

forces. In addition to this fact, it might be well to add that results obtained recently in various cities show a substantial saving by reason of the abandonment of contracts for repair work, and the substitution of city labor.

Too much emphasis cannot be placed upon the importance of centralizing the control over the pavements right in the highway bureau itself—and the larger the municipality, the more important it is that all street repairs be made by municipal forces. In any event, even though the organization is not equipped to handle the work, all contracts for repairs to cuts should be made directly with the city and not with the public service corporations. The most efficient and economic method of handling repairs, however, is by municipal forces.

After planning and working out a highway organization adequate for the requirements of the municipality, the first and most important step toward efficiency and economy in carrying out the work is the establishment of unit cost records, covering all classes of work carried on under the bureau. The basic principle of these records is simply to bring out by comparison the weak and strong points of the organization, which will act as a guide in planning and conducting the work in an efficient and economical manner. Comparisons of different subdivisions of one function of the organization may be made one with the other, or comparisons of like functions in different organizations, all of which tends to improve the methods of carrying on the work, impresses the men with their responsibility and at the same time arouses the sense of pride they should have in their work. Unit cost records are simply a modern system of records designed to raise the standard of efficiency and economy in conducting work. All maintenance work should be initiated through job orders issued from the main office, with the exception of emergency repairs, which work should be controlled through a job order issued by the superintendent or engineer in charge, a carbon copy of which should be transmitted to the main office. The foreman should be supplied with a force account and daily report sheets, through which labor hours, foreman's time, team time, and material used could be charged under their respective job order numbers and each day transmitted to the main office where the unit cost records would be compiled.

The accompanying chart illustrates a proposed organization of a bureau of highways which embraces construction and maintenance of highways, street cleaning, collection of garbage, maintenance of bridges and maintenance of sewers in a municipality, with a population of about 1,600,000 and 1,500 miles of streets and roads to care for, of which 1,000 miles are paved with first-class pavements, 300 miles with water bound and bituminous macadam and 200 miles of dirt road. It is assumed, of course, that all street repair work and bridge and sewer maintenance, as far as is practicable, will be done by municipal labor, and all original construction and repaving by contract.

The organization, it will be observed, is divided into five main divisions, which in turn are subdivided in accordance with the requirements of the functions of the respective divisions. A chief clerk is in charge of the clerical force, which embraces auditing and accounting, permits and license division, stenographers and clerks purchasing supplies, etc. The maintenance of bridges and sewers is under the direction of an assistant engineer, and is subdivided into two divisions, maintenance of bridges and maintenance of sewers. All minor repairs to bridges and sewers are made by municipal labor, more extensive repairs by contract. Sewer cleaning, of course, is done by municipal labor.

The supervision of all regulating and grading of streets, construction and maintenance of pavements and street clean-

ing is divided into two main divisions, each under the direction of an assistant engineer. Both of these divisions are subdivided into three districts, each under the direction of a district engineer. Each district has nine patrol inspectors, whose duty it is to report and measure all defects in pavements, plumbers' cuts, corporation cuts, and report encumbrances, answer complaints, etc., and supervise the street cleaning and collection of garbage, which have been assumed to be under contract in the organization under discussion. It is strongly recommended, however, that this work be performed by the municipality itself, as it is the only logical way to properly control it. It will also be observed that each district engineer has under his jurisdiction seven foremen, laborers, vehicles, carts, etc., assistant engineer, stenographer, storekeeper and corporation yard.

The number of patrol inspectors, assistant engineers, foremen, laborers, etc., may vary somewhat, depending upon the requirements of the respective districts, but the total number is approximately correct for the municipality at large.

Construction inspectors are assigned to each district as occasion requires by the assistant engineers of construction and maintenance. The other main division comprises the office force in charge of plans, specifications and contracts, the asphalt plant, and the division of subsurface structures, and is under the direction of an assistant engineer. The division of subsurface structures is a most important division, and the rules and regulations governing the placing of subsurface structures in the street, after a pavement has been laid, cannot be too strict. This is one of the most serious problems confronting the municipal engineer, and indications point to its not being under proper control in any municipality in this country. The only real solution of the problem would seem to be underground pipe galleries. The evil, however, can be minimized by exercising a more thorough control over the corporations by insisting on a strict compliance with rules and regulations designed to permit of as little disturbance as possible to pavements after being laid.

A testing laboratory has not been mentioned, as it is assumed that the municipality would have a laboratory equipped to handle the work of all the city departments.

The primary considerations in making up the accompanying chart were to illustrate a practical scheme for carrying on the work of an organization, such as referred to in this paper, by subdividing the responsibility for the work in such a manner that the chief engineer will not be swamped with detail, but at the same time will be in such close touch with all the work under his jurisdiction that he can intelligently direct and thoroughly control the operations of the bureau.

The organization under discussion has been used as an illustration in this paper, as it is one with which the writer is familiar, but is not presented as an ideal municipal highway organization—the object simply being to illustrate the essential features that must necessarily be considered in order to successfully control a municipal highway organization. The fundamental principles under discussion, however, would apply to any like organization; any deviations would simply be of minor detail.

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A copy of the Queen's Engineering Works Magazine, published by W. H. Allen, Son & Company, of Bedford, England, has been received by The Canadian Engineer. This magazine is published primarily to keep their old pupils and apprentices in touch with this firm, and contains many articles of interest to them. We have been requested to call the attention of those interested through these columns.