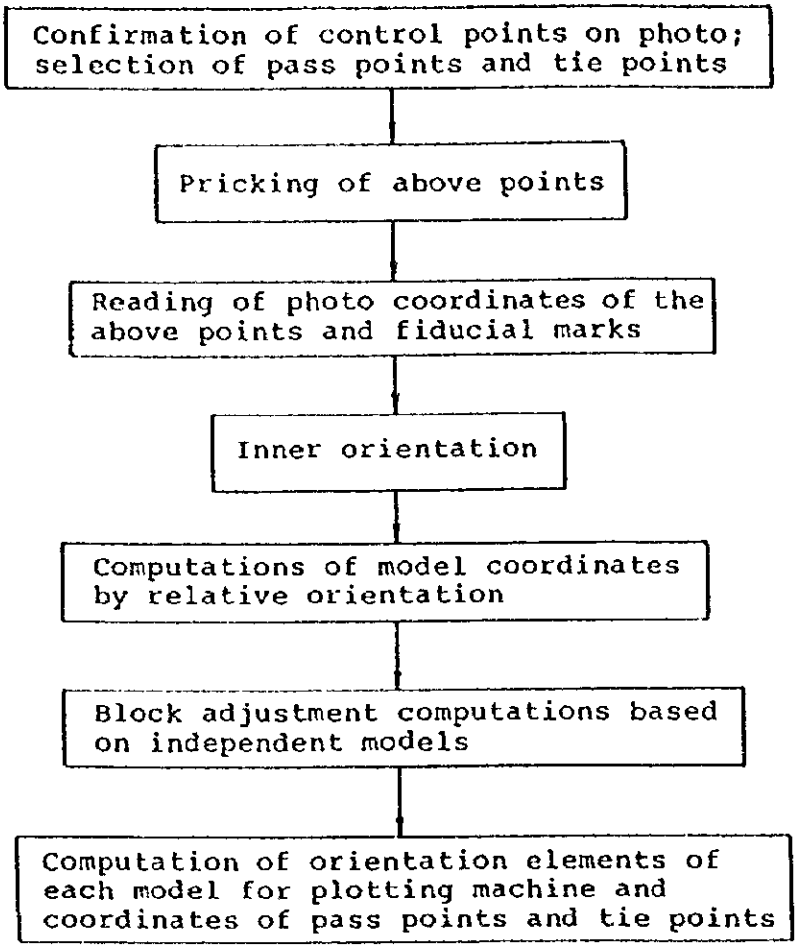


Figure 5　　Aerial Triangulation

3 - 7 - 3 Work procedure

Aerial triangulation was performed in the following procedure.



3 - 7 - 4 Work of Aerial Triangulation

Six pass points were selected in every model. The measurements for photo coordinates of geodetic control points, pass points, and tie points were performed twice independently. Tolerance of discrepancy of measurements was 0.02mm, then average values were adopted. Orientation and adjustment computations were executed within the following tolerance requirements.

Residuals of fiducial marks; 0.03 mm

Residuals of relative orientation; 0.02 mm

Discrepancies of pass points and tie points; 2.7 mm

As a result, standard deviation of control point residuals were 2.16 m horizontally and 3.78 m in elevation.

Table 11 Aerial Triangulation Models

Run No.	Execution No.	Model Qty	Run No.	Execution No.	Model Qty
R- 1	2 - 59 - 79	67	R-9A	2 - 32	30
R-2A	1 - 57 - 73	64	R-9B	1 - 7	6
R-2B	1 - 6	5	R-9C	1 - 6	5
R-2C	1 - 8	7	R-9D	1 - 22	21
R-3A	2 - 38	36	R-10A	2 - 22	21
R-3B	1 - 32	31	R-10B	1 - 11	10
R-4A	2 - 36	34	R-11	2 - 26	24
R-4B	2 - 32	30	R-12	2 - 21	19
R-5A	1 - 26	25	R-13	5 - 17	6
R-5A	33 - 63	30	R-14	10 - 15	5
R-5B	1 - 12	11	R-15	1 - 9	8
R-5C	1 - 5	4	R-16	2 - 9	7
R-6A	2 - 8	6	R-17	2 - 6	4
R-6B	1 - 27	26	R-18	1 - 7	6
R-6C	1 - 16	15	R-19	1 - 12	11
R-6D	2 - 20	18	R-20		0
R-7A	1 - 43	42	R-21		0
R-7B	1 - 18	17			
R-7C	1 - 5	4			
R-8A	2 - 35	33			
R-8B	1 - 14	13			
R-8C	2 - 9	7			
R-8D	1 - 12	11			
R-8E	3 - 4	1			
				Total	720 Models

3 - 8 Field Verification

3 - 8 - 1 Outline

Field survey involved verification of features to be represented and geographical names according to also the application rules of map symbols, and their findings were noted on 2-time enlarged aerial photographs and blue copies of existing maps.

For this purpose, the 2-time enlarged photographs with either odd numbers or even numbers were applied totaling 283 sheets of photographs..

3 - 8 - 2 Applicable map symbols

Map symbols and their application rules were determined after consultation and agreement with SMD officials responsible for map symbols based on the proposed map symbols compiled by the Study Team from the East African Map Symbols (1/50,000 Topographic Map).

3 - 8 - 3 Implementation

The survey was conducted in cooperation with SMD counterparts using 2-time enlarged aerial photos and duplicate copies of existing maps to survey the following.

- verification of geographical names and features as listed on the aerial photos in the previous survey as well as of vegetation as interpreted from aerial photos
- Road, railways, public buildings, rivers bridges, fords, wells etc.
- Existing control points
- Vegetation, terrain features
- Collection of geographical names and their verification in the field

Administrative boundaries and forest reserve were shown on the blue copies of the existing maps by SMD and handed over to the Study Team at the end of the survey.

Official names of cities and village were collected according to the data resulting from the 1991 – 1995 survey conducted by Statistics Department of Ministry of Finance and Economical Planning. The names collected of rivers and hills were entered in the blue copies of the existing maps. The rest of findings such as symbols for features, notation for facilities, vegetation symbols, etc. were shown in red ink on the 2-time enlarged aerial photographs.

3 - 9 Plotting

3 - 9 - 1 Outline

Based on the results of aerial triangulation and field surveys, geographical data and information to be represented in the topographic maps were measured and delineated by a precision plotter to produce restitution manuscripts. Plotting was done in Japan. The area to be mapped was 28,000 km^2 and the areas covered by the respective map sheets and their names are shown in Figure 6.

3 - 9 - 2 Specifications

a. Aerial photo scale :	1 : 60,000
b. Plotting scale :	1 : 50,000
c. Plotting area :	28,000 km^2
d. Number of map sheets :	40
e. Neat lines :	East-west 15' x North-south 15'
f. Projection :	UTM (Zone No.36)
g. Contour intervals :	20m
	Index line; 100m
	Auxiliary line ; 10m (on flat land)
h. Sheet used :	Polyester base #500
	Control point over-lay; Polyester base #300
	Size ; 60cm x 80cm
i. Instruments Plotters :	DSR-12/DSR-14 (Zeiss)
	Autograph-A10 (Wild)
	Stereo-Metrograph G (Zeiss)
	Aviomap AMH (Wild)
	Topocarto D (Zeiss JENA)
	Coordinategraph : XP-1100 (Daini Seikosha)

ウガンダ国ヴィクトリア湖北部地形図(1:50,000)作成調査

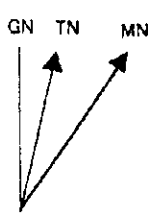
INDEX TO ADJOINING SHEETS

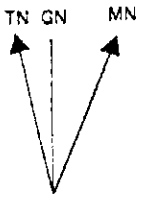
48/4 NYARWEYO	49/3 BUTEMBA	49/4 KYANKWANZI	50/3 NGOMA	50/4 KAKOGE	51/3 KABUNYATA	51/4 BALE	52/3 BALAWOLI	52/4 NAWAIKOKE	53/3 PALLISA	53/4 KAMUGE	54/3 MBALE	54/4 BUDADIRI	55/3 ELGONY
58/2 KAKUMIRO	59/1 NTWETWE	59/2 KIBOGA	60/1 WAKYATO	60/2 LUWERO	61/1 KIKYUSA	61/2 KAYONZA	62/1 KAMULI	62/2 NAMWENDWA	63/1 BUSEMBATIA	63/2 BUSOLWE	64/1 NAGONGERA	64/2 BUBULO	
58/4 MUBENDE	59/3 DEBEZA	59/4 KASSANDA	60/3 KATEERA	60/4 BOWA	61/3 BOMBO	61/4 KAYUNGA	62/3 KAGOMA	62/4 IGANGA	63/3 BUSESA	63/4 BUGIRI	64/3 TORORO	64/4 MALABA	
68/2 LUSIBA	69/1 MUSOZI	69/2 WAMALA	70/1 MITYANA	70/2 KAKIRI	71/1 KAMPALA	71/2 LUGAZI	72/1 JINJA	72/2 MAYUGE	73/1 NANKOMA	73/2 LUMINO	74/1 BUSIA		
68/4 KYAMUKAMA	69/3 MADDU	69/4 KANONI	70/3 MITALA MARIA	70/4 ENTEBBE	71/3 KAJANSI	71/4 KIBANGA PORT	72/3 BWEMA	72/4 MAGYO	73/3 DAGUSI	73/4 SIGULU	74/3 SAMIA		
78/2 SEMBABULE	79/1 KAWOKO	79/2 LUKAYA	80/1 BUNJAKO	80/2 LULAMBA	81/1 KOME	81/2 DAMBA							

Figure 6 Plotting Sheet Index (Sheet name & number)

ウガンダ国ヴィクトリア湖北部地形図(1:50,000)作成調査

磁針偏差及び真北方向角一覧表(秒単位)





1° 00' N

32° 00' E

33° 00' E

34° 00' E

59/1 NTWETWE 0° 12′ 6″ 3′ 30″ /yr 0° 1′ 16″	59/2 KIBOGA 0° 13′ 12″ 3′ 30″ /yr 0° 1′ 2″	60/1 WAKYATO 0° 14′ 18″ 3′ 30″ /yr 0° 0′ 48″	60/2 LUWERO 0° 15′ 18″ 3′ 24″ /yr 0° 0′ 34″	61/1 KIKYUSA 0° 16′ 12″ 3′ 24″ /yr 0° 0′ 21″	61/2 KAYONZA 0° 17′ 6″ 3′ 24″ /yr 0° 0′ 7″	62/1 KAMULI 0° 17′ 48″ 3′ 18″ /yr -0° 0′ 7″	62/2 NAMWENDWA 0° 18′ 30″ 3′ 18″ /yr -0° 0′ 21″	63/1 BUSEMBATIA 0° 19′ 0″ 3′ 12″ /yr -0° 0′ 34″	63/2 BUSOLWE 0° 19′ 30″ 3′ 12″ /yr -0° 0′ 48″	64/1 NAGONGERA 0° 20′ 0″ 3′ 12″ /yr -0° 1′ 2″	64/2 BUBULO 0° 20′ 18″ 3′ 6″ /yr -0° 1′ 16″
59/3 DEBEZA 0° 9′ 36″ 3′ 30″ /yr 0° 0′ 54″	59/4 KASSANDA 0° 10′ 48″ 3′ 30″ /yr 0° 0′ 44″	60/3 KATEERA 0° 11′ 54″ 3′ 30″ /yr 0° 0′ 34″	60/4 BOWA 0° 12′ 54″ 3′ 24″ /yr 0° 0′ 25″	61/3 BOMBO 0° 13′ 48″ 3′ 24″ /yr 0° 0′ 15″	61/4 KAYUNGA 0° 14′ 36″ 3′ 24″ /yr 0° 0′ 5″	62/3 KAGOMA 0° 15′ 18″ 3′ 18″ /yr -0° 0′ 5″	62/4 IGANGA 0° 16′ 0″ 3′ 18″ /yr -0° 0′ 15″	63/3 BUSESA 0° 16′ 36″ 3′ 12″ /yr -0° 0′ 25″	63/4 BUGIRI 0° 17′ 0″ 3′ 12″ /yr -0° 0′ 34″	64/3 TORORO 0° 17′ 24″ 3′ 12″ /yr -0° 0′ 44″	64/4 MALABA 0° 17′ 42″ 3′ 6″ /yr -0° 0′ 54″
39/1 MUSOZI 0° 7′ 6″ 3′ 30″ /yr 0° 0′ 32″	69/2 WAMALA 0° 8′ 18″ 3′ 30″ /yr 0° 0′ 27″	70/1 MITYANA 0° 9′ 24″ 3′ 30″ /yr 0° 0′ 21″	70/2 KAKIRI 0° 10′ 18″ 3′ 24″ /yr 0° 0′ 15″	71/1 KAMPALA 0° 11′ 12″ 3′ 24″ /yr 0° 0′ 9″	71/2 LUGAZI 0° 12′ 6″ 3′ 24″ /yr 0° 0′ 3″	72/1 JINJA 0° 12′ 48″ 3′ 18″ /yr -0° 0′ 3″	72/2 MAYUGE 0° 13′ 24″ 3′ 18″ /yr -0° 0′ 9″	73/1 NANKOMA 0° 14′ 0″ 3′ 12″ /yr -0° 0′ 15″	73/2 LUMINO 0° 14′ 30″ 3′ 12″ /yr -0° 0′ 21″	74/1 BUSIA 0° 14′ 48″ 3′ 12″ /yr -0° 0′ 27″	
69/3 MADDU 0° 4′ 36″ 3′ 30″ /yr 0° 0′ 11″	69/4 KANONI 0° 5′ 42″ 3′ 30″ /yr 0° 0′ 9″	70/3 MITALA MARIA 0° 6′ 48″ 3′ 30″ /yr 0° 0′ 7″	70/4 ENTEBBE 0° 7′ 48″ 3′ 24″ /yr 0° 0′ 5″	71/3 KAJANSI 0° 8′ 42″ 3′ 24″ /yr 0° 0′ 3″							

0° 00'

凡 例

Sheet No.
Sheet Name
Mag. Decline.
Annual Change
True North

Figure 7 Magnetic Declination for Each Sheet
(IGRF95, as of Sep. 1, 1997 – El.1,200 m)

3 - 9 - 3 Plotting of control points

Neat lines, grid lines, control points, existing geodetic control points provided by SMD, as well as pass points and tie points were plotted by coordinate-graph with plotting errors not to exceed 0.2mm on the map.

3 - 9 - 4 Orientation

Orientation was performed using the results of aerial triangulation as follows.

1) Relative orientation of each model was performed by using 6 pass points with residual parallax not to exceed 0.02mm on the contact film positives.

2)Absolute orientation was made using pass point and tie point results from aerial triangulation as well as control points including pricked points, pricked bench marks, with tolerances of 0.3mm or less for planimetry on the map and 5m or less for elevation.

3 - 9 - 5 Detail plotting

1) Detail plotting involved measurement and delineation of linear features such as roads, rivers, railways and housing, vegetation, contour lines, in that order, based on the map symbol rules as agreed between the Survey Team and SMD and on the field verified photos.

2) Colors used for plottting are as follows.

Black	-	Double line roads, railways, other linear features, buildings, outcrops, vegetation symbols
Red	-	Light vehicle roads, enclosures, small objects, covers, Indication points for specialized features, etc.
Purple	-	Coast lines, rivers, lakes and ponds, riparian vegetation.
Green	-	Vegetation boundaries.
Orange	-	Contour lines.

3) Buildings were delineated truly without generalization even in concentrated areas.

4) Contour lines were delineated in such a manner as to maintain elevation accuracy and not to affect ground features.

5) Since aerial triangulation was impossible for the islands of R20 and R21, they were oriented as single models.

6) Control point data sheet

Control points contained in the respective map sheets were entered separately and collectively on the overlay sheets to make the conrol point data sheets in the following manner.

a. Control points were represented with the applicable symbols with their names, identification numbers and elevations.
b. Bench marks were plotted at their locations by a plotting machine with their identification numbers and heights shown. Pricked points for height in minor order leveling were treated as spot heights for checking.
c. Spot heights were measured two times and their mean values were shown in meters.
d. Measurements of spot heights were taken at such places as:
   - Major mountain tops and saddles
   - Major intersections of roads
   - Knick points of slopes
   - Points typical of an area
   - Bottoms of depressions, and points necessary for clarification of topography, etc.

3 - 10 Compilation

3 - 10 - 1 Outline

Based on the plotted manuscripts and by incorporating the findings of the field verification and the research of existing data, map representations were compiled into the compiled manuscripts. The areas covered by the respective map sheets were the same as for the plotted manuscripts.

3 - 10 - 2 Specifications

a. Compilation scale :	1 : 50,000
b. Area :	28,000 km^2
c. Number of sheets :	40
d. Neat lines :	15' x 15' (UTM 36 Zone)
e. Sheet :	Compiled manuscripts; Polyester base #500
	Other data sheets; Polyester base #300

3 - 10 - 3 Preparation

Neat lines, control points, etc. were again plotted on paper specified for compilation sheets by a coordinate-graph, as similarly but separately done for plotted manuscripts. Errors in lengths of neat lines and diagonal lines were limited to less than 0.3mm and 0.4mm respectively.

3 - 10 - 4 Implementation

1) The compiled manuscripts were prepared in accordance with the map symbols as agreed with SMD. In order to maintain the uniformity of map representations, a manual was prepared to ensure technical people involved comply with the same work rules.

2) Compilation was made by the overlay method. Planimetry and contour lines were compiled on the same sheet with annotations separately on the annotation sheet. To ensure accuracy of representations and matching with adjoining sheets, four types of data maps were separately prepared: the road data sheet, vegetation data sheet, water system data sheet and control point data sheet.

3) Tick marks of longitudes and latitudes were entered on the neat lines at every 5' and, inside the neat lines, UTM grid tick at every 1km.

4) The names and sheet numbers are as shown in Figure 6.

5) The color classification for compiled manuscripts were as follows.

Black -	Double line roads, railways, buildings, bench marks, vegetation symbols Other linear feature, values of contour lines
Red -	Light vehicle roads, administrative boundaries, small objects, enclosures, sub-symbols
Green -	Vegetation boundaries, play grounds
Orange -	Contour lines
Purple -	Coast lines, rivers, ponds and other water bodies

3 - 10 - 5 Details

1) All roads and railways were represented as symbol roads and railways.

2) Small lanes and pedestrian bridges were not represented as agreed by SMD.

3) Annotations for destinations were finalized at the time of field completion in consultation with the counterparts.

4) Generalization of villages was made according to the symbol rules.

5) Dotted buildings were distributed to suit their environs.

6) Administrative names were based on data provided by SMD and district offices concerned.

7) Small villages were annotated only for those with a school or other public buildings.

8) Administrative boundaries and forest reserve area were entered by SMD at the time of

field completion.

9) In matching with existing map sheets covering adjoining area, no attempt for matching was made of such light vehicle roads and vegetation whose changes over the years were so obvious, as agreed by SMD. For matching with existing map sheets and among newly prepared map sheets, polyester base duplicate maps were used.

10)Magnetic declinations to be noted on each map sheet were computed by the international formula using the latest international magnetic distribution coefficients (IGRF95).

11)Annotations for respective map sheets were compiled on separate sheets. Lettering sizes, spacing, style, and positioning were set as specified. But with respect to the letter types that were not available in Japan, other similar types in use in Japan were chosen with approval of SMD.

12)The following four types of data sheets were prepared for each map sheet in addition to the annotation data sheet.

a. Road data sheet
Roads were classified by colors representing paved roads, all weather roads, dry season roads, light vehicle roads, etc. as specified for symbols.
b. Vegetation data sheet
For those map sheets that required preparation of mask sheets for forests and plantations, the vegetation data sheet was prepared. Vegetation were classified by colors on the map printed on the compiled manuscript polyester base.
c. Water system data sheet
The water system data sheet was made for those requiring mask sheets similarly as for the vegetation map sheet.
d. Control point data sheet
Control points, bench marks and spot heights were shown.

These data sheets were used for checking of map representations as well as for ensuring matching with adjoining sheets.

3 - 11 Preparation of Test Print Map

3 - 11 - 1 Outline

Prior to the field completion, a test print map was made of one map sheet for presentation at a meeting on drafting and printing to be held with SMD officials at the time of field completion, for SMD agreement on color tones, etc.

3 - 11 - 2 Implementation

Of the 34 map sheets, "70/4 ENTEBBE" was chosen for the test print map sheet as it was considered typically representative with a reasonable concentration of villages. It was printed in five colors by a flat bed offset printer using the same type of paper to be used for final printing. The brown for contour lines and the green for forests were prepared in three slightly different color tones for each to be examined by SMD officials at the meeting which took place on site at the time of field completion.

3 - 12 Field Completion

3 - 12 - 1 Outline

It involved final confirmation in the field of important map representations such as ground features, landforms, place names, and clarification on site of questions raised in the course of plotting and compilation. Major changes that had taken place after the aerial photography were surveyed and added to the manuscripts.

3 - 11 - 2 Implementation

Field completion was done on site in the following manner, equipped with duplicate sheets of compiled manuscripts.

1) Mainly geographical names and village names were reconfirmed. This resulted in many changes with respect to annotations; some were changes in their positions, others deleted, and new ones were added.

2) Double line roads and its destination were double-checked.

3) Reconfirmation of important features and clarification of questions raised at the time of compilation were made in parallel with the survey of geographical names and village names.

4) Forest reserve area, national park area and other specified area were plotted on the copies of manuscripts based on the data of SMD.

5) Administrative boundaries and were plotted on the copies of compiled manuscript sheets based on the data supplied by SMD.

6) The annotation lists prepared for the respective map sheets at the time of the field verification were modified according to the findings of the field completion.

7) The results of the field completion were checked by SMD and their approval was stamped on the field data sheets.

3 - 12 - 3 Correction of compiled manuscripts

The results of the field completion were incorporated onto the compiled manuscripts in the forms of corrections and additions, and after double-checking, it was finalized as the original draft maps. Simultaneously corresponding changes were made to other data sheets like the road data sheets as necessary for drafting and printing.

3 - 13 Digital Drawing / Drafting (Cartography)

3 - 13 - 1 Outline

Drafting was carried out by drawing software on computer. The raster image data digital scanned original compilation manuscripts were digitized head-up digitize system. After completion of digital drawing / digitizing, the positive films for print plate making were produced by high resolution image-setter.

3 - 13 - 2 Instruments and software for digital drawing

Instruments and others for this work were as follows;

1) Scanner
   a. HF-80 RENATUS (Dai Nihon Screen) ------ monochromatic
   b. Serchical SPECTA (Vidar System Corporation)
2) Computer
   a. EWS (UNIX)
      SUN Ultra / SUN SS-20 (Sun Micro Systems) etc.
   b. PC (Window95)
      Endeavor ATX-7000 (Epson)
   c. Macintosh
      Power Macintosh 7600/132, 7600/166, 8500/180, 9600/233 etc.
3) Color plotter
   a. HP-750C (Hulet Packerd)
   b. Tech JET 5500 (NS Cal Comp)
4) Image-setter
   a. Genasett 3100 (Dai Nihon Screen)
5) Software
   a. Illustrator Ver. 5.5 (Adobe)
   b. Imagine (USA Imagine)
   c. Arc/Info (Esry)
   d. Excel (Microsost)

3 - 13 - 3 Implementation

Digital drawing (drafting) was executed by means of computer drawing software. The rough sketch, digital scanned data of compilation manuscripts were composed with the neat line and grid data generated by Arc/Info, then corrected the raster image distortion.

Drafting by drawing software was implemented classifying more than 100 layers based on the map symbols (Figure 8). Finally, the same color symbols were composed a same layer in computer. Then, the positive films for printing were generated by high resolution image-setter. However, the red colored positive films for administrative boundaries were prepared separately from other red color layers because of the over printing work on whole color.

Each color positive films were as follows;

1) Black sheet
   a. Marginal information, annotations, building symbols
   b. Grid lines, grid values, longitudes/latitudes
   c. Vegetation symbols (mask)
   d. Ground features (scribed)
   e. Urban area (mask)
2) Blue sheet
   a. Drainage annotations
   b. Drainage
   c. Water surface (mask)
   d. Swamp (mask)
   e. Mangrove (mask)

3) Red sheet - 1
   a. Annotation
   b. Light vehicle
   c. Road (mask)
   d. Boundary (mask)

3) Red sheet -- 2
   a. Administrative boundary

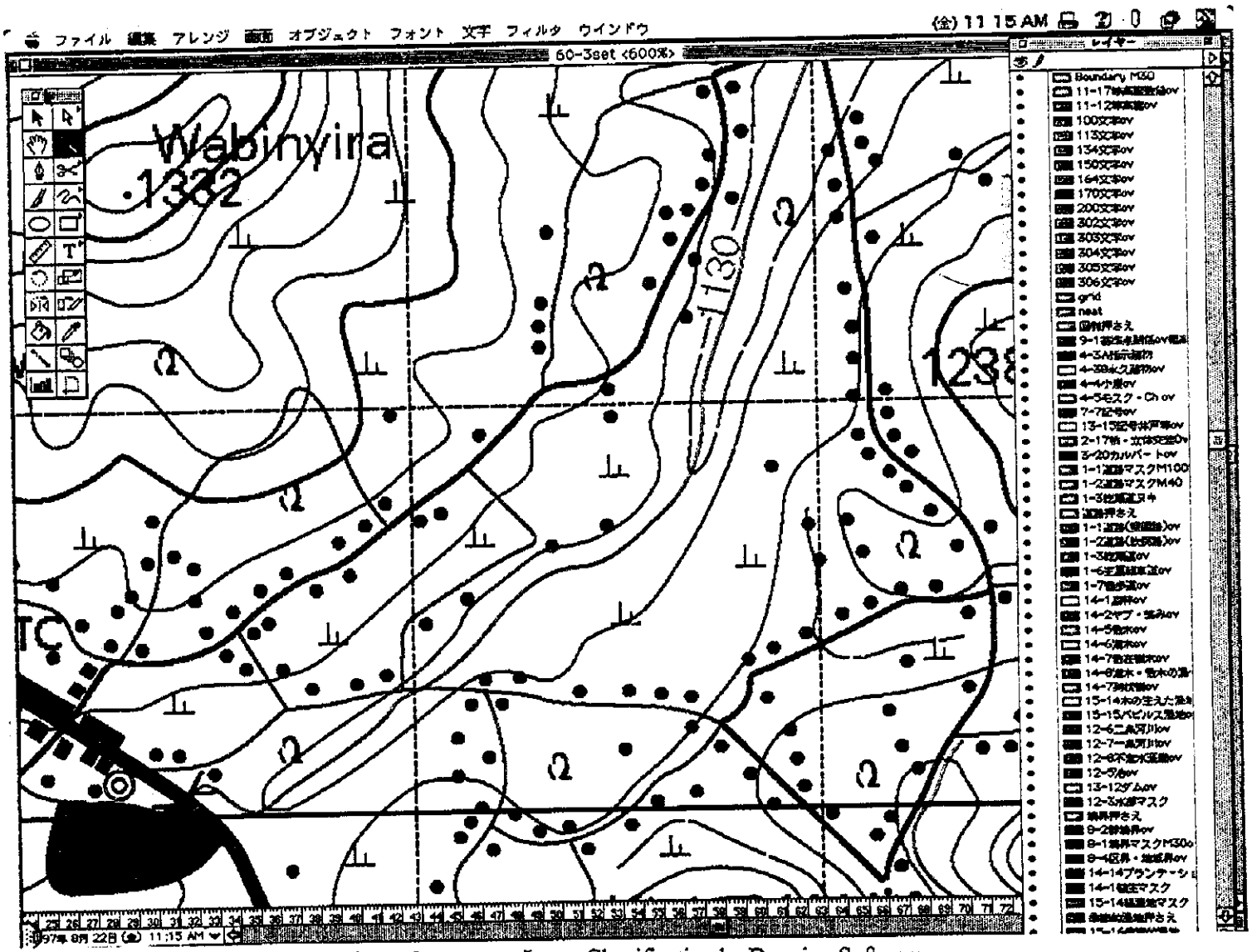


Figure 8 Layer Classification by Drawing Software

4) Green sheet:

a. Forest (mask)

b. Forest reserve boundary (mask)

c. Scrub(mask)

c. Plantation (mask)

d. Swamp (mask)

5) Brown sheet:

a. Elevation value

b. Contour line

c. Sand area (mask)

3 - 13 - 4 Preparation of composite positive film

Composite positive films without mask of each sheet were produced for easy black and white additional copies in Uganda.

3 - 14 Printing

3 - 14 - 1 Outline

The topographic maps were printed in 5 colors by offset printing. Printing is the final process of map making. Before going to the press for final printing, proof prints were made and read, and also inspected.

3 - 14 - 2 Plate making

From the negative film for each color based on the scribed draft originals, printing plates were made by photo lithography using aluminum PS plates.

3 - 14 - 3 Proof prints

Proof prints were made from printing plates by a flat bed printing machine. The proof prints were checked carefully for the quality of coloring, matching, dimensions, linear elements. Defective sheets were corrected against the scribed originals and re-made. After final proof reading, map sheets were printed to make final products.

3 - 14 - 4 Printing paper

Map printing paper of about BO in size and 90g/m2 in basis weight was used. The paper was chosen for its quality that is resistant to folding, tension, tearing, bursting, and free from contraction / expansion.

3 - 14 - 5 Printing

1,000 copies each of the map sheets were printed by offset printing.

3 – 15 Final Results

The followings were submitted to JICA as final results.

1. Signalization
   1) Air signal and pricking points description — 1 set
      (include location map, eccentric point survey note, aerial photo indicated)

2. Aerial Photography
   1) Negative film — 5 rolls
   2) Contact positive film — 12 cases
   3) Contact paper print — 8 cases
   4) Flight index map — 1 set
   5) Flight record — 1 set

3. Control Point Survey
   1) Survey note — 2 set
      (include observation note, observation record, calculation note)
   2) Control point results, Point description, Location map — 1 set

4. Minor Order Leveling (attached at Control Point Survey)
   1) Observation note — 1 set
   2) Calculation note, final results — 1 set

3) Pricking point description, location map	1 set

5. Pricking (attached at Signalization)

1) Pricking point description	1 set
2) Eccentric survey note & calculation note	1 set
3) Aerial photos indicated	1 set
4) Location map	1 set

6. Aerial Triangulation

1) Final results and index map	2 set
2) Contact positive films indicated pass-points, tie-points	1 set
3) Contact paper prints indicated pass-points, tie-points	1 set
4) Residual error table and discrepancy table of tie-points	1 set
5) Observation note	1 set

above 2), 3) were enclosed with Aerial Photography

7. Field Verification

1) 2-Time enlarged photos described the results	16 cases

8. Plotting

1) Plotting manuscripts	40 sheets
2) Control points over-lay	40 sheets
3) Orientation record	1 set

9. Compilation

1) Compilation manuscripts	40 sheets
2) Annotation data sheets	40 sheets

10.Field Completion

1) Annotation, administrative boundaries data sheets approved	1 set

11.Digital Drawing

1) Illustrator format original map data (CD-ROM)	1 set

2) Composite color out-put	1 set
3) Composite positive film	1 set

12.Printing

1) 5 Color print map	40 sheets × 1,000 copies
2) Composite positive film for plate making	1 set
3) TIFF format raster map data (CD-ROM)	1 set

13.Report	1 set

Attachments

1. Digital Drawing Symbols

UGANDA 1/50,000 MAP SYMBOLS

No.1

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Communications and Associated Features 交通及びその関連物	1	全天候道路 整図路面		0.47 — 0.73	M 100% BL 100%	1-1道路アミM100 1-1道路(整図路) OV
	2	全天候道路 軟弱路面		0.47 — 0.73	M 40% BL 100%	1-2道路アミM40 1-2道路(軟弱路) OV
	3	乾期道路		0.47 — 0.73	WHITE BL 100%	1-3乾期道白ぬき 1-3乾期道 OV
	4	な し				
	5	市街地道路		0.27 — 0.53	WHITE BL 100%	1-5市街地道白ぬき 1-5市街地道 OV
	6	主要軽車道		0.3	M 100%	1-6主要軽車道 OV
	7	その他の軽車道 及び徒歩道		0.15	M 100%	1-7徒歩道 OV
	8	な し				
	9	鉄 道		0.6	BL 100%	1-9鉄道 OV

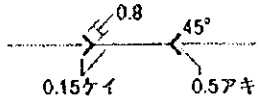
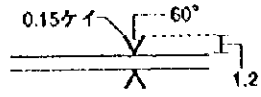
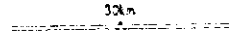
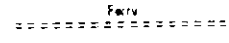
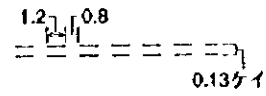
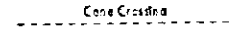
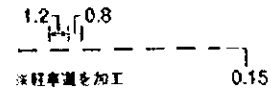
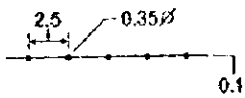
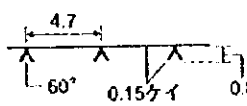
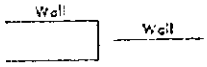
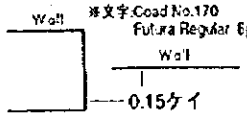
UGANDA 1/50,000 MAP SYMBOLS

No.2

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Communications and Associated Features 交通及びその関連物	10	軽便鉄道		1.8 0.75 0.13ケイ 0.13	BL 100%	2-10軽便鉄道 OV
	11	な し				
	12	鉄道側線		1.5 0.4 0.75 0.13ケイ 0.13	BL 100%	2-12鉄道側線 OV
	13	駅・停車場		0.8 0.4	BL 100%	4-3A指示建物 OV
	14	トンネル		1.0 0.5 ※該当道路を加工	BL 100%	各々の該当 道路レイヤー
	15	平面交差部	tc	Coad No.170 Futura Regular 6 pt	BL 100%	170文字 OV
	16	切り土・盛り土		極小間隔0.7 0.2アキ 実型・ 極小0.5 芯 0.3	BL 100% 地色ぬき 等高線切る	2-16切り土・盛り土
	17	橋・立体交差		0.8 45° 0.3アキ	BL 100%	2-17橋・立体交差 OV
	18	高架橋		0.8 45° 0.5アキ	BL 100%	2-18高架橋 OV

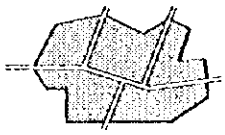
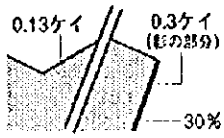
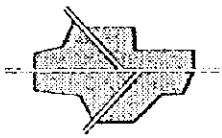
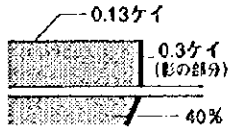
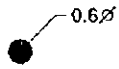
UGANDA 1/50,000 MAP SYMBOLS

No.3

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Communications and Associated Features 交通及びその関連物	19	徒歩橋			BL 100%	3-19徒歩橋 OV
	20	カルバート			BL 100%	3-20カルバート OV
	21	キロ杭		※文字:Coad No.170 Futura Regular 6pt 	BL 100%	170文字 OV 3-21キロ杭 OV
	22	フェリー(車用)		※文字:Coad No.170 Futura Regular 6pt 	BL 100%	170文字 OV 3-22フェリー
	23	フェリー(歩行者)		※文字:Coad No.170 Futura Regular 6pt 	BL 100% M 100%	170文字 OV 1-7徒歩道 OV
	24	渡河道	Ford	Coad No.170 Futura Regular 6pt	BL 100%	170文字 OV
	25	電信・電話線			BL 100%	3-25電信・電話線 OV
	26	電力線			BL 100%	3-26電力線 OV
	27	囲い			BL 100%	170文字 OV 3-27囲い OV

UGANDA 1/50,000 MAP SYMBOLS

No.4

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Buildings and Abbreviation Signs 建物及び省略記号	1	市街地			ケイ BL 100% アミ部分 BL 30%	4-1市街地ククリ OV 4-1市街地マスク
	2	村落			ケイ BL 100% アミ部分 BL 40%	4-2村落ククリ OV 4-2 村落マスク
	3	永久建物		・ 0.8X0.8は注記・記号の対象となるものの極小 ・ 0.6X0.6は実型永久建物の極小とする	BL 100%	4-3A指示建物 OV 4-3B永久建物 OV
	4	小屋			BL 100%	4-4小屋 OV
	5	モスク	☪	記号	BL 100%	4-5モスク・Ch OV
	6	Ch 教会	✝Ch	✝：記号 Ch：Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	4-5モスク・Ch OV 170文字 OV
	7	Sch 学校	Sch	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	8	Sch-Ch 教会及び学校	✝Sch Ch	✝：記号 ▪：永久建物 Sch Ch：Coad No.170 Futura Regular 6 pt Tr 50 中黒(option+shift+9で出す	BL 100%	4-5モスク・Ch OV 4-3A指示建物 OV 170文字 OV

UGANDA 1/50,000 MAP SYMBOLS

No.5

ITEMS 分 類	No.	NAME 名 称	FINAL PRODUCT 地 図 記 号	SPECIFICATIONS 仕 様 (線号m/m)	COLOR 色	LEYER レイヤー名
Buildings and Abbreviation Signs 建物及び省略記号	9	DHQ 郡行政事務所	DHQ	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	10	CHQ 市町行政事務所	CHQ	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	11	SCHQ 区界行政事務所	SCHQ	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	12	CtHo 裁判所	CtHo	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	13	Hosp Dso 病院・診療所	Hosp Dso	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	14	Mkt 公設マーケット	Mkt	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	15	MoW 土木建設局	MoW	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	16	PO 郵便局	PO	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV

UGANDA 1/50,000 MAP SYMBOLS

No.6

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Buildings and Abbreviation Signs 建物及び省略記号	17	PS 警察署	PS	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	18	PP 交番	PP	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	19	RH 公設休養所	RH	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	20	T 電話施設	T	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	21	TC 商業センター	TC	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	22	Cot S 綿花集荷場	Cot S	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	23	Cof S コーヒー集荷場	Cof S	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV
	24	UEB ウガンダ電力公社	UEB	Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	170文字 OV

UGANDA 1/50,000 MAP SYMBOLS

No.7

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線巾mm/m)	COLOR 色	LEYER レイヤー名
Other Facilitie and Conventinal Signs その他の施設及び記号	1	滑走路(舗装)		0.15ケイ M100%	ケイ BL 100% アミ部分 M 100%	7-1滑走路ほか OV 7-1滑走路マスク OV
	2	滑走路(赤土)		0.15ケイ M40%	ケイ BL 100% アミ部分 M 40%	7-1滑走路ほか OV 7-1滑走路マスク OV
	3	滑走路(草)		0.15ケイ Green 40%	ケイ BL 100% アミ部分 Green 40%	7-1滑走路ほか OV 7-1滑走路マスク OV
	4	競技場	S	1.2 1.0 0.8 0.13ケイ S ※文字:Coad No.170 Futura Regular 6pt	BL 100%	7-1滑走路ほか OV 170文字 OV
	5	墓地	C	1.2 1.0 0.8 0.13ケイ C ※文字:Coad No.170 Futura Regular 6pt	BL 100%	7-1滑走路ほか OV 170文字 OV
	6	廃墟	なし			
	7	遺跡		：記号 注記：Coad No.180 Linotext Regular 8pt Tr20	BL 100%	7-7記号 OV 180文字 OV
	8	燈台		記号	BL 100%	7-7記号 OV
	9	標識塔		記号	BL 100%	7-7記号 OV
	10	無線塔		：記号 WM：Coad No.170 Futura Regular 6 pt Tr 50	BL 100%	7-7記号 OV 170文字 OV
	11	採鉱所		記号	BL 100%	7-7記号 OV

UGANDA 1/50,000 MAP SYMBOLS

No.8

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号mm/m)	COLOR 色	LEYER レイヤー名
Boundaries 境界	1	国境界		2.5 0.23ケイ 1.2 2.0 M 30% 150線	ケイ BL 100% アミ部分 M 30%	8-1国境界 OV 8-1境界マスク M30 OV
	2	都境界		4.5 0.23角正方形 0.23ケイ 4.5 1.2 2.0 M 30% 150線	ケイ BL 100% アミ部分 M 30%	8-2都境界 OV 8-1境界マスク M30 OV
	3	市町界		1.2 0.23角正方形 1.2 0.23ケイ 2.0 M 30% 150線	ケイ BL 100% アミ部分 M 30%	8-3市町界 OV 8-1境界マスク M30 OV
	4	区界・地域界		1.0 M 30% 150線	M 30%	8-4区界・地域界 OV
	5	国立公園・保護区界	な し			
	6	凡例枠囲中の境界	な し			

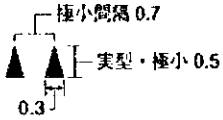
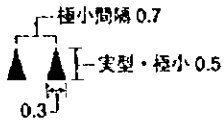
UGANDA 1/50,000 MAP SYMBOLS

No.9

ITEMS 分　類	No.	NAME 名　称	FINAL PRODUCT 地　図　記　号	SPECIFICATIONS 仕　様（線号m/m）	COLOR 色	LEYER レイヤー名
Control Points 基準点他	1	一等三角点	UPSD △ 1319 UPS5 △ 1194	△△：記　号 注記：Univers Regular 7 pt OV	BL 100% OV	9-1基準点関係
	2	二等三角点	64X7 ▽ 1339 72X5 ▽ 1281	▽▽：記　号 注記：Univers Regular 7 pt OV	BL 100% OV	
	3	その他、三・四等	24Y3 ○ 1305 23Y4 ○ 1284	○ ○：記　号 注記：Univers Regular 7 pt OV	BL 100% OV	
	4	GPS基準点	GPS ▽ 1278	▽　：記　号 注記：Univers Regular 7 pt OV	BL 100% OV	
	5	水準点	· 1245 BM	·　：記　号 0.3mm 丸ベタ 注記：Univers Regular 7 pt OV	BL 100% OV	
	6	標高点	· 1154	·　：記　号 0.3mm 丸ベタ 注記：Univers Regular 7 pt OV	BL 100% OV	
	7	写真主点	JICA/95 ┼ 838.3	┼：記　号 注記：Futura Light 6 pt OV	BL 100% OV	
	8	境界石	な　し			

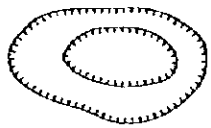
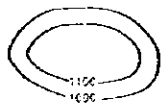
UGANDA 1/50,000 MAP SYMBOLS

No.10

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Natural Topographic Features and Countour Lines 自然地形表現及び等高線	1	平岩	なし			
	2	殻岩		線号0.15 実型	BL 100% 地色ぬき 等高線切る	10-2岩等
	3	岩		線号0.15 実型	BL 100% 地色ぬき 等高線切る	10-2岩等
	4	岩		線号0.15 実型	BL 100% 地色ぬき 等高線切る	10-2岩等
	5	溶岩	なし			
	6	噴火口			BL 100% 地色ぬき 等高線切る	2-16切り土・盛り土
	7	石切場・採石場		線号0.15 実型	BL 100% 地色ぬき 等高線切る	10-2岩等
	8	崩土			BL 100% 地色ぬき 等高線切る	2-16切り土・盛り土
	9	砂泥(内陸)		Screen	Brown100%	10-9砂泥 OV

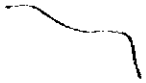
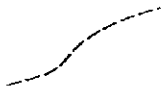
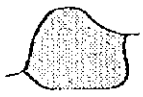
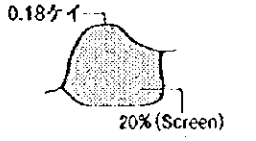
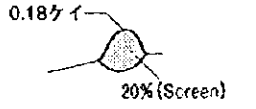
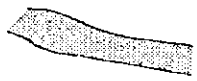
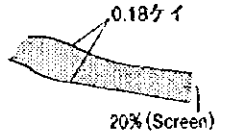
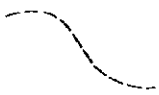
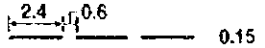
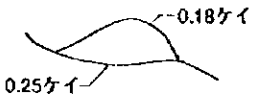
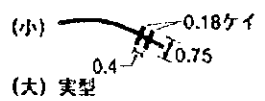
UGANDA 1/50,000 MAP SYMBOLS

No.11

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Natural Topographic Features and Countour Lines 自然地形表現及び等高線	10	砂泥(海岸)		Screen	Brown100%	10-9砂泥 OV
	11	砂丘	なし			
	12	等高線(主曲)		0.13	Brown100%	11-12等高線 OV
	13	等高線(計曲)		0.23	Brown100%	11-12等高線 OV
	14	補助曲線		4.0 0.3 0.13	Brown100%	11-12等高線 OV
	15	不明定等高線	なし			
	16	凶地		1.2 0.8 ※線号は各々等高線と同じ	Brown100%	11-12等高線 OV
	17	等高線数値		Helvetica Light 5.5 pt	Brown100%	11-17等高線数値 OV

UGANDA 1/50,000 MAP SYMBOLS

No.12

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Hydrography and Others 自然水系及びその他	1	海岸線		 0.18	青100%	12-1海岸線 OV
	2	不定海岸線		 2.4 0.6 0.18	青100%	12-2不定海岸線 OV
	3	湖（大）		 0.18ケイ 20%(Screen)	青100% 青20%	12-3湖 OV 12-3水部マスク
	4	湖（小）		 0.18ケイ 20%(Screen)	青100% 青20%	12-3湖 OV 12-3水部マスク
	5	池		 池内ベタ	青100%	12-5池 OV
	6	二条河川		 0.18ケイ 20%(Screen)	青100% 青20%	12-6二条河川 OV 12-3水部マスク
	7	一条河川 流水線		 0.15	青100%	12-7一条河川 OV
	8	不定水涯線		 2.4 0.6 0.15	青100%	12-8不定水涯線 OV
	9	分岐流水		 0.18ケイ 0.25ケイ	青100%	12-9分岐流水 OV
	10	滝	 (小) (大)	 (小) 0.18ケイ 0.4 0.75 (大) 実型	青100%	12-10滝・急流 OV

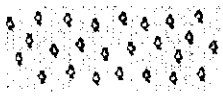
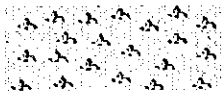
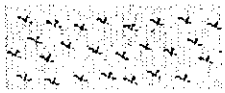
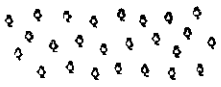
UGANDA 1/50,000 MAP SYMBOLS

No.13

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Hydrography and Others 自然水系及びその他	11	急流・早瀬	(小) (大)	(小) 0.18ケイ 2.0 (大) 実型	青100%	12-10池・急流 OV
	12	ダム (大)	Dam	※文字: Coad No.170 Futura Regular 6pt Tr 50 Dam 0.25ケイ 0.3ケイ 20%Screen	青100% 青20%	13-12ダム OV 12-3水部マスク
	13	ダム (小)	Dam	※文字: Coad No.170 Futura Regular 6pt Tr 50 1.8 Dam 1.2 0.18ケイ ベタ	青100%	13-12ダム OV
	14	地下ダム	Dam	※文字: Coad No.170 Futura Regular 6pt Tr 50 1.8 Dam 1.2 0.18ケイ	青100%	13-12ダム OV
	15	掘抜井・井戸・水溜・泉	● ○ ◇ ℓ	● (BH 掘抜井戸) 記号 ○ (Well 井戸) 記号 ◇ (WH 水溜) 記号 ℓ (Spring 泉) 記号	青100%	13-15記号 井戸等 OV
	16	水タンク	■	記号	青100%	13-15記号 井戸等 OV
	17	オイルタンク	○	記号	BL100%	7-7記号 OV
	18	水路・溝等	Ditch	※文字:Coad No.170 Futura Regular 6pt Ditch 0.15ケイ	BL100% 青100%	170文字 OV 13-18水路・溝等 OV
	19	排水・パイプライン等	Under Ground Pipeline Pipeline	Under Ground Pipeline 0.13ケイ 0.8 1.2 Pipeline ※文字: Coad No.170 Futura Regular 6pt Tr 50	BL100% 青100%	170文字 OV 13-19排水・パイプライン等 OV

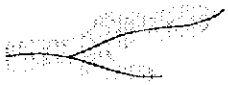
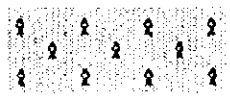
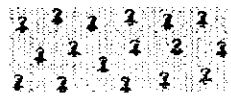
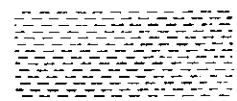
UGANDA 1/50,000 MAP SYMBOLS

No.14

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Vegetation 植生	1	森林		記号 地 Green ベタ	BL 100% Green100%	14-1森林 14-1植生マスク
	2	ヤブ・繁み		記号 地 Green ベタ	BL 100% Green100%	14-2ヤブ・繁み OV 14-1植生マスク
	3	竹林		記号 地 Green ベタ	BL 100% Green100%	14-3竹林 OV 14-1植生マスク
	4	プランテーション: コーヒー・サイザル・ シュガー・茶・米		C S Su Coad No.170 Futura Regular Tea Rice 6 pt Tr50 地 Green ハッチ 45° 0.2mmケイ 間隔0.9	BL 100% Green100%	170文字 OV 14-4プランテーション マスク
	5	散木		記号	BL 100%	14-5散木 OV
	6	灌木		記号	BL 100%	14-6灌木 OV
	7	散在樹木		記号	BL 100%	14-7散在樹木 OV
	8	灌木・散木の混合		記号	BL 100%	14-8灌木・散木 の混合 OV

UGANDA 1/50,000 MAP SYMBOLS

No.15

ITEMS 分類	No.	NAME 名称	FINAL PRODUCT 地図記号	SPECIFICATIONS 仕様 (線号m/m)	COLOR 色	LEYER レイヤー名
Vegetation 植生	9	ヤシ林		記号	BL 100%	15-9ヤシ林 OV
	10	耕地	Cultivation	Coad No.170 Futura Regular 6 pt	BL 100%	170文字 OV
	11	列状樹		記号	BL 100%	14-7列状樹 OV
	12	川沿樹木		Green ベタ	Green100%	14-1植生マスク
	13	マングローブ湿地		記号 地 20%Screen	青100% 青20%	15-13マングローブ湿地 OV 12-3水部マスク
	14	木の生えた湿地		記号 地 20%Screen	青100% Green20%	15-14木の生えた湿地 OV 15-14緑湿地マスク
	15	パピルス湿地・沼地・泥地		記号 地 20%Screen	青100% Green20%	15-15パピルス湿地 OV 15-14緑湿地マスク
	16	季節的湿地		Screen	青100%	15-16季節的湿地