REPORT AND DOCUMENTS

ON THE

PRESENT STATE, AND THE IMPROVEMENT

OF THE

WASHINGTON CITY CANAL.

WASHINGTON:
R. A. WATERS, PRINTER.
1865.

CORRESPONDENCE.

MAYOR'S OFFICE, *May 15th*, 1865.

To the Board of Aldermen and Board of Common Council:

GENTLEMEN: I submit herewith the report of the Civil Engineers appointed under the act approved September 23, 1864, entitled "an Act authorizing the Mayor to employ an Engineer to examine the plans proposed for the improvement of the Canal."

Very respectfully,

RICHARD WALLACH, *Mayor.*

WASHINGTON, *May 14th*, 1865.

HON. R. WALLACH, *Mayor.*

SIR: Obedient to your instructions, embodied in a letter dated December 6th, 1864, a copy of which is annexed hereto, we beg leave to submit the enclosed report on the subject of the Washington Canal, and the ponderous questions which present themselves, upon touching this problem so long discussed in our community.

Our convictions have been matured during a lengthy study of all the details of the questions, now so imperatively calling for a speedy and satisfactory solution, but, if contrary to our expectations, our efforts to combine great economy with efficiency should not meet the approval of your honor and the honorable bodies for whom it will be finally to decide, then we hope to have furnished all the preliminaries and data for treating this subject hereafter, with a full understanding of all the points involved.

We have the honor to be

Your most obedient,

CLUSS & KAMMERHUEBER,

Civil Engineers.

MAYOR'S OFFICE, CITY HALL,
Washington, D. C., Dec. 6th, 1864.

MESSRS. CLUSS & KAMMERHUEBER,
Architects and Engineers:

SIRS: In conformity with an act, entitled "an Act authorizing the Mayor to employ an Engineer to examine the plans proposed for the improvement of the canal, &c., and approved September 23, 1864," you are hereby appointed for the purposes of the aforesaid act, and will consider yourselves duly authorized to examine the several plans proposed for the improvement of the Washington Canal.

You will make such investigations, scientfic researches and estimates, and do such surveying as will be necessary to enable you to fully point out the peculiar advantages of each of the several plans submitted; to compare the special merits and cost of the same, and then to report in due time thereon.

A resume should be annexed to the report, giving your specified opinion which of the plans proposed will, if carried out, secure the most advantages to the city, and improve the canal permanently, or whether, by a combination of the peculiar merits of the several plans, anything can be gained, and what you propose in that respect.

To this end, the several documents submitted by the different parties are handed over to you, and you will be furnished by the proper city officers with all such data at hand, and with information relating to the topography of the city, the grade of the streets, levels and dimensions of drainage and sewerage, as may be necessary to enable you to come to the respective value of the plans proposed in connection with the present and future drainage and sewerage of the city, and which may facilitate your task in general.

Very respectfully,

[Signed,] RICHARD WALLACH, *Mayor.*

REPORT

ON THE

PRESENT STATE, AND THE IMPROVEMENT

OF THE

WASHINGTON CITY CANAL.

Original state, course and extent of the Canal.

The Washington Canal commences at the boat lock of the Georgetown Canal, near the foot of west 17th street, forming a large triangular basin, called "Mouth of Tiber creek;" between that street and West 15th street it runs from the eastern extremity of that basin along North B street to a point between West 7th and 6th streets. The distance from the boat lock to the last named point, is about 5,200 feet, where it takes a southern course for a length of 775 feet, when it assumes again an eastern direction, on a lineal extent of 1,570 feet, till striking West 3d street. At this point it turns to the south, down to Maryland avenue, traversing a distance of 623 feet, and there it bends off towards the southeast for a length of 2,365 feet, until it reaches south Capitol street, along which street it runs down for a distance of 705 feet, to a point below Virginia avenue. Now, it follows again a southeastern direction for a length of 1,988 feet, until crossing East 2d street. Here it takes a southern course down to the Eastern Branch, for a distance of 2,100 feet, where it terminates. The lineal extent of the Canal, therefore, is about 15,330 feet.

In its course it has the following bends, repectively, sharp corners.

From the	East	towards	South	under an	angle of	90°
"	South	"	East	"	"	90°
"	East	"	South	"	"	90°
"	South	"	South E.	"	"	133°
"	South E.	"	South	"	"	133°
"	South	"	South E.	"	"	122°
"	South E.	"	South	"	"	122°

The breadth of the Canal at the eastern extremity of the basin, down to West 7th street, is about 150 feet, still widening at the first bend. This part of the Canal is narrowed by several bridges to 90 feet. From the first bend down to Maryland avenue, the Canal is 70 feet wide, and from here down to South N street, it is only about 40 feet wide, which width is narrowed below the bridge across New Jersey Avenue to 19 feet. South of South N street, it forms a basin of about 100 hundred feet in width.

The sole of this Canal was originally 4 feet below low water, and either strictly level, or it had a very small fall from the west towards southeast.

Velocity of flow of water in the Canal.

Let us consider the laws according to which the water moved in the Canal whilst in its normal state, that is, the *velocity of the currents*.

Exact and careful surveys and observations, instituted last winter under our directions, have established the fact, that at low water, after the influence of the tide on the Potomac as well as on the Eastern Branch has ceased, the level of the water at the foot or southeastern end of the Canal stood in the mean 0.61 feet (seven and a half inches) below that at the western end, when measured simultaneously.

The actual velocity which the water in the Canal in its normal state and with the above *virtual declivity*, that is, the declivity of the surface of the water in the canal, may have had, cannot be established at present by direct measurements, since the upper and the lower half of the Canal at low water are completely separated by deposits of sand and mud, and in part by artificial dams built across it, as for instance at 3d Street and at Maryland avenue. So much, however, is sure, and can be computed by reliable mathematical formulas, that their velocity was relatively very small, in consideration of the great number of sharp bends, the often changing width of its bed, and with the very small virtual declivity.

And it is only at the time of low water that a maximal velocity of the currents in the Canal in its *natural direction*, i. e. parallel with the flow of the water in the Potomac river, can take place.

Tide.

Now, we shall discuss the influence of the tide on the Canal as well as on the Potomac.

The difference between mean low tide and mean high tide, is, according to the data of the U. S. Coast Survey, for which we are indebted to Charles Schott, Esq., in

charge of Computing Division, 2.9 feet. The highest spring tide, however, rises sometimes 5.8 feet above mean low water line, whilst the lowest low water observed is 1.9 feet below mean low water mark. The influence of the tide, therefore, is of utmost importance for the flow of the water in the Canal, and it is necessary, sharply to define and to illustrate its effects.

It is generally known, that the rise as well as the fall of the tide requires each about 6 hours. The rise of the water as well as its fall, in so far as the whole phenomenon passes over regularly, starts out with a gradually increasing, and ends with a slowly decreasing velocity, so that the current is most intense at half tide, viz: low tide having culminated, we have a period of rest, or *slack-water* for about 15 minutes, after which the water rises with a velocity, first increasing then decreasing, till high water has fully set in, when we have again slack water for about 15 minutes. From this time the waters subside, at first with gradually increasing, and towards the end, with slowly decreasing velocity, as above, till low water is reached, etc.

Direction of the currents.

But before the actual rising tide-water in its upward movement can reach the foot of the Canal, the level of the Potomac has risen, since the free discharge of water at its mouth is counteracted by the entering flood-tide, and a swell is produced forming a so called *back water*, subject to the identical laws, as if a weir or dam was laid across its mouth. Back water is the effect produced by the elevation of the water level in the pond close in rear of a weir, upon the surface of the stream at places still further up its channel.

Thus the water rises in the Eastern Branch at the foot of the Canal, and in the Potomac at the head of the Canal, about 17th street nearly simultaneously and the consequence is, that tide water enters the Canal from the south at the same time when the back waters of the Potomac enter it at the western end. At that period, therefore, we have two opposite currents, both directed towards the centre of the Canal which has been adduced and verified by our observations.

As the flood tide progresses the back waters of the Potomac are again displaced from the Canal in an opposite or western direction until high tide has culminated.

In this last period we have, accordingly, a more or less rapid flow of the water in the whole length of the Canal, from the foot towards its head near West 17th street.

Then, slack water for 15 minutes, until ebb tide sets in, when the water, first very slowly, then somewhat faster, and at last, following the laws of the virtual declivity, flows from 17th street towards the Eastern Branch.

It is shown, we have to discriminate between three periods. In the first, that is, before flood tide sets in, the water flows from west towards southeast, obedient to regular hydraulic laws. In the second, that is, just after the tide has commenced to rise, the water flows from the west towards southeast and from south towards northwest, simultaneously towards the center, and in the third, the current is from south towards northwest for the whole length of the Canal, when it will commence again an opposite course, after this period has elapsed.

In order not to overrate the velocity of the current produced in the Canal by the action of the tide, it may suffice to state, that a swimming body, confided to the water near 4½ street, at the time when the flood waters commenced to overcome the back water of the Potomac in the Canal bed, for the whole duration of the westerly current, that is within nearly 4½ hours, moves over the great (!) space to about 17th street, that is, about 0.5 feet per second, and is then carried back by the ebb tide to its starting point.

We have enlarged upon these elements of our problem in order to be able:

Conclusions.

1. To explain the present state of the Canal with their aid.

2. To base on them a recommendation for changes in the profile, and as far as is practicable, in the longitudinal direction of the Canal.

3. To illustrate lucidly the errors or misapplication of otherwise correct principles, in some of the proposed plans.

4. To lead the argument for those propositions, to regulate and permanently to keep clean the Canal which offer most advantages, practically and economically.

Present state of the Canal.

The present state of the Canal was characterized very tersely by Col. S. Seymour, Engineer in chief of the Washington aqeuduct, in his report of April 26th, 1864, and has indeed not been improved by the experiments made since that time. On the contrary, it may be asserted, that nearly a year's tribute of gravel, sand, animal and vegetable sediments has been added to the deposits of many previous years. On that account we

pass over a more detailed description and turn our attention to the investigation of those causes which produced a state of things so lamentable and so dangerous for the sanitary condition of the city. Thus we shall find the key for permanent remedies.

The waters of the Potomac, and even the tide water, both of which form alternately the contents of the Canal, are pure. Therefore, the rate of the velocity of its currents would not appear to be of great importance for a permanent improved condition, consequently it would be of no account, that its profile was enlarged or narrowed down at certain points, or that its course was deviating under several sharp angles. But since plenty of mineral, animal and vegetable matter, solid or in a state of solution, are discharged into it by a number of artificial and natural water channels and sewers, and have been so discharged for a number of years, it is evident that in consideration of the small velocity of the currents in the Canal, and their ever changing course and intensity, these solid matters form deposits, and that the animal and vegetable matters in solution, or swimming on the surface, are carried to and fro within the limits of the Canal, respectively within the limits of the city, until decomposition and putrefaction take place, and so far have taken place.

The results of these collections of sediments are portrayed in nearly all the plans and reports that have been referred and present themselves up to this hour to anybody, personally inspecting the Canal.

Cause of the sediments.

The cause of the sediments in the Canal must be ascribed, therefore, to its irregular course, unequal width, small declivity and to the influence of tidal action. The unequal width and the tidal influence are the only elements of those just enumerated, which it is within reach to remove entirely. The former can be regulated, either by enlarging the narrow sections, or by narrowing the widest sections, of which, of course, the narrowing is the most practicable. The latter might be stopped by gates or locks at both ends, which, however, is of no material advantage, as will be proved hereafter. The irregular course might indeed be partly improved by rounding off the sharp bends. Whether this is necesary will be illustrated at the proper time. The small declivity cannot be increased under any circumstances.

Sediments.

The sediments themselves consist to a greater part, of mineral matter. They are brought into the Canal by

Tiber Creek, by divers other natural channels, and by the rain water, in shape of pebbles, gravel, sand, dust and mud, and originate from the irregular beds of the creeks as well as from the streets, yards, and public squares of the city, most of which are not paved. The rest, or smaller part of the sediments, consist of the offal of kitchens, and of the soil and filth from water closets which are brought in by the sewers discharging into the Canal. We give only a passing notice to carcasses of all kinds, from the bloated horse to the skeleton kidden which have found their way in the Canal by divers modes.

These putrescent and decomposing organic matters deposited on and between the mineral layers, cement the latter, the more so, since they are exposed to the influence of sun and air whenever the tide is not very high. Deposits of this kind are so tough and viscous that they cannot be removed by the currents of flowing water, since these would rather wash out the sole or bed of the Canal on places permanently covered with water, consisting therefore of more soft and moveable material, and also would further wash out the earth in rear of the dry walls forming the Canal borders, and finally overthrow them.

The experiments of retaining tide water by gates until low tide, when the whole body was discharged by opening these gates and thereby to produce an artificial current which was to sweep the sediments in front of the gates have, indeed, but partly confirmed the above adduced and evident objections against the process of washing or flushing out the sediments from the Canal; but, the current produced by these means was in fact too insignificant to carry away the ground in rear of the dry walls, and to effect what was intended, namely, to remove the sediments. Instead of this it has simply stirred up and dislodged for a distance of a few hundred feet, *some* of the mud from the deeper spots of the Canal permanently covered with water, and has dug some gullies immediately in front of the gates.

The Canal which, for years past, has not been navigable uninterruptedly from one end to the other, is, at present, but a receptacle for the washings of creeks and gutters and of the contents of the sewers. But, even for those purposes, it is about not to be serviceable any longer, since the mouths of most of the larger sewers are filled up for the better half of their heights. The cleans-

ing, even without regard to ulterior purposes, has therefore, become an absolute necessity.

Cleansing.

To accomplish this first purpose, the cleansing, different means have been proposed in the plans before us. They may be divided in two classes, namely, in the removal of the sediments by currents, artificially produced in the Canal, through the medium of the tide water or the water of Rock Creek, and further, in their removal by dredging or excavating.

The first class comprises the plans of William Thomas, J. Dennis, partly of M. Bishop, and of George W. Frankland.

The second class comprises the proposals of William Wise, and in part of P. H. Donegan.

Wm. Thomas' proposals.

The sediments in the Canal have reached such a mass and are so consolidated, that even a most powerful and *constant* current could only remove them in part and after long continued action. It cannot be doubted that a current strong enough to stir up such masses, and to move them forward through the whole length of the canal would underwash and bring down the dry walls forming the borders of the Canal. But even if we dont speak of that, it will be admitted, that the whole mass of sediments would be carried to, diffused and deposited in the Eastern Branch, where it would have to be removed artificially and at greater expense, in order not to obstruct the navigation.

The main point however is, that, by stowing tide-water between gates, no such current can be produced, not even for the shortest space of time, as would be equal to the task of moving for a considerable distance any deposits, in case they do not consist of loose mud of small specific gravity, saturated with water and which was never before consolidated into a dry mass by the action of sun and air.

Indeed, the principal effect after the gates have been thrown open, consists only in stirring up the ground *immediately* in front of the opening, and the main current passes from there upwards towards the surface and towards the centre line of the channel. (See fig. 1.)

But if the deposits should be moved forward in any way by these means, it would be necessary to move the gates or locks forward in an equal proportion, respectively, to take them down and build them up at other places. The mass of water (about 3 feet above low water, and as the deposits are on some places 2 feet above low water,

therefore only 1 foot above the deposits to be removed,) is so small in proportion to the length and capacity of the area to be cleansed, and it being an impossibility to repeat the operation more than once in every 12 hours, it would take years with such expensive proceedings to do away with the *current additions* to the deposits., without even touching those of a long standing.

Mr. William Thomas adduces, as a parallel, and in order to give a striking foundation to his proposal, the case of the Mississippi river which has a current of 4 miles per hour with a fall of 8 to 10 inches. To draw a parallel between the Mississippi river and the Washington Canal appears, to say the least of it, rather a hazardous enterprize; for, besides the immense difference between their profiles, it must be considered that the water in a river acts on its bed with a constant velocity, permanently and in one direction, whilst this action can be produced in the Washington Canal only at intervals, for short spaces of time and with a very small intensity.

Mr. William Thomas further refers, at the end of his letter, dated, February 19th, 1863, to "Fall at Louisville 22 feet in 3 miles," and calculates that with "3 or 4 feet fall at low water," our case be "about" equal to that of Louisville. It appears to have been overlooked that Mr. Thomas can work only with a limited and comparatively very small mass of water which has been stored up, that this escapes from the very instant when the gates have been opened, that is, decreases in quantity which diminishes the fall gradually until it disappears altogether after a few minutes have elapsed, whilst new masses of water come forward constantly at Louisville, so that the current remains constant.

About the application of deflectors, as proposed, we state: This plan for cleansing the Canal basin is, as Mr. Thomas says, certainly not new, it has been known, even long before the "Encyclopedia Britanica" was printed, since the old Egyptians and Romans made use of the same principles when regulating their rivers. As is still done in our days, these historical nations used so called *deflectors*, for altering the currents in larger rivers, for protecting the shores of rivers against washings, and for deepening the beds of rivers by the action of the rivers themselves. To apply the same principles, in so diminutive a scale of things, must be styled an expensive and time killing sport. In cases so radically different, one and the same medicine will never do.

A few words more may be necessary in relation to the application of flood gates: If these shall be of any practical value in removing deposits they have to be constructed on principles quite different from those alluded to in the plans before us. The wings of the gate should not turn on a vertical axis, because, by this mode a central, vertical, gradually widening slot is produced, (see fig. 2,) through which the water flows amidst in the Canal, along its longitudinal axis, and with a gradually decreasing velocity, by which action a certain quantity of deposit is, or may be stirred up simply in this direction. A small part of this is rushed forward, whilst by far the greater part is deposited again by the sides and in the rear of these wings into the *calm* layers of water there found.

If, on the contrary, the gates would be so constructed, that they can be raised vertically, (see fig. 3) in whole or in sections, so that the water from the receptacle must discharge at the sole of the canal, and along the whole width of the raised part simultaneously, then the pressure of the water above the horizontal discharge sheet, would compel the latter to act equally on all deposits for the whole width, and to move them forward, if their nature and the hydraulic pressure that can be obtained, does admit of it at all. But even this mode of operating flood gates, does not appear to be advantageous in our case.

The preceding remarks have reference to those plans which have in view a cleansing of the Canal by storing the tide water.

J. Dennis proposes to give the current of the Canal, permanently, one direction. This view is perfectly correct, on the hypothesis that the velocity of the water is constantly great enough to keep the foreign substances in motion, since these would then be moved, sooner or later, from the bed of the Canal. But this velocity is in fact so small and cannot be increased essentially by artificial means, locks, that nothing but matters in solution, suspended within or swimming on the water could be carried off that way. If we further consider that no organic matters shall find an outlet in the Canal in future, it would appear that the means which Mr. Dennis proposes for accomplishing his purposes, are not only superfluous, but even disadvantageous, since all gates and locks prevent the free and untrammelled navigation. J. Dennis.

Martin Bishop finds the true cause of the deposits in the M. Bishop.

Canal in its sharp bends and varying profile as well as in the slow current, and endeavors especially to improve the latter by "securing a good portion of the current of the Potomac by extending the Canal up stream." Leaving the question untouched, by which means and at what expense this extension might be executed, it is impossible to conceive how an increase of the current could be obtained hereby without deepening the sole of the *whole* Canal to the level of the sole of the Potomac at that point where the current should be "secured," which can hardly be intended in earnest. Otherwise the sole of the Canal would form a high plateau, both ends, up stream and down stream, would form valleys below, and it is well known that the water has no particular predilection for flowing up hill.

G. W. Frankland.

In relation to the proposal of Mr. George W. Frankland, we have to mention that, even if his sealing up of Rock Creek, "by filling up the point now occupied by the dam and flood gate, thereby throwing all the water from the creek into the Canal" would not come in contact with corporative and private rights, the present Canal between 17th street and Georgetown would be by far too small to receive and carry off a "never failing stream" which, according to observations, discharges daily so great a quantity of water, freshets not even considered. Besides, the embankment of this section of Canal, consist of artificial earth dams, and consequently could never resist the action of so considerable and rapidly flowing a mass of water! And all this mainly to cleanse the Canal!

P. H. Donegan.

Mr. Donegan's views of cleansing the Canal are mostly appropriate as far as they relate to dredging the Canal. This suggestion about the construction of a water reservoir for flushing out the Canal will be discussed with similar proposals hereafter. That it is objectionable to change the direction of the current in the Canal alternately, by means of locks, etc., has been illustrated before, since we found that the main cause of the accumulated sediments in the Canal was the changing direction of the current, produced by tidal action. Mr. Donegan makes no provision for main sewers, and in consequence, it would certainly be necessary to dredge the Canal from time to time to keep it navigable. All other points of his suggestions find their illustration with those of the other proposals.

We shall, hereafter, endeavor to prove, that, if once

cleaned and precautionary measures have been taken against a *recurrence of the present deplorable* state, the Canal as it is, will answer and satisfy any reasonable expectations for all future time.

Regulation of the Canal.

The deposits in the Canal are of a nature and have reached such a mass that they cannot be removed from its bed by artificial currents. The removal of the deposits by *dredging* or *excavating* is therefore necessary in order to restore the Canal to its normal depth and to give it the necessary width. The sole of the Canal ought to be laid level and not less than 4 feet below the mark of the lowest tide, in order to keep it permanently navigable. The width of the Canal should not exceed 75 feet at any place. The earth obtained by the process of dredging or excavating could then be applied at once inside the limits of the Canal for filling in, respectively for contracting its profile. It would be advantageous for the purposes of navigation, as well as for the easy flow of water in the Canal, if the sharp corners could be rounded off, at least at those places, where the direction of the Canal deviates under an angle of 90°.

Keeping the Canal in order.

But to keep the Canal, thus regulated, in its normal state, it is necessary to prevent the ingress of all matter likely to form deposits. This is done:

1. By conveying the vegetable and animal offalls of the kitchens and water closets as well as the washings of streets, yards and roofs, by action of rain water, not in the Canal any longer but *through main sewers* direct in the Potomac.

2. By regulating the beds of the natural water channels, as for instance Tiber Creek, which convey the surface water tothe Canal, so that the intensity of the current of the water in them does not increase temporarily, as much as to carry along great quantities of stones, gravel and sand, or if this expedient would prove to be too expensive for the whole extent of these channels, by constructing a sufficient number of mud pits and gravel pits of suitable dimensions and by cleaning them as soon as they have filled up.

Main Sewers.

The main sewers will be constructed cheapest and also most to the purpose, in the present bed of the Canal itself, since, so far all or at least most of our sewers in that part of our city which is situated to the north of the Canal have emptied into the Canal. Considerable expense will be saved for digging out and for transportation of the excavated ground, and the narrowing of the exces-

sively wide Canal will be effected most easily by applying the excavated deposits within the Canal itself.

Dimensions of main sewers.

In general, sewers are made too large. This is superfluous and expensive, especially with main sewers, which, in most cases, are of such dimensions as to allow the passage of persons for inspection, cleaning and repairing.

The area of cross section of main sewers is not necessarily to be equal to the sum of *areas* of those sewers, discharging into them, but it depends on the quantity of matter brought in, which is to be drained off in a certain time.

Therefore, in cases where the nature of the terrain causes difficulties, and where the utmost economy has to be observed, the dimensions of main sewers have to be carefully determined with regard to the following principles, to wit:

Shape of section.

The shape of cross section must be such as will offer the greatest area with the least circumference; therefore it should be a circle or nearly so. This will be the most economical, since it requires the least amount of material in execution, giving at the same time the greatest strength against external pressure, and the smallest amount of frictional area to the matter flowing within.

Declivity.

The declivity which *can* be given to a drain or sewer, in most cases, depends on the nature of the terrain. But the declivity which *shall* be given depends, firstly, on the area of the cross section selected, as a proper combination of both is necessary to enable a certain quantity to flow through at a given time, and it depends, secondly, on the nature of the matter to be drained off.

When the water running through a sewer carries with it sand, gravel, or matter of great specific gravity, a great declivity is the best, as it rolls down any sediment more easily, and it is only necessary not to give to the water as much velocity as would cause the washing out of the joints in the masonry, forming the conduit.

But when that water carries with it dissolved, suspended or swimming organic matter of small specific gravity, the declivity is otherwise limited; because, if it is too small, say less than one foot fall in 3000 feet length, the velocity is so much decreased, that the greater part of organic matter may be deposited and will form a layer of slime, and if it is too great, say more than one foot fall in 500 feet length, the velocity is so much increased, that the water flows off too fast, leaving behind the most of the larger and smaller lumps which collect at the bot-

tom of the sewer, where they desiccate, and moistened at intervals by new quantities of impure water flowing over it, putrefy by the action of air and heat, forming a viscous and compact layer, increasing in depth, generating and emitting those unhealthy and offensive gases.

To determine approximately the dimensions of main sewers answering the demands of the City of Washington, and especially that portion of it which, at present, is drained into the Canal, we shall proceed as follows:

In Paris, France, where within a number of years the most careful records have been kept in relation to the nature and quantity of the contents and refuse of privies and water closets, it has been found, that the solid and liquid excrements amount per inhabitant, yearly, to 0.5 cubic metre, or 17.65 cubic feet English.

Amount of refuse water.

Let us suppose the population of Washington to be 200,000, then this would make daily about 9700 cubic feet which have to be drained off mostly within the first fifteen hours of each day, provided the whole of it would pass into the sewers.

This is equal to 0.18 cubic feet per second.

Amount of aqueduct water.

The greatest amount of water which can be furnished by the Washington aqueduct is estimated to be 50,000,000 gallons, or about eight millions cubic feet per diem. This is a provision of 250 gallons or 40 cubic feet to every individual for the above population, a rather extravagant quantity for their use.

If we take 75 gallons or 12 cubic feet water to be *used* by each individual during a day, of which 50 gallons or 8 cubic feet may reach the sewers within nine hours in the middle of the day, and if we further consider, that only two-thirds of this quantity will pass into sewers tributary to the main sewers at the border of the Canal, then we find this equal to 32.92 cubic feet per second.

The remaining one third of the water will be discharged by sewers, or otherwise, into Rock Creek, Tiber Creek, and the Eastern Branch.

A great part of the water of the aqueduct will be used for washing streets and sidewalks, for watering public and private gardens, for cleansing and other domestic uses, and for industrial purposes, and therefore never will reach the sewers.

That part of the 8,000,000 cubic feet of water delivered daily by the aqueduct, and not used as shown above, is to be saved for use in case of conflagrations, for flushing out the sewers, for fountains on public squares, &c.

Amount of rain water.

Although the rain water may be excluded entirely from the sewers, or at least only such portions of it may be allowed to enter, which serve to clean or flush them out, we shall try to calculate the amount of the same under the most unfavorable circumstances, namely, in the case of freshets.

Studies on the topography of the northern and eastern part of Washington and the surrounding country, with due regard to the present and future grades of the streets show, that only an area of 56,400,000 square feet discharges its rain water from north to south, towards the Canal. The rest of the city either discharges its water towards the Eastern Branch, Rock Creek, or directly into the Potomac.

From the quantity of rain falling upon this area, but a part reaches the sewers, and by them the main sewers. Minute and extensive experiments made on this subject in London and Paris, which cities have paved streets nearly altogether, have developed the fact, that at most, fifty per centum of the total rainfall reach the sewers, when *no* provisions are made to prevent the passage into the sewers.

A part of the rainfall evaporates at a rapid rate, especially when the rain commences; another part is absorbed by the dry dust, or enters the surface of the gardens, yards, squares and roofs, and comes to evaporate thence at a later period. Another part is retained in the gutters, in the gullies of the ground and the unequalities of the pavement, and percolates into the ground, whence it evaporates still later, or it settles down to the ground water, where it cannot enter the water tight sewers.

A part of the rain water also is collected for domestic or industrial uses, and another is discharged by the street gutters and many natural water channels, directly into the Canal.

Suppose there was a freshet equal to two and a half inches of water in five hours over the whole surface of 56,400,000 square feet, and considering that the water falling at that portion of this surface, which is most remote from the main sewers, will require at least two additional hours to reach them, we find the quantity, if all would flow to and had to be discharged by the sewers, at 11,750,000 cubic feet within seven hours.

Of this, one half will be absorbed or otherwise disposed of, as demonstrated above. From the remaining

5,875,000 cubic feet, about 2,900,000 will be received by the natural water channels and carried directly into the Canal. The rest or 2,975,000 cubic feet to pass the sewers within seven hours, would require a discharge of 118,06 cubic feet per second.

This makes an aggregate of 151.16 cubic feet of water and sewerage to be carried off per second.

Determination of dimensions.

Experience has established, that refuse water, properly diluted, either by an abundant use of water, or by means of additional flushing water, when flowing through sewers or conduits, follows the identical hydraulic laws, which are applicable to the flow of clean water, running in river channels.

The formula, used in England for the determination of the profile of sewers, and the velocity and discharge of their contents, is

$$v = V\overline{1,6\,H\,F}.$$

(Report upon the main drainage of the Metropolis, London, 1858, page 142,) where: v is the velocity in feet per second; H is the hydraulic mean depth, and F the declivity of the sewer in feet pro English mile.

This formula is materially the same as that given by Prof. Rankine in his "Civil Engineering, London, 1862," which we shall use in our case.—It is:

$$v = 92.26\ V\overline{i.m}.$$

Where v and m, are identical with v and H in the first formula, but where i, the declivity is expressed in feet per foot, that is, i is equal to the fall in feet, divided by the length, representing that fall also in feet.

The hydraulic mean depth m itself is expressed by $A : b$, where A represents the area of the water in the channel, and b its *border*, that is, the length of that part of its girth which is in contact with the channel.

The quantity Q of discharge of water, is equal to the sectional area A of the water, multiplied with the velocity v, of its current.

One main sewer

Let us propose, for example, we should have a sewer of one foot fall in 3,000 feet length, being the accepted minimal declivity of sewers, and of a circular area of 8.8 feet diameter, in order to see how that would answer our purpose.

The area in these cases would be 60.566 sq. feet.

The hydraulic mean depth	m	2.2 feet.
The declivity	i	1:3000 feet.
Therefore the velocity	v	2.4984 feet per sec.
And the discharge	Q	151.32 cub. ft. per sec.

such a sewer would therefore be of the proper dimensions to discharge all the sewerage and surface water calculated above.

Now, it is of no use to lay the sole of any sewer *lower* than the lowest water mark of the river into which it discharges, and, since every sewer should be covered with an earth embankment of not less than 2.7 feet, it would, including an 18 inch brick arch at the top of the sewer, require a height of 13 feet above the sole of the sewer, or, at the foot of West 17th Street, a height of 8.2 feet above mean high water mark.

The top of the ship lock of the Georgetown Canal is marked on the Surveyor's map to be only six feet, and the whole northern border of the Canal from that point down to South First Street less than eight feet on many places only four feet above mean high water mark. Consequently, the level of all these streets would have to be changed, at some places more than four feet, and all bridges would have to be raised. Besides this, it would interfere materially with the loading and unloading of the Canal boats.

Separate sewers.

Therefore, such a sewer is not practicable. But if we suppose, there should be two sewers instead of one, one of them starting at the foot of West 6th street and running towards West 17th street, the other starting at or near to Maryland avenue and running down to the Eastern Branch, then the circumstances are quite different.

Let both of these sewers be of 6.5 feet diameter at their mouth, and give to one of them, according to the sewers discharging into it, the sole of which cannot be changed too much, a declivity of one foot in 2500 feet length, and to the other sewer, where such objections do not exist, a fall of one foot in 2000 feet length, then we have, according to the above formula:

For the first sewer—

Velocity $v = 2.3522$ feet per second.

Discharge $Q = 78.05$ cubic feet per second.

For the second sewer—

Velocity $v = 2.6298$ feet per second.

Discharge $Q = 87.27$ cubic feet per second.

The sectional area and the hydraulic mean depths being in both cases the same.

This gives an aggregate capacity of 165.32 cubic feet per second for both sewers, or a *surplus* of 14.16 cubic feet per second, equal to about 1.224000 cubic feet per diem.

After we had concluded the foregoing calculations, based upon the well known laws of hydraulics and the experience of eminent engineers, we received the "Report of the Sewerage Commission of the City of Baltimore, 1862," and a careful and scrutinizing examination of said report, showed by comparison and application of the datas stated therein, that we are altogether on the *safe* side, as will be seen by the following:

Concerning the diameters of circular sewers which have to lead off the water coming from a fall of rain of one inch in the hour, with the house drainage from a covered (paved) and densely populated surface of given area, Mr. Roe, an eminent English engineer, whose observations extended over a period of twenty years in the Holborn and Finsbury districts of London, gives a table, according to which a sewer of 6′.5 feet inside diameter, when level, would be sufficient for a surface of 1370 acres, and consequently with a fall of one foot in 2500 feet length, drain a surface of more than 1500 acres; therefore two such sewers, one of which has even a greater declivity, will drain about 3000 acres, or over three-fifths of the whole surface of 5000 acres to be covered by the City of Washington, while, according to our calculation, the rain water of only 1300 acres of this area is to be conveyed away by our sewers.

Mr. Wicksteed, who has been very successful in constructing sewers in some of the cities of England, gives a table, stating the diameter and the gradient of circular sewers, which are necessary to produce a current of three feet per second, provided the sewer is only *one-half* filled with water, and asserts, that such a current is sufficient to carry off bricks or stones of moderate size, and almost any heavy substances, except metals.

If we extend the table of Mr. Wicksteed, then we get the gradient for a sewer of 6′.5 inside diameter to one foot fall in 1274 feet length, and if we would decrease the declivity to one foot fall in twice that length, or in 2548 feet, the current would be reduced to $\frac{3}{\sqrt{2}}$ feet per second.

The current in a given sewer, is *greater* when it is filled *more* than one half, as thereby the hydraulic mean depth is increased, and, when filled entirely, it would be $\sqrt{2}$ times of its former value. Therefore, the current of sewerage in a sewer of 6.5′ diameter and of one foot fall in 2548 feet length, would be found, according to the observations of Mr. Wicksteed, and with due regard to the laws of hydraulics, to amount to three feet per sec-

ond, which is 0.65 feet *more* than we have calculated with our formula.

In the foregoing we computed the dimensions of main sewers necessary at or near their discharging orifice. It is clear that these dimensions may be reduced, from time to time, towards the starting point of the sewers. Whether those figures marked in our diagrams, annexed to this report, as the height and width of sewers at their commencement, are to be increased or can be reduced to answer the purpose, cannot be determined without careful and exact surveys of the tributary sewers, their distribution &c., but we believe them to be not far out of the way.

Length of sewers.

The whole length of the Canal is, as above stated, about 15,300 feet, and 13,000 lineal feet of its length would suffice for the two sewers together. Their cross section is much smaller and their height from the sole to the top of the protecting earth embankment, is 2.3 feet less, for the plan of two sewers, than we found necessary for one continuous sewer. This is of great value in regard to the grades of North B street, to the ingress and egress of the bridges across the Canal, and to the use of the embankment as a wharf.

The mouth of main sewers should, under no circumstances, be laid higher than the lowest water line of the Potomac, respectively, Eastern Branch, so that the sole of the sewers at those points is constantly covered with water, and that the organic matter to be discharged, does not solidify when deprived of its moisture, by exposition to the actions of air and sun.

The importance should not be underrated further, that, two sewers being constructed as above indicated, their mouths are far distant from each other, which favors a better distribution of the discharged substances in the Potomac water, and thereby tends to dilute them more effectually, and make them totally harmless.

The advantages, further, which a system of two main sewers, as compared with the construction of only one sewer, offers in point of economy, are not trifling, as nearly 2500 lineal feet of sewer are saved, one sewer to be 7400 feet and the other needs only to be about 5400 feet in length.

By these means we shall also be enabled to lay the sole of the sewers at their starting points at least 2.5 feet deeper, whilst giving them more declivity than one sewer could possibly get.

Another essential advantage of this plan is, that the filth reaches the river by a shorter route, respectively is kept within the main sewers far less time, than otherwise. For whilst in a sewer running from West 17th street to the Eastern Branch, matters which are brought in, say at the foot of West 13th street, would have to travel 12550 feet within the sewer to be discharged, they will be carried only a distance of 2750 feet to reach the Potomac, when two sewers are adopted. And this will be the case with the greatest quantity of sewerage, since the western main sewer would drain the most populated part of the city.

Again, in comparing sewers running uninterrupted through a great distance, with smaller and shorter sewers of about the same extent, which are independent from each other, it is obvious that the latter afford greater facilities for cleaning and repairing, provided they have the necessary height in the clear for persons to pass through them.

Flushing process.

In laying out these main sewers, the application of the flushing process appears to afford the greatest advantages. It is true, the flushing process requires a certain attention and regular surveillance, but, if this is not neglected, it answers for all that generally may be expected from an efficient system of drainage, and that with least expense in original cost, as well as in the current expenses of managing them. All this, of course, provided, that the nature of the terrain does not admit of a greater declivity, and of the use of unlimited and never failing masses of water.

If the reasons adduced above, would not render impracticable the construction of a main sewer with an equal fall from West 17th street down to the Eastern Branch, then, indeed, the necessary quantity of water for constant washing, without constructing weirs and flood dikes, and the cost of working them, would be at our disposal in Rock Creek.

In the unfavorable case before us, we have to rely principally on the consumed water primarily furnished by the aqueduct, on the rain falls, on the water of the flood tides, and on the changing mass of water furnished by Tiber Creek, and we shall have to make up what is wanting by judicious and well adjusted appropriation.

Sewers with a declivity of only one foot fall in 2000 or 2500 feet length, will, in our opinion, hardly impart an

impetus to the water necessary to carry away all heavier sediments. It is therefore important to exclude from them all washing of streets and gutters. But even then it may be necessary from time to time, to "flush" them out.

This is done by providing at certain places within the sewers, iron gates or weirs, which can be operated from without, at will. When these gates are lowered, they will keep back a certain quantity of the water, and when lifted, this water will flow through the sewer with increased velocity, and in this way the necessary current can be produced, if not at once through the whole length of the sewer, so at least through certain intervals.

For the sewer of 5400 feet in length, only one such moveable gate of about four feet in height would be wanted, placed at the mouth of the same, which gate, at high tide, would prevent the flowing in of tide water, if thought proper. And for the sewer of 7400 feet in length, one such gate at its centre and another at its mouth, would be required.

The flushing of one section of such a sewer will require about three hours for perfect cleaning, and may be repeated twice a week. The surplus water of the aqueduct will probably suffice.

In solving the problems of an efficient sewerage, difficulties most analogous to those we encounter in this city had to be overcome in the case of the Hanseatic city of Hamburg (Germany). The flushing process has been resorted to throughout, and successfully. Sediments which could not be removed by these means did not occur in the course of about twelve years. The sewers of that city extend about thirty-five English miles, and some of them have not more fall than one foot in 3000 feet and the sewers are kept so clean, that in inspecting the same, no smell whatsoever can be perceived. The flushing of the whole system of sewers is done there by one foreman and eight laborers.

All the lateral sewers connected with the main sewers can be cleaned, and kept clean by flushing, as well as the mains.

Disinfection of the water.

The question, how much water is required to dilute a mephitic liquidity as much as to make it harmless to the health and imperceptible to the smell, has been treated carefully at different places. The official report of a scientfic commission in Paris on the subject of "sinks and the cleaning of sinks," edited by Dr. Grasso, reads as follows:

"The experience of the sanitary commission has proved, that the liquidities of sinks which have passed into a state of fermentation, and are putrefied by the contact with solid matter, are totally disinfected when mixed with 250 or 300 times its volume of water.

And at another place he says:

"That no comparison can be made with respect to stench between new urine and urine which is retained in a pit mixed with soil."

Further, "That the decomposition of the urine commences when it is between one and two days old."

According to our former hypothesis, the refuse of the water closets amounts daily to about 9700 cubic feet, during which time at least 2,000,000 cubic feet of aqueduct water are used. If we add to this 2,000,000 cubic feet aqueduct water used in flushing the sewers, then we have from these sources alone a 412 fold dilution of the excrements, and the soil, thus diluted, and therefore harmless and free from bad smell, would be conducted through the sewers to the Potomac which abounds in water. The further dilution of the soil by rainwater or other supplies of water, have been purposely left out in this calculation.

For these reasons, a discharge of the larger part, say about 6000 cubic feet of already diluted soil, into the Potomac near West 17th street, will cause no inconvenience whatever for the southern part of the city, the Island.

To be altogether on the safe side, the water used for industrial purposes ought also to be taken in consideration. But since the organic matters dissolved in this rinsing water, are conducted at all events before a day has passed, therefore, before putrefaction commences, not only in the main sewers, but also in the Potomac, an infection from these sources need not to be apprehended.

Profile of main sewers.

The details bearing on the construction of sewers with flushing apparatus, have been discussed above, an appproximative computation of the principal dimensions of main sewers suitable for the wants of Washington, has been given also, as far as the data within our reach and the preliminary researches admitted. This profile may appear rather diminutive when compared with the section of all branch sewers, but that these branch sewers have been built too large in many cases, we cannot be held to account for, nor can it be asserted, that on account of their size they discharge more matter than they receive, since, in the contrary, a greater quantity of

sediments is produced on account of the spreading of their sole.

The direct consequence of the latter is, that they form rather reservoirs than drains. It will never work well, to jump from the one extreme of insufficient sizes, to the other of extravagant dimensions.

Anyhow, our profile has been computed by principles upon which the successful drainage of other large cities has been based, and which have been confirmed by experience of a series of years, only provided, that not all the water of extraordinary freshets which has not been absorbed otherwise, is conveyed to the sewers, but in part through the street gutters over the main sewers. and over appropriate gravel or sand pits, into the Canal, (See fig. 4.)

Rain over falls.

This method was resorted to, because otherwise the profile of the main sewers must be enlarged considerably, in other words, the cost of construction and of the management, and the difficulties in planning would be increased.

When gravel and sand is allowed to enter the sewers, they have to be constructed with very great declivities in order to prevent sediments, and then the current of water capable of removing such sediments, would also wash out the joints of the masonry, otherwise, these deposits must be removed from the sewers by manual labor at regular intervals, which certainly would cause more expense than the emptying of the gravel pits.

Gravel pits.

The construction of gravel pits is therefore absolutely necessary for keeping clean the main sewers, as well as for keeping up the profile of the Canal, at least as long as the natural water channels, like Tiber Creek and many streets which are turned into creeks during freshets, are not regulated or paved.

The objection may be raised, that gravel pits are insufficient; but if they are laid out of sufficient size, and if care is taken that they are not transformed into "pits full of gravel," they will always answer their purpose.

The gravel and sand pits may be constructed either of blue stone or brick masonry and covered by cast iron covers or moveable flag stones, with openings beneath to receive the street washings from the gutters. They may be fitted with two or more wrought iron tanks provided with hooks for the purpose of lifting them out of the pits when filled with sand and gravel, emptying them at proper places, and replace them afterwards.

Opposite to the receiving opening of these pits, and at the same level with them, cast iron pipes running across over the sewers will be inserted and discharge directly into the Canal. In this way the rain water, charged with the washings of streets. &c., is collected within a basin and allowed to settle all heavier substances into the tanks, and the surplus will overflow, comparatively clear and pure directly into the Canal. (See diagram of section of Canal.) It will easily be perceived, that it is cheaper to empty those iron tanks and transport their contents from time to time, than to collect the deposits within the sewers, or the Canal, spread over a large surface in thin and irregular layers, and transport them afterwards about the same distances which the contents of the tanks would have to be carried.

The bottom of these pits to be above mean low water. Near the bottom have to start small iron pipes (say two inch gas pipes) leading into the Canal and passing below the main sewers, the inlet of these pipes is to be protected by strainers to prevent the passing in of solid matter, and the mouth of the same to be provided with self-acting valves, closing up the pipes when the level of the water in the Canal is above that within the gravel pits. In this way, the pits will discharge all their water into the Canal at the first low tide occuring after they had been filled by rains.

Small gravel pits of only about three feet square, containing but one iron tank could be provided below every inlet for rain water into the sewers, to prevent the heavier and coarser parts of street washings to enter even the tributary sewers, which would, in connection with a perfect flushing system, keep them always clean.

The Canal, once cleaned and regulated, as explained above, would form a satisfactory road, navigable at any time for its whole extent, as was no doubt intended when it was planned. Its water would forever be free from filth and sewerage, and its channel would not be exposed to any further mineral sediment.

If slime and mud should be brought into the Canal by high tides or freshets, or dust and earth by the gutters, these sediments could be removed easily by flushing out the Canal. For this purpose, that part of the Canal between the starting points of the two main sewers, from Maryland avenue to Sixth street west could be enclosed by two flood gates, opening inwards, by which means not only the flood water could be retained, but also any

quantity of water from Tiber Creek could be collected to constitute any desirable supply of flushing water, with head enough to remove loose sediments. The Canal would then be navigable at any time for the entire length of these main sewers, and at the intermediate section, at all times when no water is collected for flushing purposes.

It will be readily perceived that this proceeding is essentially different from that proposed by Mr. M. Bishop, which, to superficial observation may appear similar. We propose eventually to use a *small* part of the Canal as a *temporary* reservoir, the waters of which discharge at that time into the Canal, or into the sewers when preferred when the gates are opened, and are thus carried off; in order to be replaced by other water, when tide comes in again; and the flushing operation of the Canal will only have to be repeated at greater intervals of time. The gates itself being simple, and constructed according to the principles stated hereinbefore.

Mr. Bishop proposes to use the whole Canal as a wet dock, or as a reservoir, and wants to keep the water therein *constantly* at high tide. This requires strong and solid ship locks at both ends of ihe Canal, and the water in the Canal will be renewed only to a proportionally small part, such as is consumed by evaporation, by leakage of the locks, and used up by the passage of the boats. The main portion of the water will not be renewed, and will become stagnant in due course of time. The principal objection however is, that every boat, when entering or leaving the Canal, would have to pass a lock, an operation consuming considerable time for a greater number of boats.

Col. Seymour. We shall now try to explain the difference between the sewer proposed by Colonel Seymour, and that proposed by ourselves.

The formula for computing the discharge of sewers, is, as above.

$$Q = v.A = 92.26\ V\overline{i.m}.$$

To compare a sewer of 25 feet width, as proposed by Mr. Seymour, with a circular one, let us for brevity sake suppose, that both sewers have the same declivity, and the stream of water the same sectional area, and further, let us take the example of *one* main sewer, calculated above.

There we found that a sewer of 60.566 square feet area and with one foot fall in 3000 feet, would discharge 151.32 cubic feet per section.

A sewer of 25 feet width would be covered by the same quantity of water, to a depth of 2.422 feet; the border of that stream would be 29.844 feet; therefore the hydraulic mean depth 2.0294 feet; the velocity 2.3996 feet, and the discharge 145.34 cubic feet per section.

This sewer would consequently discharge six cubic feet per second or 518.400 cubic feet less per diem, than that proposed by us.

But now to the economy of this plan.

All main sewers should be of such a height as to allow the passage of a grown man. Let us suppose the sewer of Mr. Seymour to be five feet high in the clear, covered by a flat arch of eighteen inch brick work and with strong abutments to support this arch and the proper earth embankment on its top, built of dimensions sufficient to counteract the thrust. Consider that one of these abutments is to be constructed of solid stone masonry laid in cement, being on both sides exposed to the action of running water. On the other hand, our sewer would be 8.8 feet diameter, of 18 inch brick work, representing an arch of 27.64 feet inner girth. A simple comparison will show that our whole sewer will not cost more than the *arching over* of Mr. Seymour's sewer.

Our proposal in this respect is, to take down the dry wall which at present forms the northern border of the western section of the Canal; to construct a sewer at its place, so that its northern side leans against the firm ground, then to fill in the space to the south, next to the sewer, so much as is necessary to reduce the Canal as indicated above. This filling would protect the sewer against any action of the water in the Canal, and could be made with the excavated material from the bed of the Canal, and in case this should not prove to be sufficient, with other material. Between this filling and the Canal, a new dry wall is to be erected with the material of the old wall.

It is evident that this plan does not require any expensive cut-stone masonry laid in cement mortar, that it effects a considerably greater stability of the sewer, since it is flanked and separated from the water of the Canal by a mass of ground from 12 to 62 feet in thickness, nor does it require any costly foundations into the soft bed of the Canal.

The arching over of the channel of Tiber Creek, however desirable it may be for the immediate neighborhood of hat creek, would simply prevent that rubbish, dead animals, &c., be thrown into the creek; but Tiber Creek, as any person may see by inspection, fills the Canal with nearly clean sand and gravel, and it will be the main object to prevent this sand and gravel to be taken up by the water of the creek from its own banks and bed, and therefore the problem is rather, to regulate, this bed respectively, its *declivity* and its course, to give its border uniform slopes, and to protect them either by paving or sodding.

Similar steps should be taken to regulate the other smaller water courses tributary to the Canal.

Recapitulation. Let us briefly recapitulate the outlines of a plan to thoroughly clean, and keep clean the Washington Canal, with the smallest possible outlay, as it has been developed by us after careful examination of the present condition of the Canal, of the sewers, and natural water channels tributary to it, and in view of the prospective wants of an increasing population, in relation to commerce, cleanliness and health, based on such observations and surveys as enable a sound judgment of the matter.

1*st*. The deposits accumulated in the Canal are to be removed by dredging or excavation, this being the shortest, surest, and therefore cheapest way.

2*d*. The width of the Canal is to be reduced to seventy-five feet on all places where it is now over that standard, since this seems to be sufficient for any Canal of such small depth, and the material gained by the operation named above, may be used in attaining this object.

3*d*. The sharp corners at the bends of the Canal may be rounded off, as much as can be done without interfering with corporative or private interests.

4*th*. The sole or bottom of the entire Canal should be laid at least four feet below the lowest low water mark, to make it navigable at all times.

5*th*. Two main sewers connected by large pipes, starting from points near 4½ Street west, and above Maryland avenue, and running respectively to West 17th street and to the Eastern Branch, constructed of proper dimensions and provided with flushing gates, manholes, rainfalls, ventilation shafts, and other modern and useful improvements, should be built in the bed, or where necessary, into the northern or eastern border of the

Canal, and brought in connection with the branch sewers so as to receive and carry away all organic refuse of the city.

6*th*. The main sewers should undergo, at regular intervals, a thorough flushing or washing out, by means of the water of the aqueduct, or, if necessary, by means of the contents of a reservoir or pool, constructed within the Canal. The flow of this water inside the sewers will be regulated by iron moveable weirs operated from without, as described.

7*th*. The rain water shall only in part drain into the main sewers, and the surplus, especially that of freshets, carrying most washings of the streets, &c., shall be collected by means of street gutters into gravel and sand pits, which may overflow in the Canal.

8*th*. Tiber Creek and all other natural water channels discharging into the Canal, should be regulated, and where necessary, provided with gravel pits of proper dimensions at their mouths as well as on such places of their course where required.

Another way to drain the city would be, to construct a sewer with a sole laid below the bottom of the Canal, receiving all branch sewers within its reach, and emptying on both ends into large reservoirs. These reservoirs into which all the filth and sewerage of the city would collect, would have to be pumped out, by constantly working steam engines, drawing the contents into the river. This is a very expensive plan, both in construction and management, and if one or both engines are out of order, then it would not work.

There cannot be any doubt, that different views will be entertained in regard to the details of our plan. These views will, in part, have a beneficial influence on the future development of definitive working plans for initiating and perfecting the sewerage and drainage, for carrying off the surface and rain water into the Canal, and for elaborating a flushing system of the sewers in all its details. But the main feature of our plan is sound, and has been tried and improved by application in this as well as in foreign countries, so far, that it is the only one which, based on experience of the latest time, can be recommended unconditionally.

The cleansing of the Canal, although an utmost necessity, since its present state cannot be tolerated any longer, is still not the most important question. Of more importance to the health and cleanliness of a city

is the proper system of drainage, and, a city like Washington, with an increasing population, the seat of the Government of a great and enlightened nation, with a supply of water equal almost to that of the largest cities, cannot show any system at all!

What would be a benefit and blessing to any other Metropolis, "abundant water," the main and only condition for health and comfort is grossly neglected, for, the few sewers existing receive their filth as concentrated as possible and empty into an open basin in the centre of the city, partly filled with stagnant water, unfit for navigation, so that, from the coal we burn to the salt we eat, the consumer has to pay a heavy tax in the shape of cartage from Georgetown, to which our city has become tributary in consequence of the indifference shown to our vital interests.

Thus the water brought into the city with many millions of dollars outlay, is used to a limited extent, and that part consumed does hardly reach the sewers.

When the aqueduct is finished, its water should be used abundantly, because every body knows, that a pump, when steadily used, gives better and cleaner water than one which is rarely taken advantage of.

Wm. Wise. At the close of our report, we received the communication of Mr. Wm. Wise, accompanied by a drawing, directed to the Board of Aldermen and the Board of Common Council of Washington, dated January 23, 1864, and being elaborated in details, we supposed it to be our duty to give it a corresponding illustration. That the Canal in the present condition of our city, and while its present recognized grades continue, *is* our great *receptacle* of the deposit from the various sewers running through our streets, and of the washings of the surface of our streets, alleys, gutters, &c., from 17th Street west to 3d Street west, is a fact. But that it *must* be, and continue to be our great receptacle for the above purposes, will be found erroneous, when it is proved that means *can* be provided to remedy that nuisance permanently.

Mr. Wise assumes that "we cannot drain direct to the river in Washington as is done in other cities, on account of the influence of the tides upon the waters of the Potomac, which would cause the sewers leading into the Potomac to be filled up, at least in cases of freshets, nearly up to the level of Pennsylvania avenue." But other great and populous cities, exposed in the same

way, or even more, to the influence of the tides, and situated upon nearly level grounds, have been successfully drained by main sewers, leading directly into the rivers. The precaution was simply taken to provide the discharging orifice of the sewers with self acting flood gates, allowing the discharge of their contents only at low water and preventing the flood waters from entering from without. Such sewers would of course be receptacles for the sewerage during the time of such freshets, but would have capacity enough to collect and hold that matter during the short period of such occurrences. The overflowing of sewers, at points where the sole is above the highest high tide is impossible according to the law of communicating pipes, provided they are not choked or filled up entirely by solid matter, and if the level of the contents of sewers, by influx of rain water, or otherwise, would be raised above the level of water outside of the flood gates at the mouth of the sewers, these gates would necessarily be pressed open, and the surplus contents discharged.

Thus the action of the tide water upon the contents of the sewer would be stopped by the flood gates and filling up like that quoted by Mr. Wise, of sewer leading down 10th street, would be prevented by not allowing the gravel, &c., to come into the sewers.

The practicability of the erection of main sewers within the present bed of the Canal, and the narrowing of the same, we have demonstrated hereinbefore, and also the admissible and necessary declivity and other dimensions. Mr. Wise very correctly states, that a current of water could never be created in the Canal, that would give more than four miles an hour, which would be insufficient to sweep out the deposits. Consequently, we must prevent the *formation* of deposits; especially of heavy mineral substances, which, properly collected, may be used for filling in either the bed of the Canal at such places where it will be narrowed, or the triangular basin at the foot of the President's grounds.

The suggestion of Mr. Wise concerning the dredging out of the Canal, and depositing the material taken from it for improving the border of the Canal, is very appropriate, and would not only gain the Government a space of about fifteen acres of new land, but would also realize all the other advantages stated.

But, in reducing the width of the Canal, building two main sewers, as proposed by us, and accepting the

proposed improvement of the former mouth of Tiber Creek by Mr. Wise, we should in addition to the above attain the permanent regulation of the Canal, and the main conditions for a sound system of drainage and should regain 412500 square feet of land for wharfage or other purposes, located between 6th and 17th Streets west, along the entire length of North B street.

To fill up that space last named, we should need about 54000 cubic yard filling material, the most part of which, if not the entire quantity, is to be taken directly out of the bed of the Canal in the immediate neighborhood. The remaining 98000 cubic yards of the estimated deposit of the Canal with about 12000 cubic yards gained by the laying of a main sewer from Maryland avenue down to the Eastern Branch, could be used, as proposed by Mr. Wise for filling in that space between Monument square and the small Island opposite the President's grounds. The rest or 42000 cubic yards required according to the estimate of Mr. Wise, to fill up that entire space, may be supplied from time to time by the contents of the gravel and sand pits.

But if we further deepen the Canal throughout its entire length to four feet below the lowest low water mark, we shall get as much filling material as required, at once.

About the advantages of the proposed lock opposite to 17th street west, we cannot agree with the views of Mr. Wise, the more so, since the arrangement of main sewers will make it entirely superfluous, and he himself in the first part of his communication seems to have conceded, that the current of the Canal cannot by any of such means be increased materially. In relation to cellars near the Canal which are sometimes filled with water, we know of no other remedy, than firstly, to lay their floor in no instance deeper than one foot above the ground water, that is, in our case, mean low water mark, and then to provide each of them with iron or earthen drain pipes leading into the Canal, and to close their mouths with proper self-acting valves, allowing efflux but not influx of water.

As to the amount of material and work to be used in the erection of our sewers, we can only give a gross estimate, more elaborate surveys than come within the range of our problem, being required for an exact computation.

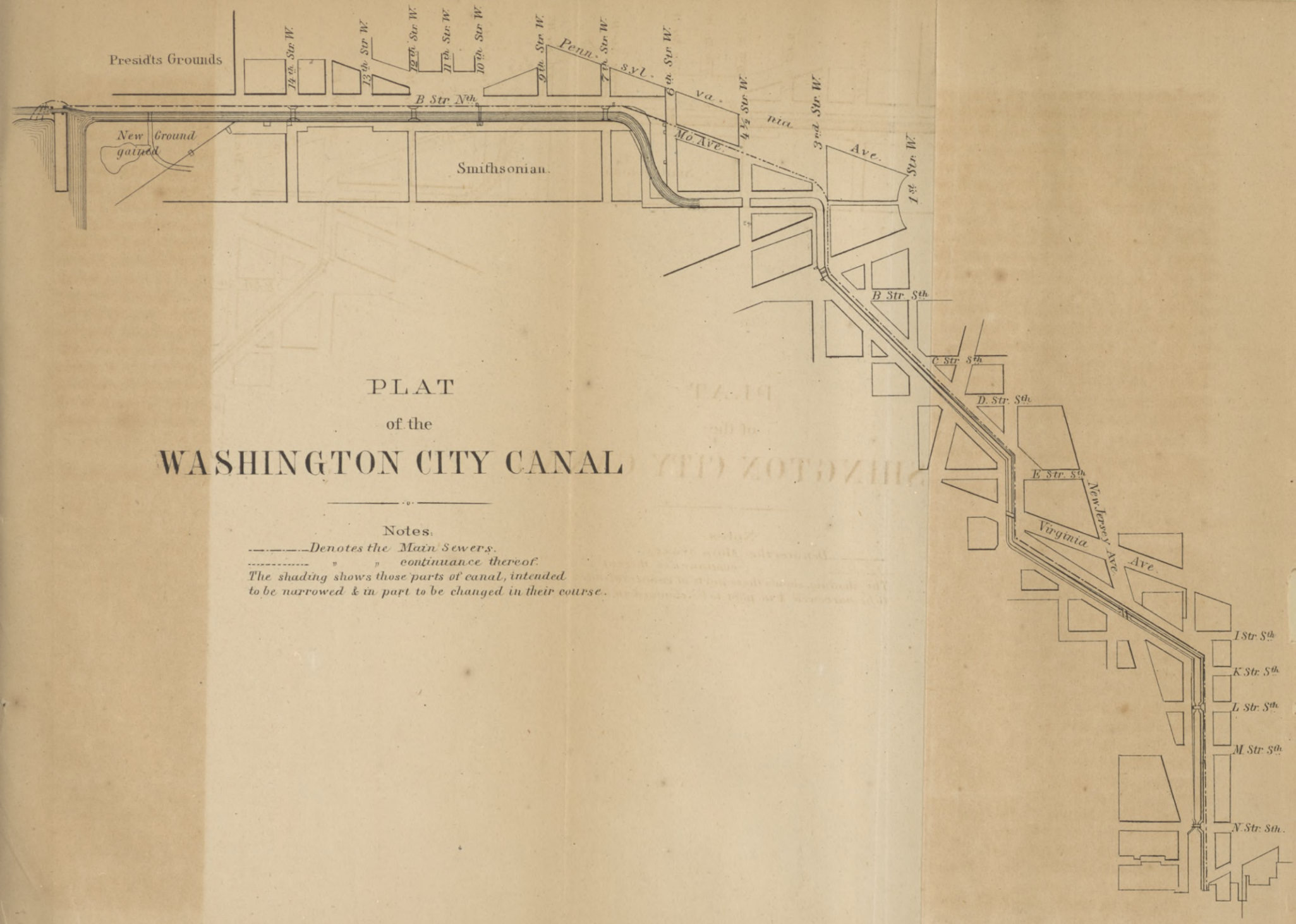
The brick work for both sewers, to be laid in best hydraulic cement, would amount to about 4212 thousands of brick.

At some places, especially for the sewer between Sixth and 17th streets west, artificial foundations of concrete may be required, say to the amount of 1200 cubic yards. Brickwork for small gravel pits 200 thousand. Excavation of main sewer leading to Eastern Branch, 65.000 cubic yards. Refilling (well rammed) 53.000 cubic yards. Dredging, partly transporting and depositing, about 150,000 cubic yards.

Taking down and replacing 7260 perches dry wall, and for loss of material and increase in height, we calcuculate about 4000 perches of new dry wall. To this is to be added 2577 perches blue stone wall with filling as proposed by Mr. Wise, then 1000 square feet flag stones, covering gravel pits, about 100 wrought iron boxes receiving gravel, about 4000 feet nine-inch cast iron or earthenware discharging pipes and 4000 feet two-inch gas pipes with valves, for those pits. There are wanted further, about thirteen manholes in the sewers, two large flood gates on their mouth, and the flushing apparatus described hereinbefore.

CLUSS & KAMMERHUEBER,
Civil Engineers.

Washington, May 12th, 1865.



PLAT

of the

WASHINGTON CITY CANAL

Notes.

———— Denotes the Main Sewers.

---------- " " continuance thereof.

The shading shows those parts of canal, intended to be narrowed & in part to be changed in their course.

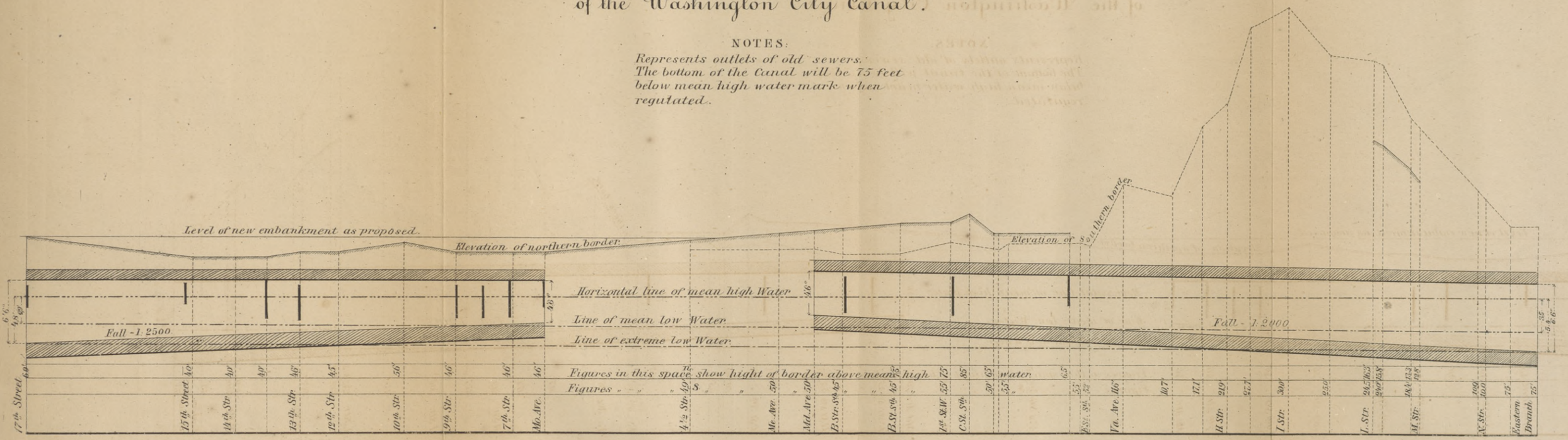
Lith. by J.F. Gedney, Washr

LONGITUDINAL PROFILE,

of the Washington City Canal.

NOTES:

Represents outlets of old sewers.
The bottom of the Canal will be 75 feet below mean high water mark when regulated.



SCALE { For Distances: 1 inch = 500 feet.
" Heights 1 " = 5 "

Washington, May 12th 1865.
Cluss & Kammerhueber
Civil Engineer.

Lith. by J.F. Gedney, Washr.

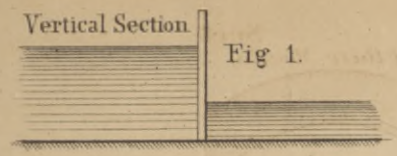


Fig 1.

Fig 2.

(Ground Plan.)

Section of Main Sewers

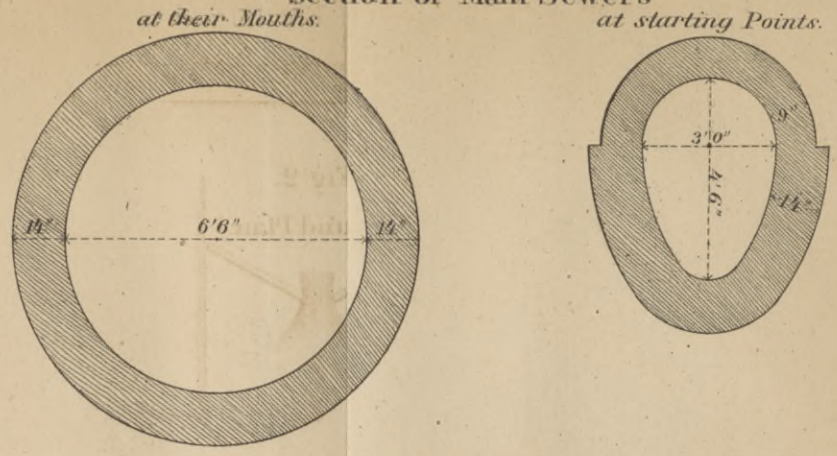


Fig. 4. Discharge of Surplus rainwater in Canal.

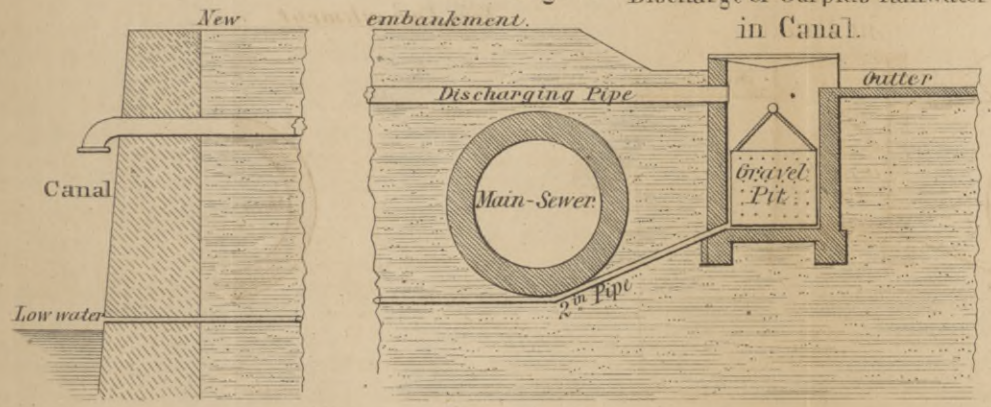
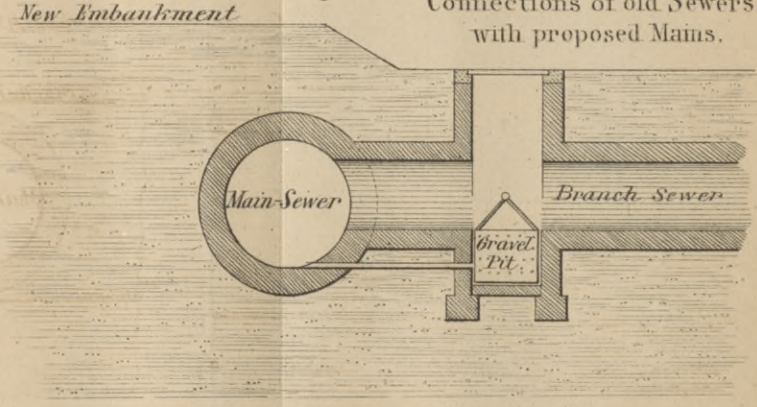
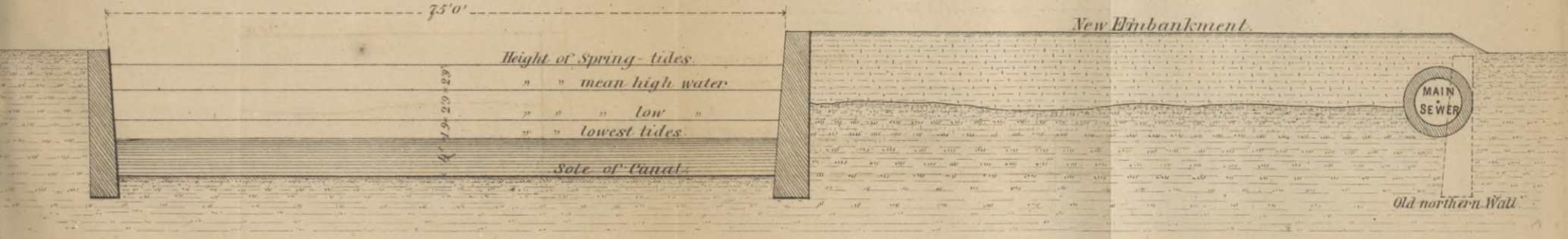


Fig. 5. Connections of old Sewers with proposed Mains.



Proposed new Profile of Washington City Canal (between West 7th and 17th Str.)



Lith. by J.F. Gedney, Washr.

DOCUMENTS.

—o—

WASHINGTON, *January 6th*, 1865.

HON. R. WALLACH, *Mayor*.

SIR: After a careful examination of the canal at low tide, I find west of 14th street several feet of water; from 14th to 7th, mud and but little water; east of 6th street, mostly sand; and at the junction of Tiber Creek, gravel I also find at each angle of the canal, a large bar, all of which *proves* that the main cause of the filling up of the canal is *Tiber Creek*. I also find that said creek drains a large valley; the city north of N street, and east of 7th street, also the south slopes of the high ground north of the city, receiving the washings of cow yards, slaughter houses, &c., which, during a freshet, is brought down, meeting slack water in the canal basin and there deposited; I also find the course of said creek to be about south, meeting the canal at 3rd street. I would therefore advise the *filling up the* canal at that angle west of the mouth of the creek, and if advisable, all the canal west to 6th street, and reclaim the land!—the stone from its walls would meet the expense; the canal south of 3rd street to be used as a continuation of Tiber Creek and would be kept clear of deposit by said creek. For the removal of the *deposit* in the canal basin, I propose the construction of a pair of *strong wooden gates* to be placed at the piers of the 12th street bridge, said piers being of substantial stone work already built; the gates would be the only expense, and may be so placed as to open west—by closing said gates at high tide and retaining the water until low tide, then opening them, the water would discharge with so much force as to sweep every thing before it and draw the deposit above. I feel sure a few such operations would clean out the entire basin.

The Mississippi river has a fall of only from 8 to 10 inches per mile, producing a current of 4 miles per hour, removing any deposit exposed to its action; the wharf at St, Louis is entirely, freed from deposit by the current of the river the city permitting no obstruction above to break its force.

The above simple and cheap plan would (in my opinion) if properly and substantially done, save thousands of dollars to the city. It may be found best to place another pair of gates at the piers of the 7th street bridge, if so, the cost will be small.

I remain, yours, &c.,

[Signed,] WILLIAM THOMAS.

To the Gentlemen of the City Council:

In explanation of the plan I have submitted for improving the Canal basin, I propose to show :

1*st.* That on closing the proposed gates at the 12th street bridge at high tide, I hold the water until low tide, when the said water will be *entirely above* the mud in the canal west of 12th street, *also the river*; that on opening said gates wide, the water above will seek the lowest point and flow rapidly through the mud into the river, and that said mud must go with it in *solution*.

2*d.* That the water above the gates so put in motion, in running rapidly over the mud above said gates, must bring a portion of mud with it, and the result would be, that every *twelve hours* the tide would fill the canal with clean water to be discharged muddy water, which if repeated would, in a few days or weeks, remove all the mud in the basin.

3*rd.* That if, after *operating* or *purging* the Canal as above a sand bar or shallow place remains, it may be removed by using a *deflector*, composed of pine timber drawing four or five feet of water, placed diagonally in the basin to contract or deflect the water thus put in motion to any side of the basin, that may be shallow.

4*th.* That the canal basin is as capacious as the harbors of Buffalo or Chicago, if it had a sufficient depth of water, that by the above plan a depth of water can be obtained, and instead of being a nuisance and a source of sickness and death to the people as well as a great expense to the City, it may be filled with vessels, producing a large revenue for wharfage.

5*th.* That the above plan for cleansing the canal basin is no new invention or scheme of my own—I claim only the application to your canal, it having been used in England many years since, and is called a *Scouring Basin*; a description of it may be found in the Supplement to the "Encyclopedia Britanica, Vol. 3rd. Part 2d, under the head of dredging."

6*th.* That after removing the deposit in the basin, that portion above the gates at 12th street will be a *wet dock* of the same description as the docks of London or Liverpool, on a small scale, and if *draws* are made to the bridges, vessels drawing 6 or 7 feet may load and unload their cargoes at your Market-house wharf, coming in and going out at high tide; this dock may be enlarged by building other gates at the 14th street bridge. The above simple and economical improvement and application of your canal basin, though it may not be acceptable to persons *owning wharves* along the river, or who desire contracts for dredging the canal as well as the *city treasury*, will, I feel sure, meet the approval of tax payers.

Yours respectfully,

[Signed,] WILLIAM THOMAS.

WASHINGTON, *February 19th*, 1865.

P. S.—Fall at Louisville, twenty-two feet in three miles, at low water. This fall is three to four feet, about equal to Louisville.

W. T.

HON. RICHARD WALLACH,
Mayor of Washington:

RESPECTED FRIEND: My first proposition in regard to the canal was, to make gates at the west end opening inwards, and gates at the east end, opening outwards, and arranging all these gates to open and close themselves. The gates at the west end to let the water into the canal when the tide rises, and stop it from running out, when it falls, so as to compel the water to all run in at the west end of the canal, and out at the east end, where the gates open and close, when the tide rises; so that the water in the canal will always run from the west towards the east end of the canal; and the current always being one way, and twice as fast as at present, there would be far less deposit in the canal than at present, and very little, if any odor, as the bottom of the canal would be covered with water. You proceeded to make gates a short distance from the west end, and subsequently I suggested that the canal be cleared at the intersection of Maryland Avenue, so that the water would run through the whole length; and close the gates you have made when the tide is up, and keep them closed while the tide is falling, and until the tide rises again, so that the water is as high west of the gates as it is east, then open the gates and let the water run in.

In doing so you will compel all of the water at the east of the gates when they are closed, to run out at the east end of the canal, and keep the current in that part of the canal near the gates on the east side always running eastward, and thus supply the canal with fresh water at every tide, which would carry off most of the filth which now accumulates, and prevent much of the bad odor if it did not entirely destroy it. It will cost very little to try the proposed experiment with the present gates, and if found satisfactory, a small outlay will place gates at the east end of the canal, and change the present gates so as to open inwards and complete the arrangement.

I recommend the proposed experiment with great confidence, as it will cost but little to try it, and I have no doubt, it will prevent the bad odor of the canal and keep it clear far better than any other mode that can be devised.

Very respectfully thy friend,

[Signed.] J. DENNIS.

WASHINGTON, 11 *Mo. 9th*, 1864.

WASHINGTON CITY, D. C., *April 4th* 1864.

HON. RICHARD WALLACH,
Mayor of Washington:

DEAR SIR: One year ago, on the 30th day of March last, I addressed you, by request, my thoughts and views on the subject of improving the Sanitary and Commercial condition of your City.

Upon much reflection through the past year, I have not been able

to discover reason for any important change, from what I then presented as a plan best adapted to the condition and circumstances involved in the case.

Please permit me to repeat, and add some few thoughts upon this all important subject. As before I would say :The canal which receives the water, and other matter passing the sewers of the city, should be made of a uniform width, and instead of short angles, all of the curves should be regular, sufficiently so, as not to obstruct the flowing of water with its full force. I would extend the canal up stream to a point in the Potomac, until I could secure a good portion of its current, and finish opening the present main canal down stream between the two rivers when it may enter into deep water. The canal thus constructed, will form a channel for a portion of the waters of the Potomac, and when there should occur a flood in that river, it would force from its new channel any matter deposited within it by the present constructed sewers of the city, and this plan will improve and finish out what *should* have been the original design to free the city of all pestilential ingredients likely to be massed by the action of its sewers near it, and carry the filth far down the river.

Now, in a commercial point of view, the foregoing described new channel of the river, may be formed into a harbor by the construction of two large *ship locks*, one at the head of the canal, the other at the outlet. These locks can be constructed in such a manner as to open, and be closed at the will of the attendant, and that very briefly, and in this manner the current of water in the canal may be controlled, and form a pool for a good harbor, through which vessels may pass or they may "lay to" at the docks formed for such purposes.

The present feeder flowing into the Canal from Rock Creek, will be sufficient to keep up the water in the harbor to such height as to prevent any variations by the fluctuation of the tide, and in the harbor there formed, there may be a very large amount of commercial business transacted near the centre of the city.

Thus I have very briefly stated the general outlines of a plan which I feel free to recommend, believing it may be the only and proper means that can be successfully used to thoroughly wash out and carry away, all of the matter annually deposited by the sewers, in the canal. The great utility of such an improvement, all intelligent persons will agree, cannot be easily estimated. The importance of the whole matter is such as to preclude the necessity of arguments in its favor With these few suggestions. I beg leave to subscribe myself,

Respectfully your obedient servant,

[Signed,] MARTIN BISHOP.

N. B —Details and estimates of cost of the work must be dependent upon proper surveys, protracts, &c.

M. B.

WASHINGTON CITY, D. C. *July 18th*, 1864.

HON. RICHARD WALLACH,

Mayor of the City of Washington.

SIR: The condition of the Washington Canal has for some years past excited considerable attention in consequence of the offensive accumulation from many sources, in some places raising the soil above the level of the water. Unless some feasible plan can be devised to remedy the evil, it must, in a very short time, produce a deleterious effect on the sanitary condition of the city.

To arrive at any practical result, it is necessary to look at the cause of the difficulty and the most economical and at the same time efficient means of removing it.

A glance at the map of the canal will show that it is subject to the influence of the tides, both at the mouth of the Tiber and at its terminus at the Eastern Branch of the Potomac. The water flowing in both ways naturally collects the deposits of offensive material towards the centre of the canal; and it has not sufficient force, at the ebb of the tide, to throw out the accumulated matter.

The plan by which I propose to remedy the difficulties which have heretofore existed, will, I think, commend itself to the attention of the proper authorities on account of its economy, simplicity and effectiveness.

The waters of Rock Creek, which is a never failing stream, flow into the basin a little below the lower bridge, and the surplus passes into the Potomac through a flood gate. I propose filling up the point now occupied by the dam and flood gate, thereby throwing all the water from the creek into the canal, leaving the present boat lock undisturbed.

Change the boat lock at 17th street, so as to make a flood gate there. Construct a dam and boat lock across the mouth of Tiber Creek, so as to allow the free passage of boats. That portion of the canal from 17th street to Georgetown would contain a head of water which, by opening the flood gate at 17th street, would force a body through the remaining portion, sufficient to sweep away all obstructions.

I have given above, in a few words, a sketch of a plan so simple, that it cannot fail to be understood, and I think so effective that it cannot fail to keep the canal free from accumulation of any deposits which might arise from extensive drainage, or any other source.

Hoping that it may be received with sufficient favor to induce you to bring it before the city authorities for any action which may be deemed necessary.

I am, Sir, very respectfully,

Your obedient servant.

[Signed,) GEORGE W. FRANKLAND.

U. S. N.

WASHINGTON, D. C. *September 5th*, 1864

TO ELIJAH EDMONSTON, ESQ.

Member of the Board of Common Council of Washington, D. C.

DEAR SIR: Agreeable to your wishes, I submit the following, as my opinion regarding the most practicable and economical plan for cleaning out the Washington Canal.

After making an examination of the course and condition of this Canal, I came to the conclusion, that it is necessary in the first place, to secure a sufficient head of water from which the Canal can be regularly flooded. In order to do this, a dam and flood-gate must be constructed at the confluence of the Canal and Potomac; and a system of flood-gates at 15th street. The area included between the dam above mentioned and the flood gates at 15th street, will constitute a reservoir in which the water can be confined at high tide, together with the water received from Rock Creek. That portion of the Canal between 17th street and Georgetown, can be converted into a feeder for this reservoir, and will be scoured out by the volume of water which can be made to rush through it, By this means we can command a large body of water in the reservoir, which, from its height above the bed of the Canal, will cause a volume to rush through the 15th street gates with sufficient force and velocity to carry with it all loose sediment. But as there is a large quantity of consolidated sediment in the canal at the present time, which may take the strongest current some time to dislodge, I would recommend the use of a dredging machine, (which could be got up cheap for the occasion) in conjunction with the current, until such matter is removed. Should it be considered necessary to have the Canal navigable, a lock must be constructed at each extremity of it, in which case the water can be made to flow towards the Eastern Branch or Potomac at pleasure. Although we can get rid of all the obnoxious matter, which the canal now contains in this way, and have it continually scoured out if necessary, yet I would suggest the propriety of diminishing the width of the Canal, as it seems to be a great deal too wide for any use that is made of it. The land gained in this way, will, in some places, be very valuable, together with facilitating the operation of cleaning the canal.

Respectfully yours,

[Signed,] P. H. DONEGAN.

To the Board of Aldermen and the
Board of Common Council.

GENTLEMEN: Having devoted considerable time and attention, both as a Corporation official and as a private citizen, to the Washington City canal, I beg leave to submit the following remarks upon the canal, as the main drainage for Washington City, and to suggest a means of disposing of the sediment therefrom in a manner that will ensure a permanent public improvement to our city.

In the present condition of our city, that is while its present recognised grades continue, the canal is and must be our great receptacle of the deposit from the various sewers running through our streets. The washings of the surface of our streets, alleys, gutters, &c., from 17th street west to 3rd street west, running back as far as M street north, are swept directly into the canal. It receives also the sediment from the 17th street sewer, which drains the War Department and Winder's building; from the 16th street sewer, which drains the President's house and grounds; from the 15th street sewer, which drains the Treasury Department, and from all the other sewers as far along the canal as C street south, draining all the principal hotels, many private houses, much of the surface of the city north of the canal, as well as the Post and Patent Offices, the Government Printing Office, the City Hall and Judiciary Hospital, and the Capitol building and grounds. In addition to the above, that portion of our city east of 14th street west and north of M street north is drained, with part of Washington County, through Tiber creek into the Washington City canal.

We cannot drain direct to the river in Washington as is done in other cities. This fact will appear evident to every one who will reflect that the water of the Potomac at high tide is within five feet of the level of Pennsylvania avenue, and in cases of freshets it rises almost to the level of the avenue, filling the cellars adjacent with water. With sewers, then, draining directly to the river, in cases of high tides and freshets the water would rise in such sewers almost to the level of Pennsylvania avenue. The surface drainage of our city flowing into these sewers, already filled with tide water, and the water thus flowing in not having the ordinary outlet at the river, these sewers would overflow, and, in addition thereto as the impetus of the stream in the sewer would be checked by the tide-water filling it, the washings from our streets and the sediment from houses adjacent would settle at that point in the sewer where the drainage meets tide-water.

Again, it would seem that the canal cannot be narrowed and arched over and then used for purposes of drainage.

This will appear evident from the fact that the portion of the city through which the canal runs, is so situated, that it would be impossible to give a sewer thus constructed a sufficient declination towards the river. A current of water could never be created in the canal that would give more than four miles an hour, which would be insufficient to sweep out the deposit that would accumulate in the canal thus constructed into a sewer. The heaviest freshets that we have known, have carried volumes of water through our canal, and with a velocity that none of these artificial means could equal, and yet the deposit in the bottom of the canal has not been reduced one inch by any of them. But granting that such a sewer would carry out the sediment, its only receptacle would be the channel of the Potomac, or the Anacostia, and that improvement cannot be esteemed as very substantial which drains the city at the expense of its navigation. The dredging of the channels would be fully as expensive as dredging the canal itself.

Believing then that unless the grade of our city is materially changed, we cannot drain directly into the Potomac, and that we cannot drain directly into the river through the canal converted into a sewer, it seems to me that the only available drainage we can have must be into the canal in its open condition, and the deposit there collecting must be removed by dredging machines. In this connection I beg leave to suggest the propriety of dredging out the canal, and depositing the material taken from it between Monument square and the small island at the mouth of the canal. A petition from the citizens of Washington, asking the assistance of the General Government in carrying out the same object, is now before the Committees on the District of Columbia, of the Senate and House of Representatives, and I believe is favorably considered. Among the objects to be attained, it suggests the following;

1st. The cleaning of the canal, so much needed as a sanitary measure.

2d. The filling up of what is now a dangerous and miasmatic swamp, which, in its present condition, is bare two-thirds of the time, and the noxious exhalations from which during the summer and early autumn months has made the Presidential mansion so notoriously unhealthy as a place of residence, and which to a very great extent will remedy this evil.

3d. By giving more uniformity to the topography of that part of the city, to render it much easier to embellish the public grounds as a mall or park, for which the surrounding grounds are intended.

4th. By connecting the grounds of the President's mansion with those of the mall, the Smithsonian Institute, and the Capitol, to obviate the necessity of passing through the business part of the city.

5th. Creating fifteen acres of new land for the United States, adjoining the Washington Monument grounds, greatly improving the same.

6th. Greatly improving the facilities for commerce, &c., &c., &c.

In addition to the above, I would also suggest the propriety and advantage of narrowing the canal. When narrowed the deposits from sewers, &c., in the canal, covering a smaller surface then at present, would necessarily be increased in depth, and consequently more easily and economically removed by the dredging machines. At present the canal contains 150,000 yards of this deposit from drainage, and 75,000 yards have been dredged out since the canal was thoroughly cleaned out fifteen years ago. Were the canal then narrowed to thirty yards in width, (the total of 225,000 yards in fifteen years, showing a yearly influx of 15,000 yards,) in two years the average depth of the sediment in the canal would be two feet. This would still leave two feet of water in the canal at low water if the canal was dredged to its proper depth. It could be narrowed more economically by being narrowed gradually, and the material in the canal could be advantageously used for filling in behind the new wall while this process of narrowing was going on.

I would also respectfully call your attention to the locks projected on the map herewith presented. Their advantage would be manifest.

In the first place by closing them in time of freshets the water in the canal would be prevented from overflowing its banks. Again, by closing them the waste water of the Chesapeake and Ohio would be forced through the canal and an influx of pure water supplied.

Very respectfully,

Your obedient servant,

WASHINGTON, *January* 23, 1864. WILLIAM D. WISE.

VIEWS OF COL. SEYMOUR,

ENGINEER IN CHIEF OF WASHINGTON AQUEDUCT.

[The views of Col. Seymour, Engineer-in-Chief of Washington aqueduct, as communicated, April 26, 1864, by request of the city authorities, are contained in a printed pamphlet, the material part of which is here reiterated.]

As I understand the problem to be solved, it may be briefly stated as follows:

The Washington canal was originally constructed across the peninsula, between the main and eastern branches of the Potomac river to a depth below the lowest tides of the Potomac, and connecting at each end with the waters of the Potomac, which at all stages, were allowed to flow freely through it. The sewerage and drainage of a large portion of the city are discharged into this canal. The ebb and flow of the tides, which average about four feet, acting upon these deposits, have filled up the bed of the central portion of the canal to a level considerably above low water mark, so that the water has ceased to flow through the canal. A small portion of the easterly end has been kept in use for a basin; and that portion of the westerly end between the mouth and 7th street west can still be used by boats of light draft during high stages of water. The sedimentary deposits in this portion of the canal are now from three to five feet in depth, and are constantly accumulating.

A plan is required by which either the whole canal, or at least that portion between its mouth and 3d street west, shall be kept free and clear from sedimentary deposit by means of the action of the tides and currents.

In the last annual report from this office upon the subject of the Washington aqueduct, dated October 1, 1863, I had occasion to refer again to the subject under the general head of "*drainage and sewerage*" as connected with the Washington aqueduct. The following is an extract from that report:

"V.—DRAINAGE AND SEWERAGE."

"The introduction, by artificial means, of a large supply of water into towns and cities for the use and comfort of the inhabitants, must, as a matter of course, create a necessity for the revolution in the system of drainage and sewerage previously in use; and on that account, as well as on account of the intimate relations which naturally exist between the two improvements, they are generally placed under the

same general direction and superintendance. This has not been the case in the present instance. The drainage facilities for the cities of Georgetown and Washington are, at present, only intended to accommodate the discharge of water falling on the surface which is naturally tributary to this drainage, together with the sewerage of the cities; and they are found in many instances to be much too limited for even those purposes.

"The introduction, by means of the aqueduct, of from twenty to fifty million addditional gallons of water daily into these cities, and the necessary discharge of a large portion of it into the drains and sewers now in use, will at once create a necessity for an entire remodeling of the present system of drainage, upon a much larger and more extensive scale. This may not be so important in Georgetown, on account of the greater irregularity of the surface and declivity of the streets, as in the city of Washington, where the ground is more level, and the drainage more sluggish.

"At the present time a large portion of the drainage and sewerage of Washington is discharged into a shallow, open sewer, of about one hundred and fifty feet in width, (sometimes called a canal,) which stretches its filthy surface through the heart of the city, and within a stone's throw of the Capitol of the United States, the President's House, the Treasury Department, and all the principal hotels on Pennsylvania avenue, breeding disease and pestilence along its borders. The accumulated filth and excrement of the city is constantly held in a state of semi-solution in this hot-bed of putrefaction, by means of the ebb and flow of the tides, over a surface of more than a million square feet. And whatever portion of it ultimately finds its way into the Potomac river, is spread out in thinner proportions over several hundred acres of flats, immediately in front of the city, the surface of which is exposed to the action of the sun at intervals during the day, and the miasma from which contaminates every breath of air which passes, from that direction, through or over the city.

"All this may be remedied by the adoption of the most simple and natural expedients. A portion of the canal, say twenty or twenty-five feet in width, should be walled in and arched over, and a flood gate inserted at its junction with the river; this portion should be used exclusively for purposes of sewerage and drainage; while the remaining longitudinal section should, by the adoption of a proper system of flood and stop gates, and locks, be kept constantly filled, to the level of high tide, with pure Potomac water. The water thus held in the canal, together with the water from Tiber creek, and the surplus water from the aqueduct, should, when necessary, be allowed to flush through the main sewer at low tide, and thus keep it entirely free from sediment and deposit. By this arrangement the open canal would not only be ornamental, but exceedingly useful for commercial purposes.

"By the construction of a breakwater in the Potomac, from the foot of Mason's island a few thousand feet down the stream, and so located as to divert the main current from the Virginia to the Maryland shore; and the removal of a portion of the north end of the solid

causeway in the present Long bridge, at the foot of 14th street, so as to admit of a channel fifteen hundred or two thousand feet in width, the main channel of the Potomac would be brought immediately in front of the city of Washington, with a depth of water from twenty to thirty feet, into which the drainage from the main sewers of the city would be discharged and completely removed by the action of the current.

"The commercial advantages resulting to the city from both of these improvements would be almost incalculable, while a fruitful cause of sickness and discomfort would be permanently removed The cost of the improvements would be comparatively moderate, and should be borne proportionately by the Government, the Corporation of Washington, and the owners of the property which would be benefitted by the immprovements"

In my opinion there are two indispensable elements necessary to the successful working of any plan that may be adopted.

First. That the water should never be allowed to flow in but *one direction* through the canal or any portion of it that may be set apart exclusively for sewerage purposes.

Second. That a sufficient body of water, with an adequate head, should at all times be at command for the purpose of *flushing* or *swashing* out the sewer during periods of low tides in the Potomac.

From the mouth of the canal, near the foot of 15th street west, to the bend between 6th and 7th streets west the canal is straight, and is about one hundred and fifty feet in width, From that point to the intersection with 3d street west, and also with Tiber creek, it is not so wide, and there are two changes in direction of ninety degrees each, as shown upon the map. The original bottom of the canal, through its entire length, is supposed to be below the level of the lowest water in the Potomac river. The rise and fall of tides in the Potomac are assumed to be about four feet.

By walling in such width of the canal, say twenty-five or thirty feet, as may be necessary for the discharge of the sewerags and drainage of the city, tributary to this portion of the canal, including the water of Tiber creek, and constructing a tight dam at the upper or easterly end, and one or more flood gates opening outwardly at the westerly end, near the entrance into the river, we would certainly prevent the influx of the Potomac during high water, and consequently the flow of any water through the sewer in an easterly direction, while, at the same time, it would be allowed to flow freely in the opposite direction whenever the internal exceeded the external pressure upon the flood-gates at the lower or westerly end, thus complying with the first essential requisite above referred to.

By constructing a lift-lock and dam across the lower or westerly end of the remaining portion of the canal, and inserting therein flood gates opening inwardly from the Potomac, this portion will become filled with Potomac water to the level of high tide, which will be held there when the tide recedes, by means of the self regulating process of the flood-gates, by which they open and close in response to the preponderance of pressure on either side. By this means we

obtain a large supply of water for flushing purposes, to which will be added the natural flow from Tiber creek, and, if necessary, any amount that may be required from the Washington aqueduct.

It is proposed to discharge this water into the upper or easterly end of the sewer at times of low water in the Potomac, by means of valve gates inserted either in the dam, or dividing wall, or both; and thus, under a head of four feet, to cleanse the sewer whenever circumstances may render it necessary; thus complying with the second essential requisite above referred to.

I have no doubt that the same theory can be successfully applied to the entire canal, in a much more simple form, in case it is deemed desirable to preserve its present dimensions for commercial or other purposes.

Assuming that the bottom is such as to allow the water to flow freely at all stages through the entire canal between the main and eastern branches of the Potomac river, as originally designed, there should be constructed a lock, with a lift equal to the rise and fall of the tide, at each end of the canal, so as to allow the ingress and egress of vessels In or near one of these locks should be inserted flood gates opening inwardly from the Potomac so as to fill the canal to the level of high water, and at the other end of the canal either flood or valve gates should be so arranged in the lock as to discharge the water from the canal into the river at low tides as often as necessary for the purpose of purification. In this way the current of the water passing through the canal would always be in *the same direction*, and, if necessary, the entire canal could be flushed out at every low tide. Whenever this should not be necessary it could be kept full of pure Potomac water to the level of high tide, which would add greatly to its healthfulness as well as to its usefulness.

Referring again to that proposed plan of improving the portion of the canal between 3d and 15th streets west, which is by far the most desirable result to be accomplished at the present time, I would say, that there appears to be no objection to reducing the width in the manner proposed by the bill introduced in Common Council, February 1, 1864, provided the proposed reduced width will afford sufficient room for commercial purposes and storage capacity for the purpose of flushing out the sewer when necessary. In that event the portion set apart for a sewer should be so located that the southern wall of the sewer would form the northern boundary of the canal when reduced in width. The sewer should also be arched over, and the space between it and the present northern boundary, filled in with the material excavated from the bottom of the canal. The city would thus reclaim a width of from seventy-five to one hundred feet along the entire length of this portion of the canal, which, being located as it is in the heart of the city, could certainly be rented for an amount sufficient to pay the interest on the capital required to make the improvement; and also to create a sinking fund that would in a short time repay the principal.

The other considerations that should urge forward this improvement in the shortest possible time are too apparent to every one to require a reference here.

The same considerations should in my opinion apply with equal force in favor of arching over the channel of Tiber creek from its junction with the canal at least as high up as New Jersey avenue; and if this matter should be undertaken in good faith by the city, there can be no doubt that the general Government would immediately arch over that portion of the creek which runs through the public grounds between the canal and Pennsylvania avenue.

Before any portion of these improvements is commenced, however, I would advise that careful and comprehensive surveys, plans, and estimates be made of the whole question of sewerage and drainage of the city, upon the results of which would depend not only the probable cost of the works embraced in this particular improvement, but the requisite dimensions and capacity of the main artery to be formed by a portion of the canal, and the sizes of the different lateral sewers or veins that must intersect and be tributary to it, and for which it will be necessary to provide apertures and flood gates in the northern wall of the main sewer.

It is very manifest that the present system of drainage and sewerage for the city is much too limited in its capacity to supply the present demands upon it, and that it should be greatly enlarged in view of the fact that very soon from twenty-five to fifty million gallons of Potomac water will be discharged into it daily from the Washington aqueduct.

These considerations should induce the adoption of a general plan of proper proportions to commence with, and the adherence to it in any branch or portion of the work that may from time to time be undertaken and completed.

I have the honor to be,

Very respectfully,

Your obedient servant,

SILAS SEYMOUR,

Chief Engineer Washington Aqueduct.