SURVEY OF INDIA

DEPARTMENTAL PAPER No. 17

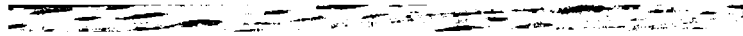
SURVEY AND MAPPING POLICY

BY

BRIGADIER G. F. HEANEY, C.B.E.

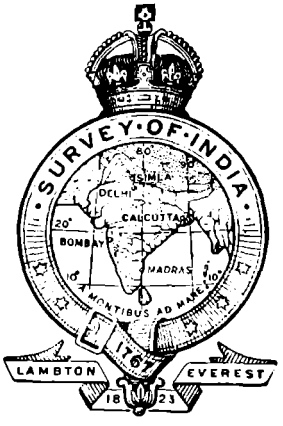
PUBLISHED BY ORDER OF
THE SURVEYOR GENERAL OF INDIA

PRINTED AT THE OFFICE OF THE GEODETIC BRANCH,
SURVEY OF INDIA, DEHRA DÛN, 1947.



For Departmental use

SURVEY OF INDIA



DEPARTMENTAL PAPER No. 17

SURVEY AND MAPPING POLICY

BY

BRIGADIER G. F. HEANEY, C.B.E.

PUBLISHED BY ORDER OF
THE SURVEYOR GENERAL OF INDIA

PRINTED AT THE OFFICE OF THE GEODETIC BRANCH,
SURVEY OF INDIA, DEHRA DUN, 1947.

PREFACE

The war and subsequent political and economic changes have affected the Survey of India profoundly. There is a pressing demand for surveys of a new type, the whole structure of pay in India is altering, and technical methods have undergone great changes.

Amidst the turmoil caused by big political, economic and organizational changes it is necessary for a department such as the Survey of India to keep in view a technical objective. What are we trying to do ? Have we any hope of achieving our objective ? Are our present methods adequate ? These are all questions the answers to which must largely influence future policy.

In trying to establish any technical objective it will always be necessary to balance what is technically desirable against what is economically possible. In other words, our objective must be one which the country can afford.

2. For some time prior to the 1939–45 war it had been realized that all was not well with our map maintenance policy. Many maps of important series were seriously out of date and it became apparent that it was beyond the capacity of the Department to keep reasonably up-to-date all the map series which it had undertaken to produce.

Colonel J. D. Campbell, D.S.O., investigated the whole problem and his findings were published in Departmental Paper No. 16 in 1937. His work has been of great assistance to me, though, as the result of changes in conditions, needs, and survey methods since 1937, my conclusions as to what is a desirable and practicable Survey and Mapping Policy, differ widely in some respects from his. We are, however, both agreed on the need for frequent revised editions of the smaller scale maps, and on the impracticability of keeping the huge series of 1-inch maps up-to-date.

3. Shortly after Partition became a fact I was asked by the Government of India to put up a plan for the future employment of the Survey of India, together with proposals for establishments to give it effect. Chapter IV is the result and supports proposals being put up to Government separately. These proposals may or may not be accepted, but it is hoped that the whole Paper will provide a background against which these or any subsequent recommendations for changes in organization and establishment may be viewed. It is also hoped that it may stimulate thought on general policy amongst serving officers of the Department and may be of interest to those who are familiar with the past work of the Survey of India or who have occasion to use its services.

4. This paper confines itself nearly entirely to problems connected with the making of surveys and drawing maps. Map production and geophysical activities are hardly touched on.

The reason for this is that the war gave the Survey of India a map reproduction organization and plant which with the addition of a few specialist personnel and special items of equipment, is likely to serve the needs of India for many years to come.

The essential geodetic foundations of the topographical survey work of the Survey of India were well and truly laid in the past and their maintenance provides no special problems. Other geophysical work may become of increasing importance in future, but can be conveniently dealt with as a separate activity, so has not been considered here.

5. Future survey policy depends on the foundations laid and the experience gained in the past. It is fortunate for the surveyor who will work in the India of the future that the geodetic and other foundations on which his work must be built, were laid when the Indian Peninsula could be treated as a whole, before its division into the Union of India and Pakistan. The earlier parts of this paper therefore deal with India as it was before Partition.

In the future both countries and the geographical and scientific world will gain much if the Surveys of India and Pakistan can eliminate by mutual co-operation some of the restrictions imposed on their work by political division.

G. F. HEANEY,
Brigadier,
Surveyor General of India.

DELHI :
September 1947.

THE SURVEY OF INDIA
SURVEY AND MAPPING POLICY

CHAPTER I

INTRODUCTION AND RETROSPECT

I. EARLY DAYS

1. The first authoritative map of India was published by a Frenchman, M. D'Anville in 1752. It had been compiled from route surveys by travellers in the interior and rough charts of the coast. Fifteen years later Lord Clive, the Governor of Bengal appointed Major James Rennell to be the first Surveyor General of Bengal. Rennell's maps were originally military reconnaissances and latterly chained surveys based on astronomically fixed points and do not pretend to the accuracy of modern maps of India based on the rigid system of triangulation commenced at Madras in 1802 and since extended over the whole of India and beyond.

2. From these beginnings the Survey of India developed. Its activities have been mainly concerned with geodetic and topographical surveys and mapping and it has carried out these throughout the whole of India and in large areas of adjacent countries. It has published maps embodying the above surveys and undertaken the compilation of smaller scale (geographical) maps covering the greater part of Southern Asia. Its geodetic activities have, after the establishment of the main geodetic triangulation over the whole of India, tended to take a second place to topographical and other work.

3. Up to the year 1905 the activities of the Survey of India can be roughly summarized as follows :—

A. Geodesy. This comprises the investigation of the size and structure of the earth, and the geodetic work of the Department consisted of primary (or geodetic) triangulation, latitude and longitude determination. From these measurements, the size or "figure" of the earth is obtained whereby points fixed by triangulation can be accurately located on its surface.

Early in the nineteenth century it was realized that a complete system of geodetic triangulation covering the whole of India was essential as a framework to which topographical and other surveys could be tied to fall into their correct places ; and during the early part and middle of the nineteenth century the main work of the Survey Department was the extension of this series of geodetic triangulation. By the end of the century the work had largely been completed. The establishment of a net of geodetic triangulation before the undertaking of extensive topographical surveys has enabled topographical and other surveys to be correctly fitted into their places, and has avoided many difficulties experienced in survey work in other countries.

Although a geodetic framework is primarily required for the control of surveys, there are a number of other activities of scientific and utilitarian value which can suitably be undertaken in conjunction with it ; and the following are some of those which were carried out in India during the period under consideration :—

(i) Precision levelling for determination of heights.
(ii) Tidal predictions and publication of tide-tables for ports in India and adjacent countries.
(iii) Observation of the direction and force of gravity.
(iv) Astronomical observations to determine longitude and latitude and time.
(v) Seismographic and meteorological observations.

Indian geodesy has disclosed widespread anomalies in the gravitational attraction of the earth's crust and has given a great impetus to similar work in other countries.

B. Topographical Surveys.—Following on the establishment of a geodetic framework in India during the early part of the nineteenth century, topographical survey work, aimed in general at producing a map on a scale of 1-inch to a mile, was pushed forward and by the close of the century had covered the greater part of India and Burma.

C. Cadastral or Revenue Surveys.—For assessment of land revenue governments require large scale or cadastral maps of cultivated areas and it is clearly of great value if these can be linked to a rigid framework so that they fall into their right geographical positions. In the nineteenth century the Survey Department carried out a considerable amount of cadastral survey work but later, with the formation of provincial survey departments, tended to confine its activities in this direction to the provision of a rigid control by traversing, on which the local survey departments could base their work.

D. Forest and other Miscellaneous Surveys.—With the establishment of a Forest Department in India there was a demand for large scale maps of reserved forests usually on the scale of 2 inches or 4 inches to a mile. The Survey Department carried out a large number of such surveys.

E. Map Publication.—In the early days of the Survey Department lithographic printing was unknown, so maps remained a rarity even of areas which had been surveyed. Towards the middle of the nineteenth century, however, a lithographic printing office was established in Calcutta which enabled large numbers of copies of individual maps to be printed cheaply. These early maps were printed only in black or black and brown, hills being depicted by hachures or form lines.

II. PERIOD 1905 TO THE OUTBREAK OF WAR 1939

4. By the close of nineteenth century the greater part of India had been surveyed on the scale of 1 inch or 2 inches to a mile. Investigations at this time, by Lord Kitchener the Commander-in-Chief who himself was a survey officer in his younger days, disclosed that the maps over the greater part of the country were very much out-of-date and were produced in a style which was not suitable for military purposes. A departmental committee consisting of experts from the Ordnance Survey in the United Kingdom and officers of the Survey of India, together with representatives of the Government of India investigated the whole scope and functions of the Survey of India, and their recommendations which were largely adopted by the Government of India have formed the basis of the work of the Survey of India from 1905 until the present day. The main recommendations of this committee were that :

(*a*) A completely new contoured survey should be undertaken of India on a scale of 1 inch to a mile. This survey was to be completed in 25 years and thereafter completely revised at 25 yearly intervals.

(*b*) Maps produced from such surveys were to be published in several colours thus bringing India into line with developments in cartographic printing in advanced countries.

Later, it was decided that certain sparsely inhabited areas such as deserts and the higher Himalayas would be surveyed on the $\frac{1}{2}$-inch or $\frac{1}{4}$-inch to a mile scales.

5. To give effect to the recommendations of the 1905 Survey Committee a very considerable expansion of the Department was authorized. The headquarters of the Surveyor General were located in Calcutta, the then headquarters of the Government of India, and administrative circles were located with headquarters as under :—

(1) Northern Circle (Topographical) at Mussoorie.
(2) Southern Circle (Topographical) at Bangalore.
(3) Eastern Circle (Topographical) at Shillong.
(4) Trigonometrical Survey (later known as the Geodetic Branch) at Dehra Dūn.
(5) Map Publication at Calcutta.
(6) Burma Circle at Maymyo, Burma—formed in 1922.

In 1925 and 1926 the Frontier and Central Circles were formed and the old Northern Circle was abolished.

The Frontier Circle concerned itself not only with topographical surveys but with the development of surveys for military purposes in co-operation with the Army.

The Burma Circle was abolished as a measure of retrenchment in 1932, only one party remaining. This party was paid for entirely by the Burma Government after the separation of Burma in 1937, but personnel were loaned from and administered by the Survey of India.

6. **Topographical Survey Party Organization.**—The basic unit for topographical surveys is the survey party and the most important survey instrument until the 1939–45 war was the plane-table. A topographical survey party is under the charge of a superintendent and for fieldwork is organized into three or four camps. Of these two or more camps are usually engaged on plane-table surveys. The camp officer is normally an officer of the Class II Service and each camp consists of up to about 12 surveyors, each with his own squad, surveying a separate area. In addition to the camps of plane-table surveyors one or more camps may be engaged on fixing by traverse or similar methods, the control on which the work of coming seasons will be based.

Where the control for future surveys is to be fixed by triangulation rather than traverse, 3 or 4 triangulators may be at work direct under the superintendent in charge of the party.

Owing to climatic conditions it is usually not possible to carry out fieldwork in India for more than six months in the year. The normal time for starting fieldwork is at the end of October ; and in most areas by the beginning of May the weather has become so hot and visibility is so bad that fieldwork has to be closed down. The party then moves to its permanent headquarters and for the next six months—the recess period—fair-draws the maps incorporating the results of the previous seasons surveys. During this period the results of traversing and triangulation are fully computed and lists of points drawn up for the use of plane-table surveyors the following field season.

7. **Air Survey.**—During the 1914–18 war air photography had been used in the revision of maps and in 1924 a forest survey was carried out by the Survey of India of an area in the Irrawaddy delta in Burma, by the use of vertical air photography. A couple of years later air photography was introduced for surveys of inaccessible areas in the North-West Frontier and received a great stimulus with the development in the War Office, London of rapid methods of plotting from strips of overlapping vertical photographs. At the outset, photography was carried out by machines of the Royal Air Force using standard Air Force photographic cameras. Later, however a camera specially designed for air survey photography was produced and a civil firm specializing in photography for air survey commenced activities in India. During the years preceding the war in 1939 there were considerable extensions in the use of air survey which were greatly assisted by new techniques of plotting. These enabled maps comparable in accuracy with those obtained from ground survey to be prepared with a minimum of ground control. Prior to the war however, India did not, largely owing to financial stringency, purchase any of the complex auto-plotting machines then recently developed in Europe and America. The standard method of using air photographs was to plot the planimetry (outline) from a series of overlapping vertical photographs, using stereoscopic methods. The contouring was done by interpolation between the heights of numerous points identifiable on the photographs. These heights were usually fixed on the ground by normal survey methods, but in some areas where the ground was inaccessible, they were fixed by an ingenious system of plotting from oblique photographs which was specially developed for the purpose.

An important factor which militated against more extensive use of air surveys prior to the 1939–45 war was purely economic.

Plane-table surveying is an art, which in the hands of the Indian surveyor using cheap and primitive instruments was capable of producing remarkably satisfactory results. The surveyor, who was generally a man with little education, was paid little ; and his squad of four or five survey *khalāsis* (coolies) were paid less. Plane-table surveying was therefore a very cheap method of achieving good results (given suitable country) at small cost. It was

at its best in open plains or in hills free from thick jungle. It did not give such satisfactory results in jungle country where visibility from the ground was restricted and it is probable that it could with advantage have been superseded by air survey prior to the war in large areas of eastern India and Burma. Such a change involving as it would have a complete re-training of numerous personnel, could however, only have been effected gradually.

8. **Revision of Surveys.**—The 1905 Survey Committee envisaged the completion of the original programme of Modern Surveys in 25 years and its revision at regular 25 yearly intervals thereafter. Owing to retrenchment and for other causes the original programme was only about three quarters finished on the outbreak of war in 1939, and very little revision of areas surveyed since 1905 had been carried out. This meant that in 1939 about 400,000 square miles of India, though for the most part mapped at about the 1 inch to a mile scale, at some time, had maps which were not less than 35 years old (and many were twice as old as this) and were printed in one or at the most two colours and were uncontoured.

In the remainder of India which had been covered by modern surveys, the maps in many areas were very seriously in need of revision.

9. **Other Surveys.**—One of the reasons for the slow progress of the original 1905 programme was the increasing demand for larger scale surveys than 1-inch. In Burma there was a large programme of Forest Surveys on the scales of 2 inches and 4 inches to a mile, necessitating the exclusive employment of a full survey party for many years. In India there was a demand for large scale surveys of Cantonments, towns (published in the form of town guide maps generally at a scale of about three inches to the mile), and for rectangulation for irrigation projects.

Shortly before the war there was a demand for a large scale map of the city of Lahore. This survey which was carried out with great precision was at the scale of 40 feet to the inch for the more closely built up areas and at 100 feet to the inch for the remaining area, and was published in 587 sheets. It is worthy of special notice as it was the first survey of its kind carried out in India, but it has been followed by demands for similar surveys of numerous other large cities.

10. **Geodetic Work.**—As has been noted in para 3-A above the main geodetic triangulation grid covering the whole of India and Burma had been completed by the end of the nineteenth century. During the period under consideration certain additional series were required to strengthen the work and these were observed. A major task of adjustment of the whole series was carried out and this too had been completed before the second world war. The other geodetic activities listed in para 3-A were also continued and in addition a magnetic survey was undertaken in the early years of the twentieth century.

One of the tasks of the Geodetic Branch was the publication in pamphlet form of geodetic triangulation data ; and a series of such pamphlets covering the whole of India and Burma was published. Except in a few areas these triangulation pamphlets contained only geodetic data, i.e., data of points or stations fixed as part of the geodetic framework. Topographical survey parties had, however, fixed innumerable points and stations throughout India which were connected by triangulation to the main geodetic series. The adjustment of this topographical triangulation to bring it into the closest accord with geodetic values and its publication in the triangulation pamphlets was very greatly in arrears ; and by far the greater part the topographical triangulation in India only exists in manuscript form*.

Financial stringency especially after the year 1932 led to comparatively little geodetic work being undertaken for some time prior to 1939.

11. **1932 Retrenchment.**—In 1932 consequent on the world slump in trade heavy retrenchment was carried out in the Survey of India and the number of Circles, Survey Parties and Drawing Offices was greatly reduced. The Central Circle was abolished, its work being carried on in a modified form by a topographical survey party working under the Geodetic Branch. The Southern Circle and Burma Circle were abolished and their work was carried on by independent survey parties working directly under the Surveyor General.

* One unfortunate result of this work being in arrears was that on the separation of Burma from India the original manuscript topographical data was transferred to Burma and was lost during the occupation of Burma by the Japanese. This loss represented the greater part of 50 years topographical triangulation work.

12. **Map Publication.**—The Survey Committee of 1905 recommended that certain standard series of maps should be produced and maintained by the Survey of India. Later additions were made, for various reasons, to those recommended, and at the outbreak of war the series maintained by the Survey of India were :—

(*a*) Topographical Maps—

(i) The "1-inch series" on the scale of 1 inch to a mile. This except as noted in para 4 above was to cover the whole of India.

(ii) The "½-inch series" on the scale of 1 inch to 2 miles. This was to be compiled from 1 inch sheets in areas for survey on this scale. In other areas it was to be produced from original ½-inch surveys.

(iii) The "¼-inch series" on the scale of 1 inch to 4 miles. This was to be compiled from larger scale maps except in certain areas such as the higher Himalayas and the Indian Desert where ¼-inch was the largest scale of survey authorized.

(*b*) Geographical Maps—

(i) The "India and Adjacent Countries series" on the scale of 1/Million or 1·014 inches to 16 miles.

(ii) The "Carte Internationale du Monde" series on 1/M scale.

(iii) Province maps on 1/M or other scales.

(iv) The "Southern Asia" series on 1/2M scale.

(v) Certain wall maps of India and adjacent countries on various scales.

Shortly before the outbreak of the 1939-War the "India and Adjacent Countries" series (*b*)(i) above had been abandoned in favour of the "Carte Internationale du Monde" series.

The 1905 Committee envisaged the periodical revision of surveys of the whole of India every 25 years. In addition to revision surveys, extra-departmental information is also used for the revision of topographical maps. The principal sources of this extra-departmental information are provincial authorities such as the P.W.D., District Officers, Forest Departments, etc., who send corrections showing changes in topography brought about by new irrigation works, roads, etc., since the surveys were carried out. Should these changes warrant it a revised edition of the map has hitherto been published.

For some years prior to 1939 the keeping of nearly all maps up-to-date had become seriously in arrears, though a determined effort was made in the years shortly before the war to bring the ¼-inch series up-to-date. This work had however not been completed when the war broke out in 1939; and it was becoming apparent that the keeping up-to-date of all the three series of topographical maps, i.e., the one inch, ½-inch and ¼-inch series was beyond the capacity of the Department.

13. **Personnel.**—Since 1905 the field and drawing staff of the Survey of India has been organized in the following Services and grades :—

(*a*) *Class I Service.*—This was until August 1947 a Secretary of State's Service. Prior to 1932 direct recruitment to the Class I Service was from officers of the regular army in the proportion of 3 Royal Engineers (British Service) to one Indian Army officer. On the adoption of the policy of Indianization as there was then no Corps of Indian Engineers, the vacancies for Indian Army officers were allotted to Indians. Later, on the formation of the Corps of Indian Engineers shortly before the war it was decided to limit the recruitment of Indian Army officers to members of this Corps, as such officers have a better mathematical and technical background than those from other Arms. No Royal Engineer officers have been appointed to permanent posts in the Survey of India since 1938.

A proportion of posts in the Class I Service has since 1905 been reserved for those promoted from the Class II Service. The number of posts has varied and in 1930–32 before the retrenchment was 13.

The main function of the Class I Service is to fill the executive and administrative posts. New entrants are graded as Assistant Superintendents during which time they are fully trained in as many branches of survey as possible. When a vacancy occurs and they are considered fit they are promoted to the grade of a Superintendent with charge of a Survey Party or the equivalent. Later, they are eligible for promotion to the administrative posts of Director and Surveyor General.

Class II officers on promotion to Class I have normally gone direct into the grade of Superintendent.

(*b*) *Class II Service.*—This Service has always been recruited in India by selection followed by a competitive examination. The minimum qualification for appearing before the selection board is a degree in Mathematics or in Science with Mathematics. A proportion of the posts in the Class II Service is reserved for promotion from lower grades.

Members of the Class II Service are designated as Extra Assistant Superintendents and do individual survey work such as triangulation and other instrumental observation work in their young days and later take charge of camps and sections in drawing offices.

(*c*) *Upper Subordinate Service.*—(This name is to be changed and in future members of this cadre will be called Topographical Surveyors Grade I. They form part of the Class III Service).

This Service requires a minimum educational qualification of Intermediate with Mathematics. Its function is to provide skilled individual workers and its members carry out the bulk of triangulation and similar work. Later, experienced Upper Subordinate Service officers are placed in charge of small camps and drawing office sections.

(*d*) *Lower Subordinate Service.*—(Now to be known as the Class III Service). No minimum education is required for entry into this Service but preference is given to candidates who are Matriculates. This Service is used for traversing, plane-table and air surveying, fair-drawing and work of a similar description, and provides the great majority of technical personnel in the Department.

CHAPTER II

THE POST-WAR POSITION

14. **Effects of the War.**—The Survey of India is a civil department and for it the second world war was both an interruption and a digression. Normal civil activities practically ceased and the whole effort of the Department was directed towards war work. A large part of the staff was mobilized and formed the backbone of the Military Survey Service in Persia, Irāq and later the South-East Asia Command.

It is not the purpose of this paper to deal with war activities which will be described elsewhere ; certain events during the war are however likely to have a lasting effect on the Department and are worth recording. They are—

(*a*) The move of the headquarters of the Surveyor General from Calcutta to Delhi in 1940.

(*b*) The move of the Directorate of Map Publication from Calcutta to Hathibarkala, Dehra Dūn in 1943 to new buildings. These were largely equipped with plant sent out by the War Office to enable the Survey Department to act as the base for map production for military forces in South-East Asia.

(*c*) The formation of the Military Survey Service which is likely to be retained as a permanent measure by the Defence Department for the post-war Army, thus relieving the Survey of India of some of its pre-war military responsibilities.

Some of the other effects of the war were—

(i) The complete exhaustion of stocks of many standard Survey of India maps.

(ii) The cleaning off of many negatives and plates from which reprints would have been made without photography, owing to the plates and negative glasses being required for military purposes.

(iii) The reduction in the number of colours used in printing topographical maps. This has resulted in many of the sheets now in stock being printed in only two or three colours instead of the eight or more used pre-war.

During the war practically no new topographical surveys were made in India and hardly any revision of standard maps was carried out. The production of revised editions of maps from extra-departmental information also fell heavily into arrears.

15. **New Trends and Demands for surveys since the end of the war.**—

(i) The planning of numerous development projects in India since the close of hostilities has resulted in a complete change in the type of demands made on the Survey of India. The irrigation, hydro-electric and other projects which are proposed all require very precise surveys not only of reservoir and dam sites, but also of the often very extensive areas proposed for irrigation, to enable canals, etc., to be laid out.

Industrialization has led to numerous demands for large scale surveys of important cities ; and the reclamation of waste land for growing more food must also be based on accurately contoured surveys.

(ii) The recommendations of the Pay Commission will increase enormously the pay of lower paid workers and will add very much to the cost of plane-table surveys and fieldwork generally. Offsetting this, the war gave a great impetus to the development of air survey ; and new cameras and plotting equipment are now on the market which will enable air survey to become a much more efficient method than it ever was in the past. It is safe therefore to predict that much work done in the past by the ground surveyor working

with a plane-table will in future be done more cheaply, expeditiously and accurately by air survey methods. For surveys for geological purposes the use of air photographs has the added advantage that the geologist can use them for a preliminary study of ground forms before undertaking his detailed fieldwork.

(iii) As the war progressed the army tended to demand maps on a scale of 1/25,000 (2·54 inches to a mile) of larger and larger areas; and the end of the war has seen a demand from the army for 1-inch maps covering the whole of India (with the exception of remote areas such as the higher Himalayas). Thus large areas for which ½-inch survey was considered adequate in 1913 are now asked for on the 1-inch scale by the army.

16. **Effects of Changed Demands on the Survey Department.**—From the above it will be apparent that the Survey of India has now to meet very heavy demands for surveys and map publication for two main reasons. These are—

(*a*) To make up the arrears of work arising from the curtailment of normal activities before and during the war.

(*b*) To provide larger scale surveys and maps for the development of India's resources in minerals, power, agriculture and industry: and to meet the increased requirements of the Army and aviation.

Of the above (*a*) is a temporary demand which given increased printing power and drawing staff should be within the capacity of the Department to meet during the next few years. It may conveniently be divided into the following:—

(i) The replenishment of existing stocks of standard maps.

(ii) The incorporation of corrections in existing maps and production of new editions in pre-war style.

(iii) The production of certain new series of maps and charts required for aviation.

In considering how demands under (*b*) should be met, we must endeavour to assess the total demands on the Department, and in this connection the following must be taken into account:—

(1) The completion of the modern survey of India involving 400,000 sq. miles of new surveys must be effected as soon as possible.

(2) Provision must be made for periodical revision of standard topographical maps of the whole country.

(3) Compilation of smaller scale maps from current surveys and the bringing out of new editions incorporating extra-departmental information must not again be allowed to get into arrears.

(4) Special air navigation charts will have to be kept up-to-date to meet the growing demands of civil and military aviation.

(5) A considerable area of mapping on the 1/25,000 scale may have to be carried out for the Army and also in connection with mineral development for the Geological Survey of India.

(6) Demands for accurate large scale surveys of cities and other industrially important areas cannot be refused indefinitely.

(7) Special surveys in connection with irrigation, hydro-electric, land reclamation and similar projects will be required at high priority, so long as development continues in India.

Of the above (1), (2) and part of (3) alone were envisaged by the 1905 Survey Committee. The balance are new activities which are demanded of this Department as part of the post-war development of the country.

In connection with (3) it may be noted that it has since the war been decided to abandon the compilation of maps on the scale of ½-inch to a mile in areas where modern maps on the scale of 1-inch to a mile exist and existing compiled ½-inch maps will not be maintained.

17. **Expansion of the Field and Drawing Staff of the Survey of India in 1946.**—As soon as hostilities came to an end it became apparent that a considerable expansion of the

Survey of India was required to meet the activities outlined in the previous paragraph and a scheme was put up for expansion of the departmental field and drawing staff which was approved in August 1946. This restored the strength of the Department to approximately what it was before the retrenchment in 1932. Since August 1946 small amendments increasing this establishment further have been sanctioned.

The expansion of 1946 provided for six Directorates. These included the Directorates of Map Publication and the Geodetic Branch, and four regional Directorates, namely, Frontier, Central, Eastern and Southern Circles. The continuance of the temporary Military Circle Directorate was also sanctioned on the condition that the Central Circle should be kept in abeyance. The topographical work of the Central Circle is being carried out by the Geodetic Branch.

These six Directorates were to administer five drawing offices and twenty-four field survey parties, in addition to certain specialist parties for Geodetic or Geophysical work.

The Director, Military Circle continues to be the Director of Survey, India Command, and is in charge of the Military Survey Service.

18. **Developments in Air Survey.**—During the last few years very great advances have been made in air survey [see also para 15 (ii)]. These advances are mainly in two directions : —

(1) An improvement in the design of air cameras and lenses enabling larger photographs to be used, thus reducing work and improving accuracy by covering a given area on a given scale by fewer photographs.

(2) Great advances in the design of machines for direct plotting of maps from air photographs. These plotting machines enable accurately contoured maps to be plotted from photographs with a minimum of ground control.

India has not up-to-date, used plotting machines for air survey mainly for two reasons :—

(*a*) Initial expense—prior to the war financial stringency reduced expenditure on survey to a minimum.

(*b*) The availability of cheap labour both of surveyors and their squads. This reduced the field in which air survey could compete economically with ground survey or a combination of air and ground survey.

The use of plotting machines for medium and large scale survey work should enable a considerably better output to be obtained than by pre-war methods, and at less cost. It has the further advantage that work carried out by one operator or agency can readily be checked by another operator or agency provided with the right machines. The possibility of this rigorous check of any part of the work would be an important factor in ensuring accurate results from work done on contract.

19. **Use of Air Survey in the future.**—The conclusions in the previous paragraph indicate that air survey is likely to be much more important in the future than it has been in the past, and it seems probable that the following are the lines on which it will develop : —

(*a*) The purchase of a battery of auto-plotting machines and their establishment at some central station where they would be available not only for the survey work of the Department but also could check air survey work by outside agencies.

(*b*) Increased use of air survey or of a combination of air and ground survey for topographical survey and revision. It is impossible to generalize on the relative cost of the two methods as so much depends on the accessibility and suitability of the area for ground survey and air photography. With the large increases in wages of junior staff now being introduced the cost of ground survey will probably increase greatly compared with air survey and it is probable that the latter will be the more economical method for topographical work on scales of 1 inch to a mile and larger.

(*c*) The letting out of work on contract to outside agencies who would not only undertake air photography but would also compile the maps. Such contract

work would be a new departure for the Survey of India but would have certain advantages, such as—

(i) The elimination of the great fluctuations in the strength of personnel of the Department (with the consequent necessity for dispersal of trained staff and their recruitment and training again later) which have been a feature of the past, consequent on periods of alternating prosperity and financial stringency.

(ii) The possibility of undertaking greatly enlarged programmes of essential surveys at short notice without necessarily curtailing routine work, and without incurring a permanent liability in upkeep of additional staff and equipment.

If air survey work were to be let out on contract it could only be satisfactorily done were this Department in a position to check it—see (*a*) above. Such work on contract would also always require the assistance and co-operation of this Department in the provision of ground control and in the essential ground work such as obtaining names, fixing boundaries, etc., and the obtaining of detail not available from air photographs.

CHAPTER III

AFTER PARTITION

20. Position of the Union of India after Partition.—

Areas.—After Partition the areas and state of survey in the Union of India will be approximately as under :—

	Area unsurveyed or surveyed prior to 1905	Area surveyed 1905–21	Area surveyed after 1921
British India ..	60,750 sq. m.	256,180 sq. m.	354,700 sq. m.
States ..	119,990 sq. m.	82,570 sq. m.	296,930 sq. m.
Total ..	180,740 sq. m.	338,750 sq. m.	651,630 sq. m.

Total area .. .. 1,171,120 sq. m.

21. Topographical Surveys in the Union of India.—

(*a*) *Completion of original programme of 1-inch surveys.*—Assuming a normal survey party using standard pre-war ground survey methods does on an average 4,000 sq. miles of new survey a season, then to complete by these methods the 180,740 sq. miles of area remaining would take 9 survey parties about 5 years or 45 party/years.

(*b*) *Revision of 1-inch surveys.*—Assuming that a normal survey party revises an average of 8,000 sq. miles of 1-inch survey in a season by pre-war plane-table survey methds then the total number of parties required to revise 1,171,120 sq. miles in 25 years will be approximately 6. This number of parties would therefore be required permanently for revision if it were to be effected every 25 years.

22. Map Maintenance.—The table below gives the approximate numbers of maps of various kinds which would have to be maintained if the pre-war policy were carried on :—

CLASS OF MAPS	TOTAL SHEETS TO BE MAINTAINED BY INDIA
TOPOGRAPHICAL	
1-inch	3,336
½-inch (Primary)	274
¼-inch	383
GEOGRAPHICAL	
1/M Carte Internationale	49
1/2M Southern Asia Series	20
General Maps of India	16
GENERAL AND SPECIAL	
1/M Province Maps	16
Guide Maps	50
Manœuvre and Radius Maps	24
Miscellaneous	38
1/M Aero Charts and Misc. Maps	100
Misc. Military Maps .. .. .. (Approx.)	152
Total ..	4,458

It is estimated that about 400 draftsmen would be required for the above work. As 80 is the largest manageable size of Drawing office this would mean 5 Drawing offices.

This maintenance would consist of compiling such maps as are made from other maps (rather than from surveys); and of the keeping up-to-date from extra-departmental sources of maps produced from departmental surveys. It would not include any survey work, or the fair drawing of sheets from new surveys as such work is undertaken by field parties.

It should also be borne in mind that the special mapping needs of the army may be considerably more than can be met by the Military Survey Service. Such extra work as the army may require will have to be met by the civil department. The allowance of 152 miscellaneous Military maps may prove inadequate as no special provision has been made for 1/25,000 mapping for the army.

23. **Project and other surveys.**—As noted in para 15(i) there has since the close of hostilities been a very great demand for surveys for development projects, cities, etc.

In terms of years work for an average survey party the present position in the Union of India is approximately as follows :—

(i) *Projects for irrigation and industrial development.*—

		Party/Years
(*a*)	Sanctioned	56·5
(*b*)	Proposed and likely to be sanctioned ..	23·5
	Total ..	80·0

Numerous other projects are under consideration and many more are likely to be sanctioned in the near future.

(ii) *Town Surveys.*—

(*a*)	Sanctioned	2·0
(*b*)	Proposed and likely to be sanctioned ..	0·7
	Total ..	2·7

In addition numerous enquiries for surveys have been received from other towns.

Total now foreseen demands for Project and Town Surveys	82·7

In other words there is continuous work for 10 survey parties for over eight years already sanctioned or likely to be sanctioned. Numerous other enquiries have been received but discouraged as there was no likelihood of its being possible to undertake any further commitments within a reasonable time.

24. **Summary of Survey Requirements.**—From paras 21 to 23 the total present requirements in drawing offices and survey parties may be summarized :—

		Units
(*a*)	*Permanent requirements for Topographical work.*—	
	(i) Drawing Offices for carrying out standard routine work	5
	(ii) Survey parties for revision of topographical maps	6
(*b*)	*Non-recurring demands.*	*Party/Years*
	Completion of topographical programme ..	45
(*c*)	*Fluctuating demands.*—	
	Projects and town surveys sanctioned or probable	83
	Total ..	128

This represents work for 13 survey parties for about 10 years, or 26 parties for 5 years.

In the above calculations no account has been taken of demands for larger scale surveys than one inch for military purposes. Further, as projects are completed others are likely to be taken up, and the demands for precise large scale surveys of towns is likely to be more insistent as industry develops and town planning increases in importance.

It should be noted that the above shows only the personnel required for drawing and survey work. It takes no account of personnel required for the other activities of the Department, such as :—

(*a*) Administration.
(*b*) Geodetic and Geophysical work and computations.
(*c*) Upkeep of technical records.
(*d*) Map sales.
(*e*) Stores.

25. **Establishments and Personnel available.**—Against the above estimated requirements in personnel we will now consider the actual strength of the various grades and classes of personnel now in the Department.

The 1946–47 establishments were worked out to provide for the whole of India, so it might at first sight be assumed that with secession of Pakistan embracing an area equal to about one quarter of the total area of the Indian Peninsula the cadres sanctioned in 1946–47 would be reduced by an equivalent amount. This is by no means the case and the recent very heavy demands on the Survey of India have indicated that the 1946–47 cadre would have been inadequate had India remained undivided.

Table A below gives the numbers actually appointed to the various grades after deducting those who have gone to Pakistan.

TABLE A

1	2	3	4
	Sanctioned cadre 1946–47	Substantively appointed 16 August '47	Deficiencies or surpluses over col. 2
CLASS I			
Surveyor General ..	1	1	..
Dy. Surveyor General ..	1	1	..
Directors ..	6	6 *	.. *
Dy. Directors ..	1	..	— 1
Supdts. ..	33	12	—21
Asst. Supdts. ..	22	1	—21
	64	21	—43
CLASS II	89	59	—30
CLASS III (*Fixed estabs.*)			
Surveyors (Topo. Grade I) ..	95	27	—68
Draftsmen (II Dn.) ..	15	12	— 3
Surveyors (II Dn. Field) ..	40	29	—11
	Jan. 1931	1 Sept. 1939	1 May 1947	16 Aug. 1947
CLASS III (*Unfixed Estab.*) (*Trained personnel only*)				
Surveyors (Topo. Grade II) (Topographical Assistants) ..	..	..	80	63
Surveyors (Ground and Air)	416	283	266	168
Draftsmen ..	285	251	366	278

* Includes 15 British Military Officers who may opt to retire, revert to British Service or transfer to Pakistan. One of them is on military duty and another on deputation in Burma.

TABLE B.—*Drawing Offices, Field Parties and Scientific Parties.*

	Drawing Offices	Topographical Parties	Projects Parties	Training Parties	Scientific Parties	Total
Jan. 1931 ..	6	14	1	..	3 + 1 det.	24 + 1 det.
Sept. 1939..	4	8	2 Detachments	..	2	14 + 2 det.
May 1947 ..	5	1	10	2	1	19

TABLE C.—*Average Officer, Upper Subordinate and Surveyor strength in a field party*

	Supdt.	Asst. Supdt.	Class II	U.S.S.	Topo. Asst.	Surveyor
Jan. 1931 ..	1	0·3	3·5	3·6	..	28
May 1947 ..	1	..	3·2	1·6	4·5	21

26. Class I Service.—From the above it will be seen that the position in the Class I Service is very serious. Of the 15 British Military officers of the Class I Service at least two will probably retire, at least two are likely to go to Pakistan, one is on deputation to Burma which will last for over two years more, and one is still on military duty ex-India. This means that the maximum number of these officers on whose services India can count is ten but the number will probably be considerably less.

This will have the effect of increasing the deficiencies in the Class I Cadre to over the 42 shown in table A out of an assumed establishment of 64.

The only way to remedy deficiencies in the grade of Superintendent and above is by promotion by selection from the Class II Service, pending the appointment and training of direct recruits to Class I. Such direct recruitment cannot, however, relieve the shortage of superintendents for a minimum of about 8 years as that is the time which will be required for the direct recruits to train and acquire sufficient experience to fit them for Superintendents charges.

27. Class II and Topographical Surveyors Grade I (late Upper Subordinate Service).—There is a serious shortage of these but the position is not so serious as might appear from the above tables, as the Department has about 80 trained topographical surveyors Grade II (late Topographical Assistants) and more are under training. These topographical (Grade II) surveyors have the educational qualifications required for topographical surveyors Grade I and many have the educational qualifications required for the Class II Service. They have had anywhere up to seven years practical survey experience either in the Survey of India or in Military Survey units, so many are fit for appointment at once to vacancies in both the Class II Service and as Topographical surveyors Grade I. All that is required is the adaptation or relaxation of certain rules which will enable them to be appointed.

The Topographical Surveyor [see also para 13 (*c*)] has a very definite function in the Survey of India which will become increasingly important with the progress of time. He is the skilled individual worker with enough education and adaptability to enable him to work independently with a minimum of supervision. He is trained in all branches of survey work.

From 1905 until the outbreak of war survey work was to a large extent stereotyped and the bulk of the work was done by uneducated personnel trained in only one branch of survey work such as plane-table surveying, traversing, etc. With the increasing variety of work which the Department is now called on to undertake and especially with the development of air survey, the surveyor without education and trained only for one activity, will give place increasingly to the topographical surveyor. It will therefore be necessary to increase the proportion of this type employed in future.

28. Ground and Air surveyors and draftsmen.—The position as regards ground and air surveyors and draftsmen is also extremely serious. Out of a total estimated immediate requirement of nearly 600 surveyors and 350 draftsmen (see paras 36-37, 40-42) we have

only 168 and 278 respectively. It takes approximately two years before a surveyor can usefully be employed on productive work. During this time he is given field and drawing training and also receives training in air survey. After completion of training his productive capacity improves over the course of the next ten years or so as he gains experience.

During training it is found that one instructor cannot advantageously instruct more than about 8 pupils and 6 is a better number. Practical considerations limit the size of training parties to about 100 trainees. Each such training party therefore needs about 12 really good surveyors as instructors besides supervising officers. These must be found from among the very inadequate numbers available for productive work and taking them away will seriously affect output during the next couple of years. This will have to be accepted if the Survey of India is to be brought back to a state when it can meet its obligations.

29. **Future Policy.**—During the next couple of years at any rate the survey work undertaken will be determined rather by what is immediately essential and by the resources available, than by any broad considerations of policy.

At the end of this time there may be sufficient resources in personnel to begin work systematically according to some policy to be laid down.

What this policy should be and what personnel will be required to implement it will be suggested in the next chapter, but in the meantime certain general conclusions may be at once reached in the light of our review. These are :—

(*a*) The original topographical survey begun in 1905 should be pushed on to completion as soon as possible; but the provision of 45 party/years estimated in para 21(*a*) for this work is beyond available resources. If therefore the work is to be done in a reasonable time the pre-war plane-table survey methods must be abandoned.

(*b*) The complete revision of all 1-inch topographical maps once in 25 years proposed by the 1905 Committee was probably over ambitious for a country with the economic resources of India, and a longer interval is probably all that is necessary or that the country can afford. Air survey during the war indicated how extremely rapidly revision of topographical maps can be undertaken when there is real necessity.

(*c*) The keeping up-to-date of $\frac{1}{4}$-inch maps and smaller scale maps compiled from them, should have priority over the correction of larger scale maps on re-issue.

(*d*) Provision for the undertaking of larger scale than 1-inch and of project surveys will always have to be made by the Survey of India but should the present demand for such work persist or grow it will be for consideration whether private enterprise should not be encouraged to put itself in a position where it can undertake contracts for air survey work for Government. Air survey is much more suitable than ground survey for letting out on contract, as it is susceptible of far more rigid check.

(*e*) Intensive training of more personnel and installation as soon as possible of plotting machines are most urgent necessities.

(*f*) Air photography will be essential in future for a great part of the work of the Survey of India, and arrangements will have to be made whereby a regular supply of photographs of the right quality is obtainable, as a matter of routine.

CHAPTER IV

A PLAN FOR TOPOGRAPHICAL AND PROJECT SURVEYS

SECTION A.—TOPOGRAPHICAL SURVEYS AND MAPPING

30. **Basis for Future Planning.**—The Survey of India is an all-India Department and its primary function is the production and upkeep of topographical and smaller scale maps of India. This is apt to be lost sight of in times of big demands for surveys for development purposes, such as the present, but it seems essential that this primary function should always be kept in view and should never be completely subordinated to temporary utilitarian requirements.

31. **Some Past Lessons.**—Experience of producing and selling maps since 1905 when the programme of modern surveys was begun, has emphasized certain lessons which must be kept in mind in framing future policy.

Some of the more important of these are :—

(*a*) The demand for the average 1-inch map is exceedingly small, and in the past has averaged less than a dozen copies a year for the majority of the more than 3,000 1-inch sheets covering the Union of India. This does not mean that the production of these maps has not been worth while. The few copies of a map distributed may be quite essential to the limited number of users. It does, however, suggest that to endeavour to bring out frequent editions of such maps incorporating the latest information, which may not be very important, may not be justified.

Many maps of areas liable to frequent changes such as those traversed by large and unstable rivers which may change their courses almost yearly would seldom be up-to-date, even if revised every year.

(*b*) The $\frac{1}{4}$-inch is the most popular topographical map of India.

(*c*) It is highly desirable to keep small scale maps up-to-date as far as possible by means of frequent new editions, at least so far as important features such as railways and metalled roads are concerned. This is especially important as flying increases.

(*d*) In case of urgent need air survey provides a method of revising large areas of 1-inch and larger scale mapping in a very short time.

(*e*) It is necessary to limit severely the number of different series of maps which the Department produces and maintains ; and no policy with regard to any series should be attempted unless it is clear that resources are sufficient to implement it successfully.

In the past much effort has been dissipated through the want of a clearly defined policy which could be carried out with the resources available.

32. **Past Maintenance Policy for 1-inch Maps.**—Referring to para 22 it will be seen that were past policy continued the Survey of India would have to maintain over 4,000 different maps, of which over 3,000 are 1-inch maps. The maintenance in a reasonable state of up-to-dateness of all these series has in the past been beyond the capacity of the Department, nor apparently in view of the considerations in para 31(*a*) was the attempt to maintain all of them justified.

Until the 1939–45 war the normal practice (subject to certain exceptions) was to clean off immediately after publication of an edition, the printing plates and negatives from which topographical maps were printed. There were two reasons behind this policy. The first was to save storage space which was an important consideration in the congested publication offices in Calcutta. The second was that on re-issue of a sheet on exhaustion of stock

all corrections which had been recorded in the "office copy" of the sheet were incorporated in the new edition. This meant that the plates and negatives used for the previous edition would probably have been unusable, so there was no point in keeping them. As a result, whenever a new issue of a map was brought out, not only had draftsmen to be employed on altering the originals, but the whole process of reproduction including the lengthy task of "colour separation" had to be repeated.

This policy not only involved the employment of large numbers of draftsmen on incorporation of corrections (many of which were not only trivial but also, as they were largely received from extra-departmental sources, inaccurate), but also congested reproduction offices.

33. **Future 1-inch Maintenance Policy.**—As a preliminary therefore to putting the map maintenance programme on a sound footing it must, it is considered, be clearly recognized that :—

(*a*) The incorporation of corrections in 1-inch sheets on re-issue between regular departmental revisions on the ground or from air photography is normally unnecessary and impracticable.

(*b*) Negatives of all 1-inch sheets must be kept standing, and if a further printing is required between regular revisions of the map, these unaltered negatives must be used.

These two deviations from past practice should alone go a long way towards reducing our map maintenance problems to reasonable proportions.

34. **Maintenance of ¼-inch Maps.**—As observed in para 31(*b*) the ¼-inch is the most popular and important topographical map of India ; and for this reason and as it is used as the basis for compilation of smaller scale maps it is essential that it should, so far as possible, be kept up-to-date. There are under 400 of these sheets and a programme whereby fresh editions were brought out once in ten years would necessitate the production of under 40 new editions yearly. Hitherto, this map except in a few remote areas, has been compiled from larger scale surveys. A result of this policy is that in certain areas which have not yet been surveyed since 1905 the ¼-inch maps are based on surveys which may be anywhere up to a hundred years old, and are printed in black. Such maps are of little value now, and a first essential of any future policy with regard to this series is to ensure that these old ¼-inch maps are replaced by modern ones with as little delay as possible.

In paras 36 and 37 below a scheme for covering the whole of India once in 40 years with vertical photography with a view to revising the 1-inch map is proposed. When the 1-inch maps of an area are revised the next step will be to compile revised ¼-inch maps from them. After this, these revised ¼-inch maps will be kept up-to-date by incorporation of extra departmentally obtained information of changes in major features such as metalled roads, railways, large irrigation canals, post offices, etc. This extra-departmental information will be checked on the ground and at least every ten years a revised edition will be published. Should stocks become exhausted between this regular publication of revised editions, new information received since the publication of the last edition should be incorporated, if this seems justified, and a fresh edition published.

In areas where the only existing ¼-inch maps are those compiled from pre-1905 surveys, and which will not be covered in the near future by air photography, new ¼-inch maps will be prepared by surveys on the ground on the ¼-inch scale. These surveys will aim at covering the ground and surveying essential features as quickly as possible and will not aim at precise delineation of hill forms and other intricate topographical detail. This will have to await the production of a ¼-inch map compiled from larger scale surveys, when these are carried out in pursuance of the routine plan for surveys and revision.

35. **Smaller Scale Mapping.**—Owing to the pre-occupation of the Survey of India since 1905 with the programme of production of new topographical maps, insufficient attention could be given to the important work of keeping small scale maps up-to-date ; and most of these were seriously out-of-date before the war. With the development of road transport and aviation there is an increase in demands for small scale maps, and it is considered essential

that these should in future be kept reasonably up-to-date. It is therefore proposed that all small scale maps should be revised at least once in ten years and if found practicable and desirable edition intervals will be shorter. Whenever a fresh edition is brought out all new information regarding metalled roads, railways and large canals will be incorporated. New technical methods will be developed with a view to enabling fresh editions to be brought out with as little delay as possible after publication has been taken up.

36. **Completion and periodical Revision of 1-inch Topographical Programme.**—We have seen in paragraph 4 that the 1905 Survey Committee recommended that a new topographical Survey of India should be undertaken which would be completed in 25 years. This was then to be revised on 25 yearly intervals.

We have further seen that at the outbreak of the war in 1939 this programme which should have been completed by 1930 had only covered about $\frac{3}{4}$ of the total area of India with modern surveys, and that practically no revision had been made of surveys completed after 1905, some of which were thus nearly 35 years old.

With the great increase in pay of Class III and Class IV personnel in the Survey of India, the undertaking of topographical surveys by plane-table methods which was practically the only method used prior to the war, will be far more expensive than in the past. It is therefore proposed to abandon the pre-war system of carrying out the regular programme of topographical surveys and revision by plane-table. In future the 1-inch topographical map of India will normally be made and revised from vertical air photography. This photography which will be carried out at the scale of about 1/30,000 will not only be of use for the production of the 1-inch map but will also be available for larger scale maps such as those on the 1/25,000 scale required for military and geological purposes and for guide maps of important towns, forest surveys, etc. The area photographed each year will be such that the whole of India is covered at maximum intervals of 40 years. In certain areas which are developing rapidly this interval may be reduced.

In addition to its value in mapping, this vertical air photography will provide a record of vegetation, erosion and other natural features of the country-side which should be of considerable value to the Forest Department, and will be available for the use of those planning new roads, railways, reservoirs and other public works.

This use of aerial photography for completing the programme of modern surveys and for revising it periodically, will not eliminate the work of plane-table and other ground surveyors entirely, although it will greatly reduce it. Ground survey work will still be needed for :—

(*a*) Fixing by triangulation, traverse or other method the control required for air surveys.

(*b*) Verifying or entering on the ground, detail which is not clear in the photographs or which cannot be obtained from them, such as boundaries. Fixing of additional heights and contouring may also be done on the ground where this is not carried out by plotting machines. The plane-table surveyor will therefore still be required in the Survey of India for an indefinite period.

37. **Organization required for Topographical Surveys.**—It was noted in para 21 that the total area of the Union of India including the States is a little under 12,00,000 sq. miles and that rather over 1,80,000 sq. miles of it have yet to be surveyed in modern style.

A programme of air photography of about 30,000 sq. miles yearly would therefore cover the whole area of India in the course of 40 years and it is proposed that as a minimum this area should be photographed annually for topographical survey work. At the outset, special attention will be paid to the completion of the 1905 survey programme but a certain amount of revision will be carried out at the same time. After completion of the original programme of modern surveys the photographic programme will be apportioned approximately equally between the areas of the various circles, thus giving each a regular programme of original or revision 1-inch survey together with the compilation from it of $\frac{1}{4}$-inch maps. It is estimated

that this work of completion of the original programme and revision will take the full time of five air survey parties constituted as under :—

Strength for 1 Party		*Total strength for 5 Parties*
CLASS I—		
Superintendent	1	5
Asst. Supdt.	1*	3
CLASS II	2*	12
Surveyors Topo. Grade I and Grade II	5	25
Surveyors Ground and Air	24	120
Computers, Traversers, etc.	4	20

These parties should be able in addition to their air survey work to undertake the rapid $\frac{1}{4}$-inch surveys envisaged in para 34 for the production of first editions of modern style $\frac{1}{4}$-inch maps where these do not exist.

The compilation of $\frac{1}{4}$-inch maps from the air survey work of these survey parties will be undertaken in the circle drawing offices.

38. **Provision for Air Photographs for Survey.**—In connection with the proposals in the previous two paragraphs it will be essential to arrange for an adequate supply of photographs of the right quality as required.

Prior to the war a large part of the photography required for air survey was supplied by the R.A.F. and the balance was obtained from a civil company specializing in this work.

The Air Force authorities in India have recently indicated that they will not be in a position to carry out survey photography for this department for a considerable time, if ever ; so in the meantime other arrangement must be made.

The different sources from which photography might be obtained are :—

(*a*) By contract with a civil firm specializing in this work.
(*b*) By doing the work departmentally. This would involve the allocation of a flight of planes for the work of the department.
(*c*) By the R.I.A.F. when and if this Force is in a position to take up the work.

This is not the place to argue the merits of the different alternatives, but when considering these the following should be borne in mind :

(i) Air photography for survey is highly skilled work and the rectifying of mistakes and omissions may be extremely costly not only to the agency supplying the photographs but also to the Survey of India.
(ii) Continuity is essential to enable technique to be developed and to justify the provision of the best equipment in planes, cameras, etc.
(iii) The development of indigeneous air photography and survey private enterprize seems essential not only to provide competition if the contract for the provision of photographs is to be put out to tender, but also to supplement the work of the Survey of India if necessary (see para 19).

SECTION B.—PROJECT AND MISCELLANEOUS SURVEYS

39. **Parties Required for Project Work.**—The five air survey parties envisaged in Section A will be required continuously for the completion and upkeep of the topographical maps of India, and they should in no circumstances be diverted to other work for which separate parties must be provided. We have seen in para 23 that there is project work for 20 survey parties for 4 years and further demands are continually being received ; in addition one or more parties will be required to be devoted continuously to training officers and surveyors. It is not considered practicable, however, to plan for an increase of the Department immediately to provide for undertaking all this project work in a short time. Should the demand persist it will be in this field that private enterprise might be called in to take up some of the

* About 50% of parties will have an Asstt. Supdt: in the rest a third Cl. II officer will take his place.

work on contract for the Survey of India. There is also the hope that with the purchase of automatic plotting machines the output of the Survey of India itself may be increased. It is therefore thought that at present, and especially considering the limited staff available at the moment for both training and productive work, it is advisable now to aim at an expansion which will provide for only 16 parties for projects and miscellaneous work including training. Each of these parties would be constituted approximately as in para 37.

It may be noted that a large part of the projects survey work undertaken hitherto consists of mapping on the scale of 4 inches to a mile : and the programme of air photography envisaged on the 1/30,000 scale for topographical purposes is suitable as a basis for such 4-inch surveys. By co-ordination of the topographical programme with project requirements it should be possible to effect considerable economies in the capital cost of projects.

Section C.—Departmental Organization

40. **Circles.**—To carry out the programme of Topographical and Project Surveys and to keep $\frac{1}{4}$-inch maps up-to-date four topographical circles will be required. The boundaries of these should coincide with political boundaries so that no provincial or State Government would normally have to deal with more than one Survey of India authority in its area.

The circles will be named and have their H.Q. as follows :—

Northern Circle	H.Q.	Dehra Dūn.
Eastern Circle	..	Calcutta.
Southern Circle	..	Bangalore.
Western Circle	..	Nasik—Poona area.

The proposed boundaries are as shown on the index map No. 3 at the end of this paper.

The first three Circle H.Qs. are already in existence. The Western Circle is considered necessary as a large part of the uncompleted topographical programme lies in the area allotted to this Circle, which will also be the scene of considerable project work. Buildings will have to be found for the Circle Office, Drawing Office, and H.Q. Offices of Parties of this Circle.

The officer establishment of each Circle H.Q. should be as follows :—

1 Director.
1 Dy. Director.
1 Class II Officer for Records and Map Sales.
1 Class II Administrative Officer.

The two Class II posts should be held either by officers of the regular Class II cadre or by G.C.S. Class II officers promoted from the technical or ministerial staff, according to availability.

Each Circle will have a Drawing Office attached to it of approximate strength as under :

Class I	Superintendent	1
	Asstt. Supdt.	1 (may be a Class II Officer).
Class II	.. .. ..	3
Surveyors Topographical	Grade 1 } ..	10
.. ..	Grade 2 }	
Draftsmen	.. .. ..	70*

Topographical and Project Survey parties will be attached to Circles according to the amount of work in hand.

41. **Establishments Required for the main Cadres.**—This paper has not dealt with the Map Production and Geophysical work of the Survey of India beyond referring to them in the narrative in Chapter I. Certain of the gazetted officers of the Class I and Class II cadres, and Topographical Surveyors are, however, employed in these branches of activity and must be taken into account when working out establishments for the regular Survey of India cadres.

* The estimated reduction in the total number of draftsmen from that envisaged in para 22 is on account of abandonment of maintenance of 1-inch sheets.

In the table on page 22 suggested strengths are given for the Class I and Class II cadres of the Survey of India. The cadre of Topographical Surveyors Grade I is fixed ; so also are the cadres of 2nd Division Surveyors and Draftsmen who in their particular activities have qualifications similar to grade I Topo. Surveyors. The cadre of grade II Topo. Surveyors will be unfixed.

In the table below is given the numbers of the various grades sanctioned in the 1946–47 cadre, and the suggested strength for revised cadres. Any personnel of the Topo. Surveyor category required in addition to the numbers in the proposed cadres will be borne on the unfixed establishment of topographical Surveyors Grade 2.

Category	1946–47 cadre	Suggested new cadre
U.S.S. Officers (Topo. Surveyors Grade 1) ..	99	90
II Division Surveyors	40	30
II Division Draftsmen	15	12

42. **Immediate action required.**—(i) *Intensive training.*—It is essential to take every possible step to increase the number of trained surveyors and draftsmen as soon as possible.

This will have to be done at the expense, during the next few years, of productive surveys.

It is therefore proposed to organize at once—

(*a*) Two training parties to train at one time up to 100 surveyors each in ground and air survey.

(*b*) One training party for training officers and topographical surveyors.

The above training work will have to take precedence over productive work, in the employment of experienced personnel for instructing and will employ about 30 trained surveyors as instructors.

This will leave only enough trained personnel to put about 6 or 7 rather under-strength parties in the field for topographical and project work in the immediate future, as opposed to the 11 which were in the field in the year 1946–47.

(ii) *Purchase of Plotting Machines.*—The purchase and installation of auto-plotting machines should be proceeded with as fast as possible and on receipt of them the training of sufficient personnel to use them to their maximum capacity, will have to be given high priority.

(iii) *Air Photography.*—Provision on as permanent a basis as possible of an organization for the supply of photographs for air survey.

43. **Conclusion.**—A complete review of the objectives and requirements of the Survey of India was carried out by the 1904–05 Survey Committee. Its recommendations marked the beginning of an era of "modern surveys". This era may be said to have closed during the dislocation caused by the 1939–45 war and the political changes succeeding it.

New problems now face us and new methods and instruments are available to meet them. The Survey of India today inherits a great reputation and a fine tradition. Let us hope that the new era which now begins and which coincides appropriately enough with the establishment of a self governing Union of India will add to both.

Estimated strength for Class I, Class II Services of the Survey of India and also of Class III personnel for supervisory and highly skilled duties

Services and Grades	S.G.O.	M.P. Directorate	4 Topo. Circles	S.R.I.	5 Drawing Offices	5 Air Survey Parties	16 Project & Misc. Parties	Totals by Grades	Total strength of Class
Survey of India Class I									
Surveyor General	1	..	..	..	..	..	..	1	..
Directors ..	1 (D.S.G.)	1	4	..	..	..	..	6	..
Deputy Directors ..	..	1	1	1†	..	..	..	6†	..
Superintendents ..	1 (A.S.G.)	2 A.D.M.P. O.C.‡ M.R.I.O.	..	1‡ Comp. & Tidal	5	5	16	30	..
Asstt. Supdts. ..	..	..	..	..	3	2	16§	21	64
Survey of India Class II	1	4*	8*	7*	17	13	40	90	90
Class III									
Surveyors Topographical Grade 1 and 2 and 2 Division Surveyors and Draftsmen	1	2	..	22	40	25	80	165	170

* One in each Circle and S.R.I. for Admin. duties may be G.C.S. Cl. II.

† One post may be held by officer G.S.C. Cl. I.

‡ May be held by G.C.S. Cl. I.

§ Includes those on probationary training.

INDEX

G.B.—P.O. J.S. 488—1-9-47—300

TOPOGRAPHICAL SURVEY POSITION
AUGUST 1947.

PĀKISTĀN

PĀKISTĀN

REFERENCES.

Areas covered by modern Surveys after 1920-21 .....

Areas covered by modern Surveys prior to 1920-21 .....

Areas unsurveyed or covered by pre-1905 Surveys .....

Scale of Index 1:12 Million

Miles 100 0 100 200 300 400 500 Miles

60° E. of Greenwich.

PRINTED AT THE SURVEY OF INDIA OFFICES (H.I.Q.)

Published under the direction of Brigadier G.F. Heaney, C.B.E., Surveyor General of India.

Reg. No. 4131 H.O.

MAP 1

TOPOGRAPHICAL SURVEY POSITION
AUGUST 1947.

PĀKISTĀN

PĀKISTĀN

REFERENCES.

Areas covered by modern Surveys after 1920-21.....

Areas covered by modern Surveys prior to 1920-21.....

Areas unsurveyed or covered by pre-1905 Surveys.....

Scale of Index 1:12 Million

Miles 100 0 100 200 300 400 500 Miles

60° E. of Greenwich.

PRINTED AT THE SURVEY OF INDIA OFFICES (H.L.O.)

Published under the direction of Brigadier G.F. Heaney, C.B.E., Surveyor General of India.

REG. No. 4131 H.D. 47.

INDIA

PROJECTS IN HAND

AUGUST 1947.

Scale 1 Inch to 160 miles

Miles 160 120 80 40 0 160 320 Miles

References

Commanded Area .....
Catchment Area .....
Area for Rectangulation ...
Other Projects .....
Dam Sites .....

References to Projects

1. Dochi (Nagaon) Dam
2. Bhakra
3. Delhi Expansion & Development Survey
4. Gandak Catchment
5. Kosi Catchment
6. Bagaha Reclamation Survey
7. Kosi Dam
8. Cinchona Research Station
9. Tista High Dam
10. Kosi
11. Tista
12. Um Tru Dam & Reservoir
13. Bihar Mica Belt
14. Son Valley Coalfields
15. Konar Dam (Damodar Project)
16. Hazaribagh Coalfields
17. Bokaro Dam(Damodar Project)
18. Bokaro Coalfields
19. Deolbari Dam(Damodar)
20. Bermo-Bhandaridah Gorge(D)
21. Gumti Dam & Reservoir

References to Projects

22. Morvi City Survey
23. Jamshedpur Town
24. Hooghly Ship Canal
25. Mahanadi Coalfields
26. Kamptee Coalfields
27. Mahanadi
28. Hirakud Dam
29. Tikarpara Dam & Reservoir
30. Naraj Dam & Reservoir
31 Tungabhadra
32 Kalinadi Reservoir
33 Sandur Reservoir & Town Development
34. Davangere Town Development
35. Bangalore Development Survey
36. Chamarajanagar-Mettupalyam Railway Survey
37. Poringalakuthu Reservoir

Printed at the Survey of India Offices (P. Z. O.)
Reg. No. 3383 M. D. D. '47—X'47.

INDIA

PROJECTS IN HAND

AUGUST 1947.

Scale 1 Inch to 160 miles

Miles 160 120 80 40 0 160 320 Miles

References

Commanded Area .....
Catchment Area .....
Area for Rectangulation ...
Other Projects .....
Dam Sites .....

U. S. S. R.
BOUNDARY UNDEFINED
AFGHANISTAN
N.W.F.P.
KASHMIR AND JAMMU
BOUNDARY UNDEFINED
PESHAWAR
Kohat
Abbottabad
Rawalpindi
Razmak
Sialkot
LAHORE
PUNJAB
Simla
Ferozepore
Dehra Dun
Ambala
Meerut
DELHI
QUETTA
Multan
INDUS R.
BOUNDARY UNDEFINED
WESTERN
BALUCHISTAN
PAKISTAN
RAJPUTANA
Agra
SIND
KARACHI
GWALIOR
Jhansi
Lucknow
UNITED PROVINCES
NEPAL
BHUTAN
SIKKIM
Dibrugarh
BRAHMAPUTRA R.
Gauhati
Shillong
ASSAM
Allahabad
Patna
BIHAR
EASTERN
GANGES R.
Dacca
BENGAL
PAKISTAN
CALCUTTA
MANDALAY
BURMA
INDIA
STATES OF
WESTERN
Ahmedabad
CENTRAL INDIA
Jubbulpore
EASTERN
Ranchi
CENTRAL PROVINCES
NAGPUR
STATES
Akyab
Deolali
BOMBAY
Ahmednagar
Poona
BARAKAR
HYDERABAD
Secunderabad
Vizagapatam
Cocanada
RANGOON
GOA
Belgaum
MYSORE
Bangalore
MADRAS
Mysore
MADRAS STATES
Cochin
CEYLON
Andaman Islands

References to Projects

1. Dochi (Nagaon) Dam
2. Bhakra
3. Delhi Expansion & Development Survey
4. Gandak Catchment
5. Kosi Catchment
6. Bagaha Reclamation Survey
7. Kosi Dam
8. Cinchona Research Station
9. Tista High Dam
10. Kosi
11. Tista
12. Um Tru Dam & Reservoir
13. Bihar Mica Belt
14. Son Valley Coalfields
15. Konar Dam (Damodar Project)
16. Hazaribagh Coalfields
17. Bokaro Dam (Damodar Project)
18. Bokaro Coalfields
19. Deolbari Dam (Damodar)
20. Bermo-Bhandaridah Gorge (D)
21. Gumti Dam & Reservoir

References to Projects

22. Morvi City Survey
23. Jamshedpur Town
24. Hooghly Ship Canal
25. Mahanadi Coalfields
26. Kamptee Coalfields
27. Mahanadi
28. Hirakud Dam
29. Tikarpara Dam & Reservoir
30. Naraj Dam & Reservoir
31. Tungabhadra
32. Kalinadi Reservoir
33. Sandur Reservoir & Town Development
34. Davangere Town Development
35. Bangalore Development Survey
36. Chamarajanagar-Mettupalyam Railway Survey
37. Poringalakuthu Reservoir

Printed at the Survey of India Offices (P. Z. O.)
Reg. No. 3383 M. D. D. '47—X'47.

PROPOSED BOUNDARIES OF TOPOGRAPHICAL CIRCLES
SURVEY OF INDIA

MAP OF INDIA
(SHOWING PROVINCES AND DISTRICTS).

REFERENCE.

Boundaries: international, demarcated, undemarcated
Do. Province or State Do. Do.
Do. District and minor State
Pakistan
Areas outside India on 15 Aug. 47.

NORTHERN CIRCLE

EASTERN CIRCLE

EASTERN CIRCLE

WESTERN CIRCLE

SOUTHERN CIRCLE

SOUTHERN CIRCLE

EASTERN CIRCLE

REFERENCES

ORISSA (O.)
PUNJAB STATES (P. S.)
PUNJAB (P.)
BARODA (Ba.)
RAJPUTANA (R.)
DECCAN STATES (D. S.)
COORG (C.)
BOMBAY (Bo.)
GWALIOR (G.)
UNITED PROVINCES (U. P.)
CENTRAL INDIA (C. I.)
GUJARAT STATES (G. S.)
MADRAS (M.)
MADRAS STATES (M. S.)
BURMA (Bu.)
BALUCHISTAN (B.)

REFERENCES

EASTERN STATES (E. S.)
STATES OF WESTERN INDIA (S. W. I.)
BENGAL (B.)

Scale 1 Inch = 160 Miles.

Miles 160 120 80 40 0 160 320 480 Miles

Published under the direction of Brigadier G.F. Heaney, C.B.E., Surveyor General of India

PROPOSED BOUNDARIES OF TOPOGRAPHICAL CIRCLES
SURVEY OF INDIA

MAP OF INDIA
(SHOWING PROVINCES AND DISTRICTS).

REFERENCE

Boundaries - International demarcated, undemarcated

Do, Province or State Do, Do

Do, District and minor State

Pakistan

Areas outside India on 15 Aug. 47.

NORTHERN CIRCLE

EASTERN CIRCLE

WESTERN CIRCLE

EASTERN CIRCLE

SOUTHERN CIRCLE

SOUTHERN CIRCLE

EASTERN CIRCLE

REFERENCES

ORISSA (O.)
1 ANGUL

PUNJAB STATES (P. S.)
1 KAPURTHALA
2 NÁBHA
3 MALER KOTLA
4 LOHÁRU
5 BILÁSPUR
6 PATIÁLA
7 JIND

PUNJAB (P.)
1 DUJÁNA
2 PATAUDI
3 FEROZEPORE
4 HISSÁR
5 LUDHIÁNA
6 NALBHA

BARODA (Ba.)
1 AMRELI
2 MAVSARI

RÁJPUTÁNA (R.)
1 KISHANGARH
2 PARTÁBGARH
3 TONK
4 DANTA

DECCAN STATES (D. S.)
1 AKALKOT
2 SÁNGLI
3 JATH
4 KOLHÁPUR
5 JABRIKHANDI
6 MUDHOL
7 KURANDVÁD
8 SAVANÚR
9 RÁMDURG
10 SÁVANTVÁDI
11 MIRAJ (Senior & Junior)
12 AUNDH
13 PHALTAN
14 JANJIRA
15 BHOR

COORG (C.)
1 NORTH COORG
2 SOUTH COORG

BOMBAY (Bo.)
1 MEHWÁS
2 BROACH & PANCH MAHÁLS
3 DAMÁN (Portuguese)
4 BOMBAY SUBURBAN
5 AHMADNAGAR
6 SHOLÁPUR
7 AHMADABÁD
8 SURAT

GWALIOR (G.)
1 GIRD GWALIOR

UNITED PROVINCES (U. P.)
1 BENARES STATE

CENTRAL INDIA (C. I.)
1 SÍTÁMAU
2 INDORE
3 BHOPÁL AGENCY
4 ALI-RÁJPUR
5 SAMTHAR
6 PANNA
7 BARAUNDA
8 JABO
9 CHARKHÁRI

GUJARÁT STATES (G. S.)
1 SURGÁNA
2 JAWHÁR
3 CAMBAY

MADRAS (M.)
1 KISTNA

MADRAS STATES (M. S.)
1 BANDÚR
2 BANGANAPALLE
3 PUDUKOTTAI
4 COCHIN

BURMA (Bu.)
1 HANTHAWADDY

BALUCHISTÁN (B.)
1 BOLÁN PASS

REFERENCES

EASTERN STATES (E. S.)
1 SARAIKELA
2 KHARSÁWÁN
3 KAWARDHA
4 BAKTI
5 SÁRANGARH
6 KHAIRÁGARH
7 CHHUIKHADÁN
8 NÍLGIRI
9 ATHGARH
10 TIGIRIA
11 BARÁMBA
12 MINDOL
13 NARSINGHPUR
14 KHANOPARA
15 NAYAGARH
16 RÁNPUR
17 ATHMALLIK
18 TÁLCHER
19 PÁL LAHARA
20 RAIRÁKHOL
21

STATES OF WESTERN INDIA (S. W. I.)
1 WESTERN KÁTHIÁWÁR AGENCY
2 EASTERN KÁTHIÁWÁR AGENCY
3 SABAR KÁNTHA AGENCY
4 RÁDHANPUR
5 DHRÁNGADHRA
6 WADHWÁN
7 PÁLITÁNA
8 LIMBDI
9 BHAUNAGAR
10 VIJAYANAGAR

BENGAL (B.)
1 HOWRAH

Scale 1 Inch = 160 Miles.

Miles 160 120 80 40 0 160 320 480 Miles

LACCADIVE ISLANDS

ANDAMAN ISLANDS

NICOBAR ISLANDS

6 6 E. of GREENWICH. 7 0 7 4 8 2 8 6 9 0 9 4 9 8 10 2 E.

REG. NO. 4176H.D. '47-X '47.

Published under the direction of Brigadier G.F. Heaney, C.B.E., Surveyor General of India.
1947.

PRINTED AT THE SURVEY OF INDIA OFFICES (H.L.O.)