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Chattam.

June 2

SURVEY OF INDIA

TECHNICAL REPORT 1951

(From 1st April 1950 to 31st March 1951)



PART I—TOPOGRAPHICAL AND OTHER SURVEYS PART II—MAP PUBLICATION AND OFFICE WORK

PUBLISHED BY ORDER OF
BRIGADIER I. H. R. WILSON, F.R.I.C.S., M.I.S. (INDIA)
SURVEYOR GENERAL OF INDIA

PRINTED AT THE OFFICE OF THE GEODETIC & TRAINING CIRCLE
SURVEY OF INDIA, DEHRA DUN, 1953.

Price Five Rupees, or Eight Shillings

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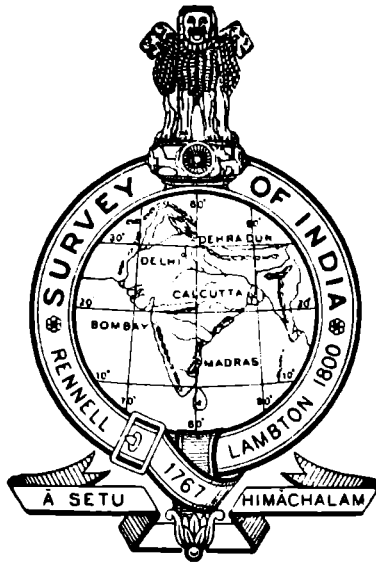
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CONTENTS

	Page
I. INTRODUCTION and SUMMARY ..	1
PART I. TOPOGRAPHICAL AND OTHER SURVEYS	
II. ABSTRACT OF TOPOGRAPHICAL WORK (with Table C)	2
III. TECHNICAL NOTES, NORTHERN CIRCLE	
Summary	21
No. 1 Party	21
No. 2 Party	26
No. 3 Party	26
No. 4 Party	27
No. 13 Party	29
IV. TECHNICAL NOTES, EASTERN CIRCLE	
Summary	30
No. 5 Party	30
No. 9 Party	33
No. 11 Party	34
No. 12 Party	36
V. TECHNICAL NOTES, SOUTHERN CIRCLE	
Summary	39
No. 6 Party	39
No. 8 Party	41
No. 10 Party	42
No. 17 Party	44
VI. APPENDIX TO TECHNICAL NOTES	
Description with a sketch of a Station Pillar	46

PART II. MAP PUBLICATION AND OFFICE WORK

VII. PRINTING AND REPRODUCTION OF MAPS 47

PART III. GEODETIC WORK

Published as a separate volume.

INDEXES

INDEX A.—Modern Topographical Surveys and Compilation	At end
INDEX C.—Index showing Project Surveys in hand ..	At end

FOREWORD

Part I of this Technical Report is prepared by Directors and Officers in charge of Survey Circles and Units respectively. The author of any particular report is normally the Officer holding office at the end of the period covered by the report.

2. Part II is prepared by the Director, Map Publication.

3. The Report, as a whole, is edited in the office of the Surveyor General, but expresses the personal views of the authors of the various sections.

DEHRA DUN :
October, 1953.

I. H. R. WILSON,
Brigadier,
Surveyor General of India.

SURVEY OF INDIA
TECHNICAL REPORT
1951

From 1st April 1950
To 31st March 1951

I. INTRODUCTION AND SUMMARY

1. Annual Reports.—The publication of the two Annual Reports of the Survey of India namely, the General Report and the Geodetic Report was suspended in 1942 for the duration of the war. The resumption of publication of these reports was made from the year 1947 in two separate volumes namely :—

- (a) *The General Report.*
- (b) *The Technical Report.*

The General Report is a brief narrative covering all work of the department and is intended for the information of the Government of India and non-technical readers.

The Technical Report which has superseded the Geodetic Report not only deals in detail with the geodetic and geophysical activities of the department, but also covers technicalities of survey work, drawing and map reproduction not included in the scope of the Geodetic Report.

The present report covers the period from 1st April 1950 to 31st March 1951. Future reports will also cover the period of the financial year which begins on 1st April and ends on 31st March.

The Technical Report is arranged as follows :—

Part I contains Table C giving a detailed statement of areas, out-turns and costs rates of surveys. It also contains technical notes on topographical and other surveys, descriptions of country surveyed, notes as to weather, communications, availability of food and on other subjects likely to be of interest to surveyors.

Part II deals with the technicalities of map drawing and reproduction and allied matters.

Part III deals with geodetic and geophysical operations with special reference to the technical aspects of the work, and to an analysis of the results. This part is published as a separate volume.

A Supplement to the Technical Report containing some of the information will continue to be prepared in typescript for departmental use.

PART I.—TOPOGRAPHICAL AND OTHER SURVEYS

II. ABSTRACT OF TOPOGRAPHICAL WORK

2. In issues of the annual General Report of the Survey of India published before the World War II, the abstract of topographical work was explained by three Tables namely, Tables A, B and C.

Table A showed the area of survey completed on various scales since 1905 as well as the approximate balance which remained to complete the contoured topographical survey of India.

Table B showed the survey of the area revised during the period under review.

Table C showed in detail the figures for areas surveyed, out-turns and cost rates of surveys, compilation and mapping by the various survey parties of the department.

Tables A and B will continue to be published in the General Report.

Table C is published in this Report.

In Table C, although every endeavour has been made to calculate the cost rates accurately, it is extremely difficult to allocate overhead charges fairly to the various classes of work. The cost rates shown in the Table C must, therefore, be considered to be approximate. The net cost represents the expenditure actually incurred on the work plus Party overhead charges, but excludes expenditure incurred on moving the party to the field and Departmental overhead charges. The overall cost is the net cost plus the cost incurred on moving the party to the field and Departmental overhead charges. The information contained in this Table is intended to be useful to those familiar with survey organization, in estimating costs in subsequent years.

The cost shown for mapping and computation are those incurred in the party, etc., offices only, except where otherwise stated. Publication charges, if required, may be ascertained from the Director, Map Publication, at Dehra Dun.

Indexes A and C published in the General Report also appear at the end of the Technical Report. The progress of modern topographical surveys (i.e., since 1905) made by the Department and of compilations made from our own or other material is illustrated in *Index A*. The surveys in hand, during the period under report, in connection with the various irrigation and development projects are shown in *Index C*.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 1 Party.—	Tawa Reservoir—Scale 4 inches to 1 mile, contours at 10 and 20 feet vertical interval	sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE</u>
<i>Hills, covered with fairly dense forest</i> ..	1. Ground verification and contouring	1.0	6.0	591.0	837.6	Around thickly forested dam-site.
	2. Plane-tabling	1.8	1.7	355.5	531.7	
	3. Air survey	220	2.6	115.0	149.5	
<i>Sub-mountainous area, covered with forests with a few open patches</i>	Jumna Hydro-electric Power Scheme—Scale 32 inches to 1 mile, contours at 5 feet V.I. Fair mapping (on 24-inch scale)	2.1	0.3	362.4	471.1	For publication on 16-inch scale.
<i>Sub-mountainous area, covered with dense forests</i>	Scale 4 inches to 1 mile, contours at 20 feet V.I. 1. Plane-tabling	5.5	5.5	258.4	350.0	
	2. Fair mapping (on 6-inch scale)	10.0	0.12	456.6	593.6	
<i>80% sandy bed area ; 20% semi-desert area with villages and cultivation</i>	Sāmbhar Lake—Scale 2 inches to 1 mile, contours at 1 foot V.I. in the bed of the lake and 50 feet V.I. elsewhere 1. Plane-tabling	50.0	15.1	60.5	81.4	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
<p>No. 1 Party.—Contd.</p> <p>80% sandy bed area ; 20% desert area with villages and cultivation</p> <p>Partly hilly and partly undulating ground, covered with forests ; cultivated along river beds with scattered trees</p>		sq. m.	sq. m.	Rs.	Rs.	NORTHERN CIRCLE.— <u>Contd.</u>
	2. Fair mapping (on 2-inch scale)	175	6·6	42·8	55·6	Includes compilation of a $\frac{1}{4}$ -inch inset and calculation of capacities of the lake.
	Didwāna Salt Lake—Scale 8 inches to 1 mile, contours at 1 foot V.I. in the bed of the lake and 10 feet V.I. elsewhere					
	Fair mapping (on 8-inch scale) ..	9·1	0·62	430·8	560·0	
	Gobind Sāgar (Bhākra Reservoir) —Scale 4 inches to 1 mile, contours at 20 feet V.I.					
	1. Triangulation	30	12·7	258·0	346·8	Difficult ground.
	2. Plane-tabling	41·1	2·3	660·5	863·9	
	3. Contour-laying on the ground ..	421·6 linear miles	38·5† linear miles	41·3 per linear mile	57·3 per linear mile	† Includes ancillary levelling.
4. Fair mapping (on 4-inch scale)	5·5	0·6	..	..	Only a beginning made with the 'Pilot sheet' for the series.	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 1 Party.—Contd.						NORTHERN CIRCLE.—
<i>70% open forest and undulating area with cultivation and villages; 30% hilly and dense forest with high grass</i>	Punasa Reservoir—Scale 4 inches to 1 mile, contours at 10 and 20 feet V.I.	570	90.0	25.6	34.3	Contd.
	1. Supplementary planimetric control					Work completed.
	2. Height control for air survey	380	18.5	34.4	45.2	
	3. Out-line air survey	82	4.1	78.3	101.8	
	4. Detail verification and ground contouring	80	6.5	150.4	197.9	
	5. Traversing (with heights)	17 linear miles	56.6 linear miles	36.4 per linear mile	49.3 per linear mile	
	6. Levelling	8.6 linear miles	43.0 linear miles	50.2 per linear mile	67.5 per linear mile	
<i>Fairly open but mostly undulating area interspersed with ravines</i>	Mahrauli (East)—Scale 6 inches to 1 mile, contours at 5 feet V.I.					
	1. Triangulation	6.0	6.0	161.7	218.8	
	2. Air survey (out-line)	6.0	2.0	396.5	519.4	
	3. Detail verification and ground contouring	6.0	3.1	373.1	500.1	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 1 Party.—Contd.		sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <i>Contd.</i>
<i>75% open and somewhat undulating plains with scattered villages ; 25% built-up area</i>	Safdarjang Landing Chart—Scale 1 inch to 1 mile					
	1. Levelling (for fixation of reference mark)	6.0 linear miles	45.0 linear miles	58.0 per linear mile	76.4 per linear mile	
	2. Plane-tabling	32	28.2	60.1	81.1	
<i>90% flat area with cultivation ; 10% built- up area</i>	Bamhrauli Landing Chart—Scale 1½ inches to 1 mile					
	1. Levelling	4.0 linear miles	30.0 linear miles	51.7 per linear mile	71.0 per linear mile	
	2. Traversing for reference mark ..	11.0 linear miles	47.1 linear miles	19.6 per linear mile	27.8 per linear mile	
	3. Plane-tabling	50	27.8	46.4	62.1	
<i>Flat and fairly open plain</i>	Bamhrauli Approach Chart—Scale 1 inch to 4 miles					
	Verification (of ¼ inch-map) ..	875	514.7	3.3	4.4	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 1 Party.—Concl'd. <i>60% open forest, hilly and undulating area ; 40% flatish area with cultivation and scattered villages</i>	Modern Topographical Survey— Scale 2 inches to 1 mile, contours at 50 feet V.I.	sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <u>Contd.</u>
	1. Triangulation	730	101.4	7.0	9.5	For publication on 1-inch scale.
	2. Air survey (out-line) ..	550	110	2.8	3.6	
3. Detail verification and ground contouring	547.4	16.8	50.4	67.6	By semi-trained personnel.	
No. 3 Party.— <i>Cultivated plains with numerous water chan- nels, scattered trees, mango groves and tanks</i>	Ganga Barrage Scheme—Scale 4 inches to 1 mile, contours at 1 foot V.I.					
	Double tertiary levelling	77.2 linear miles	43.7 linear miles	66.7 per linear mile	100.4 per linear mile	
	Traverse	85.9 linear miles	32.2 linear miles	78.1 per linear mile	117.5 per linear mile	
	Single tertiary levelling	884.7 linear miles	30.7 linear miles	41.4 per linear mile	62.3 per linear mile	
Ground verification	400.7	39.0	30.3	45.8		

* For explanation of ' net ' and ' overall ' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 4 Party.—		sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u>
						<u>Contd.</u>
	Gandak Barrage Scheme—4 inch mapping from air photo mosaics with contours at 1 foot V.I.					
<i>Flat cultivated plains with numerous water channels, scattered trees, mango groves and tanks</i>	Traverse	269.8 linear miles	34.2 linear miles	29.5 per linear mile	42.4 per linear mile	
	Secondary levelling	149.7 linear miles	56.1 linear miles	53.8 per linear mile	72.4 per linear mile	
	Double tertiary levelling	302.4 linear miles	41.4 linear miles	36.4 per linear mile	51.1 per linear mile	
	Tertiary levelling	5510.7 linear miles	78.9 linear miles	8.8 per linear mile	12.9 per linear mile	
	Photo-marking	2569.8	316.0	0.5	0.9	
	Computations	2569.8	120.6	3.5	5.6	
	Ground verification of 1-inch sheets	1930	681.2	1.2	1.7	
	Ground verification of 2-inch photo-graphs	1352.5	234.5	2.3	3.5	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 13 Party.— <i>Flat, cultivated and thickly populated plains interspersed with scrub, trees and orchards</i>	Bhakra Dam Project—Scale 4 inches to 1 mile, contours at 1 foot V.I.	sq. m.	sq. m.	Rs.	Rs.	NORTHERN CIRCLE.— <u>Concl'd.</u>
	Triangulation	550	223.0	34.6	49.3	
	Traverse, its computations and 3000-acre rectangulation	1822	31.7	55.7	83.5	
	100-acre rectangulation .. .	1490	9.0	111.5	159.8	
	Tertiary levelling to 25 acres and its computations	1453	17.2	68.5	76.6	
	Mapping of contours at 1 foot V.I. on 4-inch out-line sheets	2044	8.0	46.6	60.6	
	Revision survey—scale 1½ inches to 1 mile, contours at 50 feet V.I.	765	48.2	33.8	49.1	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 5 Party.—		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE</u>
	Revision survey (Departmental, Topo.)—1-inch scale with contours at 50 feet V.I.					
<i>60% open cultivated plain, 40% covered with congested towns on river banks and villages overgrown with trees and containing numerous tanks</i>	Ground verification of detail on photographs	6187	65.7	13.7	21.2	Includes contouring on photographs for 50% of the area.
	Tertiary rapid single levelling ..	4422	148.6	6.6	9.9	
	Tea Estates in Assam—16-inch scale without contours					
<i>70% Tea gardens with open and flat country and 30% densely wooded</i>	Traverse	27 linear miles	14.1 linear miles	79.7 per linear mile	111.9 per linear mile	
	Ground verification of detail on 6-inch air photographs	9280 acres	4035 acres	0.31 per acre	0.45 per acre	
	Dihāng Reservoir—4-inch scale with contours at 50 feet V.I.					
<i>Heavily wooded steep hills</i>	Air survey of out-line and contours including combination	25.0	1.1	280.3	364.4	
	Fair mapping	25.0	1.9	121.8	158.3	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area sq. m.	Out-turn per man per month sq. m.	Cost Rate per sq. mile (or mile)		REMARKS
				*Net Rs.	*Overall Rs.	
No. 5 Party.—Concl'd.						
<i>Low-lying plains interspersed with swamps and high grass</i>	Kopili Flood Control Scheme— 4-inch scale with contours at 1 foot V.I.					EASTERN CIRCLE.— Cont'd.
	Out-line air survey	290	16.1	19.2	25.0	
	Fair mapping	290	3.9	74.9	97.4		Contours were not surveyed but compiled in office.
	Complete job	490.0	..	715.0	962.0	As part of the area controlled dur- ing 1947-48 was subsequently not mapped, cost rates for the complete job are very approximate.
No. 9 Party.—						
<i>Generally flat ground interspersed with water channels, patches of jungle and high grass, cultivated areas interspersed with scattered trees, mango groves, tanks and groups of small villages.</i>	Kosi Irrigation—4-inch scale with contours at 1 foot V.I.					For work done in recess 1950. Low out-turn in fair mapping due to much time having been spent on the compilation of contours from levelled spot heights. For all work carried out in field season 1949-50 and recess 1950.
	Out-line air survey	621	25.2	18.3	23.8	
	Fair mapping	1053	5.9	72.6	94.4	
	Computations	1053	27.6	13.4	17.4	
Combined project		1053	2.6	278.6	501.2	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 9 Party.—Concl'd.		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u>Contd.</u>
	Ganga Barrage project—4-inch scale with contours at 1 foot V.I.					
<i>Cultivated plains with numerous water channels, scattered trees, mango groves and tanks</i>	Out-line air survey	442.6	16.7	16.8	21.8	} For work done in recess 1950. Low out-turn in fair mapping due to much time having been spent on the compilation of contours from levelled spot heights.
	Fair mapping	442.6	6.6	43.8	56.9	
	Computations	442.6	60.3	4.2	5.5	
	Combined project	442.6	3.0	236.4	438.5	
	Upper Dāmodar Valley—6-inch scale with contours at 10 feet V.I.					
<i>Undulating open plains, low mounds and hills, patches of jungle, large cultivated areas, scattered trees, and numerous tanks</i>	Triangulation	800.0	198.3	12.9	20.7	} For all work carried out in field season 1950-51.
	Double tertiary levelling	210.2 linear miles	64.0 linear miles	51.2 per linear mile	81.5 per linear mile	
	Tertiary levelling	2324.9 linear miles	56.7 linear miles	35.6 per linear mile	56.7 per linear mile	
	Ground verification	752.9	37.7	30.6	48.8	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 11 Party.—	1-inch departmental surveys	sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <i>Contd.</i>
<i>Jungle covered hills and undulating plains</i>	Ground verification and height control for 2-inch air survey compilation	698	23.3	41.7	57.5	By semi-trained personnel.
	I.C.A.O. Landing charts on 1½-inch scale					
<i>25% open and 75% congested area</i>	Traversing	35.9 linear miles	10.6 linear miles	123.4 per linear mile	170.2 per linear mile	
	Levelling (single and double tertiary)	111.9 linear miles	21.0 linear miles	46.7 per linear mile	64.5 per linear mile	
	1½-inch plane-tableing	130	10.9	77.3	106.6	Low out-turn due to congested town areas at Patna and Barrackpore and rainy weather at Tezpur.
	¼-inch verification survey (Approach Charts)	2278†	458.7	2.2	3.1	†Heights of Hazards only in 770 sq. m.
<i>Congested area</i>	Traversing for 1/12,000 Obstruction Chart	13.4 linear miles	45.0 linear miles	135.0 per linear mile	186.2 per linear mile	
	Levelling for 1/12,000 Obstruction Chart	32.6 linear miles	47.0 linear miles	54.8 per linear mile	75.5 per linear mile	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 11 Party.—Contd.		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u>Contd.</u>
	Plane-tableing 1/12,000	3.6	2.1	912.5	1258.1	Total area (where rigorous recon- noitering and heighting of obstruc- tions were done) was 68.8 sq. miles in addition to 3.6 sq. miles of rigorous plane-tableing on 1/12,000 scale.
<i>Wooded hills and open fields</i>	Upper Mahānadi Dam—32-inch scale with contours at 5 feet V.I. Ground verification and ground contouring on air surveyed out- line	4.755	0.32	2966.8	4091.4	
<i>Undulating country with scattered trees and scrub</i>	Mahānadi Irrigation (Hirakud Dam Project) -4 inch scale with contours at 5 feet V.I. Out-line air survey and fair map- ping, in recess 1950	316‡	4.5	110.9	144.2	‡This excludes 96 square miles of tracing from Hirakud Reservoir sheet and enlargements of one- inch sheets, for completion of sheets up to edges.
	Combined project	316	1.9	159.7	386.8	

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 11 Party.—Concl'd.	Gandak Barrage Scheme—4-inch scale with contours at 1 foot V.I.	sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u>Concl'd.</u>
<i>Flat open cultivated area with scattered trees all over</i>	Mapping including tracing from mosaics after inking detail under fusion, where necessary	2400	17.9	41.7	54.2	
	Combined project	2400	7.4	59.0	109.3	
No. 12 Party.—	79 A/2—Revision Survey—2-inch scale					
<i>Cultivated plains with innumerable huts and tanks. Villages usually surrounded by trees</i>	Out-line air survey	272.7	18.2	23.7	30.8	
	Bihār Mica Belt—1 : 25,000 Scale with contours at 25 feet V.I.					
<i>Hilly, undulating ground, with open and fairly dense jungle</i>	Complete air survey	180.4	2.2	223.3	290.3	
	Upper Mahānadi Reservoir—4-inch scale with contours at 10 feet V.I.					
<i>Undulating ground with open and medium dense jungle and cultivation</i>	Complete air survey	33.8	1.5	306.5	398.5	
	Upper Mahānadi Dam—32-inches scale					
<i>Undulating ground with fairly dense jungle and cultivated plains</i>	Out-line air survey	5.2	0.2	1678.8	2182.4	Work was mostly done by trainees.

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 6 Party.—		sq. m.	sq. m.	Rs.	Rs.	<u>SOUTHERN CIRCLE</u>
	Dharoi Dam Site—32-inch scale contours at 5 feet V.I.					
<i>Hilly gorge with open scrub</i>	Triangulation and computation ..	1·7	3·8	637·8	1074·6	
	Ground survey	1·7	0·35	2164·0	3975·4	
	Levelling (double tertiary) ..	110·0 linear miles	37·0 linear miles	30·5 per linear mile	57·5 per linear mile	
	Fair mapping	1·7	0·18	1958·0	2818·7	
	Combined project	1·7	12·2	6674·5	11612·6	
	Dharoi Reservoir—4-inch scale, contours at 5 feet V.I.					
<i>Undulating country, covered with scrub</i> ..	Triangulation and computations ..	39	40	29·1	48·8	
	Height control (tertiary levelling)	39	22·4	35·0	59·7	
	Photo. verification	39	27·5	9·6	15·6	
	Air compilation and mapping ..	39	1·7	254·7	373·8	
	Combined project	39	1·1	328·4	497·8	

* For explanation of ' net ' and ' overall ' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 6 Party.—Concl'd.	Airfield Surveys	sq. m.	sq. m.	Rs.	Rs.	SOUTHERN CIRCLE.—
	Approach chart—$\frac{1}{4}$-inch scale, contours at 250 feet V.I.					<u>Cont'd.</u>
<i>Cultivated flat open plains slightly undulating</i>	Verification survey	1270	276.4	2.7	4.5	
<i>Cultivated flat open plains slightly undulating</i>	Landing chart—$1\frac{1}{2}$-inch scale, con- tours at 50 feet V.I.					
	Triangulation	31	20.7	51.1	79.2	
	Tertiary levelling	30 linear miles	16.1 linear miles	79.0 per linear mile	127.4 per linear mile	
	Ground survey	31	16.0	45.1	74.1	
	Complete field work	31	5.9	172.7	276.5	
<i>Open flat plains</i>	Landing chart—2-inch scale, con- tours at 50 feet V.I.					
	Triangulation	29	33.5	48.5	74.8	
	Air survey of detail	29	31.1	19.8	28.3	
	Blue print verification and con- touring	29	14.5	49.7	80.9	
	Complete field work	29	7.6	118.0	184.0	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 8 Party.— <i>Open low hills, including the coastal belt of dense coconut plantations</i>	Airfield Surveys	sq. m.	sq. m.	Rs.	Rs.	SOUTHERN CIRCLE.— <u>Contd.</u>
	Landing chart					
	Supplementary triangulation ..	17	9.8	128.0	171.0	
	Double tertiary levelling ..	83 linear miles	40.2 linear miles	18.1 per linear mile	24.6 per linear mile	
	Computations ..	17	28.0	10.0	13.0	
	1½-inch revision survey ..	17	5.4	141.7	188.8	
	Complete job ..	17	2.3	368.2	492.4	
<i>Open cultivated plains with high hills</i>	Approach chart					
	¼-inch verification survey ..	350	477.3	2.9	4.0	
	Verification survey					
	1-inch verification survey ..	292	156.4	4.3	6.1	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area sq. m.	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 10 Party.—				Rs.	Rs.	SOUTHERN CIRCLE.—
<i>Cultivated plains with dense palmyra trees on field bunds. Open airfield in the centre of the area</i>	Airfield Surveys	763	738	1.1	1.4	<u>Contd.</u>
	Approach chart					
	$\frac{1}{4}$ -inch verification survey					
	Landing chart—1/50,000 scale, contours at 50 feet V.I.					
	Revision survey	30	9.2	95.1	123.6	
	Triangulation	83	89	7.9	10.3	
	Double tertiary levelling	9.3 linear miles	27.9 linear miles	21.5 per linear mile	28.0 per linear mile	
	Combined field work	30	..	123.6	160.7	
No. 17 Party.—						
	Airfield Surveys					
	Approach chart— $\frac{1}{4}$ -inch scale, contours at 250 feet V.I.					
	Verification surveys	1408	308	2.4	4.6	

* For explanation of 'net' and 'overall' rates see page 2.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping

Party and description of country	Class of work (including scale and V. I.)	Area	Out-turn per man per month	Cost Rate per sq. mile (or mile)		REMARKS
				*Net	*Overall	
No. 17 Party.—Concl'd.		sq. m.	sq. m.	Rs.	Rs.	<u>SOUTHERN CIRCLE.—</u> <u>Concl'd.</u>
	Landing chart—1 : 50, 000 scales, contours at 50 feet V.I.					
<i>Open ground with 30% built-up area and flat ground with 50% built-up area, covered with light vegetation</i>	Triangulation and computation ..	60	23	58.5	88.5	
	Double tertiary levelling ..	17 linear miles	57 linear miles	1.9 per linear mile	2.9 per linear mile	
	Traverse and computations ..	15 linear miles	45 linear miles	24.0 per linear mile	36.4 per linear mile	
	Original survey	60	19	39.5	59.8	
	Combined field work	60	9.4	93	148.2	
				25.9 per linear mile	39.3 per linear mile	

III. TECHNICAL NOTES, NORTHERN CIRCLE

DIRECTOR:— $\left\{ \begin{array}{l} \text{Mr. B. N. Saha, M.Sc., to 11-5-50.} \\ \text{Mr. C. P. E. Davenport (current duties) from 12-5-50 to 20-6-50.} \\ \text{Mr. H. M. Critchell, from 21-6-50.} \end{array} \right.$

DEPUTY DIRECTOR:—Lt. Col. J.S. Paintal, Engineers, from 28-11-50.

3. **Summary.**—During the period under report, the following survey units were under the administrative control of the Director, Northern Circle :—

No. 1 Party.

No. 2 Party [No. 20 (Cantt.) Detachment up to 2-10-50 and re-designated as No. 2 Party from 3-10-50].

No. 3 Party (from 1-12-50).

No. 4 Party (from 1-12-50).

No. 13 Party.

No. 2 Drawing Office.

Brief reports on the various survey operations carried out by the above mentioned units have been given in the General Report 1950-51. As the technical aspect of survey work is to be described in this report, no reference is made here to the activities of parties employed on work of a purely routine nature.

No. 1 PARTY

Officer in charge :—Mr. P. S. Shinghal, C.E.

4. **General.**—Field strength of the party remained principally employed on surveys for development projects, sponsored by the Central and State Governments. A start was, however, also made with the prosecution of the normal programme of Departmental surveys, including the new responsibility connected with the preparation of International Civil Aviation Organization Charts for aerodromes.

5. **Personnel.**—The effective average strength of technical staff of the party was :—

Gazetted officers	..	..	4
Other technical personnel	..	..	39

6. **Summary of Surveys.**—*Topographical survey tasks, done by air survey methods were* :—

(a) 6-inch survey, east of Mahrauli (Delhi), in sheets 53 H/2, 3, 6 and 7.

(b) 4-inch survey of Tawa Reservoir area in sheets 55 F/14, 15 and 16 ; and 55 J/2, 3 and 6.

(c) 4-inch survey of Punāsa Reservoir area in sheets 55 B/7, 8, 11, 12 and 16 ; 55 C/5, 9 and 13 ; and 55 F/2, 3 and 6.

(d) 2-inch survey of sheets 64 E/8 and 12.

Topographical survey tasks, done by ground survey methods were :—

(e) 4-inch survey for Jumna (Yamuna) Power Scheme in sheets 53 F/14 and 15.

(f) 4-inch survey of Tawa Dam-site area in sheet 55 F/14.

(g) 4-inch survey of Gobind Sāgar (Bhākra Reservoir) area in sheets 53 A/6, 7 and 11.

(h) 2-inch survey of Sāmbhar Lake in sheet 45 N/1.

Other principal survey tasks were :—

(i) I.C.A.O. Specifications surveys for

(1) *Landing Chart* of Safdarjang (Delhi) Aerodrome in sheets 53 H/2 and 6 ;

(2) *Landing Chart* of Bamhrauli (Allahābād) Aerodrome in sheets 63 G/11 and 15, and *Approach Chart* of the same aerodrome in sheet 63 G ; and

(3) *Obstruction Chart* of Pālam (Delhi) Aerodrome in sheet 53 H/2.

(j) Contour-laying on the ground in Gobind Sāgar (Bhākra Reservoir) area in sheets 53 A/7, 11, 12, 15 and 16.

7. Brief description of surveys, country, etc.—Of the foregoing, tasks (b) and (f) involved completing, to mapping stage, the 4-inch survey-work done for Tawa Reservoir. This is reported in detail on page 26 of the Technical Report, Parts I and II, 1950. Rigorous plane-table survey in the vicinity of thickly forested Tawa Dam-site was done in order to depict accurately the contours and detail over the canyon.

Task (e) was a continuation of the surveys reported on page 28 of the Technical Report, Parts I and II, 1950. The final map of the entire area surveyed on the 4-inch scale, and fair drawn on 6-inch scale for publication on 4-inch; was duly supplied to the indenter. The job, as a whole, was very successfully completed by newly trained personnel. The Power Scheme, however, is reported to have been shelved for the present.

Task (h) again was completion of the 2-inch ground survey of Sāmbhar Lake, described on page 28 of the Technical Report, Parts I and II, 1950. Contouring in the slushy portion of the lake was done at the end of June, just before the break of the monsoon ; but an area of 3 square miles of deep mud could not be penetrated and had to be left uncountoured.

Local enquiries conducted *pari passu* with our field work revealed that the natural depth of water in Sāmbhar Lake nowhere exceeds 3 feet.

(a) *Survey of east of Mahrauli (Delhi)* on the 6-inch scale with contours at 5 feet intervals was sponsored by the Ministry of Agriculture as a preliminary to a detailed study of an anti-soil-erosion plan. Extent of the area was about 6 square miles, for which 6-inch air photography already existed. The area was controlled by a small scheme of triangulation, based on a check-base and observed azimuth—the whole being tied on to No. 1 Party's adjoining triangulation of the year 1946. Rigorous 6-inch air survey of detail was based on the control thus provided and actual ground verification and 5-foot contouring were done in the field on a blue print of the outline.

The area, though fairly open, is mostly undulating and interspersed with ravines. The Clinopole method was used for contouring and heights were kept in terms of spirit-levelling; the average monthly out-turn came to 3.1 square miles per head.

(c) *Punāsa Reservoir survey.*—Punāsa Storage proposals over the Narbada River constitute an intermediate unit of an overall multi-purpose development scheme for the Narbada Valley, as conceived by the Central Waterpower, Irrigation and Navigation Commission. The area comprising the likely spread of the proposed reservoir for which 4-inch maps at 10 and 20 feet contours are required, would exceed 600 square miles.

Air photography of the area was carried out in 1948. The planimetric control for a part of it was taken up during March and April 1950. As a result of this, ground verification and contouring on blue prints of nearly 80 square miles of difficult country were completed during field season 1950–51. Normal survey methods were employed for doing it.

Planimetric control, required to cover the balance of the reservoir area consisted of about 570 square miles of supplementary triangulation in sheets 55 B and F. Speed of height control required for the air survey, was adjusted to keep pace with planimetric control. At the end of the field season, however, climatic considerations necessitated an area of 180 square miles being left over for completion during the next field season. Technical methods employed for this year's survey were identical with those adopted during the year 1949–50 for the survey of Tawa Reservoir except that the use of Paulin barometers was confined strictly to systematic traverses across long stretches of forests. On one particular occasion a check height traverse using a battery of 3 Paulin barometers, was run over a 3-mile length of theodolite traverse existing along a road in sheet 55 C/9, with its reference to a base battery located at Camp headquarters, (Harsūd), some 12 miles away. Not taking into consideration the humidity factor the traverse revealed at its worst station, an accidental error of 16 feet which could easily be

spotted by plotting the performance of each individual barometer on a graph. This suggested the continued utility of Paulin barometer as a practical aid to form-lining in wooded areas.

Supplementary triangulation, executed in the area of work, was connected at its two ends in sheet 55 B to Survey of India network of spirit-levelling and revealed a discrepancy of ± 3 feet only. Average density for planimetric control came to 3,800 yards apart and that for height control 450 yards apart.

(d) *2-inch survey* initiated originally at the request of Commerce and Industries Department of Vindhya Pradesh, entailed ground verification and 50-foot contouring on blue prints of 2-inch air survey of the outline and covered completely the area of pre-1905 survey in sheets 64 E/8 and E/12. Most of the triangulation framework used for survey of both the sheets, had been carried out by Eastern Circle during 1946. Wherever found to be inadequate, this was supplemented by providing a few points at the time of survey.

The work, as a whole, was done by semi-trained personnel and Departmental procedure was rigidly followed. The area under survey being full of jungle—mostly unhealthy—proved fairly difficult for beginners whose average out-turn came to 16.8 square miles a month. Communications were poor and there was an acute shortage of food grains.

One experienced surveyor, assisted by another partly trained surveyor, completed triangulation in $2\frac{1}{2}$ one-inch sheets in sheet 64 E. The triangulation was based on G.T. base Bhalua H.S.—Barjana H.S.

(g) *Gobind Sāgar (Bhākra Reservoir) survey*.—Field work on this survey on the 4-inch scale in sheet 53 A was continuation of the pre-March 1950 work, mentioned on page 27 of the Technical Report, Parts I and II, 1950. Plane-table survey was based on existing triangulation, supplemented by fresh triangulation where necessary. All the heights were obtained by observation of vertical angles by theodolite and reading the distances off the 4-inch survey plane-table sections, initially used for checking the framework graphically

In the month of December 1950, the relative priority of 4-inch survey of the remaining portion of the reservoir had to be lowered at the instance of the Chief Commissioner of Bilāspur who laid particular stress on the survey detachment doing the demarcation of 1,700-foot contour first in preference to any topographical work. As a result, 4-inch survey could not be resumed before March 1951, and was expected to be completed in June 1951. This survey was based on triangulation, completed during the autumn of 1950.

(i) *I.C.A.O. Specifications surveys*.—*Safdarjang (Delhi) Aerodrome* would have its 1 : 250,000 scale Approach Chart compiled from the $\frac{1}{4}$ -inch scale survey material produced by the party during 1949–50 for the adjoining aerodrome at Pālam (Delhi). Survey

for the 1 : 50,000 Landing Chart, falling in sheets 53 H/2 and H/6, was completed on the blue prints of 1-inch 'Delhi and Locality' map. Details of aeronautical importance were carefully surveyed on a print of the 3-inch Delhi Guide Map and co-ordinates of several aids to air navigation were determined, within the positional accuracy of 1 yard, by making plane-table resections on 100 foot to 1 inch scale maps of the locality. *Hazards* were heighted by observation of vertical angles by a theodolite and the co-ordinates and height of the *Aerodrome Reference Mark* were fixed by the normal method.

Bamhrauli (Allahābād) Aerodrome.—Surveys were carried out in sheet 63 G for the Landing Chart on the scale of $1\frac{1}{2}$ inches to 1 mile on a composite blue print of the fair drawn originals of the component 1-inch maps, and for the Approach Chart on the scale of $\frac{1}{4}$ inch to 1 mile on a published copy of the degree sheet.

Existing triangulation used for the basic modern survey, was found quite adequate except that 11 linear miles of theodolite traverse had to be run to determine the co-ordinates of certain aids to air navigation within a positional accuracy of 1/20th of a second in latitude and longitude. *Hazards* and elevated points, such as spire of temple, high tree, etc., were heighted by reading the vertical angles by a theodolite and taking the distance off the plane-table. The *Aerodrome Reference Mark* was fixed by the normal method.

Pālam (Delhi) Aerodrome for the Landing and Approach Charts of which requisite surveys had been completed during 1949–50, was included for a re-survey in connection with the preparation of an Obstruction Chart. Reconnaissance for the survey was taken up at the end of March 1951, and the task, as a whole, will be dealt with in the next year's Technical Report.

(j) *Contour-laying on the ground in Gobind Sāgar (Bhākra Reservoir) area* was resumed from where it had been left last year. The Surveyor was replaced by a Survey Assistant with orders to pursue the 1,700-foot contour which, for purposes of land acquisition, is to form the outer periphery of the reservoir. In the month of December 1950, in view the target date fixed by the States Ministry for studying certain inter-State problems of rehabilitation and compensation, all available personnel of Bhākra Survey Camp were switched over to contour-laying. Following the method described in the Appendix of the Technical Report, Parts I and II, 1950, and working on an average 9 hours a day for $27\frac{1}{2}$ days in the month, the 422-mile long contour with its 78 linear miles of double tertiary levelling was completed. Average monthly out-turn on contour-laying, per head, ranged between 28 miles in upper reaches of the wooded slopes to over 48 miles in open country.

The accumulated error in contour-laying after 5 to 10 miles distance, depending on the terrain, seldom exceeded the permissible maximum of ± 2.5 feet. To ensure the desired accuracy adjustments were made at places.

Contour positions were indicated on the ground by embedding stones and erecting cairns within inter-visible distances of 100 to 150 yards.

8. **Fair Mapping and Air survey.**—In all 16 sheets, of which 4 were fair drawn in conformity with the normal methods and the remainder compiled from 2-inch and larger scale air surveys, were completed for final printing.

No. 2 PARTY

Officer in charge :— { Mr. M. D. Nangia, to 16-4-50.
Mr. C. P. E. Davenport, from 17-4-50 to 2-10-50.
Major D. N. Sharma, Engineers, from 3-10-50.

For work carried out by this Unit see Supplement to the General Report 1951.

No. 3 PARTY

Officer in charge :— { Mr. J. C. Sikka, B.A., to 26-1-51.
Mr. T. M. C. Alexander, from 27-1-51.

9. **General.**—This party was raised on 1-11-50 to take up the survey operations of a paid-for job, Ganga Barrage Project, sponsored by the Government of West Bengal and subsequently transferred to the Central Government. Prior to the formation of this party, the project was originally commenced by No. 9 Party (E.C.).

Personnel.—The average technical strength of the party was :—

Gazetted Officers	..	2
Other technical personnel	..	23

10. **Technical Methods.**—Maps on 4-inch scale with contours at 1-foot vertical interval, were required of a total area of about 850 square miles in sheet Nos. 72 O, P, 78 C and D, half of which had already been completed to fair mapping stage by No. 9 Party, at the time of the formation of this party. Area thus left over for this unit was about 430 square miles and work on this was carried out as under :—

- (a) *Planimetric control.*—Control was provided by traverse lines using crinoline chains emanating from and closing on previous seasons' traverse stations. The latter were based on previous topographical triangulation which was re-observed to ensure sufficient accuracy, using independent base (H.S.B.) and Azimuth. All traverse stations were identified and pricked on air photographs.
- (b) *Height control.*—Lines of double tertiary levelling were run starting from and closing on precision Bench-marks and every 20 to 40 chains a semi-permanent B.M. was provided throughout the route, to control the tertiary level lines. Lines of tertiary levelling were

run, between these B.Ms., 30 chains apart, and spot-levels at 10 chains distances along the lines, were identified on the photographs. Every third spot-level was made into a bench-mark by selecting some permanent or semi-permanent (like horizontally blazed roots of big trees) objects. In the previous field season, the distance between the level lines was kept at 20 chains but due to flat terrain, this time it was decided to increase the distance to 30 chains, thereby effecting an appreciable economy in costs, without much loss of accuracy.

(c) *Ground verification.*—Colour traces and village lists were prepared considering single photos as small plane-table sections. Thus all information regarding classification of roads and tracks, telephone and telegraph lines, cultivation patches, etc., which could not be obtained from photographs by stereoscopy, was entered on these colour traces.

(d) *Compilation.*—Detail was compiled from air photographs using graphical methods. Contours were simply interpolated, with the help of spot-levels, plan positions of which were taken off the outline originals. Photographs were made use of only in a few difficult areas. All B.Ms., tertiary or secondary were entered in the body of the published maps, together with a list giving heights, which appeared in the margin. Final maps were printed mainly in 3 colours, steel grey (detail), brown (contours) and yellow (cultivation). Blue wash was given only in sheets where the river Ganges appeared in the body of the sheets.

11. **Accuracy.**—Traverse 1 in 8,000.
Tertiary Levelling .. 0.3 ft. in any line.

12. **Description of Country.**—The area consisted of cultivated plains, with numerous water channels, scattered trees, mango groves and tanks.

No. 4 PARTY

Officer in charge :—Mr. L. J. Bagnall, B.Sc.

13. **General.**—This party was raised on 1st November 1950, and was employed wholly on the 4-inch irrigation survey of the priority II area and the remaining portion of priority I area of the Gandak Barrage Scheme. The area surveyed during the period under report, falls in sheet Nos. 72 A, B, F and G.

14. **Personnel.**—The average technical strength of the party was :—

Gazetted Officers	..	3
Other technical personnel	..	35

15. Technical Methods.—Maps on 4-inch scale with contours at 1-foot vertical interval were required. Unlike the usual method of preparing line maps from photographs by rigorous air survey, outline originals were prepared by direct tracing of detail from controlled photo-mosaics of the area on 4-inch scale. Spot-level positions were also traced, along with the detail and generalized 1-foot contours were drawn, with the aid of the outline survey, the spot-levels and the photographs (in difficult areas). Controls, both planimetric and height, were provided out as follows :—

(a) *Planimetric control.*—In areas, not covered by modern surveys, theodolite traverse lines emanating from and closing on G.T. stations, were run to provide sufficient number of control points for air survey combination. Co-ordinates of principal points thus obtained, were supplied to the Air Survey Company of India, for controlling the mosaics. In areas, where modern surveys existed, no control was carried out and instead, reliable and well identified detail points selected from 1-inch maps were used.

(b) *Height control.*—Main framework consisted of a secondary levelling line which was run along the western limit of the area, connected to primary bench-marks and a line of precise levelling which already existed along the eastern limit. In between these lines, double tertiary levelling lines, 10 to 13 miles apart, were run. It was further broken down, by lines of single tertiary levelling, run approximately down the direction of general slope of the country, about half a mile apart. Semi-permanent bench-marks on existing natural or artificial objects, were established, along these lines, at approximately half mile intervals. These bench-marks along with all staff positions which could be easily identified on the air photographs were pricked on the photos.

(c) *Ground verification.*—In areas of modern rigorous survey, rapid verification of one-inch sheets was carried out for checking of names, classification of roads, etc. In the rest of the area, it was carried out on 2-inch photographs.

(d) *Compilation.*—Outline and contour originals were prepared on the lines, stated earlier. Final maps were published in black (detail) and brown (contours).

16. Description of Country.—The area consisted of flat cultivated plains, with numerous water channels, scattered trees, mango groves and tanks.

No. 13 PARTY

Officer in charge :— { Mr. T. M. C. Alexander, to 15-1-51.
 Major O. P. Anand, from 16-1-51.

17. **General.**—The unit continued to be employed on surveys in connection with the Bhakra Dam Project for the Punjab (I) Government. This project involves construction of a dam across the Sutlej river at Bhakra, which will not only increase the area already irrigated by the existing canals but will also provide water for a new canal system to be constructed.

18. **Type of Country.**—The country surveyed during the year, consists of flat cultivated and thickly populated plains, interspersed with scrub, trees and orchards, especially in the Nawāshahr Tahsil of Jullundur district. In the South-West (Nakodar Tahsil) it consists of soft and sandy plains. Areas around the banks of the Sutlej are thickly wooded and are covered with long grass.

19. **Technical Methods.**—The method of survey work has already been fully described in one of the previous reports. Rectangulation was done to 100-acre rectangles only, but levelling was broken down to 25-acre rectangles.

20. **Accuracy.**—Permissible closing errors of the different types of work carried out are given below :—

(a) *Position.*—

(i) Triangulation	.. 1 in 4,000	
	Bist Doab	Ambāla
	Area	Area
(ii) Traverse (main circuits)	1 in 2,000	1 in 1,600
(iii) Traverse (sub-circuits)	1 in 1,000	1 in 800
(iv) Rectangulation	.. 1 in 1,000	1 in 800

(b) *Heights.*—

(i) Double tertiary levelling circuits :—

0.05√M feet where M is the length of the circuit in miles.

(ii) Single tertiary levelling—0.3 feet in 4 miles.

21. **Recess Work.**—During recess the levelled heights were plotted on the 4-inch sheets after bringing them in terms of Mean Sea-Level. 1-foot contours were then interpolated for the area rectangulated during the field season.

IV. TECHNICAL NOTES, EASTERN CIRCLE

DIRECTOR :—Colonel R. T. L. Rogers, M.A. (Cantab.), F.R.I.C.S., M.I.S. (Ind.).

DY. DIRECTOR :—Mr. M. M. Ganapathy, B.A.

22. Summary.—This report deals with the technical work of the following parties :—

No. 5 Party.

No. 9 Party.

No. 11 Party.

No. 12 (Air Survey) Party.

The technical reports of the following Calcutta units are incorporated in Part II of the General Report which deals with Map Publication and Drawing Office work :—

No. 5 Drawing Office.

Photo-Litho Office.

Engraving Office.

During the year under report, for the first time since the war, this Circle has taken up a programme of departmental 1-inch original and revision surveys. Our normal role has been too long neglected and it is to be hoped that, now that departmental surveys have been re-commenced, these will continue to have a regular place on our programme. In addition, surveys for development projects such as hydro-electric, irrigation, tea garden and geological investigations were continued.

No. 5 PARTY

Officer in charge :—Mr. K. C. Gosain, B.A., M.I.S. (Ind.).

23. General.—During the field season, the majority of the personnel were employed on the field work required for normal departmental 1-inch revision surveys, from 2-inch vertical air photographs, of the Indian territory in Sheets 79 A, 79 B and 79 F excluding Calcutta and its suburbs, in West Bengal.

No fresh extra-departmental jobs were taken up, but the following, which had been carried over from previous years, were completed :—

- (i) Field work in Dessai and Purbuttia and Hunwal tea estates in Assam, in Sheet 83 J, for air survey compilation of 16-inch outline maps, from enlargements of 6-inch vertical air photographs, as required by Messrs. Jardine Henderson Limited, Calcutta.

(ii) Air survey and fair mapping on 4-inch scale for Kopili Flood Control Scheme in Sheet 83 B, for the Chief Engineer, Public Works Department, Assam.

(iii) Air survey and fair mapping on 4.4-inch scale for Dihāng reservoir in Sheet 82 P, for the Central Waterpower, Irrigation and Navigation Commission.

Technical procedures and indentors' requirements for items (i) and (ii) above are given in detail in the 'Technical Reports of 1948-49 and 1950.

24. **Personnel.**—The average strength of technical personnel available for the jobs mentioned in the preceding paragraph was (i) for field work, 1 Class II Officer, 4 Surveyors, 1 Survey Assistant and 19 Plane-tables and Levellers, several of whom were Topo. Trainees Type ' B ' or old hands not versed in air survey work ; (ii) for air survey and mapping, 2 Class II Officers, 7 Surveyors, 1 Survey Assistant and about 20 Plane-tables, Draftsmen, Levellers and Topo. Trainees Type ' B '.

25. **Areas Surveyed.**—The party carried out (i) 315 square miles of revision air survey and fair mapping on 4.4-inch and 4-inch scales for Dihāng Reservoir and Kopili Flood Control Scheme ; (ii) 6,187 square miles of ground verification of detail on 2-inch air photographs of which 4,422 square miles were levelled and provided with about 950 spot heights for one-inch revision survey ; (iii) 15 square miles of ground verification on 6-inch air photographs and 27 linear miles of theodolite traverse for 16-inch tea estate air surveys.

The out-turn of ground verification for one-inch revision survey was about 66 square miles per man per month. This was found satisfactory considering that a standard technical method for this new type of work had to be evolved as the work progressed, and that most of the personnel were either trainees or unfamiliar with air photographs.

26. **Technical Methods.**—*1-inch revision survey using 2-inch vertical air photographs.*—The existing surveys were of the period 1916-22 and did not contain spot heights or contours. The country had undergone considerable changes since the previous surveys ; river courses had shifted, several *bils* and marshy areas had been reclaimed and cultivated, villages had been extended and new habitations developed especially due to the influx of refugees from East Bengal (Pākistān) during the post-partition era. This necessitated covering the area systematically in order to fix heights at important and easily recognizable places, to verify uninterpretable photo details on the ground, to discover and correct possible errors in the existing survey and to survey on the ground those details which had appeared since the dates of photography.

To achieve these objectives, the ground work was divided into 3 parts, viz.—

- (i) Ground verification of detail on photographs,
- (ii) Fixation of spot heights by tertiary rapid levelling,
- and (iii) Contouring.

For (i), the existing 1-inch maps were examined against air photographs by ground verifiers. Where the extent and shape of villages and/or other detail shown on the existing 1-inch maps agreed generally with those on the photographs and/or where obvious detail could be identified and interpreted on photographs without doubt, no verification was considered necessary. Vegetation on the existing maps was found incorrect and had to be completely resurveyed on the ground. Also, the entire area was carefully examined for items of detail that had appeared since the date of photography. Classification of all communications, new names and correction of erroneous ones, relative heights and surveyed trees were also picked up on the ground and recorded on photographs in the field as usual.

For (ii) and (iii), the country being flat and affording limited visibility, heights were provided by levelling. Spot heights—4 to 7 per 5-minute square—were fixed by running criss-cross rapid lines of tertiary single levelling based on existing bench-marks in the area. Approximate belts containing each 50-foot contour were located from these spot heights, additional heights being provided where necessary. The contour was then surveyed on the photographs from these spot heights by taking clinometer readings to signals fixed at the height of the plane-table, and their positions pricked on the photographs.

The procedure as outlined above is still in the experimental stage. With a view to determining the relative costs, advantages and disadvantages, if air survey revision precedes ground work, one 1-inch Sheet 79 A/2 was revised by No. 12 Party (5 Party personnel being all out in the field) on 2-inch film positives (Kodalines) from the air photographs at the same scale. This preliminary revision showed many items of detail which could not be interpreted with certainty. Their further verification on the ground was necessary, as was also the collection of other information not available on photographs. With this procedure it was found that the ground verifier had to cover the whole area in detail for depiction of vegetation, collection of names, information regarding communications, relative heights, verification of doubtful detail and for weeding out those items of photo revised detail which were considered, on visiting the ground, to be superfluous for 1-inch maps. Accordingly no appreciable saving in time was discerned, and this method is probably more costly.

It is, however, evident that revision survey from air photographs has a distinct advantage over purely ground methods. The main difficulties to be overcome in revising 1-inch maps using 2-inch air photographs are concerned with the drawing and final production of the revised maps. The film positives (Kodalines) used for

carrying out the revision on the scale of photography, i.e., 2-inch, necessarily comprise more than one section for each 1-inch sheet, since negatives are not available in larger sizes. Further, these film positives do not make a good base for drawing and typing and for permanent retention as "Originals". Various methods will, however, continue to be tried, in order to select the one most suitable for publication of the revised sheets.

Dihāng reservoir.—Combination by the Slotted Template Method of air photographs on 4·4 inches to 1 mile scale, enlarged from 2-inch photographs, was carried out for 215 square miles of the area for which planimetric control had been completed during 1949-50 and outlines and contours were air surveyed. The originals on Koda-trace were fair drawn on 4·4 inches to 1 mile scale for publication or the 4-inch scale in three colours. Only 3 sheets comprising an area of 25 square miles were fair drawn for publication and work on the remainder was dropped, the investigations for the project having been suspended.

No. 9 PARTY

Officer in charge :—Mr. H. H. Phillips, B.Sc. (Hons.), A.M.I.S. (Ind.).

27. **General.**—During the first half of the year under report the party was employed on mapping of surveys in connection with the Kosi Irrigation Project and the Ganga Barrage Project to meet the requirements of the Central Waterpower, Irrigation and Navigation Commission in continuation of the same type of work done for the same indentor in previous years.

In the latter half of the year under report the party was employed on special surveys for the Damodar Valley Corporation for the production of suitable maps of the catchment area for soil conservation and irrigation purposes.

28. **Personnel.**—The average technical strength of the party was :—

In the first half of the year,			
Gazetted Officers ..	..	..	4
Other technical personnel ..	..	..	68
In the latter half of the year,			
Gazetted Officers ..	..	..	3
Other technical personnel ..	..	..	27

29. Areas Surveyed.—

800 square miles of triangulation for the 6-inch air survey in the Upper Damodar Valley area.

752·9 square miles of ground verification for air survey and tertiary levelling for 6-inch Upper Damodar Valley surveys.

30. Technical Methods.—Upper Damodar Valley surveys.—For the planimetric control of the 6-inch air survey, minor triangulation was carried out to supplement the existing triangulation data in the area in order to obtain an overall density of approximately one point in every 3 or 4 square miles. This triangulation was controlled for scale by H.S.B. extensions whenever an existing minor triangulation station was occupied. All triangulation stations and points were pricked on 2·5-inch air photographs (contact prints) by the triangulator, on the ground.

(b) In order to obtain an adequate network of heights for contouring, at a 10-foot vertical interval, tertiary levelling was carried out along lines 30 chains apart, obtaining spot heights at intervals of 10 chains approximately. Bench-marks were made on rock *in situ*, or on semi-permanent features such as milestones, *pucca* wells, house plinths or the bases of trees, where rock *in situ* did not exist. This tertiary levelling was based on Double Tertiary bench-marks, which, in turn, were based on Primary bench-marks in or near the area. As the tertiary levelling heights were to be used for 10-foot contouring the degree of error permitted was a closing error of 1-foot for any tertiary line. The average length of tertiary line was approximately 8 miles. All spot-height and bench-mark positions were identified and pricked on 2·5-inch air photographs (contact prints) by the levellers on the ground, *pari passu* with the tertiary levelling.

31. Discussion of Out-turn.—In general, the tertiary levelling out-turn was somewhat low due to the ground being very undulating. The levellers usually had to proceed with short “shots” even using fully extended staves.

In the colliery areas in particular, due to congestion of detail such as installations, pits, excavations, subsidences of ground over old excavations, buildings, power plants and their radiating lines in addition to the normal detail, both tertiary levelling and ground verification out-turns were accordingly low. To step-up out-turn of tertiary levelling in very congested areas the lines were run along roads and tracks instead of along the straight lines 30 chains apart as done in open country.

A hindrance to the triangulation, in the colliery areas, was the extensive pall of smoke that hung about on most days obscuring the visibility beyond a distance of a mile or so.

No. 11 PARTY

Officer in charge :—Mr. J. Chatterjee, B.Sc.

32. General.—The following survey operations were carried out by the party :—

(a) Ground verification and height control for subsequent air survey to produce one-inch departmental maps in Sheet 64 P.

- (b) I.C.A.O. surveys for Patna, Jharsuguda, Barraokpore, Dum Dum and Tezpur airfields, in Sheets 64 N, O, 72 C, G, 73 B, C, 79 B and 83 B. Landing Chart surveys only were done for Tezpur airfield and Obstruction Chart surveys only for Calcutta (Dum Dum) airport.
- (c) Contour survey and ground verification on blue prints of air surveyed outline, on 32-inch scale, of Upper Mahānadi Dam area in Sheet 64 H.
- (d) Air survey for four-inch irrigation mapping for Hirā-kud Dam in Sheets 64 O, P and 73 C, and for Gandak Barrage scheme in Sheets 63 N, 72 B, C and G. Both these jobs were in continuation of the work already in hand, the former being completed.

33. *Technical Methods.—1" Departmental surveys in Sheet 64 P.*—Ground heights to a density of four per square mile were obtained by normal plane-tabling methods and their positions were pricked on vertical air photographs on two-inch scale. For convenience, the plane-table sections were plotted on two-inch scale. Stations and points of previous triangulation were also pricked on the photographs. The heights of the triangulation points were checked with a theodolite by observation from the triangulation stations before using these for deducing new heights by plane-tabling. Separate height traces were not kept because the plane-table sections served the purpose. Usual name lists were kept. Ground verification of details, such as roads and tracks with classification, mosques, temples, telegraph lines, milestones with numerals, vegetation, various types of boundaries, post and telegraph offices, inspection bungalows, police stations, wells, bridges, etc., was done on colour traces of the photographs. The colour traces were made of the size of the plane-table sections, with photo limits marked.

Airfield surveys.—Landing, Approach and Obstruction Chart surveys were carried out in accordance with the specifications laid down by the International Civil Aviation Organization. As minor details are not shown and other details are generalized on quarter-inch maps, verification survey for Approach Charts was done first on one-inch sheets, instead of on quarter-inch sheets, for convenience in making fixings by interpolation and for obtaining greater accuracy in measuring distances to hazards to be heightened; and the verified details were then transferred on to quarter-inch maps.

For determining the highest point of a runway, a line of levelling was first run along the centre of the runway and the positions of the staves were marked on the runway surface. The exact location was then obtained by observations to a staff manoeuvred in the approximate location of this point. At Dum Dum aerodrome, where it was not possible to run a level line along the centre of the runway due to the high frequency of landing and taking off of aircrafts, initial spot heights on the runway were obtained by reading "abreast heights"

to points at intervals of about four chains along the centre line of the runway, from a level line run parallel to and at a distance of about four chains from it.

The plane-table survey for Obstruction Charts at Dum Dum airfield was done on 1 : 12,000 blue prints obtained by enlarging 1/50,000 Landing Chart surveys of the same area carried out in the previous field season. Air photographs of the area on scale 1 : 12,000 were also available and were very useful for checking the plane-tabling and for inserting details on the section between nearby points intersected on the plane-table section and identified on the photograph.

Upper Mahānadi Dam survey.—Contours at 5-feet vertical interval were surveyed on blue prints of the air surveyed outline, with the help of clino-poles. At the same time ground verification of details that could not properly be identified on the photographs at the time of air survey, was done, and any small errors in the air survey were corrected on the ground.

34. **Recess Mapping.**—Gandak Barrage mapping was done by, firstly chalking on photo-mosaics under stereoscopic fusion those details only which were not clear on the photographs to the naked eye, and then by tracing all the details on koda-trace sections from the photo-mosaics. Names and other information were taken from one-inch maps of the area. Generalized contouring at 1-foot vertical intervals was done by interpolation with the help of levelled spot heights, the positions of which were pricked on the photographs during the previous field season. The photo-mosaics had been “controlled” with the help of reliable points, appearing on the one-inch maps of the area, and identifiable on the photographs. Trigonometrical and traverse control points, the positions of which were identified on the photographs during the field, were also used in the preparation of the photo-mosaics.

No. 12 PARTY

Officer in charge :—Mr. J. C. Berry.

35. **General.**—The party was employed on air surveys on various scales as follows :—

(a) *Sheet No. 79 A/2.*—Air survey revision of detail only.

The survey was for the purpose of revising the departmental 1-inch Sheet 79 A/2 and was carried out on 2-inch kodalines, enlargements of the existing 1-inch sheet. The air photographs were on the 2-inch scale. There were 4 sections and on completion of the survey of the detail, the sections were passed on to No. 5 Party who carried out the ground verification and contouring, and would complete the fair mapping as well.

(b) *Bihār Mica Belt ; Sheets Nos. 72 L/2 and 6.*—The survey was carried out on 1/25,000 scale from enlargements of air photographs taken on the 1·8 inches scale. Each 1-inch sheet was divided into 6 sections, each section forming a 1/25,000 sheet. The detail was revised on kodamine enlargements of the existing 1-inch sheets, but contours were surveyed *de novo* at 25 feet vertical interval on existing height control, supplemented by height control fixed by No. 11 Party in 1948-49. This party also carried out the ground verification of names, communications, etc., in the same year.

Although the survey is of a rigorous quality with symbols, footnotes and headings conforming to departmental rules, these sheets do not form part of the standard 1/25,000 departmental series.

The survey is being done for the Geological Survey of India and the whole job has not yet been completed.

(c) *Upper Mahānadi Reservoir ; Sheets Nos. 64 H/6, 7 and 11.*—Complete air survey on 4-inch scale, with contours at 10-foot vertical interval was required. The area of the survey is approximately 80 square miles with the 1230-foot contour as the limiting line. The survey is based on the planimetric and height control fixed by No. 11 Party in 1949-50.

The work is being carried out for the Central Waterpower, Irrigation and Navigation Commission and the whole job has not yet been completed.

(d) *Upper Mahānadi Dam ; Sheet No. 64 H/6.*—Air survey on 32-inch scale, was required by the Chairman, Central Waterpower, Irrigation and Navigation Commission. The area of survey was 5·2 square miles and was divided into 15 sections. On completion of the detail survey, the sections were passed on to No. 11 Party who carried out the ground verification and contouring and would complete fair-mapping as well. The survey of detail was based on the planimetric control fixed by No. 11 Party in 1949-50.

36. *Personnel.*—The average strength of the party was 2 Gazetted Officers and 35 other personnel including 4 clerks.

37. *Areas Surveyed.*—The total area surveyed was 492 square miles on 2-inch, 4-inch, 32-inch and 1/25,000 scales.

38. *Technical Methods.*—(a) For the Upper Mahānadi Dam and Reservoir surveys, combination of air photographs was carried out by the Slotted Template method. For the revision surveys in Bihār Mica Belt and in Sheet 79 A/2, no combination was done,

but principal points of photographs were resected direct on to the sections with the help of prominent existing detail which were identified on the photographs. This method gave satisfactory results.

(b) Revision survey was carried out on kodaline and koda-trace enlargement of existing 1-inch sheets. The kodelines were printed in black and the koda-trace in purple. The survey was carried out on the koda-trace prints in which all details identified on the photographs were inked up in proper symbols and colours. The kodaline prints were then examined against the koda-trace and the existing detail which agreed fairly well was accepted and that which disagreed was erased. The new and corrected detail was then traced on to the kodelines and drawn with photopaque, which medium was found to be most suitable for drawing on film.

(c) The revision survey of Sheet No. 79 A/2 was selected to test whether it was more satisfactory, from the point of view of survey as well as economy, to carry out air survey before the ground verification, or vice versa. The second method was tried out on another 1-inch sheet by No. 5 Party during the last field season and for the results No. 5 Party's report on page 32 may be seen.

V. TECHNICAL NOTES, SOUTHERN CIRCLE

DIRECTOR:— { Mr. H. M. Critchell, to 28-5-50.
Mr. B. N. Saha, M.Sc., M.I.S. (Ind.), from 29-5-50.

DY. DIRECTOR:— Mr. P. A. Thomas, M.I.S. (Ind.), A.R.I.C.S., to 11-11-50.

39. **Summary.**—At the end of the period under report, the following survey parties were under the administrative control of the Director, Southern Circle :—

No. 6 Party.
No. 8 Party.
No. 10 Party.
No. 17 Party.

Besides the above, the Headquarters Section under the direct technical control of the Director, Southern Circle also carried out some survey tasks, reference to which is made only in the General Report of this year.

No. 6 PARTY

Officer in charge:— { Mr. P. A. Thomas, M.I.S. (Ind.), A.R.I.C.S., to 12-10-1950.
Mr. M. R. Nair, B.A., A.M.I.S. (Ind.), from 13-10-1950.

40. **General.**—The party was employed in the field on Ukai Reservoir survey for the Central Waterpower, Irrigation and Navigation Commission, New Delhi, and airfield surveys for preparation of I.C.A.O. Charts. In the recess, air survey of the Dharoi Reservoir area and fair mapping of the Dharoi Dam site and of certain departmental 1-inch sheets, surveyed during previous seasons, were taken up.

Brief notes on the methods adopted for the above surveys are given below.

41. **Ukai Reservoir Survey.**—Air-cum-ground method was adopted for the survey of the Ukai Reservoir in Sheet 46 G. Enlargements on 4-inch scale of 2-inch photographs of this area were obtained and air survey was carried out by the Slotted Template method on framework provided by triangulation carried out during 1948-49. Verification of detail on the ground and contouring at 10-foot vertical intervals in open areas and at 20-foot intervals in wooded areas were done by usual ground methods on blue prints obtained from air survey sections. Additional planimetric and height control points, as required, were fixed by supplementary triangulation, traversing and levelling during survey. The clinopole, a valuable adjunct to traversing in jungle areas and surveying contours, was extensively used. All details, were completely inked up on field survey sections.

In the jungle covered foot-hills of Tāpti Valley interpretation and identification of detail on photographs was difficult. This was reflected in errors and shifts in the position of details discovered during ground verification. This called for a more rigorous checking of air-surveyed detail on the ground. The presence of high grass in parts of the jungle area retarded the progress of work considerably.

42. Airfield Surveys.—Specifications for survey of Landing and Approach Charts have been summarized in the previous Technical Report. Methods adopted for the various airfield surveys carried out during the current season only are noted below :—

Landing Charts of Porbandar and Junāgarh (Keshod) Airfields in Sheets 41 G and K respectively were completed during the year.

Taking advantage of the air-photo cover available for the Porbandar airfield area the air-cum-ground method was used to survey the Landing Chart. Planimetric and height control points were first provided by triangulation and the heights above M. S. L. of the Aerodrome Reference Point on which all heights on these charts are based, was fixed by tertiary levelling from the nearest High Precision Level lines. Detail was compiled by radial line method on the above framework and ground verification of detail and contouring carried out by ground survey methods. Heights of obstructions and hazards were fixed by theodolite observations as they had to be correct within 3 feet.

There being no modern survey nor air-photo cover for Junāgarh (Keshod) Airfield area, detail and contours for the Landing Chart were surveyed by rigorous ground methods. 1½-inch enlargement of existing 1-inch map of pre-1905 survey was supplied to the Plane-table and the details on this were accepted after adjustment and checking on the ground.

Approach Charts.—Black prints of the existing ¼-inch Sheets 41 G and K (compiled from pre-1905 surveys) were mosaiced for the required areas of the Approach Charts. These were in the first instance corrected against office copies and against air photography where available and then verified and corrected on the ground for omissions, inaccuracies in existing survey and for gross over generalizations of main features like roads, railways and rivers. Positions and elevations of important obstructions and hazards were accepted from existing maps where they were triangulated heights. New heights were fixed by theodolite observations.

43. Air Survey of Dharoi Reservoir.—The air survey was carried out by the principal point radial line method in Sheet 45 D.

44. Description of Country.—Most of the country covered by the Ukai Reservoir was the wooded valley of the Tāpti River which cuts a deep course among the foot-hills of the Satpura Range on the north and passes through nameless low hills on the south. The area was surveyed almost entirely by plane-table traverses. The rest of the area is open, cultivated and slightly undulating plains where plane-table fixings were possible.

No. 8 PARTY

Officer in charge :— { Mr. F. M. Hawley, A.B.I.C.S., to 31-10-50.
Mr. M. W. Kalappa, B.A., A.M.I.S. (Ind.), from 1-11-50.

45. **General.**—The party was employed on the following surveys, mapping and framework of extra-departmental projects and departmental jobs :—

- (a) Tungabhadra Project.
- (b) Navja-Pophli Tunnel of Koyna Project.
- (c) Airfield surveys of Trivandrum Airfield.
- (d) 1-inch modern survey.
- (e) 1-inch verification survey.

46. **Technical Methods.**—The methods adopted for items (a) and (c) above have been described in the previous Technical Reports. The methods used for the remaining items are given below :—

Navja-Pophli Tunnel.—The air survey of an area of 11 square miles, on 4-inch scale with contours at 10-foot vertical interval, was required by the Bombay Government to bore a tunnel through a hill, 2,965 feet high and drop the waters of the Koyna Reservoir through turbines from Navja, of height 2,000 feet, to the proposed hydro-electric power-house at Pophli of height 500 feet.

The method used for providing the planimetric and height control of this tunnel area is the same as was adopted for the Pennār Dam, described in the previous Technical Report.

1-inch modern survey.—Before commencing the survey in Sheet 47 G, the old topo. triangulation data of 1882-85 and 1903-05 together with their re-determined heights of 1946-47 were scrutinized to determine whether they were in terms of G.T. triangulation and were sufficiently accurate for 1-inch modern survey and whether fresh minor triangulation was necessary.

The scrutiny revealed that the old values of G.T. stations had been accepted for the old computations carried out in rectangular terms and consequently the origin of the computations required a mean correction of *plus* 1"·69 in latitude and *minus* 2' 27"·02 in longitude, to bring it in terms of the modern values of the G.T. stations given in the G.T. pamphlet of Sheet 47 G.

To determine the standard of accuracy of the old topo. triangulation, the co-ordinates of its stations in Sheet 47 G were re-computed by the Ray Trace system in spherical terms, based on the modern values of the G.T. stations, running a main series of well-conditioned triangles from one G.T. station to another falling in the area. Based on the co-ordinates of the main series thus derived, the co-ordinates of the remaining stations of the old triangulation were re-computed. The re-computed spherical co-ordinates were then converted to the rectangular terms using the corrected origin,

mentioned in the above sub-para. The maximum discrepancy between these re-computed rectangular co-ordinates and their corresponding values in the old computation volumes, either in easting or northing, was found to be only 18 links or 12 feet, which was not plottable on the 1-inch scale. The average discrepancy was 7 links or 5 feet. The co-ordinates of the old topo. triangulation were, therefore, accepted as being accurate enough for the 1-inch modern surveys.

The graticules of the existing maps from pre-1905 surveys were first corrected and zinc-mounted blue prints of these maps were used for the 1-inch modern survey by the normal plane-tabling methods.

1-inch verification survey.—The corrections to details on Sheet No. 58 B/10 received from extra-departmental sources, were verified on the ground by the normal methods.

As the country in Sheet 58 B/10 consisted mostly of open plains, the plane-tabler and one *khalasi* of his squad were provided with bicycles to carry the full plane-tabling equipment for the verification work. The use of bicycles helped the plane-tabler to cover a larger area in a shorter time, obviating the necessity of moving his camp frequently, which he would otherwise have done almost daily, and proved very economical on the whole.

47. *Miscellaneous.*—Owing to the economy imposed during the year and consequent shortage of regular *khalasis*, the field work had to be carried out almost entirely with the imported and locally recruited *mazdoors*, paid from contingencies. The shortage of trained *khalasis* proved a great handicap in the field for the efficient execution of field work and it was found essential that in future there should be at least 1 to 2 trained regular *khalasis* in each squad of a plane-tabler and 2 to 4 regular *khalasis* in each squad of a triangulator, leveller or camp officer.

The refusal of the Bombay Government to supply supplementary rations, on the scale provided for manual labourers by the Government of India, to the personnel of the party working in Bombay State told adversely on the efficiency of the Class IV servants, who had a strenuous work to perform in the hills of the Western Ghâts.

No. 10 PARTY

Officer in charge :— { Mr. B. N. Murthy, B.Sc., to 31-10-50.
Mr. F. M. Hawley, A.R.I.C.S., from 1-11-50.

48. *General.*—This party was engaged mainly on training which continued throughout the whole year. In addition to the normal training programme, the following surveys were also carried out :—

- (a) Airfield surveys for the International Civil Aviation Organisation.
- (b) 1-inch scale modern surveys.

49. **Training.**—A batch of 95 trainees completed the training course at the end of October 1950. Of these, 73 were transferred to other units for productive work and the balance were employed in this unit on productive 1-inch scale modern surveys. A fresh batch of 34 trainees from other circles and units joined this party at the commencement of the field season 1950-51 and commenced training according to the standard syllabus laid down. This syllabus has already been set down in the Technical Report, Parts I and II, 1948-49.

50. **Airfield Surveys.**—The programme for both the $\frac{1}{2}$ -inch scale survey of the Approach Chart and the 1/50,000 scale survey of the Landing Chart of the Bezwāda Airfield in Sheet 65 D was carried out according to the specifications laid down for this type of survey which have already been described in the previous Technical Report.

51. **1-inch Modern Survey.**—From a careful examination of the old triangulation records of the area for survey in 47 H it was found that there was an adequate number of stations and points. It was felt doubtful, however, whether the accuracy of this old data carried out in seasons 1884-86 could be relied upon. In the interests of economy and to prevent duplication of work it was decided, under instructions from the Director, to test this old work to determine whether it was in terms of the G.T. triangulation and were sufficiently accurate for 1-inch modern survey or whether fresh minor triangulation was necessary.

The scrutiny and the method to determine the standard of accuracy of the old topo. triangulation is described in para 46 of No. 8 Party's current report. The scrutiny revealed that the origin of computation required a mean correction of *plus* 1".72 in latitude and *minus* 2' 27".13 in longitude to bring it in terms of the modern values of the G.T. stations given in G.T. pamphlet of Sheet 47 H.

The comparison revealed that the old computations after conversion to modern values would come well within the accuracy acceptable for 1-inch topographical surveys. It was, therefore, decided that no fresh planimetric observations were necessary.

The heights of the old topo. triangulation were re-computed in terms of the G.T. stations and adjusted in accordance with instructions in Appendix IV of T.H.B. Chapter III. The adjusted heights of topo. triangulation were used for the 1-inch modern survey, except for the intersected tree points, whose top heights were reobserved.

The method of survey was as for normal 1-inch scale plan-tableing on blue prints.

52. **Description of Country.**—The area surveyed consists of two distinct types: the low undulating and intricate belt from the coast to the foot-hills of the Western Ghāts and the Western Ghāts themselves. The hills were mostly bare but on some of the slopes

and in the valleys a great deal of vegetation was encountered. The high lands were fairly well cultivated. Reputed to be malarious, the whole area was, however, found to be practically free of mosquitos and only a very few cases of other types of illness were reported.

No. 17 PARTY

Officer in charge :—Mr. B. N. Murthy, B.Sc.

53. **General.**—The party was employed on the following surveys:—

- (a) 1-inch modern survey of Sheets 46 G/6, 10 and 46 H/5, 6.
- (b) Airfield surveys of Baroda and Bhaunagar airfields in Sheets 46 F and 46 C respectively.
- (c) Framework for the control of air surveys for future surveys in 46 F/SW.

54. **Technical Methods.**—The methods adopted for the above are given below :—

- (a) *1-inch modern survey.*—The existing triangulation, carried out during 1874 to 1892, was utilized for the control. The co-ordinates and heights of a few stations of the old triangulation were compared with their present values in the latest G.T. pamphlets 46 G and H and the following mean corrections were applied to the old co-ordinates to bring them to modern terms :

Latitude	..	minus	0".13
Longitude	..	minus	2' 27".03
Height	..		no correction.

To check the accuracy of the old topo. triangulation, where it was not based on a G.T. base but started from a G.T. station and closed on a G.T. station, the co-ordinates of selected stations in well conditioned triangles, situated alongside a G.T. base were computed by the Ray Trace system. The computed values agreed well with the values determined in the old triangulation, which were, therefore, accepted as being accurate enough for the 1-inch modern surveys. The blue prints for survey were obtained in the following manner :—

A chart showing points and stations of the old triangulation was prepared for each 1-inch sheet. Published maps of the old surveys were cut up and mosaiced on the plotted points.

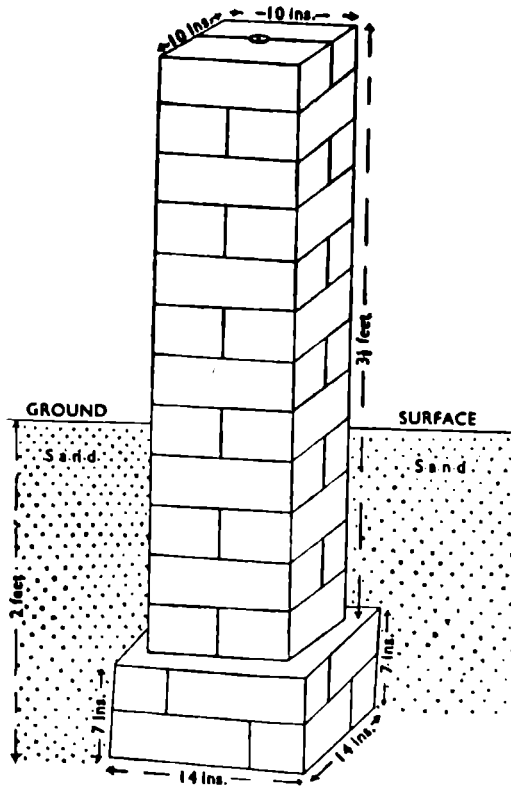
Blue prints on cloth and zinc-mounted drawing paper for use as field sections were obtained by photography of the mosaics.

The survey was carried out by the normal plane-tableing method.

- (b) *Airfield surveys.*—These were carried out in accordance with the specifications laid down for the I.C.A.O. charts. Details have been published in the Technical Report, Parts I and II, 1950.
- (c) *Framework for the control of air surveys in 46 F/SW.*—A reconnaissance of the area was carried out to find out if the old stations and points of the old triangulation existed and could provide sufficient control. It was found that very few stations could be located and identified. Consequently traverse with heights was run to provide necessary control, as no triangulation was possible owing to flatness of the area. The positions of the traverse stations were resected on the photos at the time of running the traverse.
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VI. APPENDIX TO TECHNICAL NOTES

DESCRIPTION WITH A SKETCH OF A STATION PILLAR



STATION PILLAR
(Model)

The masonry construction on which a station was made consists mainly of two parts :—

- (a) The *base* which is constructed of bricks set in cement and sand mortar, measures 14 inches square and 7 inches in thickness. It is embedded in sand 2 feet below the ground surface. A circle dot mark is cut in its centre.
- (b) The *pillar* which is constructed in the centre of the base, is $3\frac{1}{2}$ feet high and 10 inches square in section. Its top is plastered with $\frac{1}{2}$ inch thick cement and a circle-dot mark is engraved vertically over the mark in the base.

PART II—MAP PUBLICATION AND OFFICE WORK

TECHNICAL NOTES

DIRECTOR :—Colonel I. H. R. Wilson, F.R.I.C.S., M.I.S. (Ind.).

DY. DIRECTOR :—Mr. K. L. Dhawan, B.A., M.I.S. (Ind.).

VII. PRINTING AND REPRODUCTION OF MAPS

55. **General.**—The period under review has been **uneventful in so far as the introduction of any major new technique is concerned.**

With the easing of the map stock situation of **departmental sheets**, the pre-war policy of printing maps in full colours has **been revived**. On the reproduction side, the printing of **large size multi-coloured posters** for various Government Departments continued.

56. **Printing.**—Experiments are in progress to renovate **time-barred and fogged photographic material**. The results obtained so far have been very hopeful. The success of the experiment will **save the department a considerable amount of money.**

INDEX MAPS

INDEX A.—Modern Topographical Surveys and Compilation.

INDEX C.—Index showing Project Surveys in hand.

N.B.—The above two indexes are the same as Indexes A and C which appear in the General Report, 1951.