3-12 Drafting

Based on the original manuscribts, scribed originals were produced by scribing each separate color sheet negative. (Figure 16)

3-12-1 Map Symbols

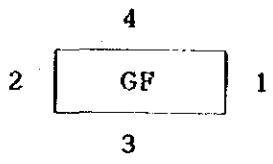
The specifications of map symbols and marginal information were those agreed with SK for application, along with the marginal information sheet provided by SK.

(1) Symbols

The applied symbols were basically applied from East Africa Specifications and identical with those of the East Kenya Topographic Mapping with exceptions of boreholes, water holes, wells, and springs.

(2) Application of Map Symbols

1) When an annotation overlaps with an important feature, the annotation was moved in location in the following order of priorities.



2) A cutline passable by vehicles is represented by the same symbol and color (red) as the trail and annotated as "Cutline" in black.

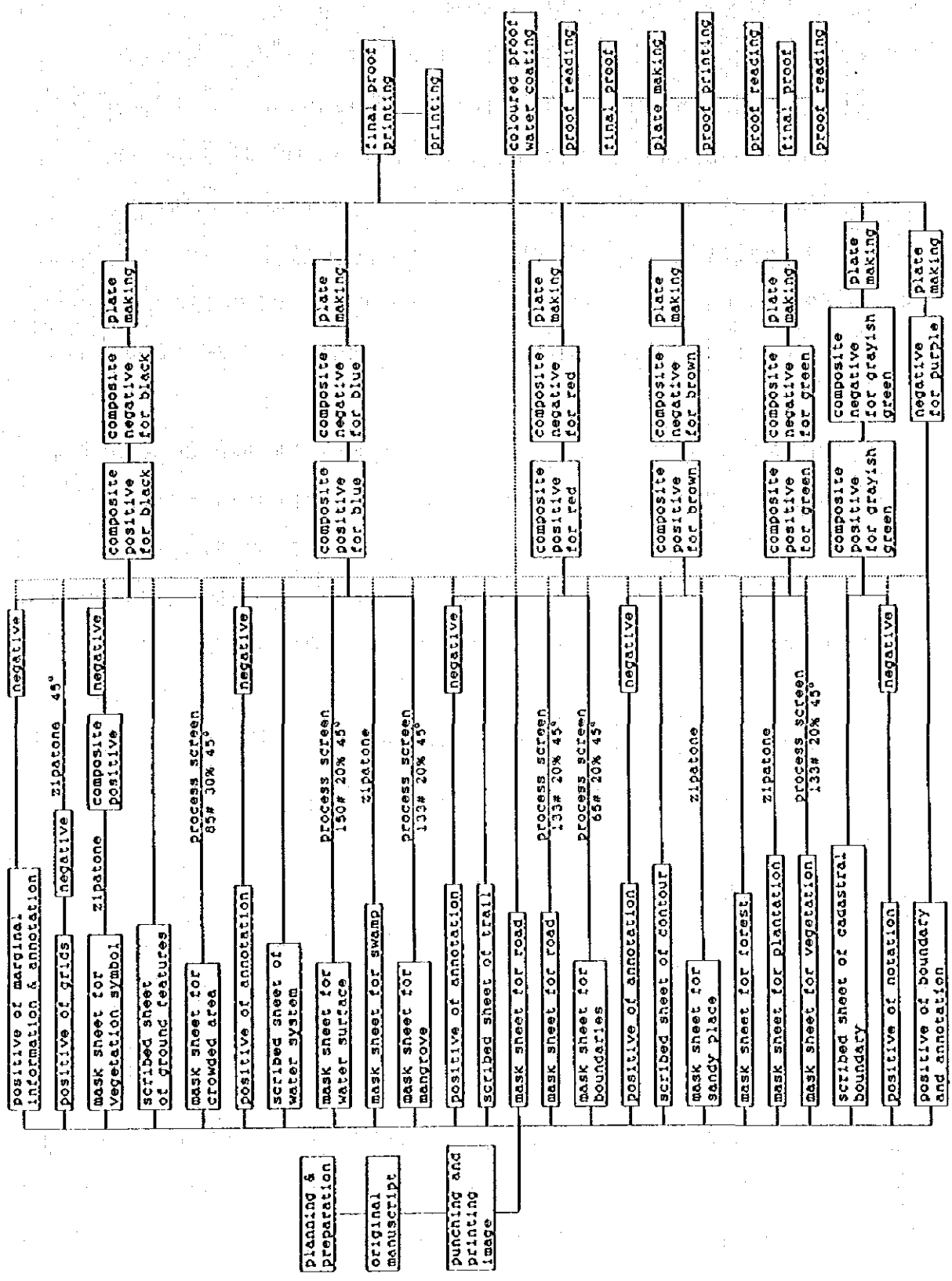


Figure 16. Schematic Diagram for Drafting and Printing

3) Fences were annotated in black.

4) Some of the specified letter types were not available in Japan and therefore substituted by similar types as follows.

Specified	Substituted
GILL SANS MEDIUM	FUTURA LIGHT
GILL SANS MEDIUM LIGHT ITALIC	FUTURA LIGHT ITALIC
UNIVERS 57 CONDENSED	UNIVERS 56 MEDIUM ITALIC
GILL SANS LIGHT	FUTURA LIGHT
GILL SANS LIGHT ITALIC	FUTURA LIGHT ITALIC
UNIVERS 65	UNIVERS 56 MEDIUM CONDENSED
BEMBO BOLD ITALIC	GODY MEDIUM ITALIC

5) Process screens for water surface were specified as 133 lines/inch but 150 lines/inch was applied.

3-12-2 Material for Drafting

The material for drafting used was stable scribing base and polyester base (#500).

3-12-3 Drafting

Drafting was done by the negative scribing method. To make color separation plates for 6-color and 7-color printing, drafting was performed for each color to produce scribed sheets, mask sheets, and positive sheets, etc.

Furthermore, their composite film incorporating them in one sheet for each color was prepared. Refer to Figure 16 for the specific processes.

3-12-4 Color Separation

Color separations were as follows. Composite film was generated to have everything in one sheet for each color for the convenience of subsequent plate making.

(1) Black sheet:

a.Marginal information, annotation, building symbols, etc. (positive)

b.Grid lines, grid values (positive)

c.Vegetation symbols (mask)

d.Ground features (scribing)

e.Crowded area (mask)

(2) Blue sheet:

a.Annotation (positive)

b.Water system (scribing)

c.Water surface (mask)

d.Swamp (mask)

e.Mangrove (mask)

(3) Red sheet :

a.Annotation (positive)

b.Trail (scribing)

c.Road (mask)

d.Boundary (mask)

(4) Brown sheet :

a.Elevation annotations (positive)

b.Contour line (scribing)

c.Sand area (mask)

(5) Green sheet :

a.Forest (mask)

b.Plantation (mask)

c.Vegetation (mask)

(6) Grayish green sheet :

a.Cadastral boundary (scribing)

b.Annotation (positive)

(7) Purple sheet :

a.Boundary, annotation (positive)

3-12-5 Making of Scribed Original

(1) Image printing on scribing sheets

Reverse images of the original manuscripts were printed on diazo coated scribing sheets. Resistering holes were punched beforehand in matching of original manuscripts and scribing bases and other sheets to provide clues.

(2) Making of scribed sheets

Scribed sheets were made for such classifications as roads, buildings, boundaries, neat lines, shorelines of rivers, lakes and ponds, contour lines, etc. for each color with due attention paid to prevent missing lines and ensure proper representation in scribing. Cross resgistration marks were entered at the mid-points outside of the neat lines and hook-shaped marks at four corners of neat lines.

(3) Mask sheet making

Line images of scribed sheets printed on the vinyl coated based with punched holes by the photo corosion method were peeled. Unnecessary lines were eliminated. Register marks were entered as in the scribed sheets.

(4) Making of marginal information polyester base and annotation sheet.

a) Manuscripts of common items in the marginal information were prepared on the polyester base. Negative film was then developed from them and reproduced on the polyester base in a necessary number of sheets, photographically. Using them as base, marginal information, annotations, building symbols, grid values, and other symbols made by photo-composing on the strip positive sheets based on the annotation data sheets and the orignal manuscript, were peeled and stuck up with liquid adhesive.

b) With respect to names of rivers, seas, lakes, letterings were made in accordance with the annotation data sheets and stuck up.

c) With respect ot elevation figures, contour figures, photo composing was made based on the control point data sheet, and stuck up.

(5) Making of grid sheet polyester base

Grid lines were scribed on the scribing base using a precision coordinategraph and then represented on the polyester base by photography. Unneceaary lines were eliminated by referring to the original manuscript.

(6) Making of additional color (purple) sheet for government use

The sheet required by the use of additional color for government use was made by producing District and Sub-district boundaries on the polyester base and sticking up annotation corresponding to the administrative names.

(7) Matching

Matching was made properly among the scribed base, mask sheet and polyester base for each color to ensure proper scribing of graphic patterns.

3-12-6 Inspection and Proof Reading

Color printed composite positive originals were made by photo lithography (water coating) and taken to Kenya for inspection and proof reading for any presence of discrepancies in representation, application, delineation, annotation, as well as for missing information, by referring to the original manuscript, annotation data sheets, and other data sheets, in cooperation with SK officials.

3-12-7 Making of comprehensive positive film

Comprehensive poisitive film focusing on linear elements was made on the polyester base so as to permit efficient revision of the topogrpahic map by SK to keep up with changes over years.

3-13 Printing

3-13-1 Outline

The topogrpahic maps were printed in 6 colors and 7 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 by the SK counterpart to ensure everything was in order.

3-13-2 Plate Making

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

3-13-3 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 orignals, and re-made. After final proof reading by the SK counterpart visiting in Japan, the map sheets were printed.

3-13-4 Paper in Use

Map printing paper of about B0 in size and 90g/m^2 in basis weight was used. The paper was chosen for its quality that is resistent to folding, tension, tearing, bursting, and free from contraction/expansion. The test results of the paper performed by an authorized public institution are given in Table 8.

Table 8 Physical and Chemical Characteristics of Printing Paper

Results of testing					
Item			Average	Maximum	Minimum
Basis weight (g/㎡)			91.0		
Thickness (㎜)			0.113	0.115	0.111
Tensile breaking strength (kg)	Dry	Machine direction	12.0	12.3	11.6
		Cross direction	8.27	8.50	8.00
	Wet	Machine direction	3.66	3.90	3.25
		Cross direction	2.89	3.05	2.80
Bursting strength (kg/㎠)	Dry		4.11	4.45	3.85
	Wet		1.87	2.05	1.70
Tearing strength (g)		Machine direction	117	118	114
		Cross direction	98.8	100.0	96.0
Folding endurance (time) (MIT type tester)		Machine direction	1,700	1,900	1,500
		Cross direction	1,900	2,500	1,600
Surface strength (A)		Surface	16	16	16
		Back	16	16	16
Smoothness (sec)		Surface	46	51	41
		Back	49	56	43
Brightness (%)			85.2	85.2	85.1
Opacity (%)			89.6	90.0	89.4
Degree of sizing (sec)			61	69	57
PH			6.4		
Expansion (%) (RH60-80%)		Machine direction	0.067	0.068	0.064
		Cross direction	0.247	0.248	0.244

Note: Wet means the condtion in which the specimen has been immersed in water at 20℃ and is soaked with superflous water.

Room temperature: 20℃

Humidity: 65%.

3-13-5 Printing

Printing was done by offset printing machine.

6-color printing : 43 sheets, 500 copies each

7-color printing : 43 sheets, 500 copies each

The 7-color prints were for government use with sub-districts represented in additional color of purple.

3-14 Comments

3-14-1 Aerial Signal

Reflecting the veriegated topography of the area covered by aerial photography, ranging from coastal plains, inland hills, to mountains and peneplains, the conditions, in which control points, both existing and newly set up, for signalization were located, were also varied. Signalization was made by trying to use such materials that were available at site. Namely:

(1) Small pieces of rocks laid out on the ground and coated with white paint.

(2) Logs laid out on the ground and coated with white paint.

(3) Combination of (1) and (2)

(4) Painting of outcrops

Aerial signal is made for identification of the location of a control point made easier by sharp constrasting of the signal against the ground due to enhanced difference in reflection of the sun light.

In the case of the earth surface of the ground, the difference in reflection is known to be largest when signalized at a clearance of one meter from the ground. But when signalization is made in a manner as above, it is impossible to have a clearance of one meter. In the case of (1), (2) or (3) above, it suffices to pay attention simply not to reduce the reflection of paint during the dry season when there is little growth of vegetation but if photography is delayed due to weather conditions, for example, until after the rainy season, the signal will be covered by grass and soiled by the time photography is resumed, requiring to be replaced.

In the rocky areas, dark green and other dark color tones of outcrops turned out to be unexpectedly reflective making it rather difficult to choose the right color of paint. When outcrops are signalized, it appears to be safer to choose cold color types with absorbtion rather than warm color types with higher reflection.

3-14-2 Aerial Photography

(1) Aerial photography for pricking

Aerial photography was planned for pricking of bench marks and for plotting. Aerial photography for the pricking purpose was the first attempt ever made. In retrospect, the attempt proved to be a success because it prevented a possible delay in the work process subsequent to pricking, in view of the difficulty experienced in the aerial photography for plotting.

Due to weather conditions, photography was carried out from under the clouds at various altitudes, resulting in variations in photo scales ranging 1/8,000 to 1/40,000. But the availability of latest photos of the leveling routes permitted pricking of the bench marks and minor order leveling and other surveys that followed.

The study area is covered with wheel prints of vehicles on safari in various directions. Unless equipped with latest aerial photos to serve as a guide for access to a point several kilometers away, it would be difficult not only to reach the destination but also to make a return. Roads going through depressed areas often have sections covered with grass grown in muddy ground, and if not carefully reading the photo, it is quite likely to get caught and stuck in such a section of road. For areas in which difficulty is anticipated in aerial photography and ground surveying involving the hinterland is difficult without aerial photos, aerial photography covering the planned routes as done in this study should help the subsequent work considerably.

(2) Aerial photography for plotting

In view of the signinficant difference in climate between the coast area with rainfall of 1,400mm and the inland area with rainfall of several hundred milimeters, different directions of flight courses were planned : NNE-SSW for the coastal area and E-W for the inland. Due to the variations in flight altitudes, datum planes were set at 500m for coastal and 1,000m for inland.

Contrary to the expectation, photography of the coastal area where much rainfall was anticipated was completed soon after the start, whereas for the inland area, photography planned for the first year was not finished on schedule due to the prolonged bad weather conditions extending from December of 1987 to March of the following year. The area happened to be located where the climate changes between the coastal and the inland zones but judging from the fact that there was not clear day during the entire minor dry season, the weather is considered to have been not normal for this particular year.

Another attempt was made without success to fly this area during the next minor dry season of July to August 1988. It was in the end of February of the following year that the aerial photography was completed. Most of the photography therefore was accomplished in the month of February for both first and second years. For aerial photography of areas where time favorable for photographic flights is limited, the use of jet aircraft with faster cruising speeds should be considered to make the best of that limited time.

Considering the photo scale of 1:60,000 and the use of a super wide angle lens, it is not advisable to use the photos for plotting of larger scale maps. Instead they can be better utilized to generate photo maps for management of huge tracts of national parks or for tourist.

3-14-3 Pricking

With respect to the existing bench marks planned for pricking, most missing bench marks occurred in the first order leveling route along the sea coast from Malindi, via Mombasa, to Lunga Lunga. They were lost mostly in connection with the road reconstruction work. Another area where lost bench marks were many next to the above section, was east of Voi where the bench marks were set up on the structures related to the railway going from Mombasa to Nairobi.

The original plan called for pricking of 383 existing stations but actually 147 stations or 38% of them were found. More lost stations occurred in the coastal area than any other place, and more than 90% of the stations were found in the less populated inland area. Extra attention needs to be paid to the location, material, and structure of those bench marks that are to be set up in areas with large population. Pricking proceeded smoothly, helped by the latest aerial photos of the proposed routes made available in time, as mentioned earlier.

3-14-4 Control point survey

(1) Geodetic control point survey

Geodetic control point survey was conducted by GPS observation in the second year for reasons that some of the existing control points to be used were lost and that the heights were not accurate enough because they were based on indirect (barometric) leveling.

The number of points from which data were required were 3 for planimetric positioning, 3 for planimetry and vertical positioning, and 4 for vertical positioning, totalling 10 points. These points being distributed in an area of about 280 km east and west and 180km north and south, 10 geodetic control points and 10 bench marks were used as given points.

Starting at an existing point, simultaneous observation was made at three points continously to close to another existing point. The number of triangles whose side lengths were obtained by 3-point simultaneous observations amounted to 13.

The repeatability of measurement as tested by observing the same side length at two different times was in the range of 1:1,610,000 to 1:55,000, and within 1:100,000 with one exception. Measured side lengths ranged from 21km to 126km averaging 52km, with standard deviations of 0.000m - 0.103m averaging 0.015m showing the accuracy declines as side lenths are longer. In GPS observations, the closures of heights were all within 50cm except where long distances and many nodal side lenghts were involved. For a distance of 100km more or less and about 2 nodal side lengths, the closure was within 10cm.

These results show the control points were accurate enough for medium scale topographic mapping. The given points were also observed as part of simultaneous observations and the control points used for geodetic surveying were proved to have good enough accuracies in positioning.

(2) Leveling

The required accuracy for leveling was 50mm /S. In view of the long distances of the routes to be covered, and as it was necessary to prevent repeating, permanent monumentation was invloved. Therefore, better accuracies were maintained throughout by using staff stands and performing two way observations or having two teams performing in parallel checking with each other while proceeding.

As a result, closure errors were all within the tolerance and even one third of the tolerance for most of the routes. At first, observations were made during the day-time but the heat was so strong as to affect the efficiency of work. Therefore, work hours were changed to morning and evening hours when it was too hot, and the work proceeded efficiently enough.

3-14-5 Aerial Triangulation

Intitally 722 models were planned for aerial triangulation but they were changed to 757 due to the photography prolonged into the second year.

When film is processed on site where facilities are not good enough, it usually so happens that contraction/expansion occurs in the film while being processed resulting in residuals of the fiducials reaching the required limit of 30 . In this study, since the film after flight was taken to Nairobi for processing, the results were excellent with 20 for maximum residual and 13.3 for standard deviation. The results of adjustment computations showed both residuals of control points and discrepancies of tie points well under the tolerance, due to the availability of accurate control points at appropriate locations.

3-14-6 Field Verification

The map symbols for East Africa Specifications covering Kenya, Tanzania, and Uganda, were basically applied for the Study. They have 13 classifications: road, ancillary road facility, railway, building, boundary, control point, miscellaneous (other facilities), customary symbols, topography, cadastral information.

The system is characterized by detailed classifications of water system and vegetation and the representation of cadastral information in the topographic map. There are 20 symbol types for water system alone. It seems to reflect small amounts of rainfall in the area and the importance attached to the information about water resources.

Vegetation has 16 symbol types. They are classified rarely by species but mostly by types and density of distributions with emphasis on ecological features.

In stereo plotting, such basic items for the topograhic maps as rivers, roads, railways, were dealt with first, followed by buildings, vegetation, contour lines in that order. Five colors of black, red, green, orange, and purple, were specified for delineation of these items not only to make their distinction easier after plotting but also to allow distinction of lines when they were overlapped. The resulting plotted manuscript is not necessarily easy to read but it is a highly accurate data sheet based on aerial photos.

Compilation produces the compiled manuscript which is a plotted manuscript made easier to read by application of some map symbols according to a certain set of criteria. Compilation involves displacement of rivers, roads, and railways that run in parallel and generalization of buildings in a densely built-up area. This is important to know in the use of the topographic map of medium scale in general.

Aerial photography was partly done in the second year. The area covered by this photography was plotted first in precedence to the field verification. But since keys for photo interpretation were already available from surrounding area, there was no problem in doing plotting.

Cadastral information includes boundaries of forest reserves, and cadastral boundaries and numbers of national lands.

The maps based on these symbols tend to have emphasis on the representation of land and natural environment rather than cultural aspects. The field verification was jointly conducted by Kenyans and Japanese. Collection of data for annotations, boundaries, cadastral information and other related data was done by SK while the Japanese team engaged in verification of topographic and ground features and keys for photo interpretation. Data for annotations including place names and administrative names had been assembled by SK ahead of time contributing to the progress of work on schedule.

With respect to topographic and ground features, it was easy for such items for which information is available like roads and railways but telephone lines, wells, water pipelines, etc. were difficult to verify due to a lack of data, requiring hearings and follow-ups on the site.

3-14-7 Stereo plotting and compilation

In stereo plotting and compilation, it is crucial to maintain accuracy required for the topographic map and uniformity in criteria for selection of items for representation and methods of delineation, and in quality of every map sheet. Therefore, a detailed manual was prepared specifically for this process of work describing the work procedures and applicable criteria to ensure uniformity.

3-14-8 Field Completion

Field completion was made on the basis of the compiled manuscripts. To meet the schedule on time, duplicates were made combining the compiled manuscripts and annotation data sheets and sent to SK beforehand for inspection. In the field, the national park offices and schools and other public institutions were most cooperative in assisting the work. Delineation of cadastral information onto the compiled manuscripts was completed most efficiently thanks to the systematic survey and inspection by SK.

3-14-9 Drafting

Drafting was done by the color separation scribing method. And printed draft samples were made by the time of field completion, and discussion with SK was held on that basis. When the scribed original was produced, a colored proof on sythesized sheet was generated by water coating method and sent to SK for approval. In the meantime, the chief engineer of the Team was dispatched to Kenya for discussion with SK on the matter and took back the results personally for incorporation in the scribed original without delay.

The scribed original can be used for reproduction in the future and therefore they should be kept by paying attention to temperature and humidity. The comprehensive positive film has been developed to help revision survey of the maps in the future.

3-14-10 Printing

The proof prints of the final products, printed maps, were read and checked by the SK counterpart. Then the maps were printed on the latest model of computer-controlled off-set printing machine with uniformity in printing quality. Quality of map paper with excellent durability was procured to reduce the tears and wears of the maps after repeated use.

3-15 References

[1] JICA : Topographic Mapping of East Kenya in the Republic of Kenya. Final Report, March 1981

[2] JICA : Report of the First Year's Work for the Topographic Mapping of South Kenya in the Republic of Kenya, March 1988

[3] JICA : Report of the Second Year's Work for the Topographic Mapping of South Kenya in the Republic of Kenya, March 1989

[4] JICA : Report of the Third Year's Work for the Topographic Mapping of South Kenya in the Republic of Kenya, March 1990

[5] DOS : East Africa Specifications

Attachments

1. Scope of Work
2. Minutes of Meetings with SK
   - 2-1 "Minutes of Meetings on Plan of Operations for Topographic Mapping of South Kenya"
   - 2-2 "Minutes of Meetings on Progress Report of the First Year's Field Work for Topographic Mapping of South Kenya"
   - 2-3 "Minutes of Meetings on the Second Year's Work for Topographic Mapping of South Kenya"
   - 2-4 "Minutes of Meetings at the End of the Second Year's Field Work of Topographic Mapping of South Kenya"
   - 2-5 "Minutes of Meetings at the Outset of the Third Year's Field Work"
     - 2-5-1 on 11th January, 1990
     - 2-5-2 on 12th January, 1990
     - 2-5-3 on 17th January, 1990
   - 2-6 "Minutes of Meetings at the End of the Third Year's field Work"

Attachments
I. Scope of Work

SCOPE OF WORK

FOR

TOPOGRAPHIC MAPPING OF SOUTH KENYA

IN

THE REPUBLIC OF KENYA

AGREED BETWEEN

MINISTRY OF LANDS AND SETTLEMENT

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

NAIROBI, 19th MARCH, 1987

Mr. DAVID MWIRARIA
Permanent Secretary,
Ministry of Lands and
Settlement

Mr. TAKESHI HIRAI
Leader of Preliminary
Study Team,
The Japan International
Cooperation Agency
(JICA)

Mr. DAVID KAMAU
Director of Surveys,
Survey of Kenya,
Ministry of Lands and
Settlement

Mr. AKIRA TAKAHASHI
Resident Representative,
JICA, Kenya Office

I. INTRODUCTION

In response to the request of the Government of the Republic of Kenya (hereinafter referred to as "Kenya"), the Government of Japan decided to conduct the Topographic Mapping of South Kenya in the Republic of Kenya (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programme of the Government of Japan, will undertake the Study, in close cooperation with the authorities concerned of the Government of Kenya. The Survey of Kenya (hereinafter referred to as "SK") shall act as counterpart agency to the Japanese study team (hereinafter referred to as "the Team") and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

The present document sets forth the scope of work with regard to the Study.

II. OBJECTIVE OF THE STUDY

The objective of the Study is to prepare the 1/50,000 Topographic Map covering an area of approximately 29,800 square kilometers shaded on the attached map (Appendix-1).

III. SCOPE OF THE STUDY

In order to achieve the above mentioned objective, the Study will cover the following items. (The technical details are shown in Appendix-4)

1. Aerial Photography
   Aerial photographs shall be taken at the scale of approximately 1/60,000.

2. Leveling
   Leveling shall be carried out to obtain vertical controls necessary for aerial triangulation and mapping work.

3. Aerial Signals and Pricking
   Aerial signals shall be placed in the field prior to aerial photography, and pricking of identified control points on the aerial photographs shall be done in the field, if necessary.

4. Field verification
   The topographic map information related to land use, vegetation, etc. shall be verified in the field.

5. Aerial Triangulation

Aerial triangulation shall be carried out by analytical method.

Adjustment shall be carried out by block adjustment method.

6. Stereo Plotting

Stereo plotting shall be carried out using stereo plotting instruments at the scale of 1/50,000.

7. Field Completion

Topographic features, vegetation, etc., which cannot be properly identified on the photographs shall be verified in the field and plotted on the compilation sheet.

Administrative boundaries and geographical names shall be verified and indicated on the paper copy of the compilation sheet by SK.

8. Drafting

Based on the compiled sheet, scribing shall be carried out on the stable polyester base for several colors separation plates. Map style and symbols shall be those adopted by SK.

9. Printing

Plate making shall be carried out using 1/50,000 scribed negatives, and printing shall be carried out by the offset method.

IV. STUDY SCHEDULE

The whole work will be conducted in accordance with the attached tentative schedule (Appendix-2).

V. REPORTS AND FINAL RESULT

A report shall be presented to SK by JICA every JAPANESE fiscal year (from April to March)
The materials mentioned in Appendix-3 will be submitted to SK by the Government of Japan.
All maps produced under this project shall bear at the lower margin the following:
This map was prepared jointly by Japan International Cooperation Agency (JICA) under the Japanese Government Technical Cooperation Program and the Government of the Republic of Kenya.

VI. UNDERTAKING OF THE GOVERNMENT OF KENYA

1. To facilitate smooth conduct of the Study, the Government of Kenya shall take necessary measures;

   (1) to secure safety of the members of the Team,
   (2) to permit the members of the Team to enter, leave and sojourn in Kenya for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees,
   (3) to exempt the members of the Team from taxes, duties and other charges on equipment, machinery and other materials brought into Kenya for the conduct of the Study,
   (4) to exempt the members of the Team from income tax and charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Team for their services in connection with the implementation of the Study,
   (5) to provide necessary facilities to the Team for remittance as well as utilization of the funds introduced into Kenya from Japan in connection with the implementation of the Study,
   (6) to secure permission for entry into all necessary areas for the implementation of the Study,
   (7) to secure permission for the Team to take all necessary data and documents, including original negatives of aerial photo, related to the Study out of Kenya to Japan by the Team,
   (8) to provide the medical services as needed. Its expenses will be chargeable on members of the Team.

2. The Government of Kenya shall bear claims, if any arises against the members of the Team resulting from, occuring in the course of, or otherwise connected with the discharge of

their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team.

3. To facilitate smooth conduct of the Study, SK shall take necessary arrangements for the Team as follows, in cooperation with other relevant organizations;

(1) to secure permission for the flight for the aerial photography and use of airports for the implementation of the Study,
(2) to secure permission for the use of communication facilities including transceiver,
(3) to provide necessary game guards to work with the Team, necessary watchmen to look after the camps, and necessary labors.
(4) to obtain the agreement of adjacent countries for the implementation of the aerial photography along the international boundary.

4. SK shall, at its own expense, provide the Team with the followings in cooperation with other related organizations;
(1) available data and information related to the Study,
(2) counterpart personnel (staff of SK),
(3) suitable office space with necessary equipment, e.g. typewriter, furniture and telephones in Nairobi and Mombasa,
(4) credentials or identification cards to the members of the Team,
(5) administrative and technical support,
(6) existing facilities and space of SK for processing the aerial photographs,
(7) information of the necessary administrative boundary and geographical names on the maps, at its full responsibility,
(8) annotation sheets in Kenya.

VII. UNDERTAKING OF JICA

For the implementation of the Study, JICA shall take the following measures, in accordance with the relevant laws and regulations in force in Japan;

1. to dispatch, at its own expense, the Study Team to Kenya for signalization, aerial photography, ground control point survey, pricking, field verification and field completion,
2. to carry out aerial triangulation, stereo plotting, drafting and printing in Japan,
3. to pursue technology transfer to the Kenyan counterpart personnel in the course of the Study.

VIII. CONSULTATION

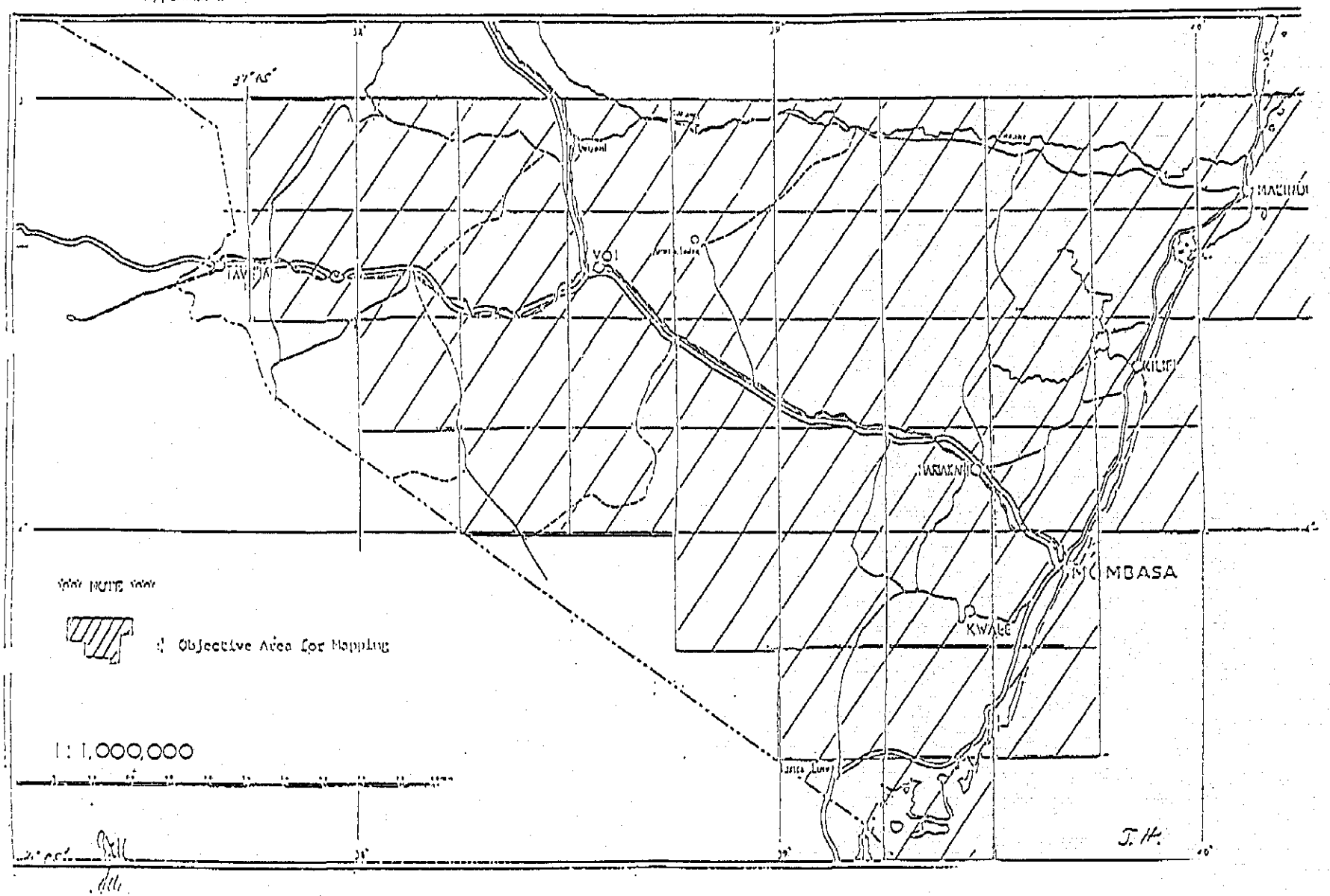
JICA and SK shall consult with each other in respect of any matter that may arise from or in connection with the Study.

NOTE:

1. In case the flight permission for the safety purpose by adjacent country is not available by one month before the operation, topographic mapping area shall be limited to the area of approximately 20 km inside along the international boundary of adjacent country.

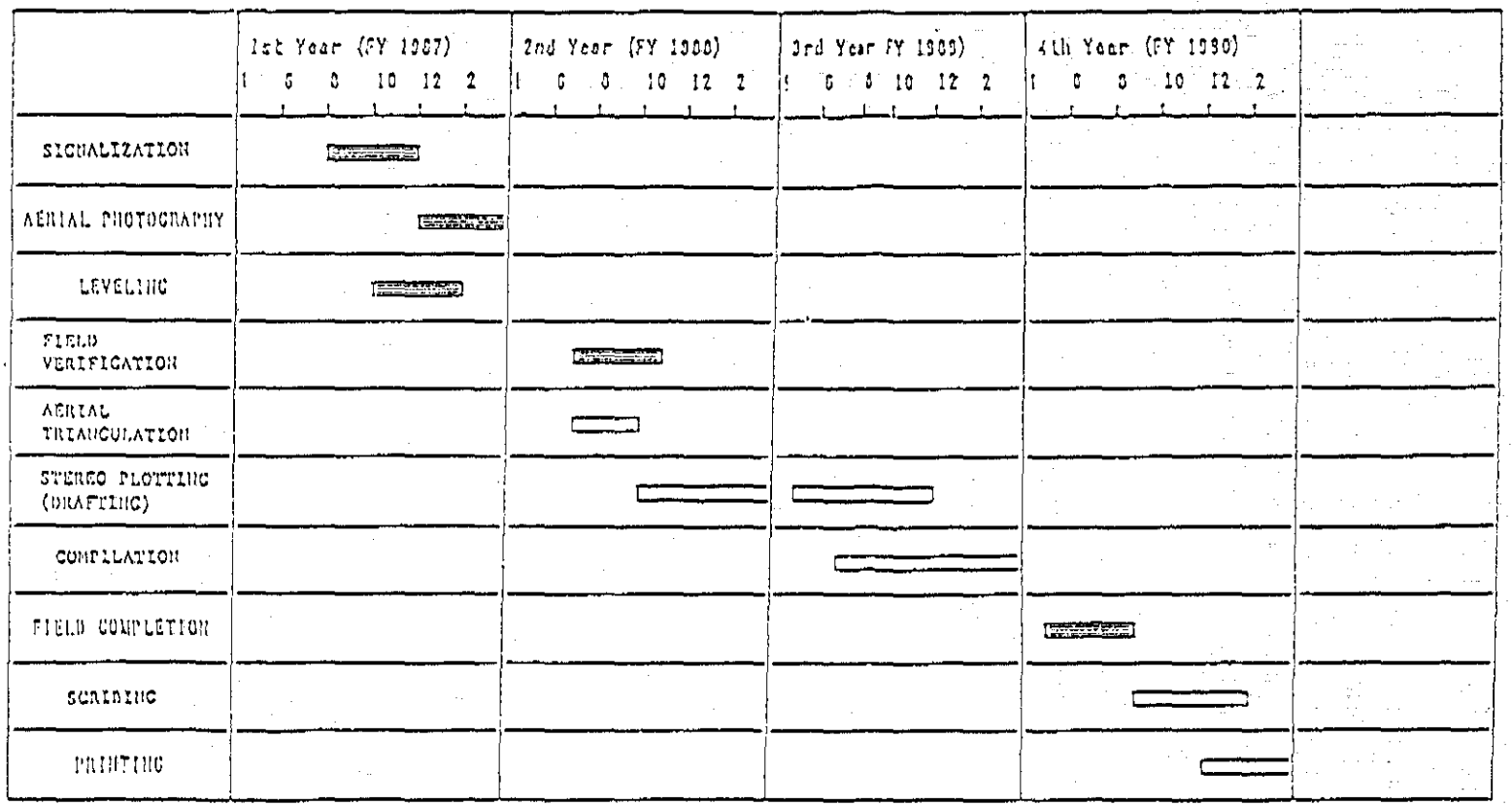
2. In case the aerial photography is not completed due to unexpected weather conditions, JICA and SK will consult with each other in respect of the confirmation of the topographic mapping area.

Appendix-1


MALINDI
VOI
KILIFI
MOMBASA
KWALE
: Objective Area for Mapping
1 : 1,000,000

Appendix-2

Topographic Mapping in South Kenya
TENTATIVE IMPLEMENTATION SCHEDULE



APPENDIX-3

Final Delivery Items

1. Aerial Photography
   (1) original negative-film (1 set)
   (2) contact positive prints (1 set)
   (3) diapositive films (1 set)
   (4) index map of aerial photography

2. Levelling
   (1) final tabulation
   (2) route diagram
   (3) field sheets
   (4) computation sheets

3. Signalization & Pricking
   (1) description of signals & pricks
   (2) reference contact positive photos

4. Aerial Triangulation
   (1) final tabulation
   (2) reference contact positive photos
   (3) diagram of aerial triangulation

5. Field verification
   (1) result photos (1 set)

6. Stereo Plotting, Compilation & Scribing
   (1) original manuscripts
   (2) compilation manuscripts
   (3) annotation material
   (4) separate scribing sheets
   (5) negative-films for printing
   (6) negative screens

7. Printing

(1) printed maps (1,000 copies for each sheet)

(2) Aluminium printing plates

(3) Color progressives

APPENDIX-4

Principal Technical Specification

1. Aerial Photography

   (1) super-wide angle camera (89mm)

2. Levelling

   (1) limit of reciprocal observation $5cm\sqrt{S}$ S:km
   (2) interval of marks 2km

3. Stereo Plotting (Drafting)

   (1) sheet line 15' x 15' in latitude & longitude
   (2) contour interval 20m
   half interval contourline at flat area 10m

2.Minutes of Meetings with SK

2-1 "Minutes of Meetings on Plan of Operations for Topographic Mapping of South Kenya"

MINUTES OF MEETINGS

ON

PLAN OF OPERATIONS

FOR

TOPOGRAPHIC MAPPING

OF

SOUTH KENYA

--- first year ---

NAIROBI, 14th Dec. 1987

MR. O.M. WAINAINA
For Director of Surveys

MR. SHO SAITO
Leader,
JICA Study Team

MR. T. DOHI
Member,
JICA Advisory
Committee

1. Date and time:

3rd Dec. 1987	15:00 - 15:30
4th Dec. 1987	09:00 - 11:20
7th Dec. 1987	09:00 - 11:00

2. Place:

3rd Dec. 1987	Survey Headquarters, Nairobi
4th Dec. 1987	Survey Field Headquarters, Ruaraka
7th Dec. 1987	"

3. Attendants: Attachments - 1, 2, 3

4. The Team briefed on the Plan of Operations for the Topographic Mapping of South Kenya for the first year (refer to Attachment-4) prepared by JICA. SK accepted the Plan.

5. Following matters were discussed and confirmed:

   (1) Concerning the Standards of the Study, the reference ellipsoid shall be Clarke 1880 (modified).
   (2) Concerning the spot height, the distribution shall be more dispersed as found necessary.
   (3) Concerning the results of aerial photography Mission I, number of sets of contact prints and index map shall be changed from two (2) to one (1).
   (4) The Government of Kenya requested the recovery of destroyed monuments of geodetic control points, but the Team could not accept the request because of the shortage of the work period.
   (5) The Team requested the increase of the number of counterparts for the field survey in succeeding phases and the Government of Kenya took note of the request.

6. Mr. Saito, leader of the JICA Study Team, reviewed the "Scope of Work for Topographic Mapping of South Kenya" (refer to Annex 1 of the Attachment-4) agreed between Ministry of Lands and Settlement and JICA on 19th March, 1987, in Nairobi, concerning the undertaking of the Government of Kenya in order to confirm the progress.

7. Mr. Wainaina, Superintending Surveyor, SK, explained the progress of the necessary arrangements. Some of those are:

   (1) SK will issue ID cards for the Team members.
   (2) One office space in Nairobi and one office space and one storage space in Mombasa are ready for the use of the Team.
   (3) SK will issue permission to take survey data, incuding negative films of aerial photographs, out of Kenya to Japan.

(4) SK will provide a list of hospitals for emergency and way of connection to flying doctor.
(5) Counterparts will contact Forest Department or land owners for permission to cut down trees when necessary. For trepassing into private property, they will also help to get clearance when necessary.
(6) For cutting trees, it is necessary to inform of the effects to counterparts in advance for them to take necessary measures.
(7) Permission will be obtained to enter National Parks, Reserves, or limited areas by SK.

8. The Team asked to provide them necessary data for map connection with the maps
(1) along the Tanzanian border,
(2) along the northern border of the project area prepared by JICA,
(3) along the northern border of the project area prepared by Canada.

The Government of Kenya replied as follows for each item:

(1) Field completed compiled manuscripts are availble. Availability of other materials such as results of control point survey and aerial triangulation and pricked diapositives will be investigated,
(2) All necessary materials are available,
(3) Availability will be investigated.

9. Team leader explained the undertaking of Japan.

(1) The Government of Kenya made request of the acceptance of trainees for each stage of the work and the Team took note of the request.
(2) The Government of Kenya made request of the provision of equipments used for the Project and the Team took note of the request.

Attachment - 1

Attendants of Meeting
(3rd Dec. 1987)

1. Government of Kenya

Mr. Absaloms	Deputy Director of Surveys
Mr. Wainaina	Superintending Surveyor Mapping
Mr. Miyazaki	JICA Expert
Mr. Ito	JICA Expert

2. Government of Japan

(1) JICA Kenya Office

Mr. Kaiho	Assistant Resident Representative

(2) JICA Study Team

Mr. Saito	Leader
Dr. Muraoka	Deputy Leader
Mr. Yoshida	Mapping Planner
Mr. Kyakuno	Chief Surveyor
Mr. Nakai	Surveyor
Mr. Kobayashi	Mechanician
Mr. Miyakawa	Surveyor

Attachment - 2

Attendants of Meeting
(4th Dec. 1987)

1. Government of Kenya

Mr. Wainaina	Superintending Surveyor Mapping
Mr. Kibore	Chief Photogrammetrist
Mr. Ndunda	Chief Cartographer
Mr. Chabeda	Chief Lithographer
Mr. Miyazaki	JICA Expert
Mr. Ito	JICA Expert

2. Government of Japan

(1) JICA Kenya Office

Mr. Kaiho	Assistant Resident Representative

(2) JICA Study Team

Mr. Saito	Leader
Dr. Muraoka	Deputy Leader
Mr. Yoshda	Mapping Planner
Mr. Kyakuno	Chief Surveyor
Mr. Nakai	Surveyor
Mr. Kobayashi	Mechanician
Mr. Miyakawa	Surveyor

Attachment - 3

Attendants of Meeting
(7th Dec. 1987)

1. Government of Kenya

Mr. Wainaina	Superintending Surveyor Mapping
Mr. Kibore	Chief Photogrammetrist
Mr. Chabeda	Chief Lithographer
Mr. Okumu	Officer in Charge, Technical Section
Mr. Ogutu	Senior Cartographer (Mapping Branch)
Mr. Miyazaki	JICA Expert

2. Government of Japan

(1) JICA Kenya Office

Mr. Kaiho	Assistant Resident Representative

(2) Advisory Group

Mr. Dohi	Head, Planning Div., Topo. Dept., Geographical Survey Institute
Mr. Kobayashi	Staff, Social Development Coop. Dept., JICA

(3) JICA Study Team

Mr. Saito	Leader
Dr. Muraoka	Deputy Leader
Mr. Yoshida	Mapping Planner
Mr. Kyakuno	Chief Surveyor

Attachment - 4

PLAN OF OPERATIONS
FOR THE
TOPOGRAPHIC MAPPING
OF
SOUTH KENYA
IN THE
REPUBLIC OF KENYA

--- 1st Year ---

October, 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

PLAN OF OPERATIONS
FOR THE
TOPOGRAPHIC MAPPING
OF
SOUTH KENYA
IN THE
REPUBLIC OF KENYA

I. INTRODUCTION

In response to the request of the Government of the Republic of Kenya (hereinafter referred to as "Kenya"), the Government of Japan (hereinafter referred to as "Japan") decided to conduct the Topographic Mapping of South Kenya in Kenya (hereinafter referred to as the "Study").

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of Japan, will undertake the Study, in close cooperation with the authorities concerned of Kenya. Survey of Kenya, Ministry of Lands and Settlement, (hereinafter referred to as "SK") shall act as counterpart agency to the Japanese study team (hereinafter referred to as the "Team") and also as coordinating body in relation to other governmental and non-governmental organizations concerned of Kenya for the smooth implementation of the Study.

II. OBJECTIVE OF THE STUDY

The objective of the Study is to prepare the 1/50,000 topographic map covering an area of approximately 29,800km^2 in South Kenya from east of Long. 37° 45' E to the coast and south of Lat. 3° S to the Kenyan territory of the Tanzanian border as shown in Fig. 1. Main items of the Study are as follows:

1. Aerial photography	approximately 29,800km^2
2. 1/50,000 topographic mapping	approximately 29,800km^2
	43 sheets.

III. SCOPE OF WORK

The scope of work to achieve the captioned objective is stated in a document entitled "Scope of Work for Topographic Mapping of South Kenya in the Republic of Kenya" agreed between the Ministry of Lands and Settlement and the Japan International Cooperation Agency issued on 19th March, 1987, in Nairobi, Kenya (Annex 1, hereinafter referred to as "S/W"). It covers

Aerial photography, Leveling, Aerial Signal and Pricking, Field Verification, Stereo Plotting, Field Completion, Drafting and Printing.

The Volume of the Study is tabulated in Table 1.

Table 1 Volume of the Study

Item	Volume	Remark
Aerial photography	approx. 29,800km^2	scale 1/60,000 (whole project area)
Leveling	approx. 720km	minor order leveling (including pricking)
Aerial signal	40 points	
Pricking	approx. 700km	existing bench marks
Field verification	approx. 29,800km^2	
Aerial triangulation	approx. 725 models	
Plotting and Compilation	approx. 29,800km^2	
Field completion	approx. 29,800km^2	
Drafting	approx. 29,800km^2	
Printing	43 sheets in 6 colours 1,000 copies each	

IV. STANDARDS OF THE STUDY

Survey standards and map accuracy are as follows:

1. Reference ellipsoid: Clarke, 1880
2. Geodetic coordinate system: New Arc 1960
3. Datum of height: Mean sea level at Port Mombasa
4. Map projection: UTM, Zone 37
5. Neat lines: 15' x 15'

6. Contour line:	Intermediate contour-20m (supplementary half interval contour-10m, subject to topography)
7. Spot height:	every 5 cm on the map in average (including photogrammetric spot height)
8. Map style and its application rule:	Those adopted for the Topographic Mapping Project for East Kenya Area, 1981, by JICA (Annex 2)

9. Map accuracy

a. Planimetry of conspicuos ground feature:	not more than 0.5mm on the map
b. Spot height:	not more than 1/3 of contour interval (6.7 m)
c. Contour:	not more than 1/2 of contour interval (10 m)
d. Grid line:	Grid lines shall be drawn every 1 km. The accuracy of plotting shall be not more than 0.15 mm on the map.

V. UNDERTAKING

The study shall be carried out in close cooperation between Kenya and Japan. Undertaking of both sides is stated in S/W (Annex 1). It is summarized as follows:

a. Kenyan side,

(1) Going through formalities necessary for the Team to enter, stay, work and leave Kenya.

(2) Taking measures to aquire permits for the Team necesary to conduct the Study.

(3) Provision of facilities for the smooth conduct of the Study.

b. Japanese side,

(1) Execution of the Study in Kenya and Japan at its own expense.

(2) Transfer of technology through the execution of the Study.

VI. WORK PLAN

The entire work shall be carried out under a four-year programme starting from October, 1987, and acomplishing in March, 1991. It shall consist of the following four phases in accordance with the time schedule shown in Fig. 2.

1. Phase I (First Year, 1987): Aerial Signal, Aerial Photography, Pricking and Leveling

1 - 1. Aerial Signal

To secure the proposed map accuracy, the accuracy of horizontal control point shall be not more than

0.07 mm x 1/plotting scale (= 0.07 mm x 50,000 = 3.5 m).

For horizontal control of photographs for aerial triangulation, 40 points of existing 1st and 2nd order triangulation and traverse points shall be used. The distribution plan is shown in Fig. 3. Aerial signals shall be set up on these proposed photo-control points.

1 - 2. Aerial Photography

Black and white panchromatid aerial photography shall be carried out in dry season with a super-wide angle camera (f = 8.8 cm) in two missions.

1 - 2 - 1. Mission I.

For pricking of existing bench marks and along proposed leveling routes, aerial photography shall be carried out in a form of strip courses for approximately 1,500 line km along these leveling routes at a scale of 1/40,000 as shown in Fig. 4. This mission is done for the efficiency of the time schedule.

1 - 2 - 2. Mission II.

For mapping, the proposed mapping area of approximately 29,800km^2 shall be flown at a scale of 1/60,000 as shown in Fig. 5.

1 - 3. Pricking.

For vertical control of aerial photographs for aerial triangulation and mapping, existing bench marks shall be pricked (approximately 700 km). Pricking of proposed leveling routes (approximately 720 km) shall also be done for the same purpose at the time of leveling work. Twice enlargement of 1/40,000 aerial photograph shall be used in the field and later pricked points shall be transferred onto the 1/60,000 aerial photograph when necessary.

1 - 4. Leveling.

To secure the proposed map accuracy, the accuracy of vertical control points shall be not more than

0.07 x contour interval (= 0.07 x 20 m = 1.4 m).

For vertical control of photographs for aerial triangulation and mapping, existing 1st and 2nd order bench marks shall be used. The distribution of existing bench marks, however, is not sufficient for aerial triangulation and mapping. Consequently, minor order leveling shall be carried out to supplement existing bench marks. Minor order leveling of the accuracy of 5 cm$\times\sqrt{S}$. Where S is the route length in km shall be carried out for approximately 720 km along main roads or national park boundaries where leveling work is found feasible, starting from and closing to existing bench marks. (Fig. 3)

Marking shall be done by utilizing conspicuous ground features or setting up marks every 2 km in average.

Pricking shall be done on aerial photographs for the vertical control for aerial triangulation and mapping on the above points and at knick points of topography along leveling routes at the time of leveling work.

Prior to the execution, reconnaissance shall be carried out for proposed leveling routes to alocate marks and for existing bench marks to find out if it is necessary to recover them in order to use them as given points for the minor order leveling.

2. Phase II (Second Year, 1988). Field Verification, Aerial Triangulation, Stereo Plotting and Compilation

2 - 1. Field Verification

Prior to field survey for verification, reconnaissance study (photo-interpretation) shall be carried out using aerial photographs and reference data collected beforehand.

In compliance with the map style and its application rule, selection of items to express on the map and topographic information related to classification of ground features shall be verified and objects which are hard or impossible to interpret on the aerial photograph shall be clarified in the field. The key for photo-interpretation needed for mapping shall be prepared. Geographical and administrative names shall be collected and verified by SX.

2 - 2. Aerial Triangulation.

To obtain coordinates of pass points and tie points, aerial trianbgulation shall be carried out by analytical method using 1/60,000 aerial photographs, comparators and electronic computers. Approximately 725 models shall be adjusted by block adjustment method.

The residual of the ground control points after adjustment and discrepancy at tie and pass points between adjacent models shall be not more than

0.8 per mil of the flight height

$\fallingdotseq$ 5,400 m x 0.8 per mil $\fallingdotseq$ 4.3 m

for both planimetry and altitude.

2 - 3. Stereo Plotting and Compilation

Stereo plotting shall be carried out by 1/60,000 aerial photograph and stereo plotting machine at the scale of 1/50,000 using the results of aerial triangulation and those obtained by field verification. Intermediate contour shall be plotted at 20 m intervals. 10 m of supplementary half interval contour shall be plotted for flat area, if necessary. The photogrammetric spot height shall be plotted every 5 cm in average on the map taking the distribution of control points into consideration.

Results shall be compiled in the format of the sheet lines of 15' X 15'. Along the northern boundary of the Study area lie the area mapped by JICA in the eastern part and that by Canada in the western part. Along the southern boundary to Tanzanian territory, the Ordnance Survey, England, is executing mapping. The connection of maps among these maps shall be taken into consideration. Necessary data for the connection, such as pricked diapositives, results of aerial triangulation, copies of original manuscript of maps, etc., shall be obtained through SK. The discrepancy of connection shall be adjusted, if it is the order of 1 mm on the map. Otherwise, it will be disregarded.

This work shall be continued to Phase III.

3. Phase III (Third Year, 1989): Stereo Plotting and Compilation (continued) and Field Completion

3 - 1. Stereo Plotting and Compilation (continued)

A part of the stereo plotting and compilation works shall be continued to this phase.

3 - 2. Field Completion

Topography, ground features, vegetation, etc., which cannot be properly identified on the aerial photographs during plotting and compilation works, shall be verified in the field and inscribed on the copies of the compiled manuscript printed on the synthesized polyester sheets. Administrative and geographical names and administrative boundaries shall be verified, confirmed and indicated on the paper copy of the compiled manuscript by SK.

4. Phase IV (Fourth Year, 1990). Drafting and Printing

4 - 1. Drafting

Based on the field completed compiled manuscript, (original manuscript), negative scribing and preparation of masks and sheets for marginal information for printing plate making shall be carried out on stable polyester bases for 6 colour separation. Map style and symbols shall be discussed with SK. These sheets shall be composed so that one colour may be in one sheet for the sake of printing plate making.(preparation of composite negative) A composite positive shall also be prepared consisting mainly of linear elements for the maintenance (revision) of maps.

4 - 2. Printing.

Making of printing plate shall be carried out using 1/50,000 composite negatives by photo-lithography.

Printing shall be carried out in 6 colours by the offset printing machine. Number of copies to be printed shall be 1,000 for each map. Specifications and size of printing paper shall be decided after discussion with SK.

5. Work Schedule.

Work schedule is shown in Fig. 2.

VII. PLAN OF OPERATIONS FOR PHASE I (FIRST YEAR, 1987)

The work for Phase I (first year, 1987) is devoted to field surveys. Field work shall be carried out during 1st December, 1987, and 3rd March, 1988 (94 days). During the period, team leader, deputy leader, mapping planner, chief engineer, mechanic and 12 members consisting of 6 parties, each of which is composed of two members - totaling to 17 member shall be dispatched for about 3 months and one member for the inspection of aerial photographs for about 2 months to the field.

1. Preparation

Before arrival of the main team to Kenya, team leader, deputy leader and other 5 staffs shall arrive in Nairobi to prepare for their reception. The main duties are as follows. Of those the items especially indebted to the cooperation of SK are:

a. To discuss plan of operations with SK,

b. To secure permission for the flight for the aerial photography and use of airports (Malindi and/or Mombasa),

c. To secure permission for the use of communication facilities. The team is equipped with 7 JRC 10 W Portable HF SCB Radiotelephones JSB-20 with frequencies of 4055 and 6098 KHz.

d. To provide game scouts, watchmen, laborers and drivers,

e. To obtain the agreement of Tanzania for the implementation of aerial photography along and over the national boundary,

f. To arrange to study and/or copy materials related to the Study, such as existing aerial photographs, survey results and descriptions of points and place names kept by SK, for reviewing survey plan,

g. To announce to authorities concerned,

h. To ask SK to contact with Tanzanian government to obtain necessary data for map connection with the map in Tanzania from Ordnance survey,

i. To ask SK to assign counterpart personnel,

j. To ask SK to obtain credentials or identification cards to the Team members,

k. To ask SK to issue permit to enter into private properties and national parks to execute survey work when necessary.

Besides the aboves, followings shall be dealt with cheifly by the Team:

l. To prepare to establish headquarters and sub-camps in the field.

m. To receive shipped equipments, machinery and other materials,

n. To purchase equipments, machinery and other materials in Nairobi,

o. To hire vehicles,

p. To contract with local private aerial survey firm for aerial photography.

2. Aerial Signal

40 points shall be selected for horizontal control of aerial photographs among existing 1st and 2nd order triangulation or traverse points, on which aerial signals shall be set up. Proposed signalizing points shall be distributed as shown in Fig. 3. Specifications of the signals are as follows:

1. Type: four-leaf type in principle. However, three-leaf type may be adopted according to the circumstances,
2. Size: size of a leaf shall be 1 m x 5 m,
3. Material: fragments of concrete or rock,
4. Colour: white in principle. Other colours may be adopted according to the ground conditions. The configuration is shown in Fig. 6.

To secure head clearance, eccentric setting up of the signal is allowed. In this case, eccentricity shall be measured.

At all the signalized points, the eccentricity of at least one conspicuous ground feature in the neighbourhood shall be measured so that the object may be used as an alternative of a control point, in case the aerial signal will not be clearly identified on the photograph. After taking aerial photographs, checking shall be made. If the aerial signals or the above mentioned alternatives are not clearly identifiable on the photograph, another identifiable ground feature shall be pricked in their neighborhood with eccentric measurement, if necessary.

The principal equipments to be used for the work shall be,

Transit	T2
Electro-optical distance meter	HP 3808 A
Radiotelephone	

3. Aerial photography

Two missions of aerial photograph shall be carried out by contracting with a local private aerial survey firm. The air base for the work shall be in Malindi and/or Mombasa and final products shall be prepared in Nairobi. For the contract, supervision of the work and inspection of the results, two engineers shall be dispatched. Except the inspection of the results, the works shall be in charge of members of the field headquarters.

3 - 1. Mission I.

For the efficiency of the execution of the Study, prior to pricking of existing bench marks and proposed leveling routes, aerial photography shall be carried out along these leveling routes (Fig. 4) with a single strip course under the following specifications:

a. Period: November, 1987
b. Camera: super-wide angle camera
c. Photographic scale: approximately 1/40,000 in principle. However, larger scales are acceptable according to unfaborable weather conditions.
d. Forward overlap: 10% + 5%
e. Flight length: approximately 1,500 km
   along existing leveling routes approximately 740 km
   along proposed leveling routes approximately 760 km
f. Cloud coverage: not to disturb leveling routes for pricking
g. Number of photographs: approximately 190
h. Film: black and white panchromatic

i. Printing paper: Kodak RC paper or equivalent

j. Results:

original negative	1 set
contact print	2 sets
double enlargement *	1 set
index map	2 sets
flight record	1 set

* No needed, if the photographic scale becomes larger than 1/20,000.

3 - 2. Mission II.

Aerial photography shall be executed covering the proposed mapping area of approximately 29,800 km^2 east of Long. 37 45' E and south of Lat. 3 down to the Tanzanian border. The height difference between inland and coastal areas being over 1,000 m and the climatic conditions between the two areas being different, the proposed area shall be devided into two large blocks and the datum height planes for flight for each area shall be differed and flight direction shall be east-west for the western block and approximately north-west along the coastal line for the eastern block (Fig. 5). The latter shall be overlapped at least one course over the former. A tie course shall be flown along the Tanzanian border owing to the low density of ground control points. Main specifications for the aerial photography shall be as follows:

a. Period: From January to February, 1988

b. Camera: Super-wide angle camera

c. Area to be covered: proposed mapping area of approximately 29,800 km^2 in the South Kenya region as shown in Fig. 5 shall be covered.

d. Photographic scale: approximately 1/60,000

e. Flight course: 25 courses (including one tie course)

eastern block (approximately north-south)	12 courses
western block (east-west)	12 courses
tie course (along Tanzanian border)	1 course

f. Flight length: Total flight length shall be approximately 4,000 km.

g. Flight height:

eastern block	5,840 m	(datum plane 500 m)
western block	6,340 m	(datum plane 1,000 m)
tie course	5,840 m	(datum plane 500 m)

h. Forward overlap: 60% $\pm$ 5%

i. Lateral overlap: 30% $\pm$ 5%

Lateral overlap for two courses along coast shall be 40 %. Caution shall be taken so that the principal points of photographs of the inner course may fall on land.

For the courses flying over the Taita-Hills in the western block, forward and lateral overlaps shall be enough not to leave stereoscopic blank area.

J. $\varkappa$: not more than 10 degrees

ψ and ω : not more than 5 degrees

k. Cloud coverage: Amount of cloud shall not exceed 3 % in successive 5 photographs. However, important areas for orientation and cartography shall not be covered with clouds.

l. Number of models: approximately 725

m. Number of photographs: approximately 750

n. Film: black and white panchromatic

o. Printing paper: Kodak RC paper or equivalent

p. Results:

original negative	1 set
contact print	2 sets
index map	2 sets
flight record	1 set

Exposed original negatives being taken out to Japan, extra copy of contact prints shall be prepared and left in Kenya for security.

In the eastern block, the flight course being along coastal line, there may happen to produce incomplete or independent models. Examination shall be done if additional ground control survey is necessary for these models.

4. Pricking of Existing Bench Marks.

For vertical control of aerial photographs for aerial triangulation and plotting, existing bench marks shall be pricked on the double enlargement of 1/40,000 aerial photographs. Later they shall be transferred onto the 1/60,000 aerial photographs.

5. Leveling

5 - 1. Planning and point selection

Number and distribution of existing bench marks are not enough for aerial triangulation, vertical control points shall be increased by executing minor order leveling for approximately 720 km along existing roads and national park boundaries as shown in Fig. 3. The plan having been made by using existing small scale maps, it is necessary to check the plan by reconnaissance survey and examine the necessity of modification of the original plan.

Along leveling routes, marks shall be set up every 2 km in average and their heights shall be calculated. Care shall be taken to include knick points of topography. Marks shall be made of wooden stick or a part of stick ground features shall be used for them.

5 - 2. Observation

Observation shall be made by double observation by 5 parites starting from an existing bench mark and closing to another existing one. Otherswise, routes shall close to themselves. Prior to observation, check observation shall be made for at least two neighboring existing bench marks, on one of which the minor order leveling is based. When the result of check observation is coincident with the nominal value within the accuracy of the check observation, the nominal value of the bench mark shall be adopted as given value. Otherwise check observation shall be extended to reach within the tolerable closure and newly observed value shall be taken as given.

Observed marks shall be pricked on the double enlargement of 1/40,000 aerial photographs at the time of observation and later they shall be transferred on to the 1/60,000 aerial photographs as in the case of pricking of existing bench marks.

Accuracy of observation:	50 mm x $\sqrt{S}$, where S is the route length in km.
Instrument to be used:	Autolevel Zeiss N2
Staff:	wodden folding staff
Staff stand:	
Radiotelephone:	

6. Others

In order to conduct smoothly the Phase II's (second year's) field survey, field verification, followings shall be discussed with SK.

a. Item to inscribe on the map and their application rule (map style and its application rule),
b. Collection of materials related to the above.
c. Issue of permit to take exposed original negatives out of Kenya to Japan.
d. Safe-keeping of equipments and materials to be left in Kenya until the next Phase.

VIII. ORGANIZATION OF THE TEAM

Organization of the Team is as follows:

Duty	Member	Number for a party	Number of parties	Total
Leader	Japanese engineer			1
Deputy-leader	"			1
Mapping planner	"			1
Chief-engineer	"			1
Mechanic	"			1
	driver			1
	vehicle			1
Aerial signal	Japanese engineer	2	6	12
	counterpart			2
	laborer	10	6	60
	driver			14
	vehicle (including 2 trucks)			14
Pricking of	Japanese engineer	2	1	2
existing bench	counterpart	1	1	1
mark	laborer	8	1	8
	driver	2	1	2
	vehicle	2	1	2
Leveling	Japanese engineer	2	5	10
	counterpart			1
	laborer	5	5	25
	driver			9
	vehicle (including 2 trucks)			9

Inspection of	Japanese engineer	1	1	1
aerial photograph	driver	1	1	1
	vehicle	1	1	1

IX. WORK SCHEDULE

The work for Phase I (first year) starts on 1st December, 1987 and shall continue to 3rd March, 1988. Detailed work schedule is shown in Tab. 2.

Tab. 2 Work Schedule for Phase I

Item \ Date	10	11	12	1	2	3	4
Mob.,demob.			1 ——7		25 ——3		
Aerial photography		1———	30	25———————		3	
Aerial signal			8 —————	11			
Pricking				12—————	25		
Leveling				12—————	25		

X. FINAL PRODUCTS

Final products of Phase I (first year) are as follows:

1. Aerial signal

a. Description of aerial signal	1 set
b. Field note and computation sheet for eccentricity measurement	1 set
c. Aerial photograph showing aerial signal	1 set
d. Index map	1 set

2. Aerial photography

a. Original negative film	1 set for Missions I & II
b. Contact print	2 sets for Missions I & II
c. Double enlargement	1 set for Mission I
d. Photo index map	2 sets for Missions I & II
e. Flight record	1 set for Missions I & II

3. Pricking and leveling

a. Field note	1 set
b. Tabulation of observed results and adjusted values	1 set
c. Computation note	1 set
d. Index map	1 set
e. Pricked photograph	1 set
f. Description of point	1 set

XI. REPORT

The progress report of Phase I shall be prepared.

XII. DRAFT OF PLAN OF OPERATIONS FOR SUCCEEDING PHASES

Draft of the plan of operations for succeeding phases is attached as Attachment.

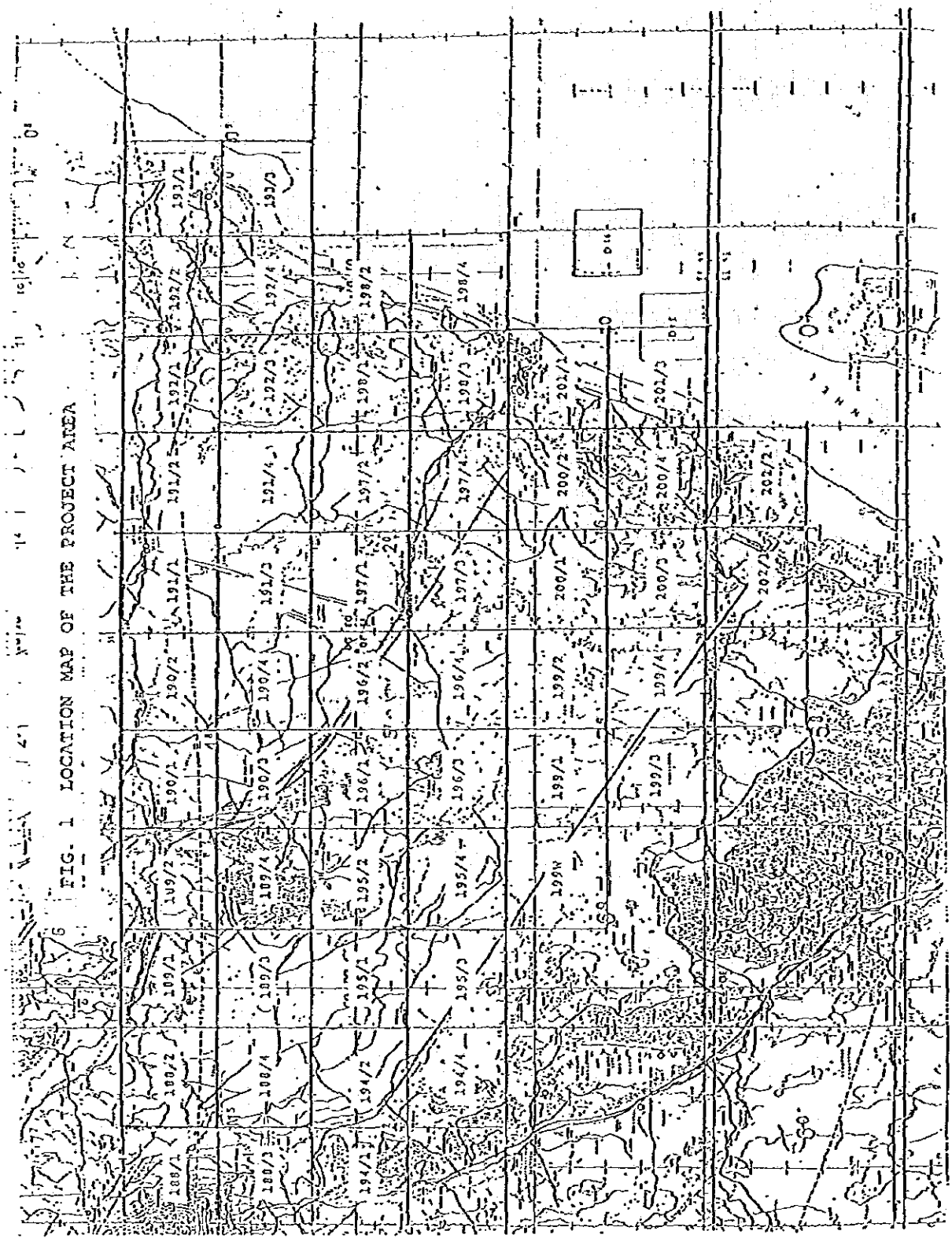


FIG. 1 LOCATION MAP OF THE PROJECT AREA

Fig. 2 WORK SCHEDULE

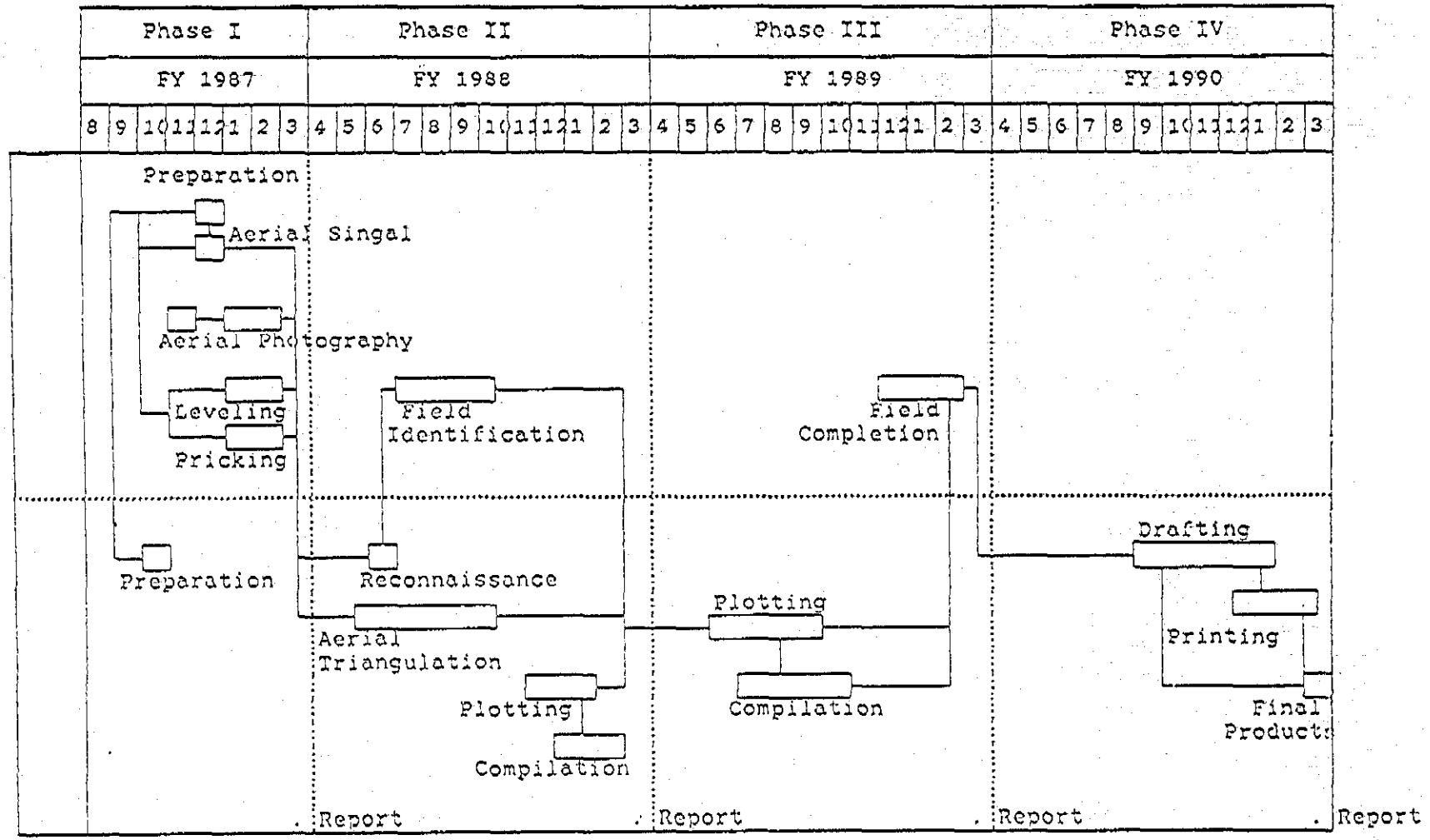


FIG. 3 DISTRIBUTION OF CONTROL POINTS

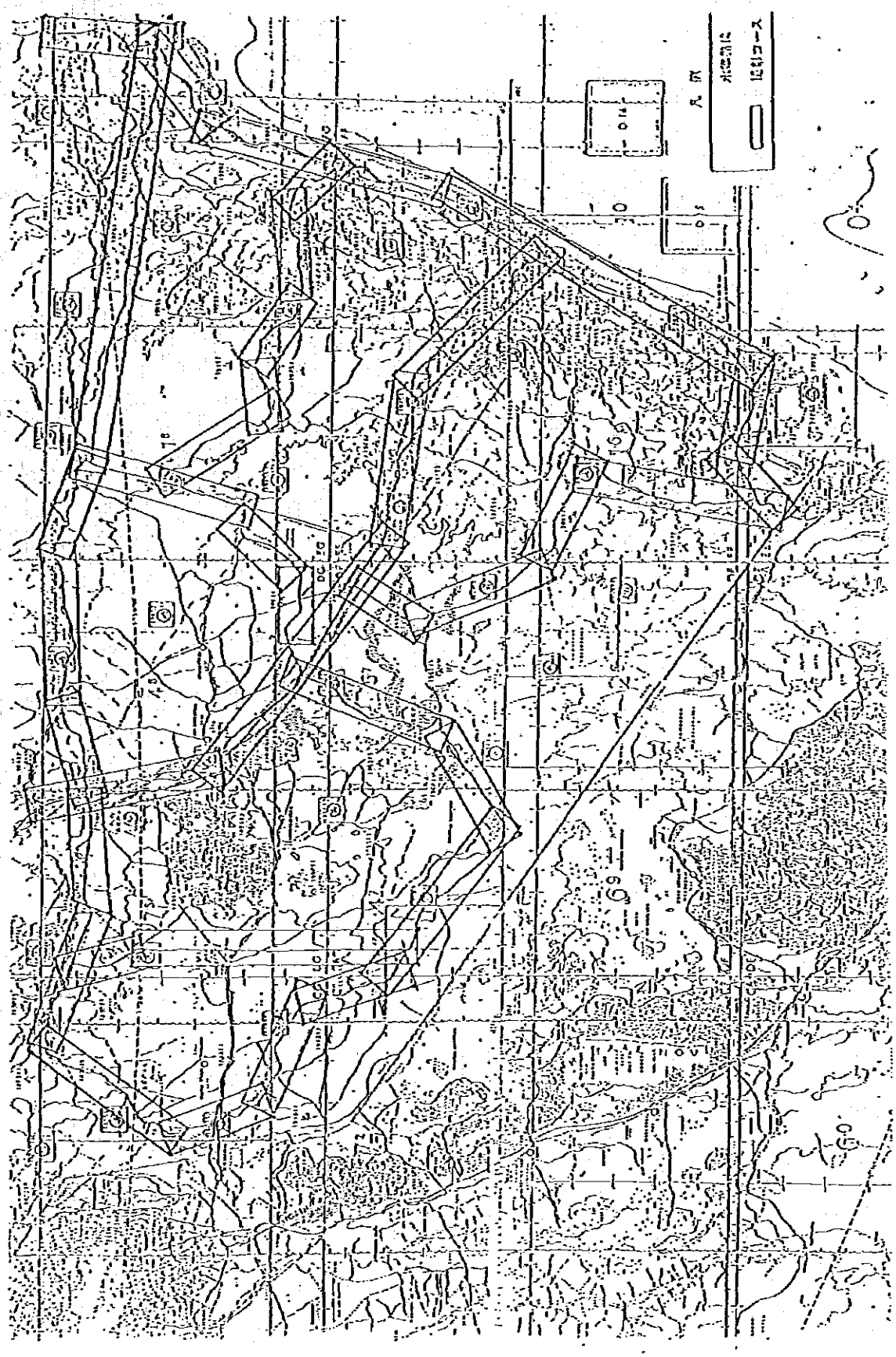
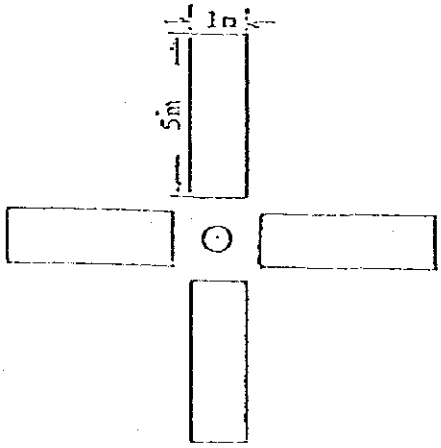
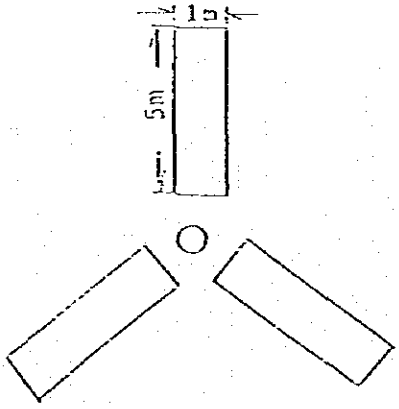


FIG. 4 AERIAL PHOTOGRAPHY FOR LEVELING ROUTES

FIG. 5 1/60,000 AERIAL PHOTOGRAPHY

FIG. 6 AERIAL SIGNAL





ATTACHMENT

DRAFT OF PLAN OF OPERATIONS FOR SUCCEEDING PHASES

The draft of plan of operations for succeeding phases is tentatively set up as follows. They are, however, subject to modification according to the progress of the Study of the preceding phase and/or to other conditions which may affect the Study.

I. PHASE II (SECOND YEAR, 1988).

1. Field Survey.

1 -- 1. Field Verification.

Using aerial photographs, the keys for photo-interpretation needed for plotting and cartography shall be prepared by verifying them in the field.

Based on the application rule of the map style, necessary items to represent on the map shall also be collected and verified in the field. Close cooperation of the SK counterparts is cordially requested.

1 - 1 - 1. preparation.

Prior to proceeding into the field, reconnaissance study shall be carried out in Japan to prepare materials which need field verification.

a. Thorough study of collected materials and pointing out of doubtful points,

b. Execution of photo-interpretation and picking up of keys necessary to verify,

c. Study of aerial photographs to point out points difficult to interpret and confirmation of the Study area,

d. Preparation of double enlargement of 1/60,000 aerial photographs which shall be used for field verification.

1 - 1 - 2. Discussion with SK.

Concerning field verification, items to discuss with SK and to be confirmed are as follows:

a. Map style and its application rule,

b. Administrative names and boundaries,

c. Data concerning names of following items:
puhlic building, church, mosque, road, railway, mountain, river, park, etc.,

d. Representation of military facilities,

e. Name and/or number of each map sheet,

f. Marginal information and legend.

1 - 1 - 3. Items of field verification.

In compliance with the map style and its application rule, followings shall be investigated and confirmed in the field:

a. Result of reconnaissance study.

b. Key for photo-interpretation,

c. Items difficult ot inerpret on the photograph.

d. Following items to represent on the map:

road, railway, building, control point, specified area, river, vegetation, topography, etc.,

e. Names necessary for annotation, administrative boundaries.

1 - 1 - 4. Adjustment.

Results of field verification shall be adjusted on the double enlargement of 1/60,000 aerial photographs.

2. office Work.

2 - 1. Aerial Triangulation.

Aerial triangulation is carried out as follows:

a. Using pricked diapositives of 1/60,000 aerial photograph on which aerial signals are photographed, coordinates of pass points, control points, etc necessary for plotting are measured by stereo-comparator.

b. Adding the results of ground control point survey, adustment computation is executed.

c. Coordinates of pass points and orientation elements of aerial photographs are calculated.

2 - 1 - 1. Method.

Aerial triangulation is done analytically by the block adjustment method by means of independent models. PAT-M43 program shall be used.

2 - 1 - 2. Area covered.

The area for aerial triangulation covers the whole area of 1/50,000 topographic mapping.

2 - 1 - 3. Distribution and number of control points.

Distribution of horizontal control points is shown in Fig. 3. Their number shall be 40. Vertical control points shall be selected among pricked bench marks.

2 - 1 - 4. Selection of pass points.

Pass points shall be selected so that their position shall be appropriate for orientation of aerial photographs and that it shall be correctly measurable on the photograph.

2 - 1 - 5. Adjustment computation.

a. The residuals of ground control points and discrepancies of pass points and tie points between adjacut models after adjustment shall be less than 0.8 per mil of the flight height for both planimetry and altitude.

b. When adjustment computation is made by dividing into blocks, the discrepancy of tie points between adjacent blocks shall be less than 0.9 per mil of the flight height for both planimetry and altitude.

2 - 2. Stereo Plotting (Restitution).

Using the results of aerial triangulation and field verification, necessary items for representing on the map shall be measured and plotted by stereo plotting machine and plotted manuscript of the topographic map shall be prepared.

2 - 2 - 1. Material.

For restitution, stable polyester sheet shall be used.

2 - 2 - 2. Neat lines.

Neat lines shall be 15' x 15'.

2 - 2 - 3. Plotting.

Neat lines, control points and grid lines are plotted using automatic coordinategraph. The maximum discrepancy shall not exceed 0.15 mm on the map.

2 - 2 - 4. orientation.

a. After absolute orientation of the photographs, the discrepancy between the plotted points and their model points shall be not more than 0.3 mm on the map.

b. For orientation of height, pricked leveling points shall be used as many as possible for the sake of accuracy of height.

2 - 2 - 5. Restitution.

a. Restitution shall be executed in accordance with the map style and its application rule in the order of linear elements, like roads, rivers, railways, etc., buildings, vegetation and contour lines.

b. If necessary, planimetry and contour lines can be restituted on separate sheets.

c. Intermediate contour shall be 20 m and half interval contour lines of 10 m shall be supplemented according to topography. Care must be taken for the representation of micro topography, the project area being rich in various types of ground features and topography like hill, plain, forest, wadi, cultivated land, etc.

2 - 2 - 6. Measurement of spot height.

a. Spot height shall be measured photogrammetrically at distinct knick points of topography.

b. Spot height shall be distributed at equal density as much as possible.

c. Density of spot height shall be generally one point per 5 cm x 5 cm on the map including the distribution of vertical control points.

2 - 3. Compilation.

2 - 3 - 1. Compilation

a. On the basis of the plotted manuscript, compilation shall be carried out using the results of field verification and materials collected.

b. If any doubtful point arises during compilation, it shall be noted to clarify at the time of field completion.

c. Annotation items shall be compiled on a separate sheet using plotted manuscript and data obtained by field verification.

2 - 3 - 2. Connection.

Map connection shall be made between

a. existing 1/50,000 topographic map along the northern edge of the project area,

b. 1/50,000 topographic map being worked by the Ordnance Survey along the southern border to Tanzania.

However, connection shall not be made if the discrepancy is the order of 1 mm and more.

3. Report.

The progress report for Phase II shall be prepared.

4. Organization of the Team.

The organization of the Team is as follows:

Duty	Member	Number for a party	Number of parties	Total
Leader	Japanese engineer			1
Deputy Leader	"			1
Mapping Planner	"			1
Chief engineer	"			1
Mechanic	"			1
	driver			1
	vehicle			1
Field	Japanese engineer	2	5	10
verification	counterpart			2
	laborer	3	5	15
	driver			12
	vehicle (including 2 trucks)			12

5. Work Schedule.

Work schedule for Phase II is shown in Fig. 2 of the main text.

II. PHASE III. (THIRD YEAR, 1989)

1. Office Work.

1 - 1. Plotting and Compilation

A part of plotting and compilation shall be continued from Phase II to prepare compiled manuscript of the 1/50,000 topographic map.

1 - 2. Preparation of Original Manuscript.

Using the results of field copletion, original manuscript of the 1/50,000 topographic map shall be prepared from the compiled manuscript.

2. Field Survey

2 - 1. Field Completion.

In field completion, important items to be represented on the map - topography, ground features and place names - and doubtful points arisen in plotting and compilation shall be clarified in the field.

For verification and inscription of names and administrative boundaries, close cooperation of SK counterparts is cordially requested. Important change of ground features after aerial photography shall be supplemented in the field.

The results of the field survey shall be put on blue print copy of the compiled manuscript.

3. Report.

The progress report of Phase III shall be prepared.

4. Organization of the Team.

Organization of the Team is as follows:

Duty	Member	Number for a party	Number of parties	Total
Leader	Japanese engineer			1
Deputy leader	"			1
Mapping planner	"			1
Chief engineer	"			1
Mechanic	"			1
	driver			1
	vehicle			1
Field	Japanese engineer	2	4	8
completion	counterpart			2
	laborer	4	4	16
	driver			10
	vehicle (including 2 trucks)			10

5. Work Schedule.

Work schedule is shown in Fig. 2 of the main text.

III. PHASE IV (FOURTH YEAR, 1990)

1. Drafting.

Using original manuscript, road classification data, annotation sheet, etc., final drafting shall be carried out by colour separation negative scribing method to be ready for making plates for printing. Negative scribed sheets, negative mask sheets and positive sheets for annotation and marginal information shall be prepared.

1 - 1. Map style

Map symbols shall be finally determined after discussion with SK in timne for drafting.

1 - 2. material.

Stable synthesized polyester sheets shall be used for all cartographic works.

1 - 3. Composite negative.

Scribed sheets, mask sheets and annotation sheets shall be composed into one negative film so that one colour may be included on one sheet for the sake of plate making.

1 - 4. Composite Positive

Composite positives shall be prepared composed of mainly linear elements to help map maintenance (revision).

1 - 5. Connection

Care shall be taken for connection of each sheet between adjacent ones.

2. Printing.

Printing shall be carried out by off-set printing machine in 6 colours. Before printing, proof shall be read and the approval of SK shall be obtained.

2 - 1. Plate making.

Printing plates shall be prepared by photo-lithography by using composite negatives.

2 - 2. Printing.

Printing shall be carried out by off-set printing machine in 6 colours. Number of copies shall be 1,000 for each sheet.

3. Work Schedule

Work schedule is shown in Fig. 2 of the main text.

IV. REPORT

At the end of the last Phase, coprehensive report shall be prepared including the progress and the results of the Study.

ANNEX

1. SCOPE OF WORK FOR TOPOGRAPHIC MAPPING OF SOUTH KENYA IN THE REPUBLIC OF KENYA

2. MAP STYLE AND ITS APPLICATION RULE

2-2 "Minutes of Meetings on Progress Report of the First Year's Field Work for Topographic Mapping of South Kenya"

MINUTES OF MEETINGS

ON

PROGRESS REPORT

OF

THE FIRST YEAR'S FIELD WORK

FOR

TOPOGRAPHIC MAPPING

OF

SOUTH KENYA

NAIROBI, 26th Feb. 1988

MR. A. K. NJUKI
For Director of Surveys

MR. SHO SAITO
Leader,
JICA Study Team

MR. M. KAWASAKI
JICA Advisor

1. Date and time: 23rd Feb. 1988 14:30 - 15:00
23rd Feb. 1988 15:30 - 17:00

2. Place: 14:30 - 15:00 Survey Headquarters, Nairobi
15:30 - 17:00 Survey Field Headquarters, Ruaraka

3. Attendants: Attachments - 1, 2

4. The JICA Study Team (hereinafter referred to as the "Team") briefly reported the progress of the first year's field work for the Topographic Mapping of South Kenya; submitting the "Progress Report of the First Year's Field Work for the Topographic Mapping of South Kenya in the Republic of Kenya" prepared by the Team. (Attachment - 3)

5. The Survey of Kenya (hereinafter referred to as "SK") appreciated the report and raised requests to continue the aerial photography and re-establish missing geodetic control points and bench marks, because they realize that those points are necessary not only for the mapping, but also for the planning and implementation of development projects in the captioned area which are the reasons for the request of the mapping.
The team took note of the request.

6. In preparation for the second year's field work, the Team requested the provision of counterparts and arrangement for permission letter to enter National Parks, Reserves or limited areas when necessary.
SK took note of the request and requested , for earlier arrangement, to inform them of the schedule of the Team as early as possible when fixed.
The Team replied to do their best to inform SK of necessary information beforehand, including the date of arrival, period, team members, etc. through JICA.

7. The Team requested SK to keep a part of contact prints of the aerial photographs taken this time for the sake of security and SK accepted the request.

Attachment - 1

Attendants of Meeting
(14:30 - 15:00, 23rd Feb. 1988)

1. Government of Kenya

Mr. Absaloms	Ag. Director of Surveys
Mr. Njuki	Assistant Director of Surveys, Mapping
Mr. Wainaina	Superintending Surveyor, Mapping

2. Government of Japan

(1) JICA Kenya Office

Mr. Kaiho	Assistant Resident Representative

(2) JICA Advisors

Mr. Kawasaki	Head, Inspection Div., Topo. Dept., Geographical Survey Institute
Mr. Izaki	Staff, Planning Div., Social Development Cooperation Dept., JICA

(3) JICA Study Team

Mr. Saito	Leader
Dr. Muraoka	Deputy Leader
Mr. Yoshida	Mapping Planner

Attachment - 2

Attendants of Meeting
(15:30 - 17:00, 23rd Feb. 1988)

1. Government of Kenya

Mr. Njuki	Assistant Director of Surveys, Mapping
Mr. Wainaina	Superintending Surveyor, Mapping
Mr. Kibore	Chief Photogrammetrist
Mr. Ndunda	Chief Cartographer
Mr. Chabeda	Chief Lithographer

2. Government of Japan

(1) JICA Kenya Office

Mr. Kaiho	Assistant Resident Representative

(2) JICA Advisors

Mr. Kawasaki	Head, Inspection Div., Topo. Dept., Geographical Survey Institute
Mr. Izaki	Staff, Planning Div., Social Development Cooperation Dept., JICA

(3) JICA Study Team

Mr. Saito	Leader
Dr. Muraoka	Deputy Leader
Mr. Yoshida	Mapping Planner
Mr. Kyakuno	Chief Surveyor

Attachment - 3

PROGRESS REPORT
OF
THE FIRST YEAR'S FIELD WORK
FOR
THE TOPOGRAPHIC MAPPING OF SOUTH KENYA
IN
THE REPUBLIC OF KENYA

--- February, 1988 ---

STUDY TEAM
OF
THE TOPOGRAPHIC MAPPING OF SOUTH KENYA
IN
THE REPUBLIC OF KENYA

JAPAN INTERNATIONAL COOPERATION AGENCY

I. INTRODUCTION

The topographic mapping of South Kenya started in October, 1987, in four-year term study, as a technical cooperation program of JICA.

In compliance with the Scope of Work agreed between the Ministry of Lands and Settlement and JICA on 19th March, 1987, the JICA Study Team, composed of 18 members, arrived in Nairobi on 3rd December, 1987 and stayed in Mombasa from 14th December, 1987, to 18th February, 1988. Meanwhile, Kenyan counterparts joined the work from time to time.

In accomplishing the first year's field work, hereinafter, the summary of the progress of the work is reported.

II. OBJECTIVE OF THE STUDY

The objective of the Study is to prepare the 1/50,000 topographic map covering an area of approximately 29,800 km^2 in South Kenya from east of Long. 37° $45'$ to the coast and from south of Lat. 3° to the Kenyan territory of the Tanzanian border. Main items of the Study are as follows:

1. Aerial photography approximately 29,800 km^2
2. 1/50,000 topographic mapping approximately 29,800 km^2.

III. SCOPE OF WORK FOR THE CAPTIONED PERIOD

The scope of work for the first year covers

1. Aerial photography
   Two missions of aerial photography shall be carried out.
   a. 1/40,000 aerial photography covering the existing and proposed leveling routes in single strip courses for approximately 740 and 760 Lkm respectively,
   b. 1/60,000 aerial photography covering the whole project area of approximately 29,800 km^2 (or 4,000 Lkm).

2. Aerial signal
   Aerial signals shall be established on 40 existing geodetic control points.

3. Pricking of existing bench marks
   Pricking on the aerial photographs shall be carried out of bench marks along existing 1st and 2nd order leveling routes extending approximately 700 km.

4. Leveling
   Minor order leveling shall be carried out along the proposed leveling routes extending approximately 720 km.

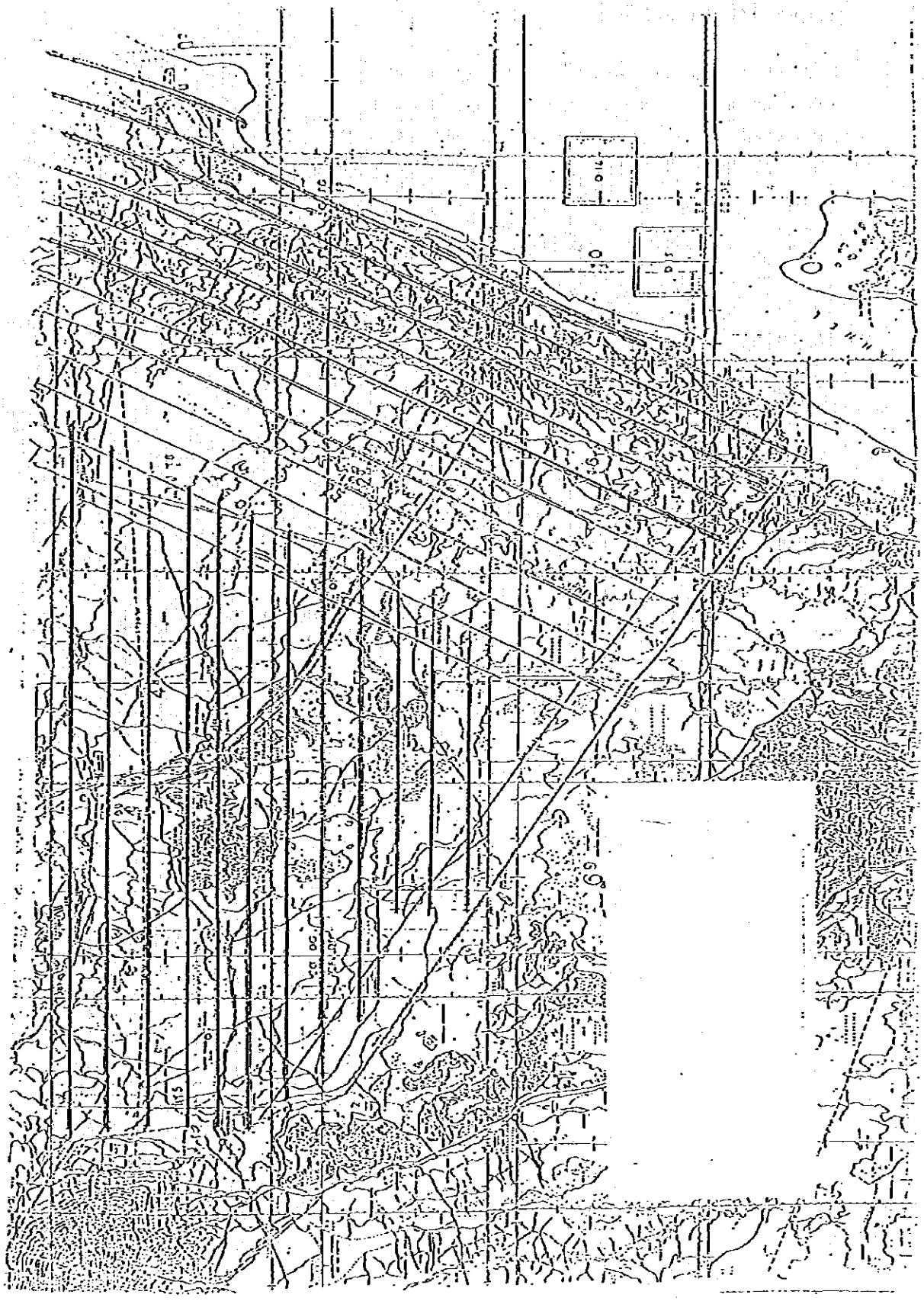
IV. AERIAL PHOTOGRAPHY

Two missions of aerial photography were carried out by contracting with Photomap Co. Ltd.

1. Mission 1:
   Aerial photography was carried out along existing and proposed leveling routes totaling approximately 1,500 Lkm with single strip courses as follows:
   a. Period: November, 1987,
   b. Camera : Super-wide angle camera,
   c. Photographic scale: Approximately 1/40,000 in general. However, due to unfavorable weather conditions, photographic scale varied from 1/8,000 to 1/40,000.
   d. Flight course map: Map showing flight courses is shown in Fig. 1.

2. Mission 2.
   Aerial photography was carried out to cover the whole project area totaling approximately 4,000 Lkm. Due to unfavorable weather conditions, however, about 70 % was covered during the period.
   a. Period: December, 1987 - February, 1988,
   b. Photographic scale: Approximately 1/60,000
   c. Camera: Super-wide angle camera,
   d. Flight course map: Map showing flight courses is shown in Fig. 2.

Fig. 1. Flight Course Map for Mission 1



V. AERIAL SIGNAL

Aerial signals were to set up on 40 existing geodetic control points as shown in Fig. 3. Among those, however, for 5 missing points, aerial signals were set up in their neighbourhood. Missing points are

1936 2, 1908 2, 1965T 4, 1995T 2 and 1995T 1.

An example of aerial signals is shown in Fig. 4.

The conditions of the monuments of the signalized geodetic control points are tabulated in Tab. 1 and summarized as follows:

Normal	22
Felled down	3
Destroyed	10
Missing	5

Among 35 existing geodetic control points, the distribution of points which are not vertically controlled is shown in Fig. 5 and summarized as follows:

	Total	No vertical control
1st order triangulation point	10	4
2nd " "	19	9
1st " traverse point	2	1
2nd " "	4	3
Total	35	17.

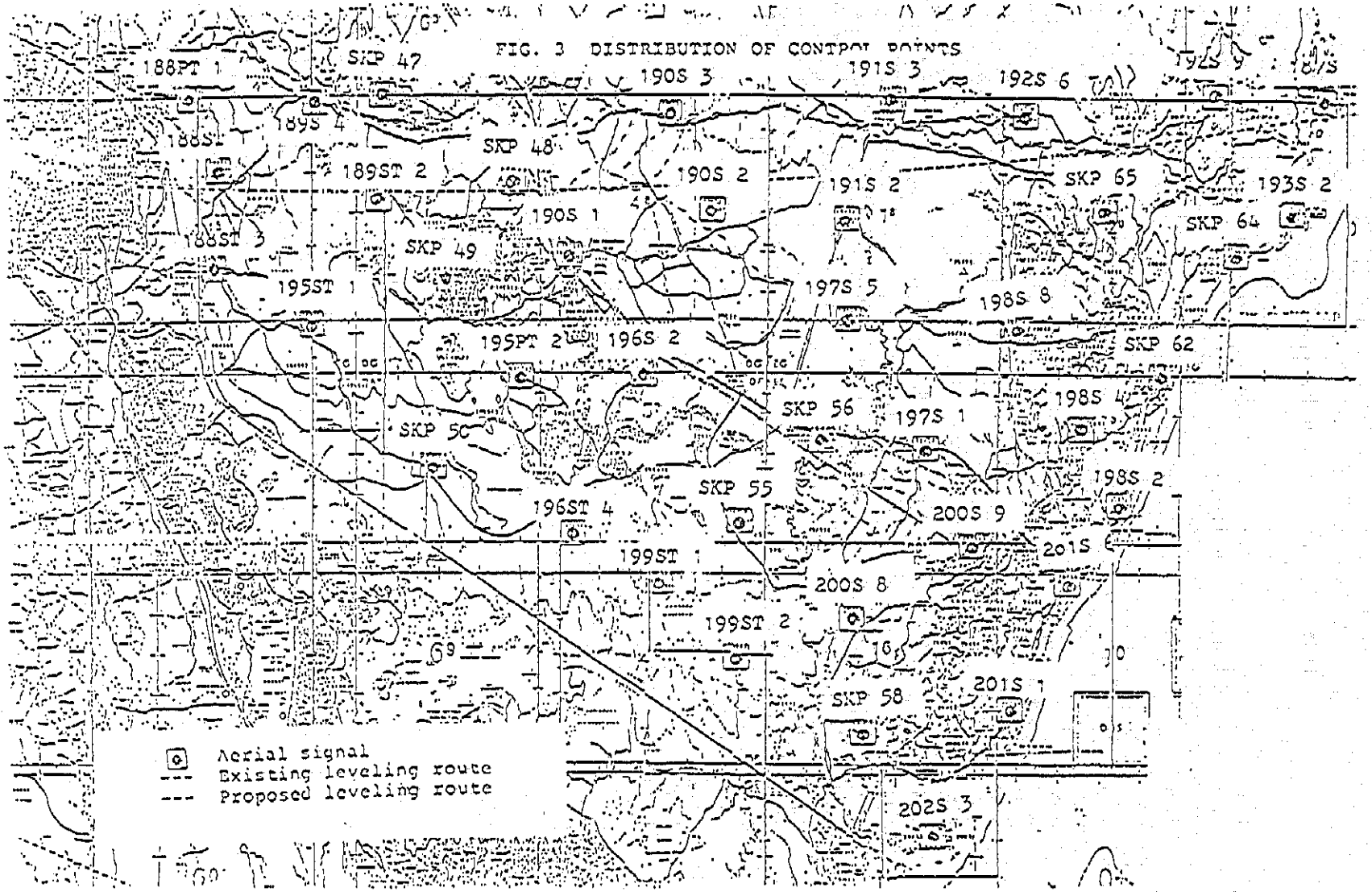


FIG. 3 DISTRIBUTION OF CONTROL POINTS

Tab. 1. Conditions of geodetic control points

Point number		Conditions of monument: Normal	Felled down	Destroyed	Missing	Vertical control
SKP	47	*				*
SKP	48	*				*
SKP	49	*				*
SKP	50	*				*
SKP	55	*				
SKP	56	*				
SKP	58			*		*
SKP	62	*				
SKP	64	*				
SKP	65	*				*
187S	1	*				*
189S	4		*			*
190S	1		*			
190S	2				*	
190S	3	*				*
191S	2	*				
191S	3	*				*
192S	6	*				*
192S	9			*		
193S	2				*	
196S	2			*		
197S	1			*		
197S	5	*				
198S	2	*				*
198S	4			*		*
198S	8			*		
200S	7	*				
200S	8	*				
201S	1	*				*
201S	6	*		*		*
202S	3			*		
188rT	1			*		*
195rT	2	*				
188ST	1		*			*
188ST	3			*		
195ST	1	*				
196ST	4				*	
199ST	1					
199ST	2				*	
189ST	2	*				
40		22	3	10	5	18

Fig. 4. Status of Control Points
No Vertical control
Missing
Aerial signal
Existing levelling route
Proposed levelling route
SKP 47
SKP 49
SKP 50
SKP 51
SKP 52
SKP 53
SKP 54
SKP 55
SKP 56
SKP 58
SKP 59
SKP 60
SKP 61
SKP 62
SKP 63
SKP 64
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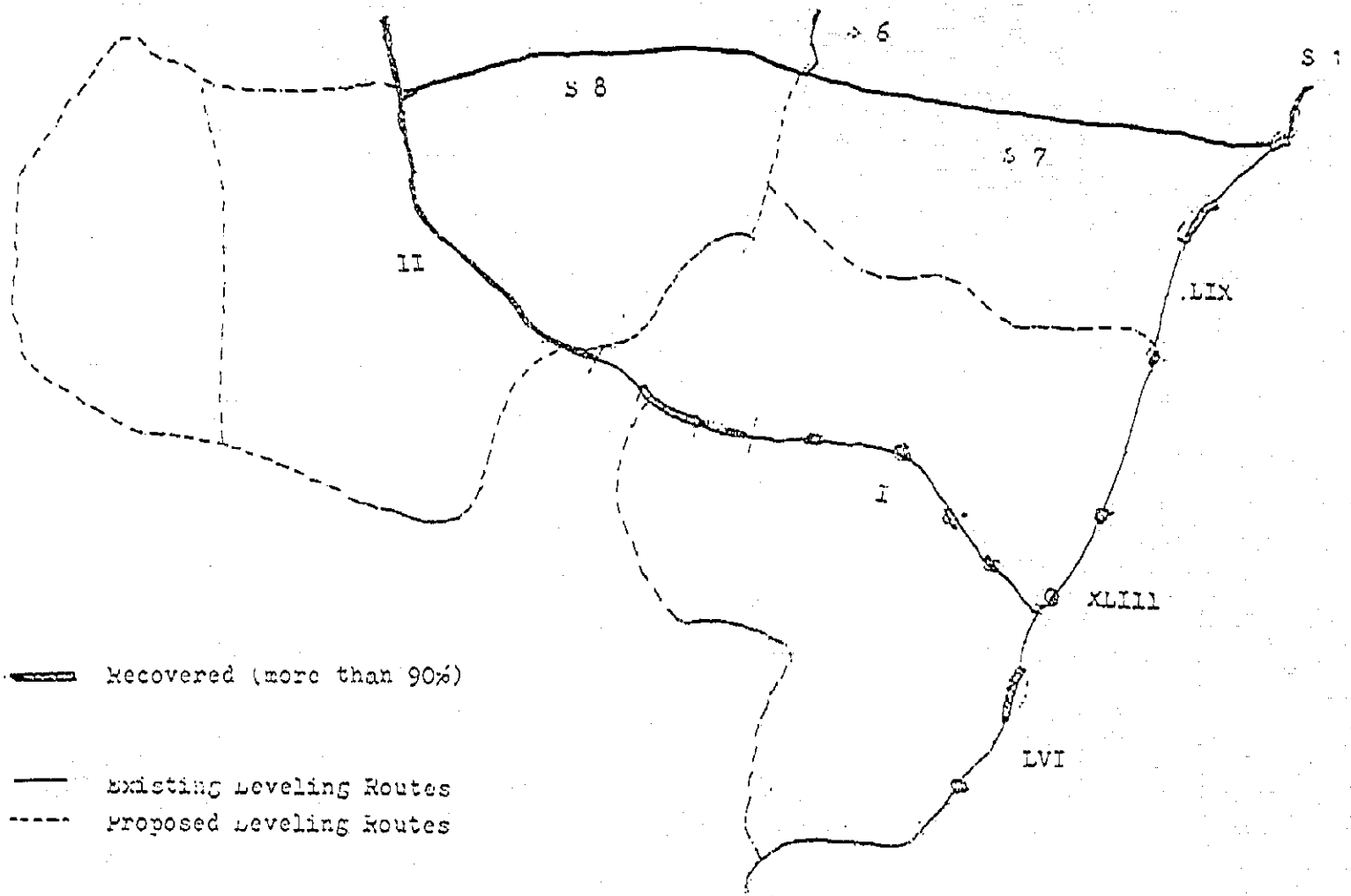
VI. PRICKING OF EXISTING BENCH MARKS

Pricking on aerial photographs of bench ma rks was carried out along existing leveling routes. However, some of the bench marks were missing. The conditions of the bench marks are summarized as follows:

Line	From - To	Recovered	Missing	Total
I	Voi - Mombasa	35	83	118
II	II/78 - II/117	28	10	38
XLIII	XLIII/8 - Bamburi	1	8	9
LVI	N - LVI/65	4	62	66
LIX	Mambrui - LIX/82	13	67	80
S1	S1/1 - S1/7	6	1	7
S6	S6/21 - S6/26	6	0	6
S7	S7/1 - S/FBM 1	27	5	32
S8	S8/1 - S8/27	27	0	27

The distribution is shown in Fig. 5.

Fig. 5 Status of Existing Bench Marks



VII. LEVELING

1. Leveling Routes

8 routes for minor order levelings were set up as shown in Fig. 6 and as follows:

Route number	Bench marks	Length
R1	J-1, R1-1,....., R1-16, S8/3	32.1 km
R2	I-21, R2-1,....., R2-34, J-1	69.9
R3	LIX-49, R3-1,..., R3-27, R-3, R3-28,... ..., R3-53, J-1	109.3
R4	Fixed point, R4-1,....., R4-64, I-38	135.8
R5	II-91, R5-1,....., R5-21, J-2	45.2
R6	J-2, R6-1,....., R6-40, R-6, R6-41,... ..., R6-81, J-3	161.6
R7	J-2, R7-1,....., R7-19, R-7, R7-20,... ..., R7-37, J-3	81.0
R8	I-21, R8-1,....., R8-45, J-3	96.3
Total	357 (New Marks)	731.2 km

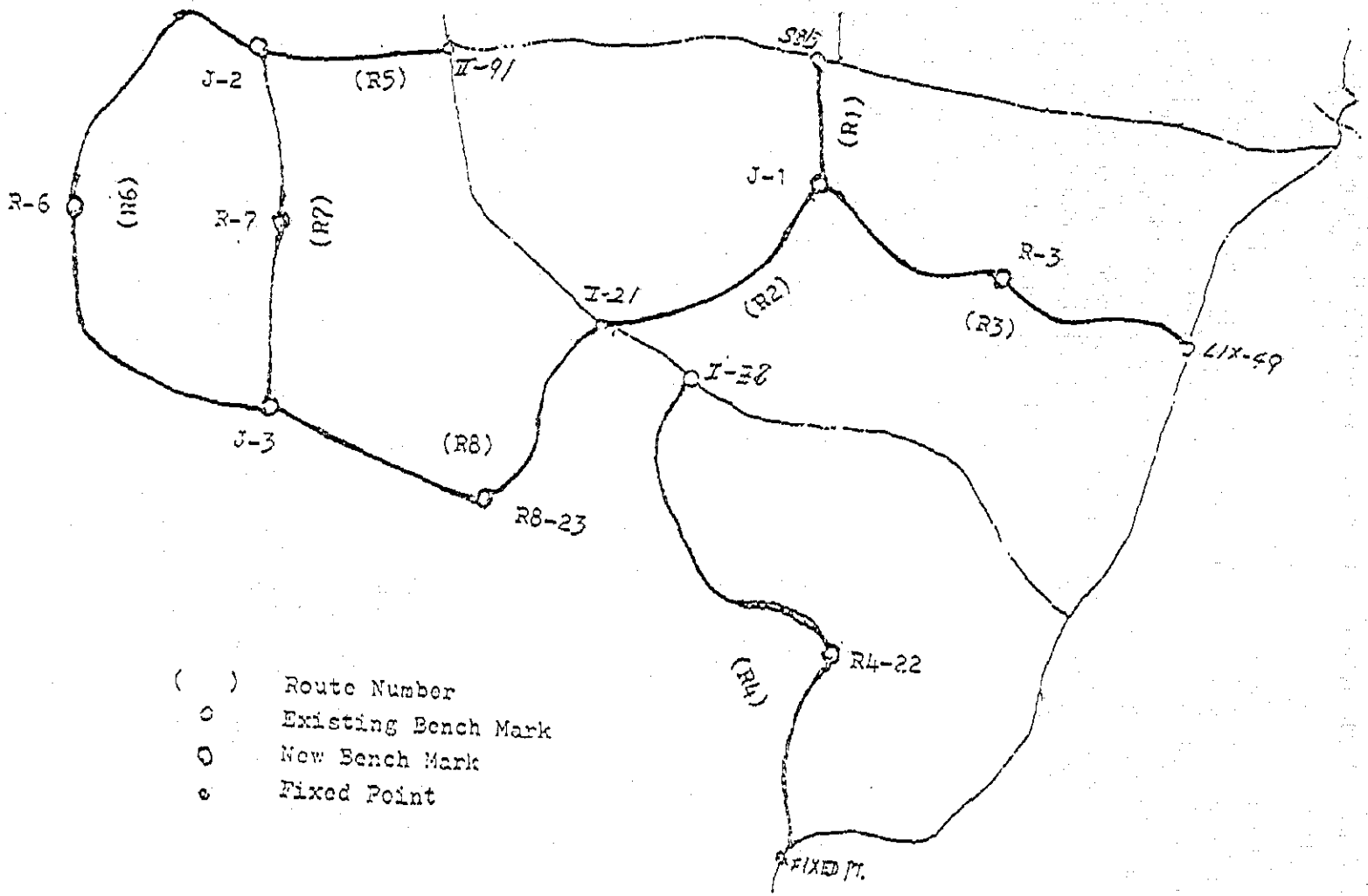
2. Measurement

Following existing bench marks were used for starting, ending and reference points for checking:

Given point	Reference point for checking
I-21	I-18
I-38	I-37
II-91	II-90
LIX-49	---
S8/3	S8/2

Check measurement was carried out with satisfactory results. The nominal values of BMs I-21, I-38, II-91 and S8/3 will be adopted as given. However, for LIX-49, it was not able to carry out check measurement, because of missing of neighgouring bench marks. It will be regarded as given point for the time being.

Fig. 6. Distribution of Leveling Routes



At the starting point of the route R4 near Lunga-Lunga, no existing bench marks were found. Closure was not estimated.

3. Marking

Permanent monuments were set up at the following 8 points as shown in Fig. 6:

J-1, J-2, J-3, R-3, R4-22, R-6, R-7, R8-23.

At some points, marking was done using stable ground features. For other points, temporary marking was done by setting up small wooden stick with a nail on the top.