"DISTRICT HEATING PLANT FOR ST.JOHNS, MICH."

A THESIS

BY

L. C. HULSE

AND

I. J. FAIRCHILD.

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East Lansing, Mich., May 15, 1914.

To the Mayor and City Council,

St.Johns, Mich.

Gentlemen:

We have the honor to submit herewith a report in detail of our investigations regarding the advisability of adding a district heating system to your city's present power plant.

Our first step in the investigation was to canvass the business district and determine the possible business available and the amount of heat required to properly serve the same.

We then inspected the plant and collected data on it's equipment and operation of the past year, and calculated the heat available in the exhaust steam from the plant and found it to be amply sufficient for our purpose. Following this we determined the pipe size to be used, and the style of conduit best adapted for the work in hand.

Next we made maps of the business district, and a profile of the grade line for the entire length of the conduit. These gave us details from which to calculate the complete cost of installation. Knowing the cost os installation and the probable life of the system, we were able to determine the yearly expense of operation.

Finally by canvassing some representative business

men as to present heating costs, we were able to set an equitable rate, and thus determine the revenue from the heating system. Subtracting from this the expense of operation, we obtained the probable profit, which, to us seems more than sufficient to warrant the installation of the system.

Appended hereto are the principal data which form the basis for the work, the computations based thereon, maps, profiles, estimates etc. pertinent to the investigation.

Very respectfully submitted,

L. C. Hulse

and

I. J. Fairchild.

PRESENT PLANT EQUIPMENT.

Two- Gordon Steam Pumps. (Compound)

Size Cylinders	10"x10" and 22" x 10"
Average Speed	17 R.P.M.
Time Used Per Day	24 Hr.

One- Knowles Air Compressor.

Size Cylinder	10"x12"

Used only for heavy demand.

One- Ingersol Air Compressor.

Size Cylinder	10" x 14"
Average Speed	80 R.P.M.
Time Used Per Day	24 Hr.

One- Skinner Engine, 150 H.P.

Size Cylinder	14"x15"
Average Speed	242 R.P.M.
Time Used Per Day	10 Hr.

One- Corliss Engine, 185 H.P.

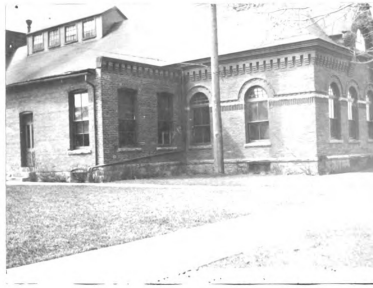
Size Cylinder	16"x36"
Average Speed	102 R.P.M.
Time Used	14 Hr.

Three- Wickes Horizontal Boilers, 100 H.P. Each.

NECESSARY ADDITIONAL EQUIPMENT.

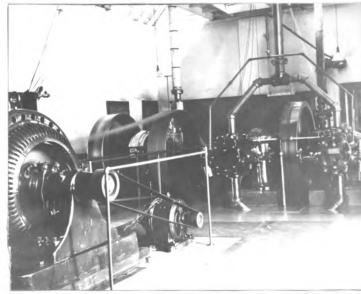
One- Wickes Vertical Boiler, 350 H.P.

(Needed for present requirements.)

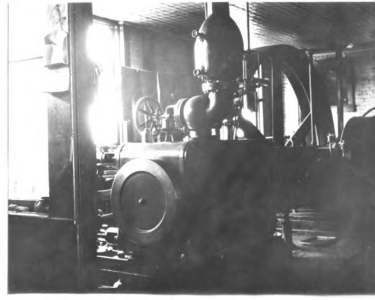


N.E. CORNER of POWER PLANT.

WEST SIDE of POWER PLANT.

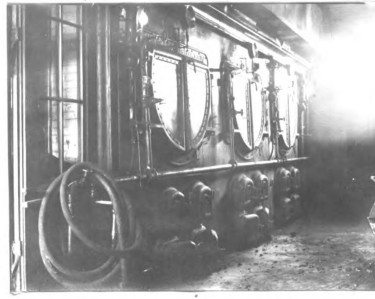


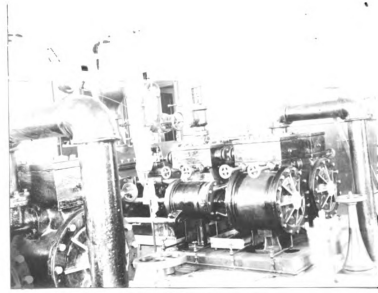
150 H.P. SKINNER and INGERSOLL AIR COMPRESSOR.



135 H.P. CORLISS ENGINE.

3 - 100 H.P. WICKES HORIZONTAL BOILERS.





GORDON WATER PUMPS.

ESTIMATION OF CUBIC CONTENTS OF BUILDINGS TO BE HEATED.

The average store building is two stories high, each floor being 22'x104'x13', giving 59,500 cu.ft. or approximately 60,000 cu.ft. for the cubic contents of each store building.

There are 75 such stores. 75 x 60,000 gives 4,500,000 cu.ft. for the cubic contents of all the business district.

One sq.ft. of radiating surface will heat 100 cu.ft. in zero weather, therefore 45,000 sq.ft. of radiation will be sufficient.

The amount of heat necessary to heat one sq.ft. of radiation one hour in zero weather is 255 B.T.U. and since 15% of the heat at the plant is lost in transmission, therefore $\frac{45{,}000 \times 255}{.85}$ gives 13,300,000 B.T.U. necessary at the plant.

TOTAL HEAT IN EXHAUST STEAM AVAILABLE.

MINIMUM.

Exhaust steam is figured as having a quality of 85%, and an available B.T.U. of 903.7 per pound, at 5# gage.

GORDON STEAM PUMP.

$$\frac{10 \times 10 \times .785 \times 10 \times 17 \times 4 \times 60 \times .2577 \times 903.7}{1728}$$

equals 432,000 B.T.U.

INGERSOL AIR COMPRESSOR.

$$\frac{12 \times 12 \times .785 \times 14 \times 160 \times 60 \times .2577 \times 903.7}{1728}$$

equals 2,450,000 B.T.U.

SKINNER ENGINE.

At 30# steam per H.P. Hr, 150 x 30 x 903.7

equals 4,600,000 B.T.U.

CORLISS ENGINE.

At 21# steam per H.P. Hr. 185 x 21 x 903.7

equals 3,550,000 B.T.U.

AVERAGE OF CORLISS & SKINNER.

(4,600,000 plus 3,550,000) divided by2 gives 4,075,000 B.T.U.

TOTAL B.T.U. MINIMUM IS 6,957,000

MAXIMUM B.T.U. AVAILABLE.

SKINNER ENGINE.

At 35# steam per H.P. Hr. 200 x 35 x 903.7

equals 6,320,000 B.T.U.

CORLISS ENGINE.

At 25# steam per H.P. Hr. 247 x 25 x 903.7

equals 5,600,000 B.T.U.

AVERAGE OF CORLISS & SKINNER.

(5,600,000 plus 6,320,000) divided by 2 gives 5,960,000 B.T.U.

(Gordon Steam Pump and Ingersol Air Compressor same as before)

TOTAL B.T.U. MAXIMUM -- 14,802,000

This is more than sufficient for the heating system.

DETERMINATION OF PIPE SIZE.

Plotting curve from table #36 in Hoffman's Handbook gives the result that a 10" pipe 3,000ft. long will carry 220# of steam per minute.

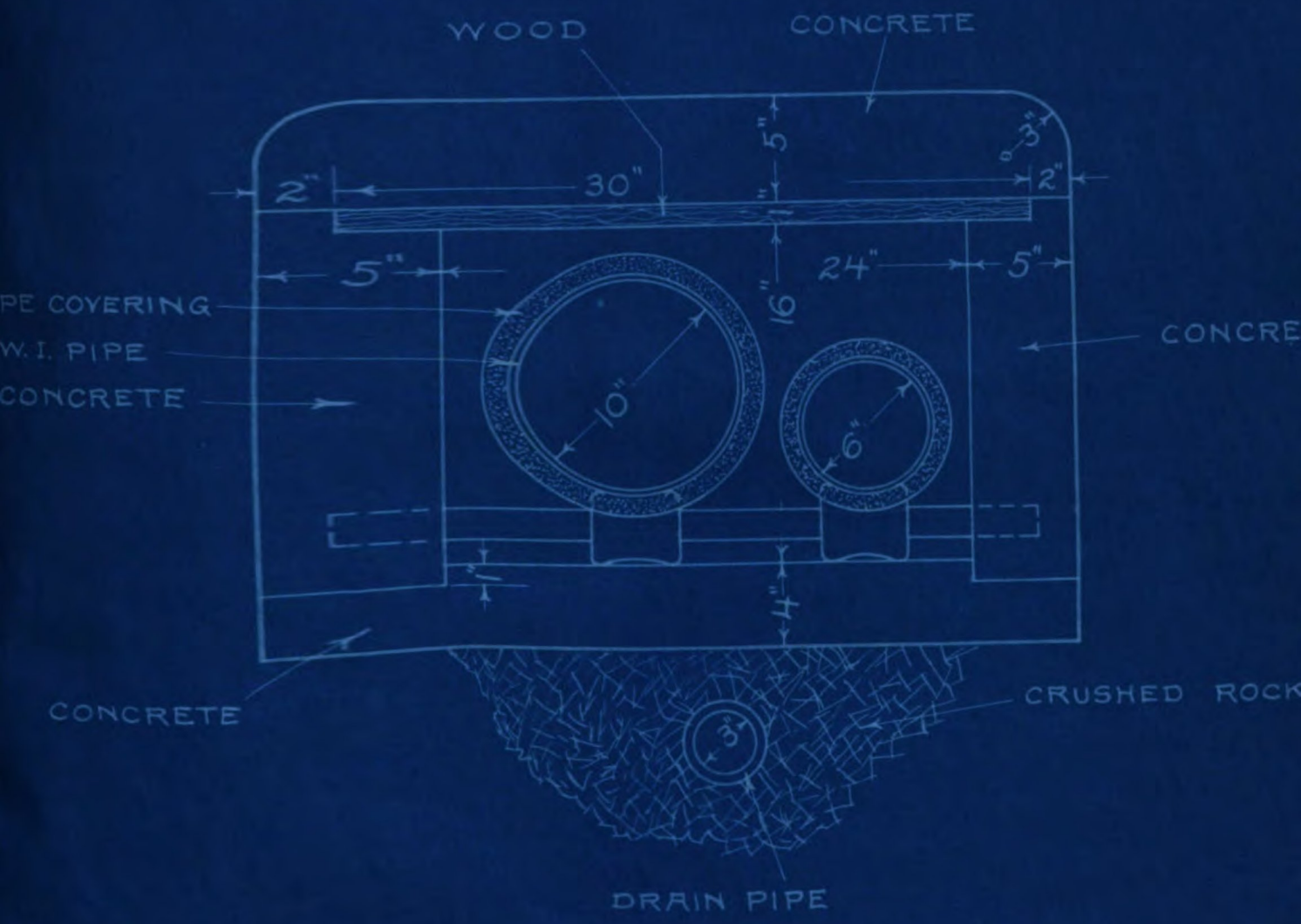
Since 1# of exhaust steam at 5# gage will supply 3 sq.ft. of radiation, $\frac{45,000}{3 \times 60}$ gives 250# steam per min.

Therefore the above 10" pipe will carry 91% of the total possible load, and since only 60% of possible business will be connected on in the first five years (see Gifford), this size will surely be ample.

We will then use a 10" main with a 6" return pipe for the long run. For other pipe sizes see plan view of street.

STYLE OF CONDUIT.

For style of conduit see drawing between pages 6 & 7. Wrought iron pipes are used throughout with screwed joints except at expansion joints, where flanged joints will be used. Service tees and nipples are extra heavy service type. Manholes are placed at each expansion joint.



PIPES AND CONDUIT

COST OF INSTALLATION.

Excavation @ 40¢ per cu.yd.

Excavation for main line	2,439 cu.yd.	
Excavation on branches	710 " "	
Total	3,149 " "	$1,260.00

Raising and replacing pavement.

@ $1.19 per yd.	$1,100.00	
New brick @ $17 per M.	31.50	
	$1,131.50	$1,131.50

Conduit in place @ $7.50 per cu.yd.

434 cu.yds.	$3,250.00	$3,250.00

Wood Covering, @ $50.00 per M.

8,880 ft.	$ 444.00	$ 444.00

Drain Tile @ $15. per M.

3,544 ft.	$ 53.20	$ 53.20

Crushed Stone @ 60¢ per cu.yd.

131 cu.yds.	$ 78.50	$ 78.50

Rollers and Anchors, @ $2.50 each.

177 needed	$ 443.50	$ 443.50

Manholes, @ $25.00 each.

7 needed	$ 175.00	$ 175.00

Pipe and Fittings.

2250 ft. of 10"	$2,880.00
526 ft. of 8"	$ 526.00
3018 ft. of 6"	$2,030.00
526 ft. of 4 1/2"	$ 234.00
768 ft. of 3 1/2"	$ 254.00
1060 ft. of 3"	$ 284.00
1060 ft. of 2"	$ 140.00
7-10" Expansion Jts.	$ 917.00

Pipe & Fittings Cont'd.

3-8" Expansion Jts.	$ 148.00	
11-6" " "	$ 272.00	
3-4 1/2" " "	$ 54.00	
4-3 1/2" " "	$ 45.00	
6-8" Service Tees	$ 77.00	
13-6" " "	$ 93.00	
6-4 1/2" " "	$ 23.00	
13-3 1/2" " "	$ 45.00	
1-10" Gate Valves	$ 26.00	
1-6" " "	$ 12.00	
38-3" Wyes	$ 47.50	
38-2" "	$ 41.30	
6-8" Nipples	$ 5.40	
13-6" "	$ 9.10	
6-4 1/2" "	$ 2.40	
13-3 1/2" "	$ 2.60	
19-3" Plain Tees	$ 59.40	
19-2" " "	$ 51.70	
	$8,279.40	$8.279.40

Diatomaceous Covering.

2250 ft. of 10" @ 52¢	$1,170.00	
526 ft. of 8" @ 44¢	$ 232.00	
3018 ft. of 6" @ 32¢	$ 965.00	
526 ft. of 4 1/2" 26¢	$ 137.00	
768 ft. of 3 1/2" 21¢	$ 161.00	
1600 ft. of 3" @ 18¢	$ 191.00	
1600 ft. of 3" @ 14¢	$ 148.00	
	$3,004.00	$3,004.00

Labor of Laying Pipe.

20% of (8,279.40 plus 3,004) equals	$2,256.00

Total Cost of Line.	$20,374.20	$20,374.20
Add 10% incidentals	$ 2,037.40	$ 2,037.40
	$22,411.60	$22,411.60

ESTIMATED TOTAL COST. $22,500.00

FIXED CHARGES.

Depreciation	5%
Repairs and Upkeep	1%
Interest on Invst.	6%
	12%

12% of $22,500.00 equals $2,700.00 per year.

INCOME.

60% of business connected on in five years, or 45 stores.

Radiation per average store, 600 sq.ft.

Present cost per store per season, $250.00

Proposed rate of 30¢ per sq.ft. per season, or $180 per store.

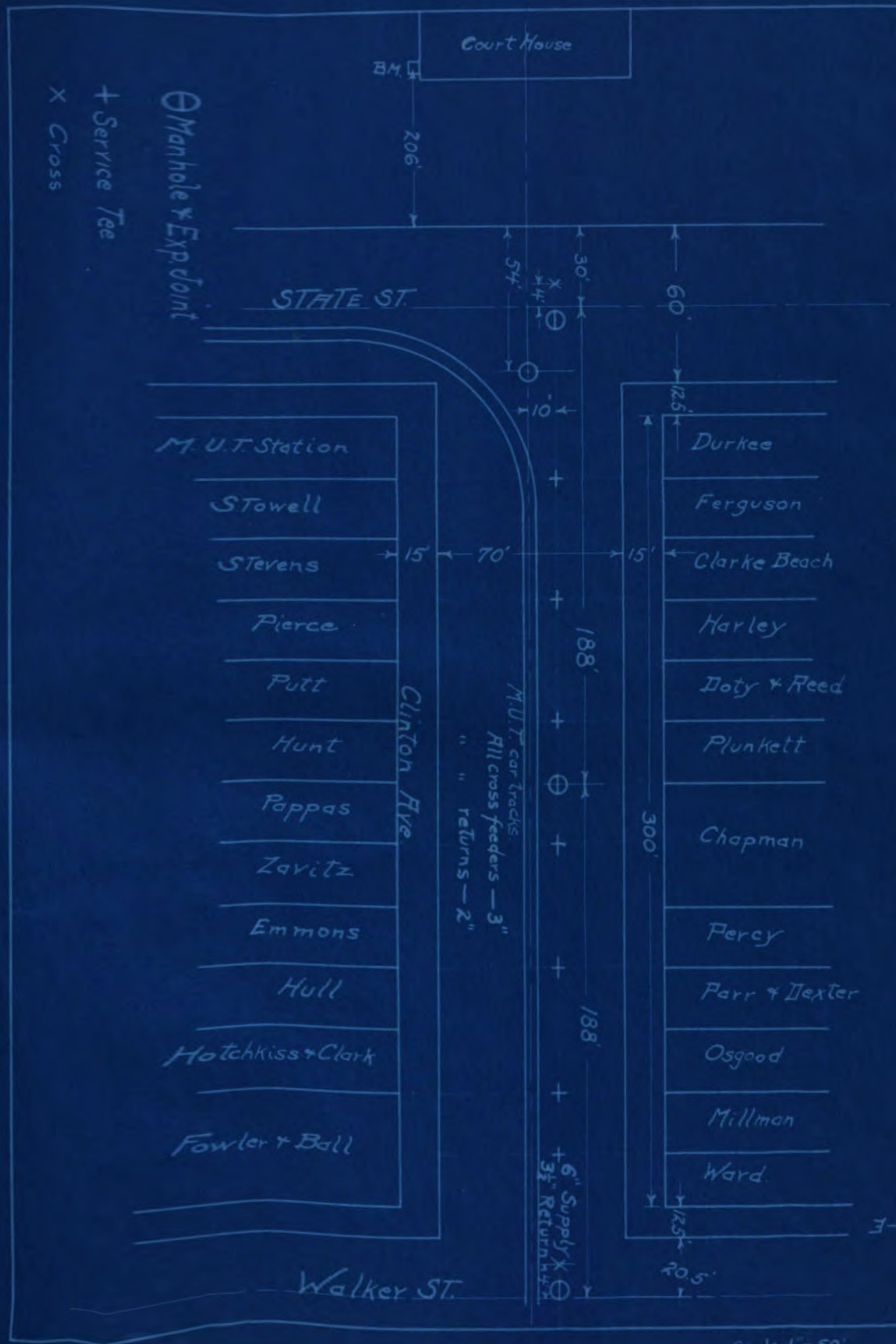
Total Income, 45 x 180 equals $8,100.00 per annum.

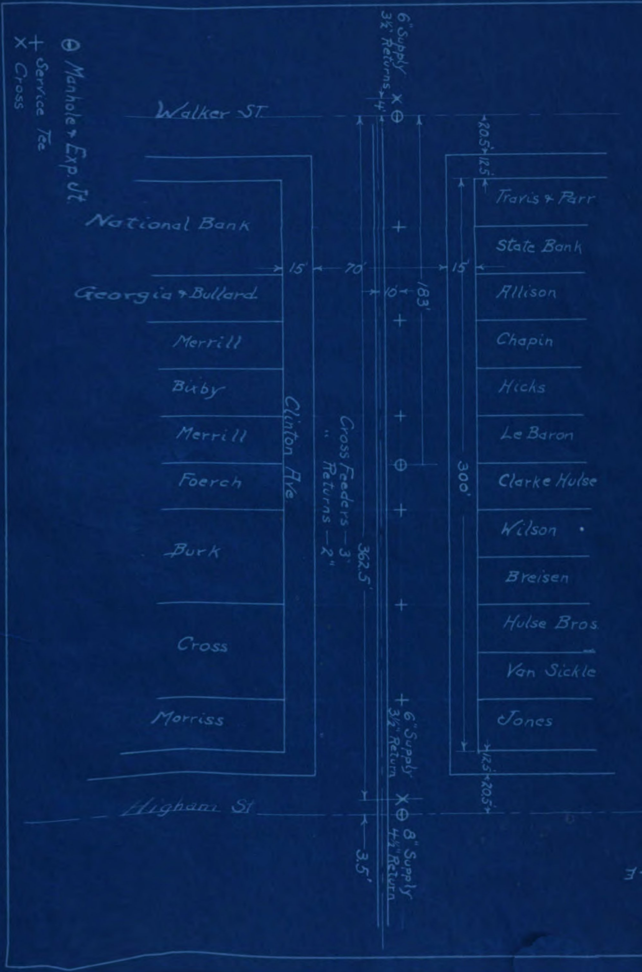
PROFITS.

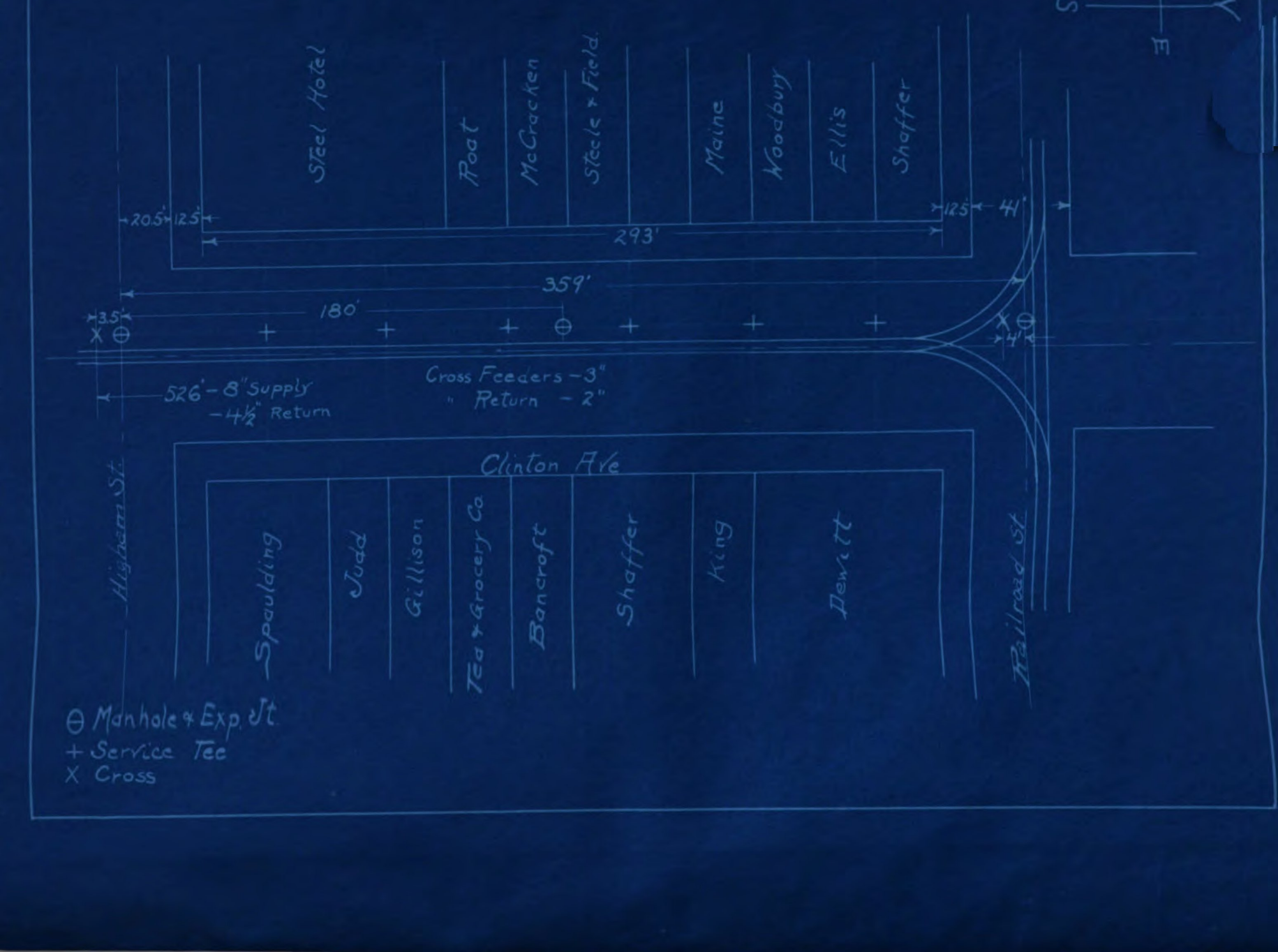
TOTAL INCOME	$8,100.00
TOTAL EXPENSES	$2,700.00
PROFITS	$5,400.00

CONCLUSIONS.

In conclusion we feel safe in saying that the above installation would be very advisable, not only as a source of revenue from the heating system alone, but also as a means of remedying the present inefficient operation of the whole plant, which with the present pumping equipment is unavoidable.


Court House
B.M.
206'
⊖ Manhole + Exp. Joint
+ Service Tee
× Cross
STATE ST.
54'
30'
60'
12.5'
10'
M. U. T. Station
S Towell
S Stevens
Pierce
Putt
Hunt
Pappas
Zavitz
Emmons
Hull
Hotchkiss + Clark
Fowler + Ball
15'
70'
15'
Clinton Ave.
M.U.T. car tracks
All cross feeders — 3"
" returns — 2"
188'
188'
300'
Durkee
Ferguson
Clarke Beach
Harley
Doty + Reed
Plunkett
Chapman
Percy
Parr + Dexter
Osgood
Millman
Ward
12.5'
20.5'
6" Supply
3½" Return
Walker ST.


⊖ Manhole & Exp. Jt.
+ Service Tee
× Cross
6" Supply
3½" Returns
4'
Walker ST.
20.5'
12.5'
Travis & Parr
National Bank
State Bank
15'
70'
15'
10'
183'
Georgia & Bullard
Allison
Merrill
Chapin
Bixby
Hicks
Clinton Ave.
Cross Feeders — 3"
" Returns — 2"
Merrill
Le Baron
300'
Foerch
Clarke Hulse
Wilson
Burk
362.5'
Breisen
Hulse Bros.
Cross
Van Sickle
Morriss
Jones
6" Supply
3½" Return
12.5'
20.5'
Higham St
8" Supply
4½" Return
3.5'


Steel Hotel
Root
McCracken
Steele & Field
Maine
Woodbury
Ellis
Shaffer
20.5'
12.5'
293'
125'
41'
359'
180'
3.5'
4'
526'-8" Supply
-4½" Return
Cross Feeders -3"
" Return -2"
Clinton Ave
Higham St.
Spaulding
Judd
Gillison
Tea & Grocery Co
Bancroft
Shaffer
King
Dewitt
Railroad St.
⊖ Manhole & Exp. Jt
+ Service Tee
X Cross