A DESIGN OF A SEWAGE TREATMENT PLANT GRANDVILLE

Thesis for the Degree of B. S.

MICHIGAN STATE COLLEGE

T. C. Williams - F. D. Hurd

1948

THESIS

SUPPLEMENTARY
MATERIAL
IN BACK OF BOOK

A DESIGN OF A SEWAGE TREATMENT PLANT

Grandville

A Thesis Submitted to

The Faculty of

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of

Agriculture and Applied Science

by

T. C. Williams F. D. Hurd

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The major drainage areas of the state have become increasingly polluted during the past years due to the policy of many towns and industries of dumping raw or insufficiently treated sewage into the streams and rivers. This practice results in the depletion of the normal oxygen content of the diluting body of water with resulting harm to aquatic and wild life. If the State of Michigan is to continue as America's vacationland, efforts must be made to remedy the situation immediately. The following pages will be devoted to the plans necessary for removal of the City of Grandville from the list of those polluting the Grand River.

It is our intent to approach the problem of design with the supposition that we are consulting engineers retained by the city. We feel that by limiting our problem to these specific circumstances we have a more satisfactory paper than would be obtained by merely taking an abstract situation.

The city of Grandville is about eight miles southwest of Grand Rapids on the Grand River in Kent County. It was incorporated in 1887 as a village and became a city in 1933 and has grown slowly except for a spurt in 1928, when the Winters & Crampton Corporation, a metal products company specializing in refrigeration and automotive hardware, located a factory in the village. The population, as shown by the decennial census, is shown in Table I. Special problems encountered in the estimate of future population

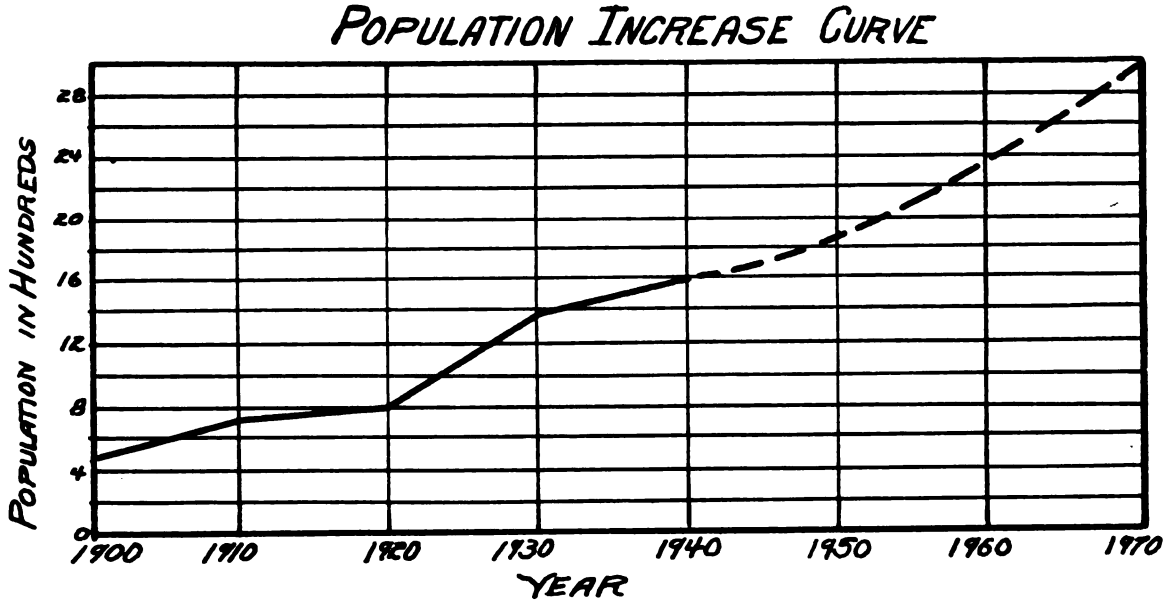
were that during the decade 1930-1940, when most towns had a very small or no gain in population, Grandville had an increase of 16.2%. Winters & Crampton employs about 1200 people on three shifts, about 600 of these are residents of Grandville. The city has, within the past year, annexed several plats which border the city on the south and east.

The city will undoubtedly continue to grow, as with modern transportation people continue to move to suburban areas. Also, there is a marked trend toward decentralization of industries, and there are a number of small industrial sites with railroads available within the corporate limits of the city. By taking the arithmetical method of increasing population, we get a population of 2,397, and by taking the geometric method we get a population of 4,100. We decided to assume a population of 3,000 in 1970 as design population.

TABLE I

POPULATION OF GRANDVILLE

YEAR	CENSUS	ESTIMATED	
		ARITHMETIC	GEOMETRIC
1900	457		
1910	680		
1920	799		
1930	1346		
1940	1566		
1950		1843	2160
1960		2120	2980
1970		2397	4100



The only industrial wastes are those of the Winters & Crampton Corporation, which we propose to treat separately.

The existing sanitary facilities of the city consist of a metered municipal water supply, a combined sewer system for about 80% of the town, and a sanitary system for the other 20%, with a septic tank sewage treatment. The existing sewers serve the city adequately, except for the portions recently annexed.

The existing sewage treatment plant is inadequate and is flooded for at least eight weeks each year, this year to a depth of approximately 15 feet. Due to lack of attention, the tank has not been working and is so full of sludge that the sewage simply flows through with little or no treatment.

We discussed the situation at Grandville with both the Stream Control Commission and Mr. Shepard of the Engineering Division of the State Health Department with the following results. The absolute minimum flow in the Grand River at Grandville is approximately 600 sec.-ft. With maximum flow

from Winters & Crampton and the city of Grandville, this would result in dilution of 400 to 1 with even greater dilution most of the time. This indicates then, that only primary treatment is required.

Mr. Shepard recommended that we use either an Imhoff tank or primary sedimentation with separate sludge digestion. In our computations you will note that we have designed both, either design being subject to the approval of the city and the Health Department. The same principles apply in either case.

The Imhoff tank design is preferred for small communities because of its low maintenance and operating costs. Also, it does not need a full-time operator to keep it in operation. Its original cost, though, is likely to be somewhat more than the cost of primary sedimentation tanks with separate sludge digestion, because of the rather involved form work and deep excavation. This we have attempted to defeat in our design by limiting the depth of the tank to about 22 feet. The proposed site aids us in this because it is relatively low ground and approximately 12 feet of fill is required to bring the plant up above any possible flood level. This design also helps to keep the temperature up in the tank to speed digestion because of the absence of ground water to absorb the heat.

The Primary Sedimentation system with separate sludge digestion also has some definite advantages. Among these are lower initial cost, greater flexibility in expansion, and greater gas production and ease of collection.

Our analysis of Winters & Crampton wastes indicated a lack of cyanide or other toxic wastes and the pH of the composite sample was 7.2. However, this was a variable item that could be treated most inexpensively by installing a storage tank in which the acids and alkalies will neutralize each other. The lack of detectable amounts of of cyanide or other toxic materials makes it permissible to forego further treatment. There may, at times, be considerable copper in the wastes, but if care is used in dumping tanks over an extended period of time, these will cause no trouble. However, after extensive tests, we did determine that it would require three grains per gallon (g.p.g.) of hydrated lime and 12 g.p.g. of Ferrous Sulphate to precipitate all the metals and remove the color of the sewage. This would make a very expensive project for a corporation of the size of Winters & Crampton, and a city the size of Grandville unless the metals were to be reclaimed.

It was therefore decided to intercept these wastes before they reach the sanitary sewers and run them through a separate direct line to the existing septic tank which could be used for storage, as mentioned above.

Analysis of Sewage

Sanitary Wastes:

Suspended solids - 182 parts per million (p.p.m.)

Loss on ignition (volatile solids) - 95% - 172.5 p.p.m.

5 Day B.O.D. - 410 p.p.m.

Industrial Wastes:

Total solids - 1115 parts per million

Suspended solids (normal) - 77 p.p.m.

Suspended solids (nite) - 152 p.p.m.

Metal oxides precipitable with lime - 222 p.p.m.

pH - 7.2

Cyanides less than 0.1 p.p.m.

Flow:

Industrial: approximately .11 million gallons per day (m.g.d.) into sewer on White Street, and approximately .22 m.g.d. into sewer on Wilson.

The water meters of the city show a yearly comsumption of 77.7 million gallons, 28.7 million gallons of which goes to Winters & Crampton Corporation. This leaves a net total of 49 million gallons consumed by the people of the city per year. This indicates an average daily consumption of 74.5 gallons per capita per day (gcd). Winters & Crampton employ 1,200 persons and their sanitary wastes must be treated at the same plant. By using a population equivalent for their factory and liberal allowances for infiltration, we determined the flow to be 97.6, or approximately 100 g.c.d.

Design Flow

Population 3,000

Maximum = 750,000 g.p.d. = 520 g.p.m. = 1.16 c.f.s.

Average = 300,000 g.p.d. = 208 g.p.m. = 0.464 c.f.s.

Minimum = 175,000 g.p.d. = 122 g.p.m. = 0.272 c.f.s.

DIVERSION CHAMBER

As the existing sewer system is approximately 80% combined storm and sanitary, it would be impractical to attempt to pump all the storm water and run it through the treatment plant, therefore, it was necessary that we design a diversion chamber to by-pass the storm flow, i.e. any quantities in excess of the peak sanitary flow. In time of flood conditions, the stop plate on the inside of the pump house may be partially closed to admit only the amount of water the plant operator deems desirable, or may be closed entirely and the plant shut down.

This design will not serve to alleviate any of the troubles previously encountered at flood time from sewers backing up, but neither will it aggravate them. (See Sheet # 8 for detail).

When the 30 inch sewer is carrying 1.17 c.f.s. (design maximum) the depth of water in the pipe will be 4.8 inches or .4 feet. Therefore, the invert elevation of the three 14 inch valves was set 0.4 ft. above the invert of the 30 in. A shear gate was required to enable the operator to adjust the size of the orifice should there be too much water flowing into the second compartment. There is also a shear gate at the entrance to the bar rack chamber so the plant may be completely shut off, should it be required.

BAR SCREEN

The bar screen chamber will be 2 ft. wide and 5 ft. deep. We will use 3/8 in. wide bars at 1 in. on centers. The maximum velocity in the channel will be:

$$V = \frac{Q}{A} = \frac{1.16}{2x.593} = 0.97 \text{ ft. per second}$$

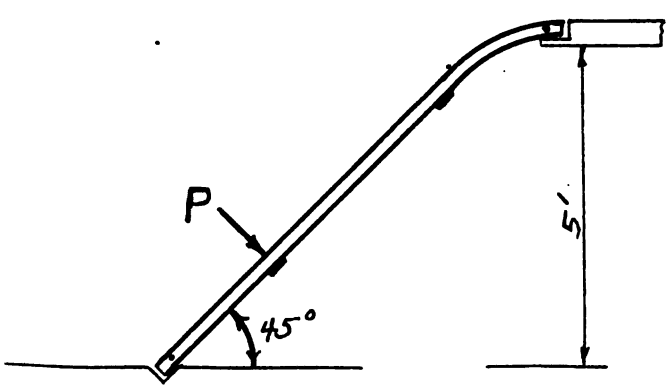
The maximum velocity between bars will be:

$$V = \frac{24}{17.55} \times .97 = 1.32 \text{ ft. per second}$$

The maximum velocity normal to the bars will be:

$$0.707 \times 1.32 = 0.93 \text{ ft. per second}$$

The largest possible head on the rack would occur when the spaces are completely plugged and water is 5 ft. deep on the entrance side; also at this time the operator will be attempting to clean the rack, exerting an additional force. There will be 16 bars in the rack across the channel width of 2 ft. Therefore, the Moment on each bar =



$$M = \frac{62.4x5x7x7x1.25}{2x16x3} = 3850 \text{ ft.}$$

$$S = \frac{M}{f} = \frac{3850}{18,000} = .213 \text{ cu. in.}$$

$$\text{Thickness} = d = \sqrt{\frac{6S}{b}} = 1.91 \text{ in.}$$

Use 2x$\frac{3}{8}$x9'-0" bars, imbed 2" in concrete

Weld two 3"x1"x2'-0" steel flats on underside.

GRIT CHAMBER

As the sewer system is 80% combined, storm and sanitary, it will be necessary to have a grit chamber. Two will be used so that one may be in operation when the other is being cleaned.

Design data:

Average Q = 0.464 c.f.s.

Maximum Q = 1.16 c.f.s.

Maximum Velocity = 1 ft. per second

Remove grains 0.20 mm. and larger

According to "Steel" these particles will settle at the rate of 0.815 in/sec.

Try channel 1.25 feet wide.

$$A = \frac{Q}{V} = \frac{0.464}{1} = 0.464 \text{ sq. ft.}$$

$$\text{depth} = \frac{A}{W} = \frac{0.464}{1.25} = 0.37 \text{ ft.} = 4.45"$$

$$\text{length} = \frac{4 \times 45}{0.815} = 5.46 \text{ feet long}$$

For Maximum flow, this requires 13.6' "Babbitt" points out that for particles 0.20 mm. in diameter, a rate of flow of 28,000 gallons per day per square foot of surface area.

$$\frac{300,000}{20,000} = 10.7 \text{ square ft.}$$

$$\frac{10.7}{1.25} = 8.6 \text{ ft. long}$$

For Maximum flow this requires 21.5 feet. Use 2-15' Channel 1'-3" wide.

We will use a proportional flow weir. The crest of this weir should be 2" above floor of bar screen chamber.

There will be a 3" drop from floor of bar screen chamber to grit chamber.

Maximum depth of flow in grit chamber:

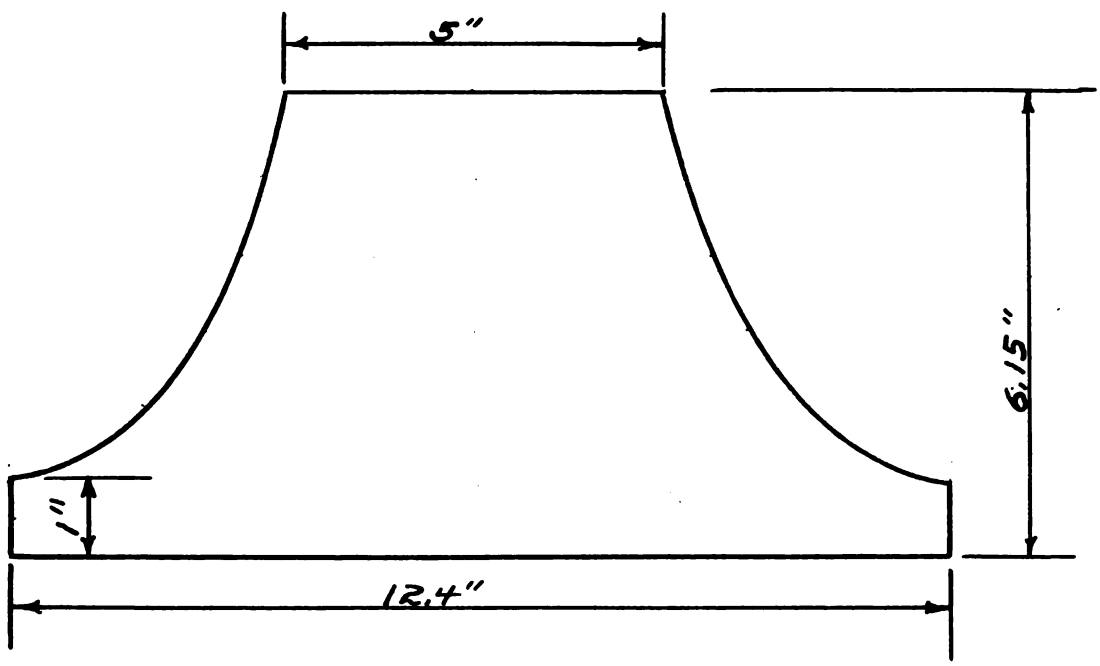
$$d = \frac{Q}{vW} = \frac{1.16}{1x1.25} = 0.928 \text{ ft.} = 11.15 \text{ "}$$

h for weir = 6.15" = 0.512'

$$1 = \frac{Q}{7.55xh^{3/2}} = \frac{1.16}{7.55x0.366} = 0.418' = 5."$$

$$K = 1h'^{2} = 5x2.48 = 12.4$$

h =	6.15"	5"	4"	3"	2"	1"
1 =	5"	5.55"	6.2"	7.15"	8.75"	12.4"



WET WELL

Design for average flow = 208 g.p.m.

10 min. flow storage

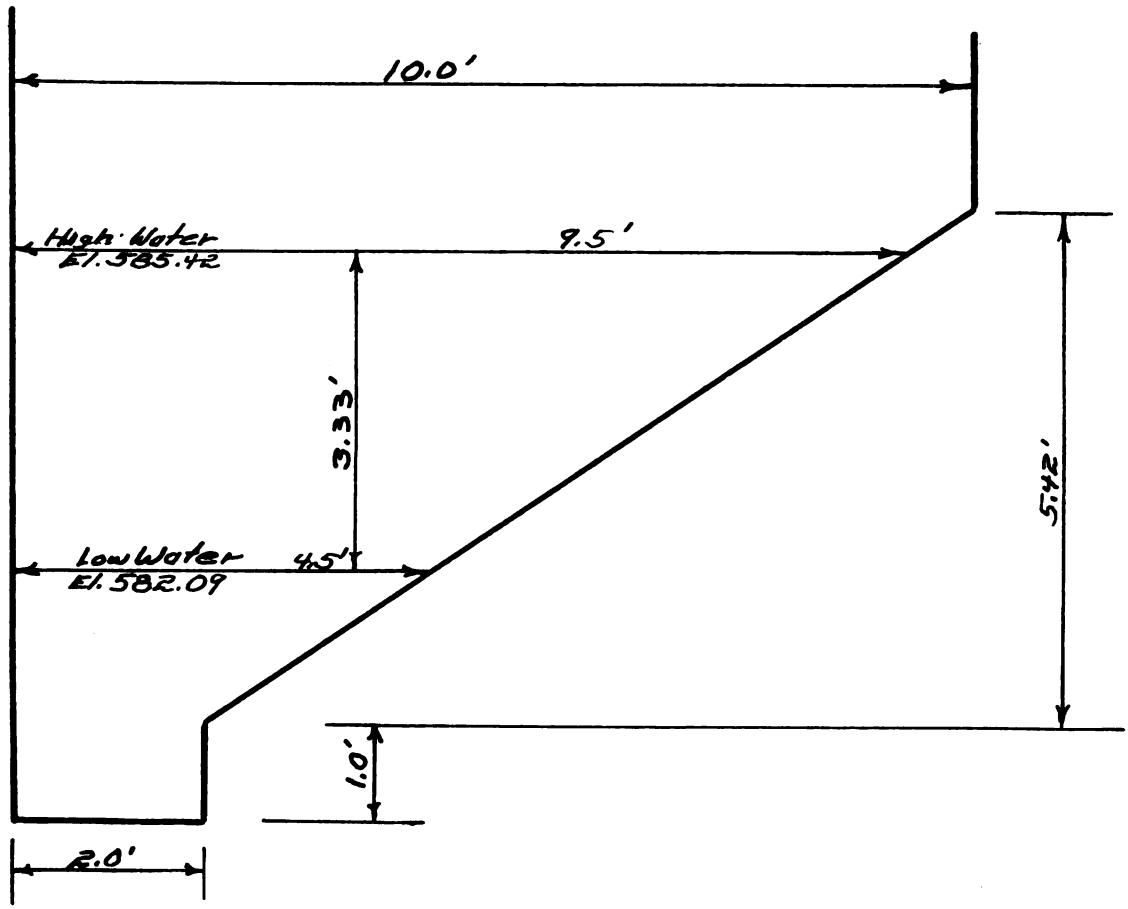
2080 gals. = $\frac{2080}{7.48}$ = 278 ft.^{3}

Try tank 6.5'x12'x3'-6"

Use 7'x12'x3'-4"

A 500 g.p.m. pump could empty wet well in:

$\frac{2080}{292}$ = 7.1 minutes



PUMPING SYSTEM

Use two 250 g.p.m. pumps with space and connections for third 500 g.p.m. in future.

Static head on pumps:

Elev. low water in wet well - 581.5

Elev. of sewage in Imhoff or primary Sedimentation tank - 607

Static head = 25.5'

Losses in piping = 3.5'

Total head = 29'

Horsepower for 250 gallon per min. pumps is:

$$HP = \frac{QWh}{550} = \frac{250 \times 62.4 \times 28}{449 \times 550} \times \frac{1}{.60} = 2.94 \text{ h.p.}$$

Use a 3 H.P. motor

Horse power for 500 gallon per minute pump is

$$HP = \frac{QWh}{550} = \frac{500}{250} \times 2.94 = 5.88 \text{ h.p.}$$

Use a 7.5 Horse power motor. (overload too great for 5 H.P. motor)

IMHOFF TANK

Design data:

Av. Q = .464 c.f.s. = 208 g.p.m.

Max. rate of flow - 800 gal/day/sq. ft.

Velocity (maximum) 1'/min.

Detention time - 2.5 hrs. for average flow

Suspended solids - 182 p.p.m.

Assume

60% removal of suspended solids

90% moisture content of sludge average in sludge compartment

1.02 = specific gravity of sludge

6 months storage " "

25% digestion of solids entered into sludge compartment

Flowing through chamber:

Volume of flowing thru chamber = 2.5x.3x5570 = 4180 ft.^{3}

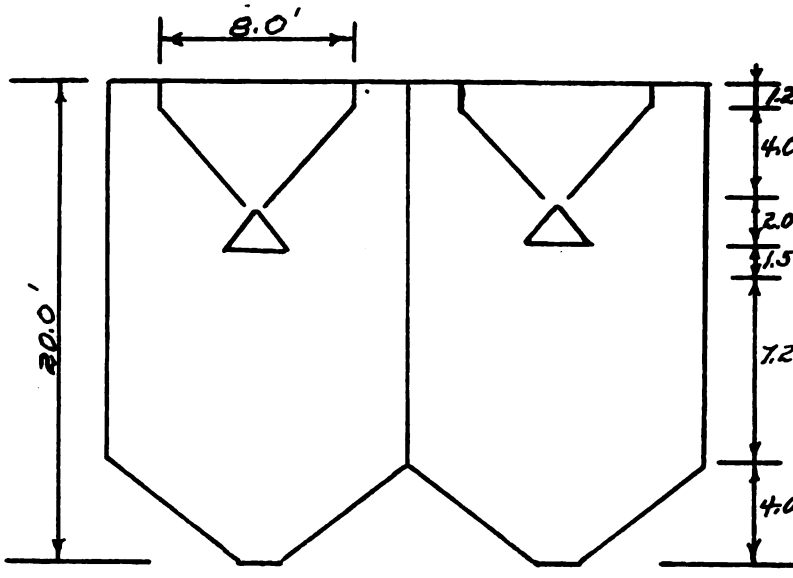
Try two tanks in parallel, each 8'x50'

Flow	G.P.M.	G/D/ft^2	Velocity	Detention
Average	208	375	0.33	2.5
Maximum	520	940	0.84	1.0

This is satisfactory.

Use two flowing through chambers 8' wide by 50' long.

Digestion Chamber:



182x.6x8.34x.3 = 273#/day removed

273x.75 = 205# net accumulation per day

$\frac{205x6x30}{.10x62.4x1.02}$ =5,800 ft^3

This is 1.93 ft^3/capita.

However, Michigan Dept. of Health requires a minimum of 4 ft^3/capita or 4x3000=12,000 ft^3.

Therefore we chose the dimensions shown.

Trough :

Design Data:

Max. Q = 1.16 c.f.s.

Av. Q = .464 c.f.s.

Approximate velocity in Trough 0.5'/sec.

Approximate area of cross section

$$A = \frac{Q}{V} = \frac{1.16}{.5} = 2.32 \text{ ft}^2$$

Try 18" wide and 15" deep Area = 1.815 s.f.

Max. Velocity = .62'/sec.

Av. Velocity = .25'/sec.

This is satisfactory.

Weirs:

Try weir 6' long

$Q = 3.33\ lh^{3/2}$

For average flow $h = \left(\frac{.464}{2x3.33x6}\right)^{2/3} = .0515' = .62''$

This is too high.

Try 7'-6" weir

For av. flow $h = \left(\frac{.464}{2 \times 3.33 \times 7.5}\right)^{2/3} = .044 = .53"$

This is as low as it is possible to obtain.

S. S. Greeley recommends an overflow of about 50,000 gal/linear ft/day for effluent weirs.

$\frac{750,000}{7.5 \times 2} = 50,000$ gal/ft/day

This is satisfactory.

Elevation of weir crest - inlet	607.05
outlet	606.95
water surface	607.00
Elevation of bottom of trough	606.85

PRIMARY SEDIMENTATION BASIN

Design Data:

Detention time - 2.5 hours for average flow

Maximum Velocity - 1 ft. per min.

Depth of water - 8 feet

Maximum rate of flow - 800 gal/ft^2/day

Surface area required = $\frac{300,000}{800}$ = 375 sq. ft.

Try 10' wide x 8' deep x 50' long

Flow	G.P.M.	G/D/ft^2	Velocity	Detention
Average	208	600	0.35	2.6
Maximum	520	1500	0.88	1.0

This is satisfactory.

Use one tank 10 feet wide by 8 feet deep by 50 feet long.

Tank will be mechanically cleaned with depth at shallow end of 8 feet and at deep end 9 feet, with hopper for sludge collection. A 6 inch cast iron pipe will be used for sludge draw off.

Influent will be through submerged orifices with baffles to diffuse the flow and help eliminate currents. Effluent will be over two edges of an effluent trough 10 feet long, giving 20 feet of effluent weir. This gives at maximum flow a rate of 37,500 gallons per foot per day which is less than the recommended 50,000 gallons per foot per day.

SLUDGE DIGESTION TANK

Average Q = .464 c.f.s.

182 P.P.M. suspended solids

Assume 95% Moisture

60% Removal of Suspended Solids

25% Digestion of Suspended Solids

85% Volatile Solids

1.02 = Specific Gravity

120 day Storage

182x.6 = 109 p.p.m. removed

.3x109x8.34 = 273#/day of dry sludge

$\frac{273}{.05}$ = 5470#/day of wet sludge

$\frac{5470}{62.4x1.02}$ = 89 ft^3/day of wet sludge

.75x89 = 67 ft^3/day net accumulation

120x67 = 8000 ft^3 required capacity

$\frac{8000}{3000}$ = 2.67 ft^3/capita

However, Michigan Department of Health requires 25-35 ft^3 per pound of volatile solid added daily.

35x182x.6x.95x.3x8.34 = 9100 cubic feet

This is 3.03 ft^3/capita: use 4 ft^3/capita

Try 30' diameter tank: Area = $\frac{\pi}{4}x30^2$ = 707 ft^2

Depth necessary = $\frac{12,000}{707}$ = 17'

Use 1 tank 30' diameter and 20' deep, (3' for supernatant).

Pipes will be provided for with-drawing the sludge at three different levels. Hot water coils will be provided

to keep temperature at 70° F. Supernatant will be returned to primary tank and digested sludge will be drawn off to the sludge drying beds.

Assuming a gas production of one ft^3/capita/day. A floating cover will be provided for the storage of this gas. The gas produced will be used to heat the service building and the digestion tank. Supplementary heating from an oil burner must be provided in the event that not enough gas is produced.

SLUDGE DRYING BEDS

The area required, according to Skinner is:

$$A = \frac{CRS}{NFW} = \frac{1x31.4x109}{6x46.8x8.8} = 1.375 \text{ ft}^2\text{/capita}$$

	Values
A = Area in ft²/capita	
C = Coefficient	1.0
R = Av. Annual Rainfall in inches	31.43"
S = Suspended Solids removed p.p.m.	109 p.p.m.
N = No. of Months drying season	6 mos.
F = Mean Temperature F.°	46.8° F
W = Mean Wind Velocity, mph.	8.8 m.p.h.

According to Fisher is: 35#/ft²/year of dry solids.

Dry solids = .3x555x365 = 60,300#/year

$$\text{Area} = \frac{60,300}{35} = 1720 \text{ ft}^2 = \frac{1720}{3000} = .573 \text{ ft}^2\text{/capita}$$

However, Department of Health requires 1.5 ft²/capita.

1.50x3000 = 4500 ft²

Use 6 beds, 15' wide x 50' long

The beds will have an 8" layer of coarse sand on a 6" layer of washed gravel 1/4" - 1/8" in diameter at top to 1" on bottom. The bottom of the bed will be of natural earth sloping to underdrains.

The underdrains will be 6" farm tile with open joints, these will empty into a 6" V.C. tile at the west end of the bed, which is laid on a 0.3% grade.

CHLORINATION TANK

Q = 208 g.p.m.

Contact time 20 minutes

Tank Volume = $\frac{20 \times 208}{7.48}$ = 558 ft^3

Use 1 tank 8' deep x 10' long x 7' wide

Plus 2' freeboard

The chlorinator will be placed in the service building in a special room with a feed line to the tank.

The chlorinator will be of such a size that it can supply 15 p.p.m. of chlorine to the effluent.

SLUDGE PIPING

H. E. Babbitt and D. H. Caldwell

$\frac{Hw}{L} = \frac{16Sy}{3xWxD} + \frac{nV}{WD^2}$ nV

Use a velocity of 7 ft/second

Try a diameter of 6"

Length = 140'

Sy = Shearing stress #/ft^2 = 0.065 #/ft^2

n = Coefficient of rigidity = 0.025

Hw = Head causing flow = 3.12 ft. of water

W = Weight of water = 62.4 #/ft^3

D = Diameter of pipe = 0.5'

V = Average velocity in ft/sec. = 7 ft/sec.

$Hw = 140 \left(\frac{16x.065}{3x62.4x.5} + \frac{.025x7}{62.4x.25}\right) = 140 \left(.0111 + .0112\right)$

Hw = 140x.0223 = 3.12'

We will use a 6' difference of elevation between the water surface in the Imhoff tank and the surface of the

sludge beds. Therefore the elevation of surface of sludge beds, when filled, will be 601 ft.

HEAD LOSSES

From suction to pump

Q = 250 G.P.M. = 558 c.f.s.

6 inch—v = 2.83 ft. per sec; $v^2/2g$ = 0.1245 feet

5 inch—v = 4.08 ft. per sec; $v^2/2g$ = 0.258 feet

4 inch—v = 6.35 ft. per sec; $v^2/2g$ = 0.625 feet

1 flared entry - 6"	= 0.1x0.1245 =	0.0125
2 feet of pipe - 6"	= $\frac{64}{100}$x2 =	0.013
1 grate valve - 6"	= 0.1x0.1245 =	0.0125
1 reducer 5"x6"	= 0.25x0.258 =	0.0645
		0.1025' 0.103'

From pump to header

1 elbow - 4"	= 0.5x0.625	= 0.3125
1 Check valve - 4"	= 0.5x0.625	= 0.3125
1 gate valve - 4"	= 0.1x0.625	= 0.0625
18 ft. of pipe - 4"	= $\frac{5}{100}$x18	= .90
1 90° tee with enlargement	= 1.50x0.625	= 0.9375
		2.5250' 2.525'

Header and pipe to tank

Q = 500 g.p.m. or 1.11 c.f.s.

8 inch—v = 3.19 feet per second $v^2/2g$ = 0.1575 feet

2 tees straight through - 8"	= 2x0.1x0.1575	= 0.0315	
33 feet of pipe - 8"	= $\frac{.59}{100}$x33	= 0.1950	
3 elbows - 8"	= 3x0.5x0.1575	= 0.2362	
8 feet of pipe - 8"	= $\frac{.59}{100}$x8	= 0.471	
1 Venturi meter 8 by 4	= 0.25x2.52	= 0.630	
1 Velocity head		0.1575	
		1.2973'	1.297
	Total losses in pipes		3.925
	Static head (low water in wet well)		22.91
	Total head pumped against		26.835'

Use 28.0 feet of water

CONCRETE DESIGN

Design equations and tables from "Reinforced Concrete Handbook" published by American Concrete Institute.

Design Data; 1940 Joint Committee

28 day strength = f'c = 3000 p.s.i.

fiber stress, compression = fc = 0.45 f'c = 1350 p.s.i.

shear (without special anchorage) = v_c = 0.02f'c = 60 p.s.i.

shear (with special anchorage) = v_c = 0.03f'c = 90 p.s.i.

bond (without special anchorage) = μ = 0.05f'c = 150 p.s.i

bond (with special anchorage) = μ = 1.5x150 = 225 p.s.i.

Steel.

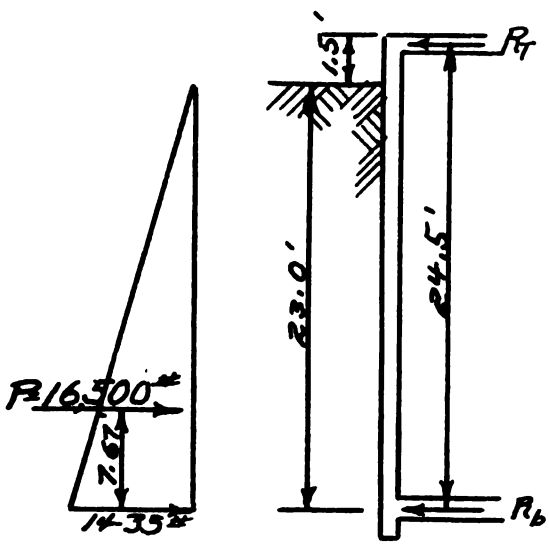
Tension in flexural members = fs = 18,000 p.s.i.

SERVICE BUILDING BASEMENT

Vertical wall

Try design for vertical steel

design for water pressure



Moment about bottom= 0

$0 = 7.67 \times 16{,}500 - 24.5 R_T$

R_T = 5180

R_b = 11,320

$31.2x^2$ = 5180

x^2 = 168

x = 13'

x_o = 14.5'

$M = -\frac{13}{3} \times 5180 + 14.5 \times 5180 = 52{,}500$ ft. lbs.

For shear = 11,320#

$$G = \frac{V}{v} = \frac{11.320}{60} = .188$$

d = 18"

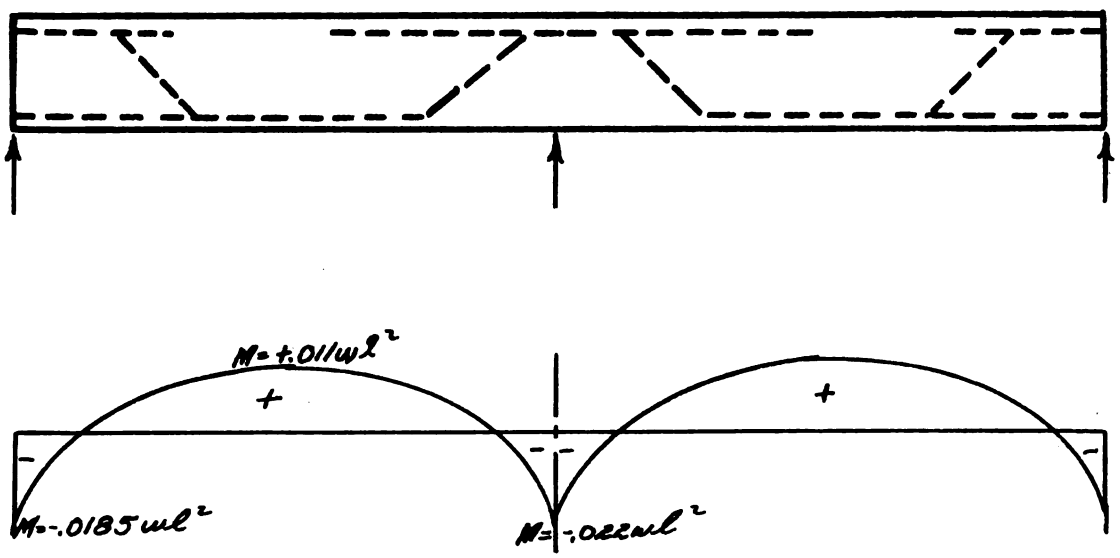
This would be a 20" wall

$$A_s = \frac{M}{ad} = \frac{52.5}{1.29 \times 18} = 2.25 \text{ in}^2/\text{ft.}$$ Use 1 $\frac{1}{8}$" @ 6 $\frac{1}{2}$"

This is too heavy a wall.

Try design for horizontal steel with buttress in middle of 30 ft. wall and beam between buttresses at elevation 600.00; then longest span would be 15.0 ft.

Two-span continuous beam



At Elevation 591.00 h = 12.5

W = 62.4h = 780#/ft²

Maximum positive moment = .011x780x30² = 7720 ft. lb.

Maximum negative moment = .022x780x30² = 15,440 ft. lb.

For Maximum Shear

$V = (7720/15{,}440) \times 1 \frac{1}{15} / 3(780 \times 15) = 1{,}540/4{,}400 = 5940\#$

$v = 60$ p.s.i. without special anchorage; 90 p.s.i.

with $d = 10"$

Use a $12"$ wall with $d = 10"$

Positive steel

$A_s = \frac{M}{ad} = \frac{7.72}{1.29 \times 10} = .50$ in^2/ft. Use $\frac{3}{4}"\phi$ @ $9"$ o.c.

Negative Steel

$A_s = 1.20$ in^2/ft. Use $\frac{3}{4}"\phi$ @ $4\frac{1}{2}"$ o.c.

At elevation 595.00 $h = 8.5$

$M = \frac{8.5}{12.5} \times 15{,}440 = 10{,}500$ ft. lb.

$A_s = \frac{10.5}{1.29 \times 10} = .82$ in^2/ft. Use $\frac{5}{8}"\phi$ @ $4\frac{1}{2}"$ o.c.

and $\frac{5}{8}"\phi$ @ $9"$ o.c.

At elevation 599.00

$A_s = \frac{4.5}{12.5} \times 1.20 = .46$ in^2/ft. Use $\frac{5}{8}"\phi$ @ $8"$ o.c.

and $\frac{5}{8}"\phi$ @ $8"$ o.c.

Vertical steel will be $\frac{1}{2}"\phi$ @ $12"$ o.c.

End walls

Consider with fixed ends.

Then $-M = \frac{1}{12} wl^2 = \frac{1}{12} \times .780 \times 18^2 = -21.0$ ft. Kips;

$+M = 10.5$ ft. kip.

Reinforcement same as side walls except that $\frac{7}{8}"\phi$ will be used rather than $\frac{3}{4}"\phi$ and $\frac{3}{4}"\phi$ rather than $\frac{5}{8}"\phi$ all at same

spacing. All bars in both walls will be bent around corners 1 1/2 feet. Splices will overlap 40 diameters.

First floor

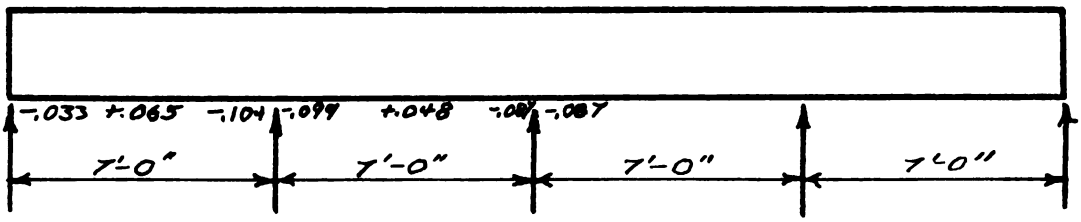
Floor beams 7'0" o.c.

Try 4" reinforced concrete floor

Dead load = 50 p.s.f.

Live load = 125 p.s.f.

Total load = 175 p.s.f.



$\frac{L_{live}}{L_{dead}} = 0.4$ $\qquad \frac{EK}{K} = 0.5$

End span

Maximum positive moment

$M = .065\ wl^2 = .065 \times 175 \times 7^2 = 558$ ft. lbs.

Maximum negative moment at first support.

$M = .104\ wl^2 = 895$ ft. lbs.

Interior span

Maximum positive moment

$M = .048\ wl^2 = 412$ ft. lbs.

Maximum negative moment

$M = .087\ wl^2 = 748$ ft. lbs.

Shear

$V = \frac{1}{15} \times 1553 \neq \frac{3}{8} \times 7 \times 175 = 104 \neq 456 = 560$ lbs.

$v = 60$ p.s.i.

$$G = \frac{.560}{60} = .009$$

4" slab is sufficiently thick for shear.

Negative steel at end

$$A_s = \frac{.33}{1.29x3} = .0855 \text{ in}^2/\text{ft}$$

Negative steel at supports

$$A_s = \frac{.895}{1.29x3} = .222 \text{ in}^2/\text{ft}$$

Use wire mesh 2 ga. @ 3" longitudinally and
8 ga. @16" transversely

For negative reinforcement over supports 4 ft. long and 18 ft. wide.

Positive steel, End span

$$A_s = \frac{M}{ad} = \frac{.558}{1.29x3} = .144 \text{ in}^2/\text{ft}$$

Positive steel, interior span

$$A_s = \frac{.412}{1.29x3} = .107 \text{ in}^2/\text{ft}$$

Use wire mesh 7 ga. @ 2" longitudinally
11 ga. @ 16" transversely

for positive reinforcement over entire floor.

Floor beam design

Uniform load = 560#/ft

$$M = \frac{1}{8} wl^2 = \frac{560}{8} \times 17^2 = 20,250 \text{ ft. lbs.}$$

$$S = \frac{M}{f} = \frac{20,250x12}{20,000} = 12.15 \text{ in}^3$$

8 I 18.4 has $S = 14.2 \text{ in}^3$

This is satisfactory

Basement floor.

Longest unsupported span = 12 ft.

W = uplift = 23.5 x 62.4 = 1460 - 150 = 1310 #/ft^2

Use +M = $\frac{1}{24}$ wl^2 as the ends are fixed

Use -M = $\frac{1}{12}$ wl^2

Positive Moment = $\frac{1}{24}$ wl^2 = $\frac{1310}{24}$ (144) = 7850 ft. lbs.

Negative Moment = 15,700 ft. lbs.

Shear = $\frac{wl}{2}$ = 1310 x 6 = 7850 lbs.

G = $\frac{V}{v}$ = $\frac{7.85}{60}$ = .131

d must = 14"

Use 16" floor

Positive steel

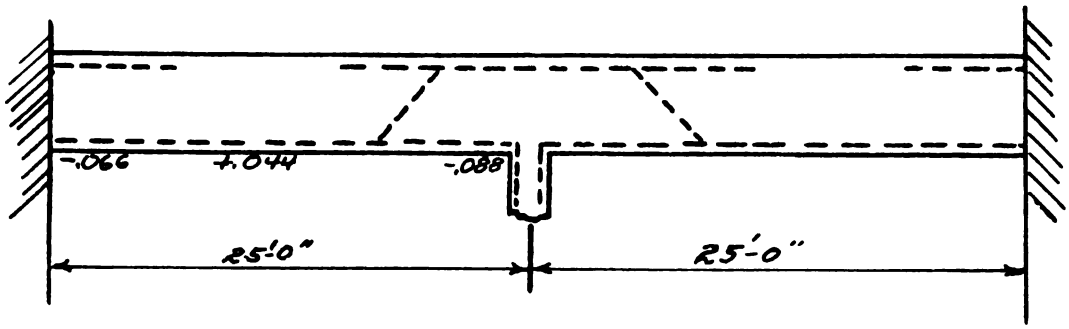
$A_s = \frac{M}{ad} = \frac{7.85}{1.29x14}$ = .434 in^2/ft. Use $\frac{3}{4}$"ø@ 12" o.c.

Negative

A_s = .868 in^2/ft. Use $\frac{3}{4}$"ø @ 6" o.c.

IMHOFF TANK

Triangular beam at bottom of flowing through chamber.



Only load is weight of beam.

This beam must be 3 ft. wide; 2 ft. deep

$W = 3 \times 150 = 450$ lbs./ft.

Negative steel at end

$M = .066\ wl^2 = .066 \times .450 \times 625 = 18.5$ ft. kips

$A_s = \frac{M}{ad} = \frac{18.5}{1.29 \times 20} = .718$ in^2/ft. Use 1"ϕ @ 12 in.

Negative steel at center support

$M = 24.7$ ft. kips

$A_s = .95$ in^2/ft. Use 1"ϕ or 1"ϕ and $\frac{1}{2}$"ϕ @ 12 in

The compressive area for above computations was assumed to be a rectangle rather than a trapezoid. The error introduced is negligible.

Shear

Maximum $V = (37.1)\ \frac{1}{25} \not\leftarrow \frac{3}{8}\ (.45) = 1.48 \not\leftarrow .17 = 1.65$ kips

Bond

Check 1" bar

$$M = \frac{V}{jd\ \Sigma o} = \frac{1650 \times 8}{7 \times 20 \times 3.1} = 30.3 \text{ p.s.i.} \quad \text{O.K.}$$

Positive steel M = 12.4 ft. kips

Compressive area is triangular.

Center of pressure would be 1/2 distance from neutral axis to vertex

Try N.A. 8" from top

$C = (8 \times 12 \times \frac{1}{2})(\frac{1}{3} f_c) = 16 \times 1350 = 21{,}600$ lbs.

$jd = 24 - 2 - 4 = 18"$

$M = 18 \times 21{,}600 \times \frac{1}{12} = 32{,}400$ ft. lbs.

This is more than needed.

Try N.A. 4" down

$C = \frac{21{,}600}{4} = 5{,}400$ lbs.

$jd = 24 - 2 - 2 = 20"$

$M = 20 \times 5{,}400 \times \frac{1}{12} = 9{,}000$ ft. lbs.

This is too small.

Use N.A. @ 5" down

$C = T = 8{,}400$

$jd = 24 - 2 - 2.5 = 19\frac{1}{2}"$

$M = 19\frac{1}{2} \times 8{,}400 \times \frac{1}{12} = 13{,}600$ ft. lbs. O.K.

$T = f_s A_s$

$A_s = \frac{T}{f_s} = \frac{8{,}400}{18{,}000} = .47$ in^2

Use 3 - $\frac{1}{2}"\phi$ bars in bottom. Bend one up at center

ADVERTISEMENT

NOTICE TO CONTRACTORS:

Sealed proposals will be received at the office of the City Clerk, Municipal Building, Grandville, Michigan, until 3:00 p.m. (Eastern Standard Time) of October 14, 1948, at which time the bids will be publicly opened and read by the Clerk and the rates of bids for the different items noted, for the construction of a diversion chamber on Kent Street and a sewage treatment plant complete. The sewage treatment plant is located at the intersection of M-114 and Kent Street. The sewage treatment plant item includes all the work on this site as specified in the plans.

The plans and specifications for the work may be examined at the office of the City Clerk, Grandville, Michigan, or copies may be obtained by making a deposit of $15.00 which will be refunded upon their return in good condition.

A certified check or bid bond for a sum of not less than 5% of the amount of the proposal will be required with each proposal as a guarantee of good faith and the same to be subject to the conditions stipulated in the instructions to bidders.

The right to accept any proposal, to reject any or all proposals, and to waive defects in proposals is reserved by the City.

By Order of the City Council.

_____, City Clerk

FORM OF PROPOSAL

_____,1948

To The Honorable City Council
City of Grandville, Michigan
Gentlemen:

Having carefully examined the site of the proposed work, and being fully informed in regard to the conditions to be met in the prosecution and completion of the work, and having read and examined the Instructions to Bidders, Contract, Bonds, Plans and Specifications pertaining to this work and agrees to be bound accordingly, the undersigned proposes to furnish all the materials, labor, tools, power, transportation, and construction equipment necessary for the satisfactory and complete construction of diversion chamber on Kent Street and a sewage treatment plant complete. The sewage treatment plant is located at the intersection of M-114 and Kent Street. The sewage treatment plant item includes all the work on this site as specified in the plans. This work shall be in full accordance with and conformity to the plans and specifications for this work now on file in the office of the City Clerk at and for the following named prices, to wit:

Item 1. Sewage treatment plant complete, 1 lump sum

@_____($) lump sum

Item 2. Diversion chamber, 1 lump sum

@_____($) lump sum

The following unit prices will apply in the event additions to or deductions from the work called for on the plans for the sewage treatment plant only are ordered by the Engineer or the City of Grandville.

	Type of Work	Unite	Price
Item 3.	Earth excavation	cu. yd.	_____
Item 4.	Concrete in place	cu. yd.	_____
Item 5.	Joint waterproofing	sq. ft.	_____
Item 6.	Reinforcing steel	lb.	_____
Item 7.	Fencing	lin. ft.	_____
Item 8.	Gravel drive	cu. yd.	_____

The undersigned agrees that, in case any additions or deductions in the amount of work contemplated are made, the above named unit prices for the various classes of work shall be used to allow for such additions or deductions.

The undersigned hereby agrees that if this proposal shall be accepted by the said City, he will, within ten days after receiving notice of such acceptance or delivery thereof at the address given below (Sundays and legal holidays excepted), enter into contract, in the attached form, to construct the said work according to said plans and specifications and to furnish therefor all necessary equipment, tools, and building appliances, materials, labor, power, and transportation as aforesaid, at and for the prices named in the foregoing paragraph; to furnish to the said City and to the State of Michigan such sureties for the faithful performance of such Contract and for the payment of all

materials used therein and for all labor expended thereon as shall be approved and accepted by the said City; and to furnish to the said City of Grandville, a Maintenance Bond if called for in the Instructions to Bidders.

The undersigned attaches hereto a certified check in the sum of _____ Dollars ($) as required in the Instructions to Bidders. And the undersigned hereby agree that, in case he shall fail to fulfill his obligations under the foregoing proposal and agreement, the said City, may at its option, determine that the undersigned has abandoned his rights and interests in such contract, and that the certified check accompanying this proposal has been forfeited to the said City; as liquidated damages and not as a penalty; but otherwise the said certified check or bid bond shall be returned to the undersigned upon the execution of such contract and the acceptance of Bonds.

The undersigned states that he has done work similar in character to that covered by this proposal at the following named times and places, to wit:

_____

_____

_____

The undersigned refers the said City to the following named parties for information concerning his experience, skill, and business standing:

_____ _____

_____ _____

_____ _____

Dated and signed at _____,

Michigan, this _____day of _____

1948.

_____

_____

Address of Bidder

_____

_____

_____

INSTRUCTIONS FOR EXECUTING CONTRACT

If the Contractor be a corporation the following certificate should be executed:

I, _____, certify that I am the _____ Secretary of the corporation named as Contractor hereinabove; that _____ who signed the foregoing contract on behalf of the Contractor was then _____ of said Corporation; that said Corporation by authority of its governing body, and is within the scope of its corporate powers.

_____
(Corporate Seal)

If the contract be signed by the secretary of the corporation, the above certificate should be executed by some other officer of the corporation, under the corporate seal. In lieu of the foregoing certificate there may be attached to the contract copies of so much of the records of the corporation as will show the official character and authority of the officers signing, duly certified by the secretary or assistant secretary under the corporate seal to be true copies.

The full name and business address of the Contractor should be inserted and the contract should be signed with his official signature. Please have the name of the signing party or parties typewritten or printed under all signatures to the contract.

If the Contractor should be operating as a partnership, each partner should sign the contract. If the contract be not signed by each partner there should be attached to the contract a duly authenticated power of attorney evidencing the signer's (signers') authority to sign such contract for and in behalf of the partnership.

If the Contractor be an individual, the trade name (if the Contractor be operating under a trade name) should be indicated in the contract and the contract should be signed by such individual. If signed by one other than the Contractor there should be attached to the contract a fuly authenticated power of attorney evidencing the signer's authority to execute such contract for and in behalf of the Contractor.

CONTRACT

This Contract made the _____ day of _____, 1948, by and between _____

_____

hereinafter called the "Contractor", and _____

_____

hereinafter called the "Owner",

WITNESSETH, That the Contractor and the Owner for the consideration stated herein agree as follows:

ARTICLE 1, SCOPE OF WORK The Contractor shall perform everything required to be performed and shall provide and furnish all of the labor, materials, necessary tools, expendible equipment, and all utility and transportation services required to perform and complete in a workmanlike manner all the work required for the construction of diversion chamber on Kent Street and a sewage treatment plant complete. The sewage treatment plant is located at the intersection of M-114 and Kent Street. The sewage treatment plant item includes all the work on this site as specified in the plans. This work constitutes the Project of the Owner, all of which shall be in strict accordance with the Plans and Specifications including any and all addenda, prepared by Williams and Hurd, Inc., Consulting Sanitary Engineers, acting, and in these contract documents referred to, as the Engineer, which Plans and Specifications are made a part of this contract and in strict compliance with the Contractor's proposal and the other contract documents herein mentioned which are a part

of this contract; and the Contractor shall do everything required by this contract and the other documents constituting a part thereof.

ARTICLE 2, THE CONTRACT PRICE The owner shall pay to the Contractor for the performance of this contract, subject to any additions or deductions provided therein, in current funds, the contract prices computed as follows:

Item	Description	Quantity	Unit Price
1	Diversion chamber	lump sum @	$_____
2	Sewage treatment plant complete	" " "	_____

Payments are to be made to the Contractor in accordance with and subject to the provisions embodied in the documents made a part of this contract.

ARTICLE 3, UNIT PRICES FOR CHANGES The following unit prices will apply in the event additions to or deductions from the work called for on the plans for the sewage treatment plant, only, are ordered by the Engineer or the City of Grandville.

	Type of work	Unit	Price
Item 3.	Earth excavation	cu. yd.	_____
Item 4.	Concrete in place	" "	_____
Item 5.	Joint waterproofing	sq. ft.	_____
Item 6.	Reinforcing steel	lb.	_____
Item 7.	Fencing	lin. ft.	_____
Item 8.	Gravel drive	cu. yd.	_____

ARTICLE 4, COMPONENT PARTS OF THIS CONTRACT This contract consists of the following component parts, all of which are as fully a part of this contract as if herein set out

verbatim or, if not attached, as if hereto attached:

1. General conditions
2. Advertisement for bids.
3. Instructions to bidders.
4. Detail specifications for
   a. The diversion chamber.
   b. The sewage treatment plant.
5. Drawings and plans.
6. Contractor's proposal.
7. This instrument.

In the event any provision in any of the above component parts of this contract conflicts with any provision in any other of the component parts, the provision in the component part first enumerated above shall govern over any other component part which follows it numerically, except as may otherwise be specifically stated.

IN WITNESS WHEREOF, the parties hereto have caused this instrument to be executed in _____ original counterparts the day and year first above written.

_____
Contractor

(Seal)
Attest:

_____

By_____

_____
Title

_____
Title

_____
Owner

(Seal)
Attest:

By_____

_____

_____

INSTRUCTIONS TO BIDDERS

PROPOSALS will be received for a general contract covering the construction of complete sewage treatment plant and diversion chamber, designated _____

_____

as shown in plan and profile and on plans on the accompanying drawings prepared by Williams and Hurd, Inc., Consulting Sanitary Engineers.

All proposals shall be addressed to the City Clerk, Grandville, Michigan, enclosed in a sealed envelope, marked "Proposal for _____"

_____

and with the name and address of the bidder indicated thereon.

The City reserves the right to reject any or all proposals or to waive any informalities in the proposals received or to accept any proposal which it may consider to its advantage. Telegraphic or telephonic proposals will not be accepted.

INSPECTION OF THE SITE Before submitted his tender, each bidder shall personally inspect the site of the proposed work to arrive at a clear understanding of the conditions under which the work is to be done. He shall be held to have compared the premises and site with the drawings and specifications, and to have satisfied himself as to conditions of the premises, existing obstructions, the actual elevations and any other conditions affecting the carrying out of his work.

No allowance or extra consideration in behalf of the Contractor shall subsequently be allowed by reason of error or

oversight on the part of the Contractor.

TIME OF COMPLETION Bidders shall state in their proposal the number of consecutive calendar days immediately following the start of work, in which they will agree to complete the work if awarded the contract.

WITHDRAWAL OF PROPOSAL If a bidder wishes to withdraw his proposal, he may do so before the time fixed for opening of bids, without prejudice to himself, by communicating his purpose to the City Clerk, in writing or in person, with the request that the bid be returned to him unopened.

PERFORMANCE BOND Before the execution of the contract for the work, the selected bidder shall furnish a performance bond with one or more solvent Surety Companies, satisfactory to the City, in the amount of one hundred (100%) per cent of the total bid price. This shall be furnished within a ten day notice from the City.

MATERIAL AND LABOR BOND Before the execution of the contract for the work, the selected bidder shall furnish a labor and material bond with one or more solvent Surety Companies, satisfactory to the City, in the amount of fifty (50%) per cent of the total bid price.

CERTIFIED CHECK OR BID BONDS A certified check or a satisfactory bid bond executed by the bidder and a Surety Company in an amount equal to ten (10) per cent of the bid and running to the City of Grandville shall be submitted with each bid.

MAINTENANCE BOND Before the execution of the contract for the work, the selected bidder shall furnish a maintenance

bond with one or more solvent Surety Companies, satisfactory to the City which shall run for a one year period from the date of the acceptance of the completed project by the City.

FEDERAL LAWS In the execution of this contract the Contractor agrees to comply with, and give all stipulations and representations required by, applicable federal laws, and further agrees to include a similar statement to the foregoing as a part of all sub-contracts entered into by the Contractor in connection with this contract.

TESTING LABORATORY SERVICE Mill, factory, field and laboratory inspection and testing of materials prior to use will be provided for by the City under a separate Contract or arrangement. The manner and extent of such service, and the selection of testing agencies, shall be established by the Engineer representing the City.

GENERAL CONDITIONS

DEFINITIONS (a) City or Owner, as herein used, shall mean the City of Grandville, Michigan, a municipal corporation.

(b) Engineer, as herein used, shall mean the Engineer designated by the City or his duly authorized representative.

(c) Work, as herein used, shall mean the services to be performed by the Contractor hereunder.

(d) Contractor, as used herein, shall mean the person, firm, or corporation with whom the City contracts for the work to be done.

TERMINATION OF CONTRACT BY CITY (a) Should the Contractor, at any time, refuse or fail to prosecute the work with

promptness and diligence, the City may terminate the Contractor's right to proceed with the work by written notice to the Contractor. In such event the City may enter upon the premises and, for the purpose of completing the work included under the contract, take possession of all materials, tools and appliances thereon and may finish the work by whatever method he may deem expedient. In such case the Contractor shall not be entitled to receive any further payment until the work is finished. If the unpaid balance of the contract price shall exceed the expense of finishing the work, including compensation for additional managerial and administrative services, such excess shall be paid to the Contractor. If such expense shall exceed such unpaid balance, the Contractor and his sureties shall be liable for and shall pay the difference to the City.

INSPECTION The city and its representatives shall at all times have access to the work wherever it is in preparation or in progress, and the Contractor shall provide proper facilities for such access and for inspection.

They shall have the right to reject materials and workmanship which are defective and require their correction. Rejected workmanship shall be satisfactorily corrected, and rejected materials shall be removed from the premises without charge to the City. If the Contractor does not correct such defective work or remove rejected materials within a reasonable time the City may remove them and charge the expense to the Contractor.

CLEANING The contractor shall at all times keep the City's streets and alleys and the adjoining premises and driveways clean and free from rubbish caused by the Contractor's operations and at the completion of the work shall remove all rubbish, tools, equipment, temporary work and surplus materials from the site and adjacent premises. Earth from necessary excavations temporarily in the City street or alley adjacent to such excavation shall not be classed as rubbish but shall be satisfactorily disposed of before final acceptance of the work. If the Contractor does not attend to such cleaning as above stipulated when so requested by the City, the City may cause such cleaning to be done by others and charge the cost thereof to the Contractor.

SUPERINTENDENCE BY THE CONTRACTOR The Contractor shall give his personal superintendence to the work or have a competent foreman or superintendent, satisfactory to the City, on the work at all times during progress with authority to act for him.

PAYMENTS Unless otherwise provided in the contract, the City shall make partial payments as the work progresses as follows: Upon application by the Contractor and certification by the Engineer, the City shall make monthly payments to the Contractor, based on ninety (90%) per cent of the value of labor and materials incorporated in the work and seventy-five (75%) per cent of the value of stable materials stored at the site, but not in place, up to the first day of that month as estimated by the Engineer, less the aggregate of all previous

payments, provided that the aggregate of all monthly payments shall not exceed ninety (90%) per cent of the contract price. Upon completion and acceptance by the City of all work required hereunder, the amount due the Contractor under this contract will be paid upon the issuance of the Engineer's final certificate, after the Contractor shall have furnished the City with a release, if required, of all claims against the City arising under and by virtue of this contract. Payments otherwise due may be withheld by the City on account of defective work not remedied, claims filed, or reasonable evidence indicating probable filing of claims, failure of the Contractor to make payments properly to sub-contractors, or for material or labor, or a reasonable doubt that the contract can be completed for the balance then unpaid. If the foregoing causes are removed the withheld payments shall promptly be made. If the said causes are not removed upon written notice, the City may rectify the same at the contractor's expense.

LIENS Neither the final payment nor any part of the retained percentage shall become due until the Contractor shall deliver to the City a complete release of all liens arising out of this contract, or receipts in full in lieu thereof, and, if required in either case, an affidavit that the release and receipts include all the labor and material for which a lien might be filed; but the Contractor may, if any subcontractor refuses to furnish a release or receipt in full, furnish a bond satisfactory to the City, to indemnify it against any claim or lien. If any lien or claim remains

unsatisfied after all payments are made to the Contractor, he shall refund to the City all moneys that the City may be compelled to pay in discharging such lien or claim, including all costs and a reasonable attorney's fee.

PATENTS The Contractor shall defend all suits or claims and shall save the City harmless from liability of any nature or kind, including costs and expenses for or on account of any patented invention, article or appliance manufactured or used in the performance of this contract.

SOCIAL SECURITY PAYMENTS The Contractor shall pay the contributions measured by wages of his employees required by the Social Security Act and/or the public acts of the State of Michigan, and shall accept exclusive liability for said contributions both on account of employees carried directly on his payrolls and for those of his sub-contractors. The Contractor further shall indemnify and hold harmless the City an account of any contributions measured by the wages of employees of the Contractor or any sub-contractor which may be assessed against the City under authority of said Act or State law of Michigan.

PROTECTION OF PROPERTY The Contractor shall carefully protect the property of the City and adjacent property. He shall take all necessary precautions for the safety of the employees on the work and shall comply with all applicable provisions of federal, state and municipal safety laws and codes to prevent accidents or injuries to persons on or about or adjacent to the premises where work is being performed.

LIABILITY TO OTHERS The Contractor shall save and hold harmless the City from and against all suits for claims that may be based upon any alleged injury, including death, to any person or property that may occur or that may be alleged to have occurred, in the course of the performance of this contract by the Contractor, whether such claim shall be made by an employee of the Contractor, a sub-contractor's employee or by a third person and whether or not it shall be claimed that the alleged injury (including death) was caused through a negligent act or omission of the Contractor; and, at his own expense, the Contractor shall defend any and all such actions and shall pay all charges of attorneys and all costs and other expenses arising therefrom.

INSURANCE The Contractor shall, during the progress of the work, maintain (1) Workmen's Compensation Insurance for all employees employed at the site of the work, or, in lieu thereof, Employer's Liability Insurance; (2) Contractor's Public Liability Insurance; and (3) Automobile Liability Insurance.

The limits of liability provided in each such liability insurance policy shall not be less than $25,000 for injuries, including accidental death, to any one person, and, subject to the same limit for each person, not less than $100,000 for any one accident involving two or more persons. Automobile Liability Insurance shall also provide a property damage limit of not less than $5,000 covering all owned and rented equipment which is used in or on the work. Should all or any part of the contract be sublet, Contractor shall, in

addition to the foregoing type of insurance, maintain Contractor's Protective Liability Insurance in an amount not less than $20,000 for injuries, including accidental death, to any one person, and subject to the same limit for each person, not less than $40,000 for any one accident involving two or more persons.

ASSIGNMENT The Contractor shall not assign this contract nor any monies to become due thereunder without the prior written consent of the City.

SAFEGUARDS The Contractor shall provide and place sufficient red lights on or near the work, and keep them burning from sun set to sun rise; shall erect suitable railings or barriers as required and necessary for the safety of the work, the public and property. If in the judgment of the duty of the Contractor to assist in reestablishing any lost or destroyed line or grade marks.

ARBITRATION In the event of any disagreement arising under this contract it shall be submitted for arbitration in the manner as provided in the "General Conditions" of the American Institute of Architects standard form, latest edition, a copy of which will be furnished by the Engineer to any bidder requesting same.

SPECIFICATIONS TO BE A PART OF THE CONTRACT All clauses of these specifications and the Notice to Bidders, or advertisement for bids, shall be a part of the contract for the work without repetition therein.

DETAIL SPECIFICATIONS FOR THE SEWAGE TREATMENT PLANT

GENERAL

Bids will be received on the sewage treatment plant which bids shall include all items as set forth under the heading of "Sewage treatment plant complete" in the advertisement for bids. The sewage treatment plant structures are mainly reinforced concrete with the service building being of brick and cincer block construction. The location of the building site is at the intersection of M-114 and Kent Street in the City of Grandville.

EXCAVATION, BACKFILLING AND ALLIED WORK

GENERAL The Contractor shall do all the excavation for the footings and substructions or the service building and attached tanks, for the sludge digester, for the sludge drying beds and for all pipe lines and sewers which are specified on the plans. This shall include the excavation for the effluent line into the river. Excavation shall include loosening, loading, removing, transporting and disposing of all materials, wet or dry, necessary to be removed for purposes of construction; furnishing, placing and removing of all sheeting and bracing, draining, pumping and backfilling of trenches and pits; supporting of structures above and below ground, and all other work required to prepare the earth subgrade for concrete or such other materials as are to be placed at the bottom of the excavation.

Elevations of the present surface of the ground are shown on the drawings. These are believed to be reasonably correct but may not be absolutely so, and are presented only as an approximation.

Excavation limits for all structures shall extend 1-1/2 ft. outside of the footing outline on all sides and shall extend from the lower side of the footing to the existing ground elevations as shown on the plans. Excavations for pipe lines shall extend from the plane of the lower side of the pipe to the ground surface as shown on the plans and shall be a width of two feet plus the external diameter of the pipe. In case where there are several pipe lines in one trench the width of the excavation shall be figured on the basis of two feet plus the sum of the external diameters of all pipe lines within this trench.

UNAUTHORIZED EXCAVATIONS All unauthorized excavations carried outside of the lines and grades given or specified, together with the disposal of such material, and all excavations and other work resulting from slides, cave-ins, swellings and upheavals, shall be at the Contractor's own expense. All spaces beneath foundations, resulting from unauthorized excavations or from slides or cave-ins, shall be refilled at the Contractor's expense with concrete or other suitable material. The final trimming of the bottoms and sides of excavations, against which masonry is to be built, shall be done just before the concrete is placed.

ADDITIONAL EXCAVATION It is expected that satisfactory foundations will be found at the elevations shown on the drawings, but in case the materials encountered are not suitable, or in case it is found desirable or necessary to go to additional depth, the excavation shall be carried to an additional depth, as ordered and refilled as directed by the Engineer.

Excavation to additional depths, when ordered, will be paid for at the unit bid price for "Earth Excavation".

REMOVAL OF WATER The Contractor shall pump out or otherwise remove and dispose of any water which may accumulate in the excavations. The Contractor shall maintain machinery on the site to properly remove all water from the excavations as fast as it may accumulate.

BACKFILLING As various structures or parts of structures are completed, the Contractor shall refill the space outside and around the walls with material which has been excavated from the site and which shall be selected for the purpose. This backfilling shall be carried to such an elavation that, when settlement has occurred, the ground surface will be at the finished grade specified on the plans. Unless otherwise specified, all forms, bracing and lumber shall be removed before backfilling.

All materials used for backfilling shall be free from roots, brush, sod and other perishable and objectionable material. If required, the material backfilled shall be well tamped or otherwise thoroughly compacted in such a manner as to prevent after-settlement, and, if required, the trenches and excavations shall be flooded with water while backfilling is being done. The maximum size, quantity and placing of large stones shall be as directed by the Engineer.

All concrete masonry, pipe lines and other permanent parts of the structures shall be protected from any undue stresses or loading or displacement or any other damage during

the process of backfilling. The materials replaced against walls or in a trench shall be thoroughly compacted to the extent that no further settlement or movement will occur after the completion of backfilling and grading. All foreign material, trash, detritus, sloughed-in or otherwise objectionable or unsuitable material allowed to accumulate along masonry walls or in trenches to be refilled, shall be removed to the satisfaction of the Engineer before placing any backfill.

DISPOSAL OF MATERIALS A selected portion of the excavated materials shall be used for backfilling and embankment about the completed structures as shown on the finished plans or as directed. Excavated material in excess of that needed for backfilling and embankment as herein described shall be disposed of in constructing roadbeds or as directed. All roots, trash and rubbish shall be burned. All other material not suitable for backfilling or embankments shall be neatly disposed of in spoil banks as directed by the Engineer.

EMBANKMENTS All surfaces whether on natural ground or on materials previously placed there and settled or hardened, upon which embankments are to be placed should be plowed in a direction parallel to the line of embankment at intervals of two feet or otherwise suitable broken and roughened in order to make a bond with the new embankment materials. All steep slopes shall be stepped, and it is essential that the embankments be carefully bonded into the adjoining slopes, care being taken to strip surface soil, muck, brush and other materials which would tend to prevent a proper water tight bonding of the embankment.

Embankments shall be made of materials secured from the excavation. Such materials shall be satisfactory to the Engineer and of such a nature that they will, under proper manipulation compact into a solid, permanent and essentially impervious embankment. Such materials shall be free from wood, muck, surface soil, roots, brush and other perishable matter and shall be of such a nature as to be sufficiently stable, not to slide or slough at the prescribed slopes when in a condition of saturation and after having been compacted.

In forming an embankment no special method of compacting will be required. The material shall be deposited in layers not exceeding 12 inches in thickness, and shall be carefully leveled and graded so as to be brought up at a uniform rate throughout the structure. The Contractor shall provide for approximately a ten per cent overfill to compensate for probable shrinkage. The fill shall not be built during freezing weather, nor with frozen materials, nor shall any material be placed when the subgrade or fill in any place is frozen.

The slopes and tops of all embankments shall be finished and trimmed in a workmanlike manner. Slopes must be dressed so that they shall not be lower than the prescribed lines, and there must be no humps or hollows which will show a variation of more than 3 inches in the length of a 10 foot straight edge applied to the finished surface in any direction. All embankment slopes around the sludge digester shall be sodded by others.

MEASUREMENTS All excavated materials will be measured in cut,

and unless otherwise specified, will be paid for only once, whether the material be placed directly in its final position or rehandled. No allowance will be made for excavation beyond the limits herein specified when made by the Contractor for working space, pump sumps and drainage ditches or other like purposes.

PAYMENT The unit price stipulated per cubic yard for "Earth Excavation" shall include the clearing of the site as well as the clearing of and preparation of any areas used for storage or for fabrication of materials; the furnishing, placing and removing of all sheeting and shoring; the backfilling, the pumping and removal of water, sewage and other liquids; the storage, rehandling and disposal of excavated material; the leveling off of the spoil banks; and the tools, appliances and labor necessary to complete the work as specified or as shown.

No separate payment shall be made for backfilling or embankment or the disposal of any material from the excavations and the work to be done under the items above enumerated shall be deemed to include the placing of the excavated materials in backfilling, embankment or in otherwise disposing of the materials as shown on the drawings or as directed by the Engineer.

CONCRETE WORK

GENERAL The work under this item shall include the furnishing, care, storage, mixing and handling of all the materials which are necessary to be incorporated into the concrete, including construction and expansion joint material; the

furnishing, erection, stripping, care and maintenance of forms; the transportation, handling and proper placement of concrete within the forms; the finishing of all exposed surfaces as herein-after specified; the protection and care of partially completed and completed work until final acceptance of the same; the furnishing of mixed concrete sufficient to make test cylinder specimens of concrete poured; and the furnishing of all means, facilities, labor and equipment necessary or proper to obtain full compliance with all requirements of this contract.

Concrete shall be composed of a mixture of Portland cement, fine aggregate, coarse aggregate and water, and each material shall meet the requirements set forth in these specifications.

CEMENT An approved brand of Portland cement shall be used which shall conform to the latest edition of the A. S. T. M. standards for Portland cement type C 150-44 and must be entirely free from lumps and at all times protected from moisture after it is stored on the site.

AGGREGATES Fine aggregate shall be clean, washed, sharp sand. Coarse aggregate shall be clean, washed broken stone or gravel uniformly graded in size from 1/4 inch to 1-1/2 inch. Fine and coarse aggregate shall be kept separate and be combined in the proportions required to produce dense, homogeneous concrete.

The fine and coarse aggregates shall be uniformly graded from coarse to fine and shall conform to the following

grading requirements:

Total percent passing square sieve openings - U. S. Std. sieve series.

Coarse aggregate.

Passing 1-1/2 inch sieve	100%
" 1 " "	95-100%
" 1/2 " "	35-65%
" No. 4 sieve	0-8%

Fine aggregate.

Passing 3/8 inch sieve	100%
" No. 4 sieve	95-100%
" " 8 "	65-95%
" " 16 "	35-75%
" " 30 "	15-55%
" " 50 "	10-30%
" "100 "	0-10%
Loss by washing not more than	3%

CONCRETE PROPORTIONS Where no preliminary tests of the concrete mixture are made, the water-cement ratio shall not exceed the values given in the following paragraph.

The class of concrete for all purposes shall be 3000 lb. and shall have a minimum compressive strength at the end of 7 days of 1800 lbs. per sq. in. and 3000 lbs. per sq. in. at the end of 28 days. These compressive strengths shall be assumed attained if a standard 6 inch diameter test cylinder cured under identical field conditions as the work shall test up to these specified 7 and 28 day strengths. The maximum water content shall be 6-1/2 gal. per sack of cement. The

minimum cement content shall be 5-1/2 sacks per cu. yd. of concrete.

The seven day strength shall be assumed to be about 60 per cent of the 28 day strength. The minimum cement set forth in the preceding paragraph shall not be reduced.

CONCRETE MIXING The mixing of concrete shall be done in a batch of mechanical mixer which shall be equipped with a positive water measuring device designed to automatically cut off the flow of water when the desired quantity has been released. The mixing element shall rotate at a peripheral speed of approximately 200 ft. per min. to insure complete distribution of the ingredients throughout the mass and produce a homogeneous mixture. The volume of the material mixed per batch shall not exceed the rated capacity of the mixer. Each batch shall be mixed for not less than one and one-half minutes after all ingredients have been charged into the mixer.

TRANSIT-MIXED Ready mixed or transit-mixed concrete may be used when it complies in all respects to the foregoing requirements and is delivered to the place of deposit in a rotating container with a total time lapse of not more than thirty minutes from the beginning of the mix.

FREEZING WEATHER Concrete may be placed in temperatures as low as 20°F. provided the aggregates and water are heated so that the mixed concrete shall have a temperature not less than 50°F. nor more than 120°F. when placed in the forms. All top surfaces, after concrete has obtained its initial set, shall be covered with cloth or paper and clean straw. The Contractor

shall take such additional steps to provide heat and prevent freezing as may be deemed necessary. Concrete damage by freezing shall be removed and replaced with sound material with no additional compensation to the Contractor.

WATER Water used in concrete or mortar shall be clean, free from oil, acid, strong alkalies or vegetable matter. Village tap water shall be used except where permission is granted in writing by the Engineer to use other water.

TESTING The Contractor shall at his own expense when directed by the Engineer provide samples of fine and coarse aggregates, cement and cured concrete test cylinders for testing purposes. The testing of these materials shall be done by a commercial testing laboratory and the expenses involved in testing shall be paid for by the Contractor.

CENTERS AND FORMS Forms for concrete shall be made of metal or first-class dressed timber. The Contractor shall have a sufficient supply of forms to avoid unnecessary delay in the prosecution of the work. If lumber is used for forms it may be a satisfactory grade of plywood or shall be tongued and grooved lumber and surfaced on the side which comes in contact with the concrete. The design of the forms shall be satisfactory to the Engineer.

All centers and forms shall be thoroughly cleaned and wet just before placing the concrete, and if necessary to secure a smooth surface, they shall be coated with an approved substance. Suitable moldings or bevel strips shall be placed in the forms to prevent sharp edges.

Forms shall not be disturbed until the concrete has

adequately hardened. Shoring shall not be removed until the member has acquired sufficient strength to support its weight and the loan upon it. Members subject to additional loads during construction shall be adequately shored to support both the member and construction loads in such a manner as will protect the member from damage by the loads.

BONDING AND JOINTS Whenever new concrete is joined to old, the concrete surfaces of the old concrete shall be roughened and thoroughly cleaned using a stiff wire brush and a stream of water. Just before a new concrete is placed, the surface of the old concrete shall be cleaned and shall be covered with a coat of cement mortar.

In general, keys shall be in width one-third the width of the walls and in depth one-sixth the width of the walls.

SURFACE FINISHING All exterior concrete surfaces that will be exposed above grade and extending 6 inches below grade or 6 inches below water line in tanks shall be free from honeycombs, fins and irregularities caused by bad form jointing. Immediately after removing forms, cut back all form ties, wet and fill all voids and honeycombed surfaces with cement mortar, 1:2 mixture, and rub entire exterior surface with carborundum to a smooth, even finish. The interior concrete surfaces of the pump room are not to receive the finishing work with the carborundum stone, however, the form ties must be cut back and the voids filled with mortar to present a smooth surface. Rubbed surface finish shall not be paid for separately but will be considered as part of the cost of the concrete in place.

STAIR TREADS The treads of all concrete stairs or steps shall contain a sufficient amount of carborundum or alundum aggregate or other suitable abrasive substance to render the treat safe against slipping.

PIPES, METAL WORK AND OPENINGS The Contractor shall build into the concrete the steel reinforcement, expansion joints, pipes, slants, sleeves, anchor bolts, steps, castings, electric conduits and other inserts, and shall leave the small openings shown upon the drawings or as ordered. Great care shall be taken to keep inserts and openings at the proper line and grade, and to thoroughly tamp under and around them so that there will not be a passage for water. The special detail for inserting pipes, etc. as shown on the drawings may be used providing a waterproof joint is assured.

MEASUREMENT The quantity of concrete to be paid for under appropriate items shall be the number of cubic yards of concrete actually placed within the lines and grades given in accordance with the drawings, specifications or directions of the engineer.

PAYMENT The unit prices stipulated per cubic yard for "Concrete in Place" shall include the furnishing of the cement, aggregate, water, joint materials, the mixing, tranporting, placing, finishing and protection of the concrete, all centers, forms and all labor, materials, tools and appliances which are necessary to complete and test for tightness the work as specified or as shown.

JOINT WATER PROOFING

GENERAL Where called for on the plans joints shall be

covered with a membrane waterproofing as described in the following paragraph.

The surface for a distance of 10 inches each side of the joint shall be prepared and primed with a cut back asphalt. The priming coat shall be applied in such a manner as to thoroughly coat the concrete surface, fill all pores and form a continuous film. A mopping of hot asphalt shall then be applied and a strip of waterproofing fabric 10 inches wide shall be pressed into it and centered over the joint. This shall be followed by a mopping of hote asphalt and a strip of fabric 20 inches wide applied and centered over the joint. A final mopping of hot asphalt completely covering the fabric and lapping on to the concrete shall then be applied. The fabric to be used shall be bituminized cotton fabric and shall conform to the requirements for woven cotton fabrics saturated with bituminous substances for use in waterproofing, A. S. T. M. Designation D-173.

MEASUREMENT AND PAYMENT Joint waterproofing will be measured by area in square feet based on a width of 20 inches as herein specified and will be paid for at the contract unit price per square foot, which price shall be payment in full for furnish the materials, labor, equipment transportation and incidentals necessary to complete the work.

REINFORCING STEEL

WORK INCLUDED The Contractor shall furnish and shall properly place in the concrete, at the locations shown on the drawings or as directed by the Engineer all steel reinforce-

ments required for properly reinforcing all the concrete structures which are to be built under this contract.

MATERIAL Reinforcing stell may be new billet or rail steel and shall meet the requirements of the standard specifications for reinforcing bars, billet, intermediate grade, A. S. T. M. Designation A-15-39, or rail steel A. S. T. M. Designation A-16-35 or the latest revision of these specifications. All reinforcing steel shall be deformed bars.

DETAIL DRAWINGS The Contractor shall furnish detail drawings and schedules, to show the number, size, length and bending of the steel he proposes to furnish, and no steel reinforcing bars shall be delivered to the site of the work prior to the approval of these drawings.

BENDING For ordinary bends the diameter of the pin used shall not be less than four times the least diameter of the bar being fabricated, providing no pin smaller than 3 inches in diameter shall be used. Semi-circular hooks shall be formed around a pin of diameter not less than 8 times the bar diameter. Heating of reinforced steel for bending will not be permitted.

STORAGE All steel shall be delivered to the site reasonably free from rush and shall be kept free from rust, oil, grease, dirt or other objectionable adhering substances. The bars shall be properly sorted as to size, number, etc. and stored in a dry place.

PLACING AND LAPPING All stell reinforcement shall be carefully placed and fastened in position so as to maintain the specified spacing between adjacent bars. Joints shall be

wired with annealed iron wire of diameter not less than number 18 U. S. Standard gage or by using acceptable clips. All lapped bars shall be fastened together securely, and, for binding adjacent bars, over-lapping shall not be less than forty bar diameters. No bar may be lapped or spliced at a point of maximum stress.

MEASUREMENT AND PAYMENT The weight of steel reinforcement to be paid for shall be the number of pounds actually placed in accordance with the drawings and specifications or as ordered. It shall not include any waste material due to the fact that the lengths supplied are too long. The weight paid for shall, however, include extra metal in laps, where authorized, due to the fact that a single bar would be unreasonably long. In computing the weights, if not determined by weighing, one cubic inch of steel shall be assumed to weigh 0.283 pound.

"Reinforcing Steel" will be paid for at the contract unit price per pound, which price shall include furnishing, storing, protecting, shaping, placing and maintaining in position of all steel reinforcement, irrespective of type, together with any supporting chairs and clips, tie wires or other fastenings and the furnishing of all labor, materials, tools and appliances necessary to complete the work as specified or as required.

BRICKWORK

GENERAL Under this heading shall be considered all mason work in connection with the construction of the service building above grade elevation as shown on the plans. The

Contractor shall furnish all materials, transportation and labor necessary to complete the mason work on the service building. All brickwork shall be considered incidental to the contract price bid for the "Sewage Treatment Plant Complete".

MATERIALS Face brick shall be sound, whole, hard-burned and uniform in size, color and texture, with square corners and straight exposed edges and shall conform to general color characteristics of samples which are identified and open to inspection during the period of bidding. All common brick shall be hard-burned, shall contain no foreign material such as stone, lime, etc., and shall show a minimum compressive strength of 2000 pounds per sq. in. All brick shall be protected from damage and weather during shipping and in storing at the job.

MORTAR FOR LAYING BRICK Mortar for exterior walls above grade may be composed of Brixment, manufactured by the Louisville Cement Company or approved equal or it may be a lime cement mortar. The mix of lime cement mortar shall be one part Portland cement, one part hydrated lime paste and six parts sharp sand.

LAYING All brick shall be thoroughly drenched with water before laying in hot weather. The outer edges of each course shall be a straight line. All brickwork shall be shoved into place and all joints shall be completely full of mortar. Brickwork shall be extended up tight to window and door frames and other structural parts. If temperature is below freezing or likely to fall during the night, all materials,

including water shall be heated before using. No brick with ice or snow on it or no frozen mortar shall be used. Every seventh course of brick shall be a header course and shall extend between the cinder blocks which are to be used as backing. All cinder blocks shall be 8" x 8" x 16", hollow and shall be equal to the best quality of block which can be secured for the job. Joints for exterior face brick shall be flush joints.

All outside door and window frames shall be caulked with an approved caulking compound.

PRECAST CONCRETE COPING Precast concrete coping blocks shall be properly set on the top of the parapet and on the top of the 4 inch pilasters shown on the general plan and elevations of the service building.

CLEANING UP At the completion of the job the face brick shall be cleaned down with a 5 per cent solution of muriatic acid with a stiff wire brush to remove all spots and stains and then thoroughly rinsed with clean water. All other materials and parts of the structure must be properly protected against damage due to this operation.

ROOF CONSTRUCTION

GENERAL The roof is of flat construction having a total pitch of 6 inches in 12 feet of width. The rafters are 2" x 10" timbers placed 16 inches on centers and covered with 1 inch nominal thickness roof boards. The drainage from the roof is collected along the low side of the roof by a gutter which is properly flashed and let into the rafters with sufficient slope to an outlet at one end of the structure.

there shall be no large cracks or knot holes in the roof boards.

MATERIALS The entire roof covering shall be built up of felt roofing, pitch and slag or stone. The coal-tar saturated felt shall weigh 15 lbs. per 100 sq. ft. and shall show no visible external defects. The coal-tar pitch shall be the best quality and shall meet the latest specifications of A. S. T. M. The roof shall contain not less than the following quantities of materials per 100 sq. ft.; four layers of coal-tar saturated rag felt, (60 lbs.), coal tar pitch, (220 lbs.) and slag or crushed stone (300 lbs.).

APPLICATION OF ROOFING Lay one thickness of sheathing paper or unsaturated felt weighing not less than 5 lbs. per 100 sq. ft., lapping the sheets at least 1 inch. Then lay over the entire surface 2 layers of 15 lb. tarred felt, lapping each sheet 17 inches over the preceding one and nail as often as necessary. Lay on a uniform coat of coal-tar pitch. Over the entire surface lay two plies of tarred felt, lapping each sheet 17 inches over the preceding one, mopping with coal-tar pitch the full 17 inch lap on each sheet so that all nails will be covered by not less than 2 plies of felt. Then over the entire surface pour a uniform coating of coal-tar pitch, into which, while hot, imbed not less than 300 lbs. of crushed stone or slag per 100 sq. ft. of roof surface. The stone or slag shall be from 1/4 to 5/8 inches in size, dry and free from dirt.

Roofing shall properly join up with all vents, sidewalls and gutters that form a part of the roof surface so

that no water may penetrate the roof.

All roofing work shall be considered incidental to the contract bid price for the "Sewage treatment plant complete" and no extra allowance will be paid the Contractor for this work.

CARPENTRY

GENERAL Wood framing, blocking and furring shall be provided when needed and called for throughout the service building. The partition enclosing the toilet room shall be wood framing covered with rock lath and two coats of plaster. All cupboards shall be of well seasoned No. 1 white pine boards for the framing and drawers and fir plywood for the doors. The table top shall be 2 inch matched hard maple and shall be finished with a black acid resisting paint suitable for a laboratory table top.

Window and door frames shall be well seasoned southern white pine and shall be properly set so heat losses around the edges shall be a minimum.

BRICK MANHOLES

GENERAL Manholes shall be installed where called for on the plans. If the manhole is specified as a standard manhole it shall conform to the standard sewer detail sheet which is a part of the plans for the sewers and is hereby also made a part of these specifications. If the manhole is specified as special, the details given on the drawings will provide for proper construction methods. The base and flow channel of all manholes shall be formed with concrete and be made smooth by trowelling. The walls shall be constructed with hard, common or vitrified brick with a minimum thickness of 8 inches.

Mortar shall be composed of one part of Portland cement to two parts of washed sand with the addition of 10 lbs. of hydrated lime for each sack of cement used. The exterior surface of the manhole walls shall be plastered with mortar 1/2 inch thick trowelled smooth. Provide and place approved iron ladder rungs at equal intervals from bottom to top as shown on the standard manhole detail. Manhole rings and covers of cast iron, furnished by the Contractor shall be carefully set in mortar at the top of each manhold. The type of manhole cover and frame selected by the Contractor shall be approved by the Engineer, before it may be used. The cover is to be of solid construction so as to exclude surface water.

PAYMENT The Contractor shall be paid the contract bidg price for "Standard Manholes" which price shall include furnishing all materials and labor for the completed job.

VITRIFIED CLAY PIPE

GENERAL The plans call for two kinds of vitrified clay pipe. The sludge drying bed underdrains are common vitrified drain tile with plain ends. All other lines are to be bell and spigot vitrified clay sewer pipe unless otherwise specified. Excavation and backfilling for the pipe lines included in this item, shall be paid for and is covered by these specifications under the heading "Excavation, Backfilling and Allied Work". This item then shall cover the furnishing of the pipe, incidental materials and the labor for laying the pipe to proper grade.

VITRIFIED CLAY SEWER PIPE All clay sewer pipe shall conform to the latest approved A. S. T. M. Tentative Specification, Designation C 13-44T. On the plans S. S. V. P. indicates standard strength vitrified pipe.

VITRIFIED CLAY DRAIN TILE All clay drain tile specified for underdrains in the sludge drying beds shall conform to the A. S. T. M. Specification Designation C4-24 for standard drain tile.

LAYING SEWER PIPE Each pipe shall be laid on an even firm bed, so that no uneven strain will come on any pipe, and particular care shall be exercised to prevent the pipes from bearing on their sockets. The bell end of all pipes shall be laid up-grade, and the joints shall be either an approved compound type such as G-K, or equal; or a slip-seal joint such as the Gladding-McBean, or equal.

The compound joint is to be made as follows: After the pipe has been laid to the proper line and grade, the bell end shall be thoroughly wiped clean, as well as the spigot end of the pipe to be jointed. The spigot end shall then be introduced into the bell end and securely butted against it. It shall not be permitted to rest in the bell, but shall be made concentric with it, by means of a closely twisted jute gasket, about one inch thick, carefully caulked in place in such a manner as to provide an even annular space. An asbestos runner shall then be passed around the pipe and clamped at the top, leaving an open gate in which to pour the compound. The joint compound shall be heated in an iron pot of sufficient size to hold

material enough for the making of several joints, and it shall be kept continually stirred while being heated. When the compound is in the fluid state, as fluid as water, it shall be poured into the joint space. A pouring vessel large enough to pour one complete joint shall be used, and each joint shall be made in one continuous pouring. Two lengths of pipe may be joined together before being laid in the trench, at the direction of the Engineer, and the two then laid in the trench as one.

LAYING DRAIN TILE The bottom of the trench, as specified on the plans of the sludge drying bed, shall be filled with 4 inches of coarse gravel and shall then be leveled off to a uniform grade sloping towards the outlet as specified. The tile shall be laid to a true line and grade and shall be laid with 1/8 to 1/4 inch open joints. Connections between the drain tile and the 4 inch sewer outlet shall be made with sewer pipe wyes or tees. Care shall be taken to not displace the pipe when backfilling with the coarse gravel.

MEASUREMENT AND PAYMENT The length of the pipe laid shall be measured in place and shall be paid for at the contract bid price per lineal foot for "Vitrified Sewer Pipe" and for "Vitrified Drain Tile". This price shall include furnishing and laying the tile. Excavation and backfill is provided for under another part of these specifications.

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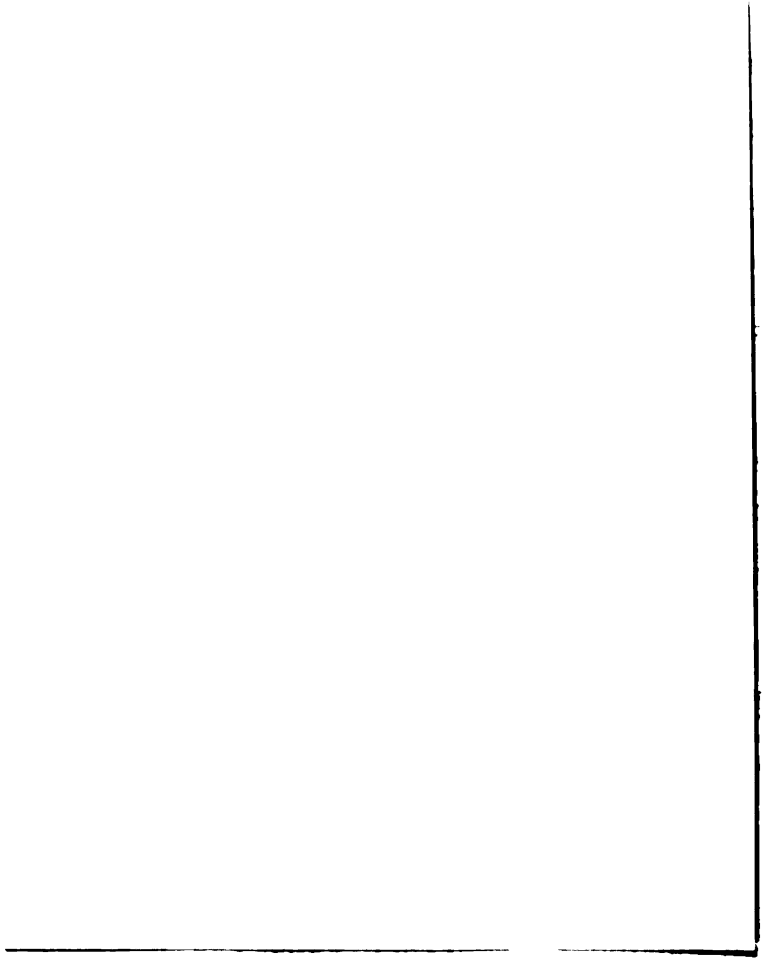
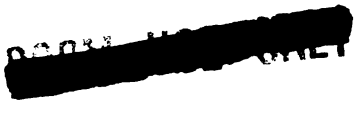




CITY OF

GRANDVILLE

WYOMING TOWNSHIP

KENT COUNTY ~ MICHIGAN

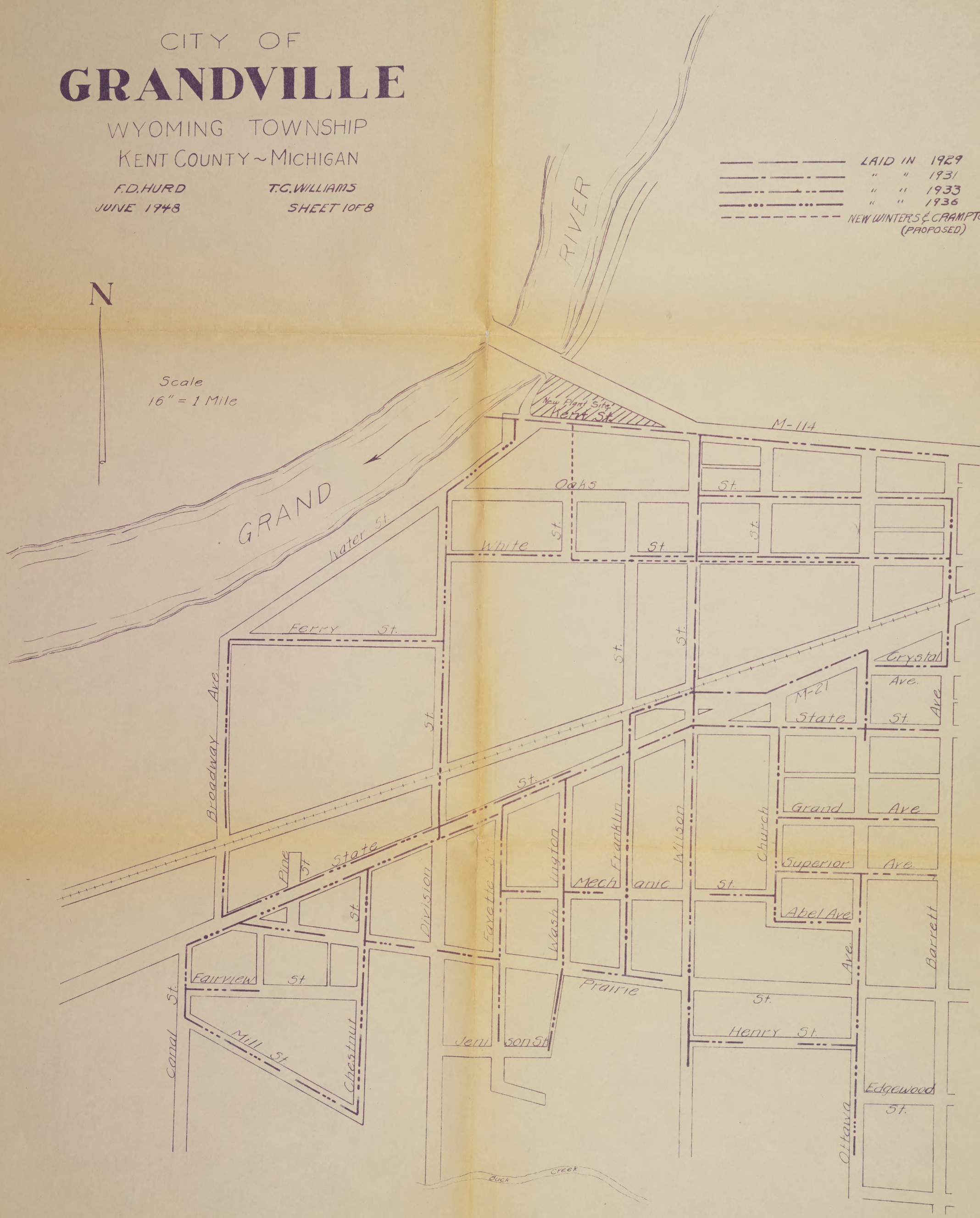
F.D. HURD — JUNE 1948

T.C. WILLIAMS — SHEET 1 OF 8

LAID IN 1929
" " 1931
" " 1933
" " 1936
NEW WINTERS & CRAMPTON SEWER (PROPOSED)

N

Scale
16" = 1 Mile



130
952
THS
Sheet 1

SUPPLEMENTARY MATERIAL

MICHIGAN STATE UNIVERSITY LIBRARIES
3 1293 03151 4197

130
.R6
T65
Sheet
2

MICHIGAN STATE UNIVERSITY LIBRARIES
3 1293 03151 4205

SUPPLEMENTARY MATERIAL

PLAN
NOTE BOOK NO.
SURVEYED
PLOTTED
ALIGNMENT CHECKED
R/T OF WAY CHECKED
BY
DATE

WINTERS & CRAMPTON CORP.

OTTAWA ST.

WILSON AVE.

FRANKLIN ST.

WASHINGTON

WHITE ST.

WHITE ST.

WHITE ST.

CHURCH ST.

KENT ST.

OAKES ST.

Combined Sewer

Existing 30"

WASHINGTON ST. (PROPOSED)

15"

This sewer is not part of this job.
It is included merely to illustrate the
feasibility of such an interceptor.

GRANDVILLE SEWAGE TREATMENT PLANT
SEPARATE SEWER FOR W.E.C.
F.D. HURD T.C. WILLIAMS
JUNE 1948 SHEET 2 OF 8

PROFILE
NOTE BOOK NO.
SURVEYED
PLOTTED
GRADES CHECKED
B.M.'S NOTED
STRUCTURE NOTATIONS CHECKED
BY
DATE

600
599
98
97
96
95
94
93
92
91
90
89

0+00 1+00 2+00 3+00 4+00 5+00 6+00 7+00 8+00 9+00 10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 20+00 21+30 22+00

℄ Church 4+00

℄ 5th Street 5+00

℄ Wilson 8+23

℄ Franklin 11+58 11+85

℄ Washington 14+81 14+61

℄ Oakes 18+11

℄ Kent 21+61

500' 15" 0.15%

250' 15" 0.15%

435' 15" 0.15%

276' 15" 0.2%

350' 15" 0.2%

350' 15" 0.2%

Inv. 597.23

Inv. 596.48

Inv. 596.1

Inv. 595.45

Inv. 594.0

Inv. 593.02

Inv. 593.45

Inv. 592.6

Inv. 592.75

Inv. 592.30

Inv. 589.05

PLATE 1-PLAN-PROFILE

EUGENE DIETZGEN

Printed in U.S.A.
On IMPERIAL Tracing Cloth

N

1" = 50'

10" outfall

℄ Fayette

℄ Washington

℄ Franklin

℄ Kent

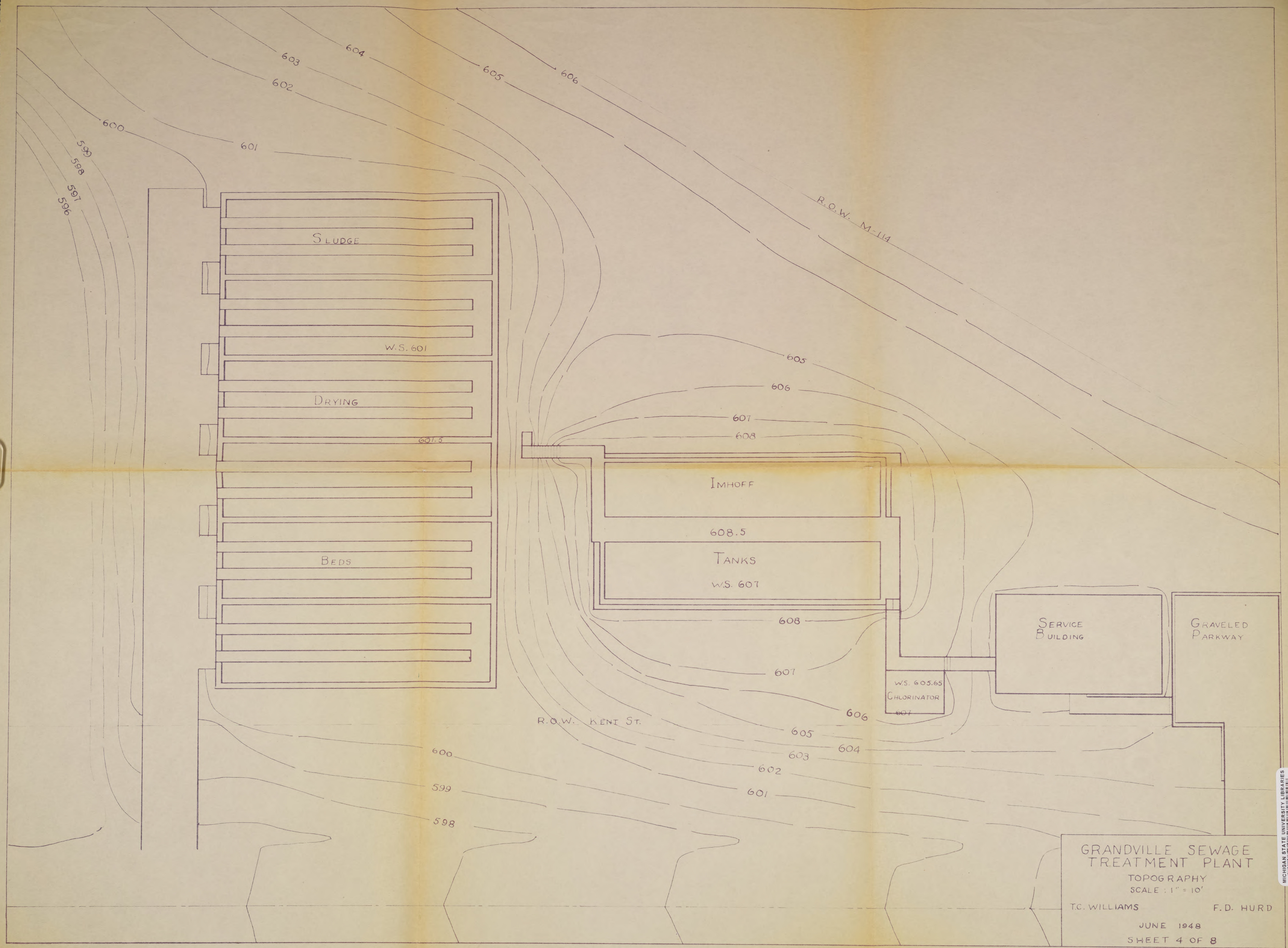
℄ Wilson

GRANDVILLE SEWAGE TREATMENT PLANT
EXISTING TOPOGRAPHY
F.D. HURD T.C. WILLIAMS
SCALE 1"=50'
JUNE 1948 SHEET 3 OF 8

18 X 26

SUPPLEMENTARY MATERIAL
MICHIGAN STATE UNIVERSITY LIBRARIES
3 1293 03151 4213

130 OF 175 Sheet 3



GRANDVILLE SEWAGE TREATMENT PLANT

TOPOGRAPHY

SCALE : 1" = 10'

T.C. WILLIAMS F.D. HURD

JUNE 1948

SHEET 4 OF 8

SUPPLEMENTARY MATERIAL

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130
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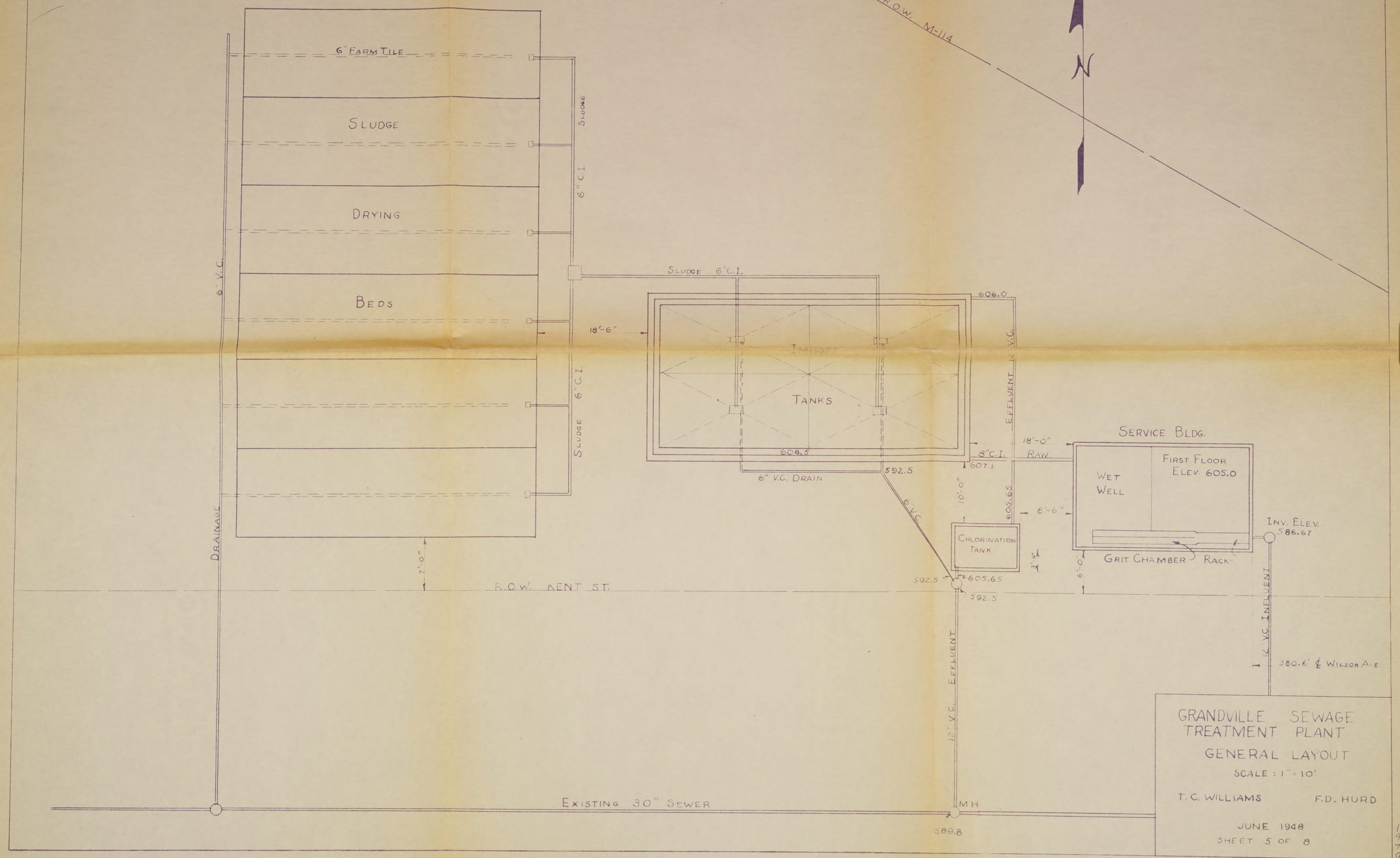
Sheet
4



GRANDVILLE SEWAGE TREATMENT PLANT

GENERAL LAYOUT

SCALE : 1" = 10'

T. C. WILLIAMS F.D. HURD

JUNE 1948

SHEET 5 OF 8

130
952
Tus
Sheet
5

SUPPLEMENTARY MATERIAL

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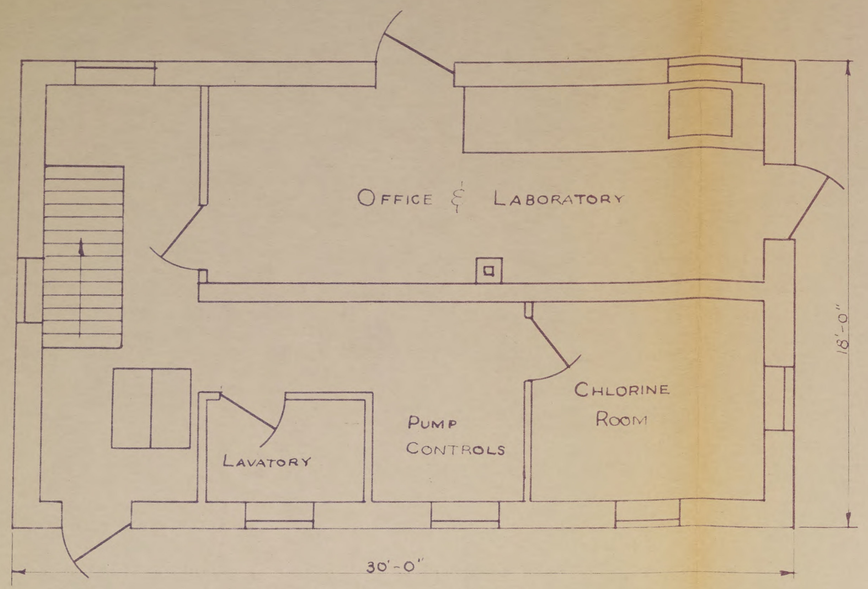
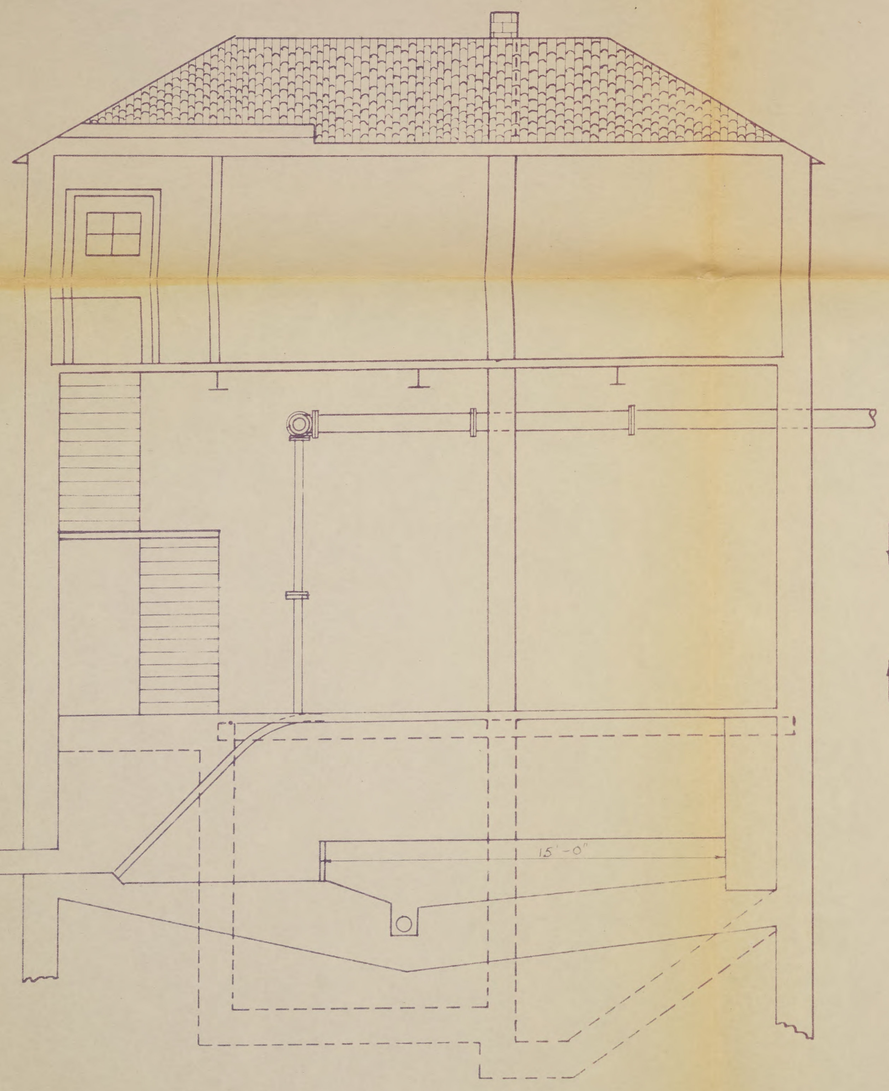
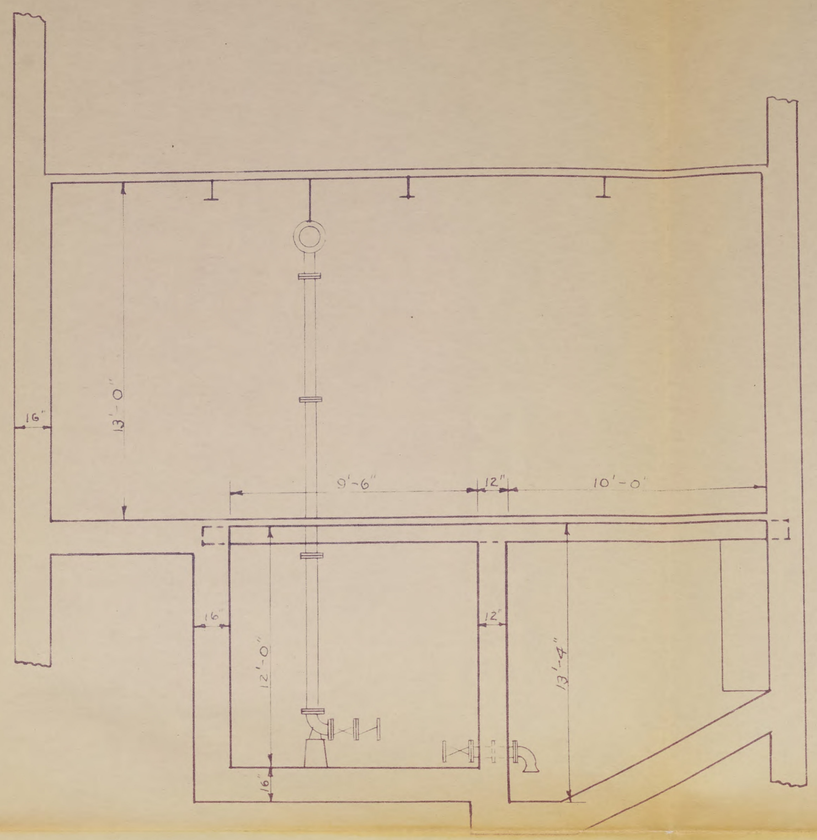
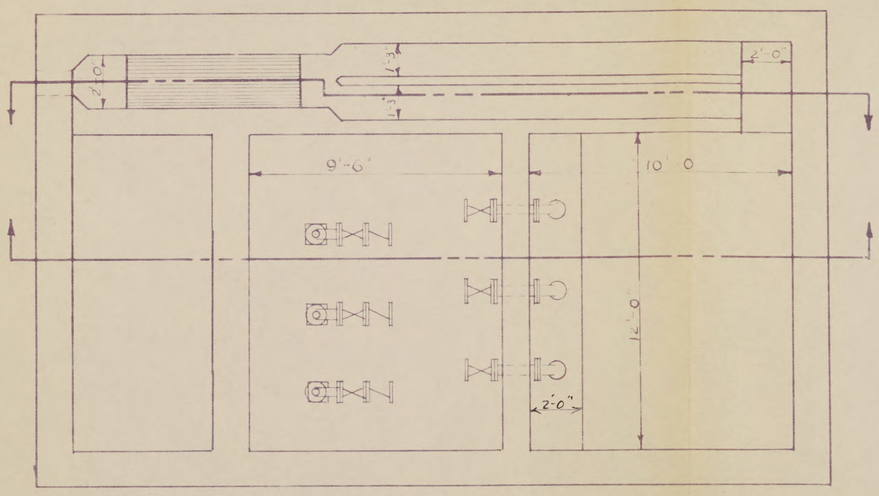




ELEVATION
SECTION A-A

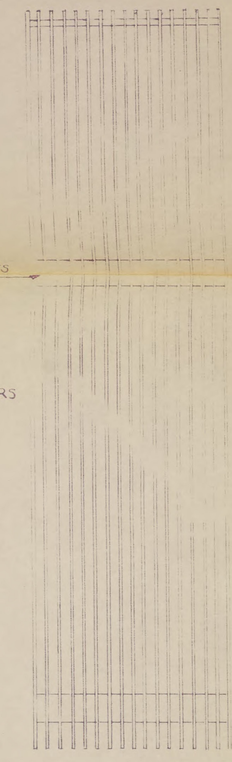


ELEVATION
SECTION B-B



PLAN VIEW
ELEV. 590.0

SERVICE BUILDING
SCALE: $\frac{1}{4}$" = 1'



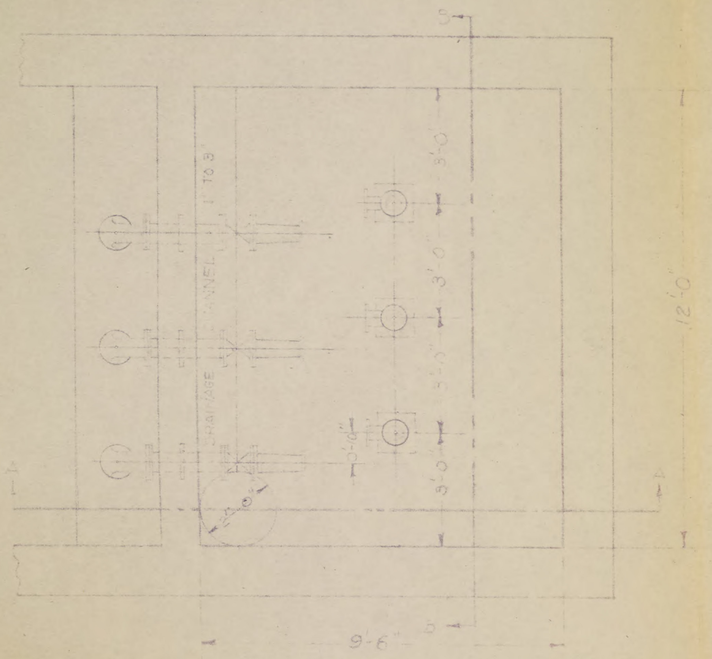
$\frac{3}{8}$" x 2" x 2'-0" STEEL FLATS
WELDED TO UNDERSIDE

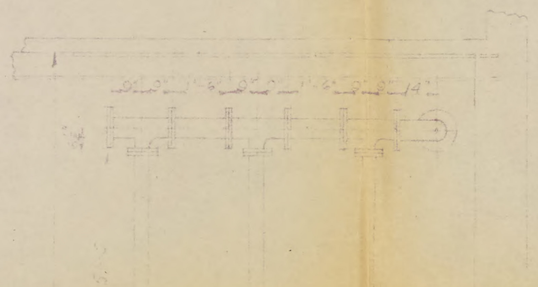
$\frac{3}{8}$" x 2" x 3'-6" STEEL BARS
SPACED $1\frac{1}{4}$" C-C

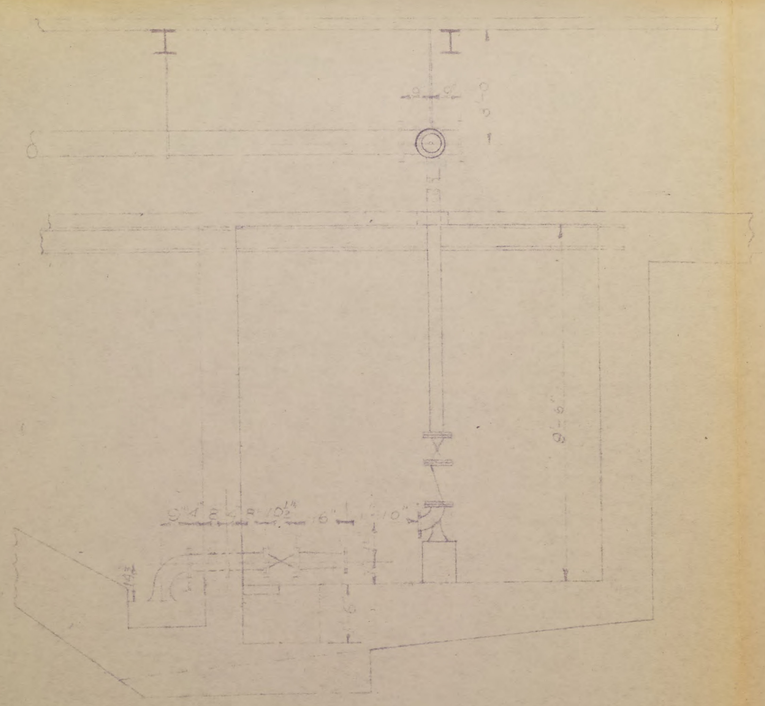
BAR SCREEN
SCALE: 1" = 1'

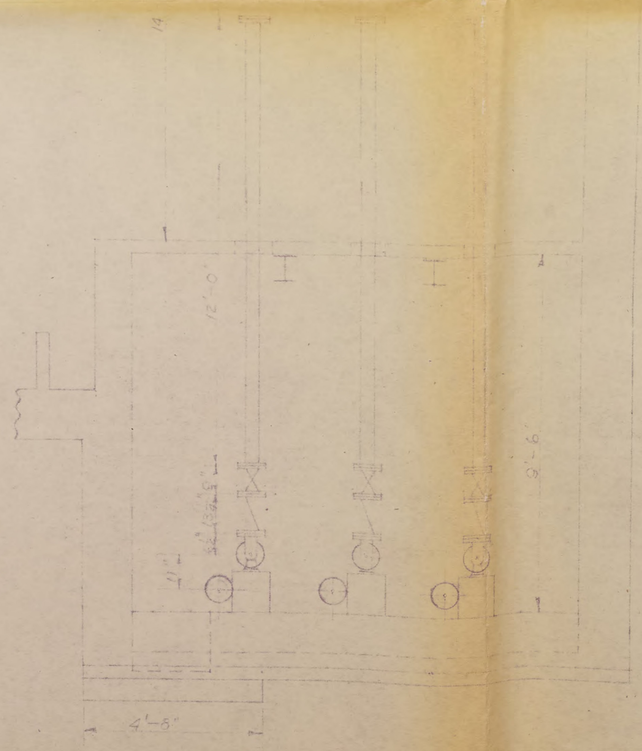
GRANDVILLE
SEWAGE TREATMENT PLANT
SERVICE BUILDING & BAR SCREEN
SCALES AS SHOWN
T.C. WILLIAMS F.D. HURD
JUNE 1948
SHEET 6 OF 8

SUPPLEMENTARY MATERIAL
MICHIGAN STATE UNIVERSITY LIBRARIES
3 1293 03151 4247
130 956 Thes Sheet 6









GRANDVILLE SEWAGE TREATMENT PLANT
PUMP ROOM DETAIL
F.D. HURD & T.C. WILLIAMS
SCALE 3/8" = 1'
JUNE 1948 SHEET 7 OF 8

18 x 25

SUPPLEMENTARY MATERIAL
MICHIGAN STATE UNIVERSITY LIBRARIES
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130
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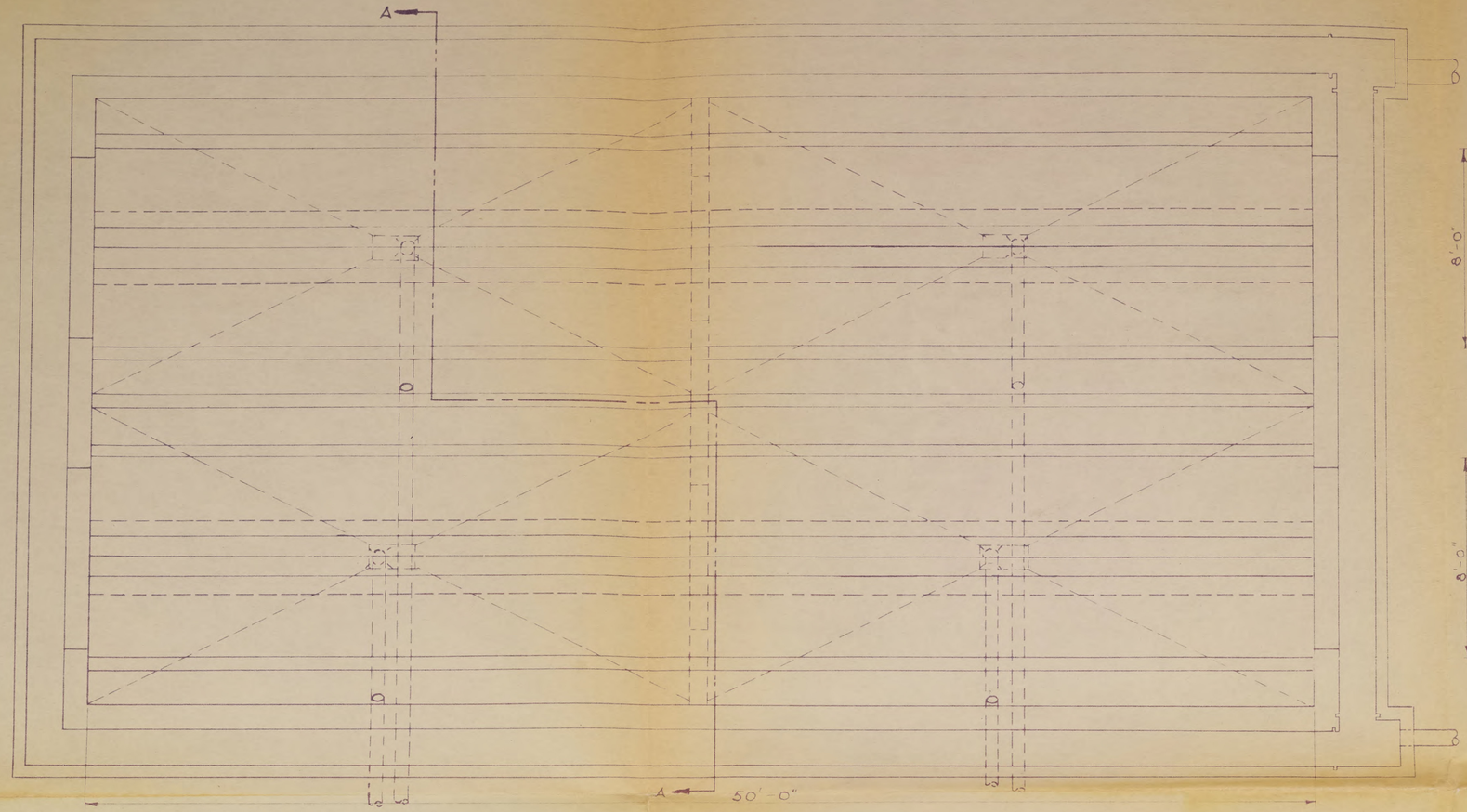
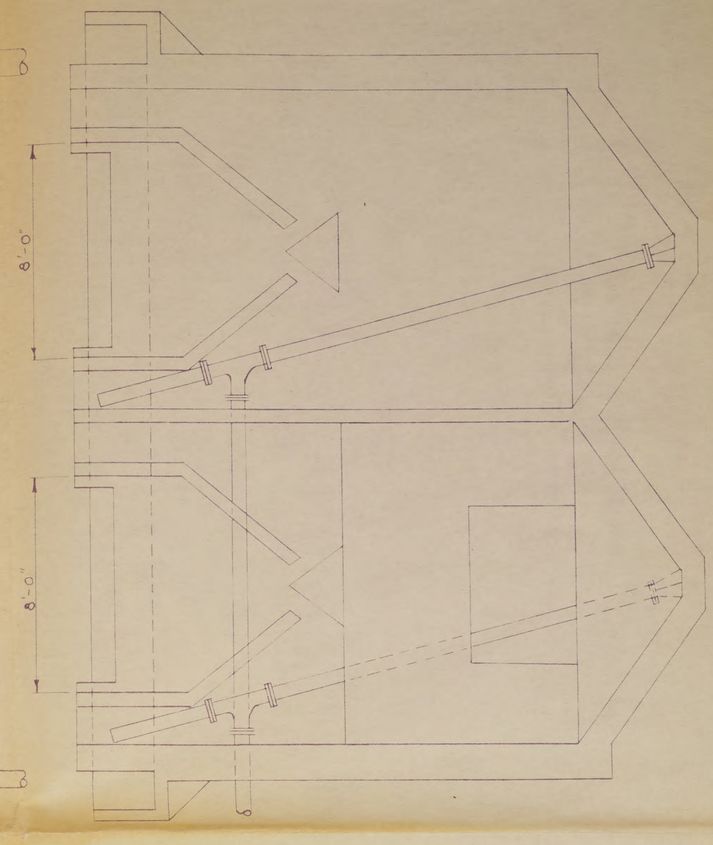
Sheet 7



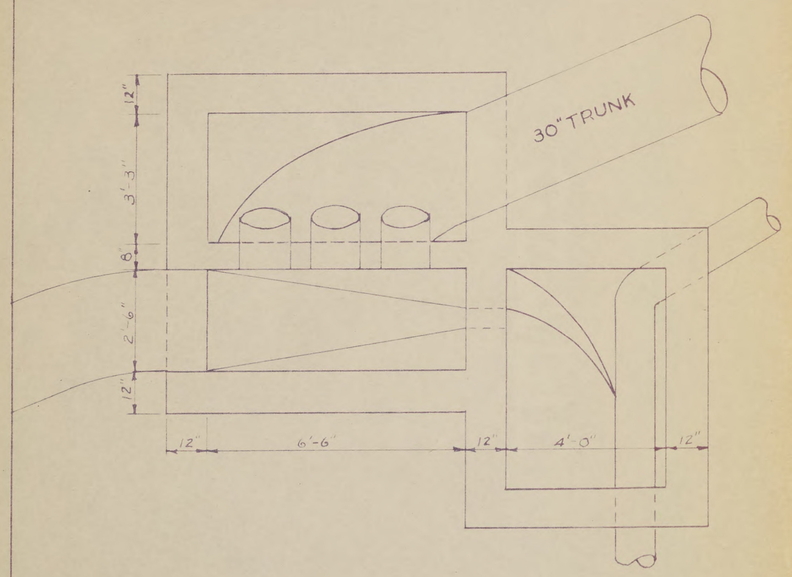


ELEVATION SECTION A-A

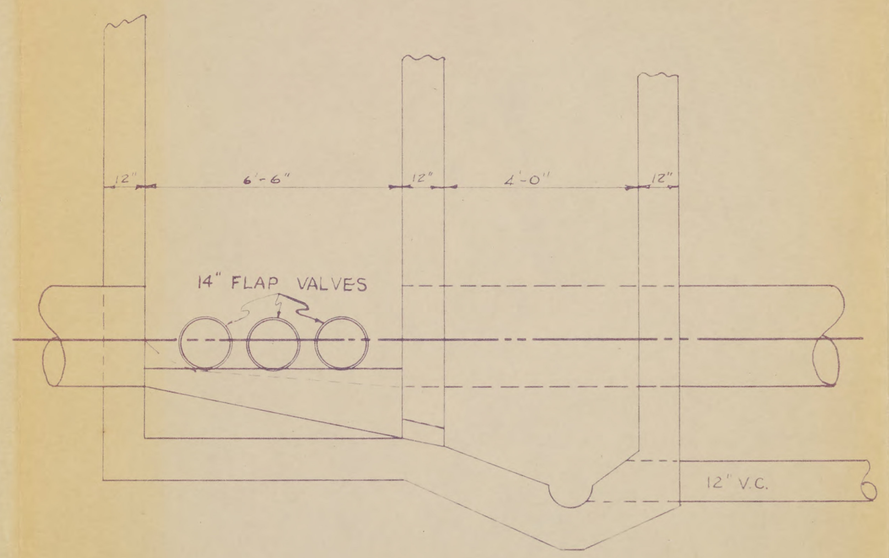
IMHOFF TANK

PLAN VIEW

SCALE: $\frac{1}{4}$" = 1'



PLAN VIEW



ELEVATION SECTION

DIVERSION CHAMBER

SCALE: $\frac{3}{8}$" 1'

GRANDVILLE

SEWAGE TREATMENT PLANT

IMHOFF TANK

DIVERSION CHAMBER

SCALES AS SHOWN

T.C. WILLIAMS F.D. HURD

JUNE 1948

SHEET 8 OF 8

SUPPLEMENTARY MATERIAL

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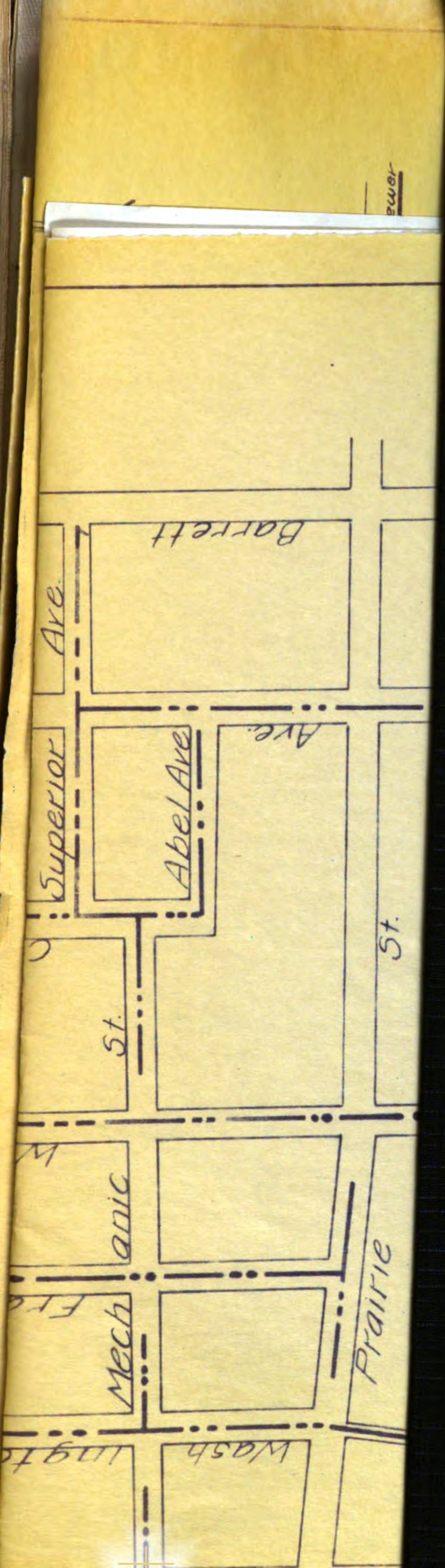
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