1933

Sewage disposal improvements at Pontiac, Michigan

Robert William Abbett

Department:

SEWAGE DISPOSAL IMPROVEMENTS AT PONTIAC, MICHIGAN

by

Robert William Abbett, M.S. in C.E.

A

T H E S I S

submitted to the faculty of the

SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI

in partial fulfillment of the work required for the

D E G R E E O F

CIVIL ENGINEER

Rolla, Mo.

1933.

Approved by Joe B Butler

Professor of Civil Engineering.

TABLE OF CONTENTS

SEWAGE DISPOSAL IMPROVEMENTS AT PONTIAC, MICHIGAN

Historical.

The past growth of Pontiac has been fostered mainly by industrial influences. Unquestionably the scenic beauty of Pontiac and the surrounding area has attracted many people to the City, but industrial influences have been the predominating factor in its growth. In its early days Pontiac was the center of the milling industry for this district. Later the industrial character changed from that of a milling town to a manufacturing town, with carriage and wagon manufacture as its main impetus. As a natural sequence, with the advent of the automobile, Pontiac became a center of automobile manufacture, and is today one of the leaders in the industry.

The growth in population of the City of Pontiac in the early years was quite typical of towns of its class, but since 1910, at which time the importande of the automobile asserted itself, Pontiac has shown rapid population growth, and in the decade from 1910 to 1920 Pontiac increased its population by over 135 per cent.

Present Growth

Recent expansions of the parent industries and smaller substantial industries in the City have

definitely changed the character of Pontiac from a small thriving manufacturing town to an industrial city of importance. A special Federal Census, authorized by the City Commission, made in July, 1927, revealed Pontiac a city of over 54,000 population. An increase is shown for the first seven years of the present decade of 58 per cent over its population in 1920.

Territorial Expansion

Accompanying this increase in population are increases in area within the corporate limits of the City. Until 1926 Pontaic's area did not change from the original City of 7.5 square miles, incorporated in 1861. In 1926 an area of 550 acres, or 0.9 square miles, was annexed to the south of the City, and in 1927 10.5 square miles were added, extending the City Limits two miles to the north and one mile to the east. This annexation increased the area of the City by 125 per cent. In the spring of 1928 a 100-acre tract lying west of the original City Limits was annexed. There are now within the limits of Pontiac approximately 19.1 square miles of rapidly developing territory.

Present Industry in Pontiac

Today Pontiac is on a firm industrial footing. The principal industries are: The Oakland Motor Company, Fisher Body Corporation, and General Motors Truck Company,

units of General Motors Corporation, manufacturing respectively Oakland and Pontiac automobiles, bodies for Oakland, Pontiac, and Chevrolet cars, and General Motors Trucks and Yellow Cabs and Coaches; and the Wilson Foundry Company, a unit of Willys-Overland Company, manufacturing Whippet, Willys-Knight, and Falcon-Knight engines.

Among the smaller but thriving diversified industries in Pontiac are the Baldwin Rubber Company, whose products are principally rubber matting and accessories for automobiles, Pontiac Paint Company, Pontiac Varnish Company, American Socket and Forging Company, Jig Bushing Company, Pontiac Die Tool and Machine Company, Pontiac Pattern and Engineering Company, Hubbard Spring Company, Boice Brothers (brick manufacturers), Angle Bumper Company, Oliver Bottling Works, Howard Foundry Company, Pontiac Packing Company, and many smaller industries contributing to the general prosperity of the City.

In 1927 and the early months of 1928 over $25,000,000 was expended in Pontiac for the expansion of the automobile plants in the City. New plants for the manufacture of Pontiac cars and General Motors Trucks and Yellow Cabs and Coaches, and additions to the Oakland plant were erected. There are at present under construction large additions to the Baldwin Avenue Plant of the Fisher Body Corporation and an immense foundry for the manufacture of Oakland and Pontiac engines.

The evidence presented in the foregoing certainly

warrants speculation as to the future possibilities of the City. Pontiac is established as an industrial city of importance, and its industrial character has been predominately responsible for its recent rapid growth and develoopement.

Future Growth of the City of Pontiac

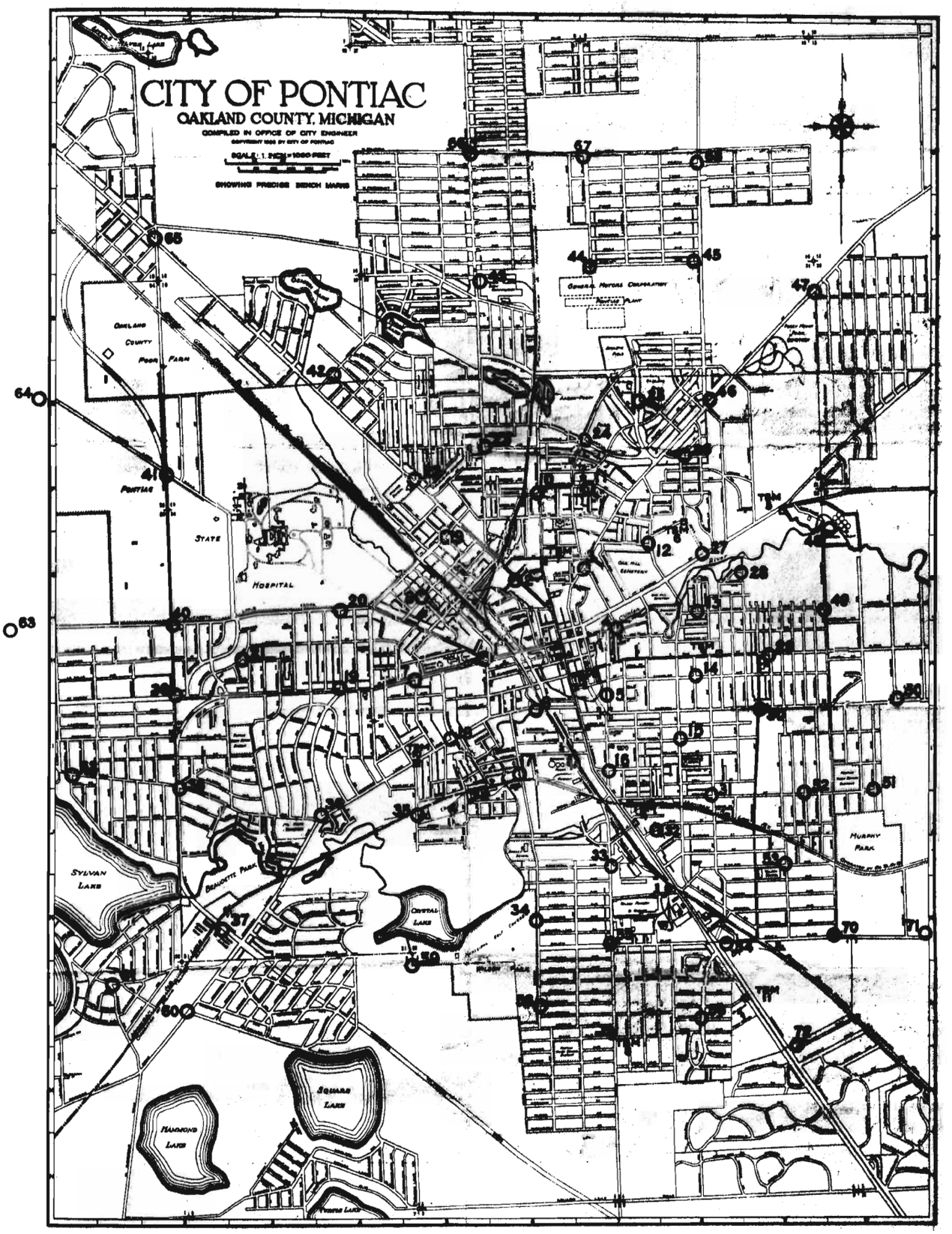
Since the factors influencing the growth of Pontiac are sufficient to establish the status of the city as one of the American cities which will grow repidly in the future, and since geograhpical considerations indicate that its territorial developement will be radial, it appears logical to assume that the site of the present sewage treatment works will in the future, become an objectionable one from the point of view of residential or industrial developement. Therefore any comprehensive study for sewage treatment extensions should include the adoption of a new site further removed from the center of population and at some point at lower elevation than that of the present site in order that the economy of gravity flow of sewage may be preserved. A suitable site for a sewage disposal plant such as may be required in the future exists about four miles from the site of the present plant. The proposed site is situated on the Clinton River, the outlet from the present plant, on land new owned by the city, and it is recommended that this land be held in reserve for the above purpose.

Present Sewage Disposal Facilities

The existing East Boulevard Sewage Disposal Plant consists of a set of bar screens, a grit chamber, a battery of three Imhoff tanks, eight trickling filter units, of the rotary-distributor type, and three secondary settling tanks. The plant was designed for a population of 52,500 in 1919 by Clarence W. Hubbell, Consulting Engineer.

At the present time the plant shows evidence of loading beyond its capacity, the distress of the Imhoff tanks being particularly acute. The effluent from the tanks is usua usually clear indicating a sufficient period for sedimentation. The operation of the entire plant is disturbed however by the constant foaming of the Imhoff tanks, indicating a probable lack of space for sludge digestion. The behavior of the trickling filters is characterized by ponding to such an extent that at least one unit must be kept out of operation constantly for drying and scarifying. It is believed that this condition is due partly to excess load and partly to the large quantities of suspended matter that are occasionally deposited into the effluent from the tanks by the overflow of foam from the gas vents. The secondary settling tanks appear to be functioning satisfactorily.

The plant is unprotected from floods and with every heavy rain its operation is disturbed by the large quantity of storm water in filtration from the sewers.


CITY OF PONTIAC
OAKLAND COUNTY, MICHIGAN
COMPILED IN OFFICE OF CITY ENGINEER
SHOWING PRECISE BENCH MARKS
OAKLAND COUNTY POOR FARM
PONTIAC STATE HOSPITAL
GENERAL MOTORS CORPORATION
OAK HILL CEMETERY
MUNNY PARK
SYLVAN LAKE
CRYSTAL LAKE
SQUARE LAKE
HAMMOND LAKE

Analysis of the Existing Sewage Disposal Plant

Outfall Sewer.

Diameter - 42 inches

Grade - 0.08%

Capacity - 28 sec. - ft.

Present discharge - 10.50 sec. - ft. (average-daily-flow)

Discharge per capita - 125 gal.(average-daily-flow)

Imhoff Tanks.

Sludge digestion capacity - 1.27 cu.ft. per capacity.

Sedimentation:

Detention period - 2.13

Velocity of flow - 46.2 ft. per hour.

Inlet and Outlet works:

Weirs - Ample capacity but of poor design.

Gas vent area - 14.8 per cent of the surface area of the tanks.

Trickling Filters:

Total area - 1.8 acres

Depth - 6.0 ft.

Volume of filter media - 10.8 acre ft.

Load on filters - 628,000 gal. per acre-ft. per day.

Note: According to modern criteria for the design of trickling filters the Pontiac

SECTION THROUGH SEWAGE DISPOSAL PLANT

TRACING THE FLOW OF SEWAGE

Office of City Engineer

Pontiac, Mich.

Drawn By: E.W.A. Mar. 1, 1928

filters are overloaded almost 100%. In spite of this fact a good stable effluent is almost constantly produced. It is believed that the explanation for this apparent paradox may be in the method used for applying the sewage to the filter media. It is possible that the application of sewage by means of retating distributors, an English practice uncommom to the United States, may be a much more efficient type of filtration than that commonly used in this country. Research has been deplorably meagre in this field.)

Secondary Settling Tanks (Dortmund Type)

Detention period - 1 hour

Velocity through tank - 18 ft. per hour

Recommendations

The suggested additions to the Pontiac Sewage Disposal Plant are shown on sheet #1 of the Plans and are itemized as follows:

1. Storm flow By-pass, consisting of a junction chamber containing over-flow weirs by means of which excess flow may be diverted from the disposal plant through a 36-inch concrete sewer to the Clinton River. This design was based largely on judgement and is shown

in detail on sheets #5 and #6 of the Plans.

2. Imhoff Tank, shown on sheets #2 and #4 of the Plans.

The interior dimensions of the Imhoff tank are made to agree with those of the existing tanks in order to eliminate all possibility of unbalancing the action of the plant by the new construction.

The inlet and outlet works to the Imhoff tank are believed to be an improvement over the existing plank weirs which are badly warped and are functioning poorly. It is recommended that these existing weirs be replaced by the arrangement shown for the new tank.

The grease skimmer is to be made to special order for the Pontiac installation. It is to consist of an inverted sluice gate installed in the wall of the tank. It will open from the top downward to enable grease and oil on the surface of the sewage to drain off into the 8-inch outlet pipe shown.

The structural design of the Imhoff tank was made somewhat complicated by the unusual shape of the cross-section. The longitudinal walls were designed as a series of horizontal beams continuous over the transverse baffle walls as supports. These beams were of eight spans 12'-6" in length. The end

walls were designed as horizontal two-span continuous beams supported by the longitudinal walls and by a vertical girder developed in the end walls themselves. This girder was supported at the base by the floor of the tank. A second support was furnished by the deflector beam which was designed structurally to act as either a strut or a tie. Above the deflector beam the girder was supported by the longitudinal baffle walls. Due to the high level of ground water the tank was designed for full hydrostatic pressure within and without, each acting separately.

The specifications for the design of reinforced concrete formulated in the Report of the Joint Committee, 1924, were followed throughout in this project. 2000-lb. concrete was specified.

The recommended additions described herein increase the capacity of the disposal plant from the existing capacity of a population of 52,500 to a population of 70,000. This should suffice for the present needs and into the future until such a time that the growth of Pontiac can be more accurately determined, when the present site may have to be abandoned altogether.

Construction

The above report was submitted to the City Commission and approved. The proposals were published and bids were received on June 3, 1927. The contract for construction was awarded to the Culbertson and Kelly Co. of Detroit, Mich., and the writer was appointed Engineer-in-charge.

Due to the persistence of ground water, the character of the soil and the inexperience of the contractor in sub-aqueous construction, considerable difficulty was encountered in completing the excavation and in concreting the bottom of the tank. After this was finally accomplished, the work progressed normally with the exception of one earth slide on the east embankment and the consequent collapse of wall forms. Special care was taken to provide a water-tight structure.

Extra work not included in the contract consisted of the replacing of the inlet and outlet works to the existing Imhoff tanks with arrangements similar to those shown for the new tank; the construction of sidewalks over the existing tanks; the construction of a new sludge drying bed; the construction of a sludge pumping station (6-inch Wood Trash Pump installed); and the construction of a sludge pipeline.

A chronological account of the progress of construction is shown in the carbon copies of the monthly reports submitted to the City Engineer by the

BIDS RECEIVED FOR ADDITION TO PLANT

CITY WILL ENLARGE ITS SEWAGE DISPOSAL EQUIPMENT

Five bids were received by the city Friday afternoon on the proposed construction of another unit to the Imhoff tanks and a junction chamber at the city's sewage disposal plant. One of the bids was well under the city engineer's estimate. The Commission will consider the bids at the Tuesday meeting and the contract will probably be awarded at that time.

Culbertson & Kelley of Detroit were low bidders with a figure of $44,145. The city engineer's estimate was $46,190.

Other bids were: Price Bros., Lansing, $64,675. R. H. Hidey, Detroit, $55,764; A. Bently & Sons, Toledo, $58,964; and Bartling & Dull, Pontiac, $59,989.60.

This work is to be done from the $150,000 fund provided in a bond issue voted last November for improvements and extensions to the disposal plant. The plant built for a maximum capacity of a city of 52,500 persons is now running to capacity. The additional unit will increase the capacity to 70,000 persons.

CITY OF PONTIAC, MICHIGAN
DEPARTMENT OF PUBLIC WORKS AND SERVICES

TABULATION OF BIDS
ADDITION TO SEWAGE DISPOSAL PLANT

TABULATED BY DEPT OF SEWERS — BIDS RECEIVED JUNE 3 1931

Items	Description	Quantity	Basis of Bid	Culbertson and Kelly		A H Hidey		A Bantly and Sons		Bantley and Dunt		Price Bros		Engineers Estimate	
				Unit	Total	Unit	Total	Unit	Total	Unit	Total	Unit	Total	Unit	Total
1	Exc. above El 880.00	950	Cu Yd	1.00	950.00	3.00	2,850.00	1.47	1,396.50	0.90	855	2.00	1,900.00	2.00	1,900.00
2	Exc. below El 880.00	3,000	Cu Yd	1.63	4,950.00	4.00	12,000.00	1.13	3,390.00	3.79	11,370.00	7.00	21,000.00	4.00	12,000.00
3	Class A Conc. (Base)	940	Cu Yd	33.00	31,020.00	32.15	30,221.00	40.10	37,694.00	43.50	40,905.00	35.00	32,900.00	30.00	28,200.00
4	Class A Conc. (Piers)	25	Cu Yd	29.00	725.00	12.00	300.00	25.60	640.00	16.80	420.00	30.00	750.00	20.00	500.00
5	C.I. Pipe & Fittings	7½	Tons	250.00	1,875.00	272.00	2,040.00	130.00	975.00	126.00	945.00	250.00	1,875.00	120.00	900.00
6	8" Conc. Inlets and Boxes	4	Each	75.00	300.00	93.00	372.00	27.00	108.00	66.00	264.00	50.00	200.00	100.00	400.00
7	Weirs, Gates, Baffles etc		Lump Sum	600.00	600.00	246.00	246.00	164.00	164.00	96.40	96.40	500.00	500.00	300.00	300.00
8	36" Reinf. Conc. Sewer	215	Lin ft.	15.00	3,225.00	7.00	1,505.00	13.90	2,988.50	24.00	5,160.00	12.00	2,580.00	6.00	1,290.00
9	Headwall		Lump Sum	500.00	500.00	230.00	230.00	1,609.00	1,609.00	187.20	187.20	150.00	150.00	500.00	500.00
	Items 1,2,3,4,5,6,7,8 and 9				$41,145.00		$53,746.00		$58,964.00		$59,939.60		$64,675.00		$46,190.00

September 30, 1927.

Mr. James R. Pollock,
City Engineer,
Pontiac, Michigan.

Dear Sir:-

I am including herewith a summary of the work done on the Additions to the Sewage Disposal Plant Contract during the Month of September.

From September 1st to September 23rd, all labor was concentrated on attempting to shape the subgrade for the hopper bottoms of the Imhoff Tank. Considerable difficulty was encountered in this work due to earth slides on the east bank of the excavation and due to a large flow of ground water. The contractor finally abondoned the plan for pouring the entire hopper at one time and on September 24th, the hopper bottom was poured with the exception of a space 6 feet square in the very bottom. This work was accomplished with little difficulty. On September 27th the second hopper bottom was poured in the same manner.

The time from September 28th to September 30th was spent on fine grading and steel work.

The total amount of work done to date is $11,598.00.

The Contractor seems to have the situation fairly well in hand at the present time and should make good progress in the future, although I anticipate a great deal of trouble when he tries to pour the remaining sections of the hopper bottoms.

Respectfully submitted,

RWA:BP

Robert W. Abbett.

February 1, 1928.

Mr. James R. Pollock,
City Engineer,
Pontiac, Michigan.

Dear Sir:-

I am including herewith a summary of work executed on the "Additions to Sewage Disposal Plant" contract during the month of January 1928.

Practically the entire month of January was spent on concrete finishing and cleaning up construction plant. The entire surface of the Imhoff Tank interior has been thoroughly rubbed with carborundum stone so that the parts of the tank which will come into contact with sewage and the parts which will be in view are smooth and true to line and grade.

The pump sump in the bottom of the tank has been sealed and the sidewalk slabs for the old Imhoff Tanks are now in place.

The force account work for the month of January includes the completion of the sludge pumping station unit and the erecting of the new sludge pumps and motor. 158 tons of flanged cast iron pipe has been placed in connection with the work. Also the new cypress weirs have been placed on the old Imhoff Tanks with the new steel plate scum baffles.

After final inspection and acceptance of the work by the City Engineer the new tank was put into operation on the afternoon of January 26th.

The requirements of the contract are now fulfilled with the following exceptions.

1.	Backfilling - 300 cu.yds.	@ $2.00	$600.00
2.	Sodding and shaping damaged slopes 5000 sq.ft.	@ 0.10	500.00

3. Repairing Pump Station Roof which was damaged by wind	$25.00
4. Leveling off earth waste piles	100.00
5. Replacing 150 lin.ft. of Hedge	75.00
	$1,000.00

Note: This estimate is approximate and is high.

Regarding Item No.7 of the contract bid calling for the construction of Weirs, Guides, Baffles and appurtenances, and including 64 lin.ft. of 24" V.C.P. sewer, during construction it was found impractical to construct this sewer and the item may be adjusted as follows:

Price bid for Item No.7 Lump Sum	$ 600.00
64 lin.ft. of 24" V.C.P. sewer @ $3.00 per ft.	192.00
Breaking concrete and replacing elbow with Tees on old outlet boxes	30.00
Total	$ 380.00
Credit for labor 28 hours @ $0.65	18.20
Net amount to be paid to contractor under Item No.7.	$ 398.20

The total cost of this project when completed will be $43,226.25. The total amount of extra work on the "Additions to Sewage Disposal Plant" (Imhoff Tank and Junction Chamber) Contract is $221.48.

The total amount of labor and materials costs for placing the new weirs in the old Imhoff Tank is $591.83.

The total amount of labor and material costs for constructing the new sludge pump station and erecting the pump and motor is $113.28, plus the cost of the brick which were furnished and delivered by the City.

Itemized statements of all estimates will be found attached hereto.

Respectfully submitted,

RWA:BP Robert W. Abbett.

SEWAGE TANK IS PUT IN OPERATION

NEW $45,000 UNIT GIVES CITY BATTERY OF FOUR TANKS AT PLANT

The city's new Imhoff tank unit at the sewage disposal plant has been placed in operation by the city. It was completed recently at a cost of $45,000.

The new tank gives the city a battery of four tanks which are supposed to care for the needs of a city of 70,000 population. No increase was made in the number of revolving sprinklers that are used in connection with the tanks to filter sewage.

CITY OF PONTIAC, MICHIGAN

DEPARTMENT OF PUBLIC WORKS AND SERVICE

March 8, 192 8

Final *Progress Estimate for the Construction of*

Additions to Sewage Disposal Plant.

Culbertson & Kelly Company.
Contractor

Issue
Charge to Sewage Disposal Bond *Fund.* *Job No.*

Item	CLASS OF WORK	UNIT	QUANTITY	PRICE	AMOUNT	√
1.	Excavation above El. 880.00	cu.yd.	1727.32	1.00	1,727.32	
2.	Excavation below El. 880.00	cu.yd.	2986.16	1.65	4,927.16	
3.	Class "a" Concrete (Plain)	cu.yd.	13.00	29.00	377.00	
4.	Class "A" Concrete (Reinforced)	cu.yd.	895.79	33.00	29,561.07	
5.	Cast Iron Pipe & Fittings	Ton	8.812	250.00	2,203.00	
6.	8" Gate Valves with Boxes	each	4.00	75.00	300.00	
7.	Weirs, Guides, Baffles & Appurt.	Lump sum		398.20	398.20	
8.	36" Reinforced Concrete sewer	lin.ft.	215.50	15.00	3,232.50	
9.	Head wall	lump sum		500.00	500.00	
10.	Weirs for old Imhoff Tanks (as per extra order)				591.83	
11.	Imhoff Tank and Junction Chamber (as per extra work order)				221.48	
12.	Sludge Pumping Station (as per extra work order)				113.28	

	Total value of work done	$44,152.84
Amount of previous estimates	$34,009.36	
15% retained	$	
mt. retained by City Commission	$ 1,000.00	
Tatal to be reducted	$35,009.36	
agreement	Amount due this estimate	9,143.48

I hereby certify that there is due

Culbertson and Kelly Company, *Contractor, the sum of*

Nine Thousand and Hundred forty three and 48/100 ..... *DOLLARS*

for work done on Additions to Sewage Disposal Plant.

Approved,

Robert W. Abbett
Eng. in Charge

City Engineer

City Manager

BP

writer and included herein. It is regretted that the file of these reports is not complete, the missing copies having been lost.

The project was completed and the new construction was placed in operation on January 26, 1928, having required seven months for completion.

Conclusions

The successful operation of an Imhoff tank depends upon the proper treatment of a number of vital features of the structure. Many of these features are too well known to warrant discussion here. Others may be divided into three classes; those dependant on proper design; those dependant on proper construction methods; and those dependant on proper maintainence and operation.

In the first class may be included the matter of disposal of grease and scum from the sedimentation chambers, which is commonly neglected in the design of moderate sized sewage disposal plants. That grease and scum may be provided for very easily is evident from an inspection of the simple arrangement specified for the Pontiac installation, which functioned quite satisfactorily.

Also included in the first class is the matter of inlet and outlet works. Weirs are not satisfactory because they permit solids to settle out in the inlet channels. Where they are used care should be taken that they are constructed from a good grade of cypress and with the crest formed of metal to insure a smoothe

uniform flow otherwise surge action in the nappe may disturb the behavior of the Imhoff tank. Weirs were used at Pontiac to be consistent with the old construction rather than from choice.

There are many critical features in the construction of an Imhoff tank which may influence its future operation but the principle ones are that the structure shall be true to line and grade and that the interior of the structure shall be hand-finished with a steel trowel and then rubbed to a smoothe surface with carborundam stone. The smallest of irregularities in the interior surface of an Imhoff tank is potentially the beginning of a collection of organic matter which is most difficult to remove when it is submerged a considerable distance below the surface of the sewage. In a short time these accumulations of organic matter obstruct the openings in the tank. The inclined baffle walls are particularly chronic offenders in this respect and they should receive very close inspection before the tank is put into use.

It is obvious that the best sewage disposal plant in existence will fail if it is not operated properly. With this in mind the writer prepared a list of instructions for the operation of the Pontiac plant. These instructions were found by experience to be satisfactory and it is believed that they will apply equally well to all installations similar to the one at Pontiac. For this reason they are included in this thesis as the Appendix.

APPENDIX.

Instructions to the Superintendent of Operation, Pontiac Sewage Disposal Plant.

The Pontiac sewage disposal plant is a very complete one. The raw sewage entering the plant passes in order through screens, grit chambers, Imhoff tanks, sprinkling filters, and secondary tanks.

The bar screens take out the bulky articles such as rags, paper, sticks, etc. Screens must be raked at least once a day, and screenings put into the covered wagons. Keep wagons covered so as not to attract flies. Screenings are to be taken to dump and buried.

The Imhoff tanks, which are the next step in the process, settle the organic solids out of the sewage. The tanks are two stories in height. The sewage flows through the upper story, or flowing through chamber, and in passing from one end of tank to the other settles out solids which go through trapped slots about 15 feet below water line into the lower story, or digestion chamber. Here bacterial action takes place accompanied by liberation of gas which passes out through the gas vents. This bacterial action changes sludge from offensive organic nature to an inoffensive sludge. When sufficient sludge has been accumulated it must be drawn off on the sludge beds through the pipe provided for this purpose.

Sludge is to be drawn slowly. Open gate slowly, let some sludge run out, close gate so as to give sludge a chance to run to

pipe and then open slowly again.

Very frequently gas is given off so violently that it carries sludge into gas vents. This must be broken up daily and sludge must be pushed down so that it can digest and so that the gas vents do not become choked and flow over. Often a hose stream must be played on the sludge in the vents so as to break it up.

In case sludge or sewage solids form on surface of flowing through chambers, this must be broken up; then it will usually settle. When it does not settle due to grease or matches, it should be skimmed off and taken to dump with the screenings. The channels where sewage flows into tanks should be cleaned daily and no solids allowed to collect on the board weirs over which sewage flows into tank. The weirs measure flow into the tanks so that if thwy get dirty some chambers will get more sewage than others. The sidewalls of the flowing through chambers are to be scraped down at least once a week, and solids should be pushed through slots.

The flow in the tanks should be reversed at least once a week on order to insure an even distribution of sludge in the digestion chambers.

The sprinkling filters are controlled by valves so that anyone of them can be cut off. These are moved by the head of water coming from the Imhoff tanks. Here the sewage trickles over a bed of stone 6 feet in depth and finally goes into the underdrains.The stone acts to separate any organic matter from the sewage which cannot be settles out

in the tanks. A bacterial action takes place on the stone in the slimy deposit one sees there. The sprinkling arms must be kept adjusted so that all parts of the bed receive the same amount of sewage. The two adjustments for levelling are the turnbuckles on the cables and stays at the sprinkler head. When water pools on the surface of stone bed it is a sign that it needs a rest so it should be cut out of service for a few days. It is important to poke out the holes in the sprinkler arms every day and also to flush out the arms by opening the gates at the ends, and letting sewage flush out during a few revolutions. Keep ball paces well oiled, oil is cheap. Occasionally it will be necessary to flush and clean out underdrains.

The secondary tanks settle out the sewage from the sprinkling filters. The sludge from these tanks should be pumped back into Imhoff tanks about once a week or any time that black sludge sppears on the surface. Very often to start sludge flowing into suction line it will be necessary to agitate by means of fire stream and by flushing back through suction line.

Thekeep a watch on operation of plant, the State Board of Health insists on daily tests being made. These are important not only to the Board, but to ourselves. The plant was built for a purpose and if it fails to deliver, we should be the first to know about it. The health and convenience of many people depends on our getting good results and the only way we know whether results are being obtained or not is by means of these tests. The plant depends, for its satisfactory operation, on settlement and bacterial action as we have seen. Settlement is a

purely mechanical action and with reasonably good operation will take place at all times. To achieve the best results the bacterial action must be encouraged and this can only be done by paying the closest attention to operation. The best operation depends on attention to the smallest details and keeping at it. Letting things slide with the idea of catching up on work later means sloppy operation as this might easily disrupt the operation of the entire plant, the bacterial action depended on being very sensitive. With the idea of getting the best out of the large investment the City has in this plant the following operation schedule should be followed:-

DAILY:

Clean screens.

Break scum in gas vents.

See that all floating sludge is pushed down.

Clean channels and weirs in tanks.

Clean out holes in sprinkler arms and flush.

Make tests.

WEEKLY:

Reverse flow in Imhoff tanks.

Scrape side slopes in Imhoff tanks.

Pump secondary tanks.

OFTEN AS NECESSARY:

Clean grit chambers after rains and when needed.

All moving parts to be oiled.

Draw sludge whenever possible.

Skim oil and grease off of tanks.

Wet down sludge in gas vents.

Have carts containing screenings removed.

Fork over stone beds.

Allow no ice to form in tanks.

Keep weeds and grass from growing on stone beds.

GENERAL:

Keep plant neat and tidy. Grass should be cut, paths raked and kept free from weeds. Paint and oil should not be spared. Remember the public is judging a lot by the appearance of the plant. Do not allow them to get a bad impression, above all do not get behind in your work. If more help or material is needed, say so. We want the plant to look right, run right, and be right.