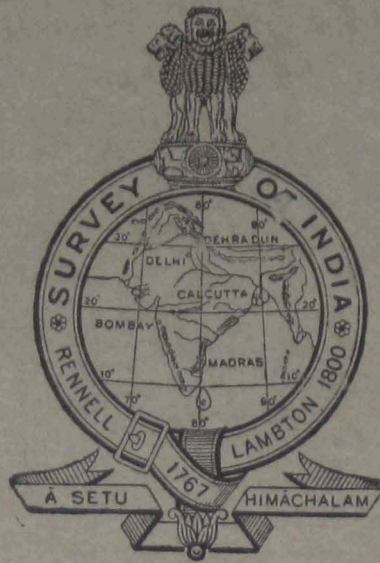


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SURVEY OF INDIA *Presented*

TECHNICAL REPORT 1948-49

(From 15th August 1947 to 31st March 1949)



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

PUBLISHED BY ORDER OF
BRIGADIER G. F. HEANEY, C.B.E., F.R.I.C.S.
SURVEYOR GENERAL OF INDIA

061-1-055
526 (54)

PRINTED AT THE OFFICE OF THE GEODETIC & TRAINING CIRCLE
SURVEY OF INDIA, DEHRA DUN, 1951.

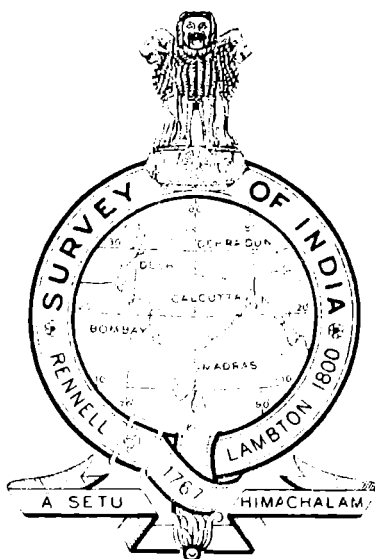
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SURVEY OF INDIA

TECHNICAL REPORT
1948-49

From 15th August 1947
To 31st March 1949

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The Technical Report which has superseded the Geodetic Report not only deals in detail with the geodetic and geophysical activities of the department, but also covers technicalities of survey work,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 Technical Report for 1947 covered the period from 1st October 1946 to 14th August 1947, after which date India was partitioned. The present report covers the period from 15th August 1947 to 31st March 1949 and is the first report relating only to the Union of India. Future reports will cover approximately 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 (previously published in the General Report) giving a detailed statement of areas, out-turns and cost-rates of surveys. It also contains technical notes on topographical and other surveys, descriptions of country surveyed, notes as to weather, communication, availability of food and on other subjects likely to be of interest to surveyors. It may also have appendices describing new technical methods and equipment.

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 being published as a separate volume this year.

The report is self-contained with indexes, charts, samples of finished work, photographs, illustrations, etc.

A Supplement to the Technical Report containing some of the information previously published in the Technical Supplement to the General Report 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 although they were omitted in the General Report, 1947.

Table C is, now published in the Technical 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. 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 (i.e., since 1905) topographical surveys made by the department and of compilations made from our own or other material is illustrated in *Index A*. The surveys in hand 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
				*Nett	*Overall	
No. 1 Party.—	New Delhi Development Survey	sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE</u>
<i>40% area undulating, 60% area flat built-up or covered with fruit gardens</i>	(Scale 100 feet to 1 inch, contours at 5-foot interval)					
	1. Air survey	26.4	1.33	1409.9	1762.4	Job incomplete, incorporation of verification corrections and fair mapping in hand.
	2. Ground verification and contours at 5-foot intervals	26.4	0.24	3715.3	4762.1	Triangulation of 26.4 sq. miles was done in 1945.
	3. Levelling	118 (linear miles)	11.45 (linear miles)	82.8	106.2	
	East Punjab Capital Site Survey					
<i>20% area on the north side hilly, 80% area flat with gradual slope towards south and crossed by sandy beds of dry streams</i>	(Scale 4 inches to 1 mile, contours at 5-foot interval in flat area and 25-foot in hilly area)					
	1. Air survey and incorporation of verification corrections and fair mapping	443	5.65	43.8	54.8	
	2. Original ground survey ..	21	4.35	393.4	501.2	
	3. Ground verification ..	443	13.67	92.6	120.0	

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 1 Party.—Contd.		sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u>
	4. Traversing	292 (linear miles)	39.33 (linear miles)	38.7	50.0	<u>Contd.</u>
	5. Height control	97	14.85	71.7	92.4	
	6. Triangulation	46	46.00	21.3	27.3	
	Complete job	464	3.5	189.5	243.2	
	Kānpur (Cawnpore) Development Survey					
<i>City area, largely built-up</i>	(Scale 16 inches to 1 mile, without contours)					
	1. Post-pointing of trijunction pillars for control	50.3	201.2	5.8	7.3	
	2. Air survey from rectified photo- graphs.	50.3	0.56	454.6	568.3	
	Complete job	50.3	0.56	460.4	575.6	
	Rewa and Satna Town Surveys					
<i>City area, undulating at places</i>	(Scale 16 inches to 1 mile, with 10- foot contours)					

* For explanation of 'nett' and 'overall' rates see page 3.

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	
				*Nett	*Overall		
No. 1 Party.— <i>Contd.</i>		sq. m.	sq. m.	Rs.	Rs.	NORTHERN CIRCLE.—	
						<i>Contd.</i>	
	1. Traversing	63 (linear miles)	30.00 (linear miles)	40.2	60.9	Job incomplete, incorporation of verification correction and fair mapping in hand.	
	2. Ground verification and con- touring	9	1.1	1226.7	1633.9		
	3. Levelling	61 (linear miles)	14.88 (linear miles)	71.4	95.6		
	4. Air survey	9	1.0	277.6	347.0		
		Survey of Agra Central					
		(Scale 32 inches to 1 mile and con- tours at 5-foot interval)					
		1. Air survey	2.1	0.2	1316.2	1645.2	Job incomplete, incorporation of verification correction and fair mapping in hand.
		2. Traversing	19.0 (linear miles)	15.83 (linear miles)	59.1	95.9	
	3. Levelling	21.0	28.77	32.1	42.3		
	<i>City area, mostly built-up ground uneven with mounds generally 20 to 50 feet high at places</i>						

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 1 Party.—Contd.						<u>NORTHERN CIRCLE.</u> <u>Contd.</u>
	4. Ground verification and con- touring	2.1	0.44	Rs. 2272.0	Rs. 2990.6	
	Survey of Cattle Breeding Research Station, Jubbulpore					
	(Scale 4 inches to 1 mile and con- touring at 5-foot interval)					
	1. Original ground survey	5.0	1.92	589.7	1011.0	No planimetric or height control was carried out. Survey was based upon existing trig. data.
	2. Fair mapping	5.0	0.93	47.8	59.8	
	Delhi city and its suburbs					
	Correction survey on 1 inch to 1 mile					
	Correction survey	995.0	497.5	1.9	2.4	For verification and correction of communications and office copy corrections and other main details.
	Ranganga Dam Survey					
	(Scale 10 inches to 1 mile, con- tours at 20-foot interval in hilly area and 10-foot interval in flat portions and on saddles)					
	<i>Low hills, area covered with dense forest</i>					

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 1 Party.—Contd.		sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <u>Contd.</u>
	1. Triangulation	11·0	10·0	341·0	435·2	
	2. Height control	11·0	4·93	241·2	312·5	
	3. Air survey and drawing	11·0	0·86	242·0	302·5	
	Complete job	11·0	0·68	824·2	1050·2	
	Bargi Reservoir Survey					
<i>Hilly area with fairly dense jungle</i>	(Scale 4 inches to 1 mile, contours at 20-foot interval in hilly area, and 10-foot interval in flat area)					
	Height control	173·0	13·84	116·3	168·6	Job incomplete, air survey in hand.
	Bargi Dam Site Survey					
<i>Hilly area with open jungle</i>	(Scale 32 inches to 1 mile, contour at 5-foot interval)					
	1. Height control	1·2	1·29	916·1	1336·4	Job incomplete, air survey in hand.
	2. Planimetric control	30·0	0·30	54·5	78·8	

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 1 Party.—Contd.	Ashni River Project Surveys- Applique Slip	sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <u>Contd.</u>
<i>Mountainous area with open jungle</i>	(Scale 4 inches to 1 mile and contours at 20-foot interval)					
	1. Air survey for appliqué slip ..	4.0	0.77	328.9	411.1	
	Konār Dam Survey, Dāmodar Valley Project					
<i>Hilly undulating country covered with dense and open jungle</i>	(Scale 32 inches to 1 mile and contours at 10-foot vertical interval)					
	1. Air survey	4.7	0.53	1148.2	1435.2	Control was provided by Eastern Circle.
	Konār Pipe Line Survey, Dāmodar Valley Project					
<i>Hilly undulating country covered with dense and open jungle</i>	(Scale 6 inches to 1 mile and contours at 10-foot interval)					
	1. Air survey	16.0	2.23	302.0	377.5	Control was provided by Eastern Circle.
	Konār Reservoir, Dāmodar Valley Project					
<i>Hilly undulating country covered with dense and open jungle</i>	(Scale 6 inches to 1 mile and contours at 10-foot interval)					
	1. Air survey	17.0	1.79	238.6	298.3	Control was provided by Eastern Circle.

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
<p>No. 1 Party.—Concl'd.</p> <p><i>Fairly built-up area surrounded by high hills covered with pine trees, etc.</i></p>	<p>Patiāla Surveys</p> <p>(Scale 16 inches to 1 mile with contours at 20-foot interval)</p>	sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <u>Contd.</u>
		9.5	2.83	457.7	615.8	Job incomplete, air survey in hand.

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 13 Party.— <i>90% flat, open cultivated plains with about 10% of area covered by thorny jungle and high grass</i>	Bhakra Dam Project	sq. m.	sq. m.	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <u>Contd.</u>
	4-inch scale with 1 ft. V. I.					
	Triangulation	735·0	105·0	6·2	7·7	
	Traverse and 3,000-acre rectangu- lation	3043·0	23·0	42·8	53·5	
	100-acre rectangulation .. .	3413·0	9·0	116·4	145·5	
	Levelling, tertiary, computation ..	3531	17·0	84·8	106·0	
	Mapping of contours at 1 ft. interval on 4-inch out-line	1819	7·5	42·7	53·4	
Complete job for years under report	1819	..	†499·9	†624·9	†Averages include also expenditure incurred on fieldwork only in an area of about 2,200 sq. miles during field season 1948-49. Mapping work in the above area was not started during the period under report.	

* For explanation of 'nett' and 'overall' rates see page 3.

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 acre		REMARKS
				*Nett	*Overall	
No. 20 (Cantt.) Party.—		acres	acres	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <i>Contd.</i>
<i>Cantonments (plains) 35% of Tambaram, Aundh and Old Artillery Range Allahābād, very open. Rāmgarh, average congestion and open in parts</i>	16-inch Traverse and computation	5935	909.7	1.7	1.8	Rāmgarh, Tambaram, Aundh, Old Artillery Range Allahābād.
Do. Do. ..	16-inch Levelling and computation	6208	4601	0.9	0.9	Rāmgarh, Tambaram, Aundh and Rānchi Camp.
<i>Lightly built-up and undulating</i> ..	8-inch, 5 feet V. I. Original survey	1675	985.3	3.9	4.0	Dehu Road Extension.
<i>Cantonments (Plains), built-up area fairly heavily congested</i>	16-inch, 5 feet V. I. Original survey	3629	124.9	8.2	8.4	Meerut, Ambāla and Jubbulpore Cantonments.
<i>Military Lands (Plains), mostly open areas</i>	16-inch, 5 feet V. I. Original survey	2664	262.9	7.3	7.8	Rānchi Camp, Rāmgarh, Tambaram Cantonment and Aundh.
<i>Cantonments (Plains), built-up and partly wooded</i>	16-inch, 5 feet V. I. Revision survey	1860	306.3	5.3	5.5	Jubbulpore Cantonment.
<i>Cantonments (plains), 90% very congested. 10% average congestion</i>	64-inch Original survey ..	407	11.6	64.7	66.8	Āgra and Meerut Cantonments Bāzārs.
<i>Cantonments (Plains), congested built-up area</i>	16-inch, 5 feet V. I. Fair mapping ..	4647	..	1.4	1.4	Āgra Cantonment, Airfield Depot Āgra and Jubbulpore Arsenal.
<i>Military camps and airfields (Plains and 10% hills) 40% average congestion, 40% slight congestion, 20% open</i>	16-inch, 5 feet V. I. Fair tracings ..	35475	..	0.3	0.3	Dudhkundi, Avadi, Babina Camp, Gummudipundi, Hakimpet Airfield, Yelahanka Airfield Keti proposed Cantonment Yaragūda, Airfield.

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 acres	Out-turn per man per month acres	Cost Rate per acre		REMARKS
				*Nett	*Overall	
No. 20 (Cantt.) Party.—Contd.				Rs.	Rs.	NORTHERN CIRCLE.—
<i>Boundary Traverse</i>	16-inch Traverse and computation	25.3	9.1	3.4	11.5	<i>Contd.</i>
No. 3 wing A/F 75% open and 25% undulating, Ferozepur built-up cantt., Red Fort built-up, W.T. Stn., Gurgaon lightly built-up, Delhi Cantt. Lines built-up Cantt., Jalahalli R.I.A.F. Camp open area, Gunnery School open area, H.Q. R.I.A.F. open area, I.E.M.E. training tracks open area, Lohagaon A/F open undulating area, I.E.M.E. Training School Centre open area; Agra A/F open cultivation with scattered hamlets also partly built-up; Lohagaon Air Field	16-inch Traverse for 5 feet and 1 foot contouring and computations Original and Revision survey	27055	1209.7	0.9	1.2	Khamaria Ordnance Factory Estate and Hapur Remount Depot. P.O.L. Delhi. No. 3 wing Airfield site, Ghaziabad, Ferozepore; Red Fort, Delhi, Wireless Transmitting Station, Gurgaon; Delhi Cantt. (Second Military Lines); Jalahalli R.I.A.F. Camp; Gunnery School Walthair; H.Q. R.I.A.F. Bangalore; I.E.M.E. Training Tracks, Lohagaon Airfield Poonna and I.E.M.E. Training School Centre, Bangalore; Agra Airfield (Priority I and II area).
<i>Kalaikunda A/F open and undulating country</i>	16-inch Traverse for 1 foot contouring and computation (Original survey)	2560	1587.3	0.4	0.5	Lohagaon Airfield, Poonna, Kalaikunda A/F Kharagpur (Priority I and II area).
<i>Kannur Site—open area with bushes and Cholavaram airfield—open area</i>	8-inch Traverse for 5 feet contouring and computation (Original survey)	1800	3000	0.2	0.2	Kannur Site (Bangalore) and Cholavaram Airfield (Madras).
<i>Cholavaram—open area</i>	8-inch Traverse for 5 feet contouring and computation (Revision survey)	3800	6333.3	..	..	Cholavaram Airfield (Madras) Old traverse reopened.

* For explanation of 'nett' and 'overall' rates see page 3.

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 acre		REMARKS
				*Nett	*Overall	
No. 20 (Cantt.) Party.—Contd.		acres	acres	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <u>Contd.</u>
<i>A.O.P. Flight—open area, Bidar Airfield lightly built-up</i>	24-inch Traverse for 1 foot con- touring and computation (Original survey)	1241	979	0.5	0.6	A.O.P. Flight Deolali and Bidar A/F, Hyderabad State.
<i>Cantonment, congested Bazar</i>	64-inch Traverse for 5 feet contour- ing and computation (Original survey)	250	83.3	23.0	27.4	Ferozepore Cantonment Bazar (E.P.).
<i>A.O.P. Flight—open area, Bidar airfield— lightly built-up</i>	24-inch Levelling for 1 foot con- touring and computation (Original survey)	1241	496.4	0.9	1.7	A.O.P. Flight Deolali and Bidar A/F, Hyderabad State.
<i>Kalaikunda A/F—Lohegaon A/F</i>	16-inch Levelling for 1 foot and 5 feet contours and computation (Original survey)	3030	1190.4	0.5	0.8	
<i>Agra Airfield</i>	16-inch Levelling for 1 foot and 5 feet contours and computation (Revision survey)	2915	1181.8	1.0	0.6	Agra Airfield, Priority I and II area.
<i>Red Fort, Shakur Basti O.D. No. 3 Wing Ghaziabad, W.T. Station Gurgaon, Feroze- pore Cantt., Jalahalli R.A.F. Camp Gun- nery School, H.Q. R.I.A.F., I.E.M.E. Training Tracks, I.E.M.E. Training School</i>	16-inch Levelling for 5 feet con- tours and computation (Original survey)	18550	5200.9	0.1	0.2	Red Fort—Shakur Basti Ordnance Depot Delhi No. 3 Wing Ghaziab- ad, W.T. Station Gurgaon, Ferozepore Cantt., Jalahalli R.A.F. Camp, H.Q. R.I.A.F., I.E.M.E. Training Tracks and I.E.M.E. Training School Banga- lore, Gunnery School Waltair.

* For explanation of 'nett' and 'overall' rates see page 3.

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 acre		REMARKS
				*nett	*overall	
No. 20 (Cantt.) Party.—Contd.		acres	acres	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <u>Contd.</u>
<i>Kannur Site</i>	8-inch Levelling for 5 feet contours and computation (Original survey)	2600	13000·0	0·1	0·1	Kannur Airfield site near Bangalore.
<i>Ambāla Sadar Bāzār—Extensions congested Bāzār Area</i>	Original plane-tabling at 64 inches to a mile scale with 5 feet contours	156·6	27·6	11·5	63·5	Congested Bāzār areas.
<i>A.O.P. Flight—open area ; Bidar Airfield</i> ..	Original plane-tabling at 24 inches to a mile scale with 1 foot contour	230	78·4	2·3	2·7	A.O.P. Flight Deolāli and Bidar Airfield, Hyderābād for planing purposes. Survey continues.
<i>Agra airfield environment—open cultivation with scattered hamlets, Red Fort—built-up area W.T. Station—lightly built-up area, Delhi Cantt., Military Lines built-up Cantt., Jalahalli R.I.A.F. Camp—open area, Gunnery School—open area, H.Q. R.I.A.F.—open area, I.E.M.E. Training Tracks—open area, Lohegaon Airfield—open undulating area, I.E.M.E. Training School Centre—open area Lohegaon Airfield</i>	Original plane-tabling 16 inches to a mile scale with 5 feet contours and revision at 16 inches to 1 mile scale with 5 feet contours	14078	253·1	2·7	3·4	Agra Airfield Environs (Priority II area) Red Fort Delhi; Wireless Transmitting Station, Gurgaon; Delhi Cantt., Military Lines; Jalahalli R.I.A.F. Camp; Gunnery School, Waltair; H.Q. R.I.A.F. Bangalore; I.E.M.E. Training Tracks, Bangalore; Lohegaon Airfield, Poona; I.E.M.E. Training School Centre, Bangalore.
<i>Agra Airfield 70% built-up and 30% open</i>	Revision plane-tabling at 16 inches to a mile with 1 foot contour	2155	253·5	..	..	Agra Airfield, Priority I area.
<i>Lohegaon Airfield, open and undulating country, Kalāikunda Airfield open and undulating country</i>	Original plane-tabling at 16 inches to a mile scale with 1 foot contour	2732	201·4	1·2	1·5	Lohegaon Airfield, Poona, Kalāikunda Airfield, Kharagpur, Priority I area.

* For explanation of 'nett' and 'overall' rates see page 3.

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 acre		REMARKS
				*Nett	*Overall	
No. 20 (Cantt.) Party.—Contd.		acres	acres	Rs.	Rs.	<u>NORTHERN CIRCLE.—</u> <u>Contd.</u>
<i>Kannur site—open area with bushes</i> ..	Original plane-tabling with 5 feet contours at 8 inches to 1 mile scale	2390	623.5	1.0	1.2	Kannur site for proposed Airfield (Bangalore).
<i>Cholavaram Airfield—open area</i> ..	Revision plane-tabling with 5 feet contours at 8 inches to 1 mile scale	320	1920.0	1.0	1.2	Cholavaram Airfield (Madras); Work discontinued.
<i>Cantonment (Plains), congested and semi-congested built-up areas</i>	16-inch scale 5 feet contours Fair mapping	18743	..	1.8	1.8	Meerut Cantt., Ambāla Cantt., Old Artillery Range Allahābād; Rāmgarh Camp; Jubbulpore Arsenal; Āgra Airfield Depot; Āgra Cantt.; Ordnance Factory Khamaria; Hāpur Remount Depot; Alipore Transit Camp; Jubbulpore Cantt.; Jubbulpore Military Lines.
<i>Part of congested Cantonment</i> ..	16-inch scale 5 feet contouring in tracing	290	..	1.3	1.3	P.O.L. Stores, Delhi Cantt.
<i>Built-up site on undulating country</i> ..	8-inch scale 5 feet contours in tracing	12270	..	0.1	0.1	Dehu Road site Extension Survey.
<i>Congested Bāzār areas inside Cantonment</i> ..	64-inch scale with 5 feet contours Fair mapping	125	..	36.5	36.5	R.A.B.I. and B.C. Bāzārs, Meerut Cantt.
<i>Airfield on open undulating plains partly built-up</i>	16-inch scale with 5 feet contours Special mapping	9886	..	0.5	0.5	No. 2 G.T.S. Tambaram; N.W.A. Airfield, Aundh; U.E.D. Manauri; Hakimpet Airfield; Begampet Airfield.

* For explanation of 'nett' and 'overall' rates see page 3.

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

Party and description of country	Class of work (including scale and V. I.)	Area acres	Out-turn per man per month	Cost Rate per acre		REMARKS
				*Nett	*Overall	
No. 20 (Cantt.) Party.— <i>Concl'd.</i> <i>Airfield sites on open undulating country, partly built-up</i>	16-inch scale with 1 foot contour Special mapping	4887	..	Rs. 2.5	Rs. 2.6	<u>NORTHERN CIRCLE.</u> <u>Concl'd.</u> Lohegaon Airfield (Poona), Agra Airfield (Priority I area), Kalai- kunda (Priority I Area) for enlargement to 1/2500 scale.

• For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 5 Party.—		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE</u>
(Field Season 1947-48 and recess 1948) ..	Barāhakshetra					
<i>Steep, heavily wooded hills</i>	(4-inch scale with 20-foot V. I.)					
	Triangulation and height control (by theodolite)	20	6.6	200.0	215.5	Height control carried out <i>pari passu</i> with triangulation.
	Triangulation	6	10	133.6	143.7	High cost is due to great delay in stores reaching the field.
	Bihār Mica Belt					
<i>Hilly, area with dense jungle</i>	(1/25,000 scale with 25-foot V. I.)					
	Triangulation	100	25.5	22.8	24.2	
	Height control (by clinometer) ..	808	84.0	38.5	40.6	
	Jamshedpur Town Extension					
<i>Undulating with sāl jungle and cultivated plains</i>	Ground survey (16-inch scale with 10-foot V. I.)	4.5	0.26	3257.8	3851.1	High cost is due to great delay in stores reaching the field.
	Fair Mapping (scale 99-foot to 1-inch with 5-foot V. I.)	4.5	0.17	1491.3	1491.3	
	Kamptee Coal-fields					
<i>Undulating with small hillocks and cultivation</i>	(4-inch scale with 10-foot V. I.)					

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 5 Party.— <i>Contd.</i> <i>Low lying plain, interspersed with swamps and high grass</i>	Ground survey	124	8.7	Rs. 97.4	Rs. 114.0	EASTERN CIRCLE.— <u>Contd.</u>
	Fair mapping	124	6.9	30.5	30.5	
	Combined project	124	..	127.9	144.5	
	Kopili Flood Control					
	(4-inch scale with 1 foot V. I.)					
	Triangulation	250	150.0	22.1	28.1	
	Traversing (without heights)	309 (linear miles)	32.1 (linear miles)	35.3 (per linear mile)	36.9 (per linear mile)	
	Tertiary simultaneous double level- ling	198 (linear miles)	14.4 (linear miles)	90.1 (per linear mile)	94.3 (per linear mile)	
	Tertiary single levelling	499 (linear miles)	10.0 (linear miles)	145.0 (per linear mile)	151.7 (per linear mile)	
	Contour survey (1 foot V. I.)	187	11.9	64.0	67.0	
Air survey (outline only)	119	3.9	40.0	40.0		

Low out-turn due to work being carried out by inexperienced traversers and levellers.

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 5 Party.—Contd.		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u>Contd.</u>
<i>Undulating ground with fairly dense jungle and some cultivation</i>	Konār Pipe Line Extension (6-inch scale with 10-foot V. I.)					
	Height control (by clinometer) ..	21	6.6	157.4	189.5	
<i>Steep, fairly heavily wooded mountainous slopes</i>	Kosi Dam Extension (32-inch scale with 20-foot V. I.)					
	Triangulation	1.5	0.48	3379.2	3536.4	High cost is due to great delay in stores reaching the field.
	Height control (by clinometer) ..	1.5	0.24	1690.0	1768.0	
<i>Undulating country</i>	Narāj Reservoir (4-inch scale with 10 and 20-foot V. I.)					
	Triangulation	317	30.9	45.0	48.8	
	Height control (by clinometer) ..	141	61.3	9.9	10.6	
<i>Plain with scattered hills and jungles</i> ..	Tikarpāra Reservoir (4-inch scale with 10 and 20-foot V. I.)					

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
				*Nett	*Overall	
No. 5 Party.—Contd.		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <i>Contd.</i>
	Triangulation	24	8.5	448.1	521.1	High cost is due to great delay in stores reaching the field.
	Um Tru Reservoir (6-inch scale with 20-foot V. I.)					
<i>Hills with dense jungle</i>	Triangulation	13	4.8	367.0	391.4	Movement to and from field was done in Govt. transport ; hence no increase for "overall" cost rates.
	Height control (by clinometer) ..	13	9.8	183.0	195.0	
(<i>Field Season 1948-49</i>)	Calcutta Electrification Scheme					
<i>Plain and at some places waterlogged</i>	(Route survey of Transmission Lines)					
	Traversing (without heights) ..	99 (linear miles)	24.8 (linear miles)	50.3 (per linear mile)	50.3 (per linear mile)	
	Tertiary single levelling ..	78 (linear miles)	20.0 (linear miles)	37.0 (per linear mile)	37.0 (per linear mile)	
<i>Sand hills with open patches of cultivation</i> ..	Digha Town Planning (16-inch scale with 5-foot V. I.)					

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 5 Party.—Contd.				Rs.	Rs.	EASTERN CIRCLE.— Contd.
	Traversing (without heights) ..	36 (linear miles)	13.0 (linear miles)	90.7 (per linear mile)	94.4 (per linear mile)	Low out-turn due to inexperienced officers carrying out this job.
	Tertiary single levelling ..	41 (linear miles)	25.6 (linear miles)	28.0 (per linear mile)	32.9 (per linear mile)	
	(Ground survey ..	3.1	0.6	1320.0	1363.0	
	Ganga Bridge Project					
	Traversing ..	291 (linear miles)	35.00 (linear miles)	42.5 (per linear mile)	49.4 (per linear mile)	More than half of the work was carried out by inexperienced officers. Half of the traversing was heightened.
	Triangulation ..	120	51.4	27.1	31.6	
	Detail verification on photographs	808	140.0	9.0	10.5	
	Kopili Flood Control					
	(4-inch scale with 1-foot V. I.)					
<i>Low lying plain, interspersed with swamps and high grass</i>	Traverse ..	210 (linear miles)	22.0 (linear miles)	90.1 (per linear mile)	93.6 (per linear mile)	High cost due to inexperienced personnel and slow progress in high grass areas.

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 5 Party.— <i>Concl.</i>		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u>Contd.</u>
	Tertiary simultaneous double level- ling	245 (linear miles)	11·2 (linear miles)	100·2 (per linear mile)	104·0 (per linear mile)	
	Tertiary single levelling with abreast heights	1277 (linear miles)	10·8 (linear miles)	133·0 (per linear mile)	138·0 (per linear mile)	Poor out-turn due to work being carried out by trainees.
	Detail verification on photographs	491	32·3	38·6	40·3	
	Tea Estates in West Bengal					
	<i>Tea garden with waste and cultivation</i> .. (16-inch scale with no contouring)					
Traverse (without heights) ..	68·3 (linear miles)	16·8 (linear miles)	116·3 (per linear mile)	137·4 (per linear mile)	High cost is due to slow progress of the inexperienced officers.	
Detail verification on photographs	17·4	20·1	82·4	95·3		

* For explanation of 'nett' and 'overall' rates see page 3.

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	
				*Nett	*Overall		
No. 9 Party.— <i>Field Season 1947-48 and recess 1948</i> <i>Generally flat ground traversed by many water channels, interspersed with patches of jungle and high grass. Cultivated areas interspersed with numerous scattered trees, mango groves, tanks and groups of small village sites (tolas)</i>	Kosi Irrigation (4-inch scale with 1-foot V. I.)	sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u><i>Contd.</i></u> High cost compared with secondary levelling chiefly due to the former following a cross country route. Low out-turn due to difficulty in transporting stores and personnel across the Kosi and due to change in programme in March 1948 by the Central Waterpower, Irrigation and Navigation Commission.	
		.. ..	85·0 (linear miles)	22·0 (linear miles)	103·6 (per linear mile)		138·0 (per linear mile)
		.. ..	194·1 (linear miles)	60·0 (linear miles)	39·3 (per linear mile)		52·3 (per linear mile)
		.. ..	151·1 (linear miles)	10·6 (linear miles)	94·4 (per linear mile)		125·6 (per linear mile)
		.. ..	419·0	95·0	37·0		49·3
		.. ..	419·0	17·6	69·2		92·1
.. ..	2771·8 (linear miles)	37·7 (linear miles)	32·5 (per linear mile)	43·2 (per linear mile)			

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 9 Party.—Contd.				Rs.	Rs.	EASTERN CIRCLE.
						<u>Contd.</u>
	Outline air survey	419.0	25.5	15.1	20.1	
	Fair mapping and computations ..	419.0	3.1	66.6	88.6	
	Combined project	419.0	..	475.8	633.5	
	Kosi Dam Survey					
	(1/1,000 scale with 10-foot V. I.)					
	Triangulation	0.2	0.07	†	†	†No reliable figures available.
	Plane-tableing	0.2	0.05	†	†	
	Fair mapping	0.2‡	0.06	†	†	
	Combined Project	0.2‡	..	†	†	‡Actual area fair-mapped was 0.5 sq. miles, out of which 0.3 sq. miles were compiled from existing 32-inch sheets.
	Kosi Catchment					
	(1 inch scale with 100-foot V. I.)					
	Triangulation	390.0	5.8	44.2	58.9	

* For explanation of 'nett' and 'overall' rates see page 3.

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	
				*Nett	*Overall		
No. 9 Party.—Contd. <i>Generally flat ground traversed by many water channels, interspersed with patches of jungle. Cultivated areas interspersed with numerous scattered trees, mango groves, tanks and groups of small village sites (tolas)</i>	Kosi Irrigation (4-inch scale with 1-foot V. I.)	sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u><i>Contd.</i></u> } Low out-turns of stone-laying and levelling is due to late arrival of photography and stores and changes in programme during early April 1949 by the Central Waterpower, Irrigation and Navigation Commission.	
		Traverse	329·3 (linear miles)	17·9 (linear miles)	72·0 (per linear mile)		89·1 (per linear mile)
		Secondary levelling	119·8 (linear miles)	45·0 (linear miles)	56·5 (per linear mile)		70·0 (per linear mile)
		Double tertiary levelling	179·8 (linear miles)	23·2 (linear miles)	89·6 (per linear mile)		110·9 (per linear mile)
		Photo-marking (including combination)	746·0	163·4	30·1		37·3
		Stone-laying	553·5	15·5	90·6		112·1
		Tertiary levelling	4428·0 (linear miles)	48·4 (linear miles)	23·7 (per linear mile)		29·3 (per linear mile)
		Outline air survey	264·6	19·8	21·0		26·1

* For explanation of ' nett ' and ' overall ' rates see page 3.

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	
				* Nett	* Overall		
<p>No. 9 Party.—<i>Concl'd.</i></p> <p><i>Cultivated plains with numerous water channels, scattered trees, mango groves and tanks. Low barren hills and tracts of marshy ground. Area for triangulation consists of jungle covered hills</i></p>	Ganga Barrage Scheme		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u><i>Contd.</i></u>
	Triangulation	178.0	62.8	31.1	38.5		
	Traverse	200.7 (linear miles)	35.8 (linear miles)	70.7 (per linear mile)	87.5 (per linear mile)		
	Double tertiary levelling	199.4 (linear miles)	44.4 (linear miles)	79.3 (per linear mile)	98.2 (per linear mile)		
	Tertiary levelling	1650 (linear miles)	39.6 (linear miles)	40.3 (per linear mile)	49.9 (per linear mile)		
	Ground verification	476.6	17.6	139.6	172.8		
	Kosi Reservoir						
<i>Fairly open and moderately high hills with patches of cultivation and jungle</i>	(1100-foot contour, ground demarcation)	125.0 (linear miles)	9.8 (linear miles)	141.7 (per linear mile)	174.8 (per linear mile)		

* For explanation of ' nett ' and ' overall ' rates see page 3.

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
				*Nett	*Overall	
No. 11 Party.—		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u>Contd.</u>
<i>Field Season 1947-48 and recess 1948</i>	Hirākud (Mahanadi) Irrigation					
<i>The ground consists of undulating country with open cultivated areas alternating with open scrub and scattered trees on high ground. Near the hills the ground is covered with dense forest</i>	(4-inch scale with 5-foot V. I.)					
	Triangulation	140	149	77.83	93.16	
	Stone-laying	912.9	8.95	47.52	65.69	Out-turn is low as about one-third of the total area was covered with dense forest.
	Secondary levelling	189.4 (linear miles)	3.16 (linear miles)	104.66 (per linear mile)	145.84 (per linear mile)	} Out-turn is extremely low as some of the lines both secondary and double tertiary had to be revised.
	Double tertiary levelling	164.2 (linear miles)	5.47 (linear miles)	103.39 (per linear mile)	148.76 (per linear mile)	
	Computation	912.9	13.83	11.11	16.54	
	Photo-marking (including combination)	912.9	16.91	19.59	25.99	
	Fair mapping	912.9	2.49	110.04	129.90	
	Outline air survey	912.9	19.02	55.77	68.06	

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett Rs.	*Overall Rs.	
No. 11 Party.—Contd.						
						EASTERN CIRCLE.—
	Tertiary levelling ..	2646.8 (linear miles)	25.20 (linear miles)	55.74 (per linear mile)	68.35 (per linear mile)	<u>Contd.</u>
	Combined project ..	912.9	..	457.9	576.74	This is full cost of a field season with its recess.
Field Season 1948-49						
<i>The ground consists of undulating country with open cultivated areas alternating with open scrub and scattered trees on high ground. Near the hills the ground is covered with dense forest</i>						
	Hirakud (Mahanadi) Irrigation (4-inch scale with 5-foot V. I.)					
	Stone-laying ..	546	12.14	50.08	79.53	Out-turn is reasonable. About one-third of the total area was covered with dense forest.
	Secondary levelling ..	57.4 (linear miles)	14.35 (linear miles)	66.33 (per linear mile)	126.1 (per linear mile)	Out-turn very low due to in- experience of observers.
	Double tertiary levelling ..	142 (linear miles)	11.83 (linear miles)	22.84 (per linear mile)	39.16 (per linear mile)	
	Computations ..	182	3.03	46.83	59.4	
	Photo-marking (including com- bination)	546	18.2	4.47	7.45	

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. II Party.—Contd.						
				Rs.	Rs.	EASTERN CIRCLE.—
	Fair mapping	54	1.29	119.46	148.89	Contd.
	Outline air survey	189	4.5	13.67	22.49	
	Tertiary levelling	1834.7 (linear miles)	42.91 (linear miles)	59.75 (per linear mile)	17.47 (per linear mile)	This is cost of a field season only.
Tikarpāra Reservoir						
<i>Undulating country with open cultivated areas</i>						
	(4-inch scale with 10-foot V. I.)					
	Triangulation	300	16.67	21.03	27.29	As a few levellers were spare, height control by levelling was resorted to.
	Height control by levelling	855.1 (linear miles)	30.6 (linear miles)	22.7 (per linear mile)	24.3 (per linear mile)	Out-turn is low as the levellers had to be trained in photo identification.
Bihār Mica Belt Area						
<i>Undulating country with patchy cultivation near streams</i>						
	(1/25,000 scale with 2.5-foot V. I.)					
	Height control (by plane-table)	1624	45.11	11.64	13.79	

* For explanation of 'nett' and 'overall' rates see Page 3.

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
				*Nett	*Overall	
No. 11 Party.— <i>Concl'd.</i> <i>Undulating open ground with rocky river bed</i>	Hirākud Dam Site (1/1,000 scale with 2-foot V. I.)	sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u>Contd.</u>
	Triangulation	2·65	0·44	30·57	43·77	
	Height control by levelling	49·6 (linear miles)	12·4 (linear miles)	18·1 (per linear mile)	29·4 (per linear mile)	
	Plane-tabling	2·65	0·06	4341·51	4584·91	

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 12 Party.—	Sivok (Tista) Bridge	sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u>
<i>Hilly ground, with fairly dense jungle and cultivation</i>	(6-inch scale with 10-foot V. I.)					<u>Contd.</u>
	Air survey of planimetry ..	2.4	4.8	37.5	37.5	
	Fair mapping ..	2.4	3.8	60.0	60.0	
	Deolbāri Reservoir					
<i>Hilly, undulating ground, with open jungle..</i>	(6-inch scale with 10-foot V. I.)					
	Ground verification of contours ..	36.3	18.2	34.3	50.2	
	Complete air survey ..	36.3	1.3	168.8	168.8	Indifferent photography: contours rapidly surveyed.
	Fair mapping of ground verified contours	36.3	1.3	159.3	159.3	Includes transfer of air surveyed contours to plane-table sections for verification in the field.
	Bagaha					
<i>Plains, with jungle varying from sparse to fairly dense, and cultivation</i>	(16-inch scale with 5-foot V. I.)					
	Air survey of planimetry ..	37.2	1.05	69.3	69.3	
	Fair mapping of ground surveyed contours	37.2	1.7	114.2	114.2	Appreciable difficulty experienced in fitting these contours to the air surveyed planimetry.

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 12 Party.—Contd.						
<i>Hilly, undulating ground, with open jungle</i>	Bermo-Bhāndaridah Gorge (16-inch scale with 5-foot V. I.)			Rs.	Rs.	EASTERN CIRCLE.— Contd.
	Complete air survey	10.7	0.2	928.0	928.0		A large percentage of the contouring was done by the Section Officer and trainees.
<i>Undulating ground with jungle of medium density and some cultivation</i>	Konār Pipe Line Extensions			Rs.	Rs.	
	Complete air survey (6-inch scale with 10-foot V. I.)	19.1	0.7	283.9	283.9	
	Complete air survey (4-inch scale with 10-foot V. I.)	1.8	1.0	218.9	218.9	
<i>Steep, fairly heavily wooded mountains</i>	Barāhakhetra (4-inch scale with 20-foot V. I.)			Rs.	Rs.	
	Complete air survey	16.0	1.2	224.0	224.0	Partly form-lined. Includes compilation from other scales.
<i>Steep, fairly heavily wooded mountainous slopes</i>	Kosi Dam Extension (32-inch scale with 20-foot V. I.)			Rs.	Rs.	
	Complete air survey	0.63	0.09	2711.1	2711.1	Partly form-lined. Includes compilation from other scales.

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 12 Party.—Contd.		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u>Contd.</u>
<i>Mountain valleys with open vegetation</i> ..	Kosi Catchment (1 inch scale with 100-foot V.I.)					
	Complete air survey	65.9	3.9	54.7	54.7	Partly form-lined. Much time spent in identifying detail at this scale and in sorting out names. Cost rate very high for this scale.
<i>Heavily forested hill-sides</i> ..	Um Tru Reservoir (6-inch scale with 20-foot V.I.)					
	Complete air survey	10.8	0.5	507.7	507.7	Considerable time wasted in identifying control on photographs.
<i>Heavily wooded, steep, gorge</i> ..	Geilkhola (Tista High) Dam (32-inch scale with 10-foot V.I.)					
	Fair mapping of outline and contours	0.8	0.1	1567.2	1567.2	Very heavy contouring.
<i>Undulating ground</i> ..	Ib River (Rāmpur) Coal-field (1/25,000 scale with 10-foot V.I.)					
	Fair mapping	32.0	5.5	38.8	38.8	

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
No. 12 Party.—Concl.		sq. m.	sq. m.	Rs.	Rs.	<u>EASTERN CIRCLE.—</u> <u>Concl.</u>
<i>Undulating ground</i>	Ib River (Jamga) Coal-field (1/25,000 scale with 10-foot V. I.)					
	Fair mapping	30.0	6.7	30.9	30.9	
<i>Hilly ground, with medium jungle</i> ..	Bokāro Coalfield (4-inch scale with 50-foot V. I.)					
	Plane-table survey of gaps in air photography	7.4	4.4	297.8	343.3	

* For explanation of ' nett ' and ' overall ' rates see page 3.

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
				*Nett	*Overall	
Headquarter Section.—	Poringalkuthu Reservoir, Cochin	sq. m.	sq. m.	Rs.	Rs.	<u>SOUTHERN CIRCLE</u>
<i>Densely wooded steep valleys</i>	4-inch, 20 feet V. I.					
	Ground control and computations	15	0.43	950.8	1023.4	
	Outline air survey	15	2.8	97.0	97.0	
	Contour air survey	15	5.1	62.4	62.4	
	Fair drawing	15	7.6	23.6	23.6	
	Kālinadi Reservoir					
	(Contoured Mosaics)					
<i>Densely wooded steep valleys, interspersed with flat-topped hills, undulating ground and patches of open cultivated areas</i>	4-inch, 20 feet V. I.					
	Height control and computations..	207	61.5	18.9	22.8	
	Contouring	207	9.6	19.1	19.1	
	Moj Reservoir					
<i>Open undulating country</i>	4-inch, 10 feet V. I.					
	Ground control and computations..	12.5	2.4	205.8	267.9	
	Outline air survey	12.5	2.93	58.1	58.1	

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
Headquarter Section.—Contd.		sq. m.	sq. m.	Rs.	Rs.	<u>SOUTHERN CIRCLE.—</u>
						<u>Contd.</u>
	Contour air survey	12.5	4.0	39.2	39.2	
	Fair drawing	12.5	9.87	23.6	23.6	
	Gavipur Extension, Bangalore					
<i>Open undulating plains interspersed with stony waste land</i>	16-inch, 10 feet V. I.					
	Ground control and computations..	1.7	1.16	719.7	749.1	
	Outline air survey	1.7	0.47	360.6	360.6	
	Ground verification and contouring	1.7	0.35	1241.2	1300.0	
	Fair drawing	1.7	0.52	279.2	279.2	
	Sandūr Town					
<i>Congested town with open suburbs and cultivated plains</i>	16-inch, 10 feet V. I.					
	Ground control and computations..	1.25	1.87	460.6	527.0	
	Outline air survey	1.00	0.28	675.1	675.1	
	Ground verification and contouring	1.00	0.68	780.6	875.3	
	Fair drawing	1.00	0.33	540.0	540.0	

* For explanation of 'nett' and 'overall' rates see page 3.

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
				*Nett	*Overall	
Headquarter Section.—Concl'd.						
Dāvāngere Town						
<i>Congested town with open suburbs and cultivated plains</i>						
	16-inch, 10 feet V. I.					
	Ground control and computations ..	5	2.73	178.2	201.5	
	Outline air survey ..	5	0.26	646.3	646.3	
	Ground verification and contouring	5	0.52	1042.1	1166.8	
	Fair drawing ..	5	0.48	517.2	517.2	
SOUTHERN CIRCLE.—						
<u>Cont'd.</u>						

* For explanation of 'nett' and 'overall' rates see page 3.

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		REMARKS
				* Nett	*Overall	
No. 6 Party.—				Rs.	Rs.	SOUTHERN CIRCLE.
1947-48						<u>Contd.</u>
<i>Intricate open hills</i>						
	Limdi Dam Site					
	2-inch, 25 feet V.I.					
	Height control ..	27.0	21.9	27.2	36.5	
	Air compilation (detail and con- touring)	27.0	7.8	44.1	52.3	
	Ground verification ..	27.0	35.0	18.6	22.3	
	Secondary levelling for above ..	100.5 (linear miles)	30.0 (linear miles)	66.7	88.4	
	Combined project ..	27.0	21.6 30.0 (linear miles)	156.6	199.5	
	Vajpur Dam Site					
	2-inch, 25 feet V.I.					
	Height control ..	25.0	20.3	29.5	38.8	
	Air compilation (detail, and con- touring)	25.0	9.2	32.6	40.7	
	Ground verification ..	25.0	38.0	17.1	22.8	
<i>Low densely wooded hills and plains</i>						

* For explanation of 'nett' and 'overall' rates see page 3.
 Note:—The above table excludes the out-turn and cost-rates of men under training employed on various surveys and fair drawing.

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
				*Nett	*Overall	
No. 6 Party.—Concl'd.						
	Secondary levelling for above ..	41.3 (linear miles)	30.0 (linear miles)	Rs. 66.7	Rs. 88.9	SOUTHERN CIRCLE.— Concl'd.
	Combined project ..	25.0	22.5 30.0 (linear miles)	145.9	191.2	
	Dharoi Dam Site					
<i>Open plains with low hills</i> ..	2-inch, 25 feet V. I.					
	Photo verification and heighting ..	27.0	27.0	44.4	47.2	
	Air-cum-ground survey ..	27.0	54.0	22.2	29.7	
	Combined project ..	27.0	40.5	66.6	76.9	
	Ukai Reservoir					
<i>Heavily wooded hills</i> ..	4-inch, 10 feet V. I.					
	Triangulation for ground control ..	787.0	69.1	22.7	29.6	

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 acres	Out-turn per man per month	Cost Rate per acre		REMARKS
				*Nett	*Overall	
No. 17 Party.—						SOUTHERN CIRCLE.—
<i>80% intricate undulating ground, densely wooded with hills rising up to 3,000 feet</i>	1-inch Air-cum-ground original survey	1630	12.8	76.0	76.0	<u>Concl'd.</u> The survey was carried out by Topographical Trainees, type B.

* For explanation of 'nett' and 'overall' rates see page 3.

III. TECHNICAL NOTES, GEODETIC BRANCH (NORTHERN CIRCLE FROM 1-11-1948)

DIRECTOR :-- { Major R. H. Sams, R.E., to 29-8-47 and from 2-10-47 to 21-2-48.
Col. G. W. Gemmell, from 30-8-47 to 1-10-47.
Major Gambhir Singh, I.A., from 22-2-48 to 30-9-48.
Mr. K. L. Dhawan, B.A., (current duties), from 1-10-48 to 21-11-48.
Mr. B. N. Saha, M.Sc., from 22-11-48.

DY. DIRECTOR :-- { Major J. S. Paintal, R.I.E., from 8-3-48 to 30-9-48.
Mr. K. L. Dhawan, B.A., from 1-10-48.

3. **Summary.**—During the period under report, the following survey units were under the administrative control of the Director, Geodetic Branch (Northern Circle from 1st November 1948).

No. 1 Party.
No. 13 Party.
No. 14 Party (from 1-1-48).
No. 15 Party.
No. 20 (Cantt.) Party.
No. 2 Drawing Office.
Map Record Office (up to 29-2-48).
Stores Office, Surveys.
Printing Office (up to 31-10-48).
Photo-Zinco Office (up to 30-11-47).
Survey Training Centre (from 1-9-47 to 31-5-48).

Brief reports on the various survey operations carried out by the above mentioned units have been given in the General Report 1948-49. 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. Suresh Prasad, to 19-11-47.
Mr. L. J. Bagnall, from 20-11-47 to 15-3-48.
Major J. S. Paintal, R.I.E., from 16-3-48 to 19-9-48.
Mr. N. L. Gupta, C.E., from 20-9-48.

4. **General.**—The party was employed wholly on paid-for surveys sponsored by the Central and State Governments for various irrigation and urban development schemes. The methods adopted for planimetric and height control, and the scales and specifications of surveys for the different projects are briefly described below.

5. **Planimetric Control for Surveys.**—The existing triangulation or traverse data was, after checking on the ground, used if

found accurate and adequate for the survey in question. If found inadequate, it was supplemented by the following :—

- (a) triangulation ;
 - (b) traverse ;
 - (c) in areas of reserved forests already surveyed on the 4-inch scale, co-ordinates of salient points identifiable on the photographs were accurately read from the forest maps and used ;
- or (d) accurate plane-table fixings and auxiliary points from existing triangulation data.

Methods (c) and (d) saved a considerable amount of time and enabled the maps to be supplied at a low cost, within the specified time and with the accuracy necessary for the purpose for which they were required, viz., the working out of capacities of reservoirs, etc.

All control points were marked on the photographs in the field.

6. Height Control for Surveys.—Where possible heights were based upon spirit-levelled heights, otherwise the heights of the existing triangulation were accepted. All height points were identified and marked in the field on the photographs, supplied to the field staff for this purpose. Heights of old trigonometrical intersected points, such as trees, were first refixed from triangulation stations by theodolite. Most of such values had changed on account of the growth of trees, etc., since the time of previous triangulation, and new values were used as the basis for fixing further height control.

Heights were observed in the field in the undermentioned ways :—

- (i) *By Theodolite.*—From the existing trigonometrically heighted stations and points, additional heights were fixed, by theodolite, about a mile apart all over the area and particularly in the valleys. This ensured a reasonable density of accurate heights on which further control by clinometric heights was based for contouring purposes.

Theodolites were also used in the following ways to provide heights correct to 1 foot :—

- (a) Vertical angles were observed to identifiable detail while distances were obtained from field charts or air survey sections or subtense bar measurements.
- (b) Tachymetry.
- (c) The theodolite used as a level to give differences in heights of points, the positions of which were identified and marked on the photographs.

- (ii) *By Clinometer.*—Clinometric heights computed from rays over a mile long or from tangent readings over 0·2 were not accepted, as they were not considered to give heights of sufficient accuracy for survey of contours at 10 to 20 feet vertical intervals.
- (iii) *By Paulin Barometers.*—This method was adopted in beds of streams and slopes covered with dense jungle, where clinometer or theodolite observations were not possible without heavy clearing.

A set of six barometers was provided for each observer. A battery of three was kept at the Base Station of known height and the other three were carried by the observer in the field. Barometer and thermometer readings at the Base Station were recorded every half-hour. Similarly temperature, barometer and time readings were recorded by the observer, at places where spot heights were required. Corrections due to temperature and closing errors, distributed proportionately to time intervals, were applied to obtain the final heights of the places of observation. The field traverse included as many points of known height as possible.

7. **Density and Accuracy of Control.**—The following table gives an indication of the density and accuracy of planimetric and height control obtained in the field :—

Scale of air survey	Planimetric control		Height control	
	Density	Accuracy	Density	Accuracy
	Yards apart		Yards apart	
4-inch ..	4,000	1 in 3,000	500	5 feet
10-inch ..	1,500	1 in 4,000	300	3 feet
16-inch ..	800	1 in 5,000	..	..
32-inch ..	400	1 in 5,000	50	1 foot

8. **Surveys with Brief Description of Country.**—(i) *New Delhi Development Survey.*—This survey on scale of 100 feet to 1 inch with contours at 5-foot interval was required by the Ministry of Works, Mines and Power, Government of India, of two areas, one to the north and other to the south of Delhi, for town development purposes.

A description of methods employed and of the country has already been published in Technical Report, 1947.

(ii) *Rāmganga Dam Site Survey*.—The Chief Engineer, P.W.D., Project Circle, Lucknow, required this survey on 10 inches to 1 mile scale with contours generally at 20-foot interval. In flat areas and saddles contouring was at 10-foot interval. The survey covered an area of 11 square miles in Kālāgarh forests, District Garhwāl, and was required for fixing a suitable site on the spillway of the proposed Rāmganga Dam.

Photography, carried out in 1945 for the preparation of a contoured photo-mosaic of the Rāmganga reservoir area, was available. Enlargements on 10 inches to 1 mile scale of this photography were used for compilation of the map by the radial line method.

Planimetric control as well as height control was provided by methods described in paras 5 and 6 (i) (a) and (ii) respectively.

The area consists of low hills covered with dense reserved forests with abundance of undergrowth, and wild animals abound. Hills are mostly composed of soft clay. The heights of trees in the area vary from 30 feet to 100 feet with the result that the accuracy of contouring was doubtful.

(iii) *Patiāla State Development Survey*.—This survey, on a scale of 16 inches to 1 mile with contours at an interval of 20 feet, was required by the Chief Engineer, P.W.D., Patiāla State, for developing colonies at Barog, Kandaghāt and Chail.

Planimetric control was provided by triangulation vide para 5 and height control vide paras 6 (i) (a) and (ii).

Air survey by the radial line method, using the above control, was in hand.

All the areas are surrounded by high hills covered with dense pine and oak forests interspersed with open spaces.

(iv) *Rewa and Satna Town Surveys*.—The Prime Minister, Rewa State, required maps of Rewa and Satna towns on the scale of 16 inches to 1 mile with contours at 10-foot vertical intervals and spot-level heights 400 feet apart for planning town development and drainage schemes. In the congested area, however, only spot-level heights 400 feet apart along roads were required.

Level heights at intervals of 400 feet were fixed by running tertiary level lines. The following procedure enabled four level heights to be fixed from each setting of level and saved a considerable amount of time.

Firstly level lines were run from the existing bench-marks in the form of a rectangle round the area of work, fixing semi-permanent bench-marks about 1,200 feet apart. Accepting the values of these bench-marks, level lines were run at right angles to the sides of the rectangle. While running these lines, the leveller observed from each setting of the level not only to back and forward levelling staves, at distances of 200 feet from the level, but also to other levelling staves at 400 feet distance from the level at right angles.

Air survey compilation was carried out from 16-inch enlargements of 8-inch photography by the radial line method. Grey prints of the outline sections were taken to the field and detail was verified on the ground and contouring at 10 feet was completed by using the clinopole method.

The area was mostly built up.

Incorporation of verification corrections and contours was in hand.

(v) *Agra Central Railway Station Survey*.—The survey was on the scale of 32 inches to 1 mile, with contours at 5-foot vertical intervals in open area and with levelled heights at 200 feet apart in the built up area. It was required by the Chief Engineer, G.I.P. Railway for planning the construction of one Central Station in Agra common to the B.B. & C.I., the G.I.P. and the E.I. Railways.

Control was provided by traverse. The air survey compilation from 32-inch enlargements of the 14-inch photography was carried out by the radial line method. Grey prints of the outline sections were taken to the field for verification of the details and survey of contours at 5-foot intervals. Contours were surveyed by the clinopole method. Level heights were provided by running tertiary level lines.

Incorporation of verification corrections and contours is in hand.

The area for survey is partly built up and partly flat cultivated plain with a number of scattered mounds.

(vi) *One-inch Correction Survey*.—Four 1-inch sheets 53 H/1, 2, 5, 6, covering Delhi City and its suburbs were corrected on the ground, as they were considerably out-of-date. Office copy corrections, communications and new colonies which had sprung up during the war, were verified and inserted on the ground with respect to recognizable detail on the 1-inch sheets. Cultivation limits and other minor detail was not rigorously checked. The surveyor was provided with a 15-cwt. truck and this enabled him to complete the correction survey of 995 square miles, within 2 months.

(vii) *Cattle Breeding Research Station, Jubbulpore*.—The survey on 4-inch scale for an area of 5 square miles with contours at 5-foot vertical intervals was done at the request of the Ministry of Agriculture, Government of India. The survey was carried out by ground methods using existing trigonometrical data.

(viii) *East Punjab Capital Site Survey*.—The Government of the East Punjab required the survey on 4-inch scale with contours at 5-foot vertical intervals in the flat area and 25-foot in the hilly area, of an area of 413 square miles, situated 8 miles west of Chandigarh Railway Station in Ambāla district. The area was selected by the East Punjab Government for its capital. The work was initiated at the close of the field season 1947-48 and was allotted

top priority by the Government of India, so that fieldwork had to be done right through the summer and rains of 1948. This adversely affected the health of the personnel employed.

Planimetric control for the whole area and height control for the hilly area only was carried out in accordance with the methods described above in paras 5 and 6 (ii) respectively. The whole area was photographed on the scale of 4 inches to 1 mile and air survey compilation was carried out on this scale by the radial line method. Grey prints of the outline sections were sent to the field for verification of detail and survey of contours at 5-foot interval in the flat area was carried out by the clinopole method. Contouring in hilly areas was carried out from the air photographs, using the network of height control supplied by the field units. Names were collected in the field and these with heights and headings, etc., were pasted on the outline originals after incorporation of verification corrections. Separate contour originals were prepared on kodatrace.

As soon as the survey of this was over, an additional demand for a survey of 51 square miles in extension of the East Punjab Capital Site Survey was received from the East Punjab Government. This extension area was only partly covered by air photography. The area without photographic cover had to be surveyed by ground methods. The whole work was completed by the end of January 1949.

The northern portion of the area is hilly, the rest being level, gradually sloping to the south. It is crossed by several dry *nālas* known as "Cho" about half a mile wide. During the rains these flood causing damage to villages near their banks.

(ix) *Bargi Dam Survey*.—This survey for an area of 1.2 square miles on the scale of 32 inches to 1 mile with contours at 5-foot vertical intervals together with the Bargi Reservoir Survey mentioned below, was required by the Central Waterpower, Irrigation and Navigation Commission for planning a dam site on the Narbada River near Bargi.

Planimetric control was fixed by triangulation based upon Hunter Short Base measurements and azimuth observations and connected to a G.T. Station. Points were fixed every $\frac{1}{4}$ mile apart with a probable accuracy of 1 foot in position. Heights for contouring correct to a foot were fixed every 50 yards apart, by tachymetry and levelling. All points were identified and marked on photographs. Air survey was in hand. One bench-mark was constructed in the Dam Site area and its height fixed by levelling from a G.T. Bench-mark. This was to serve as a datum for the engineers to run their own levelling later.

(x) *Bargi Reservoir Survey*.—Photography was taken on the 2-inch and enlarged to the 4-inch scale. It was used for air survey at this scale with contours at 20-foot vertical intervals up to the 1,340 feet contour, and at 10-foot intervals between 1,340 to 1,370 feet. No contours were required above 1,370 feet. The area

surveyed for the reservoir is 173 square miles, extending over a length of 70 miles from Bargi to Māndla.

Planimetric and height control was provided by methods already described in paras 5 (a) and (d); and 6 (i), (ii) and (iii) respectively. The slotted template method was used for combination of photographs. Work was in hand.

The area is hilly, covered with fairly dense jungle and has reserved forests of the Madhya Pradesh Government on both sides of the river. There is abundance of wild game. The area is malarious.

9. **Other Surveys.**—The following tasks were completed by air survey. Detailed reports on them have already appeared in the Technical Report, 1947 :—

- (i) *Cawnpore Town Survey.*—50.3 square miles of air survey of outline only on scale of 16 inches to 1 mile were completed for the President, Cawnpore Development Board. No contours were required by the indenter.
- (ii) *Konār Pipe Line and Reservoir.*—Air survey on scale 6 inches to 1 mile with contours at 10-foot vertical intervals; areas were 16 and 17 square miles respectively.
- (iii) *Konār Dam Site.*—Air survey on scale 32 inches to 1 mile with contours at 10-foot interval, area 4.7 square miles.
- (iv) *Extension Area of the Āshni River Project.*—This area was compiled from 10-inch photographs, using the control carried out for 16-inch Patiāla State survey and was printed off as an applique slip to sheet No. 3 of Āshni River Project, the area covered being 4 square miles.

10. **Project Surveys in hand.**—The undermentioned project surveys were in hand and reports on them will be published in the next Technical Report after their completion :—

- (i) *Korea-Rewa Boundary Dispute.*
- (ii) *Karnāli River Survey.*—On scale of 2 inches to 1 mile.

No. 13 PARTY

Officer in charge :—
 { Mr. D. C. Puri, to 31-1-48.
 { Mr. N. D. Joshi, B.A., from 1-2-48 to 14-11-48.
 { Mr. F. M. Hawley, from 15-11-48 to 1-4-49.
 { Mr. T. M. C. Alexander, from 2-4-49.

11. **General.**—This unit continued to be employed on surveys in connection with the Bhakra Dam Project for the East Punjab Government. This project involves construction of a dam across the Sutlej River at Bhakra, which will not only increase the area

already covered by the existing canals but will also provide water for additional canals not yet constructed.

12. **Type of Country.**—The country consists, as described in Technical Report, 1947, of flat cultivated plains, interspersed with scrub, long grass and trees particularly around villages and tanks and along roads and canals. In the west and south it is open, sandy and undulating. This results in complete disappearance of a number of stones through their becoming submerged in the sand.

13. **Work.**—The survey work for this project has been fully described in paras 14, 15, 16 and 17 of Technical Report, 1947.

Due to difficulties in obtaining a sufficient number of stones to mark the corners of 25-acre rectangles, the work was carried out to 100-acre rectangles only, but levelling continued to be done up to 25-acre rectangles. This had the approval of the East Punjab Government.

14. **Accuracy of Position or Height Required.**—Permissible closing errors of the different types of work carried out are given below :—

(a) *Position* :—

(i) Triangulation—1 in 4,000.

(ii) Traversing — Main line 1 in 2,000.
Tie line 1 in 1,000.

(iii) Rectangulation—1 in 1,000.

(b) *Heights* :—

(i) Double tertiary circuits— $0.05 \sqrt{M}$ feet, where M is the length of the circuit in miles.

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

15. **Recess Work.**—During recess the levelled heights were plotted on the 4-inch sheets and 1-foot contours interpolated for areas rectangulated during the field season.

No. 20 (CANTONMENT) PARTY

Officer in charge :— $\left\{ \begin{array}{l} \text{Mr. K. L. Dhawan, B.A., to 16-11-47.} \\ \text{Mr. C. T. Hurley, from 17-11-47 to 31-10-48.} \\ \text{Mr. M. D. Nangia, B.A., from 1-11-48.} \end{array} \right.$

16. **Purpose of Survey.**—The party surveyed cantonment and other military lands in all Army Commands at various scales, in accordance with the programme approved by the Engineer-in-Chief, India and the Ministry of Defence. The work done may be divided into two main categories based on the purpose for which required :—

(a) Record.

(b) Planning.

17. **Accuracy of Position or Height Required.**—(i) For 16 (a), surveys were based on a rigid theodolite framework connected to spirit-levelled heights. Detail survey at 16-inch scale

with contours at 5-foot vertical intervals and 64-inch scale without contours (of Bāzār areas) were of a high standard of accuracy. At 16-inch scale the accuracy aimed at was 5 links in position and on the 64-inch scale it was 1 link. Normal methods of fair mapping for publication in black and brown with red tint for buildings, were carried out.

(ii) For 16 (*b*), surveys were based on theodolite framework with spirit-levelled heights and the jobs were mostly done on 16-inch and 24-inch scales with 1-foot contour intervals for enlargement to 1/2500 scale by photography. These jobs were required by the Air Force (Works) for the expansion scheme for airfields in all Commands.

As the maps were required urgently, the enlargements to 1/2,500 scale were done directly from the field plane-table sections on 16 and 24-inch scales. Normal fair drawing and printing for these rush jobs were not carried out.

(iii) One survey was done on the 8-inch to a mile scale.

(iv) For surveys other than those required by Air Force (Works), fair tracing of the completed plane-table sections were prepared by the Chief Engineers of Commands for preparation of ferro-prints. Normal fair drawing and printing were not done.

18. Methods of Survey.—In brief the normal method of detail survey for 16 (*a*) was traversing with a chain and offsets with optical squares between fixed points. Interpolations and intersections were allowed only in open areas. For 16 (*b*), interpolations and intersections were used and in addition the heights were provided at every five chain grid corners by levelling.

IV. TECHNICAL NOTES, EASTERN CIRCLE

DIRECTOR :—	{	Major R. T. L. Rogers, B.E., to 15-12-47.
		Major R. S. Kalha, I.A., from 16-12-47 to 2-1-48.
		Major I. H. R. Wilson, B.E., from 3-1-48 to 17-5-48.
		Mr. B. N. Saha, M.Sc., from 18-5-48 to 9-11-48.
		Major R. T. L. Rogers, B.E., from 10-11-48.
DY. DIRECTOR :—	{	Mr. B. N. Saha, M.Sc., to 1-9-47 and from 24-2-48 to 4-7-48.
		Major R. S. Kalha, I.A., from 2-9-47 to 23-2-48.
		Mr. C. P. E. Davenport, from 5-7-48 to 23-12-48 and from 17-2-49 to 12-3-49.
		Mr. L. J. Bagnall (current duties) from 24-12-48 to 12-1-49.
		Mr. P. A. Thomas, from 13-1-49 to 16-2-49.
		Mr. M. M. Ganapathy, B.A., from 13-3-49.

19. **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.

During the period under report, no normal departmental topographical survey programme had been carried out. Surveys were executed for development projects such as hydro-electric, irrigation, town planning, river control, railway and barrage construction, and land reclamation and for geological investigations.

20. **Technical Methods.**—The general types of surveys carried out and the methods used were the same as those described in the Technical Report, 1947. Mention has been made in the party reports which follow of any additional types of surveys and modifications in methods.

For "Irrigation" type surveys the indenter has accepted the fact that, where the contouring is at 1-foot vertical interval, there is no need to publish a separate level chart with the values of "spot" levels printed in red. The positions of these "spot" levels are not recoverable on the ground and, as they are of value only to control the contouring, it has been decided that there is no point in printing the values on a special map.

For the purpose of designing the layout of a canal system for irrigation purposes, in fairly flat country, some engineers have now accepted air photo-mosaics with a mesh of level bench-marks marked on them. The bench-mark values are provided on an "overlay" trace. If the foregoing will replace the contoured map for this type of engineering project, a great deal of survey potential will be saved.

A serious error in contouring of the air surveyed Konar Dam maps was discovered by the indenter. A check disclosed other

errors in the adjoining Konar Reservoir and Pipe Line maps. The discovery of the errors took place after most of the maps had been finally printed—about two years after the actual height control, in which the errors arose, was carried out. The errors were entirely due to an urgent job being undertaken by inexperienced surveyors and without adequate supervision ; the latter being the chief cause. A lot of time and survey potential have been wasted in the checking of all the adjoining work and rectifying the errors. This provides a very useful lesson which will be profited by in the future.

21. Miscellaneous.—The out-turn of field parties, especially during the field season 1948-49, was much reduced owing to excessive delays in the railway transportation of survey stores and equipment, resulting in delays in commencing work. These delays were very marked in the case of new survey operations involving large shipments of personnel and stores which were undertaken at short notice just before the commencement of the field season.

No. 5 PARTY

Officer in charge :— { Mr. T. M. C. Alexander, to 25-6-48.
Mr. N. C. Sen, from 26-6-48 to 5-12-48.
Mr. K. C. Gosain, B.A., from 6-12-48.

22. General.—The activities of this party were centered on special surveys required for development projects sponsored by State and Central Governments. The bulk of the work was providing the framework (planimetric and height) for air survey. Ground and air surveys were also carried out.

23. Personnel.—The strength of the party varied considerably from time to time according to the requirements for completion of jobs in specified periods.

The average number of technical personnel was as follows :—

1947-48.

Gazetted officers	..	..	7
Other technical personnel	..	..	43

1948-49.

Gazetted officers	..	..	3
Other technical personnel	..	..	51

24. Technical Methods.—(a) Planimetric and Height Control was provided for the air survey of the following projects :—

Barāhakshetra Gorge, falling in Sheet 72 N, on 4-inch scale, with 20-foot contours.

Tikarpāra Reservoir, falling in Sheet 73 D, on 4-inch scale, with 10 and 20-foot contours.

Konār Pipe Line Extension Survey, falling in Sheet 73 E, on 6-inch scale, with 10-foot contours.

Narāj Reservoir, falling in Sheet 73 H, on 4-inch scale, with 10 and 20-foot contours.

Um Tru Reservoir, falling in Sheet 78 N and 78 O, on 6-inch scale, with 20-foot contours.

Kosi Dam Extension, falling in Sheet 72 N, on 32-inch scale, with 20-foot contours.

Bihār Mica Belt Survey, falling in Sheet 72 H, on 1/25,000 scale, with 25-foot contours.

Planimetric control was carried out by normal triangulation and traverse.

Height control was done either by tachymetry or by observing vertical angles with theodolites or clinometer; in the latter case distances were measured off the triangulation chart projected on a scale large enough to give a suitable accuracy of linear measurements.

(b) *Kopili River Flood Control Scheme.*—This is in Kamrup and Nowgong districts, Assam, falling in Sheets Nos. 78 N and 83 B. Maps were required for an area of 2 miles on either side of Kopili and Kalang rivers on 4-inch scale with 1-foot contours for the Chief Engineer, Public Works Department, Assam.

Planimetric and height control was done by traversing and tertiary simultaneous double levelling. Heights for the control of 1-foot contours were fixed by lines of tertiary single levelling at 30 chains intervals. Rigorous contouring was not required as the engineers wanted to know only the general profile of the country.

The area consists mostly of low cultivated plain interspersed with *bils*, swampy areas and villages surrounded by thick bamboo growth. It was thus found difficult to run straight lines of levelling, and offsetting at right angles with levelling instrument to by-pass such obstacles was a laborious and lengthy operation. In order to get an even density of heights over the area, plane-table traverse was necessary to keep the lines straight between control points and to locate intermediate points where heights were required. For future levelling in such areas, where air photo cover exists, it is considered that much time could be saved by using the air photographs to keep the level lines straight.

(c) *Ganga Bridge Project.*—This covers the Mokameh Ghāt area on the Ganges River and falling in Sheets 72 G, and 72 K. The Engineer-in-Chief, Ganga Bridge Project required.—

(i) A strip map showing details and names of 800 square miles of area from Surajgarha (72 K) to Patna (72 G) prepared by revising the existing 1" topographical maps from air photographs taken in 1948.

(ii) Co-ordinates of control points (without heights) half or one mile apart along both banks to enable the railway engineers to take cross sections of the Ganges river and the Research Station Poona to construct a model of the river on 1/500 scale.

errors in the adjoining Konar Reservoir and Pipe Line maps. The discovery of the errors took place after most of the maps had been finally printed—about two years after the actual height control, in which the errors arose, was carried out. The errors were entirely due to an urgent job being undertaken by inexperienced surveyors and without adequate supervision ; the latter being the chief cause. A lot of time and survey potential have been wasted in the checking of all the adjoining work and rectifying the errors. This provides a very useful lesson which will be profited by in the future.

21. Miscellaneous.—The out-turn of field parties, especially during the field season 1948-49, was much reduced owing to excessive delays in the railway transportation of survey stores and equipment, resulting in delays in commencing work. These delays were very marked in the case of new survey operations involving large shipments of personnel and stores which were undertaken at short notice just before the commencement of the field season.

No. 5 PARTY

Officer in charge :— { Mr. T. M. C. Alexander, to 25-6-48.
Mr. N. C. Sen, from 26-6-48 to 5-12-48.
Mr. K. C. Gosain, B.A., from 6-12-48.

22. General.—The activities of this party were centered on special surveys required for development projects sponsored by State and Central Governments. The bulk of the work was providing the framework (planimetric and height) for air survey. Ground and air surveys were also carried out.

23. Personnel.—The strength of the party varied considerably from time to time according to the requirements for completion of jobs in specified periods.

The average number of technical personnel was as follows :—

1947-48.

Gazetted officers	..	..	7
Other technical personnel	..	..	43

1948-49.

Gazetted officers	..	..	3
Other technical personnel	..	..	51

24. Technical Methods.—(a) Planimetric and Height Control was provided for the air survey of the following projects :—

Barāhakshetra Gorge, falling in Sheet 72 N, on 4-inch scale, with 20-foot contours.

Tikarpāra Reservoir, falling in Sheet 73 D, on 4-inch scale, with 10 and 20-foot contours.

Konār Pipe Line Extension Survey, falling in Sheet 73 E, on 6-inch scale, with 10-foot contours.

Narāj Reservoir, falling in Sheet 73 H, on 4-inch scale, with 10 and 20-foot contours.

Um Tru Reservoir, falling in Sheet 78 N and 78 O, on 6-inch scale, with 20-foot contours.

Kosi Dam Extension, falling in Sheet 72 N, on 32-inch scale, with 20-foot contours.

Bihār Mica Belt Survey, falling in Sheet 72 H, on 1/25,000 scale, with 25-foot contours.

Planimetric control was carried out by normal triangulation and traverse.

Height control was done either by tachymetry or by observing vertical angles with theodolites or clinometer; in the latter case distances were measured off the triangulation chart projected on a scale large enough to give a suitable accuracy of linear measurements.

(b) *Kopili River Flood Control Scheme*.—This is in Kamrup and Nowgong districts, Assam, falling in Sheets Nos. 78 N and 83 B. Maps were required for an area of 2 miles on either side of Kopili and Kalang rivers on 4-inch scale with 1-foot contours for the Chief Engineer, Public Works Department, Assam.

Planimetric and height control was done by traversing and tertiary simultaneous double levelling. Heights for the control of 1-foot contours were fixed by lines of tertiary single levelling at 30 chains intervals. Rigorous contouring was not required as the engineers wanted to know only the general profile of the country.

The area consists mostly of low cultivated plain interspersed with *bils*, swampy areas and villages surrounded by thick bamboo growth. It was thus found difficult to run straight lines of levelling, and offsetting at right angles with levelling instrument to by-pass such obstacles was a laborious and lengthy operation. In order to get an even density of heights over the area, plane-table traverse was necessary to keep the lines straight between control points and to locate intermediate points where heights were required. For future levelling in such areas, where air photo cover exists, it is considered that much time could be saved by using the air photographs to keep the level lines straight.

(c) *Ganga Bridge Project*.—This covers the Mokameh Ghāt area on the Ganges River and falling in Sheets 72 G, and 72 K. The Engineer-in-Chief, Ganga Bridge Project required.—

(i) A strip map showing details and names of 800 square miles of area from Surajgarha (72 K) to Patna (72 G) prepared by revising the existing 1" topographical maps from air photographs taken in 1948.

(ii) Co-ordinates of control points (without heights) half or one mile apart along both banks to enable the railway engineers to take cross sections of the Ganges river and the Research Station Poona to construct a model of the river on 1/500 scale.

- (iii) Co-ordinates of control points with heights 3 miles apart beyond the *Khadir* line (an imaginary line beyond which the river is never likely to wander) on both banks as permanent fixed points.

It was originally planned to fix the points by triangulation making stations at one and a half or two miles apart and observing the intermediate half mile points by intersection. This plan failed after a period because sand-storms and haze did not give clear visibility and means of crossing the Ganges river were limited. Therefore the major portion of the control was carried out by traverse and connections of points on either side of the river were made by triangulation at 20 to 30 miles intervals.

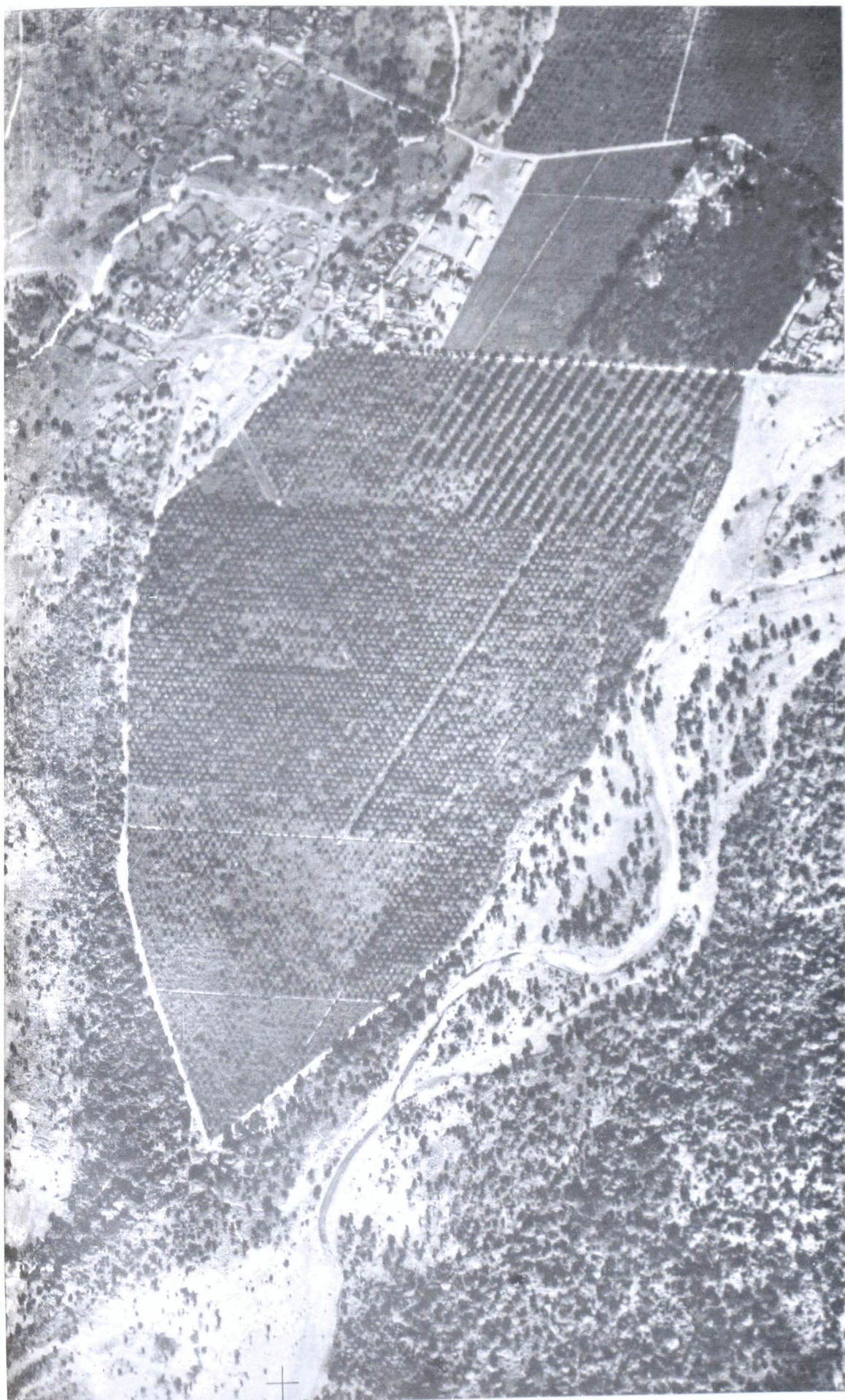
Detail on photographs was also verified on the ground for their correct classification and interpretation by air survey draftsmen.

(d) *Calcutta Electrification Scheme (Route Survey of Transmission Line)*.—This falls in Sheets 79 A and 79 B and was carried out for the Department of Electricity Development, West Bengal. Fixation of stations at 300 or 150 yards intervals along routes of transmission lines as indicated by their liaison officer and determination of differences of levelled heights between the stations were required. Normal theodolite traverse and tertiary single levelling were used for this purpose.

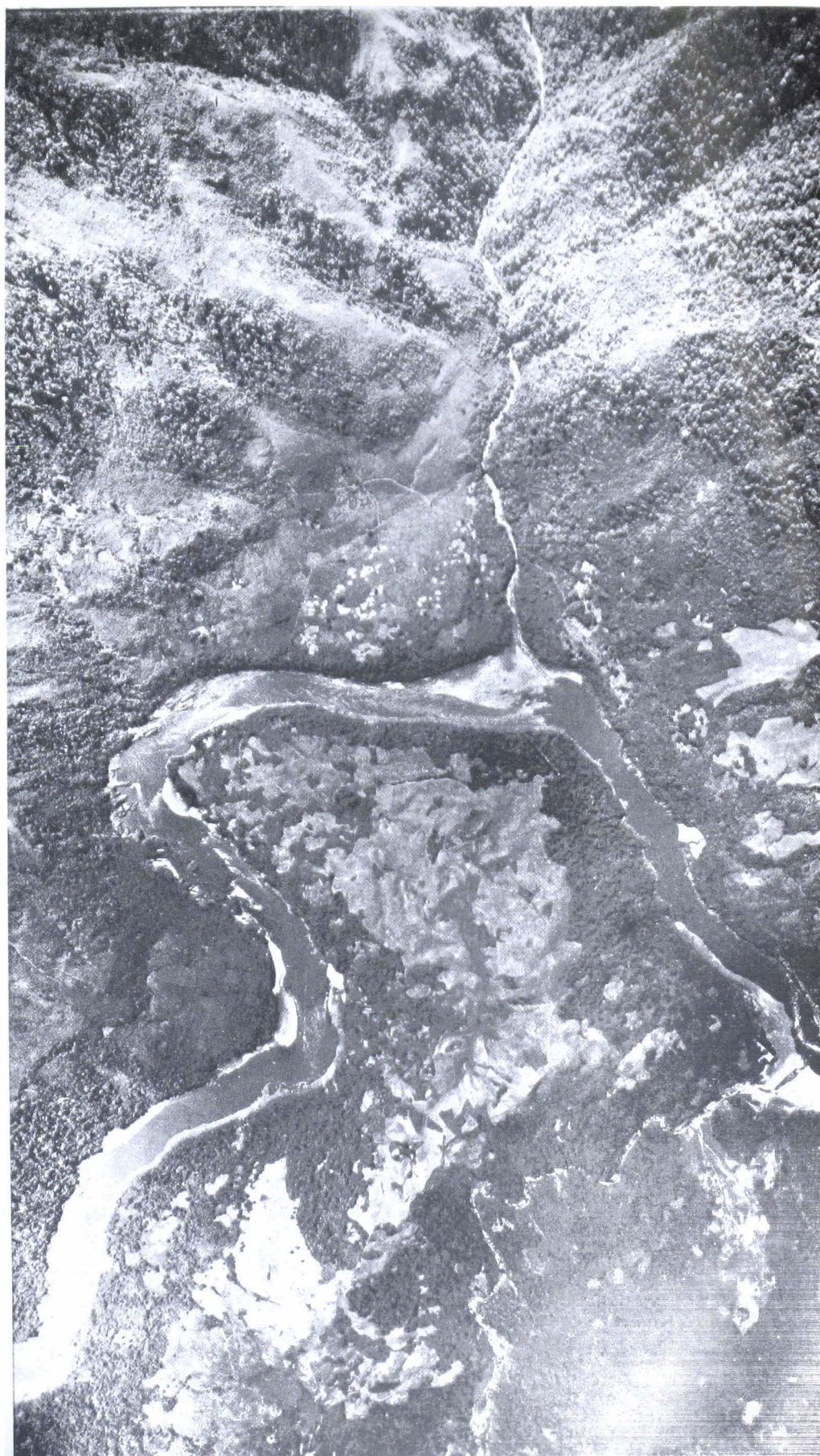
(e) *Survey of Tea Estates in Assam and West Bengal*.—These fall in Sheets 78 B and 78 F, and the work was for Messrs. Jardine Henderson, Limited, Calcutta, for finding out the precise area of their holdings for each tea estate and the areas of tea plantation, cultivated and waste lands. Traverse for planimetric control and ground verification of detail on photographs were carried out for air survey of five estates in West Bengal on 16-inch scale. The remainder of the tea estates in Assam will be taken up in recess 1949 and next field season (1949-50).

Digha Survey.—This was on the sea coast of West Bengal adjacent to the Orissa border and falling in sheet 73 O, and was required for town planning purposes by the Government of West Bengal, on 16-inch scale with 5-foot contours. Framework by traverse and heights by tertiary levelling were provided before the survey was commenced. The country is mostly undulating with shifting sand dunes, interspersed with patches of cultivation. Flattish areas were contoured by the clinopole method and steep sand dunes by normal plane-table methods with a close density of clinometric heights.

Dihāng Reservoir.—This is in the NE. Frontier tracts of Assam, falling in Sheets 82 L and 82 P. A survey on 4-inch scale with 50-foot contours was required for the Central Waterpower, Irrigation and Navigation Commission. Orders for taking up this job were received early in February 1949. Arrangements, collection and despatch of personnel and kit took several weeks. One surveyor



AN AERIAL VIEW OF A TEA GARDEN IN WEST BENGAL.



commenced his work on 1st March, the second on 25th March and the third on 7th April. Unusually early and incessant rains did not permit more than 12 to 15 working days in a month. One surveyor went sick in the field with malaria and another with septic fever due to bites from leeches and jungle flies. Thus no appreciable progress was made on this work except that portions of traverse lines totalling about 50 linear miles in length were completed. The lines are unconnected with each other. They will have to be properly connected with triangulated points next field season (1949-50). Triangulation could not be resorted to as no means of crossing the Dihāng river for stretches of 30 to 40 miles exist; and communications in the area are also difficult due to the dense jungle.

No. 9 PARTY

Officer in charge :—Mr. H. H. Phillips.

25. **General.**—The unit was chiefly employed on Irrigation surveys for the Kosi Irrigation Project to meet the requirements of the Central Waterpower, Irrigation and Navigation Commission. Maps were required for the planning of an extensive system of canals in the plains of Southern Nepāl and Northern Bihar. The whole area for survey, during the period under report (except a strip of land adjoining the west bank of the Kosi river, which will contain the head-works of the proposed West Kosi Canal) was covered with air photography, and the survey was carried out by the method described in Appendix II to Technical Report, 1947.

Although the main task of the unit was the survey of the Kosi commanded area, the following additional surveys were carried out :—

(i) In the field season 1947-48 :—

(a) A ground survey on the 1/1,000 scale, with 10-foot contours of part of the Kosi Dam area around the actual dam site falling in Sheet 72 N, required for the preliminary investigation and design of the dam.

(b) Triangulation in Nepāl in Sheets 72 E and I, to provide planimetric control for air survey on the 1-inch scale of a part of the Kosi catchment area, in connection with the Kosi Hydro-electric Project.

(ii) In the field season 1948-49 :—

(a) Planimetric and height control, ground verification and marking on the air photographs of height and planimetric control points, for subsequent air survey with contouring at 1-foot vertical interval, of a portion of area for the Ganga Barrage Scheme surveys in Sheets 72 O, P; 78

C and D. The Public Works Department of the Government of West Bengal levelled cross-sections of the river about half a mile apart for the purpose of making models of the river for experimental purposes. A proportion of the cross-section terminal points, on both banks of the river, was connected to the main traverse framework. The balance were pricked on air photographs for subsequent intersection on the air survey compilation.

- (b) Ground survey, on scale 4 inches to a mile, of a jungle covered strip of land adjoining the west bank of the Kosi river, in Sheet 72 N, with contouring at 5-foot vertical interval up to the 400-foot contour and of 10 feet between the 400-foot and 450-foot contours. This survey will form a part of the Kosi Irrigation surveys.
- (c) Marking on the ground of points along the 1,100-foot contour on both the banks of the Kosi river and its tributaries, in the Kosi reservoir area, falling in Sheets 72 I, J, M and N.

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

Gazetted officers	..	..	4
Other technical personnel	..	..	69

27. **Technical Methods.**—(i) *Kosi Irrigation Surveys.*—The standard procedure for irrigation surveys (see Appendix II, Technical Report, 1947), was followed with the following modifications :—

- (a) Stone-laying was done, in a few sheets, on blue prints of the air survey compilation of the outline, instead of on the photographs marked with the theoretical stone positions. The obvious advantage of this method is that all misidentified and therefore wrongly air surveyed items of detail can be corrected on the ground, and the positions of other items of detail checked by ordinary plane-tabling methods. The method could not be followed for all the sheets due to the late receipt of air photographs of the remaining area of work.
- (b) For the ground survey on scale 4 inches to a mile of the jungle covered strip of land adjoining the west bank of the Kosi, planimetric control was provided by theodolite traverse, and a line of tertiary levelling was run to provide height control. As the area is mostly covered with dense jungle, the area was surveyed by plane-table height traverse.

(ii) *Surveys on 4-inch scale in connection with the Ganga Barrage Scheme.*—The methods followed for providing planimetric and height control and for ground verification for air survey were the same as for the Kosi Irrigation surveys. The area did not contain any G.T. stations and the traverse lines had to emanate from and close on stations of previous topographical triangulation. To ensure a sufficient standard of accuracy of framework for 4-inch surveys, the stations of the topographical triangulation were re-observed on 5 zeros for all horizontal angles. Scale and azimuth were adjusted at each end of the series by observing Hunter Short Base extensions and astronomical azimuths.

A mesh of levelled heights was established to control the contouring. To do this, lines of tertiary levelling were run at 20-chain intervals and spot levels at 10-chain distances along the lines, were pricked on the air photographs. Every second spot level was made into a bench-mark by selecting semi-permanent natural or artificial features, or embedding a stone in the ground.

(iii) *Marking on the Ground of Points along the 1,100-foot Contour on both banks of the Kosi River and its Tributaries.*—The requirement was to locate, on the ground, the proposed top water level of the Kosi Reservoir (i.e., the 1,100-foot contour) for the purpose of assessing compensation to landholders whose lands would be inundated by the reservoir. The assessments were made on the spot and the map positions of the points located along the contour were not required to be surveyed.

To commence a tertiary level line was run starting from a bench-mark of secondary levelling at Barāhakshetra, to a point on the 1,100-foot contour. To check the accuracy of the height of this point, the tertiary-levelling was continued back to the starting bench-mark at Barāhakshetra along a different route.

From the above point further points, at the same height above mean sea-level, were located on both sides of the valley by observation with a level to improvised coloured targets. The targets had a central horizontal stripe and were fixed on poles so that the stripe was at the same height above the ground as the level axis. This working height, once fixed, was maintained throughout the whole operation for both level and targets.

The observer, having established his starting point, and adjusted his level to the correct height above the ground, observes through the telescope to the coloured targets positioned on both sides of the valley, and by a system of signals, directs the movements of the men holding the targets so that the stripes on the targets are brought on to the horizontal cross-wire of the telescope. The bottom of the pole of each target has now been positioned on the ground at the same height above mean sea-level as that of the starting point over which the level instrument is positioned, viz., 1,100 feet above mean sea-level.

Further points, at the same height above mean sea-level, were determined by carrying the method forward up the gorge. The height of each new point was checked from a second level position.

To minimize errors due to the curvature of the earth and refraction, the distance between the level instrument and any target was never allowed to exceed a third of a mile. The overall error in height, acceptable to the indenter, was not to exceed 5 feet. Except for the starting height datum near the dam site, there was no other bench-mark or trigonometrical station height in the gorge area.

The hill-sides in the area of the Kosi Reservoir are very steep, generally about 45 degree slopes, and very rugged, especially so near the Kosi Dam site. There were also numerous cliffs and landslides in the gorge.

It would, therefore, have been a more difficult and lengthy job to have done this work by ordinary levelling or by levelling combined with traverse or triangulation.

(iv) *Kosi Dam Survey*.—The framework was carried out by triangulation and the large scale survey by normal plane-table methods—as reported in Technical Report, 1947.

28. Description of the Country.—Recent old beds of the Kosi River were found to be overgrown with high grass and reeds, and burning the reeds and grass before stone-laying and levelling was found to be the most economical method of clearing these obstructions.

Patches of jungle occur in the area of survey in the plains of Nepāl, and considerably slow down the progress of all types of field work, particularly stone-laying and tertiary levelling.

29. Effect of Change of Plans on Out-turn.—It is an advantage to have a head of traverse work for next season's photographic combination and photo-marking to give stone-layers an early start, and a head of stone-laying for the next season's tertiary levelling. An attempt was made in this direction during the field season 1947-48, but no advantage could be taken of it in the field season 1948-49 due to an eleventh hour change by the indenter in the area for field work for 1948-49. This change also meant that air photography of a new area had to be undertaken in the early part of the field season 1948-49, and the party was supplied with prints after the commencement of the field season. This resulted in a very late start and a consequently poor out-turn for the whole field season.

No. 11 PARTY

Officer in charge :— { Mr. M. M. Ganapathy, B.A., to 23-8-47.
 { Mr. N. L. Gupta, from 24-8-47 to 29-11-47.
 { Mr. C. P. E. Davenport, from 30-11-47 to 1-7-48.
 { Mr. S. C. Chatterjee, B.sc., from 2-7-48.

30. General.—No. 11 Party was employed on the following work :—

- (i) 4-inch Irrigation Survey of Hirākud commanded area of the Mahānadi scheme, in sheets—64 O, 64 P, 73 C and 73 D.

- (ii) Planimetric and height control of part of Tikarpāra Reservoir area for 4-inch air survey, in sheets—73 C and 73 D.
- (iii) Height control for part of Bihār Mica Belt area for 1/25,000 air survey, in sheets—72 H and 72 L.
- (iv) 1/1,000 survey of Hirākud Dam area, in sheet—64 O.

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

Gazetted officers	5
Other technical personnel	68

32. **Technical Methods.**—The total area of the Hirākud commanded area is approximately 2,021·7 sq. miles. Of this 1,800·5 sq. miles were surveyed in three different field seasons 1946–47, 1947–48 and 1948–49. The methods used are described in Appendix II of Technical Report, 1947.

The total area of Tikarpāra Reservoir is approximately 700 sq. miles of which 300 sq. miles was triangulated to supply planimetric control points to a rough density of two per three square miles. The existing topographical and G.T. triangulation points were post-pointed in the balance of the area which provides a sufficient density of planimetric control in that area. An area of approximately 40 sq. miles was height controlled by tertiary levelling for 4-inch air survey.

1624 sq. miles of Bihār Mica Belt area were height controlled by plane-table fixings and traversing based on existing topographical and G.T. triangulation to a rough density of four heights per square mile. The existing topographical and G.T. triangulation stations and points were post-pointed on the photographs and their density was sufficient for the control of 1/25,000 air surveys.

A total of 2·65 sq. miles of Hirākud Dam area was triangulated and theodolite traversed to supply sufficient points for plane-table survey. In order to contour the area at 2-foot vertical interval a network of tertiary levelling was carried out to supply heights at approximately 3-chain intervals. The area was finally plane-tabled by combined fixing and plane-table traverse and contouring with “clinopoles”.

33. **Terrain.**—Hirākud commanded area consists mainly of undulating country covered with scattered trees and large areas of paddy cultivation. Other parts are undulating and covered with scrub and low jungle. The undulating ground necessitated a large number of close stations during levelling, while clearing in the jungle covered area further slowed down progress.

In the paddy cultivated areas, levelling could not be started before the end of November or early December, when the harvesting was completed.

Hirākud Dam area was deforested completely before the commencement of the survey. This area is more or less plain

near the Mahānadi river rising at both ends to an elevation of about 300 feet and ending on hills. The bed of the river is rocky.

34. **Climate.**—Towards the end of March and during April, levelling had to be discontinued for about three hours in the middle of the day due to heat radiation which was affecting the accuracy of observations.

No. 12 PARTY

Officer in charge :—Mr. J. C. Ross.

35. **General.**—The party carried out extra-departmental air and ground surveys, on different scales and for a variety of purposes, for other departments of the Government of India.

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

Gazetted officers	..	4
Other technical personnel	..	22

37. **Areas.**—Areas surveyed from vertical air photographs, on 1-inch, 4-inch, 6-inch, 16-inch and 32-inch scales totalled 202 square miles (the contouring for 36 square miles of which had to be verified on the ground).

Areas surveyed by plane-table, on 4-inch and 16-inch scales totalled 8 square miles.

Areas triangulated or for which supplementary height control was provided totalled 181 square miles.

38. **Air Survey Tasks.**—(i) *Kosi Catchment ; Sheets Nos. 72 E and 72 I.*—Complete air survey on 1-inch scale, with contours and form-lines at a vertical interval of 100 feet, for the Central Waterpower, Irrigation and Navigation Commission. Work was done from contact prints, and considerable difficulty was experienced in identifying detail on such small scale photographs.

(ii) *Kāziranga Game Sanctuary.*—Air survey on 1.5-inch scale of 31 linear miles of the south bank of the Brahmaputra river where it forms the northern boundary of this reserve. This survey, together with the extraction of the area of the sanctuary, was carried out for the Senior Conservator of Forests, Assam, to enable him to assess the amount that the river has encroached on the area of the sanctuary.

(iii) *Barāhakshetra ; Sheet No. 72 N.*—Complete air survey on 4-inch scale, with contours and form-lines at a vertical interval of 20 feet, for the Central Waterpower, Irrigation and Navigation Commission.

(iv) *Konār Pipe Line Extensions ; Sheet No. 73 E.*—Complete air survey on 4-inch and 6-inch scales, with contours at a vertical interval of 10 feet, for the Dāmodar Valley Corporation.

(v) *Appliqué slips to Konār Pipe Line and Pipe Line Extensions Surveys ; Sheet No. 73 E.*—Air survey revision of contours

only, at a vertical interval of 10 feet, on 6-inch scale, for the Dāmodar Valley Corporation. Detail was traced from the existing originals.

(vi) *Deolbāri Reservoir ; Sheets Nos. 72 L and 73 I.*—Complete air survey on 6-inch scale, with contours at vertical interval of 10 feet, for the Dāmodar Valley Corporation. Due to badly-tilted photographs, full advantage could not be derived from the height control, so that a trace of the contour survey had to be sent out to the field for verification on the ground. A very rapid checking of detail was also done.

(vii) *Sivok (Tīstu) Bridge ; Sheet No. 78 B.*—Air survey of detail only on 6-inch scale, for the Engineer-in-Chief, Assam Rail Link Project. Blue prints of this survey were given to field personnel of No. 5 Party, who verified the detail and contoured the major part of the area on the ground at a vertical interval of 10 feet. The remainder of the contouring was done on air photographs, also in the field. Fair-mapping for publication was also carried out.

(viii) *Um Tru Reservoir ; Sheets Nos. 78 N and 78 O.*—Complete air survey on 6-inch scale, with contours at a vertical interval of 20 feet, for the Government of Assam.

(ix) *Bagaha Land Reclamation Scheme ; Sheets Nos. 63 M and 72 A.*—Air survey of detail only, on 16-inch scale (the area being contoured on the ground, independent of detail, by No. 9 Party, at a vertical interval of 5 feet), for the Government of Bihār. Fair-mapping for publication was also carried out.

(x) *Bermo-Bhāndaridah Gorge ; Sheet No. 73 I.*—Complete air survey on 16-inch scale, with contours at a vertical interval of 5 feet, for the Dāmodar Valley Corporation.

(xi) *Konār Dam ; Sheet No. 73 E.*—Air survey revision of contours only, at a vertical interval of 5 feet, on 16-inch scale, for the Dāmodar Valley Corporation. Existing detail survey was accepted.

(xii) *Kosi Dam Extension ; Sheet No. 72 N.*—Complete air survey on 32-inch scale, with contours at a vertical interval of 20 feet, for the Central Waterpower, Irrigation and Navigation Commission.

39. **Field Work.**—(i) *Bokāro Dam Extension ; Sheet No. 73 E.*—Framework and 16-inch scale ground survey of the same area (with contours at a vertical interval of 5 feet), for the Dāmodar Valley Corporation.

(ii) *Bokāro Coal-field ; Sheet No. 73 E.*—Ground survey on 4-inch scale, with contours at a vertical interval of 50 feet, for the Geological Survey of India. This survey was carried out to fill gaps in the air photography.

(iii) *Bokāro Coal-field ; Sheet No. 73 E.*—Provision of further supplementary height control, by plane-table and clinometer, for the complete air survey of this area (the previous height control not being entirely satisfactory).

40. **Technical Methods.**—The various technical procedures adopted for similar types of surveys to the foregoing was described in Technical Report, 1947. This also contains detailed notes on methods which are applicable to the surveys now reported.

In addition, the following comments are made as a result of experience gained during the period now under report :—

- (i) The identification and pricking on photographs, by field personnel, of control points to be used for air survey has been found faulty in many cases. The pricked positions of the same point on two or more photographs have sometimes not been found to be in agreement. One reason for this is that field personnel do not prick points by stereoscopic examination of a pair of photographs, but attempt to do it from single photographs. It is considered that field prints, with control pricked on them, should invariably be supplemented by descriptions and diagrams of planimetric control points.
 - (ii) Tilted photography is causing much difficulty in contouring by the present method of inspection under a stereoscope. Under such conditions the height control loses much of its value. Where photography is appreciably tilted, it has been found more economical and accurate to carry out the contouring by plane-table methods on the ground using prints of the air survey of the detail. The advent of stereoplottting machines will, of course, greatly lessen this difficulty.
 - (iii) It has been learned from experience that contouring by present methods, of flattish areas from large scale air photographs at an interval of 5 feet or less, is not a practical proposition. It should always be done on the ground unless complete generalization of contours will meet the requirements of the survey.
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V. TECHNICAL NOTES, SOUTHERN CIRCLE

DIRECTOR :— { Mr. M. R. Nair, B.A. (current duties) to 14-10-47.
Major J. S. O. Jelly, R.E., from 15-10-47 to 18-2-48.
Major C. A. Biddle, R.E., from 19-2-48 to 9-7-48.
Mr. H. M. Critchell, from 10-7-48.

DY. DIRECTOR :— { Mr. P. A. Thomas, from 1-11-48 to 9-1-49.
Mr. H. M. Critchell, from 10-1-49 to 16-3-49.
Mr. J. C. Berry, from 17-3-49.

41. **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 control of the Director, Southern Circle, had also to carry out several project surveys. No reference has been made to No. 10 Party's work in these notes, as this party only came under the control of the Director, Southern Circle in December 1948 and its activities were changed to those of a training party for Topographical Trainees, Type 'B', of the Division II of Class III service.

A syllabus of training for Topographical Trainees, Type 'B' has been given in Appendix to these Technical Notes.

HEADQUARTERS SECTION

42. **General.**—The Headquarters Section, in the charge of Mr. M. W. Kalappa (Class II), carried out, during the period under report, air survey and mapping work in connection with several irrigation and development projects, which are mentioned in Part I of General Report, 1948-49. Matters of technical interest in respect of certain tasks are mentioned below.

43. **Pennār Reservoir Sheets 57 J, N.**—

(i) *Introduction.*—The original demand was for the survey and preparation of a map of the proposed Pennār Reservoir, on scale 4 inches to 1 mile, with contours at 10 feet vertical interval. As the map was required to calculate the capacity of the proposed reservoir and to determine the land area that would be submerged, it was decided in consultation with the Indentor, the Chief Engineer for Irrigation, Madras, to economize by preparing instead contoured photo-mosaics on the scale of 4 inches to 1 mile with contours at 10 feet vertical interval of the area from the site of the proposed dam, upstream to a height of 420 feet above mean sea-level.

(ii) *Description of Country*.—The reservoir area consisted of low jungle clad hills interspersed with open cultivated valleys which were partly flat and partly undulating.

(iii) *Existing Framework*.—The existing trigonometrical control in the reservoir area was :—

(a) Old minor topographical triangulation carried out by 7 different triangulators in various seasons between 1915 and 1922.

(b) Levelling lines carried out by the P.W.D. along longitudinal and cross-sections of the reservoir area, at about half-mile intervals and up to a height of 400 feet above mean sea-level. The heights of this levelling were adjusted to G.T. Levelling heights.

(iv) *Height Control*.—To provide adequate height control for contouring photo-mosaics the following methods by which to supplement the existing control were considered :—

(a) To cover the area by a network of supplementary triangulation and further supplement this by theodolite traversing or clinometric heights, wherever necessary.

(b) To provide additional heights by clinometer, using 2-inch scale blue print enlargements of 1-inch maps mounted on plane-tables.

(c) To identify and check existing P.W.D. levelling heights and supplement these by tertiary levelling wherever necessary.

(v) *Methods Adopted*.—A scrutiny of the old triangulation data revealed that the heights of some of the common points of the various triangulators differed by as much as 12 feet and that the triangulated heights had not been adjusted to the spirit-level net. It would have involved considerable time and labour to adjust the various triangulation series to bring the heights to terms of the spirit-level net before the heights could be accepted for 10-foot contouring. It was, therefore, decided to adopt the methods described in para (iv) (c) above, although it was realised that many of the P.W.D. levelling heights may not be identifiable on the ground and that a rigorous check of the P.W.D. levelling heights would be necessary before they could be accepted.

As the field work proceeded, it was found that only about 30% of the P.W.D. cross-section level lines and about 20% of the heights of any cross-section line were identifiable, even with the help of the P.W.D. levellers. Tertiary level lines were, therefore, run between P.W.D. cross-section lines, starting and closing on identified P.W.D. marks. Additional heights were thrown out where necessary and pin-pointed on photographs on the ground. The P.W.D. levelling heights were subjected to frequent checks *inter-se* and also by connections made to G.T. bench-marks in the area. A few large errors were detected and rectified.

In flat ground where contours were few and far apart, tertiary level lines were run along each contour.

(vi) *Out-turn*.—A detachment consisting of 3 Surveyors (Topographical Assistants) and 6 Topographical Trainees Type 'B', all new to this type of work completed the height control and post-pointing on 4-inch photo enlargements, of an area of 350 square miles in a period of 4 months. The detachment was supervised by a Class II Officer.

(vii) *Value of Methods*.—The methods adopted proved successful. By utilizing the existing P.W.D. levelling there was considerable saving in time and labour. The fixing of height control by levelling rather than by triangulation or theodolite traverse proved to be more economical for the type of country covered.

44. **Other Projects**.—The other project surveys carried out by the Headquarters Section were :—

- (i) 16-inch Pennār Dam survey in Sheet 57 N.
- (ii) 16-inch air survey and mapping of Bangalore Town Extension in Sheet 57 H.
- (iii) 16-inch air survey of Dāvangere Town and Environs in Sheet 48 N.
- (iv) 4-inch air survey of Moj Reservoir in Sheet 41 K.

The normal methods were used for ground control and the radial line method was used for air survey compilation.

For town surveys, verification of detail was carried out on the ground and contours were surveyed on the ground by the clinopole method, using foil-mounted blue prints and black prints of the air survey compilations.

No. 6 PARTY

Officer in charge :— { Mr. B. N. Murthy, B.Sc., to 2-11-48.
Mr. M. R. Nair, B.A., from 3-11-48.

45. **General**.—The party carried out the following survey programme during the two seasons 1947-48 and 1948-49 :—

- (a) A blue print survey on the 1-inch scale of Sheets 46 G/1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 13, 15.
- (b) Air-cum-ground survey of Sheets 46 C/11, 12, 13, 14, 15, 16 ; D/9 and 13, 14 and H/1, 2.
- (c) Original air survey on the 2-inch scale of the Limdi and Vajpur Dam sites.
- (d) Air-cum-ground survey on the 2-inch scale of the Dharoi Dam site.
- (e) Original air-cum-ground survey on the 32-inch scale of the Ukāi Dam site.
- (f) Original air-cum-ground survey on the 4-inch scale of the Moj Commanded Area.

(g) Planimetric and height control for (e) and (f) above and for the proposed Ukāi Reservoir survey.

46. **Blue Print Survey.**—Existing surveys were pre-1905, published in old style sheets. Prints of the old style sheets were mosaiced on the modern lay-out on the 1-inch scale using existing triangulation framework as control. Foil-mounted blue prints on 1-inch scale of the mosaics were obtained for plane-table sections. The survey was carried out by the normal ground survey methods laid down in Chapter V of the Topographical Handbook. Existing triangulation and traverse framework was used after careful verification and check on the ground.

47. **Air-cum-Ground Survey.**—Three different methods, all of an experimental nature, were employed for this survey, which was the first of its kind assigned to the party.

(a) For the survey of Sheets 46 C/13, 14, detail was verified and inked-up on air photographs on the ground. Contours were surveyed on the ground on black prints of the old 2-inch maps, using for height control the existing triangulated heights supplemented where necessary by additional heights fixed by theodolite observations. The contoured field sections thus produced were then reduced to the scale of 1·9 inches to a mile, the mean scale of the air photographs, and blue prints obtained on kodatrace. Detail from the inked-up photographs and contours from the field sections were then traced on the kodatrace blue prints from which blue prints were finally obtained for fair mapping. Colour traces were maintained in the field for each air photograph.

(b) For the survey of sheets 46 C/11, 12, 15, 16 blue prints were obtained of existing old style maps on the mean scale of the air photographs. On these blue prints detail was corrected/inserted by tracing direct from the air photographs using existing framework and unchanged detail as control. The prints thus prepared were photographed to the 1½-inch scale and black prints obtained on foil-mounted plane-table sections on which ground verification and contouring on the ground was carried out. Colour traces were maintained in the field for each plane-table section, on which all detail was inked in proper colours.

(c) In methods (a) and (b) above it was found that there was distortion of the graticules in the blue and black prints prepared from old style maps, which it was troublesome to eliminate. For the survey of Sheets 46 D/9 and 13, 15; H/1 and 2, therefore, the following method was adopted :—

Mosaics were prepared of the old surveys on standard projections by carefully fitting the old surveys to the plotted positions of the triangulation framework. From these mosaics foil-mounted blue prints were obtained for plane-table sections on the 2-inch scale, the mean scale of the air photographs. Fieldwork was then carried out in three stages :—

(i) Plane-table reconnaissance for fixing auxiliary points ;
post-pointing of auxiliary points on photographs ;

verification and inking of detail not clear on photographs.

- (ii) Tracing and compilation of detail from photographs on to the plane-table sections, controlled by existing framework and auxiliary points.
- (iii) Ground verification of detail and contouring on the ground and inking of plane-tables in colours.

The country covered by these surveys consists mainly of the great alluvial plains of Broach and Surat districts, gently sloping towards the coast of the Arabian Sea. It is devoid of any eminences except for a few flat-topped hills in Sheets 46 D/14 and H/2 and a few palm covered hillocks of sand drift formed parallel to the coast line. Due to the flatness of the country auxiliary tree points had to be extensively flagged for identification. As many of the old triangulation stations and points were unidentifiable, a careful preliminary plane-table reconnaissance was necessary to provide adequate control.

48. **Air Surveys of Limdi and Vajpur Dam Sites.**—These were carried out by normal rigorous air survey methods based on the existing plan control only. Since existing height control was insufficient for contouring this was supplemented on the ground by plane-table and clinometer.

49. **Air-cum-Ground Survey of Dharoi Dam Site.**—The method adopted for this survey was the same as that described in para 47 (c) above.

50. **Ukai Dam Site Survey.**—The survey required was of an area of 2.3 square miles on the 32-inch scale with contours at 5 feet vertical interval. The area was photographed on the 14-inch scale and enlargements obtained on the 32-inch scale.

During the course of air survey compilation in the field under camp conditions, it was found that the photo enlargements and the kodatrace distorted beyond the permissible limits during the course of the day, and satisfactory adjustment of minor control plots was, therefore, not possible. The survey was, therefore, carried out by normal plane-tabling methods.

For the 32-inch scale survey special precautions were taken for centering plane-tables over control points which were provided at intervals of about a quarter of a mile apart. Plane-table traverses were run by the back and forward ray method and were limited to about a quarter of a mile in length between starting and closing points. All distances were measured by chain or clinopole.

The clinopole was used for contouring, its use being restricted to a distance of 150 feet from the plane-table, beyond which it was found to give plottable errors in distance on the scale of survey. In flat ground every contour was traced by clinopole. In sloping ground every alternate or third contour was traced by clinopole, the intermediate contours being plotted from the traced contours. In

hilly ground the 25-foot or 50-foot contour, according to steepness, was traced by clinopole and the intermediate contours interpolated with the help of spot heights fixed by clinometer.

51. Moj Commanded Area Survey.—The object of the survey was the production of a 4-inch map of the commanded area of about 60 square miles with contours at one-foot interval. The specification also stipulated the fixing of “stones on the ground at or near the corners of a 30-chain grid, their heights above Mean Sea-Level given to the nearest one tenth of a foot and their positions marked on the 4-inch maps of the area”.

The area consists of open flat to slightly undulating country with trees in the vicinity of villages. There were patches of impenetrable *babul* jungle near the south extremity of the area. The Moj River flowing north to south divided the area into approximately two equal parts.

Detail survey was carried out by air survey methods and verified on the ground. Contours were surveyed on the ground with the aid of a dense network of heights fixed by levelling. The levelling heights were based on the heights of triangulated stations in the area. There was no precision levelling in the vicinity of the area.

Main level lines by double tertiary levelling connecting all perimeter stones were first run around the area and then down the centre of the area along both banks of the Moj River. Internal levelling was then carried out by single tertiary levelling to connect up the other stones. The closing error in the main line was 0·4 feet in 47 linear miles and in the tie lines the closing error did not exceed 0·2 feet in any line.

Stones were supplied by the Saurashtra Government and were of dressed limestone 9 inches by 9 inches by 2 feet. Stones were embedded in the ground with 6 inches projecting above ground level and were numbered serially as bench-marks. Numbers were printed with coal-tar. All stones were post-pointed on the photographs.

52. Ukāi Reservoir Survey.—The survey demand was for maps on the scale of 4 inches to 1 mile with contours at 10 feet vertical interval up to limit of 360 feet and at 5 feet vertical interval from 360 to 410 feet above mean sea-level.

Only planimetric control for air survey compilation was carried out during the field season by normal triangulation.

No. 8 PARTY

Officer in charge :— $\left\{ \begin{array}{l} \text{Mr. P. A. Thomas, to 31-10-48.} \\ \text{Mr. P. S. Shingal, from 1-11-48.} \end{array} \right.$

53. General.—No. 8 Party continued to be employed mainly on the Tungabhadra Project in Hyderabad. Air survey for the Kistna Dam Site was also undertaken by this party.

54. **Tungabhadra Commanded Area (Tungabhadra Project).**—During the two field seasons covered by this report the party remained primarily engaged on completing the planimetric and height control for the 4-inch air survey of the area commanded by the Tungabhadra Project in Sheets 56 D, H, L and 57 A, E and I. This project work was assigned to the party in 1946 and is described in the General Report, 1947. A detailed description of the various technical methods used is given in the Technical Report for 1947. These methods have proved very satisfactory and there has been no occasion to revise them or introduce any new methods. Field output increased progressively as personnel became more and more familiar with the technical methods.

55. **Cost Rates.**—Table 'C' for the cost-rates of the Tungabhadra Project survey is not included in this report. The cost-rate has varied from year to year due to unforeseen factors such as the political situation in Hyderabad State, the introduction of new pay scales, the rising cost of labour and transport, etc. An accurate cost-rate can only be calculated for the project as a whole at the conclusion of the fieldwork. The cost-rate has shown a progressive rise from 8 annas per acre estimated in 1946 to 10½ annas per acre in 1947-48 and 12 annas per acre in 1949.

56. **Kistna Dam Site Survey.**—The party took up the air survey for the Kistna Dam site on the 16-inch scale. The Dam site is located just below the junction of the Kistna and Tungabhadra rivers in Madras. Planimetric and height control was completed by normal methods of triangulation and levelling. Heights were based on G.T. precision level heights, to which connections were made by double tertiary levelling and Hunter's Short Base traverse. A few river-depths were measured to bed-rock level along and near to two possible axes of the proposed dam as these are of considerable value to the planning engineers.

No. 17 PARTY

Officer in charge :— $\left\{ \begin{array}{l} \text{Mr. M. R. Nair, B.A., to 8-9-47.} \\ \text{Mr. M. M. Ganapathy, B.A., from 9-9-47 to 4-3-49.} \\ \text{Mr. J. A. Cabral, from 5-3-49 (current duties).} \end{array} \right.$

57. **General.**—For field season 1948-49 the party was allotted the air-cum-ground survey of Sheets Nos. 48 I/7, 8, 11, 12, 15 and 16, an area of 1627 square miles excluding the area of Goa in Sheets 48 I/7 and 8. The area was covered by pre-1905 surveys, published in old style sheets Nos. 245, 246, 277, 278, 307 and 308.

58. **Air Cover.**—The area had been photographed in two parts :—

(a) On the scale of 1·7 inches to 1 mile (approx.) in February 1947.

(b) On the scale of 1·55 inches to 1 mile (approx.) in April 1947.

59. **Air Compilation.**—Air compilation and detail survey was carried out in recess 1948 by a batch of senior trainees.

In order to make as much use as possible of the old surveys, prints of the old style 1-inch maps were mosaiced on the modern 1-inch layout after applying the necessary corrections to the old latitude and longitude values. Mosaicing was controlled by existing triangulation framework. These mosaics were then photographically enlarged to the mean scale of air photography (1.6 inches to 1 mile approx.) and blue prints obtained on kodatrace. Air survey compilation was carried out on the kodatrace blue prints again using the existing triangulation framework as control.

60. **Field Work.**—Fieldwork consisted of ground verification and contouring and was carried out by Trainees on 1-inch scale blue print reductions of the air survey compilations, Zinc-mounted blue prints were used.

Owing to the densely wooded nature of the ground, fieldwork had to be carried out almost entirely by plane-table traverse.

Reserved forest boundaries were not cleared at the time of survey and were, therefore, extremely difficult to locate on the ground. Up-to-date forest maps were obtained from the Forest Department Officials and the boundaries traced on the ground from these and surveyed with reference to adjacent detail.

61. **Description of Country.**—The whole area consisted of fairly hilly country covered by dense mixed forest in which bamboo predominates.

62. **Comments on Methods.**—The pre-1905 surveys were found to be of good quality and very few changes were found in detail as a result of the rigorous verification in the field. Most of the errors found on the ground were due to faulty identification on air photographs at the time of compilation.

VI. APPENDIX TO TECHNICAL NOTES

Training Syllabus for Class III Service, Topographical Trainees, Type 'B'

Grand total weeks	Total season weeks	Period weeks	Item
..	..	8	A (a) Preliminary lectures and drawing.
12	12	4	A (b) 1/1,000 scale plane-tableing.
26	26	14	A (c) 1/25,000 scale plane-tableing including all preparatory work, e.g. :—Mounting plane-table section, projection of graticule, projection of grid, plotting trig. points, completion of border items of section.

See also Note (i) below Item A (d).

..	31	5	A (d) Introduction to air survey—stereoscopic examination of air photographs. Indexing photographs. Interpretation of air photographs including identification on the photographs of selected points on the ground and vice versa. Correction of the 1/25,000 scale map produced in A (c) from the air photographs, i.e., improvement of shapes of streams, etc. All items in A (d) are done on photographs covering areas surveyed in A (c).
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Note :—(i) Depending on the date of commencement of the course, it may sometimes be climatically undesirable to carry out A (d) in the same area as A (c). In that case :—

(a) Air photographs of the area will be issued for item A (c) and some instructions in their interpretation and use given.

(b) The more thorough introduction to air survey will follow immediately after A (c) but will be carried out in the other seasonal area. If possible, the correction of the 1/25,000 scale maps, produced in A (c), from air photographs will be carried out using prints of existing 1/25,000 scale plane-table, carried out by previous trainees in that seasonal area.

(ii) On completion of item A (d) personnel will be classified as :—

Class A.G.—Potential air and ground surveyors and draftsmen.

„ *G.—Potential ground surveyors and draftsmen.*

„ *D.—Potential draftsmen only.*

(iii) Depending on the date of commencement of the course the first Winter/Summer season's work may end with completion of item A (c) or A (d).

*Training Syllabus for Class III Service, Topographical
Trainees, Type 'B'—(contd.)*

Grand total weeks	Total season weeks	Period weeks	Item	
43	12	12	B(e)	<p>Fair drawing, including stamp typing for all three classes. On completion :—</p> <p>(1) Weed out those not likely to make even Class D.</p> <p>(2) Personnel qualifying as Class D only are posted away from the training unit.</p>
52	21	9	B(f)	<p>Class A.G.—Air survey to stage of detail survey. Class G.—Theodolite traverse, rectangulation, large scale town surveys.</p> <p><i>Note :—</i>(i) Above, plus possibly item A(d), completes 1st Summer/Winter season's work.</p> <p>(ii) Further discards from Class A.G. to class G. are now made.</p>
69	17	17	C(g)	<p>1 inch to 1 mile plane-tableing :—Includes preparation for taking the field of 10 days to 2 weeks.</p> <p>Class A.G. finishes with 2 to 3 weeks post-pointing by 1 inch plane-table height fixation of points for height control of air survey and identification of points on air photographs. Some points are pre-pointed, i.e., air photographs not used but identification sketches of points made and points later identified on the photographs and checked on the ground.</p> <p>Class G. finishes with 2 to 3 weeks tertiary levelling.</p> <p><i>Note :—</i>Class G. are now either posted away from the training unit or employed for the remainder of the season on drawing or further 1 inch plane-tableing whichever is most required.</p>
72	20	3	C(h)	Class A.G.—Tertiary levelling.
74	22	2	C(i)	Class A.G.—Rectangulation.
78	26	4	C(j)	Class A.G.—Large scale town surveys.
				<i>Note :—</i> Above completes the 2nd Winter/Summer season's work.
104	26	26	D(k)	<p>Air survey including contouring and productive work for half the period (13 weeks). Oblique air survey (Indian Oblique method) taught to selected trainees only who have made rapid progress.</p> <p><i>Note :—</i>Above completes the 2nd Summer/Winter season's work and Class A.G. are now posted away from the training unit.</p>

PART II.—MAP PUBLICATION AND OFFICE WORK

TECHNICAL NOTES

DIRECTOR:—	{	Major Gambhir Singh, I.A., to 5-10-47.
		Lt.-Col. H. W. Wright, O.B.E., B.E., from 6-10-47
		to 5-2-48.
		Mr. D. N. Banerji, L.C.E., from 6-2-48 to 27-8-48
		and 16-9-48 to 30-9-48.
		Mr. T. M. C. Alexander, from 28-8-48 to 15-9-48.
		Major J. S. Paintal, B.I.E., from 1-10-48.
DEPUTY DIRECTOR:—	{	Major Gambhir Singh, I.A., to 1-11-47.
		Major R. A. Gardiner, M.B.E., M.A., B.E., from
		12-11-47 to 2-2-48.
		Mr. H. M. Critchell, from 3-2-48 to 2-7-48.
		Mr. D. N. Banerji, L.C.E., from 3-7-48 to 9-7-48.
		Mr. T. M. C. Alexander, from 10-7-48 to 31-10-48.
		Major J. S. Paintal, B.I.E., from 1-11-48.

VII. PRINTING AND REPRODUCTION OF MAPS

63. **General.**—The period under review has been uneventful in so far as the introduction of any major new technique is concerned. The chief activities on the reproduction side were

- (a) the reprinting of maps to build up our war depleted civil stocks, and
- (b) the printing of large size multi-colour posters for various Government Departments.

64. **Reproduction from Black Print Originals.**—The absence of fair drawn originals for many sheets, due to partition and other causes, has forced us in many cases to go back to Black Print Originals, often of bad quality. Negatives from such originals seldom have sufficient density to produce satisfactory printing plates. The following method of intensification was tried out and found satisfactory in dealing with poor quality Black Print Originals:—

A slightly under-exposed negative of the original (to ensure that smudges and dirty back ground do not come out) is first produced. This is varnished, to preserve the film, and then coated with the sensitising solution used in the Powder Process.

The negative is then given a short exposure from the *back*, which has the effect of making the solution 'tacky' more especially where the line work is. The negative is then dusted over with lamp black and a good contrasty effect obtained.

I N D E X M A P S

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, 1948-49.**