

GENERAL REPORT

ON THE

OPERATIONS

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1906-07

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E.

SURVEYOR GENERAL OF INDIA



CALCUTTA

GOVERNMENT PRINTING, INDIA

1908

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GENERAL REPORT
SURVEY OF INDIA
1906-07

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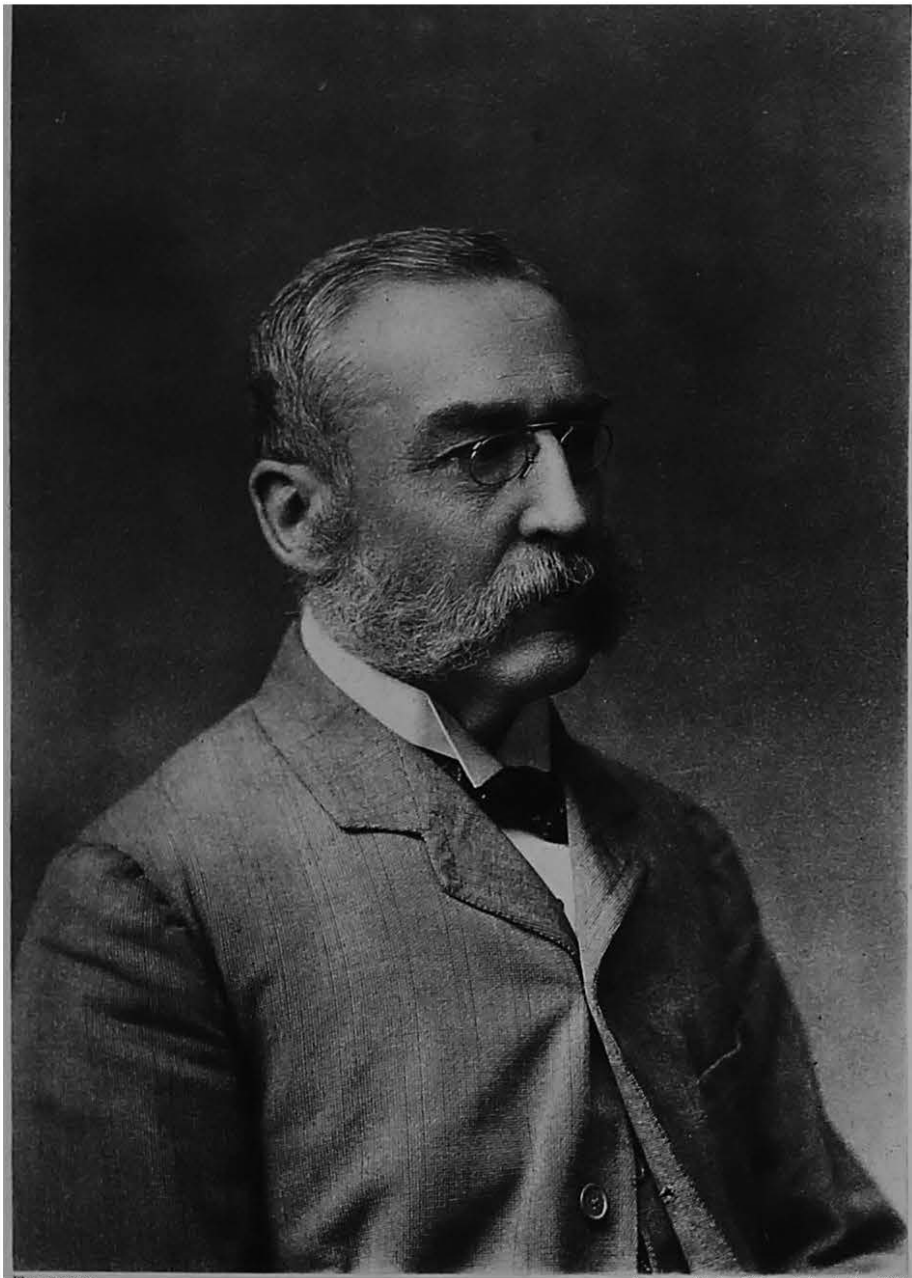
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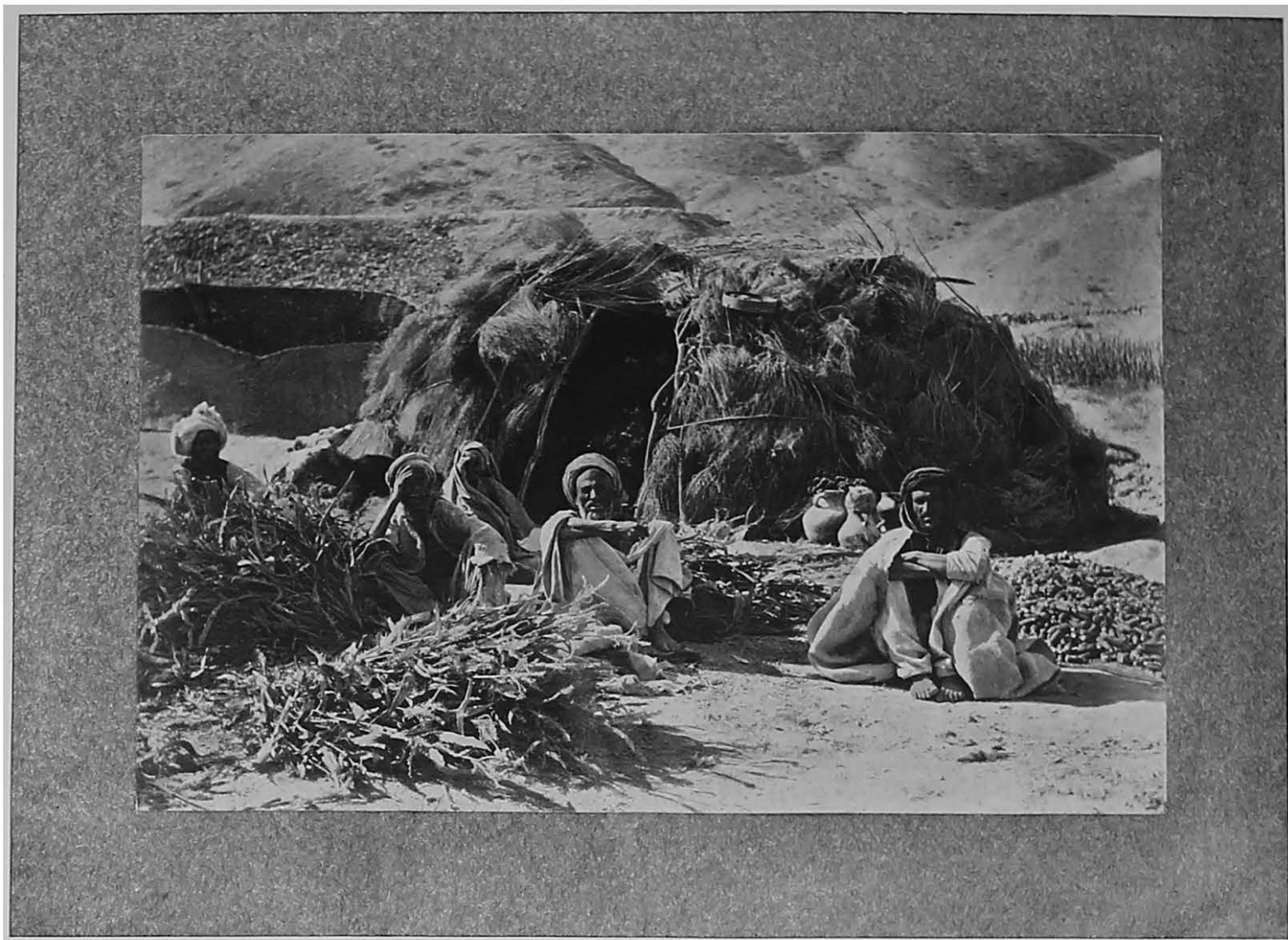
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MAJOR-GENERAL JAMES WATERHOUSE, I.A.

ASSISTANT SURVEYOR-GENERAL.

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GROUP OUTSIDE A "SUMMER HUT" ON THE TOBA - CHAMAN.

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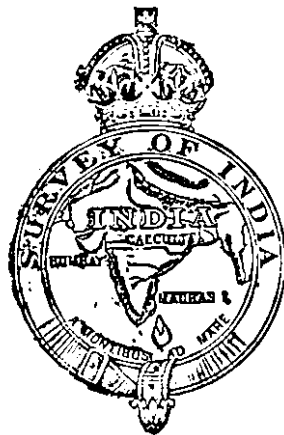
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CALCUTTA

SUPERINTENDENT GOVERNMENT PRINTING, INDIA

1908

CONTENTS.

PART I.

SUMMARY.

	PAGE
Administration	1
Field Parties, Distribution of	4
Trigonometrical and Scientific Operations	6
Topographical Surveys	6
Forest Surveys	8
Cadastral and Traverse Surveys	9
Results	9
Head-quarters Offices	10
Branch Offices	17
Local Drawing Offices	19
Establishment	20
Expenditure	21

PART II.

THE OPERATIONS OF FIELD PARTIES.

PARTY.	TRIGONOMETRICAL SURVEYS.	PAGE
24. Triangulation		23
	SCIENTIFIC OPERATIONS.	
22. Astronomical		24
23. Pendulums		25
25. Tidal and Levelling		28
26. Magnetic		32
	TOPOGRAPHICAL SURVEYS.	
1. Central and United Provinces and Central India States		37
2. Berar		39
3. Burma		41
9. Northern Circle		50
10. Upper Burma		42
11. Shan States, Burma		44
12. Northern Circle		51
14. Ditto		51
17. Bombay		39
18. Northern Circle		52
19. Madras		45
20. Burma and Assam		47
Training, Northern Circle		54
	CADASTRAL AND TRAVERSE SURVEYS.	
4, 5 and 6. Bengal		56
7. Burma		60
	CANTONMENT SURVEYS.	
Sections 1, 2 and 3. India		62
	TABULAR STATEMENTS.	
Outturn of work of Field Parties		65
Cost-rates		67

CONTENTS.

APPENDIX.

	PAGE.
Memorandum by Lieutenant-Colonel Gordon on Forest Surveys	6

ILLUSTRATIONS.

Portrait of Major General J. Waterhouse (late I. S. C.) formerly in charge of the Photo-Litho Office of the Department.	Frontispiece
An Afghan Mana (Summer hut)	”

MAPS.

	TO PAGE PAGE
1. Index chart to the Great Trigonometrical Survey	1
2. ” shewing the progress of Imperial Surveys	1
3. Specimen of a one-inch Standard Sheet	22
4. Index to the Sheets of the India and Adjacent Countries	22
5. ” ” Indian Atlas Sheets published up to 1st October 1907	22
6. Three Index maps shewing the progress of Publication	22
7. ” ” ” ” ” ” of Surveys	67
8. Index shewing progress of Forest Surveys	67
9. ” ” ” of Magnetic Surveys.	67
10. ” ” ” of Cadastral Surveys in Burma	67

GENERAL REPORT
ON THE
Operations of the Survey of India

DURING THE SURVEY YEAR

1906-1907.

PART I.
SUMMARY.

ADMINISTRATION.

1. This report deals with the operations of the department for the year ending the 30th September 1907.

Colonel F. B. Longe, R.E., administered the department throughout the year.

Colonel G. B. Hodgson, I.A., continued to hold his appointment of Deputy Surveyor General; Colonel S. G. Burrard, F.R.S., R.E., Superintendent, Trigonometrical Surveys, remained in charge of that branch until he proceeded on combined leave on the 19th March when Mr. J. Eccles, M.A., was appointed to officiate for him.

Lieutenant-Colonel P. J. Gordon, I.A., on the abolition of his appointment of Superintendent, Forest Surveys, in October, was nominated Superintendent in charge of Burma Surveys; Major C. H. D. Ryder, D.S.O., R.E., continued to hold the appointment of Superintendent, Northern Circle, throughout the year.

Major R. T. Crichton, I.A., was Superintendent, Provincial Surveys, Bengal, until 28th March when he proceeded on combined leave and was succeeded by Captain F. C. Hirst, I.A.

2. The publication of last year's report was delayed owing to discussions regarding the classification of maps, and it was only published in December 1907.

3. A scheme has been submitted to the Government of India for the re-organisation of the Photo-Lithographic offices and all the offices connected with mapping, map printing and issue have been combined under the superintendence of Major Hedley, R.E., with Major J. M. Burn, R.E., and Major Coldstream, R.E., in charge of the Drawing-Engraving and Photo-Lithographic offices, respectively.

The Punjab parties were all concentrated at Mussooree during the summer recess and those of the Burma Circle at Bangalore.

4. Beyond this no further progress was made in the re-organisation of the department as the final scheme is still under discussion.

5. Further discussions regarding the symbols to be used for different classes of roads and the insertion of boundaries have seriously hampered the preparation of the standard sheets and general maps of India and the 32-mile map of India and adjacent countries is still unpublished, but everything is practically now settled on these points and the large number of maps which have accumulated will be printed off during the coming year.

6. Slight modifications have been made in the footnotes and tables of symbols on maps on the 1-mile scale and a specimen in what is hoped will be the accepted style is attached to this report.

7. The scale on which the field surveys should be executed and the larger scale standard maps published was under discussion towards the end of the

year, this point having been raised by the Army Council and it has been decided that the general scale of survey shall be 1 inch = 1 mile, but that reserved forests and special areas shall be surveyed on the scale of 2 inches = 1 mile if required and that even the scale of 1 inch = 2 miles shall be employed for desert tracts and in sparsely populated hill country. It is probable, however, that such tracts will be avoided until the more important areas have been completed and a better estimate can be formed of their probable importance in the future. It would seem a doubtful policy to survey any areas now on a scale which is not nearly certain to fulfil all practical requirements for the next 20 years.

It has further been decided that the general scale of publication for this series shall be 1 inch = 1 mile.

8. Last year the progress of topographical work was shown for each party by means of $\frac{1}{\text{million}}$ sheet index maps. These proved likely to become too numerous owing to the scattered nature of the work and to be unnecessarily cumbersome; in this year's report 3 index maps have been substituted covering the whole of India, Assam and Burma which show the progress irrespective of parties, a reference after the name of the party showing the index on which its progress will be found. Similar index maps are published to show the progress of publication. These latter show by different colours the maps which have been published in previous years from surveys made prior to 1880, those published from surveys made between 1881 and 1904 and those published from later surveys; they also show in the same manner those published during the year for each of the 3 classes, and it is hoped these will prove satisfactory.

9. The department has been materially increased during the last few years in Imperial and Provincial officers, and the class of work has improved owing to their supervision and the time they have been able to devote to instructing the field surveyors and draftsmen; and this is especially noticeable in the vast improvement in drawing over that of later years. The present aim is to have efficient supervision and an improved class of workman, and, if anything, to reduce the number of surveyors for a given area, but to increase the outturn by employing only really efficient men. The pay of surveyors has always been small and in many instances quite out of proportion to the expenses they put the department to owing to their camp followers and frequent incapacity, but with increased supervision and consequently powers of instruction the bad men will be weeded out and the competent men will be capable of turning out a much larger area than before.

10. Major General J. Waterhouse, late I. S. C., whose portrait is given as the frontispiece of this volume, served for 31 years in this department, and for almost the whole of this time he was in charge of the map printing offices. At a time when the style of our maps and methods of map publication are being changed, it may not be considered out of place to record in this manner the valuable services of this distinguished officer, of whom Major-General Strahan (then Surveyor General) says in the General Report for 1896-97: "The immense development and the great success of the various methods of reproducing maps and half-tone subjects now in use are entirely due to Colonel Waterhouse and his retirement is a serious loss to the department." Since his retirement in 1897 General Waterhouse has maintained his deep interest in the welfare of the department, and has frequently given it the benefit of his wide experience and great technical knowledge. He has selected for it specialists in the various photo-lithographic trades in a way that no other officer could have done, for he alone knew the particulars and details of the work to be executed in this country, and in 1904 he wrote a valuable description of the United States survey methods for the use of the Survey of India at the request of the Secretary of State for India. This report was published in 1906 by order of the Government of India. The portrait will interest the younger and future members of the department, and recall to those who served with him the invariable kindness and courtesy they experienced at his hands.

Inspection Tours of Administrative Officers.

11. Colonel F. B. Longe, R.E., Surveyor General, inspected the office of No. 18 Party at Simla on the 9th October 1906, and during his return from

Simla in the beginning of November he visited Agra, Gwalior and Cawnpore, arriving at Calcutta on the 10th November. On the 1st February he left for Burma where after discussing the future conduct of survey operations in that province with the local government he inspected the field work of No. 10 Party. From Burma he proceeded *via* Colombo to Bangalore where he inspected the office of the Superintendent in charge of Burma Surveys and the Bangalore Drawing office, and also visited the head-quarters office of No. 19 Party. From there he proceeded to Satara with the object of testing its suitability as a circle head-quarters. Thence he went to Nasik with a view to investigate the suitability of the place for the head-quarters offices of the department, and returned to Calcutta on the 26th March. On the 5th April he left Calcutta and arrived at Simla on the 7th idem. On the 1st July he proceeded to Dehra and Mussooree. He returned to Simla on the 20th July.

At Mussooree he presided over the conference of the administrative officers, at which the main points that were discussed and settled were the method of depicting the various topographical items on the new one-inch standard sheet series, the symbols to be used on them, the thickening of contours at certain intervals and the insertion of contour values in the body and margins of the maps. Then came the rules for the guidance of surveyors in the field, and lastly, the orders regarding the drawing of the fair sheets in recess, their examination, and the responsibilities of the various officers concerned in their preparation. On all these points tentative orders have been already issued in the form of Circular Orders (Professional) or Circular Memoranda, but experience showed that these orders were not all practicable, and that some of them required considerable modification. In order to ensure uniformity and to prevent confusion, a small pamphlet has been prepared embodying all the conclusions arrived at, and this is intended to supersede all previous instructions on the points touched on and will be strictly adhered to in future. One of the main changes is that the officer in charge of the party will be held responsible for the completeness and accuracy of his maps when they are submitted for publication, and he will have no opportunity of applying corrections to them in proof form. The printing office will be responsible for their correct reproduction.

The next point discussed was the present system by which each topographical party did its own triangulation and traversing, and whether it would not be better to hand over all such work to the Trigonometrical branch. The conclusion arrived at practically unanimously was, that the present system was unsatisfactory mainly because the work was often conducted on unscientific principles, and generally with the sole object of providing points for the plane-table surveyors, that it interfered seriously with the topographical outturn, and being performed under so many different executive and administrative officers it was never harmonised, and when the work of two parties met it was frequently found that there were discrepancies in heights and other details which would have been avoided had the work been carried out systematically under one administrative officer and by thoroughly trained assistants. It was therefore decided that though the present system must continue temporarily, a scheme should be drawn up to strengthen the Trigonometrical at the expense of the Topographical branch and to form a triangulation and levelling party for each circle, of sufficient strength to carry out all the necessary triangulation on far more rigorous methods, and in place of the present tertiary triangulation to substitute plane-table triangulation, by which means all the necessary supplementary points would be provided for the topographical surveyor, much in the same way as the framework of surveys is prepared in America. This scheme will be worked out, if possible, during the cold weather.

This proposed change of system will not necessitate any increase of establishment, but it will give a vastly greater importance to the Trigonometrical branch, and in every way tend to efficiency and raise the standard of our work.

The next point discussed was the question of charts, and it was decided that intersected points, other than those fixed by the Trigonometrical branch, should not be shewn, as such points are not marked on the ground and are merely fixed to assist the topographical surveyor. They crowd the charts and necessitate these being prepared on unnecessarily large scales, and will not be required under the new system when it is introduced.

12. Brevet-Colonel G. B. Hodgson, Deputy Surveyor General, inspected No. 1 Party in the field and again in recess at Mussooree, where he also attended the conference of administrative officers. On the way to Mussooree from Calcutta he inspected Cantonment Section No. 1 at Shahjahánpur and tested the survey of that cantonment. Proceeding to Poona from Mussooree he inspected the offices of Nos. 2 and 17 Parties there and of Cantonment Section No. 2. He visited the Bengal Drawing Office at Calcutta frequently and practically superintended the standard mapping and drawing of traverse charts in this office. He has not inspected the Naini Tal Drawing Office during the season, but visited it in September 1906 and again in October 1907.

13. Mr. J. Eccles, M.A., Officiating Superintendent, Trigonometrical Surveys, visited Mussooree in June and September 1907 and inspected the recess offices of Nos. 22, 23, 24 and 26 Parties. He also inspected at Dehra Dún in September 1907 the offices of the Superintendent, Forest Surveys, No. 25 Party (T and L), and also the Survey Training School during the year from time to time.

14. Immediately after making over charge of the Forest Survey branch, Lieutenant-Colonel Gordon proceeded to Simla to discuss details connected with his new charge with the Surveyor General, after which he went to Bangalore and formed an office. On the 4th of January 1907 he went to Assam and inspected the traverse and triangulation sections of No. 20 Party which were working in the Sylhet district; he then met the Chief Secretary of the Government of Eastern Bengal and Assam and discussed the future programme of topographical surveys in that province. He then proceeded to Burma where he inspected Nos. 7, 10 and 20 Parties in the field and conferred with the Financial Commissioner, the Director of Land Records, and the Chief Conservator of Forests regarding revenue and forest surveys, and was also present at a meeting between the Lieutenant-Governor of Burma and the Surveyor General, at which future survey operations in that province were discussed.

He returned to Bangalore on the 26th of February and in July attended the conference of the administrative officers of the department at Dehra Dún and Mussooree. During the recess he frequently visited the offices of his parties with the view of securing uniformity in the style of mapping.

15. Major C. H. D. Ryder, D.S.O., R.E., Superintendent, Northern Circle, left Mussooree for Dehra Dún on the 4th October 1906, where he went into the organization of the Training party. He returned to Mussooree on the 8th idem. In the beginning of November his head-quarters office was moved to Chandbagh, Dehra Dún; he left Dehra Dún for Pesháwar on the 14th idem, his head-quarters office following him within a month. On the 29th April he proceeded to Simla to confer with the Surveyor General of India, and he returned to his head-quarters at Mussooree on the 4th May 1907.

16. Major R. T. Crichton, Superintendent, Provincial Surveys, Bengal, during the field season inspected each section working under him, at least once; from July 1st to August 13th Captain F. C. Hirst toured in Bengal and Eastern Bengal visiting each section; the latter also reported on the cadastral work done during the year by the Settlement Officers of Chota Nagpur, Faridpur and Jalpaiguri.

DISTRIBUTION OF FIELD PARTIES.

17. Field operations were carried out by 22 parties and 4 sections or detachments. Of the parties, 13 were employed on topographical surveys, 1 on principal triangulation, 4 on purely scientific operations, 2 on traverse surveys for cadastral purposes, 1 on traverse and cadastral surveys, and 1 on traverse and topographical surveys. The sections and detachments were employed on cantonment and town surveys. The following table shows the distribution according to the nature of the work on which the parties were employed:—

No. of Party.	Nature and <i>locality</i> of operations.	Page in this Report.	Executive Officers.	Scale.	Administrative Superintendent.
24	TRIGONOMETRICAL. India	23	Captain C. M. Browne, D.S. O., R.E.	...	S. T. S.

SUMMARY.

5

No. of Party.	Nature and <i>locale</i> of operations.	Page in this Report.	Executive Officers.	Scale.	Administrative Superintendent.
SCIENTIFIC.					
22	India (Latitudes) . . .	24	Captain H. M. Cowie, R.E. . . .	...	S. T. S.
23	" (Pendulums) . . .	25	Major G. P. Lenox Conyngham, R.E. . . .	...	"
25	" (Tidal & Levelling) . . .	28	Mr. C. F. Erskine . . . . .	...	"
26	" (Magnetic)	32	Captain R. H. Thomas, R.E. . . .	...	"
TOPOGRAPHICAL.					
1	Central Provinces	37	{ Major A. H. B. Hume, R.E. . . . Lieutenant K. W. Pye, R.E. . . . Lieutenant M. N. MacLeod, R.E. . . . }	2"=1 M. }	D. S. G.
2	Berar	39	{ Captain H. Wood, R.E. Mr. C. J. Veale }	2"=1 M. }	"
17	Bombay Presidency	39	{ Mr. B. G. Gilbert-Cooper " S. F. Norman }	4"=1 M. } 2"=1 M. }	"
3	Lower Burma	41	{ Mr. E. F. Litchfield Captain C. P. Gunter, R.E. . . . }	1"=1 M. }	Sup., Burma Surveys.
10	Upper Burma	42	Captain A. A. McHarg, R.E. . . .	{ 1"=1 M. } 2"=1 M. }	"
11	Shan States	44	{ Captain R. H. Phillimore, R.E. . . . Lieutenant L. G. Crosthwait, I.A. . . }	1½"=1 M. }	"
19	Madras Presidency	45	{ Lieutenant-Colonel W. J. Bythell, R.E. . . . Captain F. F. Hunter, I.A. . . . Mr. G. T. Hall }	1"=1 M. } 2"=1 M. } 4"=1 M. }	"
20	Burma and Assam	47	{ Major A. Mears, I.A. Major C. W. H. Symonds, I.A. . . . Mr. P. F. Prunty }	2"=1 M. } 4"=1 M. }	"
9	Northern Circle	50	{ Major F. W. Pirrie, I.A. Lieutenant S. W. S. Hamilton, R.E. . . . Lieutenant K. C. Baker, R.E. . . . }	2"=1 M. } 4"=1 M. }	Sup., Northern Circle.
12	"	51	{ Captain E. T. Rich, R.E. Lieutenant S. W. S. Hamilton, R.E. . . . }	2"=1 M. }	"
14	"	51	Captain H. L. Crosthwait, R.E. . . .	2"=1 M. .	"
18	"	52	Captain E. A. Tandy, R.E.	2"=1 M. .	"
Training	"	54	Mr. G. P. Tate	2"=1 M. .	"
CADASTRAL & TRAVERSE.					
4	Bihár	56	{ Captain F. C. Hirst, I.A. Mr. N. Bedford }	16"=1 M. }	S. P. S., Bengal.
5	Chota Nagpur	57	Mr. C. S. Kraal	16"=1 M. .	"
6	Eastern Bengal	57	" A. W. Smart	Various	"
Det.	Calcutta	58	" R. B. Smart	105'6"=1 M. .	"
7	Burma	60	" O.D. Smart	16"=1 M. .	Sup., Burma Surveys.
CANTONMENT SURVEYS.					
Section No. 1.	Meerut and Lucknow Divisions.	62	{ Mr. J. McHatton " F. S. Bell }	16"=1 M. } 64"=1 M. }	D. S. G.
2	Poona and Mhow Divisions.	63	Mr. L. J. Pocock	{ 16"=1 M. } 64"=1 M. }	"
3	Secunderabad Division	63	" E. G. Little	{ 12"=1 M. } 16"=1 M. } 48"=1 M. } 64"=1 M. }	"

TRIGONOMETRICAL SURVEYS.

18. The Triangulation party (No. 24) continued the series of principal triangulation trending westwards from Kalát, called the Kalát Longitudinal series. The length completed was 150 miles. Fifteen triangles were completed covering an area of 3,390 square miles, and the average triangular error was $0''\cdot41$.

SPECIAL OPERATIONS.

19. Major G. P. Lenox Conyngham, R.E., and Captain H. M. Cowie, R.E., were employed in the continuation of the gravimetric survey. Captain Cowie took observations to determine the deflection of the plumb line at 11 stations in Káthiáwár and round the Gulf of Cambay. The values obtained were in accordance with the general character of the deflections in Rajputana.

20. To determine the variation in the value of gravity Major Lenox Conyngham took pendulum observations at 12 stations in the neighbourhood of the Himalayas and of the Siwálíks, and on or near the Great Arc. The general character of the variations found was in accordance with expectation, but local anomalies of considerable amount were also disclosed. Two of Basevi's stations were included in the programme.

21. The result of Professor Dr. Hecker's observations at Jalpaiguri in 1905 have been received and found to agree perfectly with those of Major Lenox Conyngham.

22. Tidal operations were continued by No. 25 Party, observations being recorded at eight stations.

The observatory at Karachi was carried away on the 6th June by a cyclone.

23. Levelling operations were carried on in the Punjab, the United Provinces and the Presidencies of Madras and Bombay. The American "Binocular" levels were used for the first time and were found to be a great improvement.

24. Four detachments of the Magnetic party extended the survey into Burma and Assam. Vertical force magnetographs were erected at all the base-stations, and the dip circles were replaced by earth inductors.

25. The systematic observations to Himalayan peaks in connection with the difficult problem of refraction were continued. The results are of great interest, but many more are required before definite conclusions can be drawn.

26. The following statement shows the cost of the more purely scientific work of the department for the year under report:—

		₹
No. 22 Party,	Astronomical	21,624
" 23 "	Pendulums	30,520
" 24 "	Triangulation	74,768
" 25 "	Tidal and Levelling—	₹
	Tidal observations	14,873
	Preparation of Tidal Tables	26,732
	Levelling operations	42,903
		<hr style="width: 100%;"/>
		84,508
" 26 "	Magnetic—	
	Magnetic observations	11,185
	Magnetic field work	67,394
		<hr style="width: 100%;"/>
		78,579
		<hr style="width: 100%;"/>
	TOTAL	2,89,999

27. Surveyor Lachman Jadu, R.S., accompanied the boundary commission which was employed on the erection of pillars on the Burma-China boundary between Panghsang Nalawt and the Mè-hkong river. Few opportunities presented themselves for adding further details to the existing maps, but the adjacent portion of the Southern Shan States will be topographically surveyed by No. 11 Party in 1908-09.

TOPOGRAPHICAL SURVEYS.

28. *Central and United Provinces and Central India States.*—No. 1 Party carried out a supplementary survey on the 2-inch scale of 838 square miles of country previously surveyed on the 16-inch scale by local agency in the Central and United Provinces and a re-survey on the same scale of 664 square miles of

portions of the adjoining native states of Central India. The survey of 135 square miles of forests was revised and also the contouring of 297 square miles of former season's work which had been based on old and inaccurate trigonometrical heights. The result of the season's work is that the maps of 1,934 square miles have been brought up to date. No triangulation was done, but 816 linear miles of theodolite traverses were run to provide extra points and heights.

29. *Berar, Central Provinces.*—An area of 1,680 square miles was triangulated and 1,296 square miles were surveyed on the 2-inch scale by No. 2 Party, in connection with the training of young officers of the Provincial service. The boundaries of all A and B forests that fell into the area under survey were surveyed on the 4-inch scale for the Forest Department.

30. *Bombay Presidency.*—No. 17 Party, which had been hitherto employed exclusively on forest surveys, commenced general topographical survey this season on the 2-inch scale in the West Khandesh district and adjoining native states and re-surveyed 348 square miles previously surveyed on the 1-inch scale, and revised the survey of 2,292 square miles. An area of 2,155 square miles was triangulated in advance and 62 square miles of forests and 140 linear miles of forest boundaries were surveyed on the 4-inch scale for the Forest Department.

31. *Eastern Bengal and Assam.*—An advance section of No. 20 Party traversed and triangulated over 4,000 square miles in degree sheet 78 P in anticipation of the detail survey, which will be commenced in 1907-08 on the 2-inch scale.

32. *Burma.*—Nos. 3, 10, 11 and 20 Parties were employed on topographical surveys in Burma and surveyed 8,713 square miles, of which 5,339, including revision and supplementary work, were on the 1-inch, 1,612 on the $1\frac{1}{2}$ -inch, 1,711 on the 2-inch, and 51 on the 4-inch scales.

33. *Madras Presidency.*—No. 19 Party commenced topographical survey operations and surveyed 1,515 square miles on the 2-inch scale in Malabar and revised 45 square miles on the 1-inch in Mysore. 374 square miles of forest were also surveyed on the 4-inch scale in Ganjam and Coimbatore.

34. *Northern Circle.*—No. 12 Party in the Pesháwar valley triangulated 4,730 square miles and surveyed on the 2-inch scale 1,230 square miles.

No. 14 Party in the Kohát district triangulated 4,495 square miles and surveyed on the 2-inch scale 1,547 square miles.

No. 18 Party in the Bannu and Dera Ismail Khan districts triangulated 1,240 square miles, and surveyed on the 2-inch scale 1,801 square miles. 1,009 linear miles were traversed in the above districts and 626 linear miles in the Jhelum colony. In the Bári Doáb 195 bases for revenue surveys covering an area of 1,123 square miles were laid, and this area was traversed throughout.

No. 9 Party in the Dera Gházi Khan district triangulated 1,897 square miles and surveyed 258 square miles on the 2-inch scale and revised 258 square miles on the 4-inch scale.

The Training party in the Jhelum district triangulated 1,059 square miles and surveyed on the 2-inch scale 322 square miles.

The total area triangulated was 18,964 square miles and the area surveyed 7,519 square miles.

The cost-rates per square mile omitting the Training party are Rs. 9-10-0 for triangulation and Rs. 44-10-0 for the detail survey. As the parties work southwards the outturn will increase and the cost-rates diminish.

All the parties recessed at Mussooree, except the Training party which was at Dehra Dún. All the parties in this circle recessing in or near Mussooree under the eye of the Circle Superintendent proved most successful and resulted in a more uniform and improved style of drawing. The want of an office, common to all parties, was however much felt, their offices being unavoidably scattered over Mussooree in bungalows rented at a heavy expense, and often very unsuitable as drawing offices.

During the winter 1907-08 a large drawing establishment will be employed at Dehra Dún to cope with the arrears of drawing.

35. *Bengal.*—The survey of a block of hills lying to the south of Monghyr was commenced, but little progress was made since it was decided during the field season to cadastrally survey this area, and most of the surveyors employed on it had to be used for traverse work preparatory for the cadastral survey.

36. *Eastern Bengal.*—The survey of the Sunderbans tract in the Khulna and 24-Parganas districts was continued; an area of 1,591 square miles was traversed and surveyed in detail on the 4-inch and 2-inch scales. The balance of the Sunderbans tract (about 1,050 square miles) will be completed during the next survey year.

37. The outturn of topographical surveys on all scales is as follows:—

	Square miles.
Central and United Provinces and Central India	1,934
Berar	1,296
Bombay	2,702
Bengal	1,642
Burma	8,713
Madras	1,934
Northern Circle	7,519
TOTAL	<u>25,740</u>

FOREST SURVEYS.

38. The Inspector General of Forests having agreed to a reduction in the standard scale of forest surveys from 4 inches to 2 inches to the mile, the Government of India have decided that in future all reserved forests shall, as a general rule, be surveyed on the latter scale in the course of the general programme of the Survey of India, no charge being made to the Forest Department. In cases where surveys on a larger scale are required or when surveys on the 2-inch scale are wanted apart from the regular programme of the Survey of India, the whole cost will be debitable to the Forest Department. Boundaries of forest surveyed on the 2-inch scale will be surveyed on the 4-inch scale, if required, free of charge. In consequence of this decision Nos. 9, 17, 19 and 20 Parties, which have hitherto been exclusively employed on forest surveys, have now become topographical parties.

39. *Burma.*—No. 20 Party completed the survey of the Mepalè reserves in Thaugyin surveying an area of 51 square miles under the old conditions. It also surveyed 500 linear miles of forest boundary in Minbu, and, in the course of its regular programme, surveyed topographically 474 square miles of forests in the Pakkoku district (Yaw Forest Division). As 4-inch boundary surveys of these reserves were not required they were not carried out.

No. 10 Party in the course of its regular programme surveyed 148 square miles of forests in the Shwebo district (Katha Forest Division) on the 2-inch scale without a special boundary survey, as this was not required by the Forest Department.

There was a small area of forest in the Salween district included in the programme of No. 3 Party, but as its survey on the 2-inch scale would have prevented the completion of degree sheet 94 F on the 1-inch scale, the work was postponed and will be carried out in connection with the survey of the adjoining sheet.

40. The maps of the 4-inch surveys have been prepared in the Forest Survey office at Dehra Dún and published. The 4-inch boundary surveys will also be dealt with in that office. A special edition of the sheets in which forests surveyed on the 2-inch scale occur will be published on that scale for the use of the Forest Department.

41. The cost-rates of forest surveys cannot be satisfactorily compared with those of former years as the conditions were altogether different; the parties formerly engaged on forest surveys were employed principally on regular topographical surveys and the 4-inch forest surveys were only of small outlying areas carried out to complete forest blocks already commenced on that scale.

42. *Madras Presidency.*—No. 19 Party surveyed 340 square miles of reserved forest on the 4-inch scale in the Ganjam district and 34 square miles on the same scale in Coimbatore under the old conditions. 311 linear miles of forest boundary were also traversed by theodolite in Ganjam, Malabar and Trichinopoly.

43. The areas surveyed have been included in those given for topographical surveys.

CADASTRAL AND TRAVERSE SURVEYS.

44. Two cadastral parties were employed, one in Bengal (Bihár) and one in Burma. Two parties were employed on the traversing of areas in Bengal and Eastern Bengal and Assam which will be cadastrally surveyed by the Settlement Department. Record-writing over 1,845 square miles in Bihár was also carried out.

45. In Burma 509 square miles were cadastrally surveyed in the Pakòkku district completing the revenue survey of that district and 47 square miles in the Lower Chindwin and Thayetmyo districts. Six hundred and ninety-one square miles were also traversed in the latter district. Owing to the physical nature of the country the cadastral survey in the Pyapôn district was carried out *pari passu* with the traverse survey, 171 square miles being traversed and 131 square miles (including 6 of water area) cadastrally surveyed on the 16-inch scale.

46. The Government of Burma having decided that all extensive areas at present ripe for revenue surveys will have been dealt with when the programme for 1907-08, consisting of 856 square miles in Thayetmyo, Pyapôn, Pegu and Yamethin districts, is completed, the party will be broken up and all future revenue operations in the province will devolve on the local Land Records Department.

47. Copies of a preliminary edition of the maps of the added area of Rangoon town have been made over to the Revenue and Municipal authorities.

48. The total area traversed and surveyed cadastrally during the year is as follows:—

Province.	Traversing.	Cadastral Survey.
Bengal	6,309(a)	1,683
Eastern Bengal	1,022(b)	Nil.
Burma	862	687
TOTAL	8,193	2,370

(a) Includes 25 square miles of miscellaneous surveys.

(b) Includes 4 square miles of miscellaneous work.

CANTONMENT SURVEYS.

49. The survey of cantonments was continued by 3 small parties in the Meerut, Lucknow, Poona, Mhow and Secunderabad Divisions. The survey of 28 cantonments was completed during the season and of 3 almost completed. Of these 44,800 acres were surveyed on the 12 and 16-inch scales and 1,660 acres on the 48 and 64-inch scales. All the cantonments in the Secunderabad Division have now been completed and one of the parties has been broken up. In addition to the above outturn, most of the cantonments that were surveyed last year were contoured during the current season.

RESULTS.

50. The total outturn of detail topographical and forest surveys on all scales is 25,740* square miles against 23,312 square miles of similar surveys during the previous year. No surveys on a smaller scale than 1 inch = 1 mile were carried out during the year; the total area triangulated and traversed for topographical or forest surveys is 31,851 and 1,684 square miles respectively against 27,134 square miles for the previous year. The increase in the outturn of topographical survey and triangulation is mainly due to the reduction in the scale of forest surveys from 4 inches to 2 inches = 1 mile.

The total area of cadastral surveys is 2,370 square miles and of the area traversed for this purpose is 8,193 square miles against 2,982 and 6,464 square miles respectively for the previous year.

The total actual area surveyed is so dependent on the scales of survey, the distances which the field parties have to cover to reach their work from their head-quarters and the nature of the country dealt with in any one

year that it is difficult to estimate the increasing efficiency of the department, but there has been a very material improvement in the class of the work performed and in the resulting maps. The scale on which the surveys have been mainly carried out this year is new to many of the surveyors who were for the most part trained to work on the 4-inch or 1-inch scales. Those previously working on the 4-inch scale strove to show on the 2-inch all the details they had previously shown in the larger scale, and those who had worked on the 1-inch scale were distressed at the additional details they found they could show on the 2-inch scale. It has altogether been a trying year for the surveyor, but it has not been wanting in instruction, and though the scale of survey is now to be reduced again to 1 inch = 1 mile for general purposes, the experience gained will be beneficial and a far larger area of first class work in the coming and in future years is anticipated. The improvement in outturn can only be gradual.

HEAD-QUARTERS OFFICES, CALCUTTA.

51. The general superintendence of these offices continued under Colonel F. B. Longe, R.E., Surveyor General. The Surveyor General's and the Mathematical Instrument Offices were in charge of Brevet-Colonel T. F. B. Renny-Tailyour, R.E., up to 10th April and thereafter under Lieutenant-Colonel J. M. Fleming, I.A.; the Drawing, Engraving and Map Record and Issue Offices were under Lieutenant-Colonel J. M. Fleming up to 10th April and afterwards under Captain W. M. Coldstream, R.E. The Photo-Litho Office was under Lieutenant-Colonel Bythell till 10th November, when he was relieved by Major W. C. Hedley, R.E. After the re-arrangement of work of the Photo-Litho Office Major Hedley was placed in charge of the Drawing and Reproducing Offices and under him were placed two officers, Major J. M. Burn, R.E., and Captain W. M. Coldstream, R.E., to supervise the work of the Drawing, Engraving and Map Record and Issue Offices and the Photo-Litho Office, respectively.

52. *Drawing Office.*—The appointment of the expert such as Major Hedley to the combined charge of the Drawing and Photo-Litho Offices which was effected during the year under report is already having beneficial effect, in that all maps now sent to the Printing Office are as complete as they can be, for fewer proofs are required and the number of corrections to be carried out on plates has been most materially reduced. His appointment has also enabled the officer in charge of the Drawing Office to devote far more time to the actual supervision of the mapping, owing to his being relieved of the mass of the correspondence which is now dealt with by the Superintendent himself.

53. The most important work before the Drawing Office should be the compilation of the $\frac{1}{\text{million}}$ sheets, the 32-mile and the smaller scale maps of India, and every endeavour is now being made to put the best available draftsmen on this work. In the past time, these men have been far too much occupied in examining and correcting drawings (which have been sent in an incomplete state either by field parties or by other departments) before despatching them to the Photo Office for publication. It is hoped that in future but few maps will have to be treated in this way and that the mass will go straight to the Photo-Litho Office with the orders of the Superintendent of the Map Publication.

54. A table showing the maps that have been dealt with during the year and the number of maps that have been published is appended. From this it will be seen that the number of publications is very small as compared to the work in hand. This is largely due to the fact that the symbols and mode of showing details on the standard sheets was under discussion throughout the greater part of the year, and also to the fact that most of the maps received from outside were incomplete in some form or other. The symbols have now been decided on and publication should proceed more rapidly in future.

55. Owing to the receipt of fresh orders regarding the colouring of the small scale maps of India from the Secretary of State, the publication of these maps is still in abeyance, but the 32-mile map of India will be published very shortly.

56. Owing to the demand for 1-inch maps it has been found necessary to continue the compilation of standard sheets on that scale from old surveys in order to avoid having to reprint such maps in several sections but the actual work on these maps has been cut down as far as possible, and it is estimated that in two years' time the stock of all standard sheets for which there is any demand will have been replenished.

Statement of work in hand and completed during 1906-07.

Class of Map.	Scale.	Total number of sheets in hand during 1906-07.	Number of sheets published.
General Map of India	$\frac{1}{32}$ to $\frac{1}{128}$	34	6
India and adjacent countries	$\frac{1}{M}$	18	4
Provincial Maps	various	23	...
District Maps	1, $\frac{1}{2}$ & $\frac{1}{4}$	43	11
Standard Sheets	various	951	381
Degree Sheets	$\frac{1}{2}$	4	4
Administration Report Maps	$\frac{1}{2}$ & $1\frac{1}{2}$	35	3
Plans of Cities and Cantonments	various	117	50
Triangulation and Traverse Charts	1, $\frac{1}{2}$ & $\frac{1}{4}$	83	36
Index Maps (including Index showing progress of work)	various	74	64
Miscellaneous Maps, etc. . . . .	...	9	3
Various maps for other departments	various	236	167

57. *Engraving Office.*—The Engraving Office has been very largely employed in correcting and bringing up to date a large number of miscellaneous maps, amongst which are the 64-mile, 80-mile, 192-mile and a few provincial and district maps.

The following new provincial maps have been almost completed:—

Bengal, Madras, Punjab and Gujarat.

A new 3-inch map of Calcutta has been completed.

The following new maps have been put in hand and will form the chief work of the office for the next few years:—

32-mile India in 12 sheets.

The $\frac{1}{M}$ series, 13 sheets in hand.

The printing section pulled 49,914 impressions.

58. *Photo-Litho Office.*—From October 1st to November 11th, 1906, the Photo-Litho Office was in charge of Major W. J. Bythell, R.E., when he was relieved by Major Hedley, R.E. On April 11th Major Hedley handed over the direct charge to Captain W. M. Coldstream, R.E., and assumed general charge of both the Drawing and Photo-Litho Offices.

59. His first step was to completely separate the Photo and Litho sections and the Stores section. These had previously all been under the general superintendence of Mr. R. Fogarty, and the officer in charge dealt with each section through him. He preferred to deal direct with each section and therefore abolished the post of Head Assistant and made Mr. Fogarty, Superintendent, Litho, and Mr. Taylor, Superintendent, Photo, and put Mr. Meade in charge of the Stores, making him independent of both the other sections. The Photo-gravure section which was formerly independent, was placed under the Superintendent, Photo. In describing the changes which have been made it will be convenient to start with the Photo section.

60. The first thing he did was to abolish altogether the system of publishing maps by photo transfers. Formerly when a reprint of an old standard map was required each quarter sheet was photographed separately and the photo transfers were laid down and fitted together on the zinc plate, the footnotes, scale, etc., etc., being afterwards added by type transfer. This was a very troublesome method and had the great disadvantage that accuracy of scale could not be attained by it. The four quarters of the map are now pinned up on the board in position, with all the accessory work quite complete. One negative only is taken, a helio is made and sent to litho. An immense simplification of the work has thus resulted, with at the same time a considerable improvement in quality.

61. Every care is now taken that each negative is as good as can be obtained from the original. Every negative is inspected and passed by the Superintendent, Photo, who pays particular attention to scale. Every original which is received has the dimensions on which it is to be published marked on it, and it is most important that the greatest accuracy be observed in this part of the work.

62. *Negative Touching.*—The section for “touching” negatives has been very much increased. Formerly little was attempted beyond pointing out defects or pin holes in them, and necessary corrections or additions were always made on the plate. Our present method is to make such corrections on the negative, and thus ensure a fresh and untouched helio, from which far better results can always be obtained. This change of method has resulted in a large increase of negative touching, but a corresponding decrease in the work on the zinc plates. It has been found possible to supply the necessary staff of negative touchers from the younger litho draftsmen and zinc correctors, and several of these men have already become fairly expert at drawing on glass, making additions or corrections or writing new names. It is usual in England to call a man who is expert at such work a glass engraver, and there is all the difference in the world between a glass engraver and a mere negative “duffer.”

This section has become of the very greatest importance in view of the fact that we have now begun the publication of the new maps in 5 colours. Unless the duffing and subsequent touching up is well and carefully done, the resultant map must be a failure. This work has been quite new to nearly all the men and many errors have been made, but there has been a gradual improvement which is bound to continue, and in another two years' time he anticipates no trouble at all in this section.

63. *Helio Section.*—The negatives having been duffed and touched go to the Helio section. The quality of the helio plates now turned out leaves very little to be desired. There are differences in the methods employed here and at the Ordnance Survey at Southampton, but they are comparatively unimportant. It is much more important that whatever method is employed it should be well and carefully done. Every plate is now inspected and initialled by the Superintendent, Photo, before being sent to the Litho section and it is to this efficient superintendence that Major Hedley attributes the improvement in quality.

64. *Vandyke Section.*—The direct zinc printing, or Vandyke section as it is called, is quite efficient and turns out a large amount of work. The methods are not quite the same as at Southampton, but are suitable for the class of labour available. Most of the work received is drawn on thin paper or on tracing paper, but many originals on thick drawing paper have been successfully reproduced, and there is no difficulty in vandyking through thick paper provided the drawing is good.

65. *Photogravure Section.*—This section, as has been already mentioned, has been placed under the Superintendent, Photo, instead of being under a separate head. There is nothing special to report.

66. Allusion was made last year to Mr. Taylor's process for reproducing a hill-shaded drawing without any hand touching, and a map illustrating this method was published. Further experience has confirmed the high opinion then formed of this method, and it is intended to use it for the reproduction of all brush drawings.

67. Major Hedley considers that the Photo branch is now in good order. The weak spot is the negative touching section, but this will undoubtedly improve with more time and practice. The rest of the branch is capable of dealing with far more work than it now receives. He considers that our lenses, although good, are not quite all that might be desired. We have, however, ordered one of the best lenses and on its arrival he expects still further improvement in the negatives.

Major Hedley reports that the work of reorganizing the Photo branch has been made comparatively easy by the zeal, skill and energy of Mr. Taylor. He brought out Sergeant Lucas, R.E., with him as his expert adviser in photographic matters, and he reports that he has been most useful.

68. *Lithographic Branch.*—This branch is now under Mr. R. Fogarty, who is able to devote his whole time to it, having been relieved of all responsibility for the Photo branch. The great change in this branch has been the placing of all the printing work under Mr. Vandyke. Formerly it was partly under Mr. LeFranc and partly under Mr. Vandyke. All the printers both for hand presses and machines, are now downstairs, with the exception of those printing cadastral maps. On the other hand all the litho draftsmen, zinc correctors and proof examiners are upstairs under the general superintendence of Mr. LeFranc. Mr. Vandyke is undoubtedly our greatest expert in all kinds of printing, and the quality of the work has benefited enormously by the new arrangement.

69. The printing has been made very much easier by the fact that helio plates are now received practically complete. All the tedious work of setting up and transferring the footnotes is thus avoided and the corrections to the plates are now as a rule very small, and their quality for printing from is proportionately improved.

70. The principle hitherto observed has been to supply proofs for everything and to expect to have to carry out large alterations and corrections on the plate. The principle now worked on is to have the originals as complete and accurate as possible, the Photo-Litho branch accepting full responsibility for the accurate reproduction of the original. In the case of departmental maps printed in black only, proofs are not now supplied, but the work of reproduction is carried straight to completion. The saving of labour all round thus effected is incalculable.

71. *Coloured Maps.*—The department has this year begun the preparation and publication of the new coloured maps. Some difficulty was anticipated in registration as it was feared the plates might not be all the same size. Owing to the care now taken in the Photo section in measuring the negatives, these fears have not been realized, and there has been no difficulty in registration, though the plates have been prepared from different negatives of the same original. In many cases, however, the hills, which are drawn on a separate original, have been found impossible to register, although the plates were the same size. This has been due to faulty drawing, but under new rules the hills will be drawn on blue prints of the outline and Major Hedley anticipates no such difficulty in future. He reports that he has been very pleased with the way in which Mr. Vandyke, assisted by Mr. Colquhoun, has carried out the proving and printing of these maps.

72. *Graining plates.*—The graining of zinc plates by hand has been abolished and all the work is now done by machines which were designed by Mr. S. M. Coard of the Engraving branch. It is all carried out in what used to be the carpenter's shed, instead of being more or less scattered over the office. This admits of far more efficient superintendence, and it is more to this extra supervision than to the substitution of machines for hand work that Major Hedley attributes the great improvement in the quality of the grain obtained. Much of the improvement in Helio, Vandyke, and Printing sections is due to this improvement in the zinc graining. A well grained plate is the foundation of all good work on zinc.

73. *Paper.*—Hitherto standard sheets have always been printed on thick paper, and maps, mostly extra departmental, which were required to fold were printed on bank-post. A map printed on thick paper will not fold without cracking, and for this reason and also on account of its bulk it is quite unfitted for use in the field. On the other hand bank-post, although a tough paper which folds well, is a bad printing paper. A new paper which will fold without tearing, which is durable, and which at the same time is a very good printing paper has been introduced. Of each edition of the 1-inch maps, both old and new, and of the degree sheets, three quarters will be printed on this thin Rag-litho paper and $\frac{1}{4}$ on thick paper. Those printed on Rag-litho paper can then be folded for binding with a report, or for use in the field, and experience will soon show whether there is any demand for thick paper copies. It is anticipated that the thin paper will be generally preferred. Thin paper has two other great advantages, inasmuch as its price is less than one-third that of the thick, and it can be stored in about half the space. This latter is a very important point as the problem of the storage of maps was becoming somewhat pressing.

74. *Store fittings, etc.*—Many minor improvements have been made in the Litho section which may be briefly referred to. Many old and useless zinc plates have been cleaned off and either re-grained or sold as old zinc. Proper racks have been made for those plates which had to be kept and a register has been made of them. Great attention is now paid to keeping the whole place clean, and all old and useless papers, stores, etc., have been either destroyed, sold, or returned to store. New benches and tables have been provided to the great convenience of the printers, and new racks from which paper can be suspended from the ceiling for seasoning have been supplied. For all our new fittings, some of which have been mentioned, this section is indebted to the assistance of the Mathematical Instrument Office.

75. *Type Section.*—The former Superintendent, Mr. DePyvah, has retired and it has been found possible to continue the section under the charge of the principal native assistant. The space occupied by this section would be very valuable for storage room, and it will probably be abolished or transferred to Dehra Dún.

76. *Store Section.*—Major Hedley thought it best that the Store section should be quite independent of the Photo and the Litho. He therefore took Mr. Meade out of the Photo section and placed him in charge of the stores, with Mr. Tulloch as his assistant. Mr. Meade has shown much zeal and energy in rearranging the stores and in preparing new store ledgers. This work was very urgently needed. Stock is now being taken and all stores of every description which come into the office are now taken on charge by the store-keeper and issued with the proper vouchers to the sections for whose use they are required. This is very far from having been the case in the past. Stock had not been taken for years, but it is absolutely necessary in the future that it should be taken periodically and systematically.

The Store section is much cramped for room.

77. *General Remarks.*—Major Hedley further reports as under: "I have already said that the department has suffered very much in the past from the fact that originals sent for reproduction were seldom complete, and that large corrections in the proof stage were looked upon as a matter of course. I wish to emphasize this point again. It is no exaggeration to say that the corrections took two or three times as much time and trouble as the reproduction of a correct drawing. This has now I hope been put right. Unless originals are correct a reproduction office does not have a fair chance."

"The department has also suffered from the complete want of a proper system of registration. A map was taken in hand, begun and lost sight of. Many maps were in hand for years, especially departmental maps, as reminders from outside usually resulted in extra-departmental maps being given the precedence. It was, however, by no means uncommon to find extra-departmental jobs which had also been in hand for years. It appears to have been the custom to take up any job we were asked to do without considering whether it could be done in a reasonable time, without interfering with our proper departmental work."

"A proper system of registering all work, not only as it comes into the office, but as it passes from one department to another, has now been introduced and returns are now prepared monthly showing all work which has been in hand more than three months. I hope that we may be able to complete all simple work we take in hand, and specially reprints, within three months. It is just as easy to work close up as to have a balance of 6 months' arrears. If we cannot do outside work within a reasonable time, and without interfering with our own maps, I refuse it altogether. It is far better to refuse it than to take it in hand and not do it for years. There is usually no difficulty in reproducing any map which is properly drawn for photography, or which is based on one of our own maps, but we always refuse to reproduce rough drawings in many colours such as are very commonly received. There are two exceptions to this rule. We never refuse work for the Foreign Office or for the Military authorities if we can possibly manage to do it."

Monthly Report.—"The old form of monthly report has been changed. The new report gives the progress for the month, and the balance of work outstanding at the end of the month, for each section of the office. I look upon this as a most valuable reform. It enables the officer in charge and the Surveyor General to see at once when work is accumulating in any section of the office and to take steps accordingly."

"An accurate account is now kept of the cost of every job. This gives a certain amount of work, but it is undoubtedly necessary and well worth the trouble."

"I think I may say the department is now running on the proper lines, though a few small changes are still necessary; but I cannot say that the department as a whole is really efficient. It does a certain amount of work and does it well, but its outturn is far short of what it is capable of. What is still lacking is zeal and energy. There is no incentive to the men to work. They know that their pay and prospects will remain exactly the same whether they work well or badly. No workshop can be really efficient under such conditions, although

“there will always be some men, and our office is no exception to the rule, who do their level best under any conditions. As you know, I have submitted proposals for remedying this state of affairs and I hope they may soon be approved. The pay of many of the men is too small. The printers especially are very much underpaid and (I refer to the natives) are not drawn from a sufficiently intelligent or educated class to be really efficient. They can do simple work moderately well under close supervision. That is all you can say for them. Here also improvement depends on the Surveyor General getting complete control of the pay and promotion of the men.”

“There is a great want of elasticity in the office. The office hours are very short, only 6 hours a day, and the pay is so small that many (possibly most) of the office employes work before and after office hours to supplement their income drawn from the office. Working extra time is almost unknown, and yet it would often be very convenient. I believe that overtime is often worked at the Mint and at the Government Printing Office, and that the men get extra pay for it. I think the same system might well be introduced here.”

* * * * *

Climate.—“I have now had a year’s experience of the climate of Calcutta. I do not think it presents any serious difficulties to turning out good printing work, and the photographic difficulties are such as can be overcome. It would, however, be far pleasanter to work in a cooler and drier climate and such a change would probably conduce to greater efficiency. A move from Calcutta would also be as good as an increase of pay for the employes, many of whom find it almost impossible to live in Calcutta on their present salary.”

Officer in charge.—“It is absolutely necessary for the efficiency of the office that it should be in charge of an officer who understands the work and this officer should hold the post for at least 4 years. It is quite useless to put an officer in charge who has had no experience of this kind of work. He is bound to be completely in the hands of his subordinates. It is not necessary for him to be as good a photographer as Mr. Taylor or as good a printer as Mr. Vandyke, but he must know the proper organization, be able to know good work from bad, be able to say whether a man is doing the proper amount of work, be able to say how a map should be reproduced, and many other things which must be learnt. It would take an officer about a year to get a fair knowledge of these things with an experienced officer to teach him. I consider it of the first importance to have a properly trained officer always in charge, and unless this is provided for it is hopeless to expect a high standard of work.”

“The following table shows the outturn for each of the last three years:—

Litho Section.

Year.	Class.	Number of pulls.	Number of maps in black.	Number of coloured maps.	TYPE SECTION.	
					Pulls.	Copies.
1904-05	Departmental	396,662	...	...	...	...
	Extra-Departmental	738,165	...	...	...	...
	Cadastral	61,481	...	...	...	...
	TOTAL	1,196,308	827,705	84,689	2,292,749	1,209,953
1905-06	Departmental	425,961	...	...	...	...
	Extra-Departmental	811,629	...	...	...	...
	Cadastral	47,378	...	...	...	...
	TOTAL	1,284,968	825,643	106,971	1,816,405	972,525
1906-07	Departmental	341,887	...	...	...	...
	Extra-Departmental	683,774	...	...	...	...
	Cadastral	97,340	...	...	...	...
	TOTAL	1,123,001	696,336	110,681	2,124,148	1,065,582

“Our output of litho work this year has been considerably affected by the fact that although there has been abundance of work for the large machines, the small machines have often been idle through want of work. This year also for the first time the 16,000 Weather Charts which are printed monthly have been printed in the Type section instead of the Litho section. Our average runs are very small and a monthly run of 16,000 simple maps greatly helped our total output.”

“The total cost of the office during the year has amounted to ₹2,79,140; under the main heads of supervision ₹24,419, establishment ₹1,22,864, contingencies (including cost of materials and chemicals procured locally) ₹30,246, stores from England ₹1,01,610. This last amount is approximate only as it represents the value of stores not yet fully expended which were received from England on the annual indent of the preceding year.”

“A sum of ₹42,828 has been recovered by book transfer for work done for other departments and in cash from private individuals. The value of work done for the Government of India and for the Survey of India is not charged.”

78. *Map Record and Issue Office.*—The number of maps issued during the year was 103,502 sheets of an aggregate value of ₹1,20,984. Of this total the maps supplied to Government officials on book debit amounted to ₹40,135, those to the India Office to ₹5,739, and to Agents ₹8,344. The sum of ₹19,106 was also realized in cash from sales to private individuals.

79. The number of new editions published was 698, and of reprints 181. The number of original maps, volumes of computation, etc., issued from store to other departments or branches of the office was 5,471, of which 5,224 were received back.

80. The transfer of the Forest maps was continued during the year and 11,697 sheets were sent to the Superintendent, Forest Map Office, Dehra Dún, for storage.

81. The overhauling and re-registering of original maps and volumes was steadily proceeded with. The plane-table sections of some 8,000 sheets, together with 1,304 fair sheets and 1,634 volumes, were re-registered and arranged. The map and manuscript stores are in good order, and much credit is due to Mr. Rundlett, the curator.

82. The revision of the catalogues was held in abeyance as a new system is to be introduced. The great difficulty which this office has to compete with in this matter is that a very large number of the maps which are still catalogued are out of print; and many are so old that they will never be reprinted. The result of this is that orders frequently cannot be completely complied with, and much inconvenience and extra labour is involved. The first step in the re-organization of this office will be the preparation of a new and complete catalogue for the whole of India and it will contain only the maps of which it is intended to keep a stock. It will probably be printed annually with corrections to date. Now that the new system of numbering the topographical maps is in force and the new index maps have been completed, the preparation of a complete catalogue will be simple and it should be available within a few months. The chief difficulty will be to decide which of the older maps are to be retained on the lists and which rejected.

83. The sale of maps to the public is still very small. This is chiefly due to the small number of agencies at which they are procurable. Arrangements will be made to establish agencies in all the larger towns during the coming year and it is expected that a much larger demand for the general maps of India and for local maps will arise. Decentralisation is essential in this direction.

84. The system of hand-colouring maps before issue which has been one of the main causes of delay in complying with demands for standard sheets on the 1-inch scale will be gradually abolished; all such maps will in future be printed in colours, but a certain amount of hand colouring will have to be continued on the degree sheets and $\frac{1}{\text{million}}$ sheets for some years to come at any rate.

85. *Mathematical Instrument Office.*—During the year under report, *i.e.*, from 1st April 1906 to 31st March 1907; there has been a decrease in the demands made on this office. For each of the last three years the value of the instruments, etc., issued was ₹3,54,005, ₹4,22,179 and ₹3,82,345; the value of repairs to instruments received for that purpose and returned in a serviceable

condition was R40,069, R41,818 and R42,181; and the value of instruments received from Government officers as "no longer required" was R85,994, R76,096 and R58,128.

The book value of instruments, etc., in the serviceable store at the end of each of the last three years was R3,92,653, R4,53,251 and R5,35,535. The increase in hand at end of the year under report compared with the previous year is due to a decrease in the demand for instruments.

The book value of the stock of instruments, etc., in the repairable store at the end of each of the last three years was R1,46,734, R1,19,907 and R1,12,389. As usual, no instruments for which there was demand were kept in the repairable store for any length of time; they were sent to the workshop for repairs and transferred to the serviceable store for issue as soon as possible.

Two "profit and loss" statements have been prepared—one for the stores branch and the other for the workshop. The stores show a gain of R2,956, and the workshop a loss of R7,988. This loss is chiefly due to a larger expenditure having been incurred during the year under report than in the previous year, owing to a sum of R6,695 having had to be paid to the men on account of grain compensation, nothing on this account having been paid in the previous year. The number of men and boys employed at the end of each of the last three years was 352.421 and 451. The total value of the issues during the year under report shown in the "profit and loss" statement on account of stores amounted to R3,93,952 as against R4,32,013 in the previous year, and the value of the work done in the workshop during each of the last three years was R1,58,958, R2,01,083 and R2,16,730.

The value of the instruments, etc., manufactured in the workshop for the serviceable store during each of the last three years was R64,188, R82,638 and R87,588. The value of instruments, etc., purchased locally during each of the last three years was R14,405, R17,810 and R4,189.

The value of instruments, material, etc., obtained from England through the Director General of Stores during each of the last three years was R1,91,113, R2,87,740 and R4,36,240.

During the year under report steam for working the machinery was superseded by electric motors, the existing steam engine being of insufficient power to drive all the available machines. The carpenter's and tinman's establishment of the Photo-Litho Office was taken under the supervision of this office during the year.

Stock-taking has been taken seriously in hand and in a short time the stores and workshops should be in thoroughly satisfactory order, though the space available for the workmen is very cramped.

Extensions of the buildings are proposed partly to enable the manufactures to be increased and corresponding reductions to be made in the number of instruments received from England and partly to lessen the danger of accidents to the workmen.

This department is being re-organised, and an additional specialist has been obtained from England through the Secretary of State. There are therefore 3 thoroughly trained European managers in the place of the 2 mathematical instrument makers who had until this year to superintend the whole of this large and growing industry.

BRANCH OFFICES.

TRIGONOMETRICAL OFFICE.

86. The superintendence of the Trigonometrical Survey remained in the hands of Lieutenant-Colonel S. G. Burrard, R.E., F.R.S., till his departure on combined leave on 19th March, when he was relieved by Mr. J. Eccles, M.A., who also held charge of the technical offices throughout the year.

Mr. T. A. Pope joined the office on 28th January 1907, and was given the superintendence of the Photographic Office. He was also placed in charge of the Forest Survey Office from 7th February 1907.

Lieutenant F. F. Hunter, I. A., who joined on 27th April 1906 on special duty, was transferred on 17th May 1907 to No. 19 Party, Lieutenants J. D. Campbell, R.E., E. B. Cardew, R.E., R. Foster, I.A., H. T. Morshead, R.E., G. F. T. Oakes, R.E., F. J. M. King, R.E., and R. S. M. Harrison, I.A., who were appointed during the year, were put through a course of topographical and astronomical work.

Lieutenants Campbell and Morshead unfortunately contracted enteric and were invalided to England on 6th June 1907. The other officers were also put through a complete course of principal triangulation. Fifteen Sub-Assistant Superintendents were put through a course of training during the year and three officers were instructed in exploration work.

87. The following computations were carried out in the Computing Office, for incorporation with the Synoptical volume of the North-East Longitudinal series:—

Computations of latitudes, longitudes and azimuths of—

- (1) Snow peak triangulation in west, central and east Nepal.
- (2) The Sikkim triangulation peaks.
- (3) Gundak river triangulation.

Computations of the heights of—

- (1) Himalayan peaks with modified co-efficients.
- (2) Dehra Dún and Jaunsar Bâwâr triangulation.
- (3) Barckley's snow peaks.
- (4) Ryall's Milam-Hundes triangulation.

The azimuth and co-ordinate lists of the North-East Longitudinal series are in hand.

Computations in connection with Colonel Burrard's paper on the Himalayan geography were completed.

The co-ordinates of the points of the Dehra Dún charts were altered from their former origins to the east end of the Base line.

The longitudes in the Synoptical volumes of the Great Arc series, section 8°-18° and of the Khanpisura series were corrected to Greenwich terms.

The closing errors in the levelling from Sujâwal to Sukkur and Sukkur to Shikârpur were dispersed.

Observations for heights received from Mr. Calvert, I. C. S., and M. Rigodi Righi were reduced.

Compilations for the Levelling volume which have been in hand for some years are now nearing completion.

The charts of the Kalât series and the maps for Colonel Burrard's paper on Himalayan geography were examined and passed. The drawing and checking of the rays for degree charts of the North-East Longitudinal series are in hand.

The compilation of data for trans-frontier degree charts is in hand.

Professional Volume XVIII of the Survey of India was printed and distributed.

The printing of the Synoptical volume of the North-East Longitudinal series is progressing.

The meteorological observations continued as usual.

The necessary professional aid in connection with the protection of stations was rendered to the office of the Superintendent, Trigonometrical Surveys.

598 stations were repaired by the district officers at a cost of ₹3,605-2-9.

Out of 333 districts from which the reports are annually due, 20 failed to make returns.

In the Drawing Office the following maps were either wholly or partly drawn and sent to press:—

- (1) One North-East Frontier sheet on scale 16 miles = 1 inch.
- (2) One North-East Frontier sheet on scale 8 miles = 1 inch.
- (3) Map of Nepal, 2nd edition, on scale 16 miles = 1 inch.
- (4) Specimen triangulation chart.
- (5) Index route map of the Western Himalayas, etc.
- (6) Two standard sheets of the United Provinces.
- (7) One standard sheet of the Punjab.
- (8) Four 4-inch sheets of Punjab for publication on half scale.
- (9) Four Triangulation charts.
- (10) Fourteen Sind level sheets.
- (11) Index map to level sheets in India and Burma.
- (12) Five miscellaneous maps.
- (13) One diagram for Great Trigonometrical Survey, Professional Volume No. II, and five for Professional Paper No. 10.

While the following are nearly ready :—

- (1) One Sind level sheet.
- (2) Six Punjab level sheets.

The following are still in hand :—

- (1) Four sheets of the map of India and adjacent countries.
- (2) Six Punjab level sheets.
- (3) Forty-four degree-triangulation charts of the North-East Longitudinal series.

Headings, footnotes (including symbols) and area-statements were completed on 197 maps which were also sent to press.

The proofs of all maps have been examined and corrections carried out as usual, and a careful scrutiny given to all the printed copies before issue.

2,844 maps were coloured.

1,177 maps and diagrams were photographed against 983 during 1905-06 and 223,186 pulls taken against 108,064 in the same period. The increase in pulls is due to the introduction of a printing-machine worked by a gas-engine which has been in use since 15th April 1907.

88. As soon as the simultaneous reduction of the level network has been completed next summer it is proposed to fix the final values of the heights of all bench marks throughout India and to correct and republish all the Levelling pamphlets. The present series of pamphlets, each of which deals with one line of levels, has proved inconvenient and it is proposed to catalogue the pamphlets in future by areas and not by lines so that all the bench marks falling in each sheet of the $\frac{1}{\text{million}}$ map series will be found in a separate Levelling pamphlet for that sheet.

FOREST SURVEY OFFICE.

89. This office continued under the superintendence of Major P. J. Gordon, I.A., Superintendent of Forest Surveys, until the 15th October 1906, when that officer was transferred to another appointment and the Forest Survey Branch as such ceased to exist. The head-quarters office, however, is being maintained for the storage and issue of Forest maps and records, and for the preparation of Forest maps of various kinds. From the 15th October 1906 till the 7th February 1907 the charge was held by Mr. C. F. Erskine, and from the latter date by Mr. T. A. Pope on his return from furlough.

During the year 221 maps were sent to press and 233 were published at Dehra Dun. These numbers are smaller than last year, owing chiefly to the exclusion of all Forest maps of the Bombay presidency, as these no longer pass through this office, but are sent direct to the Poona Photo-Zinco Office for publication. 11,100 maps were issued, of which 6,450 were coloured and 3,210 mounted in book form.

A sum of R1,750 was realised by the sale of maps, or more than double the amount realised last year.

In accordance with the recommendations of the Survey Committee, arrangements were made for the storage in this office of the entire stock of Forest maps hitherto stored in and issued from the Map Record and Issue Office, Calcutta. A complete set of new racks for the accommodation of these maps is under construction and was nearly completed at the close of the year. Much of the Calcutta stock has already been transferred, and it is expected that the remainder will follow shortly.

LOCAL DRAWING OFFICES.

90.—*Mussooree Drawing Office.*—The Mussooree Drawing Office was this

Personnel.

Provincial Officers:

Messrs. R. R. Dickinson, in charge and W. J. Cornelius (Retired Provincial Officers).

Subordinate Establishment:

Surveyor, 5 permanent and 12 temporary Draftsmen, and 1 Writer.

year placed under the administration of the Superintendent, Northern Circle, and was in charge of Mr. R. R. Dickinson, Extra Deputy Superintendent, 2nd grade, for the whole year.

Of the sheets of the India and adjacent countries series, 10 sheets have been dealt with during the year; of these two were completed and sent to press for publication, another was completed and sent to press for blue prints for hill sheet, and another has been examined and is under correction and will be sent to press shortly. Work has been started on four new sheets and the skeletons of three are nearly finished and the fourth is about one-eighth done.

As usual this office has got through a large amount of miscellaneous work was also able to lend assistance in the shape of three draftsmen to No. 18 Party from 27th March to 31st May 1907, six draftsmen to triangulation section of above party from 19th June to 31st August 1907, one senior draftsman to No. 9 Party from 29th July to 30th September 1907, and three draftsmen to No. 15 Party from 17th September to 30th September 1907.

91. *Burma Drawing Office.*—This office was under the charge of Mr T. Shaw, Extra Deputy Superintendent, throughout the year and was employed on the compilation of Degree sheets and index maps and the fair drawing of arrears of standard mapping and the correction of fair sheets. The training of young draftsmen was also continued.

A lithographic press was set up at the end of the year and arrangements will be made to prepare in this office, by the Vandyke process, the blue print reproductions of standard sheets for the contour sheets, which are required in order to ensure accurate registration. During the year under report there was considerable inconvenience and delay owing to this having had to be carried out at Calcutta.

This office will now be absorbed in that of the Superintendent in charge of Burma Surveys.

92. *United Provinces Drawing Office.*—The compilation of standard maps for publication on the 1-inch scale from recent cadastral revision survey was continued and also of charts of the traversing connected therewith. Mr. J. M. Kennedy, Extra Assistant Superintendent, 2nd grade, remained in charge throughout the season, and in September 1907 Mr. F. W. Marten, Sub-Assistant Superintendent, 1st grade, was transferred to this office from Bengal Surveys to assist him. The subordinate establishment has been considerably reduced as most of the draftsmen are newly entertained and those who have shown no promise of becoming really efficient draftsmen have been discharged. At the end of the season the number of draftsmen was 24 and computers 3.

93. One sheet, comprising the two new standard sheets $63 \frac{1}{1 \& 5}$, was drawn in the old form, and 13, *vis.*, $63 \frac{J}{12 \& 16}$, $63 \frac{K}{14}$, $63 \frac{N}{4, 8, 12, 16}$, $63 \frac{O}{1, 2, 5, 9}$ and $63 \frac{G}{11 \& 1}$ were drawn in the new style. The last two sheets were drawn from 2-inch topographical survey executed by No. 14 Party. All these sheets were sent to Calcutta for publication. Of traverse charts, 14 were drawn and additions were made to 11 which had been partly drawn by No. 14 Party, and all were sent to Calcutta for publication. Four district maps of Allahabad, Fatehpur, Kheri and Bahraich were also drawn, and those of the first three districts were sent to Calcutta for publication.

ESTABLISHMENT.

94. During the year under report the department has lost the services of three Imperial officers, *vis.*, by the retirement of Mr. E. F. Litchfield, the death of Lieutenant H. S. May, R.E., and by the reversion to the Home service of Major A. H. B. Hume, R.E.

The following officers have been appointed to the department:—Lieutenants J. D. Campbell, E. B. Cardew, H. T. Morshead, J. F. T. Oakes and F. J. M. King, Royal Engineers, and Lieutenants R. Foster and R. S. M. Harrison Indian Army.

95. From the Provincial service four officers have retired:—Messrs. G. T. Hall, W. H. Penrose, R. R. Dickinson and J. Marten; one resigned:—Mr. D. J. Hunter; three died:—Messrs. C. D. Simons, J. G. Jamieson and A. G. Harrington; while Mr. W. J. Beedham was discharged as unsuited to the department.

Sixteen officers have been appointed to the Provincial service as probationers.

96. Lieutenant H. S. May, Royal Engineers, Assistant Superintendent, 2nd grade, died of fever in Hill Tipperah on the 14th April 1907. He received his

commission in the Royal Engineers on the 22nd November 1899, and, after serving in the South African war from March 1901 to the end of the war, for which he received the medal and 5 clasps, arrived in India in 1903 and was on the 7th June 1904 appointed to the Survey of India. For many weeks before he died he had been suffering from severe fever, but his high sense of duty led him to struggle on; he continued to work until he was absolutely prostrated and he died before medical aid could reach him.

Lieutenant May was an officer of great promise and his death was a severe loss to the department.

EXPENDITURE.

97. The total cost of the department for the year ending 31st March 1907 was ₹30,59,249 against an estimated cost for 1907-08 of ₹35,06,220. The increase which at first sight appears large, is attributable to many causes, most of which are unavoidable, some of which are politic in that the work will be done quicker and the expenditure on it will be less than if it were spread out over several seasons.

The estimated expenditure on Topographical surveys has gone up from ₹11,86,000 to ₹17,67,180. This is due to the absorption of the forest survey parties and the transfer of an additional party to the frontier, as well as to the endeavours which are being made to work off all arrears of mapping, to the necessity for providing for compensation for dearness of provisions, and to the large number of parties which are working in areas where local allowances and travelling allowances at enhanced rates are admissible. It is also due to the increase in the number of Imperial and Provincial officers under training and to the large number of soldier-surveyors attached to the field parties for instruction. The estimated expenditure under the heads Trigonometrical parties has risen from ₹2,57,000 to ₹3,67,000 approximately. In the case of No. 24 Party there is an increase of ₹68,000 alone, which is accounted for by the fact that there are now two sections, one triangulating in the extreme west of Baluchistan and the other in the extreme east of the Shan States, both of which areas are very expensive and difficult of access; but a few years will see this work completed, and the work has to be hurried on in order to afford basis from which the topographical surveyors can break down. The cost of the Magnetic party has gone up by ₹12,000 owing to its work being in Burma, but this will be completed and the expenditure on this survey will be considerably reduced in future as the general survey will be completed this year and the detail survey of small areas only will be undertaken in future. There is also an increase of ₹14,000 in the Tidal and Levelling party owing to the formation of a new levelling detachment, and of ₹12,000 in the Astronomical party.

The expenditure on cantonment surveys for 1907-08 is estimated at ₹66,000 as compared with ₹63,000 in the year under report but these surveys will shortly be finished and practically the whole of this amount will be saved within the next two years. There is also an increase of ₹30,000 approximately on account of Mathematical Instruments, which is due to the necessity of equipping the increased establishments with such instruments. The charges under this head should be less in future.

98. Every endeavour is being made to reduce all unnecessary expenditure. There is a certain amount of work to be done and it can be carried out either by employing a large number of poorly paid and indifferent surveyors to do it or by recruiting and training a better educated and better paid class and employing fewer of them. There can be no doubt that the second alternative is the one to be adopted because the pay of the surveyor, even a good one, is nothing as compared with the expenses of his squad of *khaiasis*, his and their travelling charges, etc. The cost of training the Imperial and Provincial officers and civil and military surveyors during the year under report amounted to some ₹96,000; during 1907-08 it is estimated at a much higher figure, but after that year it will be considerably reduced as the parties will have nearly their full complement of trained men, and we shall only have to train sufficient to replace casualties.

99. The department has suffered most seriously of late years from the fact that there have never been sufficient Imperial officers to carry out the work, and consequently but few of them have had practical training in surveying before they were drafted to charges. Similarly the Provincial officers were required to

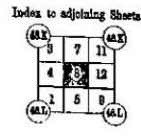
supervise the work of the ever increasing number of native surveyors and there was no time to train them and lastly the curtailment of the topographical work and expansion of cadastral and forest surveys on large scales conducted on very different principles, had reduced the number of men of all classes who had a thorough practical knowledge of surveying on the 1-inch and 2-inch scales to a very low ebb. Within the last two years however many of them have been carefully trained and it may be confidently expected that the trouble and expense involved will be amply repaid both in the quality and quantity of work which will be done.

100. In my next report I hope to be able to compare the outturn and cost of the department for the current year and that now under report and to show the estimated expenditure for the following year also; but this is difficult because the survey and financial years are different, the survey year ending on the 30th September and the financial year on the 31st March.

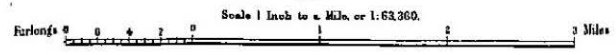


Dist. No. 13853, of S. I. July 22, 1908.

Other Gauges (1) Double (2) Single Line	...
Mineral Lines and Tramways	...
Main Road, metalled, with Mile-stone	...
Main Road, unmetalled	...
Village Cart track	...
Canal Road	...
Mule path, 8 Pass	...
Foot-path	...
Telegraph Line	...
Wells: (1) Masonry tank (2) unlined, (3) Mine	...
Temples or Pagoda, Mosque, Fort, Watch-tower	...
Diserted Village	...



Published under the direction of Brevet-Colonel S. G. Burrard, R.E., F.R.S., Officiating Surveyor-General of India, 1908.



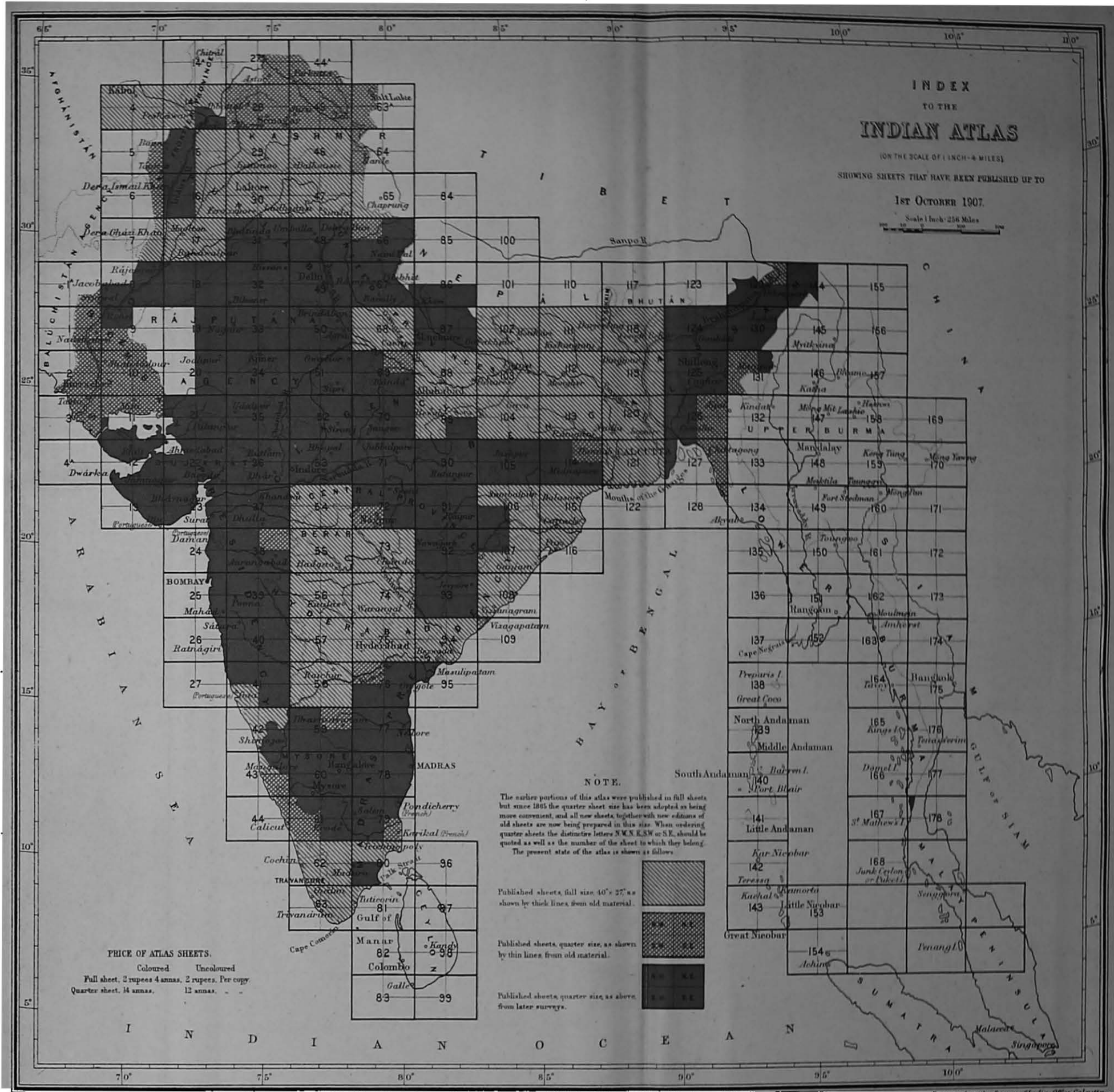
The longitudes refer to the Greenwich meridian. Contours are at 50 feet intervals. Chronometric and relative heights are approximate.

Perennial water and all canal systems are coloured blue. Forest and jungle is coloured dark green when dense and light green when open.



Boundary External of India, Province or State	---
Division	---
District	---
Sub-Division, Tahsil, Pargana &c.	---
Undemarcated of Cultivation	---
Forest Reserves	---
Triangulation or levelled Bench Mark	△ Shali
Height, Trigonometrical, Chronometric, Barometric	1539, 1923, 152
Post Office, Telegraph Office & P.O. & T.O. combined	PO TO PTO
Dak Bungalow, Rest House, Camping Ground, Police Station	DB RH CG PS
Uprising, Khasm, Inspection Bungalow, Court House	KB IB CH

Price One Rupee



INDEX
TO THE
INDIAN ATLAS

(ON THE SCALE OF 1 INCH=4 MILES)

SHOWING SHEETS THAT HAVE BEEN PUBLISHED UP TO

1st OCTOBER 1907.

Scale 1 inch=256 Miles

NOTE.

The earlier portions of this atlas were published in full sheets but since 1895 the quarter sheet size has been adopted as being more convenient, and all new sheets, together with new editions of old sheets are now being prepared in this size. When ordering quarter sheets the distinctive letters N.W.S., E.S.W. or S.E. should be quoted as well as the number of the sheet to which they belong. The present state of the atlas is shown as follows:

- Published sheets, full size 40" x 27", as shown by thick lines from old material.
- Published sheets, quarter size, as shown by thin lines from old material.
- Published sheets, quarter size, as shown by solid black from later surveys.

PRICE OF ATLAS SHEETS.

	Coloured	Uncoloured
Full sheet.	2 rupees 4 annas.	2 rupees.
Quarter sheet.	14 annas.	12 annas.

Engraved at the Survey of India Office, Calcutta.

Published under the direction of MAJOR F. B. LONGE, R. E. Officiating Surveyor General of India

Litho., B. I. O., Calcutta.

INDEX No. 1

Showing progress of publication
up to 30th September 1907





Key to Degree Sheets. Key to Standard Sheets.

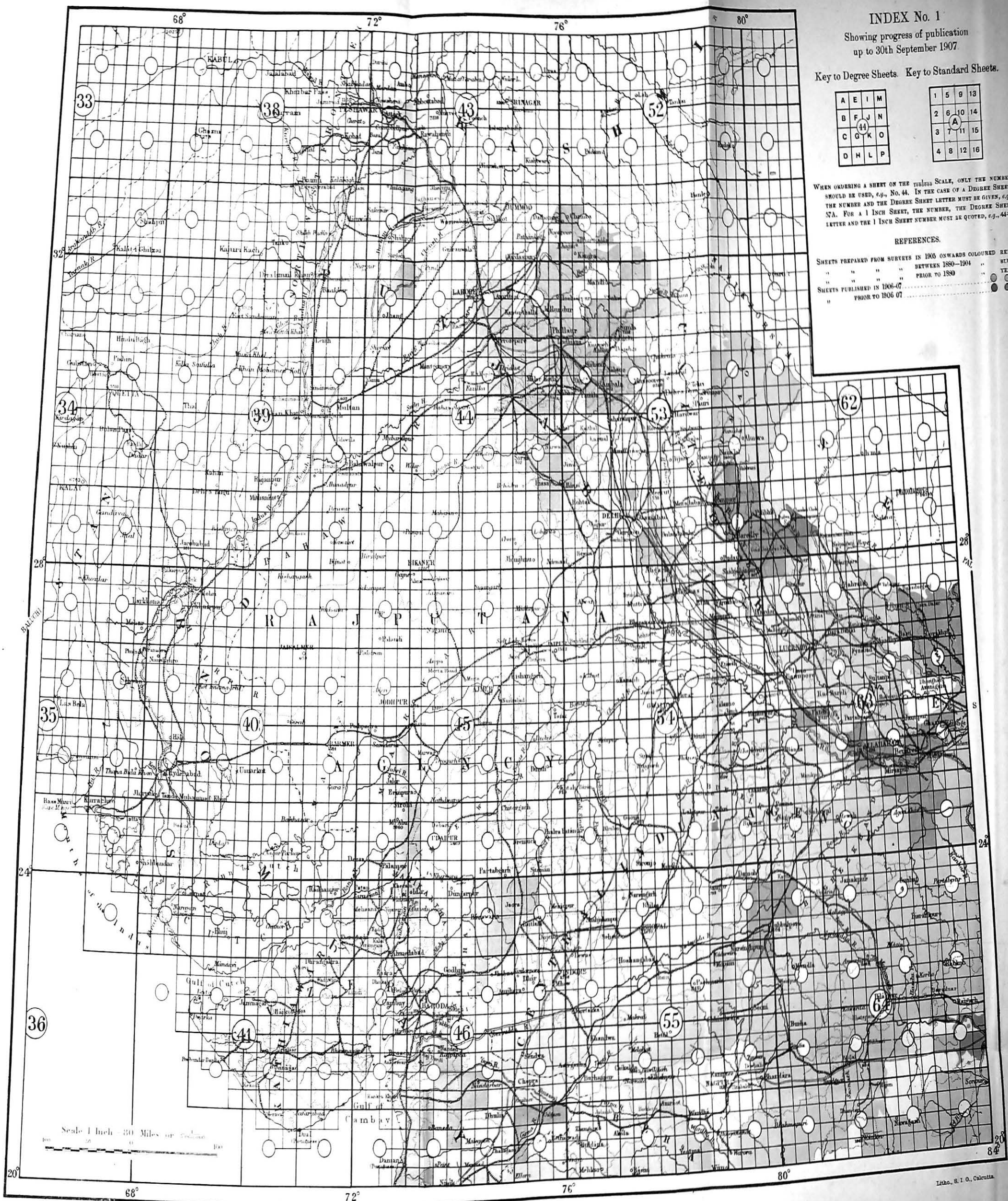
A	E	I	M
B	F	J	N
C	G	K	O
D	H	L	P

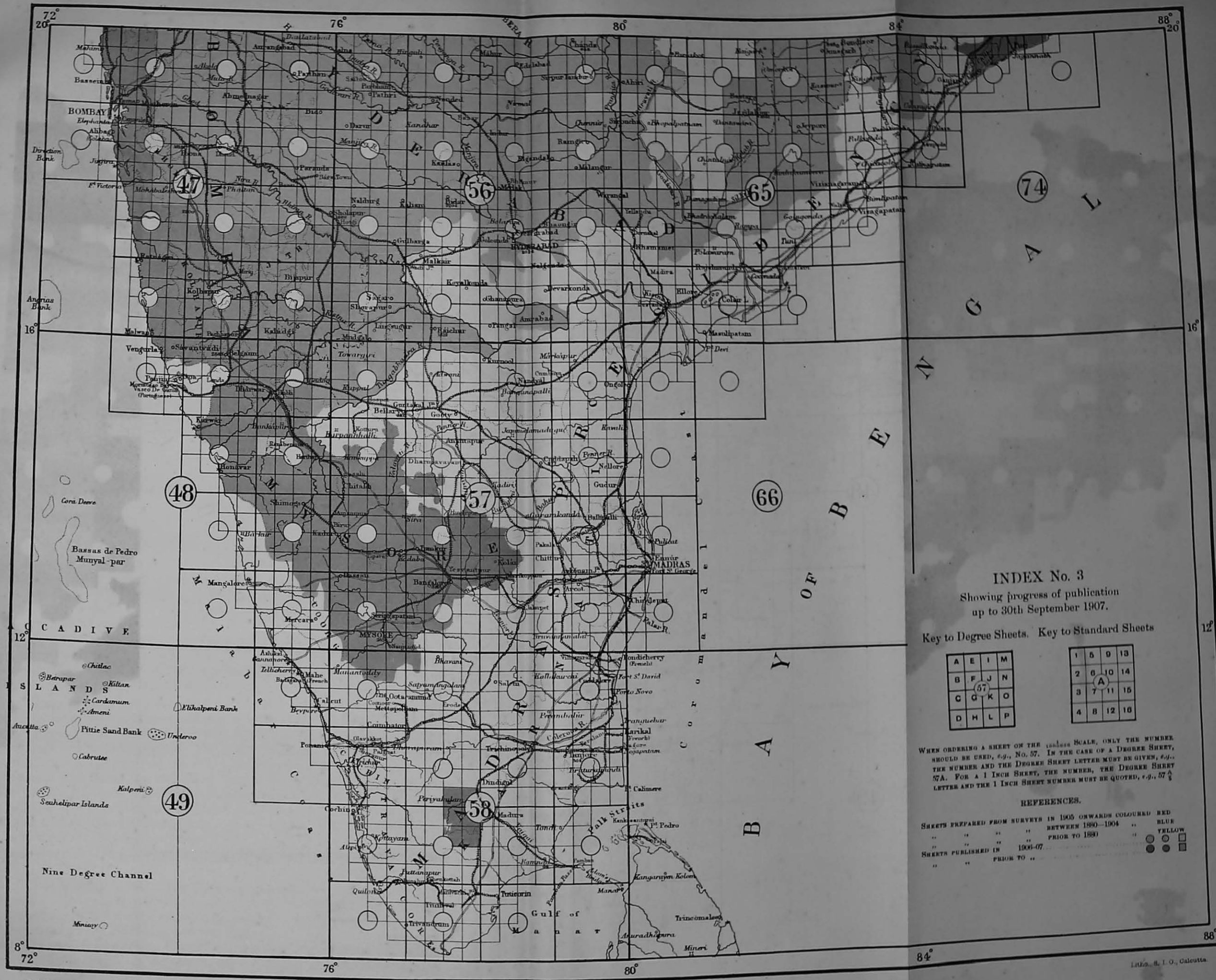
1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

WHEN ORDERING A SHEET ON THE **TRAVERSE** SCALE, ONLY THE NUMBER SHOULD BE USED, e.g., No. 44. IN THE CASE OF A DEGREE SHEET, THE NUMBER AND THE DEGREE SHEET LETTER MUST BE GIVEN, e.g., 57A. FOR A 1 INCH SHEET, THE NUMBER, THE DEGREE SHEET LETTER AND THE 1 INCH SHEET NUMBER MUST BE QUOTED, e.g., 44 $\frac{1}{2}$

REFERENCES.

SHEETS PREPARED FROM SURVEYS IN 1905 ONWARDS COLOURED RED
 " " " " BETWEEN 1880-1904 " BLUE
 " " " " PRIOR TO 1880 " YELLOW
 SHEETS PUBLISHED IN 1906-07 "   
 " " " " PRIOR TO 1906 07 " 





INDEX No. 3
 Showing progress of publication
 up to 30th September 1907.

Key to Degree Sheets. Key to Standard Sheets

A	E	I	M
B	F	J	N
C	G	K	O
D	H	L	P

1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

WHEN ORDERING A SHEET OF THE 1:50,000 SCALE, ONLY THE NUMBER SHOULD BE USED, e.g., No. 57. IN THE CASE OF A DEGREE SHEET, THE NUMBER AND THE DEGREE SHEET LETTER MUST BE GIVEN, e.g., 57A. FOR A 1 INCH SHEET, THE NUMBER, THE DEGREE SHEET LETTER AND THE 1 INCH SHEET NUMBER MUST BE QUOTED, e.g., 57 1/4.

REFERENCES.

SHEETS PREPARED FROM SURVEYS IN 1905 ORWARDS COLOURED RED	●
" " " " BETWEEN 1880-1904 " " BLUE	○
" " " " PRIOR TO 1880 " " YELLOW	□
SHEETS PUBLISHED IN 1906-07	●
" " PRIOR TO "	○

PART II.

THE OPERATIONS OF FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 PARTY.

101. The party was under the charge of Captain C. M. Browne, D.S.O., R.E., throughout the year under report.

Personnel.

Imperial Officers :

Captain C. M. Browne, D.S.O., R.E., in charge.
Lieutenant E. B. Cardew, R.E., from 1st September 1907.

Provincial Officers:

Messrs. C. D. Simons, till the 18th November 1906, C. H. Tresham and Munshi Abdul Hai from the 16th September 1907. Messrs. V. D. B. Collins from the 3rd June 1907, V. P. Wainwright from the 16th May 1907, F. W. Smith from the 16th September 1907, and G. A. Norman from the 17th September 1907.

Subordinate Establishment:

6 Recorders, 1 Writer and 1 Hospital Assistant.

to Dalbandin, from whence the first station Pragi was reached on the 1st November.

102. The programme of the party was to continue westwards the Kalát Longitudinal series from where it had been left off in season 1904-05 and the party assembled at Nushki by the 9th October. After spending some days in making the necessary arrangements for supplies, escorts, etc., the party marched along the Seistan trade route

103. After adjusting the instrument observations were commenced and were continued until the 16th March 1907, when the field work was closed with the approval of the Superintendent, Trigonometrical Surveys. At Kisanen Chapper an Astronomical Azimuth was observed: while the observations were in progress here news was received that Mr. Simons was seriously ill, and Captain Browne had to leave at once for Merui. Mr. Simons died before he could arrive there and some days were necessarily spent in settling his accounts and re-arranging the squads, and it was the 26th November before observations could be recommenced. This sad event cast a gloom over the party, and his absence was badly felt.

Subsequently observations were continued without much interruption until Gat-i-Barot was left on the 4th January. The country then became more open and the dust-laden wind blew almost incessantly, causing great annoyance and frequently obscuring even the nearest objects.

104. Owing to the configuration of the country the triangulation west of the line Gharibo-Malik Shah was very difficult to carry out. Koh-i-Sultan with its group of high peaks rose alone to the west, north lay an enormous sandy desert stretching to the Helmand, while to the south a wide stony plain gradually sloped down to the Hamun-i-Mashkhel. In consequence a hexagon had to be employed of which one station, Kondi, had to be built in the open plain, and the others on low hills round the central station which was on the highest point of Koh-i-Sultan. The station in the plains gave a lot of trouble, when observed to from Malik Shah it was unsteady and a great number of observations (130) had to be taken to it to get a satisfactory value. But the worst was experienced when observations had to be taken from it, owing to mirage with its abnormal refraction.

105. The country in which the work lay is about as desolate and barren as a land can be. It is practically uninhabited except for a few nomad shepherds, and the residents in the thanas maintained along the Seistan trade route; but it is full of interest to the geologist and the surveyor.

At times during December, January and February the most bitter cold was experienced, not so much on account of the lowness of the temperature, which

was never as low as it is in the Quetta district, as from the wind which seems to get through everything.

After closing work at Miri Sultan on the 16th March the party left for Nushki, where it arrived on the 5th April. Captain Browne with Mr. Tresham proceeded in advance by rapid marches to the Kalát district to select the stations for the first figure of the proposed Toba series.

106. Owing to the great elevation of most of the stations of this new series, many of which are over 10,000 ft. high, and some over 11,000 ft., it will be impossible to carry on the work except in the summer or early autumn, so that in order to be able to start the observing next spring, Mr. Wainwright was sent on the 20th September 1907 to build the stations and to continue the reconnaissance into the Toba plateau.

107. Captain Browne, having entrained his party at Nushki for Dehra Dún, where it arrived on the 12th, proceeded to Quetta to make arrangements for the proposed programme for the principal triangulation in Baluchistan for next year, arriving in Dehra Dún on the 17th April.

108. Five Imperial Officers were attached to the party for instruction during the recess and the programme decided on was the re-observation of certain stations of the great arc, and the fixing of two new stations at Shorpur and Top-Tiba; also the observation of an Astronomical Azimuth at Banog. Owing to the interruption from haze the observations at Doiwalla and Shorpur were postponed as it is probable that further stations on the south side of the Siwaliks will be required. Field work was therefore closed on the 22nd of June.

109. In recess the computations of the season's work were completed. Orders were received to make arrangements for the re-starting of the Great Salween series in Burma, without stopping the work in Baluchistan, which was to include the reconnaissance of the Toba series, in addition to the work on the Kalát Longitudinal series. This necessitated the considerable strengthening of the party.

110. The health of the party was no worse than might have been expected from the character of the country in which it was working: beyond Nushki fresh vegetables were unobtainable, and the constant drinking of distilled water increased the difficulty of digestion. In consequence of this there were a great many cases (110) of, and 1 death from, scurvy.

111. A number of observations of magnetic declination were taken in Western Baluchistan along the trade route and on the Great Trigonometrical stations. The results were handed over to the officer in charge No. 26 Party for computation and incorporation in his report.

112. The party was inspected in recess by the Superintendent, Trigonometrical Surveys, on the 24th September.

SCIENTIFIC OPERATIONS.

GEODETIC.

ASTRONOMICAL LATITUDES.

NO. 22 PARTY.

113. This party was employed under Captain Cowie, R.E., on latitude operations in Kathiáwár and round the Gulf of Cambay. Observations were taken at twelve stations, including Dehra Dún.

Personnel.

Imperial Officer:

Captain H. M. Cowie, R.E., in charge.

114. The results of the season's work are given below :—

TABLE OF RESULTS OF SEASON'S WORK.

Name of Station.	Latitude.	Longitude.	Height above mean sea level.	Deflection of the plumb line. (O—C)
	° ' "	° ' "	Feet.	"
Dángarvádi H. S.	20 43	70 59	96	—8.52
Kunkaváv T. S.	21 39	70 59	591	—1.65
Dungarpur H. S.	22 48	71 2	404	—4.69
Chamárdi H. S.	21 49	71 58	42	—2.77
Ingrodi T. S.	22 57	71 51	118	—5.08
Páldi H. S.	22 54	72 34	208	—5.47
Ghoráráo H. S.	22 52	73 24	323	—3.12
Pávágad H. S.	22 28	73 33	2,721	—4.38
Sidhpur H. S.	22 4	73 31	169	—3.44
Álamvádi H. S.	21 35	73 33	848	—3.68
Tarbhán H. S.	21 1	73 6	140	—5.77

These values of O—C conform to the general character of the deflection of the plumb line in Rajputana and the west of peninsular India.

The results given by the observations in Kathiáwár show that there exists a source of attraction about Latitude $21^{\circ} 30'$, the relatively dense mass causing this attraction distributed here along an axis roughly south-west by west and north-east by east. As the central portion of the Kathiáwár peninsula is covered with a basalt overflow, the density of which is greater than the average surface density, it is probable that the local deflections of the plumb line are due to this basalt mass.

The results given by the observations at stations to the east of the Gulf of Cambay show that Thikri, Latitude $22^{\circ} 2'$, Longitude $75^{\circ} 27'$, in the Nerbudda valley, lies in a small tract of abnormal positive values of O—C, the deflection of the plumb line.

115. At the time of submission of this report, the reduction of the Dehra Dún observations had not been fully completed.

PENDULUM OPERATIONS.

NO. 23 PARTY.

116. The work undertaken was the determination of the force of gravity at

Personnel.
Imperial Officer:
Major G. P. Lenox Conyngham, R.E., in charge.

Provincial Officer:
Babu Hanuman Prasad.

stations at the foot of the Himalayas, in and near the Siwaliks, and at a few stations belonging to or near the Great Arc including Nojli and Kaliána which were two of Captain Basevi's stations in 1865-66.

117. The objects in view were to ascertain whether the deficiency in the force of gravity, which seems to be a peculiarity of submontane tracts, is of sensibly constant amount over considerable areas, or is subject to local variations: to

examine some stations outside the Siwaliks at a place where the Siwaliks and Himalayas are distinctly separate, and to commence the search for the exact position of the crest of the hidden range, the existence of which was demonstrated by Colonel Burrard, R.E., F.R.S., in Professional Paper No. 5.

The stations.	118. The stations selected may be classified as follows:—
At the foot of the Himalayas	Rájpur Kálsi
In the Dún	Fatehpur
In the Siwaliks	Asárori Mohán Hardwar
Outside the Siwaliks	Roorkee Nojli
On the Great Arc	Kaliána Meerut Gesupur.

Observing Rooms.

119. At all these places observing rooms were obtained, in some cases good and in others only fair.

At Kaliána the observatory built by Sir G. Everest in 1835, and utilised on several subsequent occasions, was occupied. At Nojli the lower storey of the tower, which is the station of the Great Trigonometrical Survey, served as the observing room, but it was not very convenient, being too small and the temperature conditions in it not good. At most of the other stations Major Lenox Conyngham was indebted to officers of the Public Works Department or Military Works Service for the loan of inspection bungalows.

At Rájpur a good room in the premises of the Glass Factory was kindly lent, and in Meerut an excellent room in a private house was generously placed at the disposal of the party.

120. The alterations made since last field season in the attachment of the dummy pendulum, which carries the thermometer for determining the temperature of the pendulums, proved successful and a distinct increase in the accuracy of the results has been secured.

Temperature.

121. An iron pedestal for the pendulum stand was taken into use this year, replacing the brick pillars which had hitherto been employed. This reduced the amount of preparation necessary at each station.

Pedestal.

122. The star transits for the determination of clock rate were observed throughout by Babu Hanuman Prasad to the entire satisfaction of the officer in charge. The same instrument and method were used as during the season 1905-06.

Clock Rate.

123. Orographical corrections were required at six of the stations. It would perhaps have been legitimate to estimate several of them from general considerations, or from analogy with some of those stations for which the analysis has already been carried out. But as this could not be done for all it was thought better to perform the calculation in full in each case. The information gained will probably render it unnecessary to expend so much labour on the matter in future.

Orographical correction.

Results of the season's work.

124. The results of the observations are given in the table.

STATION.	Latitude.	Height above sea level.	Observed value of gravity = g .	g reduced to sea level = g_0 .	Theoretical value at sea level = γ_0 .	$g_0 - \gamma_0$.
	° ' "	Feet.	Dynes.	Dynes.	Dynes.	Dynes.
Rájpur . . .	30 24 12	3,321	979'002	979'205	979'330	-0'125
Kálsi . . .	30 31 0	1,684	979'131	979'234	979'339	-0'105
Fatehpur . . .	30 25 57	1,415	979'147	979'232	979'332	-0'100
Asárori . . .	30 14 25	2,467	979'059	979'205	979'317	-0'112
Mohán . . .	30 10 53	1,660	979'109	979'209	979'313	-0'104
Hardwar . . .	29 56 29	949	979'122	979'179	979'294	-0'115
Roorkee . . .	29 52 20	868	979'129	979'181	979'288	-0'107
Nojli . . .	29 53 28	879	979'143	979'194	979'290	-0'096
Kaliána . . .	29 30 55	810	979'154	979'202	979'260	-0'058
Meerut . . .	29 0 26	734	979'151	979'194	979'221	-0'027
Gesupur . . .	28 33 2	691	979'125	979'166	979'186	-0'020

It is to be noticed that there is everywhere a deficiency in gravity, which is considerable near the hills and grows rapidly less as we move southwards.

It is also to be noticed that the defect is less at western stations than at similarly situated points further to the east. Thus at Kálsi we have a defect of 0'105 and at Rájpur one of 0'125; at Fatehpur one of 0'100 and at Dehra one of 0'123; at Mohán one of 0'104 and at Hardwar one of 0'115; at Nojli one of 0'096 and at Roorkee one of 0'107.

These amounts are all larger than that found at Kalka, where the situation is similar to that at Kálsi or at Rájpur, but much less than the defect at Pathánkot which is in a position comparable to that of a place half way between Nojli and Mohán. At Kalka the defect was 0'085 and at Pathánkot 0'179; at Siliguri, again, which may be compared with Roorkee, the defect was 0'137.

We have evidence therefore that at the base of the hills and to some distance from them there is always a defect in the force of gravity, which we may interpret as a deficiency of density in the earth's crust, but that the amount of this deficiency is by no means constant.

The observations of 1904-05 and of 1905-06 showed that as we recede from the hills the force of gravity increases with reference to the calculated value, and at a distance of about 130 miles from the foot of the hills the excess attains a maximum. The southernmost station of this season was only about 100 miles from the foot of the hills and at it gravity was still in defect.

It is important that the position of the line of maximum excess, and also the amount of the excess, be determined with considerable precision along the whole length of the Himalayas.

125. Professor Dr. Hecker, who made pendulum observations at Jalpaiguri in 1905 in conjunction with Major Lenox Conyngham, has furnished his results. His value for g at Jalpaiguri based on Potsdam is 979'624; that obtained by Major Lenox Conyngham through Kew and Dehra Dún is 979'622. The accordance is very satisfactory.

TIDAL AND LEVELLING OPERATIONS.

No. 25 PARTY.

*Personnel.**Imperial Officer:*

Mr. C. F. Erskine, in charge.

Provincial Officers:

Messrs. J. P. Barker, H. G. Shaw, E. H. Corridon, Munshi Syed Zille Hasnain, Mr. A. M. Talati, Mr. O. N. Pushong, Babu P. N. Sur and Mr. D. H. Luxa.

126. Mr. C. F. Erskine held charge of the party throughout the year.

Subordinate Establishment:

1 Surveyor, 25 Computers, 2 Native Artificers and 4 Tidal Observatory Clerks.

TIDAL OPERATIONS.

127. Observations were taken by means of self-registering tide-gauges during the year at the stations enumerated in the following list:—

STATIONS.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	REMARKS.
1 Aden	1879	Still working	27	
2 Karachi	1881	Working up to 6th June 1907.	26	Wrecked on 6th June 1907. Being re-erected.
3 Bombay (Apollo Bandar)	1878	Still working	29	
4 Bombay (Prince's Dock)	1888	"	19	Property of Port Trust.
5 Madras	1880 re-started 1895	1890 Still working	10 } 12 } 22	
6 Kidderpore	1881	"	26	
7 Rangoon	1880	"	27	
8 Port Blair	1880	"	27	

128. In addition to the above, readings to tide-poles were taken at Bhávnagar, Chittagong, Akyab and Moulmein.

129. The 8 tidal observatories at work were inspected during the year; the registrations have been satisfactory at all of them, except at Karachi, where unfortunately a cyclone, which swept over the harbour on the 6th June, carried the cabin and all instruments and records therein located, bodily into the sea. Immediate steps were taken for the re-erection of the cabin and the necessary tidal instruments were promptly despatched from Dehra Dún. The Port Officer expects to have the cabin ready for the installation of the instruments and the resumption of observations in a short time. During the interruption, hourly readings to a tide-pole, during daylight, are being taken.

130. Owing to the contemplated enlargement of the Madras harbour, it will in all probability be necessary to remove the tidal observatory from its present position to some point on the new arm of the harbour which will project northwards. The exact position of the new observatory cannot be defined until the proposed new arm of the harbour has been completed and the present entrance to the harbour closed.

131. A tidal wave appeared in the Indian seas between the 4th and 6th January. The effect of this wave in raising the level of the water was depicted on the tidal diagrams at Port Blair, Madras, Bombay and Karachi. At Port Blair it was 5 inches, at Madras so small as to be reckoned insignificant, at Bombay it was 2 inches and at Karachi 3 inches.

132. In the following tables are given the annual and decadal percentages of the predicted time and height errors of high and low water at open coast and riverain stations:—

Percentage of Errors in Predicted Times and Heights at Open Coast Stations from Automatic Registrations.

YEAR.	Number of Stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within 1/8 of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1897	8	71	75	96	97	97	97
1898	9	74	70	96	95	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	83	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
1906	6	85	81	96	97	94	95
Average of 10 years	8	76	71	95	95	95	94

Percentage of Errors in Predicted Times and Heights at Riverain Stations from Automatic Registrations.

YEAR.	Number of Stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within 1/8 of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
1906	2	59	53	74	64	92	95
Average of 10 years	2	56	60	73	60	92	91

133. The re-opening of the observatory at Moulmein was expected to have taken place early in this year, but owing to revision of plans and estimates requiring the official sanction of Government the erection had to be put off. Further

postponement of the work was necessitated by the advent of the monsoon; during the rains the state of the river due to floods, etc., is such that the construction of the observatory during this period would be slow and involve unwarrantable expenditure; the work had therefore to be held over until cessation of the rains. A set of the required instruments is ready for despatch at a moment's notice.

134. The establishment of tidal observatories at Koweit and Bahrein in the Persian Gulf has been proposed and approved by the Indian Government; the final decision of the Home Government is awaited. The needful preliminary measures involved in the undertaking have been attended to, so that there will be no delay in entering upon the project when final sanction shall have been obtained.

135. The idea of erecting a tidal observatory at Suakim in the Red Sea is still borne in mind, but no measures have been taken towards the furtherance of the scheme during the past year.

LEVELLING OPERATIONS.

136. There were three detachments engaged on the levelling operations of the past season.

137. No. 1 Detachment was employed principally on the revision of old levels along the G. I. P. Railway between Bombay and Madras *via* Gulbarga, Raichur, Gooty, Arkonam. The portion levelled over was from Bombay to Bársi Road, a distance of 236 miles. This detachment also connected standard bench-marks at Bombay, Poona, Kirkee and Ahmednagar and executed a short line of levels from Mussooree to Lal Tibba in Landour. The total outturn amounted to 257 miles of levelling. The field season for this detachment commenced on 13th October and ended on 30th May.

137. No. 2 Detachment executed the following lines of levels: Gwalior to Jhánsi, Segra Tower Station to Dera Ismail Khan, Ráwalpindi to Chach Base and thence to Pesháwar, and Saháranpur to Dehra Dún, the last being revision work. Eight new standard bench-marks were connected at the following places: Jhánsi, Delhi, Ambála, Ludhiána, Ferozepore, Jhelum, Attock and Pesháwar. The mileage totalled up to 284 miles. The field season began on 21st October and terminated on 16th May.

138. No. 3 Detachment was mainly employed on the line Bombay to Madras for purposes of revision, the portion revised being from Bársi Road to Kosgi, a length of 236 miles. Connection was made with the standard bench-marks at Sholapur and Devláli. In Mussooree a short line of levels was run to Banog H. S. The total outturn was 264 miles. This detachment's field operations lasted from 29th October to 4th June.

139. The new height of Raichur derived from the revised levelling from Bombay differs from that obtained from observations taken between 1878-81, by 1 foot 10 inches, the difference tending to cancel the error of 3 feet between the mean sea levels of Bombay and Madras as exhibited by the old levelling.

140. The new value for Raichur also diminishes the difference between the mean sea levels of Bombay and Kárwár, taking the route Bombay, Gulbarga, Raichur, Bellary, Hubli, Kárwár, by 9 inches; the difference by the old levelling being 11 inches.

141. The circuit Moorghai, Chach, Lahore, Ferozepore, Moorghai was completed last field season, the closing error being $7\frac{1}{2}$ inches.

142. The line Saháranpur to Dehra Dún was revised with the object of ascertaining whether any change had taken place in the heights of Dehra and Mussooree due to the earthquake of 4th April 1905. The result showed Mussooree unaltered and Dehra apparently raised by 5 inches.

143. Comparisons have been made between the results of levelling across water by three methods, namely: (1) the tide-pole or water-gauge method, (2) by vertical angles taken with a theodolite, (3) by observations with levels. A very good opportunity presented itself last field season of testing the accuracy of the different methods. The *locale* of these experiments was on the Indus

river at Darya Khan. Tide-pole and vertical angle observations were taken where the channel was narrow, about $\frac{1}{2}$ mile in breadth; the actual levelling a few miles lower down, where islands had formed, affording the observers a convenient line for levelling across; the distances between staff and instrument not being more than 7 chains in any instance. The results by vertical angles are identical with those obtained by actual levelling, both differing from the result by the tide-pole method by 3 inches.

144. During the past year 19 standard bench-marks were erected, of which 14 have been connected; 27 are now in course of construction.

Up to date the number of standard bench-marks completed is 41; of these 36 have been connected, 5 remain to be levelled to. In all, 68 have been dealt with since 1903, when the scheme of erecting standard bench-marks all over India was initiated.

145. The number of bench-marks reported in the past year as destroyed is 205.

146. Binocular Precise Levels, imported from America, were for the first time used by Indian levellers last field season, with satisfactory results. Their employment involved certain deviations from the methods of levelling in vogue when observing with the cylindrical levels, the main departure being the reading of only one face of the staves on 3 wires of the instrument. The party has four of these levels, of which three were in use in the field.

147. The levelling operations to be performed during the coming field season are:—

For No. 1 Detachment: to level from Gooty to Madras, about 258 miles closing on the bed-plate of the tide-gauge at Madras, and to connect the standard bench-marks at Cuddapah and Madras.

No. 2 Detachment: to level from Ferozepore along the railway line, towards Ahmedabad as far as Bikanir, about 257 miles, and to connect the standard bench-marks at Bikanir, Multán and Dera Ismail Khan.

No. 3 Detachment: to connect the standard bench-mark at Raichur, to level from Kosgi to Gooty, about 68 miles; then to go on to Hyderabad (Deccan), connect the 3 standard bench-marks at Secunderabad and level towards Wardha (C. P.), partly by rail and partly by road, over a distance of about 200 miles.

REFRACTION OBSERVATIONS.

(AUTUMN 1906, SPRING 1907.)

148. Refraction observations were continued in October, November and December 1906, and March, April and May 1907.

The snow peaks, Bandarpunch 20,720 feet, Srikanta 20,120 feet, Jaonli 21,760 feet, and Kedarnath 22,770 feet, were observed from Mussooree 6,931 feet, Nag-Tibba H. S. 9,915 feet (spring 1907 only), and two stations at Nojli, one at ground level 888 feet, and the other at top of Nojli T. S. 938 feet (spring 1907 only).

Reciprocal vertical angles were taken between Mussooree-Dehra, Mussooree-Nojli (Shaw's) Mussooree-Nojli T. S. (spring 1907 only) and Mussooree-Nag-Tibba H. S. (spring 1907 only).

The spirit-levelled heights being accepted as correct, the errors due mainly to refraction are:—

Between Mussooree-Dehra, 3 feet for both seasons.

Between Mussooree-Nojli (Shaw's), 2 feet for autumn 1906, and 7 feet for spring 1907.

This difference in the heights for autumn and spring is chiefly due to the changes in the angles taken at Mussooree for these seasons.

Between Mussooree-Nojli T. S., 10 feet for spring 1907.

The results of the observations are as follows:—

(i) At Mussooree. No change in the difference of height of Dehra and Nag-Tibba H. S. for the years 1905-06 and 1906-07.

- (ii) As in the year 1905-06, the deduced heights of snow peaks and the two stations at Nojli were again lower in spring 1907 than in autumn 1906; Bandarpunch being 11 feet lower, Srikanta 8 feet, Jaonli 5 feet, and Kedarnath 12 feet, Nojli T. S. about 12 feet, and Nojli (Shaw's) 9 feet.
- (iii) It follows from the preceding paragraph that for the past two years refraction has varied between autumn and spring.
- (iv) The difference in the heights of snow peaks between autumn 1905 and autumn 1906, spring 1906 and spring 1907 were, respectively as follows:—

	Autumn.	Spring.
Bandarpunch	7 feet	0 foot
Srikanta	5 feet	13 feet
Jaonli	8 feet	10 feet
Kedarnath	16 feet	No observations in Spring 1906.

The autumn heights 1906, being lower, and the spring height 1907, higher.

- (v) During 1906-07, it sometimes happened that the angles of depression to the two stations at Nojli were less at 10 A.M. than at 8 A.M., varying from 2 seconds to 10 seconds, thus the heights of these two stations at Nojli would have been higher at 10 A.M. than at 8 A.M. No such irregularity occurred in 1905-06.

At Nojli. - The changes in the angles of elevation at minimum to Mussooree have been very small during the years 1905-06 and 1906-07, and consequently refraction has been steady during these years for observations to Mussooree.

- (i) The heights of the snow peaks were lower in spring 1907 than in autumn 1906, Bandarpunch being 28 feet lower, Jaonli 4 feet, and Kedarnath 27 feet.

For want of observations no comparisons can be made in the difference of height of snow peaks between the years 1905-06 and 1906-07.

At Nag-Tibba H. S.—The heights of snow peaks in spring 1907 were higher than in spring 1906, Bandarpunch being 8 feet higher, Srikanta 14 feet and Jaonli 18 feet.

MAGNETIC OPERATIONS.

No. 26 PARTY. -

149. *Work of the field detachments.*—During the year under report field operations were carried on by four detachments: two were employed in Burma, one in Assam, Manipur and Lushai, and the fourth in Chota Nagpur, the Agency tracts of Vizagapatam and the Tributary States of Orissa.

Personnel.

Imperial Officers :

Captain R. H. Thomas, R.E., in charge.
Lieutenant H. J. Couchman, R.E.

Provincial Officers :

Messrs. E. C. J. Bond, and H. P. D. Morton, Babu R. P. Ray,
Mr. E. A. Meyer, and Babu N. R. Mazumdar.

Subordinate Establishment:

14 Observers, Recorders, Computers, and 2 Surveyors and 1 Writer.

In addition, observations were made at eight stations.

grouped round Buxar to investigate the abnormal value of declination found in 1903-04.

The total outturn of new stations was 152. The field season commenced on the 19th October 1906 and the party proceeded to recess quarters on 1st May 1907.

150. *Work of the Imperial Officers.*—A second Imperial Officer, Lieutenant H. J. Couchman, R.E., was posted to the party in September 1906; with his assistance all the repeat stations, 22 in number, were visited. The officer in charge inspected the observatories at Dehra Dún, Barrackpore, Kodaikanal and Toungoo, and carried out comparative observations at each to determine the differences from the survey standard.

Vertical force magnetographs were erected at Barrackpore, Kodaikanal and Toungoo observatories and satisfactory adjustments of the temperature co-efficients made.

Vertical force magnetographs are now working at all the observatories and have continued to give good results except at Kodaikanal. At this observatory, however, the magnet which had proved unsatisfactory at Dehra Dún has been only temporarily mounted, pending the arrival of a new magnet which will be installed in December next; it seems probable that the agate knife edge of the present magnet is defective. The officer in charge also installed earth inductors of the Schulze pattern in each observatory to replace the dip circles; the inductors were previously compared with one another and gave extraordinarily accordant results, the greatest difference in dip between any pair, by simultaneous observations, being $\pm 0\cdot2$.

The temperature co-efficient of the Toungoo H. F. magnetograph was also satisfactorily determined, the value found being $-7\cdot4\gamma$ per 1°F .

151. *Total work to date.*—The total number of stations occupied to date is 1,110 with 22 repeat stations.

In addition the Magnetic Survey is indebted to Captain C. M. Browne, D.S.O., R.E., who observed the magnetic declination at 25 stations on the Seistan trade route with equipment supplied by this party. Included in these observations are the largest values of east declination observed during the present survey, *viz.*, 5°E at Malikshah in latitude $29^{\circ} 1' 42''$, longitude $62^{\circ} 58' 57''$, and $7^{\circ} 43'\text{E}$ at Gharibo in latitude $29^{\circ} 20' 30''$, longitude $62^{\circ} 58' 30''$.

152. *Work during recess.*—During the recess season the computations of the field work have been completed, while the reduction and tabulation of the base station results are also practically finished. The field instruments were all compared with the survey standards at the beginning and end of the field season. Further investigations have been made with regard to the correction of the field observations for diurnal variation. From the results from the four base stations, Colaba, Dehra Dún, Barrackpore and Kodaikanal, simple formulæ connecting change in diurnal variation with change in latitude had already been established, by which using the results of two base stations the diurnal variation at any third station may be determined: in the present investigation the results of Toungoo observatory were included to determine whether the formulæ would still hold good within the wider limits of longitude.

The results were quite satisfactory, and the formulæ have now been established for the limits of the magnetic survey of India.

It was again noticed that the results when using the Kodaikanal H. F. values were never so satisfactory as when this observatory was excluded from the discussion; in the reduction this observatory will not be used, if the curves from two other base stations are available. The discordance probably arises from the fact of this observatory being situated on rock which is distinctly magnetic. Investigations into the variation of disturbances from point to point are in progress at the present time on lines suggested by Sir A. Rücker, F.R.S.; these investigations which require a knowledge of the variations of the vertical component of the earth's field could not be commenced until results from the vertical force magnetographs were available and the installation of these instruments was completed only in March last.

153. *The base stations.*—With the exception of the Kodaikanal vertical force instrument, the base station magnetographs continued to work satisfactorily throughout the year.

With the compensation devices provided, the temperature co-efficients of the vertical force instruments were reduced to the figures noted below:—

Dehra Dún	$-5\cdot2\gamma$	} per 1°F .
Barrackpore	.	.	.	.	.	.	$+3\cdot9\gamma$
Toungoo	.	.	.	.	.	.	$-2\cdot1\gamma$
Kodaikanal	.	.	.	.	.	.	$+3\cdot4\gamma$

The earth inductor No. 30 by Schulze has replaced dip circle No. 44 as the survey standard, the difference between their indications being—

$$\text{Inductor 30} - \text{Dip Circle 44} = +0\cdot8.$$

154. *The mean values of magnetic elements at observatories for 1906.*—The mean values of the magnetic elements at the observatories for 1906 are as follows:—

Dehra Dún	Declination	2° 39.'2 E.
	H. F.	.33365 C.G.S.
	Dip	43° 29.'8.
Barrackpore	Declination	1° 14.'1 E.
	H. F.	.37259 C.G.S.
	Dip	30° 26.'4.
Kodaikanal	Declination	0° 36.'3 W.
	H. F.	.37425 C.G.S.
	Dip	3° 21.'1.
Toungoo	Declination	0° 43.'6 E.
	H. F.	.38715 C.G.S.
	Dip	22° 59.'2.

155. *Work projected for 1907-08.*—During the next field season (the last of the preliminary survey) three detachments will be employed in Burma and its administered tracts, while a fourth will observe in India in such tracts as remain.

It is estimated that 110 new stations will be established which with previous seasons' work will give a total of 1,220.

The extension of the survey into the Himalayas which is most desirable must be deferred until the detailed survey is begun.

It is hoped that the reduction of the field work may be so far advanced as to indicate, before the field season 1908-09, the disturbed districts in which detailed observations should be taken; but this reduction cannot be properly effected until satisfactory formulæ, empirical or theoretical, have been found for the variation from point to point of disturbances, and sufficient data accumulated for the investigation of the proper values to assign to the secular change in the districts intervening between the base stations: should then, as is probable, this reduction not be sufficiently advanced, the detailed survey will be begun by the examination of the northern edge of the Deccan trap which has already been asked for by the Geological Survey.

156. A table showing the approximate preliminary values (uncorrected) at the field and repeat stations in 1906-07 is appended, together with a reference index map showing all the stations of observation to date.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1906-07.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ' "	° ' "	° ' "	° ' "	C.G.S.	
959	Gahmar	13	25 29 0	83 48 10	36 6	E 1 42	0'3603	
960	Dumraon	14	25 34 40	84 7 30	36 1	" 0 19	0'3547	
961	Mandalay	1	21 59 50	96 6 30	29 10	" 0 51	0'3801	
962	Wunbye	2	21 56 10	95 32 20	29 6	" 0 55	0'3794	
963	Alôn	3	22 13 30	95 4 50	29 35	" 1 4	0'3792	
964	Maymyo	4	22 2 20	96 28 0	29 20	" 0 54	0'3787	
965	Gokteik Viaduct	5	22 20 10	96 51 30	29 59	" 0 50	0'3787	
966	Hsipaw	1	22 36 40	97 17 50	30 33	" 0 54	0'3777	
967	Manpwe	2	22 50 40	97 35 30	30 58	" 0 57	0'3766	
968	Paukkan	6	22 14 10	95 52 10	29 44	" 1 2	0'3785	
969	Shwèbo	7	22 35 0	95 41 50	30 22	" 0 57	0'3780	
970	Kanbalu	1	23 13 10	95 32 40	31 47	" 0 58	0'3748	
971	Kawlin	2	23 47 30	95 41 10	32 39	" 0 42	0'3747	
972	Naba	3	24 15 0	96 11 10	33 37	" 0 57	0'3727	
973	Mohnyin	4	24 46 30	96 21 20	34 52	" 0 7	0'3720	
974	Taungni	1	25 10 20	96 44 20	36 6	W 0 21	0'3707	
975	Myitkyina	1	25 23 20	97 24 10	36 7	E 1 43	0'3619	
976	Sinbo	1	24 46 40	97 2 50	34 56	" 1 31	0'3703	
977	Bhamo	2	24 15 30	97 13 10	33 42	" 1 4	0'3731	
978	Sikaw	3	23 50 0	97 4 0	32 50	" 1 11	0'3734	
979	Namhkam	4	23 50 0	97 40 10	32 52	" 0 54	0'3740	
980	Hsenwi (Theinui)	5	23 17 40	97 57 10	31 56	" 0 57	0'3753	
981	Mantôn	6	23 15 0	97 7 0	31 47	" 0 51	0'3753	
982	Mogòk	8	22 56 0	96 31 20	30 59	" 0 58	0'3776	
983	Wainglon	5	23 27 50	96 36 30	32 15	" 1 18	0'3727	
984	Tagaung	6	23 30 20	96 0 50	32 25	" 1 9	0'3738	
985	Thabeikkyin	9	22 50 50	95 58 20	31 6	" 1 1	0'3765	
986	Sin-gu or Nga-sin-gu.	10	22 32 50	95 59 30	30 36	" 1 11	0'3784	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1906-07—contd.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ' "	° ' "	° ' "	° ' "	C.G.S.	
987	Yeshin . . .	३३ 7	23 43 10	95 7 20	32 42	E 0 56	0°3736	
988	Manyu . . .	" 8	24 19 20	95 33 40	33 35	" 1 13	0°3736	
989	Nánantón . . .	" 9	24 45 30	95 40 30	34 39	" 1 0	0°3702	
990	Homalin . . .	३३ 1	24 51 50	95 54 30	35 0	" 1 10	0°3693	
991	Paungbyin . . .	" 2	24 16 0	94 48 20	23 47	" 1 8	0°3708	
992	Klndat . . .	" 3	23 44 10	94 26 0	32 43	" 1 10	0°3730	
993	Kaléwa . . .	" 4	23 11 20	94 18 20	31 36	" 1 2	0°3756	
994	Peginma . . .	३३ 1	22 43 50	94 42 30	30 41	" 1 3	0°3769	
995	Gházípur . . .	३३ 15	25 33 50	83 33 20	...	" 1 37	0°3600	
996	Zahúrábád . . .	" 16	25 44 40	83 43 30	36 11	" 1 31	0°3573	Dip not observed.
997	Ballia . . .	" 17	25 45 10	84 9 10	36 42	" 1 10	0°3550	
998	Dighwára . . .	३३ 10	25 41 30	85 0 40	36 5	" 1 22	0°3590	
999	Ekma . . .	" 18	25 58 10	84 32 10	37 22	" 1 5	0°3492	
1000	Ránisankail . . .	३३ 10	25 54 10	88 15 10	36 29	" 1 32	0°3600	
1001	Taria . . .	" 11	26 15 40	88 23 40	36 49	" 1 33	0°3617	
1002	Charpanguri . . .	३३ 9	26 33 0	90 8 10	37 51	" 1 30	0°3588	
1003	Bijni . . .	" 10	26 28 50	90 42 10	37 25	" 1 24	0°3628	
1004	Patacharkuchi . . .	३३ 10	26 30 40	91 4 10	37 49	" 2 12	0°3571	
1005	Jia Bor . . .	" 11	26 43 30	91 42 30	38 3	" 1 38	0°3603	
1006	O'událgiri . . .	" 12	26 45 50	92 6 50	38 8	" 1 29	0°3598	
1007	Mokersá . . .	" 13	25 31 10	91 25 0	35 10	" 1 9	0°3633	
1008	Nongshobar . . .	३३ 11	25 32 10	90 52 50	35 31	" 1 38	0°3674	
1009	Rongrengiri . . .	" 12	25 33 0	90 33 20	35 40	" 1 9	0°3657	
1010	Damalgi . . .	" 13	25 31 40	90 6 50	36 9	" 2 19	0°3654	
1011	Nálitábári . . .	" 14	25 5 10	90 11 10	34 39	" 0 55	0°3667	
1012	Asma . . .	३३ 11	24 54 10	90 53 20	34 41	" 1 16	0°3671	
1013	Ajmiriganj or Abidábád . . .	३३ 6	24 33 50	91 14 10	34 5	" 1 16	0°3691	
1014	Sunámganj . . .	३३ 14	25 4 10	91 23 30	34 55	" 1 23	0°3676	
1015	Sylhet . . .	३३ 7	24 53 0	91 52 0	34 40	" 1 17	0°3678	
1016	Mokokchang . . .	३३ 8	20 19 40	94 31 50	37 31	" 1 11	0°3639	
1017	Wokhá . . .	" 9	26 5 40	94 15 40	36 59	" 1 11	0°3656	
1018	Kohmá . . .	" 10	25 40 10	94 6 40	36 12	" 1 15	0°3656	
1019	Karong . . .	" 11	25 18 40	94 2 30	35 32	" 1 9	0°3670	
1020	Manipur . . .	३३ 5	24 48 30	93 56 30	34 31	" 1 4	0°3697	
1021	Lengbu . . .	" 6	24 44 40	93 24 10	34 27	" 1 8	0°3698	
1022	Kolosib . . .	३३ 8	24 15 20	92 42 10	33 29	" 1 12	0°3714	
1023	Aijal . . .	" 9	23 43 30	92 43 10	32 27	" 1 6	0°3730	
1024	Tenzoil . . .	" 10	23 18 20	92 47 10	31 44	" 1 7	0°3734	
1025	Lungleh . . .	३३ 2	22 53 40	92 44 50	30 56	" 1 5	0°3753	
1026	Rángámati . . .	" 3	22 38 10	92 11 50	30 24	" 1 4	0°3762	
1027	Bhatiyari . . .	" 4	22 26 10	91 45 0	29 56	" 1 0	0°3766	
1028	Mirsarai . . .	" 5	22 46 40	91 37 50	30 38	" 1 4	0°3753	
1029	Silli . . .	३३ 13	23 21 10	85 50 40	32 1	" 1 14	0°3673	
1030	Ránchi . . .	" 14	23 22 40	85 19 30	31 52	" 1 25	0°3667	
1031	Jariagarh . . .	" 15	23 1 40	85 1 0	31 3	" 1 0	0°3689	
1032	Kolebira . . .	३३ 10	22 42 20	84 42 0	30 30	" 1 6	0°3714	
1033	Chakarkend . . .	" 11	21 18 10	83 30 30	27 48	" 0 51	0°3725	
1034	Pátna . . .	३३ 10	20 42 20	83 8 20	26 14	E 0 44	0°3759	
1035	Khariár . . .	३३ 10	20 17 40	82 46 0	25 35	" 0 23	0°3758	
1036	Nawarapara . . .	" 11	20 48 40	82 31 50	26 54	" 0 38	0°3725	
1037	Saraipali . . .	३३ 12	21 18 20	83 0 30	27 52	" 1 2	0°3725	
1038	Pithora . . .	३३ 14	21 15 20	82 31 10	27 32	" 0 49	0°3712	
1039	Tumgaon . . .	३३ 15	21 11 40	82 7 20	27 30	" 0 46	0°3722	
1040	Chimúr . . .	३३ 11	20 29 0	79 22 10	25 46	" 0 43	0°3710	
1041	Garhchiroli . . .	" 12	20 11 0	80 0 40	25 17	" 0 48	0°3736	
1042	Jaroundi . . .	" 13	19 59 40	80 26 20	25 0	" 0 39	0°3739	
1043	Parlákót . . .	" 14	19 47 0	80 41 10	24 29	" 0 35	0°3750	
1044	Koilibeda . . .	" 15	19 57 40	80 59 0	24 40	" 0 36	0°3748	
1045	Narainpur . . .	३३ 12	19 43 10	81 14 50	24 5	" 0 44	0°3752	
1046	Kondagaon . . .	" 13	19 35 10	81 40 10	24 5	" 0 31	0°3768	
1047	Kilepal . . .	३३ 10	18 58 40	81 36 40	23 4	" 0 29	0°3765	
1048	Barsur . . .	३३ 14	19 8 10	81 23 20	23 19	" 0 23	0°3760	
1049	Byramgarh . . .	" 15	19 0 30	81 2 40	22 56	" 0 24	0°3774	
1050	Vijapur . . .	३३ 14	18 47 20	80 49 0	22 15	" 0 23	0°3789	
1051	Pothikál . . .	" 15	18 32 30	80 54 0	22 15	" 0 19	0°3754	
1052	Chintulnár . . .	३३ 11	18 20 50	81 11 10	21 41	" 0 34	0°3793	
1053	Madder . . .	३३ 16	18 46 20	80 33 10	23 6	" 0 37	0°3737	
1054	Matimirka . . .	" 17	18 59 30	80 16 50	23 1	" 0 32	0°3746	
1055	Kumargura . . .	३३ 16	19 26 30	80 32 30	23 38	" 0 37	0°3771	
1056	Ahiri . . .	" 17	19 24 40	79 59 50	23 54	" 0 38	0°3749	
1057	Ghot . . .	" 18	19 49 0	79 59 20	24 40	" 0 32	0°3737	
1058	Kondasantha . . .	३३ 12	17 46 0	82 33 40	19 56	" 0 51	0°3816	
1059	Parlakimedi . . .	३३ 6	18 47 10	84 5 0	22 27	" 0 25	0°3803	
1060	Jagganathpuram . . .	३३ 11	19 1 50	83 46 30	22 57	" 0 29	0°3794	
1061	Sirgudi . . .	" 12	19 25 20	83 49 0	23 43	" 0 30	0°3785	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1906-07—contd.

Serial No.	Name of station.	Survey No.	Latitude.			Longitude.			Dip.		Declination.		Horizontal Force.	REMARKS.	
			°	'	"	°	'	"	°	'	°	'	C.G.S.		
1062	Govindapur	13	19	29	50	84	25	20	23	54	E	0	40	0'3789	
1063	Ghúsari	19	25	22	30	84	9	10	35	37	"	1	0	0'3653	
1064	Arrah	20	25	33	0	84	40	20	35	46	"	1	30	0'3602	
1065	Palón	1	17	26	20	95	56	0	19	41	"	0	39	0'3900	
1066	Minbla	2	17	58	30	95	42	20	20	52	"	0	39	0'3890	
1067	Paungdé	3	18	29	50	95	29	50	22	1	"	0	41	0'3882	
1068	Prome	4	18	49	40	95	13	20	22	41	"	0	39	0'3874	
1069	Henzada Shore.	5	17	38	30	95	29	10	20	14	"	0	43	6'3893	
1070	Athók	6	17	12	10	95	5	0	19	4	"	0	41	0'3904	
1071	Bassein	1	16	46	20	94	44	30	18	7	"	0	35	0'3909	
1072	Pegu	7	17	20	30	96	28	40	19	32	"	0	47	0'3903	
1073	Pyuntaza	8	17	53	0	96	43	20	20	52	"	0	29	0'3884	
1074	Nyaungbintha	9	18	24	20	96	27	20	22	1	"	0	41	0'3873	
1075	Myohla	1	19	24	40	96	16	10	24	5	"	0	49	0'3870	
1076	Pyókkuwe	2	19	57	10	96	13	30	25	19	"	0	46	0'3846	
1077	Shweda	3	20	31	10	96	4	50	26	18	"	0	54	0'3837	
1078	Thédaw	11	21	5	10	96	3	50	27	28	"	0	48	0'3818	
1079	Kyauksé	12	21	36	30	96	8	0	28	30	"	0	47	0'3799	
1080	Mahlaing	13	21	5	40	95	38	40	27	24	"	0	52	0'3816	
1081	Myingyan	14	21	28	30	95	23	40	28	11	"	0	55	9'3806	
1082	Pakókku	15	21	20	0	95	5	30	28	4	"	0	33	0'3799	
1083	Sabè	2	21	27	20	94	35	0	28	22	"	0	52	0'3802	
1084	Pasók	3	21	23	0	94	11	0	28	3	"	0	53	0'3799	
1085	Shwegóndaing	4	21	49	10	94	6	30	28	59	"	0	50	0'3783	
1086	Thitkyidaing	5	22	1	20	94	32	10	29	15	"	0	55	0'3784	
1087	Salingyi	16	21	58	30	95	4	40	28	30	"	0	43	0'3818	
1088	Seikpyu	1	20	54	20	94	47	30	27	0	"	0	48	0'3820	
1089	Kyaukyè	2	20	34	40	94	48	30	26	22	"	0	46	0'3826	
1090	Minbu	3	20	10	0	94	53	20	25	31	"	0	43	0'3837	
1091	Sinbaungwè	4	19	43	0	95	9	30	24	31	"	0	43	0'3850	
1092	Thayetmyo	5	19	19	30	95	11	10	23	45	"	0	40	0'3859	
1093	Mindón	4	19	21	10	94	44	10	24	0	"	0	40	0'3857	
1094	Myothit	5	19	45	20	94	38	10	24	41	"	0	45	0'3841	
1095	Ngapè	6	20	4	50	94	28	0	25	29	"	0	42	0'3837	
1096	Sidóktaya	7	20	25	50	94	14	0	26	10	"	0	45	0'3824	
1097	Tauksók	8	20	43	30	94	8	10	26	45	"	0	50	0'3818	
1098	Kyindwé	9	20	58	10	93	50	10	27	5	"	1	0	0'3806	
1099	Thónlábyi	6	21	4	20	94	16	10	27	26	"	0	50	0'3811	
1100	Chaunggya	6	20	44	0	95	13	30	26	49	"	0	37	0'3818	
1101	Myindègyi	7	20	26	30	95	36	30	26	0	"	0	49	0'3837	
1102	Taungdwingyi	8	20	0	0	95	32	50	25	13	"	0	40	0'3846	
1103	Nget-pyaw-gyin	9	19	34	20	95	39	20	24	17	"	0	45	0'3860	
1104	Taunglè	10	18	53	30	95	40	20	22	46	"	0	44	0'3872	
1105	Thamaing	1	16	51	50	96	7	0	18	27	"	0	37	0'3911	
1106	Myohaung	10	20	35	20	93	11	20	26	22	"	0	53	0'3816	
1107	Myebón	11	20	4	0	93	22	20	25	18	"	0	43	0'3835	
1108	Rathedaung	1	20	29	10	92	45	10	26	3	"	0	48	0'3822	
1109	Maungdaw	2	20	49	50	92	21	40	26	50	"	0	53	0'8310	
1110	Chakiria	6	21	46	0	92	5	50	28	41	"	0	55	0'3785	
1111	Devláli		19	53	10	73	48	50	24	57	"	0	12	0'3639	
	Nushki No. 1		29	33	10	66	1	0			"	2	17		Declination only observed.
1112	Do. „ 2		29	32	0	66	0	40			"	2	15		Ditto.
1113	Khuchaki		29	4	20	65	29	50			"	2	27		Ditto.
1114	Padag No. 1		29	1	20	65	18	10			"	2	57		Ditto.
1115	Do. „ 2		29	1	30	65	17	30			"	3	12		Ditto.
1116	Chahar Sar		28	57	0	65	0	10			"	1	58		Ditto.
1117	Yadgar		28	57	30	64	56	0			"	2	7		Ditto.
1118	Karodak		28	57	10	64	40	50			"	2	32		Ditto.
1119	Dalbandin No. 1		28	54	10	64	25	30			"	2	34		Ditto.
1120	Do. „ 2		28	54	30	64	25	40			"	2	32		Ditto.
1121	Kisanen Chapper		29	4	0	64	22	40			"	2	38		Ditto.
1122	Malik Siah Koh		29	12	20	63	55	0			"	2	35		Ditto.
1123	Malik Teznan H. S.		29	24	40	63	40	50			"	1	47		Ditto.
1124	Gat-i-Barot		28	57	10	63	35	10			"	2	30		Ditto.
1125	Gharibo . I		29	20	30	62	58	30			"	7	43		Ditto.
1126	Do. . II		29	20	10	62	58	10			"	3	1		Ditto.
1127	Do. . III		29	19	30	62	58	0			"	3	51		Ditto.
1128	Malik Shah		29	1	40	62	59	0			"	4	58		Ditto.
1129	Kondi . I		28	50	20	62	36	0			"	2	45		Ditto.
1130	Do. . II		28	49	40	62	35	40			"	2	40		Ditto.
1131	Tuzgi . H. S.		28	53	10	62	15	0			"	2	50		Ditto.
1132	Shuri . H. S.		29	11	0	62	29	50			"	2	38		Ditto.
1133	Nil Dik		29	15	40	62	42	20			"	2	55		Ditto.
1134	Miri Sultan H. S.		29	7	10	62	48	20			"	2	38		Ditto.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1906-07—concl'd.

Repeat stations.

Serial No.	Name of station.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Forces.	REMARKS.
		° ' "	° ' "	° ' "	° ' "	C.G.S.	
I	Udaipur	24 35 33	73 41 57	33 43	E 1 25	0'3533	
II	Karachi	24 49 50	67 2 2	34 5	" 1 41	0'3458	
III	Quetta	30 11 52	67 0 20	42 58	" 2 57	0'3232	
IV	Bahawalpur	29 23 27	71 40 37	41 59	" 2 53	0'3319	
V	Rawalpindi	33 35 16	73 3 6	48 8	" 3 40	0'3123	
VI	Bharatpur	27 13 31	77 29 28	38 43	" 2 0	0'3400	
VII	Bangalore	12 59 35	77 35 58	9 45	W 0 35	0'3815	
VIII	Dhárwar	15 27 26	74 59 35	15 17	" 0 10	0'3763	
IX	Porbandar	21 38 20	69 37 6	28 39	E 1 16	0'3601	
X	Fyzabad	26 47 27	82 7 40	37 49	" 1 50	0'3534	
XI	Sambalpur	21 28 3	83 58 26	27 48	" 0 53	0'3731	
XII	Waltair	17 42 54	83 19 1	21 8	" 0 21	0'3786	
XIII	Darjeeling	26 59 49	88 16 39	38 19	" 1 40	0'3566	
XIV	Gaya	24 46 30	84 58 54	34 12	" 1 13	0'3663	
XV	Secunderabad	17 27 11	78 29 16	20 8	" 0 22	0'3791	
XVI	Bhusával	21 2 46	75 47 18	26 53	" 0 52	0'3681	
XVII	Jubbulpore	23 8 57	79 56 44	30 55	" 1 6	0'3648	
XVIII	Favoy	14 4 50	98 12 30	12 12	" 0 38	0'3954	
XIX	Lashio	22 56 47	97 44 40	31 19	" 0 51	0'3762	
XX	Akyab	20 7 53	92 53 18	25 28	" 0 52	0'3828	
XXI	Silchar or Cachár	24 49 43	92 47 21	34 40	" 1 16	0'3692	
XXII	Dibrugarh	27 29 24	94 55 40	39 28	" 1 23	0'3585	

NOTE.—The above values of Dip, Declination and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered as preliminary values only. Where blanks occur, values have been already found during previous field seasons, or the observations have not been completed. The Survey numbers refer to the published chart : thus No. 3 denotes No. 3 station in the dotted square the spherical co-ordinates of whose centre are 26° North Latitude, and 76° East Longitude. All Longitudes are referable to that of Madras observatory taken at the value 80° 14' 47" East from Greenwich.

TOPOGRAPHICAL SURVEYS.

CENTRAL AND UNITED PROVINCES AND CENTRAL INDIA STATES.

NO. 1 PARTY (VIDE INDEX MAP NO. 1).

157. The party was again employed in completing standard sheets of which the Central Provinces portions had been surveyed. Field work commenced towards the end of October and continued till the end of May, when notwithstanding the long field season, the programme still remained unaccomplished. There has been some improvement among the many inferior surveyors in this party and they will be given another chance, but those who still remain inefficient at the end of the next field season will be discharged. Five soldier-surveyors were attached to the party for training, all of whom completed their second season's extra training, but none of them were recommended for retention in the Survey regiments.

Personnel.

Imperial Officers :

Major A. H. B. Hume, R.E., in charge up to end of February when he reverted to Home service.

Lieutenant K. W. Pye, R.E., joined the party on 7th October 1906 and in charge from 1st March to 17th June 1907.

Lieutenant M. N. MacLeod, R.E., in charge from 18th June 1907.

Provincial Officers :

Messrs. F. S. Bell, F. P. Walsh, W. Skilling, C. Litchfield, B. M. Berrill, and R. E. Saubolle.

Subordinate Establishment :

55 Surveyors, etc.

158. The greater part of the area surveyed lay in the United Provinces and Central India States adjoining the northern border of the Central Provinces, where the country is hilly and mostly covered with jungle, the hills having long gentle slopes on one side which were very difficult to survey. The outturn for the season and cost-rates are as follows :—

	Square miles.	R
Re-survey on the 2-inch scale of Central India States previously surveyed on the 1-inch scale.	664	38·2
Supplementary survey on the 2-inch scale of maps compiled from cadastral surveys in the United and Central Provinces.	838	25·7
Revision survey	432	21·8
Fair mapping	1906	6·7

The boundaries of 63 villages with a total length of 290 miles were traversed for the local government at a cost of Rs. 9,209. No triangulation was done. The work was based on the triangulation and traversing of the previous surveys, the altitudes of which, as mentioned in last year's report, are inaccurate. To rectify these, 816 linear miles of traversing was done, connecting the old work with a line of levelling of the G. T. survey, and the results were very satisfactory. The maps of all forests met with, which had been previously surveyed, were revised and also some of the contouring of former seasons, which was necessitated by the corrections that have now been applied to the heights.

159. The total area surveyed was 1,934 square miles, of which the survey of 200 square miles was done by men under training, and excluding them, the average outturn for the season per surveyor was 62 square miles. That of the men under training was 50 square miles. Taking each class of work separately, the average monthly outturn per surveyor of supplementary survey was 6·6 square miles and of re-survey 7·7 and the average number of plane-table fixings per square mile 24 for the former and 21 for the latter. The corresponding figures for revision survey were 11·2 square miles, 10 fixings and 7 heights. These latter figures, however, are misleading as the contouring having been based on inaccurate data, had to be completely re-done. This also affects the cost-rates.

160. The mapping was not quite completed during the recess, but the maps will be submitted for publication during the field season. No triangulation charts have been completed yet, but are in hand. The party was inspected by the Surveyor General during the recess and by the Deputy Surveyor General during both field and recess seasons.

161. Next season supplementary triangulation and traversing will be done in sheet 55M., although the whole sheet has hitherto been shown as surveyed during the present operations. There are, however, large forests in it which were surveyed several years ago, the maps of which were not revised. Also the contouring requires revision all through for the reasons given in para. 157. The following sheets comprising an area of about 3,250 square miles will be re-surveyed or revised :—Nos. 54 $\frac{L}{7, 8, 12, 16}$; 54 $\frac{P}{4, 7, 8, 12, 16}$; 55 $\frac{M}{9 \& 13}$ and 55 $\frac{I}{5}$. As better arrangements have been made this season for preparing the ground in advance of the detail survey, it is confidently anticipated that this programme will be complete.

BERAR.

NO. 2 PARTY (*VIDE* INDEX MAP NO. 1).

162. The instruction of newly joined Provincial officers and soldier-surveyors, together with a survey on the 2-inch scale of Berar in sheet 55, was continued. One Provincial officer was discharged at the close of the field season as unlikely to become an efficient surveyor.

*Personnel.**Imperial Officer :*

Captain H. Wood, R.E., in charge. On leave from 29th July to 8th September.

Provincial Officers :

Mr. C. J. Veale, in charge from 29th July to 8th September, and 15 Probationers.

Subordinate Establishment :

6 Soldier-Surveyors, 1 Surveyor, and 1 Computer.

Three of the soldier-surveyors completed their second season's training and have been recommended for retention in the department and transferred to the North-West Frontier. Field work commenced on the 16th October 1906 and closed on the 27th April 1907. The triangulation was extended over an area of 1,680 square miles of hilly and heavily wooded country. The average number of square miles to each point trigonometrically fixed and to each height was 2.5. The cost-rate of the triangulation is slightly higher than that of the preceding season, as the work of one officer had to be entirely rejected.

163. The area surveyed in detail was 1,296 square miles and consisted generally of flat cultivated land interspersed with low bare hills, excepting in a small area where the hills were jungle-clad. The average monthly outturn of detail survey of the Provincial officers was 11.8 square miles. That of the soldier-surveyors who were undergoing their second year's training 13.7 square miles, and of those in their first year 9.7 square miles. The average outturn per working day of both Provincial officers and soldier-surveyors was 0.5 square miles. All these figures include a 4-inch survey for the Forest Department of the boundaries of all A and B class reserved forests which fell in the area under detail survey. The total length of boundaries thus surveyed was 142 miles. The cost-rate of the detail survey has fallen considerably this year owing partly to the fact that there was only one Assistant Instructor. A second officer was not available, but has now been appointed.

164. The party was inspected during the recess by the Deputy Surveyor General. The computations were all completed as also the mapping, including the sheet left unfinished last year, and all the maps were forwarded to headquarters for publication. Next season sheets $55 \frac{H}{1, 2, 5, 6}$ and $55 \frac{L}{3, 4}$ will be triangulated, and sheets $55 \frac{H}{4, 7, 8, 12, 16}$ will be surveyed on the 2-inch scale.

BOMBAY PRESIDENCY.

NO. 17 PARTY (*VIDE* INDEX MAP NO. 1).

165. This party which has for many years been employed exclusively on forest surveys became available this season for regular topographical survey and has commenced work in sheet 46 under the administrative control of the Deputy Surveyor General. Mr. Gilbert-Cooper proceeded on long leave on the 4th April 1907. The party left Poona for the field about the 10th November 1906, and returned to recess quarters about the same date in May 1907. There was a certain amount of sickness during the cold months, especially north of the Tapti river, and one or two serious cases occurred, including Mr. Gilbert-Cooper, whose condition gave

*Personnel.**Imperial Officer :*

Mr. B. G. Gilbert-Cooper, in charge up to 4th April 1907.

Provincial Officers :

Mr. S. F. Norman, in charge from 5th April 1907.

Babu Amar Singh, Mr. J. H. S. Wilson, from 16th October 1906, Mr. P. R. Anderson, Babu A. K. Mitra, from 16th June 1907 and Mr. F. B. Kitchen.

Subordinate Establishment :

36 Surveyors, etc.

rise to some anxiety at one time. One surveyor developed a mild form of plague shortly after taking the field, and was on the sick list about a month. Dispensaries were, however, conveniently situated throughout the area under survey and medical assistance was readily obtainable, but the outturn was considerably affected, nevertheless.

166. The following table shows in detail the outturn, with cost-rates including mapping, for the year under report:—

	Square miles.	R
Triangulation	2,155 .	5.5 per square mile.
Revision survey on the 2-inch scale	2,292 .	15.6 " "
Re-survey " " "	348 .	31.6 " "
Forest survey " 4-inch "	62 .	65.8 " "
	Linear miles.	
Survey of forest boundaries on the 4-inch scale.	140 .	4.7 per linear mile.

As this is the party's first season of work on the 2-inch scale, no comparisons can be made with the work of former seasons. The re-survey cost twice as much as the revision survey, but the latter includes 364 square miles of forests that had been surveyed comparatively recently and required very little revision and the area re-surveyed consisted chiefly of difficult country at the foot of the Satpura hills. The cost-rate of the forest survey does not include mapping. It was done for the Forest Department and consisted of 54 square miles of forest in the Nandurbar *taluka*, West Khandesh district, and 8 square miles of two organised forest blocks in the Sinnar *taluka* of the Nasik district. The boundaries of all forests that fell into the area under survey and had not been previously mapped were surveyed on the 4-inch scale.

167. The average monthly outturn per man for the various classes of survey and the outturn per working day are as follows:—

	Sq. miles daily.	Sq. miles monthly.	No. of plane-table fixings per sq. mile.
2-inch { Revision survey	0.70	16.4	16
{ Re-survey	0.34	8.0	39
4-inch Forest survey	0.12	3.3	113

The area surveyed in detail included a portion of the valley of the Tapti river which runs between high bare banks and was found to be identical with the old survey; even the water channel of the dry season having undergone no change whatever.

168. The Deputy Surveyor General inspected the party during the recess. The mapping has made good progress, and every effort has been made to reduce the large amount of arrears pertaining to last season. It is hoped that before the close of the recess, 22 maps on the 4-inch scale and 51 on the 8-inch scale will be submitted for publication in addition to the 8 standard sheets of this season's topography, for which Mr. Norman deserves much credit. The computations are somewhat backward, but it is expected that all will be completed before the party takes the field again in November.

169. During the coming season the existing triangulation in the area previously surveyed on the 1-inch scale in sheets 46 $\frac{O}{9, 10, 13, 14}$ and parts of 46 $\frac{O}{11 \& 15}$ will be supplemented and the survey of the following sheets will be revised on the 2-inch scale:—Nos. 46 $\frac{O}{4, 8, 12, 16}$ and 46 $\frac{K}{1, 5, 9, 10, 13, 14}$. Sheets 46 $\frac{K}{2 \& 6}$ which were partly surveyed during the current season will be completed, and the entire degree sheet will then have been surveyed. The survey of about 500 linear miles of the boundaries of forest reserves which fall into the area under survey will be done on the 4-inch scale.

BURMA.

NO. 3 PARTY (*VIDE* INDEX MAP NO. 2).

170. The party was transferred from the administrative control of the

*Personnel.**Imperial Officers :*

Captain C. P. Gunter, R.E., in charge.
Lieutenant L. G. Crosthwait, I. A.

Provincial Officers :

Messrs. W. M. Gorman, J. Donaghey, E. Claudius, Munshi
Asmatullah Khan, and Mr. H. D. W. Stotesbury.

Subordinate Establishment :

18 Surveyors, 4 Draftsmen, 1 Typer, 3 Writers and 1 Hospital
Assistant.

Deputy Surveyor General
to that of the Superintendent
in charge of Burma
Surveys on the 16th October
1906.

171. The programme
consisted of a topogra-
phical survey on the 1-
inch scale of Degree sheet
94 F comprising parts
of the Southern Shan
States, Karenni, and of

the Salween district situated immediately to the west of the Burma-Siam
boundary, and the triangulation of Degree sheet 94 G.

172. The area under survey consisted almost entirely of a mass of very
steep and rugged mountains rising to over 8,000 feet in the north-west and to
5,000 feet in the south-west, gradually falling to the Salween which is here
about 350 feet above sea level. In Karenni the hills are bare and rocky but
further south they become gradually covered with jungle growth, and at Papun
the forest is of a tropical character and nearly impenetrable.

173. The party left its recess quarters at Bangalore on the 12th of Novem-
ber 1906 and the bulk of the party returned there on the 26th of June 1907.
As the programme for 1907-08 lies in Upper Burma it was necessary to make
every endeavour to complete sheet 94 F, and this was successfully accomplished
though not without difficulty, one small detachment of the party having
remained in the field until the 9th of July.

174. The health of the party in Karenni was good, but further south
malarial fever was prevalent and near Papun it was so bad that no member of the
party working there escaped from it. The rains broke near Papun in the begin-
ning of May after which work was carried out under circumstances of unusual
discomfort.

175. Great difficulties were met with in obtaining food supplies and local
labour; means of communication were very difficult and the necessity for heavy
jungle clearing further retarded the work. Chinese mules and ponies were hired
to enable the officers to move freely about among their men and for the trans-
portation of rations.

176. As it was decided in the middle of the field season that the party
should be transferred to Upper Burma in the following (survey) year, triangulation
was stopped and the assistants employed on it were transferred to the topo-
graphical camps to ensure the detail programme being completed. 1,399
square miles were triangulated and 1,266 square miles reconnoitred in sheet 94 G.

177. 2,859 square miles were topographically surveyed on the 1-inch
scale in sheet 94 F, and 66 square miles of forest which had been previously
surveyed on the 4-inch were revised on the 1-inch scale. 54 square miles
were also re-surveyed in sheet 94 B. There was a small area of reserved
forest which it was proposed to survey on the 2-inch scale, but it was found
impossible to carry this out without risking the non-completion of the degree
sheet, so it was abandoned and will be taken up later in conjunction with the
survey of the next sheet. Owing to the steepness of the ground, contours
were drawn at intervals of 100 instead of the customary 50 feet, but the inter-
mediate contours will be inserted in the fair maps.

178. The average daily outturn of a surveyor was 1.29 square miles, the
average number of plane-table fixings being 6.4 per square mile.

179. The cost-rate of triangulation R6-0-11 per square mile is moderate
and that of detail survey R34-15-0 per square mile, although apparently high
for 1-inch survey, may be considered satisfactory when the difficult nature of

the country is taken into consideration, and it compares favourably with that of former surveys in similar country.

180. On the return journey from Papun one of the boats capsized in the Yonzalin river and its contents, including some original field sections, sank and two assistants spent an unpleasant three days on a sand bank trying to recover the lost property: most of it was eventually recovered by *Karen* divers, including the field sections which, having been carefully packed in tin cases, were fortunately found to be undamaged.

181. Owing to the late return of the party from the field and to the delays consequent on the introduction of the new system of mapping it will be impossible to complete all the fair mapping of the area surveyed during recess. But this will, however, be done during the field season by draftsmen of the party who will be attached to the Burma Drawing Office for the purpose.

182. As the triangulation was incomplete, the computations have not been taken up.

183. The programme for 1907-08 consists of the completion of the detail survey of sheet 84 K on the 1-inch scale, forest reserves being surveyed on the 2-inch scale and of triangulation in sheet 84 J.

184. The party was frequently visited and inspected during the recess by the Superintendent in charge Burma Surveys.

UPPER BURMA.

No. 10 PARTY (*VIDE* INDEX MAP NO. 2).

185. The party was transferred from the administrative charge of the Deputy Surveyor General to that of the Superintendent in charge Burma Surveys on the 16th October 1906.

Personnel.

Imperial Officer:

Captain A. A. McHarg, R.E., in charge.

Provincial Officers:

Messrs. P. J. Barrington, M. J. Sheehan, W. G. Jarbo, E. M. Kenny and Munshi Abdul Rahim, K.S.

Subordinate Establishment:

21 Surveyors, 2 Writers, 1 Typer and 1 Hospital Assistant.

and of the triangulation of parts of Degree sheets 84 M and 83 P.

187. About half the area consisted of wooded hills of no great height but requiring a considerable amount of clearing, and the remainder, in the valley of the Mu and along the railway line, was either flat or slightly undulating.

188. The party left its recess quarters at Bangalore on the 7th of November 1905 and returned on the 12th of June 1906.

The health of the party was fair, although cases of fever were frequent. Two *khalasis* died during the field season and four others died of cholera contracted on the journey from Calcutta to Rangoon.

189. An area of 706 square miles was triangulated in advance. The work was of a patchy nature and was supplementary to triangulation which had been done previously, a good deal of clearing had to be done. The work occupied one Provincial Officer and one surveyor for about five months. Fifty-nine linear miles were traversed with a theodolite, chiefly along forest boundaries, to supplement the triangulation.

190. The detail survey consisted of original and supplementary surveys on the 1-inch scale, of 2-inch surveys of forests not previously surveyed and 1-inch revision surveys.

The outturn of each of the above classes was as follows:—

	Sq. miles.
Original survey, 1-inch	1,054
" " 2-inch	148
Supplementary survey, 1-inch	1,179
Revision survey, 1-inch	127
TOTAL	2,508

The country being for the most part undulating and thickly wooded, was not favourable for plane-tabling by interpolation and almost the whole area had to be surveyed by means of plane-table traverses, a slow and laborious process. The supplementary survey was carried out by examining and adding new detail to 1-inch reductions of the cadastral surveys; as the whole of the area thus surveyed had to be rigorously traversed, the rate of progress was not much faster than for original survey. In the revision survey special attention was paid to supplementary heights and to the classification of roads.

191. The average daily outturn of a surveyor was 0.95 square miles for 1-inch survey, 1.07 for 1-inch supplementary survey, and 0.40 for 2-inch surveys, the average number of plane-table fixings per square mile being 21 for 1-inch and 74 for 2-inch survey.

192. The cost-rates for the different classes of work are as follows:—

Nature of survey.	Cost per square mile.	REMARKS.
Triangulation	19.50	
Traversing	13.61	₹23.07 per linear mile.
Detail survey, 2" = 1 mile	54.06	
" " 1" = 1 mile	39.84	
" " supplementary	30.25	
" " revision	12.19	

The rates are necessarily high owing to the nature of the country in which the party was working and the slow and laborious method of plane-table traversing by which the work had to be carried out. The high cost of traversing is due to the patchy nature of the work. The cost-rate of 2-inch survey and of 1-inch revision is moderate.

193. In addition to the regular work of the party Surveyor Lachman Jadu, R.S., was attached to a party which was employed on building boundary pillars on the Burma-China boundary between Panghsang Nalawt and the Mè-hkong river. He had not many opportunities for adding to the original survey of that part of the country which, however, will be surveyed by No. 11 Party in 1908-09 in ordinary course.

194. There was some delay in the fair mapping in consequence of a new system having been introduced, but it is expected that most of the maps will be drawn and sent to press before the party leaves recess quarters: any sheets which may be incomplete will be completed in the Burma drawing office.

195. The computations of the party have all been completed, and three triangulation charts will be sent to press before the end of the recess.

196. The programme for 1907-08 consists of the completion of the standard sheets on the 1-inch scale comprised in Degree sheet 84 M, also parts of Degree sheets 93 A and 93 E: the area to be surveyed in the latter is somewhat in advance of the general programme of the party, but is undertaken at the request of the Geological Survey Department which requires maps of this area on account of the development of the mines occurring in it.

197. The party was inspected in the field by the Surveyor General and the Superintendent in charge Burma Surveys, and also in recess by the latter officer.

SHAN STATES, BURMA.

NO. 11 PARTY (*VIDE* INDEX MAP NO. 2).

198. The party was transferred from the administrative control of the Deputy Surveyor General to that of the Superintendent in charge Burma Surveys on the 16th October 1906.

*Personnel.**Imperial Officers :*

Captain R. H. Phillimore, R.E., in charge up to June 6th and again from September 8th to the close of the year.

Lieutenant L. G. Crosthwait, I.A., attached and officiating in charge from 7th June to 7th September.

Provincial Officers :

Messrs. S. S. M. Fielding and V. W. Morton.

Subordinate Establishment :

14 Surveyors, 2 Soldier-Surveyors, 1 Computer, 1 Writer, and 1 Hospital Assistant.

199. The party continued the detail survey of the Southern Shan States to the east of Longitude $99^{\circ}30'$ in the Kēngtūng State in sheets 93O and 93P and triangulation in the same State east of Longitude 100° in sheets 102 C and 102 D up to the Mè-hkong river which here forms the boundary between the Shan States and French Indo-China.

200. Application had been made by the political authorities for permission for the triangulators to cross the Mè-hkong into French territory, and His Excellency the Governor General of Indo-China readily assented to the proposal and most courteously sent an officer, Monsieur Salé, from Bān Houei Sai to meet our triangulators; they met at Kēnglap, but no stations were observed from in French territory although several points were fixed by intersection. A similar permission was obtained to enter Siamese territory in the south and two stations were observed from, which proved most useful in fixing points in the low-lying ground where the Siamese frontier meets the Mè-hkong.

201. The country surveyed consists of an intricate mass of jungle-clad hills and includes part of the high range which forms the watershed between the Salween and the Mè-hkong rivers. Villages were not so frequent and there were fewer paths than in the western portion of the Kēngtūng State; the forest growth was also more dense.

202. The party left its recess quarters at Tounggyi on the 4th of November 1906 and did not reach its ground until the beginning of December; field work was closed early in April and the party was ordered to Bangalore for recess in order that it might be reconstructed under the immediate superintendence of Lieutenant-Colonel Gordon, in charge Burma Surveys. A part of it returned to Burma *via* Hsipaw and part *via* Taunggyi. The distance from Kēngtūng to Hsipaw (which is only a few hours from Maymyo by rail) is 22 marches by a good fair weather mule road, while from Kēngtūng to Taunggyi it is 23 marches; but the former route has its advantages as the latter, when Taunggyi is reached, is still ten marches from the nearest railway station. For many reasons Taunggyi proved unsuitable for recess quarters and it has been decided to transfer them to Maymyo which will probably be one of the head-quarters of the Burma circle when it is formed, but pending final arrangements the party was, as a temporary measure, transferred for the recess of 1907, to Bangalore.

203. The health of the party in the field was not particularly good and nearly all the members suffered from fever during the earlier part of the season. Instead of importing all the *khalasis*, as in former years, an experiment was made in employing local labour and each surveyor had two Shans in his squad; little difficulty was experienced in obtaining these men who were frequently changed and worked cheerfully and well. The officer in charge, who has recently passed in the Shan language, made a point of getting to know the head men personally and, in consequence of this, supplies and labour were willingly provided. The *Sawbwa* of Kēngtūng detailed court officials to accompany the officer in charge and the triangulators, and these being men of influence were of great assistance in getting roads cleared and bridges erected.

204. 1,781 square miles were triangulated in advance, which, with the area previously triangulated, will provide sufficient points for the detail programme which it is hoped to carry out in 1907-08. The smoke haze which generally envelopes the country from February onwards was not nearly so troublesome as usual owing to frequent thunderstorms.

205. 1,612 square miles were topographically surveyed on the $1\frac{1}{2}$ -inch scale in Degree sheets 93 O and 93 P. This scale was adopted experimentally as the steepness of the ground prevented contours being drawn at the usual vertical intervals of 50 feet on the 1-inch scale.

206. The average outturn of the $1\frac{1}{2}$ -inch scale for a working season of four and-a-half months was 126 square miles per surveyor, as compared with 161 square miles on the 1-inch scale in the previous season, the average number of plane-table fixings being 8.2 per square mile as compared with 6.5 on the 1-inch scale in the previous season.

207. The cost-rate per square mile of the detail survey was ₹42.4. The cost-rate of triangulation was ₹8.7 per square mile as compared with ₹15.5 in 1905-06.

208. Special care was taken over the collection and transliteration of place names. Vernacular revenue registers were obtained from the *Saxbwa's* court at Kēngtūng which showed all villages arranged according to circles. These were transliterated by the officer in charge in consultation with the political authorities, and to each plane-table was then issued a correct list in English of all villages likely to fall in his work. Names of hills and streams were collected by the plane-tables, and verified by the officer in charge or one of the assistants by enquiries in the immediate neighbourhood. In previous seasons too much reliance has been placed on names written in Burmese or Shan by illiterate *hpoon-gyis* and interpreters. Even had the names always been correctly recorded in Shan, accurate transliteration would not follow without local enquiry, for the Shan character has no signs to distinguish the closed series of vowels from the open series; and thus "Lūng" and "Lōng" would appear written alike, as also would "Lēng" and "Ling". The *Hkon* character which is used east of the Salween-Mè-hkong watershed, however, not only shows all these distinctions, but shows distinctions in the vowel tones; and the pronunciation of a word follows directly from its spelling. The village names as now recorded and printed on the maps give also the tribal name of the inhabitants. This change is regarded as of great value by the political authorities. Up to last season the tribal names were shown in brackets below the village name proper.

209. The five sheets fully surveyed were drawn during the recess and submitted for publication. The triangulation has been computed and the results are satisfactory.

210. The programme for 1907-08 is in continuation of that of the year under report, and it is hoped that the survey of the Southern Shan States south of the Wa country will be finally completed in 1908-09.

211. The party was frequently visited and inspected by the Superintendent in charge of Burma Surveys during recess.

MADRAS.

NO. 19 PARTY (*VIDE* INDEX MAP NOS. 2 AND 3).

212. The party was under the administrative control of Colonel Hodgson,

I. A., Deputy Surveyor General, until the 14th July 1907 and thereafter of Lieutenant-Colonel Gordon, I. A., recently appointed Superintendent in charge of Burma Surveys, who resided at Bangalore, its recess quarters.

Personnel.

Imperial Officers:

Lieutenant-Colonel W. J. Bythell, R.E., in charge from 23rd November to 5th June 1907.

Captain F. F. Hunter, I.A., in charge from June 6th 1907.

Provincial Officers:

Messrs. G. T. Hall, in charge till 22nd November 1906, R. Waller-Senior, J. Smith, W. F. E. Adams, M. J. Sheehan, E. J. Biggie, B. C. Newland, Babus M. M. Mudaliar and Balaji Dhondiba.

Subordinate Establishment:

48 Surveyors, 1 Hospital Assistant, 2 Writers and 1 Record-keeper.

213. This party, which had been employed exclusively on forest surveys since 1886, commenced the 2-inch topographical survey of parts of the Malabar and Nilgiris districts and the revision on the 1-inch

scale of part of the Mysore State.

The programme also included advance triangulation in the same districts, 4-inch forest surveys in the Ganjam and Coimbatore districts, and forest boundary traverses in Malabar and Trichinopoly.

214. The country under survey was of a varied description and included part of the Wynaad covered with dense jungle with numerous coffee plantations and many abandoned gold workings. Part of the coast tracts of Malabar was also surveyed, a long belt of land between the sea and the Ghâts most of it only a few feet above sea level with dwellings scattered over the entire area, each homestead consisting of a comfortable hut, standing in its own garden enclosure in which vegetables, as well as the pepper vine and betel and cocoanut palms, are cultivated.

In Ganjam the area surveyed consisted of wild rugged hills covered with jungle.

215. The party left Bangalore for the field during November 1906, and the last sections did not return until the end of June 1907.

216. The health of the party was not good, except in the coast tracts of Malabar. In Ganjam, Coimbatore and the Wynaad the party suffered severely from fever, and two deaths occurred among the *khalasis*. Almost daily rain occurred in Malabar from April onwards.

217. Supplies were generally plentiful, but except on the coast of Malabar, local labour was very scarce and of poor quality. In the Wynaad the work was seriously retarded by the difficulties experienced in procuring coolies; in Ganjam all labour was imported as the jungle tribes in that part not only refused to work, but actively interfered with the surveyors.

218. An area of 3,438 square miles was triangulated, chiefly in Degree sheets 49 M and 58 A. This is more than sufficient for the detail surveyors during the season 1907-08. It is based on the Great Arc meridional series, and the results are generally satisfactory. No use was made of the Madras Revenue survey triangulation as it was found impossible to reconcile it with the results of our triangulation.

219. 311 linear miles of forest boundaries were traversed by theodolite in Ganjam, Malabar and Trichinopoly.

220. The traversing of the Mysore-South Canara boundary commenced last year could not be finished as the demarcation was incomplete.

221. The area topographically surveyed on the 2-inch scale was 1,515 square miles, not including 116 square miles of overlap. 45 square miles of old 1-inch survey in the Mysore State were revised on that scale in order to complete standard sheets. The outturn of forest survey on the 4-inch scale was 374 square miles.

The outturn on the 2-inch scale was less than was expected, partly owing to the difficulties of country and climate, but principally to the surveyors being new to work on that scale. It is, however, satisfactory to note that as the men became accustomed to the scale of survey the rate of progress improved, and towards the end of the season was not under what was hoped for.

222. The average outturn per surveyor was 9.84 square miles per month on the 2-inch and 2.84 square miles per month on the 4-inch scale. The average number of plane-table fixings was 37.4 per square mile on the 2-inch and 98.6 on the 4-inch scale.

223. The outturn and cost-rates of the party for the year under report and the two previous years are as follows:—

Description of Survey.	OUTTURN.			COST-RATE PER SQUARE MILE.		
	1904-05.	1905-06.	1906-07.	1904-05.	1905-06.	1906-07.
Triangulation 4" . . .	1,012	70	2,555	R 14	R 33	R a. p. 5 4 11
" 2" . . .	...	2,150	3,412	...	6	5 11 3
Traversing 4" to mile . . .	29	174	311	31	28	13 12 6
Topography " . . .	750	832	374	124	104	91 7 3
" 2" to 1 mile . . .	...	...	1,515	...	...	45 1 8
" Revision 1" to 1 mile. . .	...	...	45	...	...	4 6 9
Overlap 2" to 1 mile . . .	...	...	116.5	...	...	.....

The cost-rates compare favourably with those of former years. The decreases in the rates for triangulation and traversing are owing to the larger outturn. The decrease in 4-inch topography is principally due to the section employed on the work having been under the charge of a junior Provincial officer and also to the outturn having been large for one section. There is no exactly similar survey on the same scale to compare the rates of 2-inch surveys with, but, although high, they cannot be considered excessive after taking into consideration the difficulties of the country and the fact that none of the surveyors had any previous experience in 2-inch surveys.

224. The French settlement of Mahe was surveyed in the course of the work, through the kind permission of His Excellency the Governor of Pondicherry, and nothing could have exceeded the courtesy of the French officials who gave every facility for carrying out the work.

225. Five standard sheets have been mapped on the 2-inch scale and are ready for publication. Forty-four forest maps on the 4-inch scale were also completed and 35 remain in different stages. The forest boundaries shown on the maps have been verified by the local Forest officers.

226. All computations have been completed.

227. The programme for 1907-08 consists of the continuation of the topographical survey in Degree sheets 49 M and 58 B, with a revision of the area previously surveyed on the 1-inch and 4-inch scales, advance triangulation in Degree sheets 49 N and 58 B, and the completion of the 4-inch forest surveys in Ganjam.

The triangulation of Coorg will be also taken up in anticipation of the topographical survey of that province, which is considered urgent, and which will be commenced in 1908-09.

228. The party was frequently visited and inspected in recess by the Superintendent in charge Burma Surveys.

BURMA AND ASSAM.

NO. 20 PARTY (*VIDE* INDEX MAP NO. 2).

229. The party remained under the administrative control of Lieutenant-

Colonel Gordon throughout the year, first as Superintendent, Forest Surveys, and then as Superintendent in charge Burma Surveys. Major Mears proceeded on combined leave to England on the 22nd October 1906 and was succeeded by Major Symonds who held charge of the party until the 18th June 1907, when he also went on combined leave, handing over charge to Mr. Prunty, Extra Deputy Superintendent, 2nd grade.

Personnel.

Imperial Officers :

Major A. Mears, I.A., in charge until the 14th October 1906.

Major C. W. H. Symonds, I.A., in charge from 15th October 1906 to 18th June 1907.

Lieutenant H. S. May, R.E., up to 14th April 1907.

Provincial Officers :

Messrs. P. F. Prunty, in charge from 19th June 1907 to the end of the year, C. C. Byrne, Babu Pramadaranjan Ray, Mr. J. H. Williams, Munshis Amjad Ali and Abdul Hai.

Subordinate Establishment :

43 Surveyors, 13 Traversers, 4 Draftsmen, 6 Computers, 2 Writers and 2 Hospital Assistants.

230. The programme of the party was a varied one. The 4-inch forest surveys on which the party had been employed in Burma since 1882 were nearly completed, and it had been decided that the party should next year be transferred to Assam for topographical surveys; for this reason a strong triangulation and traverse section was sent in advance to that province and employed in Degree sheet 78 P

which comprises parts of the Sylhet and Mymensingh districts and of Hill Tipperah State. A small section completed the 4-inch survey of the Mepalé forest reserves in Thaungyin; three surveyors carried out a forest boundary survey in Minbu, and the bulk of the party was employed on 2-inch topographical surveys in Degree sheets 84 J and 84 K, chiefly in the Pakòkku district. The 2-inch scale had been laid down as a large part of the area consisted of forest reserves for which 2-inch maps were essential.

231. The area under survey consisted of country of very varied nature. In Sylhet the ground was flat, being seldom over 50 feet above sea level and covered with swamps of large extent, and in the south and east by low hills with tea gardens. In Pakòkku district the area under survey consisted of wide valleys separated by ranges of wooded hills, and in Thaungyin steep rugged hills covered with dense evergreen forest were met with.

232. The party left its recess quarters at Dehra Dún on the 1st of November 1905, and after a field season of from six to six and-a-half months re-assembled at its new recess quarters at Bangalore early in June 1906. It is probable that on an early date the head-quarters of this party, which will probably be employed in Eastern Bengal and Assam for the next twenty years, will be transferred to Shillong.

233. The general health of the party in the field was good, but there was a serious outbreak of cholera on the journey to the field from which 19 *khalasis* died; 7 *khalasis* also died from fever in the field.

Lieutenant H. S. May, R.E., who was employed on triangulation in Hill Tipperah, suffered constantly from fever throughout the season, but continued his work in spite of having often to be carried to his stations. He eventually succumbed to an attack of black water fever while being taken into the nearest station.

234. Supplies were fairly plentiful in Burma, except in the extreme north of the Pakòkku district and in Thaungyin, where special arrangements had to be made. In Sylhet supplies were abundant and easily procured at the weekly markets.

Local labour was procurable in Burma, but in Sylhet the supply was scarce and unreliable.

235. *Assam*.—It was proposed to carry out a first class series of secondary triangulation in the south of Degree sheet 78 P, and the late Lieutenant May was entrusted with the work. Owing to the physical difficulties of the country this series was abandoned and a network was substituted, but little progress was made owing to Lieutenant May's sickness and death. Traversing was relied on for the provision of points for detail survey in 1907-08, in this sheet and 1,801 linear miles were observed with the theodolite with an average of four stations per mile. 856 permanent marks were embedded and all prominent objects near the traverse lines were fixed. The stations have been made over to the local authorities, and it is hoped that they will be useful for connecting the traverses of the local revenue surveys.

236. *Burma*.—An area of 1,563 square miles, of which 17 square miles were supplementary survey, was topographically surveyed in the Pakòkku district; over a fourth of the whole area, or 474 square miles, consisted of forest reserves. Owing to the nature of the country the work had to be carried out almost entirely by plane-table traversing and the surveyors were unaccustomed to the scale of survey. Progress was therefore slow.

Fifty-one square miles of forest reserves in Thaungyin were surveyed on the 4-inch scale: here, too, owing to the very difficult nature of the country, the progress was not so rapid as could have been wished.

Three surveyors also surveyed 500 linear miles of forest boundary on the 4-inch scale in Minbu.

237. The average monthly outturn of a surveyor was 8 square miles on the 2-inch and 2.56 on the 4-inch scale. The average number of plane-table fixings was 200 per square mile for 4-inch survey and 61 for 2-inch.

The outturn and cost-rates of the party for the year under report and the two previous years are given in the following table:—

Description of work.	AREA SURVEYED.			COST-RATE IN RUPEES PER SQUARE MILE.		
	1904-05.	1905-06.	1906-07.	1904-05.	1905-06.	1906-07.
Triangulation, square miles . . .	800	1,622	...	7·8	9·1	...
1st class secondary (triangulation), square miles.	...	...	187	...	...	38·5
Traversing linear miles . . .	976	881	1,801	44·5	42·6	20·5
Topography, 4-inch scale, square miles.	680	682	51	142·5	147·7	305·7
4-inch scale boundary survey, linear miles.	...	...	500	...	...	9·2 per L. M.
2-inch scale, square miles . . .	...	...	1,546	...	...	65·5
Supplementary survey, square miles.	...	...	17	...	...	26·1

The cost-rate of triangulation cannot be compared with those of former years as the work was incomplete, having been abandoned at an early stage owing to the death of Lieutenant May. The cost of traversing is just half what it was during the two previous years; this was due to the country being flat and little clearing being required. The cost-rate of 4-inch surveys was abnormal, being twice as large as the average of the party for the last two years; all the conditions were adverse; the area was a small one and was situated in a remote part of the country where special rationing arrangements had to be made. The jungle was very dense and there was much sickness among the men.

It was anticipated that the work would be completed in two months, but in reality it occupied three. The cost-rates of small detached areas cannot be satisfactorily compared with those of large blocks.

The cost-rates of 2-inch detail survey were high; this was due to the country being intricate and difficult and to the work having been carried out by plane-table traverses, a slow and expensive process, instead of by interpolation which was impracticable. The rate though high does not compare unfavourably with the rates of former surveys on the same scale in Burma.

238. The relations with the inhabitants of Sylhet were somewhat strained at first and some of the traverse stations were destroyed, but later on, when the people understood the nature of the work, they became more friendly.

239. The mapping of the 4-inch surveys was undertaken by the Forest Survey Office at Dehra Dún and the maps of the Mepalé reserves have now all been published. The 2-inch mapping, consisting of six standard sheets, will be completed before the party takes the field. The maps were drawn on the 2-inch scale for reduction to the 1-inch standard sheets and special editions on the 2-inch scale of the forest portions will be published for the use of the Forest Department.

240. The computations have been completed and plot sheets prepared for next season's work.

241. The programme for 1907-08 consists of the topographical survey of Degree sheet 78 P and the triangulation and traversing of Degree sheet 83 D.

242. The party was inspected in the field in Burma and in Assam and during the recess at Bangalore by the Superintendent in charge Burma Surveys.

NORTHERN CIRCLE.

NO. 9 PARTY (*VIDE* INDEX MAP NO. 1).

- 243. This party which had previously been employed on forest surveys in the Madras presidency and in other parts of India was re-organised and transferred to the Punjab at the commencement of the field season.

*Personnel.**Imperial Officers :*

Major F. W. Pirrie, I.A., in charge up to 10th June 1907.
Lieutenant S. W. S. Hamilton, R.E., in charge from 11th June to 22nd July 1907.
Lieutenant E. C. Baker, R.E., in charge from 23rd July 1907.

Provincial Officers :

Messrs. J. A. Freeman and P. A. T. Kenny up to 15th May 1907.

Subordinate Establishment :

17 Surveyors, 4 Computers, 2 Clerks and 2 Soldier-Surveyors.

It was employed on topographical surveys on the scales of 4 inches and 2 inches to 1 mile in Dera Gházi Khan district of the Punjab.

The work was controlled where necessary by theodolite traverses and triangulation and a large area was triangulated in advance.

West of Dera Gházi Khan in the nearly flat ground the old revenue maps on the 4-inch scale of 1874-75 were used as a basis of the topographical surveys. It was found necessary to re-traverse part of the ground in order to further control the work, and near Choti-Bala and Sakhi-Sarwar in sheet 39 $\frac{K}{1}$ and elsewhere where the ground was undulating and hilly, it was found necessary to triangulate the whole ground and carry out an original survey on the 2-inch scale.

Both the 4-inch supplementary survey and the 2-inch original survey are being fair drawn on the 2-inch scale for publication on the 1-inch.

The triangulation of sheet 39 $\frac{K}{1}$ was carried out by Major F. W. Pirrie and computed in the field. The remaining triangulation was done by Lieutenant S. W. S. Hamilton, R.E., and Mr. P. A. T. Kenny.

The field office opened at Dera Gházi Khan on the 15th December 1906, and closed on 10th June 1907.

244. The outturn of the party for the season is as follows:—

Original 2-inch survey	: : : : .	258·36 square miles.
Revision 4-inch survey	: : : : .	257·72 "
	TOTAL	. 516·08 "

The 2-inch work comprised the whole of standard sheet No. 39 $\frac{K}{1}$
" 4-inch ditto ditto ditto " 39 $\frac{J}{12}$

1,897 square miles of country were triangulated.

This area is in standard sheets 39 $\frac{J}{2, 3, 4, 5, 6, 7, 8}$ and portions of $\frac{J}{10, 11}$. In sheet 39 $\frac{J}{12}$ traversing was necessary. The origin of traverse was Gola G. T. station.

245. The cost-rates for survey are very high owing to so great a proportion of the members being new to this style of work and practically under instruction. They are—

	R	a.	p.	
4-inch revision survey (including traversing)	. 73	11	9	per square mile.
2-inch original survey	. 40	2	11	ditto.
Triangulation	. 13	1	9	ditto.

The character of the country surveyed was very varied. The eastern portion of sheet 39 $\frac{J}{12}$ borders on the Indus river and is flat and artificially irrigated by wells and inundation canals. The western portion is flat, but not irrigated and has few wells; there is, however, a system of embankments built to catch the flood waters which are discharged from the hills in the rainy season.

The ground in sheet 39 $\frac{K}{1}$ is flat in the extreme south-east, but changes to low hills and then to a high, broken and precipitous range as you go westwards and to the north.

NORTHERN CIRCLE.

NO. 12 PARTY (*VIDE* INDEX MAP NO. 1).*Personnel.**Imperial Officers:*

Captain E. T. Rich, R.E., in charge up to 12th September 1907.
 Lieutenant M. N. MacLeod, R.E., up to 17th June 1907.
 Lieutenant S. W. S. Hamilton, R.E., in charge from 13th September 1907.

Provincial Officers:

Munshi Rahmatullah, Mr. W. Newland from 22nd September 1906, Babu Dhani Ram, Messrs. H. C. W. Stotesbury and F. H. Grant from 9th June 1907.

Subordinate Establishment:

27 Surveyors, Computers, Writer, etc., and 3 Soldier-Surveyors.

It completed—

(a) a network of triangulation over an area of about 4,730 square miles.

(b) detail survey on 2-inch scale of 1,230 square miles.

248. The detail survey work was carried out on 59 plane-tables and was tested by 1,309 *in situ* fixings.

249. The cost-rate of the detail survey and of the triangulation is as follows:—

	<i>R</i>	<i>a.</i>	<i>p.</i>	
2-inch detail survey	53	10	4	per square mile.
Triangulation	8	13	11	ditto.
Fair mapping	15	0	9	ditto.

The cost-rates this year are less than half those of the last season, which is satisfactory.

250. The work in the field was closed on the 13th June 1907, when the party returned to Mussooree for recess.

The arrears of the last year's fair mapping and that of all the sheets surveyed during the current year are well in hand, and it is hoped that they will mostly be completed by the end of this recess.

251. During the ensuing field season the party will survey parts of the Pesháwar district.

252. The health of the party during the field season remained very satisfactory, but 2 *khalasis* were killed in a tribal skirmish and a surveyor and his squad were captured by tribesmen and held captive for four days.

253. The party was inspected twice during the field season by the Superintendent, Northern Circle, and during recess by the Surveyor General.

NORTHERN CIRCLE.

NO. 14 PARTY (*VIDE* INDEX MAP NO. 1).

254. As indicated in last year's report, this party worked in an easterly direction through Kohát district.

*Personnel.**Imperial Officers:*

Captain H. L. Crosthwait, R.E., in charge.
 Lieutenant E. C. Baker, R.E., from 1st October 1906 to 22nd July 1907.

Provincial Officers:

Messrs. J. O. Greiff to 25th November 1906, H. H. B. Hanby, J. H. S. Wilson to 15th October 1906, E. J. Biggie, H. B. Simons, C. West, A. B. Hunter, B. C. Newland to 30th June 1907, A. G. Harrington to 3rd August 1907 and A. A. Graham from 10th July 1907.

Subordinate Establishment:

43 Surveyors, etc.

255. The total area topographically surveyed on a scale of 2 inches=1 mile was 1,547 square miles. The cost-rate per square mile works out at *R*39'8.

256. The area triangulated was 4,495 square miles, of which 3,808 square miles is in advance of the detail survey and

will be utilised during the coming season. The cost-rate is *R*7'2 per square mile, including computations and the preparation of charts.

257. The fair mapping of the following sheets was taken up and should be almost completed by the end of this recess; $38 \frac{K}{15, 16}$, $38 \frac{O}{2}$ (southern portion, north not yet completely surveyed); $38 \frac{O}{3, 4, 7, 8}$ (northern portion). The cost-rate for mapping works out to approximately ₹10·8 per square mile.

258. Taking the total cost, including triangulation, topographical survey and mapping, the amount spent on a fair sheet drawn on a scale of 2 inches=1 mile for reduction to 1 inch=1 mile in standard form, having an area of about 250 square miles, works out approximately to ₹14,500.

259. The programme for the ensuing season is in continuation of last season's work in an easterly direction.

NORTHERN CIRCLE.

NO. 18 PARTY (VIDE INDEX MAP NO. 1).

260. The party was occupied during the year with the following duties:—

- | | |
|---|--|
| <p style="text-align: center;"><i>Personnel.</i></p> <p style="text-align: center;"><i>Imperial Officers:</i></p> <p>Captain E. A. Tandy, R.E., in charge.
 " M. O'C. Tandy, R.E., till 5th November 1906.
 Lieutenant V. R. Cotter, I. A., from 6th October 1906.</p> <p style="text-align: center;"><i>Provincial Officers:</i></p> <p>Messrs J. Marten till 16th April 1907, C. George from 16th October 1906 till 31st May 1907, C. J. S. Rae, C. E. C. French till 31st May 1907, J. R. Newland, Babu Maya Das Puri, Messrs. L. Williams from 8th February 1907 and F. C. Pilcher from 10th July 1907, Mr. W. Robert, especially re-employed till 31st March 1907.</p> <p style="text-align: center;"><i>Subordinate Establishment:</i></p> <p>34 Surveyors, 48 Draftsmen and Computers, 3 Writers and 1 Soldier-Surveyor.</p> | <p>(a) Triangulation in Bannu, Kohát, Dera Ismail Khan, and Miánwáli districts.</p> <p>(b) Traverse and compilation in Bannu and Dera Ismail Khan districts.</p> <p>(c) Plane-tabling and fair mapping of parts of Bannu and Dera Ismail Khan districts.</p> <p>(d) Miscellaneous traverse work, including the completion of that in the Jhelum colony; a special traverse, including the laying down of base lines in a large part of the Bári Doáb desert; and the preparation of traverse data in a suitable form for laying out rectangles in the Rechnā Doáb portions of the Lahore and Montgomery districts.</p> <p>(e) Punjab riverain surveys, including the preparation of boundary maps on all the rivers of the Punjab, and some special supplementary traverse to assist demarcation on the Beas river.</p> <p>(f) Arrears of mapping, including some Himalayán and Punjab sheets.</p> |
|---|--|

261. The change in the *locale*, coupled with the shifting of the office from Simla to Dehra Dún, caused a good deal of trouble at the commencement of the field season.

The area finally allotted for survey in the Bannu and Dera Ismail Khan districts was almost entirely without triangulation or heights; and the only fixed points available were the village trijunction pillars fixed by the old revenue survey of 30 years ago. These were, over a large part of the area, so few and far between, that supplementary traverse work had to be carried out. At the same time triangulation had to be pushed rapidly along the Marwat and Bhattani ranges which separate the two districts.

The result was that work had to be commenced in very enclosed country where compilations of the old surveys would have been specially valuable as forming the basis of the new work; as soon as compilations had been made, the plane-tables first sent out were recalled and the compilations added to them; they were then sent out again for completion. The traversed heights could not be closed properly until the triangulated points on which they were based had been computed out, and as this was not done till late in the season, practically the whole of the plains portion of the work had to be gone over again to put in the contours. In the hilly ground the triangulation was not ready till so late that the surveyors had in the end to be crowded into the three sheets containing it, in order to get them finished, eight surveyors having in one case to work on one quarter sheet.

All the arrangements arising from the moves at the end of recess had made it impossible to finish any of the 16 fair sheets that were in hand last year. They were therefore taken to the field head-quarters at Bannu and the last of them was sent to press late in March 1907.

A second triangulator had to be obtained from the Quetta party during the field season, and computers from other parties.

262. The country surveyed was entirely new to officers and men, and there were constant difficulties in providing water, escorts and transport; it was also a most unhealthy year and several deaths and a good deal of sickness occurred.

263. Owing to unavoidable delays the party office did not close at Simla till November 10th; it opened on 20th at Bannu, the field *khamal* having meanwhile been moved there from Multán; the Himalayan and Riverain sections with all old records, etc., moved from Simla to Dehra Dún about the same time.

Head-quarters were moved from Bannu to Dera Ismail Khan early in May and the field office was closed on the 23rd May and re-opened in Mussooree on the 1st June.

264. *Triangulation* was carried across all the hills in the north of Dera Ismail Khan district which separate it from Bannu; a further chain was carried along the Maidan range east of Bannu connecting with No. 14 Party's work in Kohát district.

Two triangulators were employed on the work and the area and cost-rate were 1,240 square miles and R11·2, respectively.

1,099 linear miles of supplementary traversing was done at a cost of R6·6 per linear mile.

Mr. Rae, in charge of all this, had to leave for Montgomery in the middle of January to take charge of the Bári Doáb work, after which it had to be carried on without an assistant.

265. *Plane-tabling and fair mapping*.—Six sheets, $38 \frac{L}{9, 10, 11, 12, 13, 14}$ were completed to margin; two sheets, $38 \frac{L}{8 \text{ and } 15}$ were commenced; and in 3 sheets, $38 \frac{L}{1, 5, 6}$ as much work was done as political considerations would allow.

The total area surveyed was 1,881 square miles and the cost-rate R31·8.

In the northern parts of the Bannu Doáb the ground is very enclosed, being covered by high sugarcane cultivation, trees and villages, and it is intersected by innumerable water channels; in the centre of the district there are large areas of impassable clay ravines, running to depths of 60 or 70 feet. The rest of the plains are nearly waterless, and the ground is difficult to portray, one common feature being that river beds and deep nullahs gradually dwindle away to nothing as one follows their course downwards.

The intricacy and broken nature of the small ranges between Bannu and Dera Ismail Khan makes it impossible to show them satisfactorily even on the 2-inch scale, and the fair drawing is very difficult.

The fair mapping of all the work will be finished by the end of recess, except sheets $38 \frac{L}{8 \text{ and } 15}$, the survey of which is incomplete.

266. *Miscellaneous Punjab traverse work*.—On the work in Jhelum colony nine traversers were employed, commencing work on the 20th November and being gradually transferred to the Bári Doáb in the months of January and February. Six hundred and twenty-six linear miles of supplementary traverse were done at a cost of R10·6 per mile.

Meanwhile arrangements had been concluded with the Punjab Government to traverse and lay down base lines over the whole of the desert areas of the Bári Doáb, in Montgomery and Multán districts; on their guaranteeing a grant of R10,000 to cover the cost of buying and embedding mark-stones.

The work consists of first traversing, and then laying out from the traverse lines, base lines about $2\frac{1}{2}$ miles apart over the whole area, the object being to prevent men working on the square system from going far astray in laying out and apportioning land in the new colony, and to enable the Punjab Settlement staff to break up the whole area into one system of rectangles without an accumulative error.

Better and probably cheaper methods of attaining the desired results could be easily devised if the whole work were carried out professionally, but the procedure adopted appears that best calculated to assist the settlement survey staff, and the work should save an immense amount of delay and confusion in the

creation of the new colony, and should also afford settlement maps which will form a reliable basis for future topographical surveys.

195 bases, covering an area of 1,123 square miles, were laid down, and some work traversed ahead, at a cost of ₹20,811, during the past season; and it is hoped to get the remaining area, about 3,000 square miles, completed at a cheaper rate during the coming field season.

Captain M. O'C. Tandy's method of using existing traverse data to assist settlement surveyors in breaking up extensive areas into rectangles appears to have been a great success in Gujránwála district, as the results are reported to be two or three times as cheap and more accurate than if they had been carried out without this assistance; to this may be added the important advantage of having the whole country on one system of rectangles, which certainly could not otherwise have been effected with any approach to accuracy.

This procedure, again, is a compromise with the existing Settlement methods, and does not by any means secure the most advantageous use of the existing traverse data; but in existing circumstances it has certainly been a compromise worth making, and this year the party has supplied further data for the extension of the same system of rectangles into the Rechna Doáb portions of Lahore and Montgomery districts.

The area for which data were supplied last year was 1,530 square miles, and that now supplied is 920 square miles.

267. *Punjab riverain surveys.*—The fair mapping and compilation has suffered somewhat owing to the transfer of the party from the Punjab. It is hoped to remedy this difficulty by locating the office in Lahore during next field season.

The first practical test on a large scale of the advantages of the riverain maps was made last cold weather when, by the use of the survey maps and the deputation of a traverser to locate fresh marks on the ground, all discrepancies in the boundaries between Kapurthala State and Amritsar were brought forward and, for the most part, at once disposed of.

Babu Maya Das Puri has continued to carry on this most difficult work with discretion and energy.

268. *Arrears of mapping.*—The chief arrears of the party are those which the Himalayan section was specially organised to dispose of. This section was transferred from the party to the charge of the Superintendent, Frontier Surveys, from 1st April, by which time it had arrived within measurable distance of the end of its labours.

As already described, the Multán standard sheets were all disposed of during the field season, and the current mapping is now absolutely up to date.

The only work outstanding next year will be a certain number of triangulation and traverse charts, and large scale town maps of Amritsar, Baháwalpur and Dera Gházi Khan, which were brought up to date at the time of survey, and should be re-drawn as soon as time permits.

269. One soldier-surveyor fell ill very early in the season, and was brought into Bannu, where he died in hospital; one computer died on return to recess, after much hardship working with a triangulator in very waterless hills till the end of May. Six *khalasis* died during the season, and there was a great deal of fever and dysentery in all ranks.

NORTHERN CIRCLE.

TRAINING PARTY (*VIDE INDEX MAP NO. 1*).

270. The party was formed on 1st October 1906. Mr. Petters (and Mr.

Personnel.

Provincial Officers:

Mr. G. P. Tate in charge, and Mr. M. C. Petters.

Subordinate Establishment:

4 Instructors, 18 Surveyors (under training), 2 Traversers, 3 Soldier-Surveyors, and 1 Writer.

P. A. T. Kenny who was lent to this party) left Dehra Dún in the middle of October to take up the triangulation. Owing to a difficulty in obtaining labour, they were unable to commence work till nearly the end of October.

On 5th December the detail surveyors assembled at Jhelum and the same difficulty was experienced in organizing the staff of *khalasis*. But the time was utilized to compute the triangulation and the plane-tables were plotted and men sent out to work by degrees, and by the end of December every camp was out of Jhelum.

Four camps were formed under four experienced surveyors as instructors. One of these, Surveyor Kader Sharif, had to leave the field owing to serious illness. Two of the instructors proved unable to stand hard work, and but for the zeal and energy of the fourth, Surveyor Ghulam Hyder Khan, the outturn and quality of the work would have suffered.

271. Training was carried on under service conditions. One man only was found to be not suitable and discharged from the field. The quality of the work was good. The men under instruction were anxious to learn. Owing, however, to want of practice in drawing, the delineation of the country is much weaker than the survey.

Work was rigorously tested. All work not up to 1st class standard was rejected, re-surveyed, or revised. The general character of the ground surveyed was difficult. Sheet No. 43 $\frac{H}{9}$ was completed and some work was also done in sheet No. 43 $\frac{G}{12}$.

An area of 322 square miles was surveyed on the 2-inch scale and 1,059 square miles triangulated. Cost-rates have been omitted as this is a training party.

272. Plague broke out with great virulence towards the close of the field season, but the party did not suffer from it.

273. The head-quarters of the party were removed from Jhelum to Rohtas in January, and in February to Dina, where the Superintendent, Frontier Surveys, inspected the party.

The party entrained at Dina railway station on the 13th and work was resumed at Dehra on 23rd May.

Systematic instruction has been going on during the recess and the men have shown a praiseworthy desire to improve.

CADASTRAL AND TRAVERSE SURVEYS.

BENGAL AND EASTERN BENGAL (*VIDE* INDEX MAP NO. 2).

274. The operations in Bengal and Eastern Bengal were under the supervision of Major R. T. Crichton, I.A., Superintendent of Provincial Surveys, until March 28th, 1907, since when, Major Crichton going home on well earned leave, Captain F. C. Hirst, I. A., has officiated. The work was carried out by 3 parties, one of which comprising one traverse and two cadastral sections was very large.

The outturn for the year is as follows:—

	Bengal.	Eastern Bengal.
Traversing	6,309	1,022
Cadastral survey	1,683	...
Record-writing	1,845	...
Topographical surveys on the 4-inch and smaller scales .	1,591 (a)	...

(a) Excluding 51 square miles in Monghyr.

NO. 4 PARTY (BENGAL).

*Personnel.**Imperial Officer:*

Captain F. C. Hirst, I.A., in charge till 28th March 1907.

Provincial Officers:

Messrs. N. Bedford in charge from 29th March 1907, T. W. Babonau, E. G. Hardinge, C. A. O'Donel, J. C. C. Lears, O. J. H. Hart, P. Kennegy, F. W. Marten, A. B. Smart, I. Newton, J. H. Johnson.

Subordinate Establishment:

3 Supervisors, 4 Hospital Assistants, 19 Writers and Accountants, 63 Computers, Draftsmen, etc., 49 Traversers, 8 Head Inspectors, 54 Inspectors, 933 Amins, 933 Moharrirs and 1,965 Menials.

275. This party consisting of one traverse and two cadastral camps was employed in the Bhágalpur, Monghyr and Patna districts, and also carried out a number of petty surveys.

276. The outturn of the season is as follows:—

District.	Nature of operation.	Area in square miles.	Cost-rate per square mile.
Monghyr	Traverse	1,190	35'9
	Cadastral	1,307	53'0
	Record-writing	1,307	52'0
	Triangulation for topography .	275	... (a)
Patna	Traverse	852	34'2
Bhágalpur	Cadastral	375	61'1
	Record-writing	538	48'4
Various	Petty surveys, excluding linear relaying work.	29	...

(a) The cost is included under the heading "Traverse."

The cost-rates for traversing are fair when it is considered that a portion of the area dealt with was very rough in character and much jungle clearing was required. The rates for cadastral and record-writing are good.

277. The traversing has been suitably connected with the Great Trigonometrical stations and proves well. There were 31,714 theodolite stations which were marked by 4,364 stones at village trijunctions, 25,871 cylinders and 1,479 pegs. Demarcation was as a rule fair.

The detail survey was checked by 3'5 linear miles of test survey per square mile of detail work, and over 27% of the record entries have been checked by the survey staff. This party will in future do no cadastral work; such operations for the whole of Bengal being handed over to the Settlement Department from the first of October 1907.

An attempt to deal topographically with some 275 square miles of rough country in South Monghyr failed as an unexpected alteration in programme necessitated the employment of the staff retained for this, on other work.

The programme for next year consists of the completion of the traversing of the Patna district and the traversing of about 350 square miles of the Shahabad district. In addition several petty surveys and the topographical survey of the 275 square miles of Monghyr district referred to above will be carried out.

NO. 5 PARTY.

278. This party dealt with traverse work for cadastral survey in the districts of Midnapore, Ranchi, Singbhum and Sonthal Parganas. In addition one or two petty surveys were carried out.

Personnel.

Provincial Officers :

Messrs. C. S. Kraal in charge, C. H. G. Johnson and L. B. Fitz-Gibbon.

Subordinate Establishment :

2 Supervisors, 55 Traversers, 34 Computers, etc., and 693 Tindals and other Menials.

The total outturn was as follows :—

District.	Nature of operation.	Area in square miles.	Cost-rate per square mile.
Ranchi	Traversing for cadastral survey .	1,128	37.3
Sonthal Parganas	Ditto ditto .	807	26.6
Singbhum	Ditto ditto .	601	30.4
Puri	Ditto ditto .	97	49.1
Midnapore	Ditto ditto .	15	24.8
	TOTAL .	2,648	

279. The cost-rates for traversing are very fair considering the scattered nature of the programme.

280. The work has been connected with the Great Trigonometrical survey and proves well except in Singbhum ; there somewhat high corrections had to be applied as the ground was very rough in places ; the subtense bar was in frequent use both in Ranchi and Singbhum. In all 50,203 theodolite stations were used ; of these the village trijunctions are marked by 4,789 stones or marks on existing stones and the remainder by 45,414 galvanized iron cylinders, stones, pegs or marks cut on rocks. The demarcation was on the whole very fair.

281. The programme for the next year is the completion of the traversing of the Ranchi district (1,172 square miles), the traversing of about 630 square miles of Manbhum and of 210 of Midnapore and of 15 of Singbhum district.

NO. 6 PARTY (EASTERN BENGAL).

Personnel.

Provincial Officers :

Messrs. A. W. Smart, late Extra Deputy Superintendent, in charge, O. E. C. Judd, P. F. Delaney, L. B. Fitz-Gibbon, T. F. Kitchen and B. F. Cooper.

Subordinate Establishment :

1 Supervisor, 43 Traversers, 21 Surveyors, 35 Clerks, Computers and Draftsmen, 900 Guards, Tindals and Khalasis and 4 Hospital Assistants.

282. This party comprised one traverse and one combined traverse and topographical section.

The areas accomplished are as follows :—

District.	Nature of operation.	Area in square miles.	Cost-rate per square mile.
Jalpaiguri	Traverse for cadastral	1,018*	72.2
24-Parganas	Traverse and topography, 4-inch .	638	76.0
Khulna	Traverse and topography, 2-inch .	953	92.9

* In addition 4 square miles were traversed for petty survey work.

The rates are good considering the nature of the country.

283. In Jalpaiguri there were 19,604 theodolite stations, which were marked as follows:—5,527 stones, 867 galvanized iron cylinders, 486 pucca pillars, 78 iron posts, 42 wooden posts, and 12,604 pegs. In the Sunderbans area the 6,592 new stations have been marked by 1,331 trunks of trees cut down to the required height, 5,046 pegs and 215 galvanized iron cylinders; the marking of stations was done on the same principles as reported last year. Zigzag traversing with the subtense bar was again adopted, the area dealt with being very thickly wooded and consisting of a very complicated network of streams and creeks; the results of this traversing proved well.

284. The difficulties hitherto experienced in the Sunderbans survey repeated themselves; in order to convey fresh water and stores to suitable centres, a fleet of 2 steam launches, 3 flats and 85 boats was maintained.

285. The survey of the 24-Parganas Sunderbans is now completed and that of the Khulna Sunderbans will be finished next year; in addition to this programme, the survey of about 900 square miles of Jalpaiguri and 1,200 of Mymensingh and Faridpur will be taken up next year.

MISCELLANEOUS SURVEYS.

286. The miscellaneous surveys dealt with were as follows:—

- (a) *Calcutta Municipality*.—The mapping for the re-survey of the Calcutta suburban areas and the Dihi Panchannogram is still in hand; progress in the latter is delayed owing to work in many cases having to be held up pending the attestation of that already done; out of 397 maps of the suburban area for the Calcutta Corporation only 37 remain to be drawn; these sheets lie along the junction of the city and suburban areas, and steps are being taken to revise the city sheets affected, so that they may fit on to the new suburban sheets accurately. Of 469 sheets of the Panchannogram Estate, 256 have so far been drawn. The revision of the city survey itself is also probably about to be undertaken.
For the Port Commissioners an area of 1,498 acres was traversed and 600 surveyed in detail; this area covers a portion of the lands to be acquired for dock extension by the Port of Calcutta.
- (b) The Colgong Municipality of district Bhágalpur was traversed and cadastrally surveyed, a record-of-rights being also written.
- (c) A cadastral survey was made of village Mawalikabad in district Bhágalpur.
- (d) 15 villages of Purnea and Bhágalpur lying in the Kosi *diara* were traversed and cadastrally surveyed.
- (e) The work along the Mechi river (Nepal-Darjeeling boundary) was finally completed, an assistant being sent to point out the positions of the points selected last year for the boundary pillars; some of these had been lost, because the local authorities had been unable to put down permanent marks at the time of the original demarcation.
- (f) The boundary between Nepal, Bhágalpur and Purnea around the point of entry of the Kosi river into British territory was examined with a view to deciding how far permanent marks could be erected in the old beds of that river with safety; this question will be finally settled next year.
- (g) A 2-inch map of the Jamálpur Municipality (district Monghyr) was made in order to complete the preliminary standard sheets of that district, the Municipality having been omitted intentionally from cadastral operations.
- (h) The last survey of the Binda *diara* (district Monghyr) was examined, certain boundaries having been lost; these were rectified.
- (i) The record of occupancy of the Bhágalpur Municipality, compiled two years ago, was examined as it was found to be faulty in places; every plot was checked and all mistakes were corrected.
- (j) Some work on the boundary between Udaipur State and Bilaspur district of the Central Provinces was carried out to assist the Commissioner appointed to decide that boundary dispute.

- (k) A map was made showing the position of certain lands in Ghorapakhia (district Malda) with reference to previous surveys, so that the Collector of Malda might be able to decide a long standing dispute in the bed of the Ganges river.
- (l) The Revenue survey boundary of Maldanga in district Malda was relaid at the request of the Collector of that district.
- (m) Some petty arrears work in district Dacca were carried out but an inundation prevented the completion of this work which will now be held over until the survey of the district is resumed; this will probably be in survey year 1910-11.

BENGAL DRAWING OFFICE.

287. As reported last year, the work of this office falls under seven main sections:—

- (a) *Standard mapping*.—North Bihár falls in 77 standard sheets, some of these being the old size, and some of the new size; up to the end of last year 38 of old size sheets altogether had been sent for publication; during this year 5 of old size and one of new size, covering portions of the districts of Darbhanga, Bhágalpur and Purnea, have been sent for publication; six others are nearing completion.

In Eastern Bengal and Assam, 6 sheets of old size and 3 of new size of Tippera and Backergunge were in hand during the year, 1 was sent for publication and the others are in various states, 6 being practically ready for publication.

- (b) *District maps*.—The district maps of Darbhanga and Chittagong have been sent for publication, and those of Monghyr and Bhágalpur will be commenced shortly.
- (c) *Traverse Charts*.—In Orissa, out of 49 charts forming the Orissa division, 13 have been sent for publication, and 15 others are practically completed; 10 remain to be examined, and the remainder are well in hand. The charts of North Bihár will be commenced as soon as Orissa has been dealt with.
- (d) *Thana maps*.—Maps of 3 *thanas* of Backergunge district, of 5 *thanas* of Faridpur, of 4 *thanas* of north Bhágalpur, of 2 *thanas* of Purnea, of 9 *thanas* of Ranchi and of 4 *thanas* of Singhbhum have been prepared.*
- (e) *Reproduction of village maps*.—During the season 3,793 sheets have been traced, 4,910 examined, and 656,407 copies despatched to Collectors and Settlement Officers; in 1904-05 239,082 copies were despatched, and in spite of this rapid increase the outturn has by no means yet reached its limit.
- (f) *Badar Section*.—This section needs no comment.
- (g) *Map Record Section*.—During the year 4,854 original sheets were received, making a grand total to date of 101,715 sheets; 16,102 paper traces were received, the total number of such traces now lodged being 37,624.

* Trijunction mark maps of 3 *thanas* of Backergunge, 6 of Tippera and 1 of Noakhali (Sarail and Chakla Roshnabad Estates), 10 of Darbhanga, 3 of North Monghyr, 4 of North Bhágalpur, 1 of Cuttack, 6 of Gaya and 2 of Patna (the work in the two last districts being made up from portions of scattered cadastral work) have been completed during the year.

UPPER AND LOWER BURMA.

NO. 7 PARTY.

288. The party was transferred on the 16th October 1905 from the administrative control of the Deputy Surveyor General to that of the Superintendent in charge Burma Surveys.

*Personnel.**Provincial Officers :*

Mr. O. D. Smart in charge, Mr. C. G. Lee, Babu Jagdamba Prasad, Messrs. C. S. Littlewood, S. F. Norman, and W. E. Swiney.

Subordinate Establishment :

17 Traversers, 13 Computers, 13 Draftsmen, 2 Typers, 5 Estimators, 6 Inspectors, and 45 Field Surveyors.

289. The programme consisted of the completion of the cadastral survey of the Pakòkku district, advance traversing in the Sinbaungwe township of the Thayetmyo district and the traverse and cadastral survey of part of the coast tracts of the Pyapôn district. The programme was completed with the exception of the cadastral survey of 14 square miles in Pyapôn which had, owing to heavy rain, to be postponed till next season.

290. The outturn and cost-rates were as follows :—

Locale.	TRAVERSING.			DETAIL SURVEY.							REMARKS.
	Kwins.	Square miles.	Cost per square mile including demarcation.	Kwins.	Sheets.	Fields.	Acres.	Square miles.	Cost per square mile.	Average size of fields in acres.	
Pakòkku (cadastral).	263	637	(b) 66,633	(b) 325,528	509	77	(a)	Scale 16 inches=1 mile.
Lower Chindwin (cadastral).	...	...	...	2	4	28	2,088	3	10	1'13
Thayetmyo (cadastral).	335	691	66	20	49	6,857	28,050	44	158	0'76	
Pyapôn (cadastral) .	112	171*	186	107	234	31,706	80,108	125	205	1'2	
Pyapôn water area .	...	...	...	...	...	...	3,829	6		
TOTAL AREA	447	862	...	392	924	105,224	439,603	687	...	...

(a) Calculated on the cultivated area only.

(b) Includes jungle.

* Includes 26 square miles of jungle not for detail survey.

The cost-rates are all affected by the fact that there are no officers of the Imperial service with the party now. Those of traversing in Thayetmyo are R25 per square mile less than those for country of a similar nature in Pakòkku during the previous season.

In Pyapôn, although necessarily high, the rates both for traverse and cadastral survey compare very favourably as compared with work of a similar nature in Kyaukpyu in season 1902-03.

The cost-rates of cadastral survey in Pakòkku are R5 per square mile less than for last season's work in the same district ; in Thayetmyo the rates for cadastral survey are high owing to work having been taken up late in the season and the small area surveyed.

291. *Pakòkku*.—The cadastral survey of this district was commenced this season on the 10th November 1906 and completed on the 26th March 1907, when the section was transferred to Thayetmyo ; the area surveyed lay in the Pauk and

Seikpyu townships and consisted of 107 square miles containing 60,516 fields of an average size of 1.13 acres. The remaining area of 402 square miles, consisting of hills and jungle, was not surveyed, but the traverse lines were provisionally accepted as *kwin* boundaries. The work was checked by 110 linear miles of test lines by the officers of the party and by 157 linear miles of independent *partals* by Inspectors, giving an average of 2.5 linear miles of check survey to each square mile cadastrally surveyed. The average number of *amins* employed was 38 for 118 days, and the average daily outturn per *amin* was 15 acres, comprising 14 fields. The origin of survey was the same as for the rest of the district, *vis.*, Latitude $21^{\circ} 30'$, Longitude $94^{\circ} 30'$. The health of the section while in the Pakkoku district was good.

292. *Lower Chindwin*.—Two jungle *kwins* adjoining the Pakokku district which had been left out in previous years were surveyed cadastrally.

293. *Thayetmyo*.—The area to be traversed (691 square miles) lay in the Sinbaungwè and Minhla townships and was completed between the 6th November 1906 and 29th April 1907. It consisted chiefly of low hills covered with scrub jungle. The average number of traversers was 7 for 150 working days, and their average daily outturn was 12 angles and 124 chains.

No stations of the Great Trigonometrical Survey occurred in the area traversed, but the work was connected with seven trigonometrical stations of topographical series. The average linear error was 11.3 feet per mile. Double chaining was employed and totalled 1,625 linear miles. The theodolite was set up at 12,220 stations, of which 10,934 were new and were marked with galvanized iron cylinders at an average cost of twelve annas per station. Azimuths were observed at 78 stations and vertical angles at 2,677 stations. The origin of survey was Latitude $19^{\circ} 30'$ and Longitude $95^{\circ} 15'$.

The cadastral survey was commenced on the 29th March and closed on the 29th April 1907. The average number of *amins* employed was 17 for 30 days and the average daily outturn of each *amin* was 10 acres or 13 fields. The cultivated portion only were surveyed and amounted to 8 square miles, comprising 6,723 fields of an average size of 0.76 acres. The hilly and jungly area amounting to 36 square miles was not surveyed, but the traverse lines were accepted as *kwin* boundaries. The work was checked by 15 linear miles of test line by Provincial officers and by 9 miles of independent *partal* by Inspectors, giving an average check of 3 linear miles to each square mile surveyed.

Six cases of cholera occurred in this section at the beginning of the field season of which four proved fatal, but the health of the section was otherwise good. One *khalasi* was supposed to have been murdered, but no clue could be found by the Police.

294. *Pyapôn*.—The traverse survey of the area dealt with in the Pyapôn district commenced on the 17th December 1906 and was completed on the 20th of May 1907. The cadastral survey commenced on the 4th of February and closed on the 28th June 1907. The area surveyed lay in the Pyapôn and Bogale townships: it is situated in the delta of the Irrawaddy, intersected by tidal creeks and mostly subject to inundation. The only means of communication was by the ordinary boats of the district called "*sampans*." The average number of traversers was 8 and the average daily outturn was 7 angles and 67 chains, this small outturn being due to heavy jungle clearing, tidal difficulties and slow communications by country boats. No trigonometrical stations were connected with. Double chaining was employed and totalled 812 linear miles. The theodolite was set up at 6,357 stations of which 5,725 were new and marked with galvanized iron cylinders at an average cost of thirteen annas per station. Azimuths were observed at 44 stations. The origin of survey was Latitude $16^{\circ} 45'$ and Longitude $94^{\circ} 45'$.

The cadastral survey was carried out by an average of 17 *amins* and 3 Inspectors and the average number of working days was 89. The average daily outturn of each *amin* was 53 acres comprising 21 fields. The total area surveyed was 131 square miles, consisting of a land area of 125 and a water area of 6 square miles. It comprised 27,116 fields of an average size of 1.2 acres. The area was mapped with full topographical details. The work was tested

by 85 linear miles of test lines by Provincial officers and 153 miles by Inspectors, giving an average of 1·9 linear miles to every square mile.

The men of this section suffered severely from fever and bowel complaints, the average number of sick being 77 per mensem; two deaths occurred and 13 men were invalided during the field season.

295. The 16-inch maps of all the current season's work have been completed and all containing cultivation have been sent to Calcutta for reproduction, the originals of the remainder, comprising jungle land only, have been sent to the Deputy Commissioners for record. To meet the immediate requirements of the Settlement Commissioners and Director of Land Records traces of 43 *kwins* in Pakòkku and of 52 *kwins* in Pyapòn have been prepared.

296. All the 2-inch mapping in Pakòkku has been submitted for publication and the new material in Pyapòn will be added to the existing maps. The portion of the Thayetmyo district under cadastral survey having been recently topographically surveyed will not be mapped on the 2-inch scale.

297. Unpublished proofs of the Rangoon town added area have been supplied to the district and municipal authorities and the maps will be published after the boundary pillars, which had not been erected at the time of survey, have been added.

298. The traverse computations have been completed and 60 traverse charts have been prepared for press, 27 remaining in various stages of progress. On publication of these charts the original traverse computations will be made over to the district authorities for record and safe custody.

299. The programme for 1907-08 consists of the cadastral survey of 647 square miles in Pakòkku, 14 in Pyapòn, 175 in Pegu and 20 in Yamethin districts. The area for survey in the two last named districts has yet to be traversed.

300. The Government of Burma having decided that all the cultivated areas in the province which it considers of sufficient importance to require the services of an Imperial Survey party will have been completed by the end of next field season, it is proposed to break up the party in October 1908. The revenue surveys of the province will in future be carried out by local agency. The maps of the area surveyed by No. 7 Party will continue to be reproduced in Calcutta, but, after their publication is complete, future revenue maps will be reproduced in the local Lithographic Press.

301. The party was inspected during the field season by the Superintendent in charge Burma Surveys.

CANTONMENT SURVEYS.

NO. 1 SECTION.

302. During the season under report, this section was employed on the survey of the cantonments in the Meerut and Lucknow divisions. Mr. J. McHutton, a retired officer of the Provincial service, remained in charge till the 21st June 1907, when he was obliged to tender his resignation owing to a serious accident, and Mr. F. S. Bell, Extra Assistant Superintendent, 4th grade, was placed in charge temporarily till the end of the season, when Mr. E. G. Little, also a retired officer of the Provincial service, relieved him.

303. The survey of 7 cantonments was completed:—Dalhousie, Delhi, Muttra, Lansdowne, Shahjahánpur, Sitapur and Dinapore. That of Ranikhet and Benares was almost completed and of Naini Tal, Almora and Landour was commenced. The maps of 8 cantonments:—Solon, Dagshai, Sabáthu, Kasauli, Jutogh, Bakloh, Dalhousie and Muttra were forwarded to the Trigonometrical

office for publication, and those of 7 were published, namely, Kohát, Campbell-pore, Roorkee, Sabáthu, Solon, Dalhousie and Jutogh. The areas surveyed during the season and the cost-rates were—

	Acres.	Rupees per acre.
Triangulation	6,711	0·38
Traversing	17,272	0·28
Detail survey on 16-inch scale	16,787	0·74
" " 64 " " 	253	4·22
Mapping	6,495	0·29

The cost-rate of the season's work has thus been R5·9 an acre, the cost of the 64-inch field work alone being R4·2. The programme was not quite completed, owing to there being so many hill cantonments in which work cannot be done during the cold weather or the rains. The average daily outturn of 16-inch survey was 12 acres and that of the 64-inch, 1 acre.

304. Next season it is proposed to resume the survey of Abbottabad, Nowshera and Mardán, in which work was commenced last season but was suspended owing to projected additions to the cantonments. Almora, Naini Tal and Landour, which have all been commenced, will also be completed, it is hoped, and also Bannu. The Deputy Surveyor General inspected this section twice during the season.

SECTION NO. 2.

305. This section was formed temporarily in December 1905 for the survey of the cantonments in the Poona and Mhow divisions and remained in charge of Mr. L. J. Pocock, also a retired officer of the Provincial service. The survey of the 8 cantonments of Poona, Kirkee, Khandála, Purandhar, Baroda, Ahmedabad, Devláli and Ajmer was completed, and the maps of the first 6 were forwarded to the Trigonometrical office for publication. The survey of Nasirabad, Mount Abu, Neemuch and Ahmednagar was almost completed and that of Aurangabad, Jubbulpore and Mhow commenced. Next season all the cantonments in these two divisions should be completed, those remaining for survey, besides the three abovementioned, being Indore, Sehore and Pachmarhi. The bazaars of Secunderabad and Bolarum of the Secunderabad division will also be surveyed by this section on the scale of 50 feet to the inch and probably this will not be completed by the end of next season as there are 42 bazaars and the scale is very large.

306. The Deputy Surveyor General inspected this section at Poona in July 1907. The season's outturn and cost-rates are—

	Acres.	Rupees per acre.
Traversing	18,494	0·3
Detail survey on the 16-inch scale including mapping.	13,327	1·0
" " 64 " " " " " "	581	9·3

In addition to the above, all the cantonments that were surveyed last season were contoured during the season under report. The average daily outturn of 16-inch survey was 17·8 acres and of 64-inch survey, 1·4 acre without contouring. With contouring the outturn was 10·3 acres on the 16-inch scale. The cost-rate of the 16-inch survey without contouring was R0·5 per acre and of the 64-inch survey, R8·8.

SECTION NO. 3.

307. This section was also formed temporarily early in 1906 for the survey of certain cantonments in the Secunderabad division and has now been broken up as the survey of all the cantonments has been completed, with the exception of the bazaars of Secunderabad and Bolarum which will be done by No. 2 Section. The cantonments have been surveyed on the 12-inch scale and the bazaars on the 48-inch. The entire civil and military station of Bangalore was surveyed on the 16-inch scale and also the cantonment of Belgaum of the Poona

division. The five Sappers who were employed in this section last season were all recalled to their corps and cadastral surveyors engaged in their place.

308. The outturn for the season and cost-rates, including mapping, are—

	Acres.	Rupees.
Traversing	9,068	0'3
Detail survey on the 12-inch scale	3,573	} 1'0
" " " 16 " 	11,113	
" " " 48 " 	645	} 5'2
" " " 64 " 	181	

The average outturn per working day was—

	Acres.
Traversing 17 stations and 50 chains . . . . .	...
Detail survey on 12 and 16-inch scales	8'3
" " 48 and 64 " 	1'6

The bazaars of Cannanore and Trichinopoly had not been demarcated when the section was broken up, though the attention of the Military authorities and Executive Engineers was repeatedly called to the necessity for demarcating them, the first intimation having been given in each case before the survey was commenced in April 1906. The same difficulty occurred in all the cantonments of this division, the demarcation of most of them having been carried out after the surveyors had left them, consequently none of the maps have been submitted for publication yet.

Summary of the outturn of work of the field parties during the year 1906-07.

TOPOGRAPHICAL SURVEYS.

Scale of Survey, inches to a mile.	Number of Party.	Locals of Operations.	TRIANGULATION.										TRAVERSE.					DETAIL SURVEY.					
			Instrument used.	Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Minor.		Tertiary.		Intersected points.		Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane table fixings per square mile.	Linear miles of test lines.	Number of <i>in situ</i> test fixings.	Linear miles of Forest boundary traverse.
								Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.										
4	2	Berar and Central Provinces . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	148
	6	Bengal, 24 Parganas . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	9	Northern Circle . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	27	Bombay Forests . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	19	Madras { Coimbatore	5 & 6	26	1'3	1'8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
		{ S. Malabar, Ganjam, Trichinopoly. . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	20	Lower Burma . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	2	1 Central Provinces, United Provinces and Central India Agency.	5 & 6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	2	Berar-Central Provinces	6	1,680	2'5	2'5	40	8'1	0'2	52	10'0	0'2	557	0'4	..	..	..	..	..	..	..	..	..
	4	Bengal-Monghyr	6	275	3'0	..	21	12'6	0'3	43	..	1'2	28	..	13	117	1,550	..	..	..	..	..	..
	6	Bengal-Khulna	5 & 6	..	..	..	..	..	..	..	..	..	..	..	953	1,105	4,757	0'2	0'1	..	..	..	..
	9	Northern Circle	5 & 6	1,897	1'9	1'9	26	4'7	0'3	72	7'0	0'2	(f)	(f)	..	..	..	..	..	..	..	..	..
	10	Upper Burma . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	12	Northern Circle	6	4,750	2'9	3'0	49	8'3	0'1	28	9'2	0'1	1,648	0'3	..	..	..	..	..	..	..	..	..
	14	" "	6	4,495	3'6	3'6	..	..	..	107	8'7	0'2	1,028	0'6	..	..	..	..	..	..	..	..	..
	17	Bombay and Central India	6 & 7	2,155	10'5	10'5	..	..	..	164	8'0	0'3	1,451	0'8	..	..	..	..	..	..	..	..	..
	18	Northern Circle	6	1,240	3'2	3'0	..	..	..	76	8'0	0'1	316	(f)	..	2,302	5,095	0'5	0'8	..	..	..	..
	19	Madras { Nilgiri }	6 & 7	3,412	4'7	4'7	51	9'0	0'2	17	12'9	0'4	670	0'3	..	..	..	..	..	..	..	..	..
		{ N. Malabar } . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
		{ Coimbatore } . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	20	Assam Sylhet and Tippera	8	187	37'4	37'4	2	3'3	..	..	..	..	..	..	..	1,801	6,365	2'7	2'1	..	..	..	..
		Burma { Pakokku Hill Tracts. } . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
		{ Lower Chindwin } . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
		Northern Circle, Training	8	1,059	1'8	1'8	49	8'0	0'1	9	9'3	0'5	531	0'5	..	..	..	..	..	..	..	..	..
1 1/2	11	Southern Shan States, Burma	6	1,781	4'6	4'5	..	..	..	21	12'0	0'2	374	0'4	..	..	..	..	..	..	..	..	..
1	3	Lower Burma	6	(f) 2,665	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	..	..	..	..	..	..	..	..	..
	10	Upper Burma	6	706	3'0	3'3	6	12'6	0'5	8	7'6	0'2	219	2'3	..	..	..	..	..	..	..	..	..
	19	Madras—Mysore . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

(a) Resurvey.
 (b) Supplementary Survey.
 (c) Revision Survey of Forests.
 (d) Do. of Contouring.

(e) Revision survey.
 (f) Computation incomplete.
 (g) Not including plane-table traverse stations.

Summary of the Outturn of work of the field parties during the year 1906-07.

CADASTRAL SURVEYS.

Scale of Survey inches = 1 mile.	Number of Party.	Locals of Operations.	TRAVERSING.					DETAIL SURVEY.				RECORD-WRITING.				
			Instrument used. Diameter in inches.	Area in square miles.	Linear miles of new chain- ing.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Linear miles of test lines.	Number of villages.	Number of fields.	Average size of fields in acres.	Area in square miles.	Number of villages.	Number of fields.
16	4	Bengal, Monghyr	5 & 6	1,190	3,283	15,284	0'6	0'03	1,307	4,636	1,151	9,36,429	0'86	1,307	1,151	9,36,429
		" Monghyr hill block . . . . .	...	...	117	1,550	...	...		...	39	6,239	15'97		39	6,239
		" Patna	5 & 6	852	3,379	16,165	1'07	0'02	...	...	...	...	...	...	...	...
		" Bhagalpur . . . . .	...	...	...	...	...	...	375	1,238	204	2,45,167	0'99	538	207	3,37,697
	5	" Ranchi	5 & 6	1,128	3,568	17,516	1'2	0'5	...	...	...	...	...	...	...	...
		" Sonthal Parganas	5 & 6	807	3,293	14,997	2'1	0'4	...	...	...	...	...	...	...	...
		" Singhbhum (Dalbhum)	5 & 6	601	2,082	15,410	1'3	0'8	...	...	...	...	...	...	...	...
		" Puri (Chilka lake)	5 & 6	97	430	1,455	1'2	0'5	...	...	...	...	...	...	...	...
		" Midnapore (Dalbhum)	5 & 6	15	96	507	2'2	0'9	...	...	...	...	...	...	...	...
	6	" Udaipur boundary	6	...	59	318	0'4	0'2	...	...	...	...	...	...	...	...
		" 24-Parganas (Sunderbans)	5 & 6	638	677	2,347	0'23	0'05	...	...	...	...	...	...	...	...
		" Khulna do.	5 & 6	953	1,105	4,757	0'21	0'05	...	...	...	...	...	...	...	...
	7	Eastern Bengal, Jalpaiguri	5 & 6	1,023	3,902	26,143	1'8	0'2	...	...	...	...	...	...	...	...
		Miscellaneous . . . . .	...	28	...	...	...	...	1	...	...	...	...	...	...	...
		Burma, Pakokku . . . . .	...	...	...	...	...	...	509	675	263	...	(c) 1'1	...	...	...
		" Lower Chindwin	3					2	...	(c) 0'8
" Thayetmyo		5 & 6	691	1,62,432	12,220	1'6	0'6	44	79	20	...	(c) 0'8	...	...	...	...
" Pyapon	171															
TOTAL . . . . .			...	8,193	...	...	...	2,370	...	...	...	...	1,845	...	...

(a) Includes 3 square miles surveyed during previous season.
 (b) Includes 22 square miles of Government Estates and Tikari villages.
 (c) Calculated on cultivated area only.

SPECIAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	Locals of Operations.	SPIRIT LEVEL- LING OPERATIONS.		TRAVERSING.			DETAIL SURVEY.		RECORD WRITING.		
			Miles levelled over.	Trigonometrical stations connected with.	Area in square miles.	Linear miles of new chain- ing.	Number of stations at which the theodolite was set up.	Area in square miles.	Linear miles of test lines.	Number of fields.		
...	25	Tidal and Levelling	(a) 805	16	...	...	...	...	...	...
105'6	Detachment	Calcutta suburbs . . . . .	...	...	...	...	...	...	...	83
32	Do.	Panchannagram . . . . .	...	...	...	...	...	...	...	115
105'6	Do.	Port Commissioners' area . . . . .	...	...	2	18	460	1'0	(b)	...
16	Do.	Cantonment Section No. I.—Meerut and Lucknow Divisions.	...	...	27	330	4,035	26'2	95	...
64		Do.	Do. do.	0'4
16	Do.	Cantonment Section No. II.—Poona and Mhow Divisions	...	...	29	295	3,078	20'8	90	...
64		Do.	Do. do.	0'9	15
12	Do.	Cantonment Section No. III.—Secunderabad Division .	...	...	14	233	5,251	5'6	216	...
16		Do.	Do. do.	17'4
48		Do.	Do. do.	1'0
64	Do.	Do. do.	...	...	...	...	0'3	...	...	
TOTAL			(a) 805	...	72	876	...	73'6	...	...

(a) Double levelling.
 (b) In situ testing.

INDEX No. 1

Showing progress of modern Topographical Surveys up to 30th September 1907.

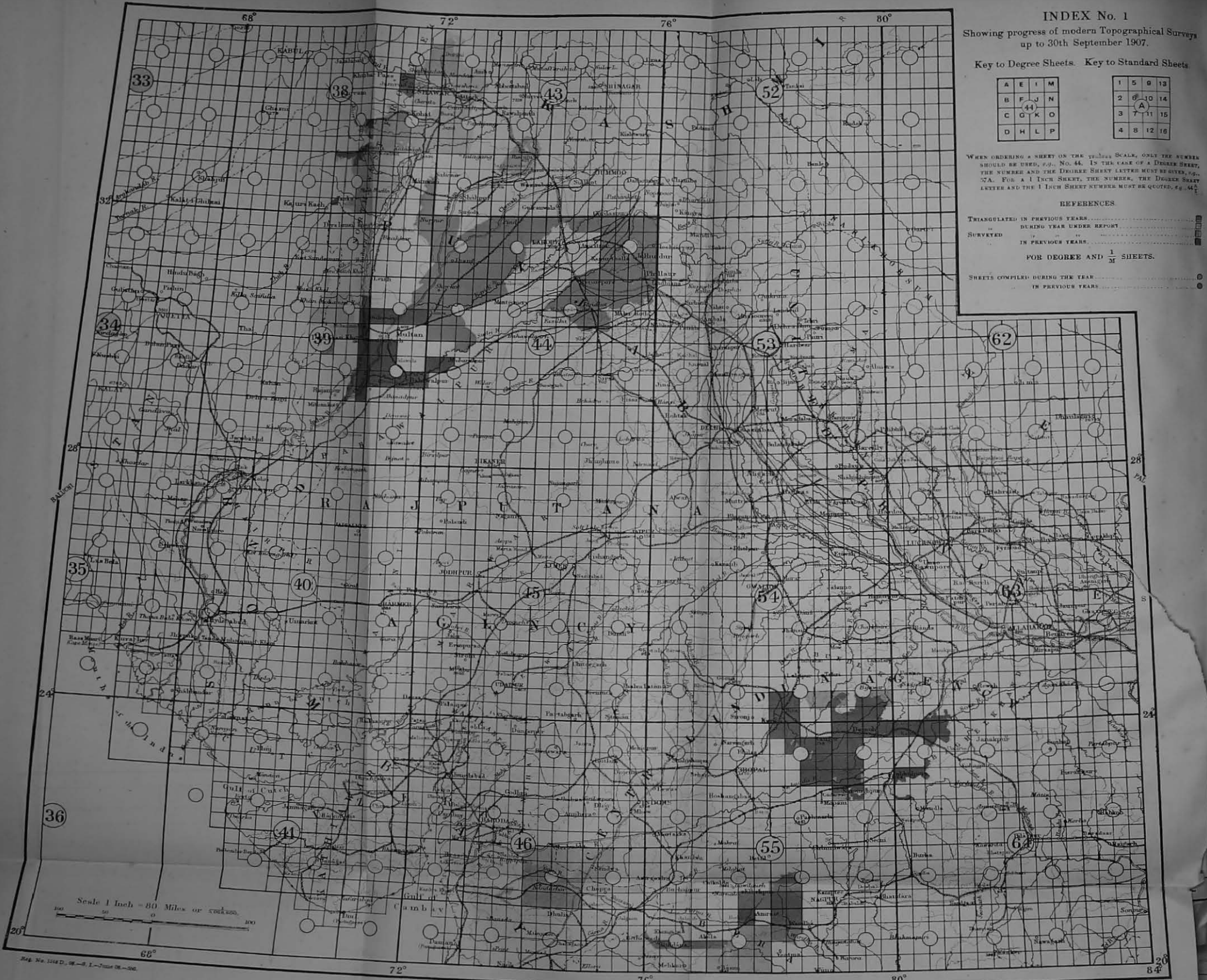
Key to Degree Sheets. Key to Standard Sheets

A	E	I	M	1	5	9	13
B	F	J	N	2	6	10	14
C	G	K	O	3	7	11	15
D	H	L	P	4	8	12	16

When ordering a sheet on the Indian Scale, only the number should be used, e.g., No. 44. In the case of a Degree Sheet, the number and the Degree Sheet letter must be given, e.g., 7A. For a 1 Inch Sheet, the number, the Degree Sheet letter and the 1 Inch Sheet number must be quoted, e.g., 44.

REFERENCES

TRIANGULATED IN PREVIOUS YEARS
 DURING YEAR UNDER REPORT
 SURVEYED IN PREVIOUS YEARS
 FOR DEGREE AND 1/4 SHEETS.
 SHEETS COMPILED DURING THE YEAR
 IN PREVIOUS YEARS





INDEX No. 2
 Showing progress of modern Topographical Surveys
 up to 30th September 1907.

Key to Degree Sheets Key to Standard Sheets

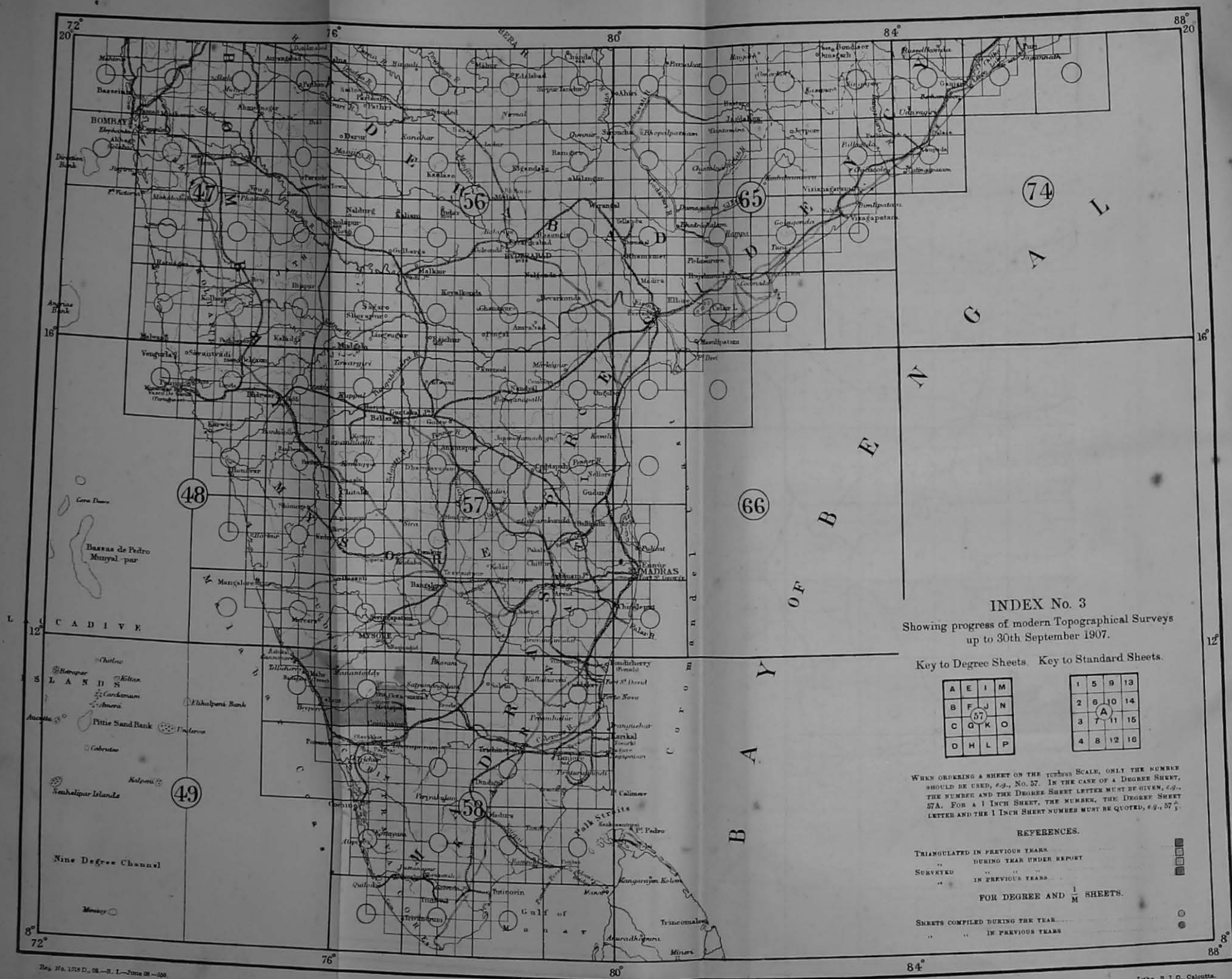
A	E	I	M	1	5	9	13
B	F	J	N	2	6	10	14
C	G	K	O	3	7	11	15
D	H	L	P	4	8	12	16

WHEN ORDERING A SHEET ON THE 1:50,000 SCALE, ONLY THE NUMBER SHOULD BE USED, e.g., No. 84. IN THE CASE OF A DEGREE SHEET, THE NUMBER AND THE DEGREE SHEET LETTER MUST BE GIVEN, e.g., 57A. FOR A 1 INCH SHEET, THE NUMBER, THE DEGREE SHEET LETTER AND THE 1 INCH SHEET NUMBER MUST BE QUOTED, e.g., 543.

REFERENCES.

TRIANGULATED IN PREVIOUS YEARS
 DURING YEAR UNDER REPORT
 SUBVERTED
 IN PREVIOUS YEARS
 FOR DEGREE AND 1 M SHEETS.
 SHEETS COMPLETED DURING THE YEAR
 IN PREVIOUS YEARS

Scale 1 Inch = 80 Miles or 128,000 Feet



INDEX No. 3

Showing progress of modern Topographical Surveys up to 30th September 1907.

Key to Degree Sheets. Key to Standard Sheets.

A	E	I	M
B	F	J	N
C	G	K	O
D	H	L	P

1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

WHEN ORDERING A SHEET ON THE TERNER SCALE, ONLY THE NUMBER SHOULD BE USED, e.g., No. 57. IN THE CASE OF A DEGREE SHEET, THE NUMBER AND THE DEGREE SHEET LETTER MUST BE GIVEN, e.g., 57A. FOR A 1 INCH SHEET, THE NUMBER, THE DEGREE SHEET LETTER AND THE 1 INCH SHEET NUMBER MUST BE QUOTED, e.g., 57A.

REFERENCES.

TRIANGULATED IN PREVIOUS YEARS

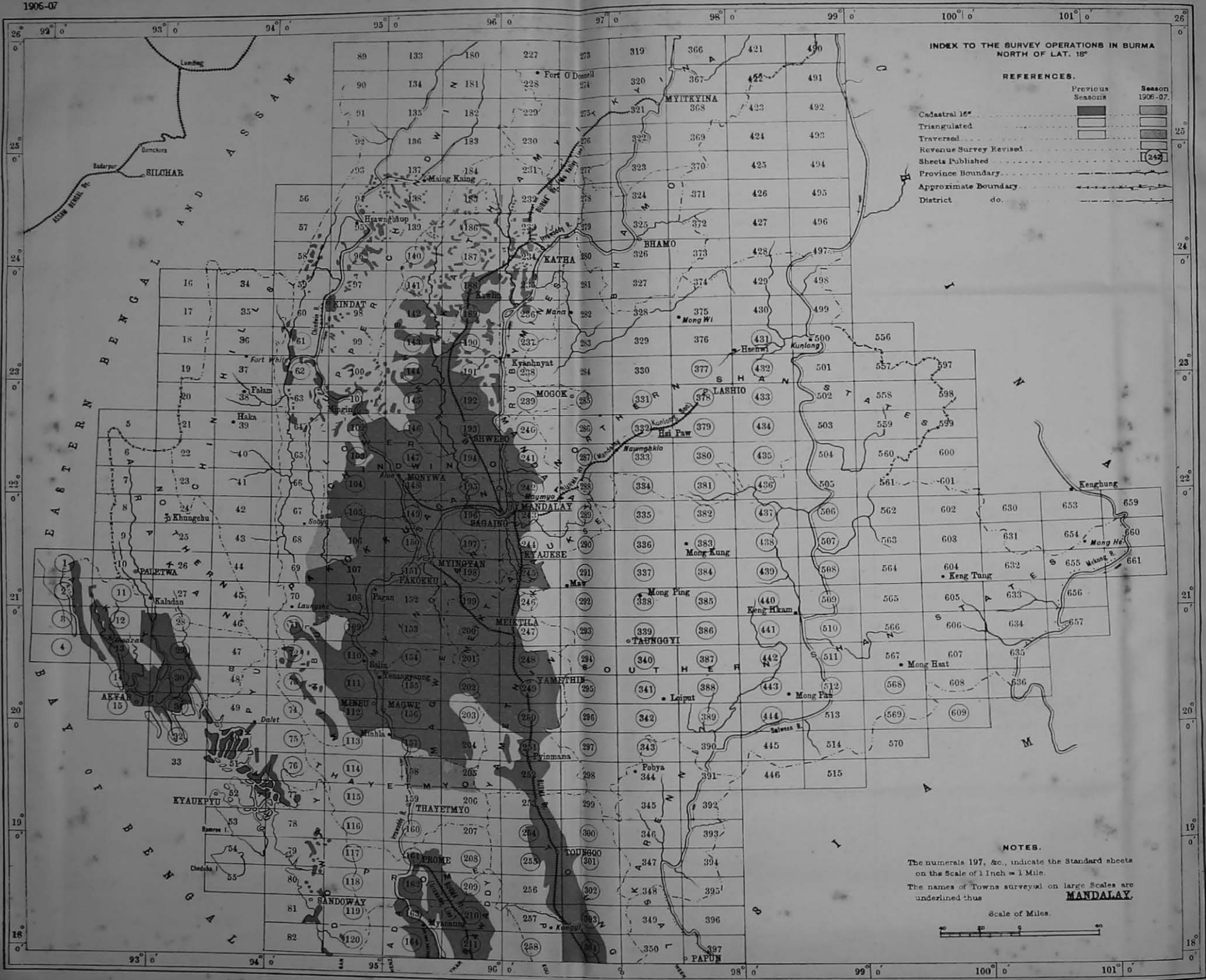
 " DURING YEAR UNDER REPORT

SURVEYED " " IN PREVIOUS YEARS

FOR DEGREE AND ¹/_M SHEETS.

SHEETS COMPILED DURING THE YEAR

 " " " IN PREVIOUS YEARS



INDEX TO THE SURVEY OPERATIONS IN BURMA NORTH OF LAT. 18°

REFERENCES.

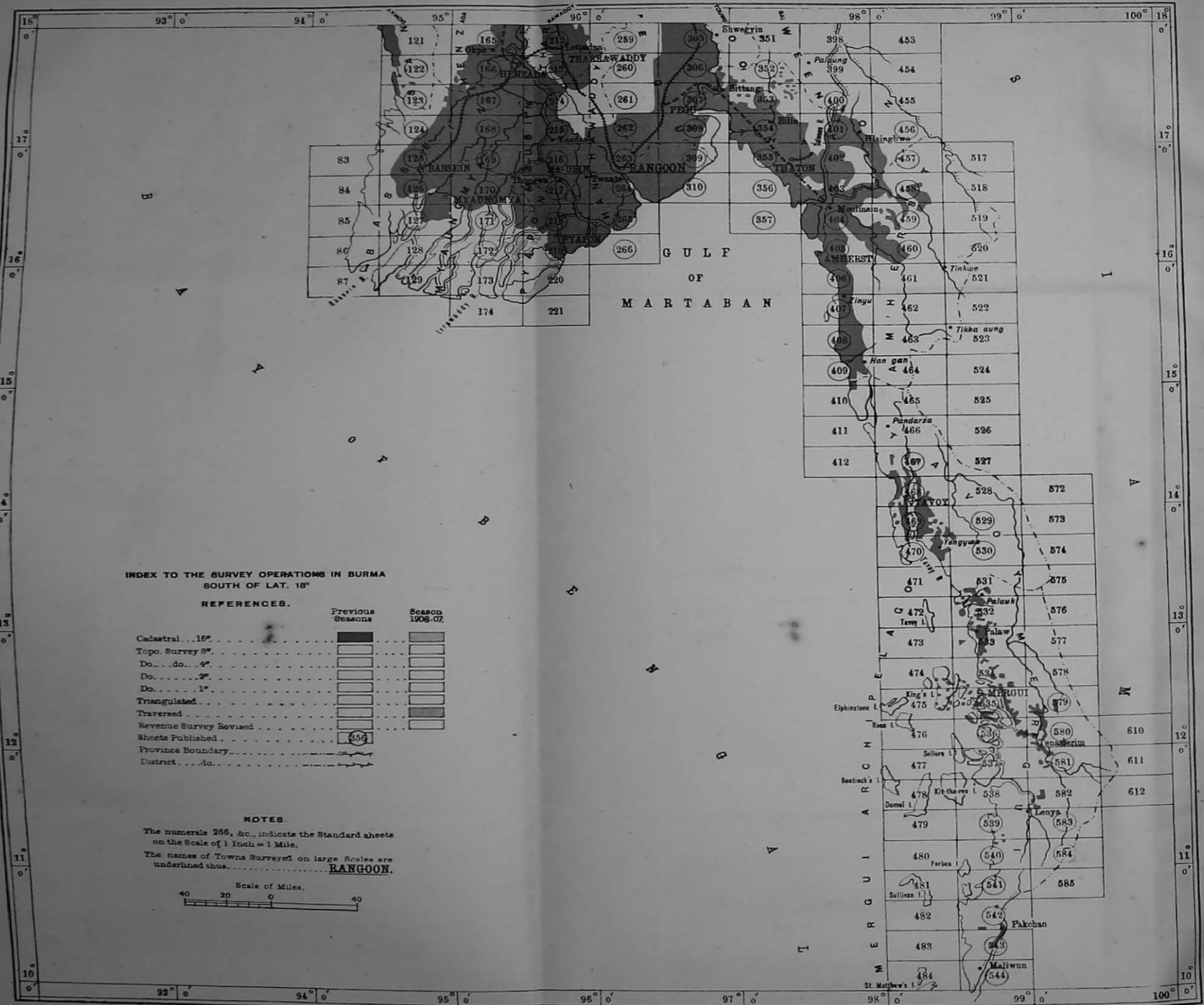
	Previous Seasons	Season 1906-07
Cadastral 16"		
Triangulated		
Traversed		
Revenue Survey Revised		
Sheets Published		
Province Boundary		
Approximate Boundary		
District do.		

NOTES.

The numerals 197, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The names of Towns surveyed on large Scales are underlined thus **MANDALAY**.

Scale of Miles.



INDEX TO THE SURVEY OPERATIONS IN BURMA SOUTH OF LAT. 18°

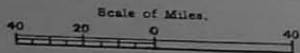
REFERENCES.

	Previous Seasons	Season 1906-07
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Topo. Survey 8"	<input type="checkbox"/>	<input type="checkbox"/>
Do... do... 4"	<input type="checkbox"/>	<input type="checkbox"/>
Do... do... 2"	<input type="checkbox"/>	<input type="checkbox"/>
Do... do... 1"	<input type="checkbox"/>	<input type="checkbox"/>
Triangulated	<input type="checkbox"/>	<input type="checkbox"/>
Traversed	<input type="checkbox"/>	<input type="checkbox"/>
Revenue Survey Revised	<input type="checkbox"/>	<input type="checkbox"/>
Sheets Published	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Province Boundary	<input type="checkbox"/>	<input type="checkbox"/>
District... do...	<input type="checkbox"/>	<input type="checkbox"/>

NOTES.

The numerals 256, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The names of Towns Surveyed on large Scales are underlined thus: RANGOON.



APPENDIX.

Memorandum by Lieutenant-Colonel P. F. Gordon, I.A., on Forest Surveys in India.

(1) The Forest Survey Branch was created as a separate agency for Forest Surveys in 1872. The Branch was placed under the control of the Inspector General of Forests and Captain F. Bailey, R.E., then a Deputy Conservator of Forests in the North-West Provinces, was appointed Superintendent of Forest Surveys and Working plans.

Prior to the formation of this Branch it had been found that the ordinary small scale topographical maps were unsuitable for the purposes of forest administration, and it became necessary in many cases to supplement these maps by others on larger scales; these were produced by local or provincial agency but want of uniformity of scale and style impaired their use and, even when sufficient for local requirements, they were useless for geographical purposes, and their value was quite incommensurate with the cost of their production.

(2) From the outset the Government of India insisted on the necessity for placing the work of the Forest Survey Branch under competent professional supervision with a view to its field surveys being made suitable for incorporation into the standard maps of India.

To shew the importance attached to this supervision the following note regarding the formation of the Branch made by the Secretary to Government may be quoted: ". . . the Branch so far as its pure surveying work is concerned must work strictly and absolutely in accordance with the rules of the Imperial Survey Department and be subject, in all matters of professional detail, to the guidance of the Surveyor General in such wise as to satisfy him that he may safely accept in his own maps the geographical details furnished to him (at such time and in such form as he may prescribe) by the Forest Surveys. I consider this of such importance that I cannot now move further in the matter until the papers have been laid before Colonel Thuillier and Captain Bailey shall have satisfied him that in all these respects everything will be done entirely to his satisfaction."

In 1873 the Duke of Argyll, then Secretary of State for India, while approving of the formation of a Forest Survey Branch remarked on the importance of connecting Forest Surveys with those under the Surveyor General in order that they might be capable of reduction and of being used for geographical purposes. With this object in view Colonel Walker, R.E., F.R.S., Superintendent of Trigonometrical Surveys, was asked by the Government of India to assist and advise in the work. Captain Bailey repeatedly acknowledged the great benefit he had derived in organizing the Branch and in carrying out its operations, from Colonel Walker's assistance and advice which were at all times readily afforded. In 1876 the Marquis of Salisbury, then Secretary of State, in the course of a despatch on the subject, noticed with satisfaction that the co-operation of the Superintendent of the Great Trigonometrical Survey in the work executed, had been of value.

Colonel Walker, in submitting the annual progress report of the Forest Survey Branch for 1876-1877 to the Government of India, placed on record that the maps produced by the Branch were well suited for reduction and incorporation into the standard map of India on the scale of one inch = one mile executed by the professional Survey Department. He also remarked that the principal object which was originally contemplated had been satisfactorily accomplished.

In 1878 Colonel Walker was appointed Surveyor General and the Government of India requested him to exercise, as Surveyor General, the same professional supervision as he had hitherto exercised as Superintendent of the Great Trigonometrical Survey.

(3) The annual progress report of the Forest Survey Branch was until 1877 submitted to the Government of India by the Superintendent, Great Trigonometrical Survey, and from 1878 to 1893 by the Surveyor General. From 1894 the report on the operations of the Forest Survey Branch was incorporated in the General Report of the Survey of India and has continued to be so incorporated up to the present time. The Superintendent of Forest Surveys continued however to submit a special report giving a more detailed account of the work which was published annually.

(4) In the early years of its existence the Head-Quarters of the Forest Survey Branch was located in various private houses hired as offices. It was soon realised that this arrangement was unsuitable and Dr. Brandis, then Inspector General of Forests, writing in 1875 remarked: "It is essential that all original maps and records be kept permanently in one place guarded from risk of fire and insects and that they should be kept in systematic order so as to be readily accessible. . . for this purpose a permanent Forest Survey Office is necessary. . . eventually it may be an advantage to build an office in the vicinity of the Great Trigonometrical Office."

This hope was not realized until 1903 when the present office was built in the compound of the Great Trigonometrical Survey office at Dehra Dún.

(5) From the commencement the rules regarding the apportionment of the cost of Forest Surveys were somewhat complicated. In 1888 the Government of India laid down

definite rules whereby a certain proportion of the cost of Forest Surveys executed by the Survey of India should be borne, in respect of the value of the work for topographical purposes, by the Survey of India and the balance by the Forest Department. The proportion was regulated by the proportion of Forest area, the whole area under survey by a party, and also by the scale of survey. These orders were amended on various occasions until finally in 1904 one uniform rule was applied to the whole of India whereby 70 per cent. of the cost of Forest Surveys was to be borne by the Forest Department and 30 per cent. by the Survey of India.

(6) The necessity for good maps for general Forest administrative purposes and more especially for the preparation of working plans is fully recognized in all countries where the management of State Forest is carried out on scientific principles. The question of the most suitable scale for Forest maps has always been one on which there has existed a great difference of opinion. In Europe Forest maps are prepared on very large scales, but the case is not on parallel lines with that of India, as in Europe the maps are almost solely used as legal documents in connection with the record of the boundaries and not, as in India, for working the forests. When the Forest Survey Branch was organized Conservators of Forests were consulted as to what scale should be adopted: their opinion differed widely: the 4-inch, 8-inch, and the 16-inch all had their supporters, but on the whole the 8-inch was the scale preferred by most of those consulted.

There were, however, many objections to this scale being adopted, such as the enormous cost of the survey and the unwieldiness of the maps, and it was finally decided, with the approval of the Superintendent, Trigonometrical Surveys, to adopt the 4-inch scale and this scale, with certain exceptions, became the standard scale for Forest Surveys in India. This decision is upheld by the late Mr. D'Arcy who, in his "Notes on the preparations of working plans" published in Calcutta in 1892, states that a scale of 4 inches to a mile is the largest that is generally required in India. The 16-inch scale was adopted for *babul* forests of small area in the Deccan and the 8-inch for the Teak Forests of the Konkan where the intensity of the working required maps showing all possible detail with the greatest accuracy. In both these instances the value of the forests justified the expenditure. In the Thana district of Bombay a 4-inch survey which was made between 1881-1885 was found inadequate and a survey on the 8-inch scale which has just been completed was demanded.

(7) In several instances it was thought that a mere boundary survey would serve the purposes of Forest administration but such surveys have almost invariably had to be replaced by detail surveys. Such boundary surveys are principally useful in checking encroachments, and in the Central Provinces most of the Forest Surveys have been supplemented by an additional boundary survey on the 16-inch scale for comparison with village maps.

(8) The training of Forest Officers in survey work was part of the original scheme for a Forest Survey Branch and during the early years of its existence many Officers of the Forest Department were attached to the Branch. In 1878 the Forest School was established at Dehra Dún and Captain Bailey was appointed its first Director in addition to his other duties as Superintendent of Forest Surveys; as his duties as Director occupied most of his time much of the work in connection with the supervision of the Forest Survey Branch devolved on his Assistant, Mr. W. H. Reynolds, who was eventually in 1883 appointed to succeed him as Superintendent. Mr. Reynolds continued in charge until 1900 when on his retirement he was succeeded by Captain P. J. Gordon, I. A., Deputy Superintendent, Survey of India, who continued to hold the appointment until the Forest Survey Branch ceased to exist on the 15th October 1906.

(9) On the 1st April 1899, No. 20 Party, Survey of India, which had been employed on Forest Surveys in Burma was amalgamated with the Forest Survey Branch, and the Branch, which had hitherto been under the administrative orders of the Inspector General of Forests, came under the general and professional control of the Surveyor General.

On the 1st April 1904, the Governments of Madras and Bombay having accepted the suggestion of the Government of India that the Forest Surveys in these Presidencies should come under the supervision and professional control of the Superintendent, Forest Surveys, the Branch was reconstituted under the designation of the Forest Survey Branch of the Survey of India and all its establishment reverted or was transferred to the Survey of India. The expenditure on Forest Surveys throughout India was by the same resolution distributed in a uniform manner, 30 per cent. to Topographical Surveys in consideration of the value of the work in the preparation of standard maps, and 70 per cent. to Forests.

(10) The Branch as reconstituted consisted of No. 9 Party employed in detachments in various parts of India, where there was not sufficient Forest Survey work for a complete party, No. 17 Party in the Bombay Presidency, No. 19 Party in Madras and No. 20 Party in Burma. The Drawing and Map Record and Issue Office continued as before at the Head-Quarters of the Branch at Dehra Dún.

(11) In 1904 the Indian Survey Committee, appointed to consider among other matters, the methods and expenses of surveys and the organization of the Department, recommended that special Forest Surveys should cease as a general rule, and, where required on scales larger than those of the regular Topographical, their cost should be debited to the Forest Department.

This recommendation being in conformity with the views of the Surveyor General and of the Inspector General of Forests, it was decided that the various parties constituting the

Forest Survey Branch should be absorbed and employed for the future on Topographical Surveys.

On the 15th October 1906 the post of Superintendent of Forest Surveys, in accordance with another of the recommendations of the Committee, lapsed, and the Forest Map Record and Issue and Drawing Offices were placed under the charge of Mr. C. F. Erskine, Deputy Superintendent, Survey of India.

(12) In the future it is proposed that all Forests occurring in sheets coming within the regular programme of the Survey of India shall be surveyed either on the scale adopted for the sheet or, if required, on any other scale up to two inches=one mile, and also that, when required, an additional boundary survey of such Forests on the 4-inch scale shall be made without any extra charge to the Forest Department, but that, when any surveys are required outside the regular programme of the Survey of India, or on scales larger than 2 inches=1 mile the cost of such surveys shall be paid for entirely by the Forest Department.

(13) Among Officers who have been intimately connected with the Forest Survey Branch the following may be mentioned in addition to the Superintendents already referred to:—

Mr. H. C. Hill, afterwards Inspector General of Forests, who was attached to the Branch from 1874 to 1878.

Mr. E. F. Litchfield, Deputy Superintendent, Survey of India, who was attached from 1875 to 1895.

Mr. Chill, who belonged to the Branch from its formation until his death in 1888; Messrs. T. S. Marten, J. Marten, Hughes, Nichol and C. Litchfield of the Survey of India were all employed for long periods.

This record would not be complete without more than a passing reference to Mr. A. Descubes who joined the Branch in 1887 and was soon afterwards appointed Superintendent of Forest map records. The care and up-keep of the map records of the Forest Department has been under his charge since he joined and most of the working plan and other special maps of the Forest Department which have been published have been compiled and prepared by him.

Among the subordinates the Head Clerk, Babu Kalikanth Kar, the Head Computer, Babu Badri Dutt, and Surveyors, Fulsi Ram, Odey Singh and Bhup Singh Bist, who have spent their whole service in the Branch, deserve special notice.

(14) 68,424 square miles of Forests or nearly two-thirds of the total area of reserved forests in India have now been surveyed on the 4-inch or larger scales: much of the remaining area consists of forests the value of which is not considered sufficient to justify the expense of a special survey.

(15) The first survey undertaken by the Forest Survey Branch was that of the Forests of Debra Dún on the 4-inch scale, the survey of the plains portion being carried out during the same period by the Survey of India: this Survey was conducted on ideal lines as both departments worked in close connection with one another each confining its operations to its own legitimate sphere: the principal object which was originally contemplated in associating the Forest Surveys with the Trigonometrical Surveys was here most satisfactorily fulfilled and the resulting maps although prepared over thirty years ago still answer their purpose. Until 1879 the operations of the Forest Survey Branch were almost entirely confined to the United Provinces and Oudh, but from that year until the present time its operations have extended to every Province in India.

Various Revenue and Topographical parties of the Survey of India have also been employed since 1878 on Forest Surveys in the Punjab, United Provinces, Bengal, the Central Provinces, Burma, and in the Madras and Bombay Presidencies.

(16) The following table gives in detail the Forest areas surveyed in various forest divisions on the 4-inch and larger scales:—

Detail survey on 4-inch scale and larger scales of Forest Reserves on 30th September 1906.

Province.	Circle.	Area surveyed up to 30th September 1906.
		Sq. miles.
Bengal	Bengal	2,563
United Provinces of Agra and Oudh	Eastern Circle	2,050
	Western Circle	1,999
	TOTAL	4,612
	Carried over	6,612

Detail survey on 4-inch scale and larger scales of Forest Reserves on 30th September 1906—contd.

Province.	Circle.	Area surveyed up to 30th Sep- tember 1906.
		Sq. miles.
	Brought forward	6,612
Punjab	Punjab	3,398
	Jubal-Taroch	170
North-West Frontier Province	North-West Frontier	366
Central Provinces,	Northern Circle	7,788
	Southern Circle	7,268
	Berar Circle	3,142.5
	TOTAL	18,198.5
Burma	Northern Circle	3,210
	Southern Circle	3,061
	Tenasserim Circle	3,213
	Pegu Circle	2,918
	TOTAL	12,402
Eastern Bengal and Assam	Eastern Bengal and Assam	985
Ajmer-Merwara	Ajmer-Merwara	142
Madras	Northern Circle	4,110
	Southern Circle	5,171
	Central Circle	5,347
	TOTAL	14,628
Bombay	Northern Circle	2,345
	Southern Circle	4,671
	Central Circle	4,507
	Sind Circle . . . . .	...
	TOTAL	11,523
	GRAND TOTAL	68,424.5

(17) Attempts have been made in different Provinces to utilize the services of the surveyors for the purpose of keeping up a record of soils and forest growth, but owing to the want of expert knowledge on the part of the men, such records have proved of little value.

(18) A critical examination of the cost-rates of forest surveys in different Provinces and by the various agencies would be out of place here; nor would it serve any useful purpose. The cost-rates are influenced by so many considerations outside the actual professional work of the surveyor that comparisons would be misleading.

Forest maps are issued free of cost to Government Departments: each edition consists of from 50 to 100 copies and as each edition is exhausted a new edition embodying all changes in boundaries is published. The maps are available for sale to the general public but there is little demand for them.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

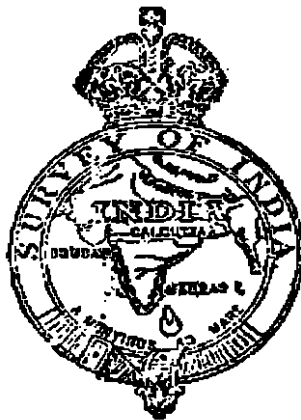
THE GOVERNMENT OF INDIA

DURING

1906-07

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E.
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