

tage. It is becoming more fully realized every day that a contour map, with a location line laid on it in the office and revised afterwards, where necessary, in the field, is a very valuable part of preliminary surveys in such a kind of country. This topography party consists of two or three men, equipped with a level board, level rod and hand level, or else with a clinometer and tape to measure side slopes; the work is carried on one day behind the level party, and the method of procedure is somewhat thus:

Detached sheets of paper about 18 inches by 24 inches, have plotted on them the centre line and level height at each 100 feet and hub, according to the previous day's records; these sheets are mounted on a drawing board and taken into the fields, where 5 feet or 10 feet contours are plotted and sketched direct, for a distance of 20 to 50 feet in elevation, up and down hill from the centre line, depending on evident requirements; with a little practice, the distance to each contour can be taken and plotted very rapidly, obviating the necessity of notes. Intermediate irregularities, etc., can be also sketched in by eye, and the sheets when taken back to the office can be placed in proper alignment and chainage, and a tracing taken if necessary; but probably the projected location line will be at once placed on these sheets and then transferred to the field at once, or by another party following, or the whole matter may be held over until a decision is arrived at as to the correct location route to adopt; this will evidently vary with each case. If the contour notes are recorded in books in the field, they may be plotted on a continuous roll in the office; but such a method is more tedious, and little irregularities which would be sketched in the field are often omitted in notes. A topography party relieves the transitman of all note-taking except centre alignment, whereas all notes of natural and artificial topography are taken by the transitman where no topography party is employed, thereby delaying the progress of the whole survey. A topographer should preferably be a Provincial Land Surveyor also, so that his work in recording land lines and making plans may at once be legalized.

The qualifications and duties of the members of a survey party are somewhat as follows:

*The Chief of Party* should be a man of vigorous mental and physical attainments, familiar with the details of survey life and minutiae, with a wide experience of construction, and even, if possible, of maintenance of railways, well informed on such matters as have been touched on in previous chapters, and capable of commanding prompt obedience and zealous assistance on the part of every member of the party. If, in addition, a man can be found who has also a natural genius for railway location, he cannot be too highly treasured or paid. The chief of a survey party is the most important position in the pay of a railway company where location is of a difficult and perplexing nature. Crippled constitutions and receiverships are more often the result of poor location than from any other cause, hence the high value of the men who decide on such matters. A chief may be a strict disciplinarian and still command the regard of his assistants; he should have free scope to dismiss anyone not competent and willing to do good work; and should never do any work for subordinates, except in the rarest instance, but should be well on at the front most of the time, devising the next step before it is needed, and having in view a general plan of the country, not looking straight ahead, but feeling that just "beyond" there may be a better line. The rate of progress is fixed by those at the front, the others must keep up. A chief of party carries usually a pocket note book,

or even topography book, an aneroid barometer and a pocket compass.

*The Transitman* should be an engineer of some experience, particularly in handling men, keeping full and accurate notes, and rapid and yet delicate handling of his transit. He should be alive to the general movement of the men in his party, which means that he should not always be looking through his telescope at them, but commanding their movements directly also, and above all, he should put his transit in position quickly, and not keep a whole party waiting while he dawdles over his levelling screws, etc. Where there is no topographer, the transitman, in addition to keeping notes of the survey alignment, must sketch neatly, with necessary measurements, all buildings, roads, farm lines, etc., in fact all artificial and natural topography, and obtain all owners' and tenants' names. In a level country, topography should extend for at least 500 to 1,000 feet on each side of the line, as the location may be moved that much, and thereby run through houses and barns that have not been noted. This should be done where necessary by accurate chainage offsets. In country of steep side inclinations this is not necessary; judgment will determine the width of the topography belt needed in each instance.

*The Leveller* may be a young engineer of limited experience, although preferably one capable of rising rapidly to higher position, and not one whose engineering horizon is bounded by such work. In addition to centre line levels, taken at each 100 feet station, hub, and intermediate change of vertical direction, the leveller notes the wooded and cleared portions, the class of timber, probable nature of material in cuttings and borrows; the depth, volume of flow and high water mark of all streams, and establishes bench marks, at say each half mile on preliminary surveys.

*The Level Rodman and Chainmen* should not only be instructed how to do their work, but day after day should be made to chain and hold their rods correctly; chains should be tested frequently. It is certain that more errors are due to poor chaining and rodding, to insecure hubs, and to slovenly work amongst subordinates, generally, than to poor instrumental work, although the blame for such errors is usually laid on the latter.

*A Front Picketman* is invaluable and should be distinct from the chainmen; he should be an active, intelligent man, one who can select a transit site with judgment, make and drive a hub well, take centre, make and drive reference stakes, make a cross-head for back-sight, and then, after placing his picket *exactly* on line, or laying it on the ground, continue to make stakes until the transitman arrives, or better still, if so directed, he may continue to the next site and be ready by the time the transit is placed, to take hub again. In cleared country, hubs should be driven in secluded spots along fence lines, etc., wherever possible, or else in a few months all traces of line across cultivated fields will be obliterated. If hubs come, necessarily, in open places, extra ones should be put in in sheltered spots. If the line is being carried through forest, the same care will not be necessary to preserve the line, and transit sites will depend more on natural profile; in this case the front picketman should be continually taking line for clearing, and leading, and commanding the axemen, being himself also, for the time, an axeman. In general, it is best to not have a back picketman; but have the transitman place a cross-head on line within a few inches of his transit telescope just before moving forward. If a back picketman is employed, it is best to still use a cross-head and keep the man merely as a guard and