

REPORT
ON
SEWER CONSTRUCTION
DEPARTMENT OF PUBLIC WORKS
CITY OF DETROIT

PREPARED BY THE
DETROIT BUREAU OF GOVERNMENTAL RESEARCH

September 1916.

Summary of Recommendations

Sewer Construction

It is recommended:

- 1 — That the Sewer Engineer devote more time to supervision of construction, the assistant engineer having direct charge of surveys, lines and grades. (P.3)*
- 2 — That the Chief Inspector supervise night work, or unless the volume of construction work is greatly increased, the position be abolished. (P. 4)
- 3 — That salaries of Survey party be changed. (P. 4)
- 4 — That the acting clerk, now under Chief Inspector, be appointed as clerk, placed directly under Sewer Engineer, and his duties be increased to include construction cost records. (P. 6)
- 5 — That the salary of Sewer Engineer be increased to an amount commensurate with his responsibilities. (P. 6)
- 6 — That the Inspectors be on a yearly salary rather than a per diem basis and character and qualifications of inspectors be raised. (P. 7)
- 7 — That the Inspectors submit daily reports giving in detail work done, materials used, and force employed. (P. 8)

* Note:— The numerals in parentheses following each recommendation, refer to the page number of the portion of the text discussing the recommendations. Similarly in the body of the text, the numerals preceding many of the paragraphs refer back to the recommendations as listed in the Summary of Recommendations.

8 — That the Inspectors be not required to leave their work in order to secure their pay, but be paid either on the work or through the mail each week. (P. 9)

9 — That the cleaning of catch basins be transferred from Sewer Department to Street Cleaning Department (tentatively suggested). (P. 11)

10 — That the Supervision of operation of the Fairview Sewage Pumping Station be transferred from the City Engineer to the Sewer Department. (P. 11)

11 — That a District Superintendent for the Central District of the Sewer Department be appointed in place of the Assistant Superintendent. (P. 12)

12 — That a checker, or time-keeper, be assigned to the Central District. (P. 12)

13 — That Inspectors, reporting directly to the Sewer Engineer of the City Engineer's office, be assigned to construction work being done by the Sewer Department. (Tentative) (P. 12)

14 — That the Sewer Department bid formally on all Sewer Construction work advertised for contracts, and that cost records be kept of all work performed. (P. 13)

15 — That the Inspectors exercise care in setting, and frequently checking "sightarms", and make it the rule to personally check the invert grade of the sewer laid. (P. 14)

16 — That more attention be paid to the alignment of sewers, and the survey party set sufficient stakes to make possible the control of alignment. (P. 15)

17 — That the Survey Party also return to the former practice of frequently checking grades given, and sewer inverts. (P. 17)

18 — That the Survey Party give line and grade for the construction of all storm sewers. (P. 17)

19 — That the giving of lines for Sidewalk construction or any other extraneous duties be removed from the jurisdiction of the Sewer Engineer. (P. 17)

20 — That mean sea level be adopted as the datum for elevations in all public work, and permanent bench marks based on precise levels be established throughout the city. (P. 18)

21 — That standard sizes, scales and titles be adopted for all drawings. (P. 18)

22 — That plans be signed by division and city engineer when approved. (P. 18)

23 — That titles for plans be printed from type rather than by the draftsman by hand. (P. 18)

24 — That the original or file copies of drawings not be taken from the office. Either a Photostat be installed, or tracings be made as file copies of all drawings. (P. 19)

25 — That the use of the “station and plus” method of laying out plans and profiles be adopted. (P. 19)

26 — That a change in size of sewers be made by breaks in the invert of the sewer rather than the arch, unless special conditions prevent. (P. 19)

27 — That in establishing street and alley grades more weight be given to economy in drainage with the view of reducing the construction of storm sewers. (P. 20)

28 — That official plans be prepared for storm sewers and record plans filed when such sewers are completed. (P. 21)

29 — That responsibility for sewer design be more clearly defined than it is at present. (P. 21)

- 30 — That rainfall and run-off data be gathered, the operation of existing sewers be watched, and the present method of design checked by the “rational” method. (P. 21)
- 31 — That records of existing sewers, including storm sewers, be brought up to date. (P. 22)
- 32 — That a comprehensive sewerage system be planned, looking both to extensions and to the collection and disposal of sewage. (P. 22)
- 33 — That more inspectors be used in some cases. (P. 25)
- 34 — That a school of instruction for inspectors be established. (P. 25)
- 35 — That sewer construction methods be “toned up” – that closer supervision be given and that inspectors be elected and retained for merit only. (P. 25)
- 36 — That a system for identification of tested cement be put into effect. (P. 26)
- 37 — That occasional, if not regular, tests of all construction materials be made. (P. 30)
- 38 — That a Bureau of Tests, under which the duties of the cement tester, gas inspector, meter inspector, and certain other special employees can be grouped, be established (tentatively suggested). (P. 30)
- 39 — That sewer specifications be revised, make specific, and non-essentials be eliminated. (P. 32)
- 40 — That proposal sheets be extended to include uncertain items upon which the contractor cannot bid closely on the present basis of lineal foot of sewer complete. (P. 33)
- 41 — That borings showing material to be excavated be made by the city, samples filed for examination, and results noted on contract plans. (P. 33)

42 — That every effort be made to furnish the bidder with complete and concise information as to the quantity and character of the work to be done, so that all bidders will start on the same basis and there can be no just grounds for a charge of favoritism. (P. 34)

This preliminary report on the methods of sewer construction employed by the Department of Public Works of Detroit, is based on data collected through several field inspection trips and interviews with city employees directly responsible for such work. Although the time devoted to the study was necessarily limited, particular care was taken to observe not only several contracts or jobs, but observations were verified by one or more re-inspections at later dates. It is believed that the comments and suggestions presented are supported by a substantially fair and accurate view of the local practice of sewer construction. Recommendations as to the final changes in organization are not presented, because to be of value, such recommendations must be based upon a study of all branches of the Department of Public Works. This report therefore confines itself to such suggestions as may be effected without a general reorganization of the Department of Public Works.

KINDS OF SEWERS

Definitions of the kinds or classes of sewers constructed by the city will assist to a clear conception of the problem:

Public Sewers are those constructed in main streets and rights-of-way for the conveyance of both domestic sewage and storm water, the city paying the entire cost of construction.

Lateral Sewers are those constructed usually in alleys, for the conveyance of domestic sewage and roof drainage, the cost of construction being assessed against abutting property with the exception of the proportions in street intersections.

Storm Sewers are those constructed in streets for the purpose of draining the street surface, the city paying the entire cost.

“Lateral Sewers” when first constructed convey only domestic sewage and roof drainage, but eventually gutter inlets in alleys or parallel streets are connected. Similarly, sooner or later, houses are connected to storm sewers, although this is reported to be the exception rather than the rule. So it may be stated that in general the Detroit sewers are of the combined type conveying both storm water and sewage.

ORGANIZATION AND DUTIES

The work of sewer construction is conducted under two separate divisions of the Department of Public Works:

1. The Sewer and Sidewalk Engineer, who reports directly to the City Engineer
2. The Sewer Department, the General Superintendent of which reports directly to the Commissioner of Public Works.

Sewer and Sidewalk Engineer

The Sewer and Sidewalk Engineer has charge of all sewer Construction done under contract. This work includes surveys and the giving of lines and grades for public and lateral sewers; the supervision of construction; the preparation of partial and final construction estimates for these sewers, and the measurement of sewers when completed for final estimates and record plans. In addition to this work, the Sewer and Sidewalk Engineer gives line for the construction of all sidewalks.

The force under the Sewer and Sidewalk Engineer (\$2000 per year), includes a grade and survey party of three men, (one assistant engineer, at \$1500, one leveler at \$1400 and one rodman at \$1200); a chief inspector at \$1600, a clerk (classified as an inspector) at \$4.00 per day, and inspectors at \$4.00 per day assigned as needed. The work of Sewer design does not fall under the direction of the Sewer and Sidewalk Engineer, but is conducted by draftsmen reporting directly to the City Engineer.

1. It is the practice of the Sewer and Sidewalk Engineer to work with the grade party, one automobile serving the entire party, — possibly the result of a former organization in which the duties of the Sewer and Sidewalk Engineer did not include supervision of construction. It is suggested that a preferable method would be for the survey and grade party to work

directly under the assistant engineer in charge of this party, leaving the Sewer Engineer free to supervise all departments of the work coming under his jurisdiction, devoting the major portion of his time to the actual work of construction.

2. Formerly, sewer construction was supervised by three chief district inspectors reporting to the Commissioner of Public Works. The present Commissioner reduced this number to one, — placing this Chief Inspector directly under the Sewer and Sidewalk Engineer. With the present small volume of work, the Chief Inspector could be dispensed with, the Sewer Engineer assuming these duties. If the volume of work should be greatly increased, such a change might not be advisable, and right now the Chief Inspector could be used to advantage in the supervision of night work. However, whether or not this change is made, it is clear that a closer contact between the Sewer Engineer and the Inspectors is necessary, and there is no doubt whatever that such contact would result in a more efficient service and a general improvement in the character of the work obtained.

3. As to the survey and grade party, the number of men, three, is sufficient, but the class of men and salaries paid cannot produce a well balanced and efficient party. As compared with similar positions throughout the country, a salary of \$1500 for the Chief of Party is a little above the average. However,

increased responsibilities through absence of the constant support from the Sewer Engineer, together with a recognition of the high cost of living in Detroit, would warrant this or a slightly increased salary. A leveler at \$1400, even though he be proficient both as a leveler and a transitman, is overpaid. In most places \$75 per month is paid for such services unless the duties include charge of party. Certainly a maximum of \$100 should secure a first class man for this position. A salary of \$1200 for the position of rodman is out of all proportion with the duties involved, regardless of the ability of the rodman. The rodman in this party acts as erstwhile chauffeur, stake driver and rodman. Young ambitious graduates of technical schools are eager for such experience and can be secured at a compensation of \$85 per month and undergraduates for even less.

A salary of \$1600 for the Chief Inspector is sufficient, as the duties of this position are now being conducted, and as before noted unless a large increase in the volume of work is anticipated the position might well be abolished. However, when such a position exists, compliance with the specifications and close attention of inspectors to their work, depends largely on the ability, energy and conscientious attention to duty of the Chief Inspector. A chief inspector can make himself invaluable and if the duties of this office are fulfilled as they should be, a compensation of \$1800 per year is not too much.

4. A clerk at \$4.00 per day keeps record of time of inspectors, assists the Chief Inspector in locating "Y" branches which are in question, and acts as inspector in emergencies. It appears that this position was created for the present incumbent, because when acting as inspector, he was seriously crippled by an accident and it devolved upon the city to either pension him or retain him on the payroll. In order to meet this situation, the time of this inspector is illegally charged to various public sewer funds. It would be much better, assuming that the incumbent is qualified, to make this position a legal clerkship through ordinance, adding to the present duties that of keeping costs records of all sewer contracts and having this clerk report direct to the Sewer Engineer, rather than to the Chief Inspector as at present.

5. The salary of the Sewer and Sidewalk Engineer, namely \$2000 per year, is altogether too small for the responsibilities involved. Further, the present duty of the Sewer and Sidewalk Engineer in giving line for the construction of sidewalks is clearly foreign to the principal work of this division. This work may have been assigned to the Sewer and Sidewalk Engineer because of pressure of work in other divisions of the City Engineer's office, but it is evident that much closer attention should be given to the grades and lines of sewers under construction than is at present possible. Therefore, regardless

of conditions as to volume of work in other divisions, no extraneous duties should be added to the work of the Sewer Engineer to the exclusion of a proper supervision of his regular work. The inspectors on sewer construction report through the Chief Inspector to the Sewer and Sidewalk Engineer.

6. The situation in Detroit with regard to inspectors is similar to that in many municipalities where frequently inspectors are political ward workers with or without qualifications as the case may be. Many, with a compensation of \$4.00 a day, irregular time, undoubtedly receive more than they could possibly obtain elsewhere. Such men look upon their position simply as a job and are satisfied to continue in their present capacity for life. A yearly salary (ranging from \$75 to \$100 per month) with possibility for promotion would secure more efficient service from these same inspectors. Further, it would attract more capable men to this most important work. To be sure the adoption of a yearly system would interfere with the present practice of keeping a large force of inspectors on the payroll on part time, and would probably meet with considerable political opposition. Further, a change to this system would occasion certain complications, especially in connection with work where the cost is assessed, but the necessary adjustments could be effected if desired. Also the qualifications of the men employed must necessarily be such

that their services can be utilized on office work, such as estimates, computations, reports, preparation of record plans, etc. when the weather or other conditions make construction work impossible. A combination of such work with the duties of inspector is bound to react favorably by increasing the interest of the inspector in his work. The responsibility of an inspector in his work cannot be overestimated. At present the inspectors as a body are not competent, the inspection service is not efficient, and good contract work is secured by chance.

7. At present inspectors submit no written records of work done other than a record of "Y" branches or slants placed for sewer connections. This commission alone is almost sufficient to insure carelessness on the part of the inspector. With even high grade employees in responsible positions some form of automatic "tickler" or check on work is necessary if uniformly systematic and painstaking service is to be secured. An inspector's daily report which records in detail work done, material used, and force employed, serves not only this purpose, but furnishes a permanent record for future reference in case of claims, damage suits or investigations. Further, it supplies data from which can be determined within useful limits, the

cost of the work to the contractor, — information which is essential to an intelligent policy in the awards of contracts.

8. It is the practice to pay inspectors weekly at the office of the City Treasurer in the City Hall. This method requires that the inspector leave his work for a period varying from two hours to the greater portion of a day, depending upon the distance of the work from the City Hall and the reliability of the inspector. During the absence of the inspector the contractor proceeds with the work of construction as he sees fit. It should not be possible to assume that the inspector is of so little value in the work that a half day's absence out of each week is unimportant. And it will be generally conceded that the place for the inspector is on the job, early and late, whenever construction work is in progress. It would appear advantageous if inspectors were paid off on the job by the Chief Inspector or a paymaster of the City Treasurer or through the mail by check.

Sewer Department

The General Superintendent of the Sewer Department has charge of maintenance of sewers, including the cleaning of sewers and catch basins; supervision of connections to sewers; the repair of sewers; and the construction of all catch basins with connections to sewers, additional manholes where needed and storm sewers. Also when bids for sewers to be constructed

under contract appear to be excessive, this department builds such sewers with city forces.

The overhead force employed by this department is as follows:

1 superintendent	\$2800	per year
1 assistant superintendent	1400	“ “
2 district superintendents	1800	“ “
1 clerk	1300	“ “
2 checkers	\$3.00	per day.

The rates of compensation for the various employees in the overhead force are fair, though they certainly are not excessive, considering the responsibility and work involved.

In addition to this overhead force foremen, bricklayers, stationary engineers, watchmen, carpenters, laborers, and teams are employed as required. Seven sewer tappers, whose duty it is to make all connections with sewers, report to the clerk of the Sewer Department. In conducting the work of the department, the city is divided into three districts. The Central Districts, extending from the east side of Trumbull Avenue to the west side of Hastings Street, is directly under the supervision of the General Superintendent and the Assistant Superintendent. The Western and Eastern districts extending west and east respectively from the limits of the Central

District are under district superintendents reporting to the General Superintendent.

The Clerk, in addition to the supervision of the work and keeping of reports and time of the sewer tappers and flushing gangs, receives all complaints and orders all supplies for this department.

9 and 10 – As the scope of this report in so far as it touches the work of this department is confined to sewer construction, discussion of the work of maintenance is postponed for a later report. However, it might well be mentioned that observation of the work of street cleaning indicates that responsibility for the condition of catch basins can as a rule be traced to this division. It might, therefore, be advantageous to transfer the work of catch basin cleaning from the Sewer Department to the Department of Street Cleaning. Similarly, supervision of the Fairview Sewage Pumping Station which now falls under the City Engineer might properly be under the Sewer Department. While the transfer of the supervision of this station to the Sewer Department probably would not affect materially the efficiency of operation of the station, it would seem to be logical to place this pumping station under the division which has charge of all other work of sewer maintenance.

11. In general, it may be said that the organization of the Sewer Department, based as it is on the district plan, is ideal for this sort of work. However, there is evidently a tendency on the part of the General Superintendent to assume too much detail work, such as investigations of complaints, etc. Illness and later the death of one of the district superintendents has undoubtedly accentuated this tendency. A clean-cut organization is preferable, making the assistant superintendent a district superintendent if qualified, and so leaving the general superintendent free to serve solely in a supervisory capacity.

12 – The present system of time-keeping seems to be unusually satisfactory. Time is kept by the assistant superintendent for the Central District, and by two checkers for the Eastern and Western districts respectively, these men reporting directly to the General Superintendent. It is the practice of the General Superintendent to check up the time as he goes about the work. With the appointment of a District Superintendent for the Central District and the consequent doing away with the position of assistant superintendent, an additional checker would be needed to cover this district.

13. In connection with the construction work of the Sewer Department, it is suggested that the inspectors should be placed on all such work, these inspectors being under the supervision

of the Sewer Engineer of the City Engineer's office. To be sure, with the present quality of inspection obtained on contract work, such inspection would be of small value. The presence of a \$4.00 a day inspector doing little or nothing and knowing less about the work than a \$3.00 a day foreman, would serve simply as a source of irritation. With first-class inspectors the situation would be altogether different. Not only does the foreman need instructions as to the quality of work required, but it is important that any kind of work should be subjected to inspection by an agency which is concerned primarily in the quality rather than the quantity of work done.

14. As before stated, when in the opinion of the City Engineer and the Commissioner of Public Works, the lowest bid for a sewer construction contract seems high, if the work is not large in amount, the Sewer Department is ordered to build the sewer. The Commissioner is to be commended for this practice, as it is a most excellent device for keeping contractors' bids within hand. The only criticisms offered concern the off-hand and informal methods connected with this character of work. No estimate or bid on the probable cost of this work is made by the Sewer Department, nor are detailed cost data kept of the work done. The General Superintendent of this department examines the City Engineer's estimate and all bids submitted, and with this information, coupled with his own experience,

concludes whether he can do the work at a figure substantially below the lowest bid. It would seem worth while for the General Superintendent of the Sewer Department to submit a "bid", sealed, at the same and every time that other bids are received, and that such a "bid" should be based on cost records of past performances. (Whether or not this bid should be read publicly is a debatable point.) Such a practice would in the first place keep contractors constantly on their mettle. It would also at once furnish the Commissioner with a carefully and officially prepared measure of other bids, and so would assist materially to a prompt and proper action on all bids received.

With the suggested minor changes in organization, contract sewer construction work could be handled more efficiently and such changes would not interfere with reorganization changes in the Department of Public Works, should these later appear advisable.

SURVEYS, LINES AND GRADES.

15. As before noted, the survey party under the Sewer and Sidewalk Engineer, makes surveys and gives lines and grades for the construction of public and lateral sewers. Construction of storm sewers by the Sewer Department is usually performed without stakes for either lines or grades, nor is the completed sewer surveyed or record plans prepared or filed. Due to the

flat topography of Detroit, the work of surveying and the giving of lines and grades is comparatively easy and it is undoubtedly because of this fact that the storm sewers are being constructed as well as they are, without either line or grade stakes. On the other hand, because of the flatness of the topography, grades are slight and the necessity for accuracy in both line and grade is all the more imperative. While the so-called "sight-arm" method of giving grades is apparently crude, if the contractor is required to furnish "arms", which are true and in good condition, if the inspector exercises care in setting and frequently checking these "arms" and personally checks the grading of the invert, it is possible that sufficiently accurate work can be done by this method in Detroit.

16. – From the work inspected, it would seem that more attention should be given to the alignment of sewers. At present, if a trench is excavated to approximately the line given and the sewer laid somewhere in the trench, the work seems to be acceptable. It would be practicable to set the grade stakes to serve also as line offset stakes, placing a tack in the top of each stake at a definite distance off center line and above invert grade. Light plumb bobs could then be hung from the "sight arms" on line, as an aid to the inspector in keeping his sewer to the alignment given. Also marker stakes might be set say 18" beyond the grade and line stakes (that is away from the trench)

and on one side of these markers could be noted the distance (station and plus) from the zero point or beginning of the contract and on the reverse side the cut to the invert grade, in feet and tenths. The so-called "batter-board" method of giving lines and grades for sewers is more accurate and furnishes means for a closer control of the entire work of construction than the "sight-arm" method now in use. However, it probably is more expensive. It is therefore not recommended that the present method be changed at this time, but that the suggestions in connection with the "sight-arm" method be adopted and the results noted.

Objections may be made to the marking of cuts in feet and tenths rather than in feet and inches, because inspectors are not accustomed to the division of feet into tenths. This is a small point of itself, but as all engineering surveys are made in feet and tenths, and plans are prepared, grades figured and other computations made on that basis, there seems no reason whatever for departing from this system in this one particular, especially when the added work and possibility of error in converting computations into fractions of inches is considerable. If the inspector is not mentally capable of adjusting himself to this change, with one or two demonstrations, it would be a strong indication of his incompetency as an inspector.

17-18-19 – Formerly, it was the practice for the grade party to visit various construction jobs, frequently checking grades and also the invert of the sewer just laid, leaving with the inspector a memorandum to the effect that the grades had been checked. Apparently this excellent practice has been done away with, probably due to pressure of other work. If this is the case, as before stated, the giving of lines and grades for sidewalk construction should not be permitted to interfere with the careful supervision of the lines and grades for sewer construction, but should be assigned to some other division of the Engineering Department. The survey party of the Sewer and Sidewalk Engineer should also give line and grade on all storm sewers with exactly the same methods and degree of accuracy as is in use on other sewers.

20 – The adoption of mean sea level as the datum for elevations in all public works is suggested. As the difference in elevation between the present city datum and mean sea level is known, the immediate use of sea level datum in the preparation of plans would not cause any complications or increase of work. This should be done, but the suggestion should be carried farther and permanent bench marks based on precise levels should be established throughout the city. The public works of Detroit are sufficiently extensive and important to justify the adoption of approved surveying methods.

PREPARATION OF PLANS.

For the purpose of this report, a study of the work of sewer design was not necessary. However, in examining the various plans of sewers under construction, certain points in connection with the preparation of plans were noted which it may be well to record.

21-22. While there seems to be a standard size for such plans as are to be bound in book form, it is suggested that standard sizes be adopted for all drawings, whether they be for public sewers, storm sewers, streets or bridges. Similarly, in so far as practicable, it is recommended that the same scales be used in all cases and an uniform arrangement of the drawings as to position of profiles, plans and title be adhered to. It is also an excellent practice to have the drawings not only initialed by the draftsman and checker as is now done, but also signed both by the division engineer and city engineer in order to show that they have been officially approved.

23 – It is also suggested that the titles for all drawings be printed from type rather than by hand. Sufficiently workmanlike titles can be obtained in this manner at a lower cost and the draftsman's time can be utilized to better advantage on other work.

24 – Also if the present practice of inking in all originals, rather than using tracings as file copies, seems preferable, the installation of a Photostat for making duplicates would be found invaluable. With its installation innumerable uses for the Photostat would develop rapidly, and undoubtedly extensions of service to other departments would follow automatically. At any rate it is urged that the present practice of taking original drawings into the field be stopped.

The laying out of all plans and profiles on the basis of 100 feet stations in addition to the present practice of giving lot widths is recommended. Two or three plans prepared in this manner were noticed, but there is evidently opposition to this change because it is an innovation. With the general adoption of this method of preparing plans, not only the draftsmen and estimators will be benefited, but inspectors will find the plans much more intelligible and the work of the field parties in giving line and grades will be facilitated.

26 – It is also noted that it is the practice to carry invert grades through changes in the size of sewers, changes in size being made in the arch rather than in the invert. As it is the hydraulic gradient that is the controlling factor in determining the flow in combined sewers, under the method of design used in Detroit either the sewers cannot flow full, or if full, must run

under pressure. A better practice is to make such changes of size in the invert. There may be conditions in portions of Detroit which make the adoption of such a method impracticable. Also if the depths of sewers at the upper ends are made close to the minimum allowance, this change in the method would increase the depth of excavation. On the other hand, instances have been noted of sewers under construction where change of size could have been made in the invert by breaks, and at the same time excavation quantities would have been reduced. The adoption of this change is not urged as final, but it is suggested that the matter be carefully considered by the City Engineer.

27 – In field inspections of the construction of storm sewers and catch basins, it was found that long stretches of storm sewers were constructed to connect up with perhaps one or two storm inlets. The necessity for some of this construction work was not evident. It appears that the fixing of the street grades with the selection of summits and valleys is based largely on the elevations of existing structures, little attention being paid to the most economical method of drainage. While conformance to existing conditions of abutting property is necessary in order to avoid both complaints and damage suits, it would seem that a more careful layout of street grades might reasonably satisfy existing conditions, and also reduce the work of storm sewer

construction, thereby saving the city annually a considerable sum of money.

28-29 – Further, in connection with the preparation of plans, the present practice of preparing pencil sketches on odd slips of paper in lieu of carefully prepared plans for the construction of storm sewers should be corrected immediately. With the completion of these sewers no records are filed, and, consequently, there are miles of sewers constructed in Detroit, the existence and details of which are contained only in the heads of them men who constructed them. Over thirty miles of storm sewers were constructed during the year 1915 in this way. The reason for this condition, as well as other points noted, is undoubtedly due to the lack of a clean-cut organization in connection with the design of sewers, this work being left to various draftsmen who may be delegated to the work as the City Engineer sees fit. While there may be an apparent economy in such elasticity within the drafting force, when careful and constant supervision of the design of sewers is sacrificed to this elasticity, there is no question that the net results are decidedly expensive.

30 – The design of sewers in Detroit is based on the Burklizeigler formula, in which the intensity of rain fall is assumed as two inches per hour, the slope of area drained as

two feet in 1000, and the percentage run-off for the character of surface drained varying from .6 in the suburbs to .8 in the downtown districts of the city. This is an old formula for the estimation of storm water flow, but is still used in many cities with apparently satisfactory results. The City Engineer states that the sewers in Detroit are generally adequate, but on the other hand, the Sewer Engineer is of the opinion that many of the sewers are overloaded. Certainly, it is probable that lateral sewers which were adequate for the conveyance of domestic sewage and roof drainage, have been overloaded by the connection of numerous catch basins or gutter inlets made necessary by the rapid development of the city.

31-32 – Seldom after sewers are designed is little attention paid to their operation for the purpose of checking the accuracy of the methods of design. But, as in all other branches of engineering, there has been an advance in the method of sewer design during the last thirty years. It is therefore suggested that a careful study be made of a compilation of rainfall records extending over a long period of years, and that from these data the present method of design be checked by the so-called “rational method”. Further, records should be brought up to date showing such essential factors as size, depth, and slope of all existing sewers, including storm sewers. With this information available it is recommended that a comprehensive system of sewerage be

planned, looking both to extensions to keep pace with the rapid growth of the city, and to the collection and ultimate treatment and disposal of sewage.

CHARACTER OF CONSTRUCTION.

In general, the quality of construction work inspected was found to be poor and not in accordance with specifications. There was one exception to this general characterization, namely, brick work in tunnel contracts on the Morrell Avenue sewer. It should be also added that all manholes inspected seemed to be well built and in accordance with the specifications.

The pipe laying inspected was extremely poor. No attempt was made to lay the sewer to a true line, and only roughly to grade. Bellholes for pipe were not excavated, and consequently, the pipe was improperly bedded, if it was bedded at all. If, in bringing the pipe to grade, it was necessary to raise the pipe, this was done by blocking it up with lumps of clay, of course leaving the barrel of the pipe without a bearing. No mortar was placed at the bottom of the joints and very little in the joint below the springing line of the pipe. In placing the mortar on the top of the joint, no effort was made to force mortar into the joint. Several pipes just laid were inspected inside, and were found low at the joint and usually the joints were open at the top. In fact, the only operation which seemed fairly well

performed was the backfilling in open cuts. Even in this only ordinary care was taken in tamping around the sides of the pipe. On one contract in lowering the pipe into the trench, the pipe just laid was used as a buffer, constantly breaking the joint. As a rule, the line of the trenches was so irregular that the pipe hugged either one side or the other of the trench, making a close-fitting and well mortared joint or backfilling under the pipe impossible. Summing up, the pipe laying was extremely poor, and practically every clause in the pipe laying specifications was broken.

As a rule, the backfilling inspected was fair and some was very good. In one case in an alternate cut and tunnel job for a pipe sewer the work was so handled that good backfilling was impossible. Exceptional cases may arise where occasional short tunnels for pipe sewers in shallow cutting are unavoidable, but best practice dictates that the use of such tunnels should be limited, and when used, the tunnels should serve simply as braces for the trench and should be so short that they can be easily and completely backfilled.

33 – On certain contracts, particularly on pipe sewers where excavating machinery made the rate of progress rapid, there were not sufficient inspectors assigned to the work to provide proper supervision. While of course it is highly commendable to

keep down the cost of inspection wherever practicable, it is not economy to do this at the expense of the quality of the work obtained.

34 – Conversation with various inspectors as well as the Chief Inspector, and the General Superintendent of the Sewer Department, disclosed a not unexpected condition, namely, that in the performance of routine work over a period of years, the entire work of sewer construction had apparently slipped into a rut. It might be assumed that because of this long period of experience, methods were well standardized and inspectors informed as to the requirements of the specifications. It is apparent, however, that this is not the case, and the necessity for some form of school of instruction for inspectors is evident.

35 – It is plain that the work of sewer construction would benefit from a decided toning up. The reasons for present conditions may be traced to two sources, — laxity of supervision, and political influence in the selection of inspectors. Both of these conditions can be remedied, — the first easily, as both the Chief Inspector and the Sewer Engineer seem open to suggestions. The second, elimination of political influence in the selection of inspectors may not come so easily. However, first-class inspectors, subject to discipline without

question or interference from outside forces, are absolutely essential if good constructive work is to be secured.

TESTING OF MATERIALS.

Little attention seems to be given the quality of materials used on the work. In fact, the specifications themselves are none too explicit as to terms under which various material will be acceptable to the city, and laxity in inspection of materials is to be expected. For example, — no limit of absorption is placed on sewer brick; gradation of sand is not specified; and the maximum size only is fixed for broken stone or brick for concrete. The cement specifications are those of the American Society for Testing Materials.

36 – However, with regard to the inspection of cement there is no means of tracing the cement tested through to the job on which it is used. In response to the specific question “is this cement tested?” put to several inspectors, including the Chief Inspector, the most definite answer obtainable was “I suppose so, —there is a cement tester down at the City Hall”.

It is the practice for the cement tester’s assistant to take samples upon notification by the contractors that the car is on the siding. The cement is then removed to a warehouse, little attention being paid to the stacking of it so that it can be

identified by the number of the car from which it was unloaded. As a matter of fact, no cement has been condemned by the cement tester for several years, but were he to condemn any cement, unless he did so before it was removed from the car, it would appear difficult, if not impossible, for him to separate the condemned cement from the other cement stored in the warehouse. Even were the cement tested and rejected on the job and removed from the job, because of lack of means of identification, there could be no assurance that the condemned cement was not returned and used in the work.

The present value of the cement tester lies in the fact that he serves as a very imperfect check on the manufacturer of cement. There is no check whatever on the contractor to prevent him from using condemned cement or cement which has not been tested. It is conceded that the process of cement manufacture has become well standardized during recent years. Cement plants are conducting routine tests of their own product, and the necessity for further tests may be questioned. It is doubtful, however, if any competent authority on the subject can be found who would recommend doing away with the testing of cement and the use of some system which guarantees that the cement used in the work is the cement tested. It is admitted also that unless the city actually furnishes the cement used on public

work, a system of absolute check on all cement used would not be easy to maintain and would be expensive. Recognizing these conditions, the Detroit situation with respect to cement may be summarized: — If the sole value of the city cement tester is to serve as a check on the manufacturer, this can be secured by testing the cement at the mills through the agency of some reputable testing laboratory. Either the testing and inspection of cement should be thorough, or it should be declared unnecessary, and the position of cement tester should be abolished.

As to the testing of brick and sand for sewer construction, the Detroit practice of sizing up the materials and inspecting them without tests is not at all unusual. The difficulty with this practice is that standards based solely on “experience” may not be well founded. Also such standards vary and may be unconsciously lowered unless occasionally checked up and revised by means of tests.

In order to get a line as to quality of materials used, samples of cement and sand were taken from four contractors, and samples of brick from three, and these were tested by the Perry Testing Laboratory. The results of these tests, attached, show that in all cases the cement was up to standard. The sand was uniformly too fine, but the mortar tests have good results,

particularly so considering the character of the sand. The brick was high in absorption and both in absorption and compression did not meet the requirements of the American Society for Testing Materials for "hard-burned" brick, as called for by the Detroit specifications.

Because a sewer does not "fail" in the sense that it does not collapse or deteriorate at an alarming rate, is not proof that it was well constructed, nor is it justification for carelessness in the acceptance and use of materials. If it were true that sufficiently satisfactory results can be produced with inferior materials and workmanship, then specifications should be revised accordingly so that the city would receive the benefit in reduced prices.

Nor is it conclusive to say that the materials used are the best that can be obtained in the locality. If the materials are plainly of an inferior quality, it is better to pay the price, and go elsewhere and obtain satisfactory material. But as a matter of fact, this may not be necessary, as it is not at all improbable that strict specifications would raise the quality of materials available. "It would not be fair to make no differentiation between a well-made and burned product and an inferior one, as is now the case in many places where the average contractor looks more to cheapness than quality. By recognizing quality,

and thus offering the possibility of a better price for better products, an incentive is furnished the manufacturer which is lacking at the present time”.*

* Materials of Engineering Construction – International Engineering Congress 1915 – p. 167 – “Clay Products as an Engineering Material” by A. V. Bleininger, Bureau of Standards, U.S. Department of Commerce, Pittsburgh, PA.

37-38 – Occasional, if not regular, testing of all materials accompanied by explanations to inspectors of results found, would have a very beneficial effect in improving not only the quality of materials used, but in raising the entire standard of construction work. When such tests are not made, there is a tendency to feel at ease and assume that everything is proceeding properly. The installation of a thorough system of testing and inspection of cement and all other materials by the city is favored and further it is tentatively suggested that as part of any reorganization of the Department of Public Works, there be created a Bureau of Tests, under which can be grouped the duties performed by numerous employees, such as the Cement Tester, and the Gas, Meter, Sand, Lumber and Material Inspectors.

REVISION OF SPECIFICATIONS.

The Detroit sewer specifications have merit in their brevity. However, specifications should be specific, even to the sacrifice

of brevity. "The excavation to be made ***** of such width *** as may be necessary," leaves too much for discussion between foremen and inspectors. It is sufficiently broad, but it is not specific. As a matter of fact, the trenches for pipe sewers which were inspected were not as wide as was "necessary" for a proper performance of the work.

On the other hand, the specifications contain numerous "requirements" to which little or no attention is paid. For example, — take the first paragraph of specifications entitled "Excavation". In addition to the above the specifications on width of trench there are the following requirements, "if through any cause the excavation is made deeper than is necessary, the contractor will at his own expense, refill to the proper grade with brick, masonry or concrete *****". In no case without special permission, shall the excavation of trenches be more than 200 feet, nor less than 50 feet in advance of the masonry. When trenching machines are used, that portion of the trench below the springline must be excavated and bottom formed by hand". No instance was found in which excavation below grade was being refilled with anything other than the excavated material. Also very little attention seemed to be paid to the amount of trench open ahead of the masonry. In fact, in one trench inspected on which an excavator was used, the buckets of the excavator were within two feet of the last

pipe laid. On this same contract, the inspector stated that although occasionally the machine dug below grade, he tried to keep it from digging below an elevation of three to four inches above grade. As an 18" pipe was being laid, according to the specifications the machine should not have been allowed to operate within at least 9" of the invert grade of the pipe.

39 – Similarly, many of the important paragraphs in the specifications can be analyzed and numerous “requirements” found which are not enforced. It is urged that if the specifications are not sufficiently specific, this should be rectified; if not enforced, they should be enforced; or if certain requirements are considered unnecessary, these should be eliminated so that the contractor can bid on specifications which mean what they say.

In this connection, the following quotation from a paper on “Municipal Inspection Methods in the Borough of Manhattan”, is pertinent. “The keynote of these instructions is alertness, courtesy, tact, and last but not least, strict compliance with the specifications. As far as the inspector is concerned, he must enforce them not only in spirit, but to the letter. A little lee-way here and a little lee-way there, and inspection soon becomes a farce. This insistence upon strict compliance with the letter of the specifications implies that these have been drawn with the

utmost care and utmost fairness. It means that non-essentials have been eliminated and that, where definite limits have been established, these are as liberal as is compatible with safety and good work”.*

40 – A complete revision of the specifications is recommended, and in this connection there is suggested for consideration the advisability of extending the proposal sheet to include such items as “sheeting left in place”, “gravel re-fill”, etc. The necessity for such work cannot be estimated by the contractor and his bid “per lineal foot”, sewer complete”, must be sufficiently generous to cover such contingencies. If they do occur, the city pays for what it receives. If they do not occur, the city loses. Or, if the contractor under-estimates the necessity for such work the city gains at the contractor’s expense.

41 – Sewer construction being sub-surface work, is to a large extent a gamble. It is money in the pocket of the city to eliminate, in so far as is practicable, all elements of chance, and for this reason in addition to the preceding suggestion it is recommended that borings or test pits along the line of proposed sewers be made to the depth of sub-grade, in cases where such

* American Society of Municipal Improvements – Proceedings of the 1915 Convention – p. 264 – by Felix Kleeberg, Chemist Department of Public Works, Borough of Manhattan, New York City.

information would be of value. Samples of the materials removed from these borings can then be placed on file for examination by the bidders and the results of the borings indicated on the contract plan.

42 – Under the present practice in the construction of sewers, it is difficult to see how an outside contractor can bid intelligently or closely on this work. By an outside contractor is meant not necessarily an out-of-town contractor, but one who is not closely in touch with the city employees in charge of sewer construction work, and accustomed to their methods. With a total lack of information concerning sub-surface conditions, only the contractor who has had wide local experience in sub-surface work can bid at all intelligently. Add to this condition, specifications loosely drawn and more loosely enforced, and filled with clauses which may or may not be enforced, and there exists a difficult situation. Either the contractor must assume that the specifications will be rigidly enforced and bid accordingly, or in order to compete with contractors who understand that various clauses in the specifications will not be enforced, he must anticipate non-enforcement of the specifications. The contractor who bids on this basis and who finds that he is required to do his work in accordance with the specifications, must either abandon his contract or carry it out at a loss and will not be at all likely to bid again on city

contracts. Specifications should be so drawn and uniformly enforced that there can be no just grounds for a charge of favoritism.

A superficial examination of published bids does not indicate that the cost of sewers is excessive were first-class work obtained. But it is difficult to compare construction costs in different cities because so many variable factors are involved and before the local costs can be analyzed, further data on Detroit sewer contracts is needed. However, were the specifications enforced, it is not improbable that bids would be higher. On the other hand, if, along with a rigid enforcement of carefully revised specifications, supplementary information were supplied, so that any contractor would be enabled to bid intelligently, there could be expected a keener competition with a corresponding drop in prices and far better workmanship.

TABLE 1

TESTS OF CEMENT AND MORTAR

Tensile Strength — 1 lbs. per sq. in.

<u>JOB</u>	<u>CONTRACTOR</u>	<u>Neat</u>		<u>Ottawa Sand</u>		<u>Job Sand</u>		
		<u>1 da.</u>	<u>7 da.</u>	<u>7 da.</u>	<u>28 da.</u>	<u>7 da.</u>	<u>28 da.</u>	
14th & Lothrop	Wm. Porath	554	678	694	306	334	268	350
Morrell Sec. 8	J.A. Mercier	452	588	650	234	264	236	356
Morrell Sec. 9	Wm. Porath	504	676	718	250	296	224	214
Tuxedo, Sewer	Apfel & Jeynes	430	606	714	224	260	226	312
Standard Specifications		175	500	600	200	275	140	102

NOTE:

Samples satisfy standard specifications for fineness, specific gravity, constancy of volume, and time of setting.

Standard specifications of American Society of Civil Engineers state: "If the strength developed by the aggregate in the 1:3 mortar is less than 70 per cent of the strength of the Ottawa sand mortar, the material shall be rejected."

TABLE 2
TESTS OF SAND

<u>JOB</u>	<u>CONTRACTOR</u>	<u>Percent passing sieve</u>			
		<u>No. 4</u>	<u>No. 10</u>	<u>No. 40</u>	<u>No. 100 No. 200</u>
14th & Lothrop	Wm. Porath	100.0	98.0	76.5	2.2 0.7
Morrell Sec. 8	J.A. Mercier	97.9	88.1	54.0	5.5 1.5
Morrell Sec. 9	Wm. Porath	100.0	99.3	72.3	4.0 1.0
Tuxedo, Sewer	Apfel & Jeynes	99.2	93.6	56.8	4.4 0.8

NOTE:

Detroit sewer specifications require "clean, sharp, and sharp and well-screened bank or lake sand". Grading of sand is not specified unless "well-screened" is stretched to include grading.

Sanford E. Thompson, in paper on "Concrete Aggregates" presented at International Engineering Congress, 1915, states that for sand "Tests indicate that best percentages passing a No. 40 sieve may range from 18% to 27%".

A common specification for good practice is "All materials referred to as sand must pass a No. 40 sieve. Not more than 20% should pass a sieve having 50 meshes per lineal inch, and not more than 5 per cent should pass a sieve having 100 meshes per lineal inch."

TABLE 3

TESTS OF SEWER BRICK

<u>JOB</u>	<u>CONTRACTOR</u>	<u>Compressive Strength Pounds per sq. inch.</u>	<u>Absorption of Water per cent by Weight</u>
Tuxedo, Sewer “	Apfel & Jeynes “	3033 2600	19.02 21.37
Morrell Sec. 9 “	Wm. Porath “	2330 2033	20.51 22.03
Morrell Sec. 8 “	J.A. Mercier “	1847 1705	23.16 23.44

NOTE:

Detroit sewer specifications require “bricks of the best quality of hard-burned bricks, burned hard entirely through”. No limit of absorption is specified.

The American Society for Testing Materials specifies for “Hard-burned brick, average compressive strength 3500-5000 pounds per square inch; average absorption not more than 12 per cent”, and for the next lower grade “Common brick, average compressive strength 2000-3500 pounds per square inch; average absorption not more than 18 per cent.”