

T H E S I S  
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P L A N S   A N D   S P E C I F I C A T I O N S  
.....for a.....  
S E W E R A G E   S Y S T E M  
for  
ALL OF CORVALLIS LYING WEST OF NINTH STREET

Submitted to the Faculty  
of the  
OREGON AGRICULTURAL COLLEGE  
for the  
Civil Engineering Degree

by

Redacted for Privacy

Approved June 10, 1908.

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Department of Civil Engineering.

PLANS AND SPECIFICATIONS FOR A SEWERAGE SYSTEM  
FOR ALL OF CORVALLIS LYING WEST OF NINTH STREET.

INTRODUCTION.

In the smaller cities and villages works for the purification of the sewage are lacking and in such places the usual method of disposal are very crude and offensive. Such crude and unwholesome methods are injurious to the health of the community and should give way to something better.

There are various factors and conditions which combine in determining the kind of system to be used in removing the sewage. It must be designed so that it will remove the impurities at once and to such a place that they shall not interfere with the public health.

At the present time only a portion of Corvallis is sewered and a portion of the City still employ the most crude and unhealthful methods of disposal. The district east of Ninth Street, as shown on the map, has an effective system of well constructed sewers, of the combined storm-water and domestic sewage type. Upon investigation, however, it was found

that this system is already connected up with more territory than it was originally designed to drain, and that a further extension of them would be impractical. With the added territory which has been connected with these mains, they are now taxed almost to their limit, and further extension might produce serious results.

The problem, then, for consideration was to design a system or systems which will drain the city districts west of Ninth Street and provide for the needs in the future. Since the water-carrying system of the Combined type is being used and has proven successful it was unnecessary to consider other methods of purification or disposal.

The Willamette river, flowing as it does, along the east side of the city provides a good means of disposal but the topography of the city is not very favorable for sewer construction. The flat condition of the surface of the ground limits the grades that can be used and leaves little chance in that particular. It therefore became necessary to choose routes whereby a sufficient grade could be secured to attain the necessary minimum velocity, at the same time keeping in mind the economical side of the question.

After surveys had been made and topographical working maps of the city completed two different propositions seemed to be feasible. The first of these

considered was to build independent systems for the two portions of the city lying on different sides of the Campus. The other proposition was to drain the two districts through one main and connect the whole in one system.

The portion of Corvallis lying north of the College Campus has a natural drainage basin, the lowest part of which runs along twelfth street from Monroe to a point near Harrison Street, and from there it runs in an easterly direction to tenth street. The draw follows along tenth street to a point near the city limits, then east it joins the Willamette river a short distance north of the city. A sewer running along twelfth street to the intersection of Tyler Street; thence east along Tyler Street to the intersection of tenth street; thence along tenth street to the city limits and running from thence east along the present city limits to the river, would form a suitable main to intercept all laterals for the drainage of that district. This route also makes use of the low ground and, therefore, reduces the cost of excavation materially.

The portion of the City south of the College Campus lies near Mary's river, as will be seen on the accompanying map and at first it was thought best to construct a sewer leading south to that river.

The small and uncertain flow during the dry season; the probability of a necessity for a change of locality for the old pumping system, as well as further considerations made other plans necessary. Upon further investigations it was found to be feasible to drain this district to the north across the College Campus and connect with the large main at the intersection of Monroe and Twelfth Streets. This plan was found not only feasible but, on the whole, probably more economical. The map herewith attached shows the location of the mains and laterals of the proposed sewer as now contemplated.

The rainfall at Corvallis is very high during the winter months, but excessive storms occur very seldom. The rainfall is usually steady, and extends over long periods at a time, and after a few days practically all of the water will reach the Sewers. ~~The present~~  
The present existing systems were designed to carry a probable run off of about a quarter of a cubic foot per second per acre, and thus far they have proven satisfactory. Gaugings of the College ditch during the winter of 1908 seems to indicate that this run off is sufficiently large for the greater part of the year. The value was then used to determine the discharge in the design of the system.

Sewers which will carry this quantity of water for each acre drained will probably carry off all the water entering them during the majority of the time. But as the maximum rainfall occurs simultaneously with the high water in the Willamette river it would be impractical to design a sewer to carry all the surface water for a very short time in the wet season, owing to back water in the outlet.

When the grade had been established and the discharge determined Kutters formula was used in computing the sizes of the sewer. These values are given in Table I. This table also shows the length of each section, and the grade as established on the profile.

The excavation was figured from the profile and is tabulated in Table 2. All material excavated at a depth up to 8 feet was computed as being removed in one handling and estimated to cost 25 cents per cubic yard. The material below this depth must necessarily be handled twice. A cost of 50 cents per cubic yard was estimated for excavating this material. These prices are supposed to cover the cost of back-filling and tamping.

All sewers having a diameter of 2 feet or over are to be made of reinforced concrete; egg-shaped in form and having proportional dimension as given by Merriman. The reason for making the barrel of the

sewer egg-shaped is to obtain a higher velocity during the period of minimum flow.

The reinforced concrete sewer is now being used extensively in this country and is coming into use more as the properties of concrete are better understood. The life of the concrete sewer is probably as great as that made of any other material in common use while its cost is no greater than a brick sewer. The thickness of the sewer was taken at six inches. This is nearly in accordance with modern practice.

The tables included herewith give the estimate of the cost of the various items of construction and are self explanatory. Table 5 gives estimates of cost of the Terra Cotta pipe sewers. The cost of the sewer pipe was taken from a catalogue of one of the large manufacturing plants and the discounts deducted. The other values in the table are from examples in the field with the local conditions applied.

The other tables are self explanatory and need no further discussion. Table 7 is a summary of costs of the proposed sewer showing also the total cost of the system.

The Specifications are taken from Folwell's text on sewerage and adapted to the local conditions. No originality is claimed for these specifications, but they are general specifications adapted to a specific problem.

MATERIALS.Sewer-pipe.

All pipe and specials, unless otherwise specified, shall be of the best quality, salt-glazed, vitrified clay sewer-pipe of the hub-and-spigot pattern; both body and bell shall have a thickness not less than  $1/12$  the inside diameter of the pipe. Each hub shall be of sufficient diameter to receive, to its full depth, the spigot end of the next following pipe or special without any chipping whatever of either, and also leave a space of not less than one half inch all around for the cement-mortar joint; it shall also have a depth from its face to the shoulder of the pipe on which it is moulded at least 2 inches greater than the thickness of said pipe. Straight and curved pipe having diameters up to and including 15 inches shall be furnished in 3-foot lengths. Branches may be in 2-foot lengths. All pipe and specials shall be sound and well burned, with a clear ring, well glazed and smooth on the inside and free from broken blisters, lumps, or flakes which are thicker than  $1/6$  the nominal thickness of the pipe and whose largest diameters are greater than  $1/8$  the inner diameter of said pipe; and pipe and specials having broken blisters, lumps, and flakes of any size shall be rejected unless the pipe can be so laid as to bring all

of these defects in the top half of the sewer. No pipe having unbroken blisters more than  $1/4$  inch high shall be used unless these blisters can be placed in the top of the sewer. Pipes or specials having fire-checks or cracks of any kind extending through the thickness shall be rejected.

No pipe shall be used which, designed to be straight, varies from a straight line more than  $1/8$  inch per foot of length; nor shall there be a variation between any two diameters of a pipe greater than  $1/24$  the nominal diameter.

No pipe shall be used which has a piece broken from the spigot end deeper than  $1\frac{1}{2}$  inches or longer at any point than  $\frac{1}{2}$  the diameter of the pipe; nor which has a piece broken from the bell end if the fracture extends into the body of the pipe, or if its greatest length is greater than  $\frac{1}{2}$  the diameter of the pipe, or if such fracture cannot be placed at the top of the sewer. Any pipe or special which betrays in any manner a want of thorough vitrification or fusion or the use of improper or insufficient materials or methods in its manufacture shall be rejected.

### Brick.

Section 2. For all brick-work none but the best quality of sound, hard-burned, perfect-shaped bricks, presenting a regular and smooth surface, shall

be used. After being thoroughly dried and immersed in water for 24 hours they shall not absorb more than 10 per cent by weight of water. Shale brick, if used, shall be composed of rock thoroughly ground and shall be homogeneous throughout and uniformly burned.

### Iron Castings.

Section 3. All iron castings shall be made from a superior quality of gray iron, remelted in the cupola or air-furnace, tough and of even grain, and shall possess a tensile strength of not less than 18,000 pounds per square inch. All castings shall conform to the shape and dimensions shown upon the drawings and shall be clean and perfect, without blow-or sand-holes or defects of any kind. No plugging or other stopping of holes will be allowed. The castings shall be thoroughly cleaned of all lumps and subjected to careful hammer tests.

### Wrought Iron.

Section 4. All wrought iron must be tough, ductile, and fibrous, of a uniform quality, free from crystalline structure, cinders, flaws, or cracks. In bars it must have an ultimate strength of 50,000 pounds per square inch. Iron which has been burnt in the forage will be rejected. Each wrought-iron piece furnished

shall correspond in all respects to the dimensions specified.

Sand.

Section 5. All sand shall be clean, sharp, and free from loam, clay, or vegetable matter.

Sand and Gravel.

Section 6. The sand and gravel used in concrete work shall be that found in gravel beds near Corvallis. This shall be free from loam and of the perishable matter, and shall be selected so that the proportion of sand to gravel shall be composed of 3 parts sand to about five parts gravel. Any sand and gravel differing by an appreciable amount from these proportions will be rejected by the Engineer.

Cement.

Section 7. Unless otherwise specified all cement shall be of the best quality of Portland cement, and when tested neat in briquettes shall show a tensile strength of at least 100 pounds after 1 hour in air and 23 hours in water and of at least 400 pounds after 1 day in air and 6 days in water. The fineness of the cement must be such that the residue shall not be more than 1 % on a number 50 sieve, 10% on a number 100 sieve and

30% on a number 200 sieve. Cement for brick masonry or pipe-joints, when these are laid in wet ground, shall be quick-setting and show a tensile strength of at least 115 pounds per square inch after 24 hours. Pats of neat cement made on glass and brought to a thin edge shall show no checks after setting in boiling water.

The cement mixed neat and stiff into pats  $\frac{1}{2}$  inch thick shall develop "initial" set in not less than 20 minutes and "hard" set in not less than 45 minutes after mixing, except in the case of quick-setting cement to be used as specified above.

The engineer shall be allowed to test all cement and notice of its receipt by the contractor must be made to the engineer at least 48 hours in advance of its use upon the work. Any cement not satisfactory to him shall be at once removed from the work.

#### Timber.

Section 8. All timber and planking used in cradles, platforms, and foundations shall be of Oregon Fir straight, sound, free from sap, shakes, large, loose or decayed knots, worm-holes, or other imperfections which may impair its strength or durability. Piles shall be of sound, straight, Fir timber of lengths specified by the engineer for each locality. They shall be not less than 6 inches in diameter at the smaller end.

The bark shall be removed in all cases.

EXCAVATION.

Excavation of Trench.

Section 9. The trench shall be excavated along the line designated by the engineer and to the depth necessary for laying the sewer or sub-drain at the grade given by him. In the case of pipe sewers it shall be 1 foot wider than the outside diameter of the pipe, and for concrete sewers at least 8 inches wider than the greatest external horizontal width of the structure to be placed therein, without any undercutting of the banks. Where, in the opinion of the engineer, the original earth is sufficiently compact and solid for the foundation of the work the contractor shall excavate the bottom of the trench to conform to the external form and dimensions of the invert or foundation as ordered. For pipe sewers the bottom of the trench under each bell shall be so hollowed out as to allow the body of the pipe to have a bearing throughout on the trench bottom and permit of making the joint. In case a trench be excavated at any place, excepting at joints, below the proper grade it shall be refilled to grade with sand or loam thoroughly rammed, without extra compensation

unless the extra excavation was ordered by the engineer.

The material excavated shall be laid compactly on the side of the trench and kept trimmed up so as to be of as little inconvenience as possible to the travelling public and to adjoining tenants. All streets shall be kept open for travel during the progress of the work.

No tunnelling will be allowed except by written permit, with restrictions, from the engineer. When tunnelling, the contractor will excavate the material to such cross-section as may be designated, using timbering or other tunnel-lining and shoring satisfactory to the engineer. The location and size of any shafts, and the location of pumps, derricks, boilers, and other machinery, must be approved by the engineer. The engineer shall have the right to limit the amount of trench which shall be opened or partly opened at any one time in advance of the completed sewer, and also the amount of trench left unfilled.

The contractor shall not, without permission from the engineer, remove from the line of the work any sand, gravel, or earth excavated therefrom which may be suitable for refilling the trench until the same shall have been refilled.

Pumping and Bailing.

Section 10. The contractor shall furnish all necessary machinery for the work, shall pump, bail, or otherwise remove any water which may be found or shall accumulate in the trenches, and shall perform all work necessary to keep them clear of water while the foundation and the masonry are being constructed or the sewer laid. In no case, unless by special permission of the engineer, shall water be allowed to run over the invert or foundation or through the sewer until the cement is satisfactorily hardened. The disposal of the water after removal shall be satisfactory to the engineer.

Shoring and Sheathing.

Section 11. Whenever necessary the sides of the trench shall be braced and rendered secure and either open or close sheathing used, to the satisfaction of the engineer; such sheathing and bracing to be left in until the trench is refilled, all such bracing and sheathing being done at the contractor's expense. Sheathing left in permanently by the order of the engineer, and only such, will be paid for at the price bid. When left in the trench sheathing shall be cut off at a point about 1 foot below the surface. The contractor shall, at his own expense, shore up and otherwise protect any building which may, in the opinion of

the engineer, be endangered by the work.

### Railway-crossings.

Section 12. When any railway lines are to be crossed or interfered with specific directions as to the time and manner of doing this work will be given by the engineer, and the contractor shall conform to such directions. He shall be allowed for material furnished and made part of the permanent construction, so far as it may be additional to that indicated on the plan, but all other work shall be done at his own cost.

### Interference with Existing Structures and Watercourses.

Section 13. In excavating and back-filling trenches and laying the sewer care must be taken not to move or injure any gas, water-, sewer-, or other pipes, conduits, or structures without the order of the engineer. If necessary the contractor shall, at his own expense, sling, shore up, and secure, and maintain a continuous flow in said structures, and shall repair any damage done to them and keep them in repair until the final acceptance of the completed works, leaving them in as good condition as when uncovered. Should it be necessary to move the position of a pipe or conduit this shall be done in accordance with the instructions of the engineer, and the contractor shall be allowed

for material furnished and made part of the permanent construction, so far as it may be additional to that indicated upon the plans, and for labor performed on such additional construction, but all other work shall be done at his own expense.

At such street-crossings and other points as may be directed by the engineer the trenches shall be bridged in a secure manner, so as to prevent any serious interruption of travel upon the roadway and sidewalks and also to afford necessary access to public and private premises. The material used and mode of constructing such bridges and the approaches thereto must be satisfactory to the engineer; the cost of all such work must be included in the regular price bid for the sewer. All fire-hydrants shall be left uncovered and accessible. The contractor shall at his own expense provide for all watercourses, gutters, and drains interrupted by the work and replace them in as good condition as he found them.

### CONSTRUCTION.

#### Foundations.

Section 14. When timber or pile foundations other than those shown in the plans are necessary, in the opinion of the engineer, special designs will be

furnished the contractor, who, in accordance with such designs, shall place such foundations in position satisfactory to the engineer. Planking in platforms shall be laid in the manner directed, closely joined, and each plank spiked to each cap or sill with nails or spikes of a length at least  $2\frac{1}{2}$  times the thickness of the plank. If cradles or platforms are laid directly upon the ground this must be graded perfectly even and smooth to receive them and give a good and firm bearing throughout. If caps or sills are used the spaces between them and under the planking must be filled with good earth thoroughly rammed.

Concrete or stone-masonry foundations shall be constructed where ordered in a manner similar to that specified for "Concrete" and "Stone Masonry".

#### Concrete.

Section 15. Concrete unless otherwise specified shall consist of one part by bulk of cement to 3 parts sand to five parts gravel. The sand and gravel shall be used as found in the natural bed and shall conform to the specifications given above. The cement shall be thoroughly mixed neat in a clean tight mortar box, The sand and gravel must then be thoroughly drenched with clean water and then shall be added to the cement in the proportion stated above. The

concrete must then be worked over and mixed until each stone is completely covered with mortar and all spaces between the gravel completely filled with sand.

#### Forms.

Section 16. Such forms and centres as may be necessary to give the finished concrete the desired form shall be furnished by the contractor without extra charge. These shall be sufficiently stiff and substantial to retain the concrete firmly in place, and shall not be withdrawn until the same has set to the satisfaction of the engineer. No concrete shall be made or used when the temperature is below 35° Fahr. without the permission of the engineer, whose instructions and restrictions for such use shall be followed.

#### Stone and Brick Masonry.

Section 17. Stone and brick masonry, unless otherwise specified, shall be laid with mortar composed of 1 part by measure of natural cement to 2 of sand, mixed as specified for concrete mortar. No mortar shall be used after it has set or partially set.

Stone masonry must be laid true and by line and built of the exact dimensions shown in the plans of the work. All stones shall be laid upon their natural beds and roughly squared on the joints, beds, and faces,

the stone breaking joints at least 6 inches, and with at least one header for every three stretchers. Headers shall be at least 3 feet long or extend entirely through the wall. No stone once bedded shall be lifted by spalling, but any spalls used must be embedded in the mortar before setting the stone. Each stone shall be floated to place in a full bed of mortar and every joint thoroughly filled with the same. No dressing of stone upon the wall will be allowed.

For brick masonry in straight walls or sewers none but whole, sound brick shall be used. For manholes, flush-tanks, and similar work a limited number of half brick may be used, not to exceed  $1/3$  of the whole in any case. Unless the engineer direct otherwise each brick shall be thoroughly wetted immediately before being laid. It shall be laid with a full, close joint of cement mortar on its bed, ends, and side at one operation. In no case is mortar to be slushed in afterward. Special care shall be taken to make the face of the brick-work smooth, and all joints on the interior of a sewer shall be carefully struck with the point of a trowel or pointed to the satisfaction of the engineer. Where pipe connections enter a sewer or manhole "bull's-eye" shall be constructed by laying rowlock courses of brick around them, the cost of such construction being included in the regular price bid for the sewer or

appurtenance. Around pipe more than 15 inches in diameter 2 rowlock courses shall be laid.

Laying Pipe Sewers.

Section 18. Previous to being lowered into the trench each pipe shall be carefully inspected, and those not meeting the foregoing specifications shall be rejected, and either destroyed or removed from the work within 10 hours; except that pipe suitable for sub-drains may be used for that purpose, but shall be kept apart from the sewer-pipe. All lumps or excrescences on the ends of each pipe shall be removed before it is lowered into the trench. No pipe shall be laid except in the presence of the engineer or his authorized inspector, and the engineer may order the removal and re-laying of any pipe not so laid. The trench shall be excavated in accordance with Section 9. No sewers shall be laid within 10 feet of the excavating. Pipes having any defects which do not cause their rejection shall be so laid as to bring these in the top half of the sewer, and if the bell or spigot be broken the defective place must be liberally covered with near-cement mortar, reinforced with a piece of pipe or pipe-ring if the engineer so direct.

The pipes and specials shall be so laid in the trench that after the sewer is completed the interior

surface thereof shall conform accurately to the grades and alignment fixed and given by the engineer. All adjustment to line and grade of pipes laid directly upon the bottom must be done by scraping away or filling in the earth under the body of the pipe, and not by blocking or wedging up. Before laying, the interior of the bell shall be carefully wiped smooth and clean, and the annular space shall be free from dirt, stones, or water. A narrow gasket of packing dipped in cement grout shall be properly calked into each joint, after which cement mortar shall be introduced therein. Such gasket shall be in one piece, of sufficient length to reach entirely around the pipe and of a thickness sufficient to bring the bottoms of the two pipes to the same level. No joint shall be cemented until the gaskets of the next joints in advance are properly inserted. Special care must be taken to properly fill with mortar the annular space at the bottom and sides as well as at the top of the joints. After such space has been filled, the cement having been compacted with a wooden or iron calking-tool, a neat finish shall be given to the joint by the further application of similar mortar to the face of the hub so as to form a continuous and even bevelled surface from the exterior of said hub to the exterior of the spigot all around. All water must be kept out of the bell-hole during laying, or else such bell-hole

must be completely filled out with the cement mortar specified or with concrete, for which mortar or concrete no extra compensation will be allowed. The interior of the joint shall be wiped clean of cement by a wad made of a sack filled with hay, large enough to tightly fill the pipe and attached to a rod or cord, which shall at all times be kept in the sewer and pulled ahead past each joint as soon as it is cemented. The mortar used shall be composed of 1 part cement to 1 part of sand.

As soon as the cementing of any joint has been completed the bell-hole under the hub must be carefully and compactly filled with sand, loam, or fine earth, so as to hold the external mortar finish of said joint securely in its place. Refilling shall also be made with selected material, free from stones, carried half-way up the sides or circumference of the entire length of pipe and compacted with a proper tamping-tool. The trench shall then be filled to a point at least 2 feet above the top of the pipe with material containing no stone larger than 2 inches in any dimension.

While the pipes and specials are being laid in each section between manholes or other permanent openings light from the remote end of the section shall remain constantly in plain view throughout the entire length of such section or division. Sections between openings will in general not exceed 300 to 400 feet;

in particular cases the distance may be somewhat greater.

At such places as will be directed by the engineer, branches will be inserted in the sewer for future connections. Each branch thus inserted shall be closed by a thin vitrified stoneware cover or plug, which shall be placed before the special pipe is lowered into the trench. The covers shall be so inserted and cemented in as to prevent any water entering the sewer, at any time before their removal, through such branches. The entire cost of furnishing and setting such covers shall be included in the regular price bid for branches. Where directed by the engineer deep cut connections shall be constructed as shown upon the plans.

Any omission of the required branches, manholes, lamp-holes, or other special constructions indicated upon the plans, or that may be specially ordered beforehand by the engineer, shall be corrected by the contractor at his own expense.

Before leaving the work for the night or at any other time the end of the sewer shall be securely closed with a tight fitting plug.

#### Regular Appurtenances.

Section 19. Manholes of the various kinds --line, intersection, drop, etc.--lamp-holes, flush tanks, inlets, and other appurtenances shall be built

where the engineer may direct, in size, form, thickness, and all other respects in accordance with the plans, but manholes whose height exceeds 12 feet shall have walls 12 inches thick below that depth. All appurtenances shall be brought up accurately to the grade given by the engineer. Great care shall be taken to make the channels in manholes and lamp-holes conform accurately to the sewer grade. In the case of pipe-sewers split pipe shall be used for the inverts to these channels where possible. Where a curve in the channel or some other condition prevents this the channel shall be formed of bricks on edge, set in Portland-cement mortar. Brick channels shall be lined with neat Portland-cement mortar  $\frac{1}{4}$  inch thick, and the inverts shall be exactly semi-circular of the diameter of the pipes which they connect. If these be of different diameters the channel shall taper uniformly from one size to the other.

Flush-tanks and inlets shall be plastered on the outside with  $\frac{1}{2}$  inch of cement mortar; and on the inside shall be given three coats of thin Portland-cement grout, without sand, applied with a brush, each coat being allowed to set before the next is applied.

Care shall be taken to place the inlet tops, when these are in the sidewalk, exactly in line with the curb, and to place the bottoms of the openings or the gratings exactly on the gutter grade given.

All manholes and flush-tanks shall be fitted with steps similar to those shown on the plans, and spaced 15 inches apart vertically. All tops or other fittings shall be set during the construction or at the completion of each appurtenance, in a firm, neat, and workmanlike manner.

All concrete, stone, or brick masonry shall conform to the specifications given in Sections 14 and 15. Each appurtenance shall be begun within 24 hours of the time it is reached in the laying of the sewer, and shall be completed and the excavation closed as expeditiously as possible.

#### Back-filling and Cleaning Up.

##### Back-filling.

Section 20. In back-filling sewer-trenches loose, fine earth, free from stones, shall be used up to a point 2 feet above the sewer, and shall be thoroughly compacted in 6-inch layers with hand-rammers. The remainder of the trench shall contain not more than 1/3 broken rock, and no stone of this shall weigh more than 50 pounds. If necessary to meet this requirement the contractor shall supply suitable material for back-filling. The filling of the trench above the level of 2 feet above the sewer shall be rammed in 9-inch

layers, or, when directed by the engineer, the trenches shall be water-tamped. Water-tamping shall be done in each case as directed by the engineer. All back-filling shall be done by hand and in no case shall scrapers or ploughs be used. In back-filling of tunnels or under railroad tracks especial care shall be taken to thoroughly compact the material.

### Street Surfaces.

Section 21. In all streets the surface of the trenches shall be finished in a workmanlike manner, and shall in every respect be equal in quality, character of materials and workmanship to the street existing over the line of the trench immediately previous to making the excavation. The expense of restoring the same must be in the price bid.

### Cleaning up.

Section 22. As soon as the trench has been refilled and paving replaced all stones, plank, or other refuse material of whatever description deposited and left by the contractor on the streets shall be removed therefrom and the said streets restored in all respects to the same condition as before the trenching was commenced. All surplus earth which may be left on the

street after the trenches have been refilled as specified above shall be regarded as the property of the contractor, and must be removed as soon as possible at his expense.

Final Inspection.

Section 23. Upon notification by the contractor of the completion of the work herein contracted for the engineer will carefully inspect all sewers, appurtenances, and all other work done by the contractor. In each stretch of pipe sewer intended to be straight light shall be visible from one end to the other. Any broken or cracked pipe shall be replaced with sound ones. The interior of brick sewers shall be of the required shape and dimensions, sound and of a uniform surface. Any deposits found in the sewers, protruding cement or packing, shall be removed and the sewerbore left clean and free through its entire length. There shall be no appreciable amount of leakage into any stretch of sewer. All underdrains shall discharge water freely and give evidence of having a clean and open bore. All manholes, lamp-holes, and other appurtenances shall be of the specified size and form and of a neat appearance, and their tops shall be set to the proper grade. In general the work shall comply with these specifications, and if found not to do so in any respect shall be

brought to the proper condition by cleaning, pointing, or, if necessary, excavating, and rebuilding, all at the expense of the contractor. But if it be found after uncovering any pipe or other work at the order of the engineer that no defect exists, or that the defect was not due to any fault of the contractor, then the expense of this shall be borne by the city.

#### GENERAL PROVISIONS, PAYMENTS, ETC.

##### General Provisions.

Section 24. If any alterations in plan directed by the engineer diminish the quantity of work to be done they shall not constitute a claim for damages nor for anticipated profits, and any increase or decrease shall be paid for or deducted according to the quantity actually done, and at the price established for such work under this contract.

The work shall be prosecuted in such manner and from as many different points, at such times and with force as the engineer may, from time to time during the progress of the work, determine.

The contractor will be furnished with a set of drawings showing the details and dimensions necessary to carry out the work, dimensions in figures thereon having precedence over the scale. These plans and

a copy of these specifications are to be kept constantly at the work by the contractor or his authorized foreman. The plans submitted to contractors for proposals are to be interpreted in conjunction with the specifications, and descriptions of the character of the work appearing on the plans are made a part of these specifications. No deviations from the drawings will be allowed without the direction of the engineer to that effect.

Should it be necessary at any time to move monument stones or other permanent records the contractor shall not disturb them until given permission by the engineer.

The contractor shall provide suitable stakes, plank, and forms, and render such assistance to the engineer, at his own expense, as may be necessary to establish lines and grades for the guidance of his work, and shall carefully preserve said points at all times.

If any person employed by the contractor on this work shall appear to be incompetent or disorderly he shall be discharged immediately on the requisition of the engineer, and such person shall not again be employed on the work.

Responsibility for Injuries.

Section 25. The contractor shall be responsible for injuries to person and property inflicted during the prosecution of the work, and for all damages caused by the negligence of the contractor or any of his employes, workmen, or servants, and the city may at its discretion withhold the amount of such injury or damage from any estimate due him which may be needed to make good such damages or injuries, and the city shall not in any wise be liable therefor.

The contractor shall place sufficient lights on or near the work and keep them burning from twilight to sunrise, shall erect suitable railing or protection about the open trenches, and provide all necessary watchmen on the work by day or night, for the safety of the public.

Imperfect Work.

Section 26. When any work or material is found to be imperfect, whether passed upon or not by the inspector, the said work shall be taken up and replaced by new work at any time prior to final acceptance.

If the contractor shall be notified by the engineer of any requirements or precautions neglected

or omitted, or of any work improperly constructed, he shall at once remedy the same, and if he fail so to do the engineer, under the direction of the city, shall perform such work at the contractor's expense and deduct the same from amounts due or to become due the contractor.

Unnecessary Delays.

Section 27. In case of any unnecessary delay, in the opinion of the engineer, he shall notify the contractor in writing to that effect. If the contractor should not, within 5 days thereafter, take such measures as will, in the judgment of the engineer, insure the satisfactory completion of the work the engineer may then, under authority from the city, notify the aforesaid contractor to discontinue all work under this contract, and it is hereby agreed that the contractor is to immediately respect said notice and stop work and cease to have any rights to possession of the ground. The engineer shall thereupon have the power to place such and so many persons as he may deem advisable, by contract or otherwise, to work at and complete the work herein described, and to use such materials as he shall find upon the line of said work, or to procure other materials for the completion of the same, and to charge the expense of said labor and materials to the afore-

said contractor; and the expense so charged shall be deducted and paid by the party of the first part out of such money as may be then due, or at any time thereafter become due, to said contractor under and by virtue of this agreement or any part thereof; and in case such expense is less than the sum which would have been payable under this contract if the same had been completed by the party of the second part he shall be entitled to receive the difference, and in case such expense is greater the party of the second part shall pay the amount of such excess so due.

#### Extra Work.

Section 28. If any work of the general nature of the work herein contracted for, but for doing which a bid has not been especially made, shall need to be done the contractor shall do the same under the direction of the engineer, and shall receive therefor the actual cost of labor and material used plus ten per cent (10%) for superintendence and use of tools, but he shall not be entitled to receive payment for any work as extra work unless ordered by the engineer to do the same as such. No claim for extra work will be allowed if not made before the payment of the next following monthly estimate.

Time of Commencement and Completion.

Section 29. The party of the second part agrees to begin the work herein contracted for within two weeks of the awarding of the contract, and to fully complete the work herein specified on or before the.... day after the awarding of said contract, but the party of the first part may extend the time of completion should they deem it for the best interest of the city. It is expressly understood that the party of the second part agrees to pay all expenses, such as engineering and inspection, that the city may be put to by reason of the work being incompleted at the time specified in the contract.

Definitions.

Section 30. Whenever the word "engineer" is used in the specifications it refers to the engineer in charge of the work and also to his authorized agents.

The "party of the first part" is the city by and for which the work herein described and referred to is being done, and the "party of the second part" is the person or persons contracting to do said work.

The word "sewer" in its general sense in these specifications refers to the sewer-barrel and to any bends, slants, branches, or other details joined to

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or forming a part thereof. The word "appurtenance" refers to all manholes, flush-tanks, inlets, and all structures forming a part of the sewerage system, but not included in the term "sewer".

#### Position of the Engineer.

Section 31. The engineer shall have the final decision on all matters of dispute involving the character of the work, the compensation to be made therefor, or any question arising under this contract. He shall, as representing the city, have the option of making any changes in the line, grade, plan, form, position, dimensions, or material of the work herein contemplated, either before or after construction is begun, and all explanations or directions necessary for carrying out and completing satisfactorily the different descriptions of work contemplated and provided for under this contract will be given by said engineer.

#### Duties of the Contractor.

Section 32. The contractor must perform the work contracted for strictly according to these specifications, and follow at all times, without delay, all orders and instructions of the engineer in the prosecution and completion of the work and every part thereof, and constantly be on the ground or be represented

by a duly qualified person to look after the work and receive instructions.

Measurements and Payments.

Section 33. Measurements of sewers and drains shall be taken from the centre of the uppermost manhole or flush-tank on each line to the centre of the manhole at its junction with a main or lateral, or to the centre line of such main or lateral at the junction, including all branches, manholes, or other appurtenances along the line. The depth by which sewer prices will be graded will be measured from the surface of the ground to the under side of the sewer-pipe or masonry or of the timber platforms or foundation-sills. The price bid for sewers or drains shall include furnishing all material and labor for excavating, shoring, constructing the sewer or drain in accordance with the specifications and plans, back-filling, restoring the street-surface as previously specified, and for all matters in connection therewith heretofore specified as being so included. Measurements of connections shall be taken from the outside (bell) end of the branch to the upper end of the connection-pipe. Branches shall be paid for by the piece at the price bid, which shall include the cost of furnishing and fixing plugs in said branches where necessary.

Deep-cut connections shall be paid for at the prices bid for "deep-cut connections," "pipe," "concrete," and "timber in foundations," according to the actual quantities used, the bid for "deep-cut connections" including the combining of these and the setting of, and extra care in back-filling around, the pipe.

Flush-tanks shall be paid for at the price bid for each particular size of tank, this to include the tank complete as set forth in the drawings and specifications, including the excavation and back-filling, ventilation-pipe and iron head.

Ordinary manholes shall be paid for on the basis of a depth of 8 feet, with an additional amount for each foot by which the depth exceeds 8 feet, the price bid to include excavating and back-filling, furnishing and setting iron castings and steps, and completing the whole as set forth in the plans and specifications. The depth of flush-tanks, manholes, shall be measured from the invert of a pipe sewer, or the springing of a brick sewer, to the top of the iron head when properly set.

The price bid for "crossing-" and "drop-manholes" shall be an additional sum over and above the bid for the same as a regular man-hole, and shall be held to cover furnishing material for and constructing

the crossing or drop device as shown in the plans, as an addition to the regular manhole. The bid for the crossing-manhole shall be a lump sum; that for the drop-manhole shall be per vertical foot, measuring from the invert of the lower to that of the upper sewer.

The price bid for inlets, catch-basins, and other appurtenances shall include the excavation and back-filling, and furnishing all materials and constructing each appurtenance in strict conformity to the plans and specifications.

The price for stone, brick, or concrete masonry not otherwise provided for shall be per cubic yard by actual measurement in place, provided such dimensions do not exceed those indicated or implied in the plans or instructions of the engineer.

Iron-work, both cast and wrought, shall be paid for by the pound, but no payment for iron-work as such shall be made for the heads or steps or other devices included in the manholes and other appurtenances as shown in the plans and specifications.

The price for timber in foundations shall include the furnishing and setting of the same. The price bid for furnishing piles shall be for the lengths actually delivered, where these do not exceed those ordered by the engineer. The price for driving piles shall be per foot, measured from the bottom of the pile when

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driven to the surface of the ground in which it is driven, and shall include cutting off the piles at the elevation given by the engineer.

The engineer on the first of each month, or within 5 days thereafter, during construction, will estimate approximately the amount of work completed during the preceding month, according to these specifications, and eighty-five per cent (85%) of the amount due beyond the reservations herein made will be paid the contractor on or before the 15th day of each month for the work of the preceding month.

When the contract shall have been completely performed on the part of the contractor the engineer shall proceed to make final measurements and estimates of the same, and shall certify the same to the city.... who shall, except for cause herein specified, pay to the contractor, on or before the 15th day after such completion of the contract, the balance which shall be found due, excepting therefrom such sum as may be lawfully retained under any provision of this contract.

CONTRACT.

This AGREEMENT, made and concluded the..... day of..... in the year One Thousand Eight Hundred and ....., by and between the City of Corvallis, of the first part, and....., Contractor, of the second part,

WITNESSETH, That the said party of the second part (has) (have) agreed, and by these presents (does) (do) agree with the said party of the first part, for the considerations herein mentioned and contained, and under the penalty expressed in a bond bearing even date with these presents and hereto attached, to furnish at (his) (their) own proper cost and expense all the necessary material and labor, except as herein specially provided, and to excavate for and build, in a good, firm, and substantial manner, the sewers indicated on the plans now on file in the office of the city engineer, and the connections and appurtenances of every kind complete, of the dimensions, in the manner, and under the conditions herein specified; and (has) (have) further agreed that the engineer in charge of the work shall be and is hereby authorized to inspect or cause to be inspected the materials to be furnished and the work to be done under this agreement, and to see that the same correspond with the specifications.

The party of the second part hereby further agrees that (he) (they) will furnish the city with satisfactory evidence that all persons who have done work or furnished material under this agreement, and are entitled to a lien therefor under any law of the State of ....., have been fully paid or are no longer entitled to such lien, and in case such evidence be not furnished as aforesaid such amount as the party of the first part may consider necessary to meet the lawful claims of the persons aforesaid shall be retained from the moneys due the said party of the second part, under this agreement, until the liabilities aforesaid may be fully discharged and the evidence thereof furnished.

The said party of the second part further agrees that (he) (they) will execute a bond in a sum equal to 25 per cent of the contract price, secured by a responsible Indemnity or Guarantee Company of, or authorized by law to do business in, the State of Oregon and satisfactory to the city, or by at least three responsible freeholders of Benton County satisfactory to the city, for the faithful performance of this contract, conditioned to indemnify and save harmless the said city, its officers or agents, from all suits or actions of every name or description brought against any of them or on account of any injuries or

damages received or sustained by any party or parties, by or from the said party of the second part, (his) (their) servants or agents, in the constuction of said work, or by or in consequence of any negligence in guarding the same or any improper materials used in its construction, or by or on account of any act or omission of the said party of the second part, or (his) (their) agents, in the performance of this agreement and the faithful performance of this contract in all respects by the party of the second part; and the said party of the second part hereby further agrees that so much of the moneys due to (him) (them), under and by virtue of this agreement, as shall be considered necessary by the said city may be retained by the said party of the first part, until all such suits or claims for damages as aforesaid shall have been settled and evidence to that effect furnished to the satisfaction of said city.

The said party of the first part hereby agrees to pay, and the said party of the second part agrees to receive, the following prices as full compensation for furnishing all materials, labor, and tools used in building and constructing, excavating and back-filling, and in all respects completing the aforesaid work and appurtenances, in the manner and under the conditions before specified, and as full compensation for all loss or

damages arising out of the nature of the work aforesaid, or from the action of the elements or from any unforeseen obstructions or difficulties which may be encountered in the prosecution of the same, and for all expenses incurred by or in consequence of the suspension or discontinuance of the said work, and for well and faithfully completing the same and the whole thereof according to the specifications and requirements of the engineer under them, to wit:

For all 3.4 feet concrete sewer,

from 12 to 16 feet.....\$--- per lineal foot

For all 3.2 feet concrete sewer,

from 12 to 16 feet..... --- " " "

For all 3.0 feet concrete sewer,

from 12 to 16 feet..... --- " " "

For all 2 foot terra-cotta sewers,

from 9 to 16 feet..... --- " " "

For all 1.3 feet.terra-cotta sewers,

from 9 to 16 feet..... --- " " "

For all 1 foot terra-cotta sewers,

from 9 to 16 feet.,,,,,,, --- " " "

For all 0.8 feet terra-cotta sewers,

from 9 to 16 feet..... --- " " "

For each manhole 8 feet deep, complete ---

For each vertical foot of manhole more

than 8 feet deep, 8-inch wall ... ---

For each vertical foot of manhole more

than 8 feet deep, 12-inch wall... ---

For timber foundations..... --- per M B.M.

And the said party of the second part further agrees that (he) (they) will not assign, transfer, or sublet the aforesaid work, or any part thereof without the written consent of the city, and that any assignment, transfer, or subletting without the written consent aforesaid shall in every case be absolutely void.

IN WITNESS WHEREOF the said party of the second part (has) (have) hereunto set (his)(their) hand and seal and the said party of the first part has caused these presents to be sealed with its common seal and to be signed by the .....on the day and year above written.

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Table 1.

Section	Location of Section	Length	Discharge in cubic Feet per Minute.			Slope	Size of Sewer	
			Begin- ning of Section	Middle of Section	End of Section		Round Feet.	Egg-shaped
								D
A	From River to Tenth St.	2603.2	4250		5000	.002	3.4	5.1
B	From x 10th St.to Tyler	826.8	4186.		4186	. "	3.2	4.8
C	Along Tyler 10th to 12th	506.0	3841	3841	3986	"	3.2	4.8
D	" 12th to Harrison	370.0	1981		1981	.0025	2.3	3.5
E	" " " Van Buren	374.0	1981		1981	"	2.3	3.5
F	" " " Jackson	370.0	1918		1918	"	2.3	3.5
G	" " " Monroe	400.5	1788		1788	"	2.2	3.3
H	From Monroe to x Col.S.	797.7	1038		1308	"	2.0	3.0
I	" x College Sr.to Adams	531.8	860		860	.004	2.0	
J	" Adams to Depot St.	420.0	300		300	.005	1.3	
M	Tyler St.Branch 12 to 15	764.0	1067	1263	1654	.006	2.0	3.0
N	Tyler St. Branch15 to 19	1118.0	437		1069	.006	1.75	
O	Monroe St.Branch	1050.0	186		315	.01	1.0	
P	" " to end	1500.0	120		186	.02	0.8	

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Table 2.

Section	Length	Width of Trench	Average Depth	Volume in Cubic Yards	Removed with one Handling		Removed with two Handlings.		Total Cost Of Excavation
					Volume	Cost at 25¢	Volume	Cost at 50¢	
A	2603.2	5.9	14.6	8238	5140	\$1285.00	3138	\$1569.00	\$2854.00
B	826.8	"	16.1	2943	1471	367.85	1472	736.00	1103.85
C	506.0	"	16.1	1780	890	222.50	890	445.00	667.50
D	370.0	4.3	16.0	945	472	118.10	472	236.25	354.35
E	374.0	"	16.0	955	478	119.75	477	238.50	358.25
F	370.0	"	16.0	945	472	118.10	472	236.25	354.35
G	400.5	"	16.0	1023	512	128.00	512	256.00	384.00
H	797.7	3.0	12.4	1180	709	177.25	471	235.50	352.75
I	531.8	"	12.4	730	472	118.00	258	129.00	347.00
J	420.0	2.5	9.6	461	461	115.25			115.25
M	764.0	3.0	16.1	1260	610	152.50	650	325.00	477.50
N	1118.0	"	16.1	2096	1040	260.00	1056	528.00	788.00
O	1050.0	2.5	12.4	1209	778	194.50	431	215.50	410.00
P	1500.0	"	12.4	1727	1110	277.50	617	308.50	586.00

Table 3.

Section.	D.	Length of Section.	Area of Shell	Cu. Yds. of Concrete	Cost of Sand and Gravel	Bbls. of Cement	Cost of Cement	Re-enforcing in Square Feet.	Cost of Re- enforcing	Cost of Material for Forms.	Total Cost of Material
A	3.4	2603.	6.1	588	\$352.85	606	\$ 1965.50	37223	\$1116.70	\$650.75	\$5695.80
B	3.2	826.8	5.9	99.3	59.60	102	331.50	11213	336.38	206.75	934.00
C	3.2	506.0	5.9	73.0	43.80	75	243.75	6477	194.30	124.50	606.35
D	2.3	370.0	4.3	59.2	35.50	62	201.50	3404	102.10	92.50	431.60
E	2.3	374.0	4.3	60.4	36.24	63	204.75	3431	102.95	93.50	437.44
F	2.3	370.0	4.3	59.2	35.50	62	201.50	3404	102.10	92.50	431.60
G	2.3	400.5	4.3	64.1	38.45	66	214.50	3680	110.40	100.10	463.45
H	2.0	7297.0	3.8	115.7	69.42	119	386.75	6382	191.46	199.25	846.88
M	2.0	764.0	3.8	112.4	64.84	112	364.0	6112	183.36	191.45	803.20

Table 4.

Section of Sewer	Cost of Mixing Concrete	Drayage	Moving and Set- ting Form	Placing and Ramming	Clearing Away	Finish- ing at 10¢	Total Cost for Labor
A	636.80	90.60	780.90	294.00	21.10	260.50	2083.90
B	109.93	25.20	248.10	50.00	12.30	82.60	515.13
C	80.05	17.50	151.80	36.30	9.00	50.60	415.25
D	65.15	12.20	111.00	29.60	8.40	37.00	262.35
E	66.50	14.00	112.20	32.60	8.50	37.40	271.30
F	65.15	12.50	111.00	29.60	8.40	37.00	262.65
G	70.50	15.50	120.00	32.00	10.00	40.00	288.00
H	67.75	18.45	235.25	30.75	12.00	79.75	343.95
M	119.25	18.00	229.20	54.00	25.30	76.40	522.15

Table 5.

[illegible]

Table 6.

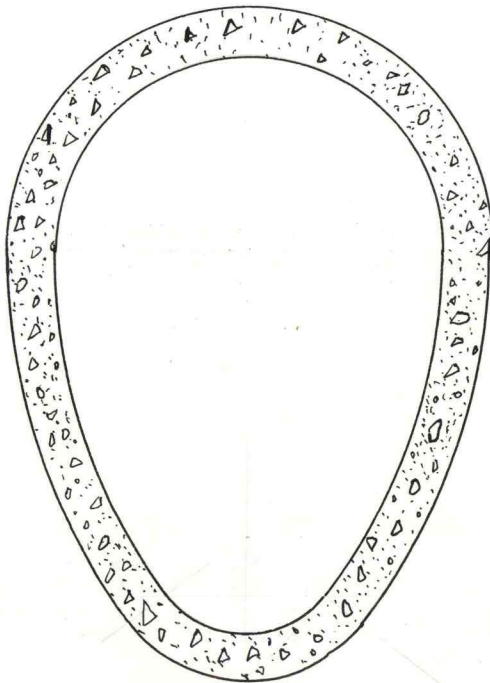
ESTIMATE of COST of MANHOLES.									
SECTION	NUMBER of MANHOLES	BRICK per MANHOLE	COST of BRICK 8.50, M	RING AND COVER.	CEMENT	SAND	LABOR	COST of C MANHOLE.	
A	18	1750	14.85	7.50	9.00	1.00	14.00	46.35	370.80
B	4	2000	17.00	"	10.50	1.20	15.00	51.20	204.80
C	3	2000	17.00	"	10.50	1.20	15.00	51.20	150.60
D	1	2000	17.00	"	10.50	1.20	15.00	51.20	51.20
E	1	2000	17.00	"	10.50	1.20	15.00	51.20	51.20
F	1	2000	17.00	"	10.50	1.20	15.00	51.20	51.20
G	1	2000	17.00	"	10.50	1.20	15.00	51.20	51.20
H	2	1500	12.75	"	6.75	.85	12.00	39.85	79.70
I	2	1500	12.75	"	6.75	.85	12.00	39.85	79.70
J	3	1250	10.65	"	6.00	.60	10.50	35.35	105.75
M	3	2000	17.00	"	10.50	1.20	15.00	51.20	153.60
N	5	2000	17.00	"	10.50	1.20	15.00	51.20	256.00
O	4	1500	12.75	"	6.75	.85	12.00	39.85	159.40
P	3	1500	12.75	"	6.75	.85	12.00	39.85	119.55

Table 7.

## A SUMMARY of COST of THE PROPOSED SEWER for CORVALLIS.

SECTION	KIND OF SEWER	LENGTH	EXCAVATION	MATERIAL	LABOR	MANHOLES	TOTAL COST.	
							PER FOOT.	SECTION
A	Concrete	2603.2	2854.00	5695.80	2083.90	570.80	4.24	11004.50
B	"	826.8	1103.85	934.00	513.13	204.80	3.35	2755.78
C	"	506.0	667.50	606.35	415.25	150.60	3.60	1839.10
D	"	370.0	354.35	431.60	262.35	51.20	2.97	1099.50
E	"	374.0	358.25	437.45	271.30	51.20	2.98	1118.20
F	"	370.0	354.35	431.60	262.35	51.20	2.97	1099.50
G	"	400.5	384.00	463.45	288.00	51.20	2.96	1186.65
H	"	797.7	352.75	846.88	343.95	79.70	2.04	1623.28
I	T.C.	531.8	347.00	961.85	54.21	79.70	2.771	1443.76
J	T.C.	420.0	115.25	327.60	21.85	105.75	1.35	570.45
M	Concrete	764.0	477.50	803.20	522.15	153.60	2.55	1956.45
N	T.C.	1118.0	788.00	1436.08	114.45	256.00	2.32	2594.53
O	T.C.	1050.0	410.00	504.50	52.70	159.40	1.07	1126.60
P	T.C.	1500.0	586.00	562.45	67.55	119.55	0.88	11335.50

# Cross-section of Proposed Sewer.



$$D = ab$$

$$R = 1\frac{1}{2}D$$

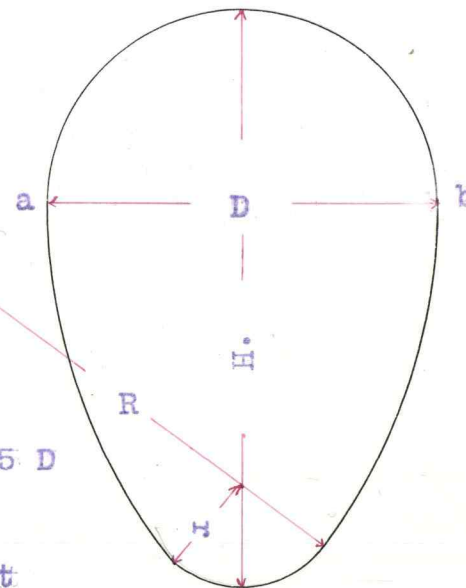
$$r = \frac{1}{4}D$$

$$H = 1\frac{1}{2}D$$

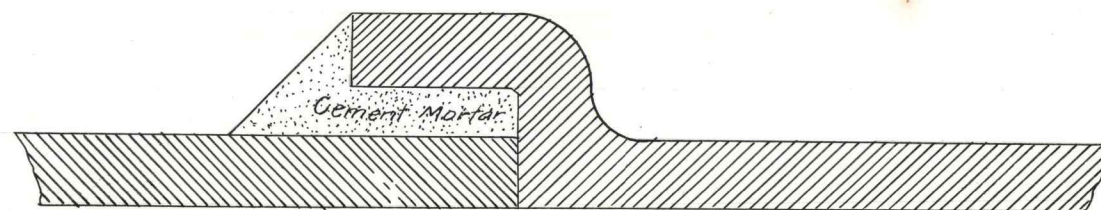
$$t = .5ft.$$

Area of  
Section = 1.1485 D

Area of  
Shell = 1.2638 t



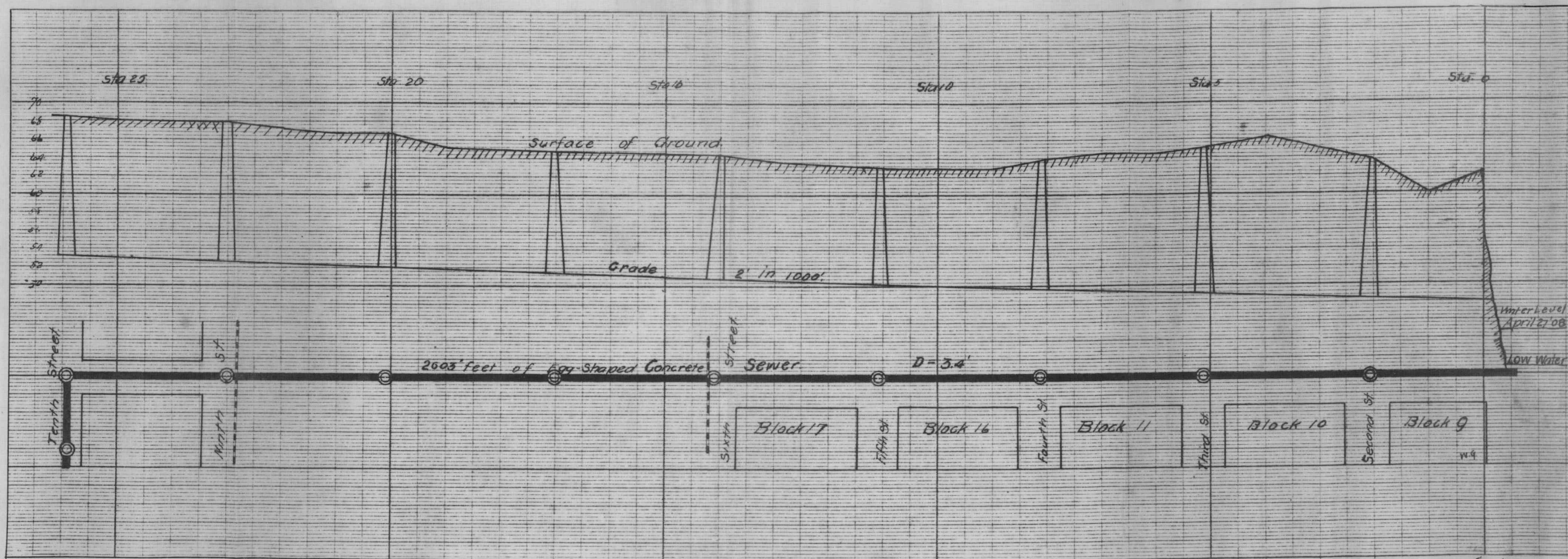
Section	Dimensions				Area of shell.
	D	R	r	H	
A	3.4	5.1	0.85	5.1	6.1
E & C	3.2	4.8	0.8	3.2	5.9
C, D, E, F.	2.3	3.45	0.575	3.45	4.3
H & M.	2.0	3.0	0.5	3.0	3.8



DETAIL of JOINT for TERRA-COTTA SEWER.

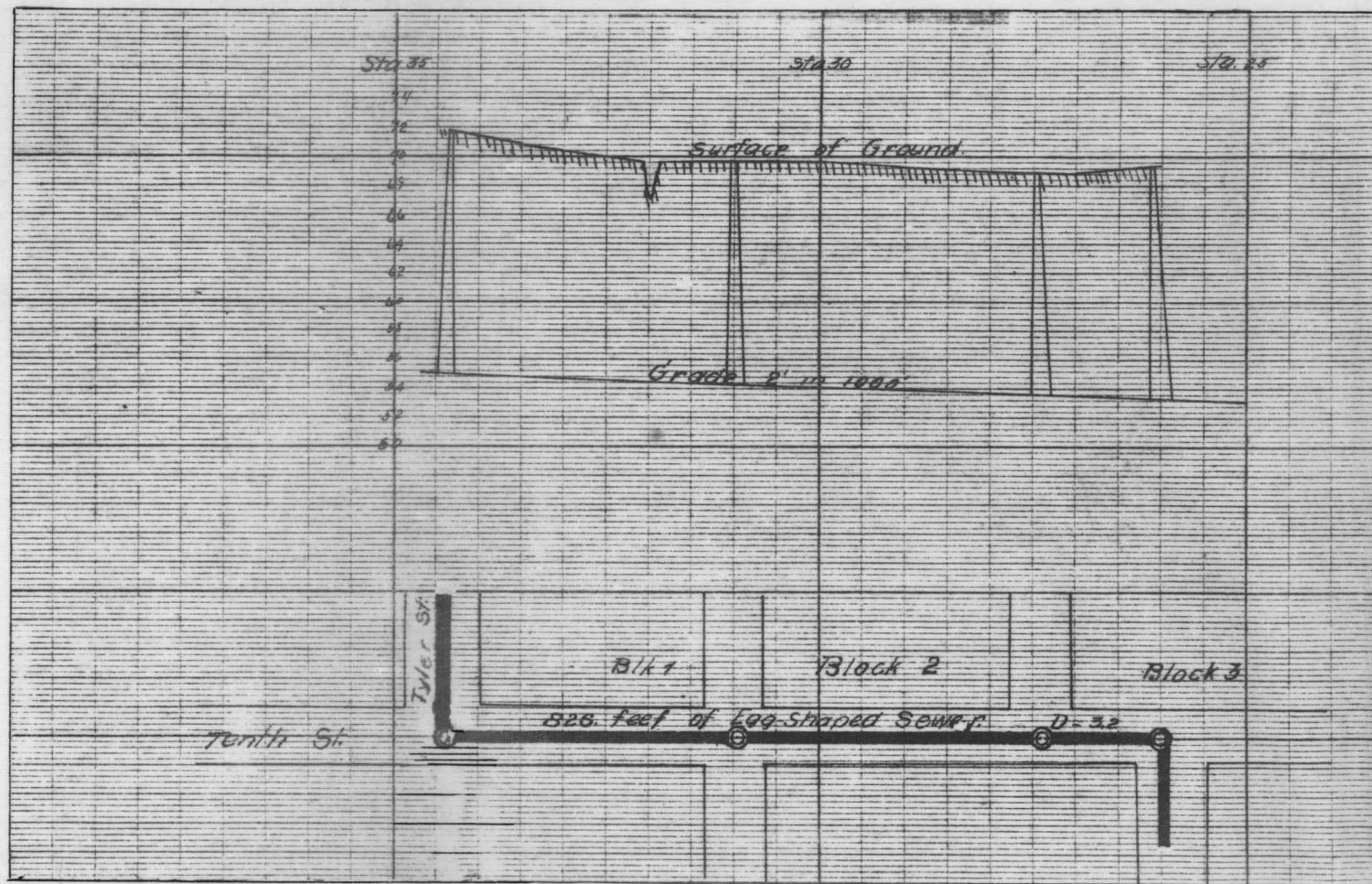


# Plan and Profile of Section A of Proposed Sewer.



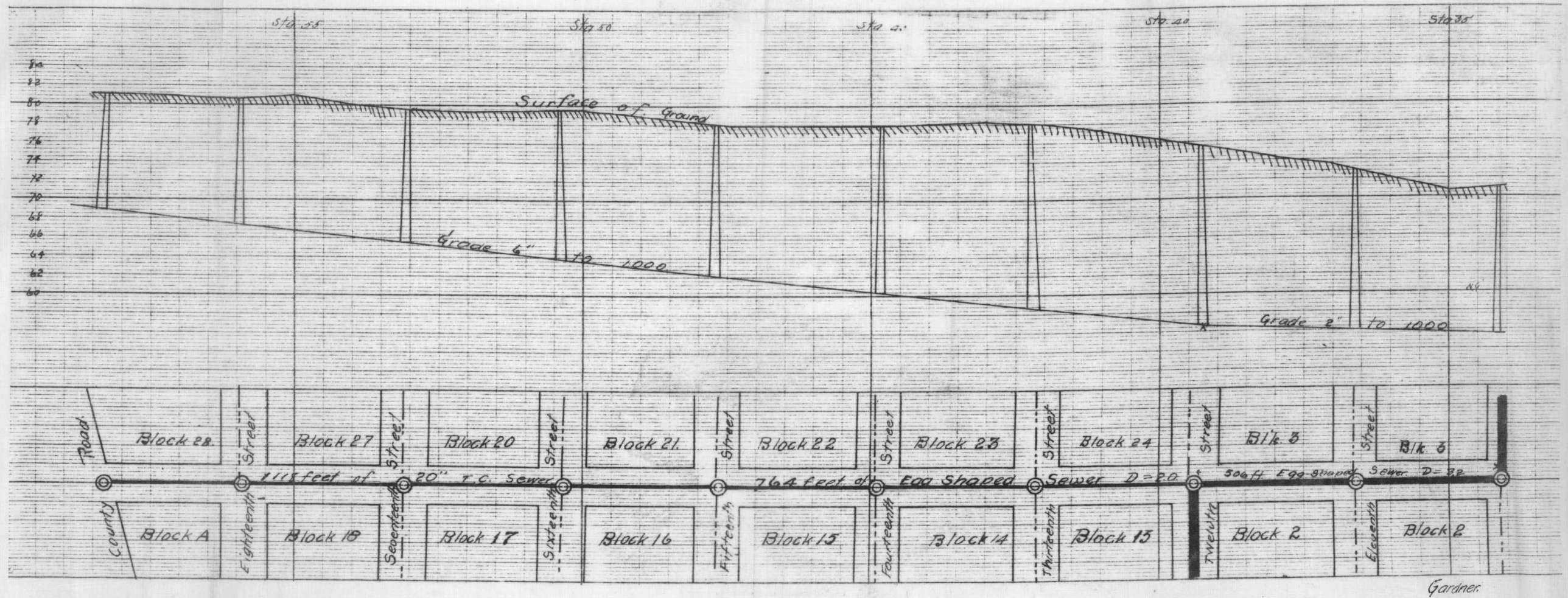
Gardner.

# Plan and Profile of Section B of Proposed Sewer

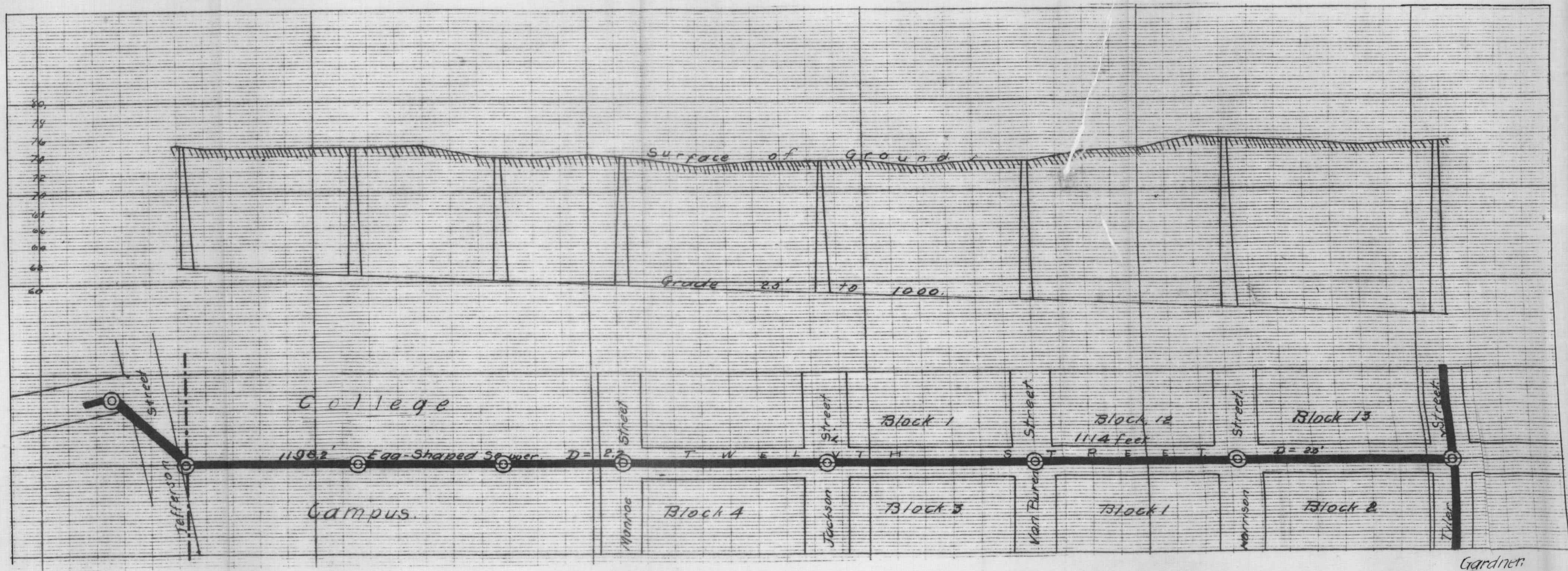


Gardner.

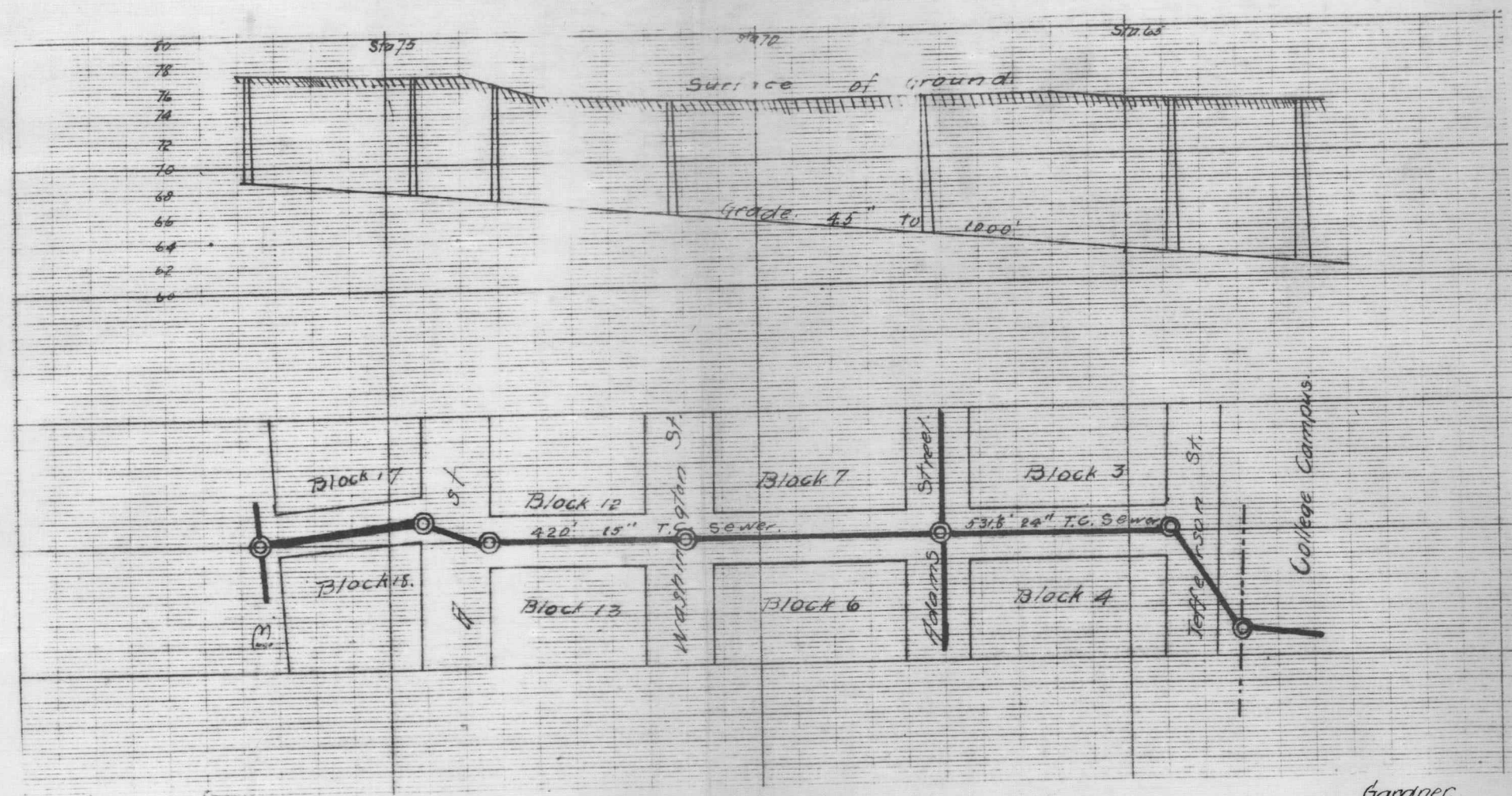
# Plan and Profile of Section C.M.+N of Proposed Sewer.



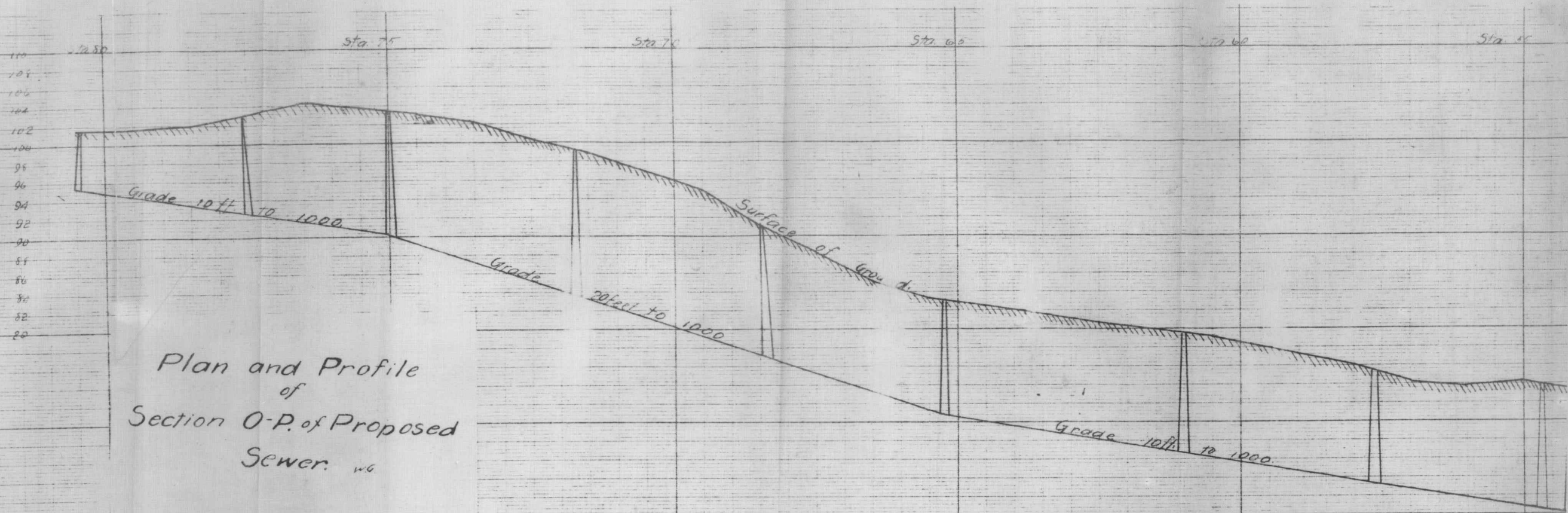
# Plan and Profile of Section D-H of Proposed Sewer



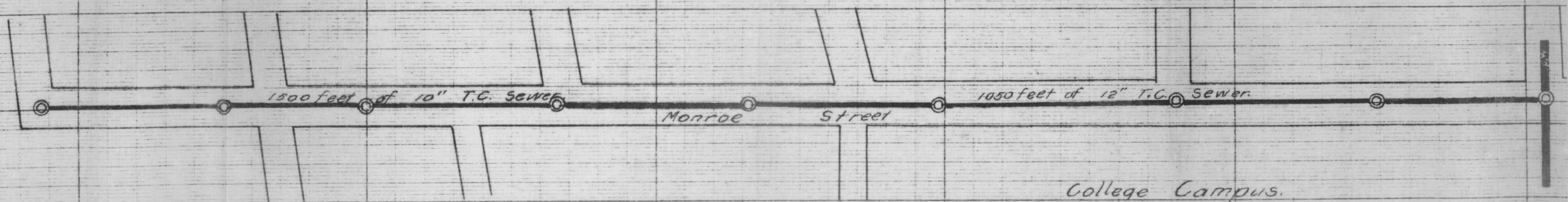
Plan and Profile  
of  
Sections I - J of Proposed  
Sewer



Gardner.

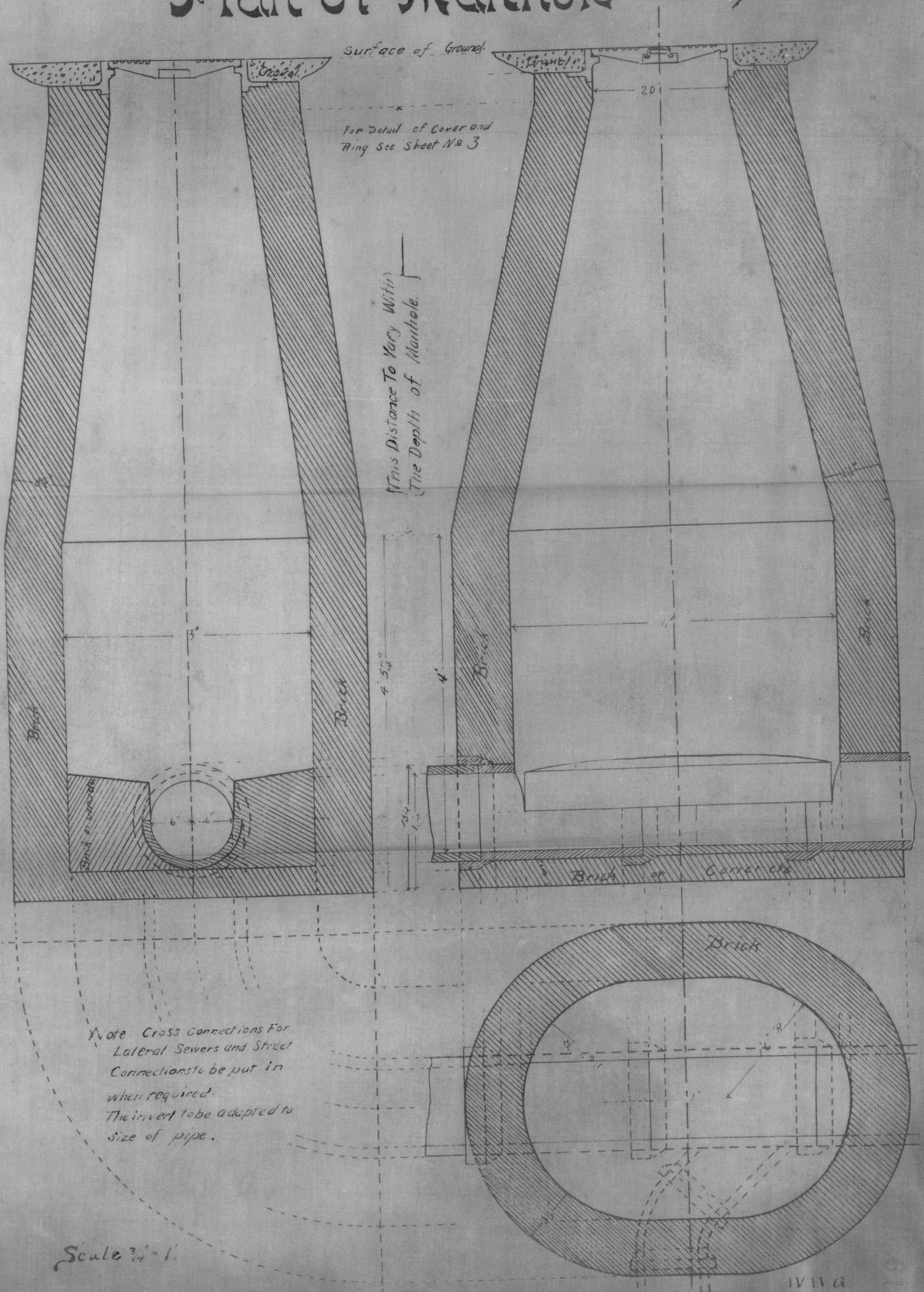


Plan and Profile  
of  
Section O-P. of Proposed  
Sewer. 106

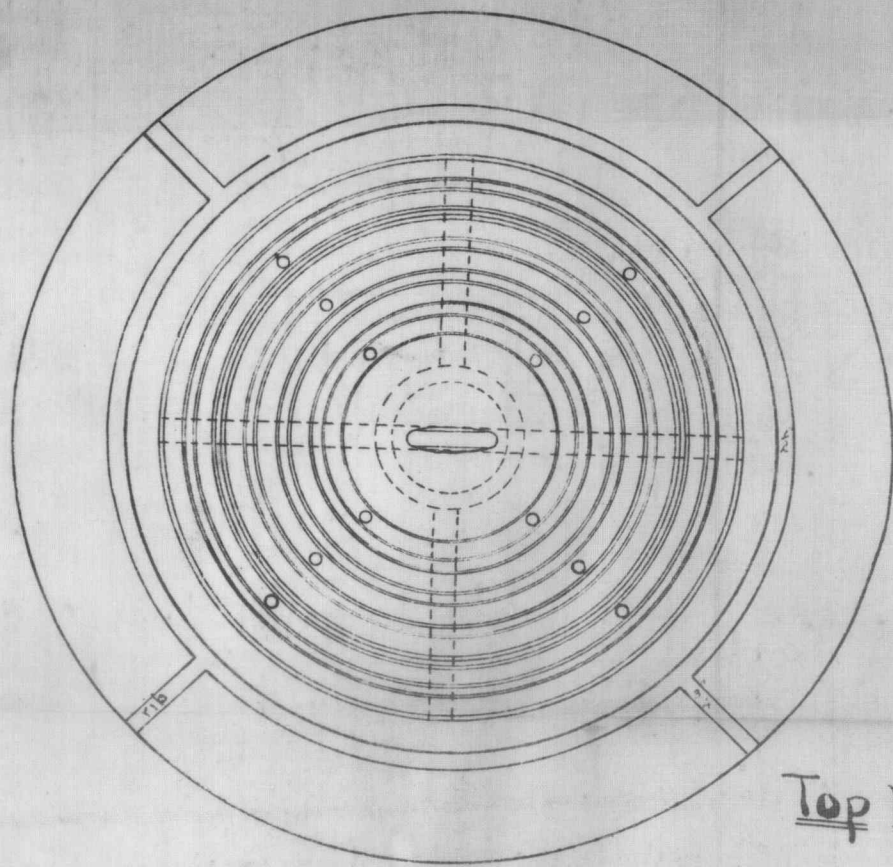


# Plan of Manhole

Sheet No. 2

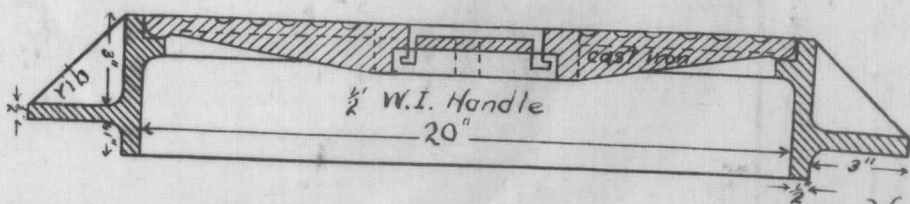


# Plan of Manhole Ring and Cover

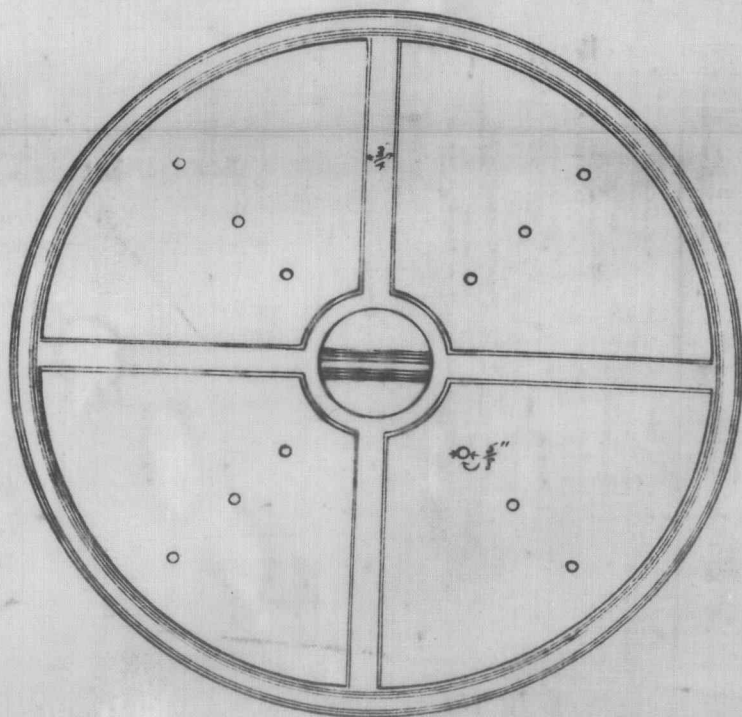


Scale 3" = 1'

Top View of Ring and Cover



Vertical Section



Bottom View of Cover

# Design of Flush-Tank and Manhole Combined

