A DESIGN FOR [a]
SEWAGE DISPOSAL PLANT
FOR
INDEPENDENCE, KANSAS.

A THESIS SUBMITTED TO THE FACULTY OF
THE SCHOOL OF ENGINEERING OF
THE UNIVERSITY OF KANSAS.

FOR

THE ADVANCED DEGREE OF CIVIL ENGINEER
IN CIVIL ENGINEERING

BY
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PREFACE

For the past three years the writer has been City Engineer of Independence, Kansas and at the time of his coming the city was under an order from the State Board of Health to not build any more sewers until provision had been made to treat the sewage then being discharged into the Verdigris River or streams tributary thereto as the River was being used as a water supply by the City of Coffeyville, Kansas. At that time it was impossible to build a plant adequate to treat the sewage, not then treated, to a sufficient degree of purity and stay within the money allowed by the State Law to be expended for disposal works by cities of the second class.

The writer was refused a permit to extend certain lateral sewers by the State Board of Health and then put the matter up to the Board of City Commissioners who instructed the City Attorney to draft a special bill and get the same introduced into the legislature by our senator and representative. This bill was passed during the 1920-21 legislature and enabled the City of Independence, Kansas to spend $100,000 in the construction of disposal works to treat the sewage of the city.

The writer immediately started to work to make a study of the conditions relative to the construction of a
sewage disposal works. A great many types of plant were considered but the choice finally settled down to a sprinkling filter with a variable head dosing tank with primary treatment with Imhoff tanks to remove the solids. The writer was very much taken with tank described in the discussion by Kenneth Allen, M. Am. Soc. C.E. of Leonard S. Doten's paper on Sewage and Waste Disposal for the United States Army, Volume LXXXIII, page 337, of the Transactions of the American Society of Civil Engineers. This discussion, which is on page 359 of above mentioned Volume, contains a description of a tank devised by J. W. Alvord, M. Am. Soc. C.E., for the United States Housing Corporation during the late war. The writer wrote to the places where the tanks had been put in use and found that they had given first class service, as far as the tanks were concerned, at every place they had been installed, but owing to the tank being new the State Board of Health was rather reluctant to grant approval of this type without a visit to one of the plants. Speed was one of the essentials of the project so the Imhoff Tank was chosen as the type of sludge separator to be used. The arrangement of the final settling basin so that the sludge could be drawn off into the pump pit and repumped into the Imhoff tank was obtained from Metcalf and Eddy, Volume III, page 469, American Sewage practice. This arrangement was put in practice in
the Fitchburg, Mass., plant. By this method any unstable organic matter, such as worms, will be put through the rotting process to reduce it to a stable condition, in which it will not be likely to decompose and give off offensive odors when exposed on the sludge drying beds.

The methods of computing the distribution system and time of discharge of the dosing tank were obtained from an article by E.E. Sands, July 13, 1922, Hydraulics of Dosing Tanks and Trickling Filters, Engineering News-Record page 67.

The reinforcing of the concrete work was calculated by means of tables, Thomas and Nichols' "Reinforced Concrete Design Tables."

The writer has tried to write the report in such a way that it will be beneficial to the student in design of disposal plants. Special effort was made to show the method of calculation of the reinforcing. If this report is ever of any use in aiding an Engineer to design a disposal plant, the purpose of the writer will be fulfilled.

Independence, Kansas

March 24, 1923.

The Author.
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CHAPTER I.

ESTIMATED QUANTITIES OF SEWAGE.

The sanitary sewer system of Independence, Kansas, is divided into four districts each of which has a separate outlet. These four districts will be referred to hereafter as follows; The West Side District, the Business and Central District, the Southeast District and the Northeast District. These Districts are shown on the following page in colors as follows; The Westside District is shown in red. the Business and Central District is shown in Gray, the Southeast District is shown in green and theNortheast District is shown in blue. The small district just south of the Verdigris River where it turns to the East is shown in yellow. At the present this district colored yellow is so small and so few houses connected that it is not considered in the treatment plans. When the district becomes large enough to be a menace to the purity of the river it will be carried over into another district.

The West Side District at the present time is the only district where the sewage is treated. The treatment is by Septic Tanks and Contact Beds. The maximum flow of sewage which may be expected from the West Side District when fully built up based upon the assumption of a maximum flow of 150 gallons per capita per 24 hours and a population of 40 persons per block is estimated at 600,000 gallons per 24
hours. At the present time only one half of this flow or 300,000 gallons per 24 hours is being treated by this plant. This present plant has a capacity of treating about 500,000 gallons per 24 hours with a good effluent. Any increase in this district can be by-passed by gravity to the new plant by building about 1800 feet of new main sewer.

The Business and Central District is bounded by Rock Creek on the south and by other districts on the other three sides and can never increase. The flow from this district when fully built up will be about 684,000 gallons per day. The flow at present is 476,000 gallons per day as determined by actual measurement for 16 consecutive days.

The Southeast District is the last district to be sewer- ered in the city and at present has about 10% of the houses connected. The flow was too small to measure so the flow was estimated from the number of lots to be connected into the sewer. The main sewer of this district was designed large enough to take the flow of the Northeast District which will be pumped from the outlet just below the water works dam to Main and Waldschmidt where it will then flow by gravity to the main of the Southeast district at Magnolia Street and Waldschmidt Avenue. The maximum flow to be expected from this district is 492,000 gallons per day.

The Northeast District cannot be brought to the site of the disposal plant by gravity but will have to be pump-
ed from a point near the Waterworks dam into the Southeast District. The flow to be expected from the Northeast District when fully built up will be about 600,000 gallons per day.

**RECAPITULATION OF FLOW TO BE EXPECTED FROM ALL DISTRICTS.**

- West Side District: 600,000 gals. per day.
- Business or Central District: 684,000 gals. per day.
- Southeast District: 492,000 gals. per day.
- Northeast District: 600,000 gals. per day.

Total: 2,376,000 gals. per day.

Less flow at present treated... 500,000 gals. per day.

Total flow to be designed for 1,876,000 gals. per day.

The above flows are all maximum flows based upon a maximum flow of 150 gallons per capita per day. The average flow is assumed to be 75% of the maximum flow or 1,407,000 gallons per day. The new plant will be designed for a flow of 1,500,000 gallons per day average and a maximum flow of 2,000,000 gallons per day.

The present plant now in operation will treat the sewage of a population of 3330 and the new plant to be built will treat the sewage of a population of 13330 making a total population of 16660 provided for. The present population of Independence, Kansas is 12,900. The difference between 16660 and 12900 is 3760 which is the population provided for above present requirements. The design as above will provide for an increase in population of 22.5% before
# Pumpage at Water Plant at Independence, Kansas

## Average Gallons Pumped Per Day by Months

<table>
<thead>
<tr>
<th></th>
<th>1920</th>
<th>1921</th>
<th>1922</th>
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</thead>
<tbody>
<tr>
<td>January</td>
<td>1,469,032</td>
<td>1,551,612</td>
<td>1,457,420</td>
</tr>
<tr>
<td>February</td>
<td>1,564,286</td>
<td>1,640,000</td>
<td>1,390,715</td>
</tr>
<tr>
<td>March</td>
<td>1,694,838</td>
<td>1,600,709</td>
<td>1,482,580</td>
</tr>
<tr>
<td>April</td>
<td>1,546,000</td>
<td>1,570,000</td>
<td>1,356,666</td>
</tr>
<tr>
<td>May</td>
<td>1,720,645</td>
<td>1,738,665</td>
<td>1,830,322</td>
</tr>
<tr>
<td>June</td>
<td>2,104,000</td>
<td>1,925,000</td>
<td>1,879,333</td>
</tr>
<tr>
<td>July</td>
<td>2,509,677</td>
<td>2,074,838</td>
<td>1,841,935</td>
</tr>
<tr>
<td>August</td>
<td>2,425,806</td>
<td>2,076,744</td>
<td>2,161,290</td>
</tr>
<tr>
<td>September</td>
<td>2,180,000</td>
<td>1,929,333</td>
<td>2,000,000</td>
</tr>
<tr>
<td>October</td>
<td>2,125,806</td>
<td>1,596,774</td>
<td>1,801,290</td>
</tr>
<tr>
<td>November</td>
<td>1,626,000</td>
<td>1,438,000</td>
<td>1,554,000</td>
</tr>
<tr>
<td>December</td>
<td>1,599,677</td>
<td>1,410,967</td>
<td>1,457,419</td>
</tr>
</tbody>
</table>
the plant will be working at designed capacity.

The pumpage record at the City Water Works checks up these foregoing quantities very closely. The pumpage record for the last three years is shown on the following page. The high pumpage record in the summer months does not affect the flow in the sewers as the excess water is used for sprinkling and irrigation of gardens. The winters are rarely ever cold enough in this locality to cause a heavy flow from taps being left open to prevent the freezing of pipes.

The Rock Creek intercepting sewer is to be extended from the manhole marked "A" a distance of 2838 feet to the site of the disposal plant. At the point of junction "A" the manhole is to contain an overflow weir to take the excess flow of storm water, which comes from roofs being connected to the sanitary sewers and infiltration during wet weather, along the line of the old outfall to Rock Creek.

One of the first considerations of the design of the plant is that the sewage will have to be pumped or raised in elevation at the site of the plant. To get a fall of sufficient amount to carry the maximum flow to be expected from the Business or Central District through the extension of the Rock Creek intercepting sewer, the sewer will have to be placed at an elevation of 32 at the site of the plant. This elevation will give a fall of 3.5 feet in a distance
of 2838 feet. The elevation 32.00 is only 4.5 feet higher than the elevation of low water in Rock Creek. Any plant that would be put in would have to be operated with a very small loss of head and the excavation would be excessive as the average elevation at the site of the plant is a little above 40.00, unless pumping is resorted to. Since pumping is necessary it is only a question of increasing the head on the pumps to put in sprinkling filters. Sprinkling filters will give a much better effluent at the same expense in the location selected than either contact beds or sand filters. Therefore sprinkling filters are selected as the type of apparatus to be used in the disposal plant.

The preliminary treatment best suited to sprinkling filters is that given by an Imhoff tank as the sewage arrives at the filter in a fresh condition and thereby lessens the liability from odor from spraying stale sewage in the air.
CHAPTER II.

GENERAL DESCRIPTION OF PLANT.

The sewage enters the plant through a control manhole. The control manhole is provided with flap valve actuated by a float mechanism that closes the valves in the event of a flood stage of the creek and prevents the overflow of the plant. The plant is surrounded by a levee the top of which is placed at the elevation 52.00 which is 1 foot higher than record high water at this point. The high water is caused from back water from the river and the current is negligible. From the control manhole the sewage flows through a short connecting sewer to the wet well of the pump house. In the wet well the sewage first encounters a bar screen with one-inch spacing which rough screens the sewage and takes out rags, sticks and material which might injure or cling to the pump impellers. This screen is constructed on an incline with a trash floor at the upper end to facilitate cleaning. After passing through the screen it falls to the floor of the wet well and when the level rises it actuates a float that controls the starting mechanism of the pump motors. The floats are to be set so that one pump will come in action at a time. From the pumps the sewage passes through risers to a header line and thence into the inlet flume of the Imhoff tanks. From the flume it passes over
a weir in each tank. After passing over the weir it passes under a baffle which distributes the flow. While flowing through the tanks the solids settle out and pass through the slots in the bottom of the flow through compartments. Under the flow through compartments are the sludge digestion chambers where the solids are partly decomposed into liquids and gases. The gases pass upwards through the gas vents to the outside while the undecomposable solids settle to the bottom where they may be drawn to the sludge bed or filter at the will of the operator. The sewage in the flow through compartments passes under another baffle which holds back the floating solids, then over weirs into the dosing tank. From the dosing tank it is dosed at intervals through a siphon and distribution system onto the sprinkling filter bed. The filter bed is filled with an average of 5\% feet of crushed rock through which the sewage trickles and is oxidized. The sewage is collected at the bottom of the filter in the underdrain system and passed to a flume on the north side of the bed. From the flume it is carried to the final settling basin and detained long enough to settle out any material which may be unloaded from the sprinkling filter. The sewage passes from the final settling basin thru a short connecting sewer to the control manhole where it is turned into the outfall and thence flows to the creek.

The sludge from the final settling basin is discharged
at the will of the operator into the wet well of the pump house from where it is pumped back through the Imhoff tanks and resettled. The sludge from the Imhoff tanks after being drawn out on the sludge filter is allowed to dry and is then spaded off and disposed of. The liquids from the sludge filter are collected in an underdrain system and carried back to the wet well and again passed through the plant. All of the surface drainage in the plant during wet weather is carried to the pump chamber and pumped to the Imhoff tanks. In case of high water and the flap valves of the control manhole are closed a by-pass valve in the dosing tank is opened and the surface drainage and seepage are by-passed to the creek through a cast iron 12 inch sewer. The following pages are photostadt copies of the plans.
PLANS FOR

SEWAGE DISPOSAL PLANT

INDEPENDENCE, KANSAS.
CHAPTER III

DESIGN OF CONTROL MANHOLE.

The elevation of the bottom of the Control manhole is fixed at 32.00 for this is the elevation of the invert of the extension of the Rock Creek intercepting where it arrives at the site of the plant. The elevation of the top of the control manhole was placed at elevation 52.00 which is the elevation of the top of the levee. This height will prevent the overflow of the manhole in times of high water into the plant site. The manhole is made 10 feet long and 5 feet wide inside measurement to provide sufficient room for all apparatus such as floats, float mechanism, valves and inlet and outlet sewers. The float displacement was designed large enough to lift the flap valves and close them with a large allowance for friction. It was found necessary when investigating the moments to add a counterweight on the float side of the walking beam to hold the valves wide open. The division wall is provided with a shear valve to pass the sewage at any time. The division wall is made 3 feet high. This height will not back sewage up to the manhole containing the waste weir and will thereby let the sewage flow through the extension of the intercepting sewer in times of high water and prevent it from being introduced into Rock Creek at the higher point when not treated. The calculations for reinforcing are given.
in Chapter X. The reinforcing is calculated to resist the pressure of water when the manhole is at the point of overflowing. The pressure of the earth on the outside is taken into account and is reinforced against when the manhole is assumed empty.
CHAPTER IV.

DESIGN OF PUMPING EQUIPMENT.

In the design of the pumping equipment one half of the total flow is assumed to run off in 8 hours time. The total flow in Chapter I was assumed to be 1,500,000 gallons per 24 hours, then

\[
\frac{1,500,000}{2 \times 8 \times 60} = 1,562.5 \text{ Gallons per minute.}
\]

At first it was intended to place two units in the plant each of sufficient capacity to take the total load. The second unit to act as a standby in case of a break down or repairs. A motor when starting draws a large current so that on a large motor it is not economical to start and stop very often which would be the case if a unit was installed with capacity to take the total load. The above being the case it was decided to divide the capacity of one of the units and make a total of three units in the installation. The units to be as follows: one 1550 gallon per minute unit and two 775 gallon per minute units.

The pumps are put in a dry well with the suction lines leading through a wall into a wet well. This arrangement makes it possible to work on the pumps at any time without putting the plant out of operation. Gate valves are put in the suction and discharge lines of each pump for the same reason. The motors are connected to the centrifugal pumps.
by vertical shafts which are supported by thrust bearings both at the motor and at the pumps. Three intermediate bearings are provided which are supported by 8 inch I-Beams set in the walls of the pump chamber. In the arrangement of the pumps and motors and cross beams supporting the side walls of the pump chamber, the pumps were drawn in and the risers and header line detailed. The cross beams were then located so as not to interfere with any of the apparatus. After the general arrangement of the equipment was laid out and the inside dimensions of the pump chamber and wet well fixed the design of the thickness of the walls and the side of the stiffening beams and reinforcing rods was made. The design of the structural elements of the housing will be found in Chapter X. The size of the motors are computed from the rate of pumping and the total lift. The efficiency of the pumps was assumed at 60%. The total lift from the low elevation in the wet well to the elevation of the weir lip in the Imhoff tank is 22 feet 8 inches. Then the Horse power required on the 1550 G.P.M. pump would be:

\[ H.P. = \frac{1550 \times 8.33 \times 22.67}{33,000 \times 0.60} = 14.78 \]

The characteristics curves of a Centrifugal Pump show that the power need increases as the head decreases. As the pump goes into action the head on the pump will be less by the amount of the height of the sewage in the wet well above the point where the pump goes out of action. Therefore the
necessity of having the pumps overpowered is apparent. The size of 20 H.P. was taken as ample. The two smaller pumps are just half the capacity of the larger so half the power is used. The two smaller pumps however will be under a more continuous duty so the Temperature rise allowed under continuous duty and load is specified to be not greater than 40 degrees Farenheit while the larger pump has a temperature rise of 50 degrees Farenheit is allowed.

The motors are controlled by self starting devices which are operated by float switches. Overload switches are specified in the circuit which will throw any pump out of service that gets a large overload.

The complete design of the reinforcing will be found in chapter X.
CHAPTER V.

DESIGN OF IMHOFF TANK.

The Imhoff tanks are designed in two units each of equal capacity. The flow through compartments have a detention period of $1\frac{1}{2}$ hours on the average flow. Deep baffles are used at the entrance end and also at the outlet ends of the tanks so as to get a uniform flow through the whole cross section. The longitudinal baffles separate the flow through compartments from the sludge digestion compartments. The slope of the hopper bottoms in the flow through or settling compartments are made 1.25 vertical to 1.0 vertical. The slots are designed 6 inches wide and the overlap of baffles at the slot are practically 8 inches. To save depth in the total flow through compartments were made double. This method of design also allowed of steeper slopes on the baffles. Between the two settling compartments is the floating sludge compartment and gas vent. The gas vent is designed with an area equal to 10% of the superficial area of the tank. Walks with handrails are provided along the sides of the gas vents so that the sludge in the gas vents may be agitated. The sludge digestion chamber is designed for a sludge capacity of 0.7 cu. ft. per capita. This capacity is calculated from a point 2 feet below the slots. The capacity of both tanks for sludge is 9371.4 cu. ft. The sludge is drawn from the sludge chamber and distributed on the
sludge filter by gravity. The sludge pipes are designed 8 inches in diameter. The pipes are so arranged that each tank may be desludged separately. In the bottom of the sludge compartment the sludge pipes are increased to 18 inches in diameter to facilitate the entrance of the sludge into the sludge pipes.

The design of the reinforced concrete in the Imhoff tank is shown in detail in chapter 10.
CHAPTER VI.

DESIGN OF SPRINKLING FILTER.

In the design of the sprinkling filter the following factors or conditions are given.

Quantity of sewage to be treated...1,500,000 gal. per day.

Assumed rate of application per acre per day is 2,500,000 gallons.

Available head from high level in dosing tank to top of sprinkling nozzles 8.5 feet.

Assumed loss of head in distribution system 1.5 feet.

Available head at nozzles would then be 7.00 feet.

CALCULATIONS.

Area of filter bed.

\[
\frac{1,500,000}{2,500,000} = 0.60 \text{ Acres required}
\]

Design of distribution system based upon Worcester nozzles with 13/16 inch orifice.

Worcester nozzles discharging under 7.00 foot head will discharge 23 gallons per minute.

Spacing of nozzles based upon distribution curves of the Worcester nozzle, which are shown on next page, will be 15.0 feet for circular spray nozzles. The nozzles are spaced so as to allow for overlapping sprays. Area of bed covered by one nozzle would be 195 square feet.

Number nozzles required = \[
\frac{43,560 \times 0.6}{195} = 134
\]
\[ \frac{13}{16} \text{ Inch Nozzle Orifice} \]

**Total Discharge**

**GALLONS PER MINUTE.**

**DISTANCE FROM NOZZLE IN FEET**

**WORCESTER NOZZLE.**

**DISTRIBUTION AND DISCHARGE CURVES.**
Size of bed was now determined by trial. For economy it is necessary to make the bed as nearly square as possible and the half spray nozzles placed so as to cover as much area of bed as possible and reduce waste of filter surface. Spacing half spray nozzles 18 inches from the short side it was found that the dimensions necessary were 168 feet by 160' - 10-5/8". This size makes an area of 0.62 acre. It was found that 126 full spray nozzles and 12 half spray nozzles would be necessary to cover this area. Full spray nozzles discharge 23 gallons per minute and half spray nozzles discharge 12 gallons per minute. Total discharge of nozzles would then be at high head;

\[
\begin{align*}
126 \times 23 &= 2898 \text{ gallons per minute.} \\
12 \times 12 &= 144 \text{ gallons per minute.} \\
\text{Total} &= 3042 \text{ gallons per minute.}
\end{align*}
\]

3,042 gallons per minute = 6.76 cubic feet per second.

On the following page is shown the skeleton outline of the distribution system. The page following that gives a tabulation of the discharges and velocities and unit losses of head in the various parts of the distribution system. The nozzle farthest away from the dosing siphon is used start with. The riser is designated by the letter "a". The latteral from this nozzle to the next is designated "b". The culminative discharges are shown in the second column under the heading "Maximum quantities in G.P.M." The sizesof
<table>
<thead>
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<th>PIPE</th>
<th>MAX. QUAN. G.P.M.</th>
<th>SIZE OF PIPE</th>
<th>VELOCITY F.P.S.</th>
<th>FRICTION LOSS F. P. 1000</th>
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<td>3&quot;</td>
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<tr>
<td>b</td>
<td>23</td>
<td>4&quot;</td>
<td>0.6</td>
<td>1.0</td>
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<tr>
<td>c</td>
<td>46</td>
<td>4&quot;</td>
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<td>d</td>
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<td>e</td>
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<td>10&quot;</td>
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<td>h</td>
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<td>j</td>
<td>795</td>
<td>12&quot;</td>
<td>2.3</td>
<td>1.8</td>
</tr>
<tr>
<td>k</td>
<td>1590</td>
<td>14&quot;</td>
<td>3.3</td>
<td>3.0</td>
</tr>
<tr>
<td>l</td>
<td>3042</td>
<td>18&quot;</td>
<td>3.8</td>
<td>2.8</td>
</tr>
</tbody>
</table>
COMPUTATION OF LOSS OF HEAD
IN DISTRIBUTION SYSTEM.

Nozzle...................................................... 7.000
4.0 Lin. ft. 3" riser pipe @ 2.6 ft. per 1000... .010
Entrance head 4" to 3"............................... .023
15.0 Lin. ft. 4" pipe @ 1.0' per 1000........... .015
15.0 Lin. ft. 4" pipe @ 2.0' per 1000........... .030
11.0 Lin. ft. 4" pipe @ 4.6' per 1000........... .051
Entrance head 6" to 4"............................... .074
13.0 Lin. ft. 6" pipe @ 2.0 ft per 1000......... .026
13.0 Lin. ft. 8" pipe @ 1.7 ft per 1000......... .022
13.0 Lin. ft. 10" pipe @ 1.3 ft per 1000........ .017
13.0 Lin. ft. 10" pipe @ 2.1 ft per 1000........ .027
13.0 Lin. ft. 10" pipe @ 3.1 ft per 1000........ .041
6.5 Lin. ft. 12" pipe @ 1.8 ft per 1000......... .012
Entrance head 1½" to 12"............................. .121
83.0 Lin. ft. 1½" pipe @ 3.0 ft per 1000......... .259
45.0 Lin. ft. 1½" pipe @ 2.8 ft per 1000......... .126
Loss of head in siphon............................... .440

Total loss of head......................... 8.290
DIAGRAM OF DISTRIBUTION SYSTEM.

160' -- 10 5/8"

12"

10" 10" 10" 8" 6"

18"

14"

168 ft.
pipe were then assumed and placed in column 3. After assuming the sizes of pipe the velocities were calculated. If in any case the velocities were too high the size of the pipe was decreased until a proper velocity was obtained. A high velocity increases friction and makes a large loss of head while a low velocity will allow deposits in the distribution system. After all the sizes of pipe were calculated according to this method the losses of head were calculated and tabulated. The total losses were found to be 8.29 feet. The head available was 8.50 so the distribution system has a head of 0.21 feet more than necessary.

The underdrain system is composed of concrete floors which slope to two main gutters. These gutters drain to the north and are one foot wide. These gutters are covered with 13 inch wall coping. The lateral drain system is composed of slotted, split drain tile spaced 2 feet 6 inch centers. The ends of these lateral drains all extend through the filter walls to facilitate aeration and also flushing. The inside ends of the drains are taken to a high gutter in the center of the bed. This center gutter has a riser of 15 inch VSP at the upper end to provide for aeration. The average depth of the filter material is $5\frac{1}{2}$ feet. The depth varies from 5 feet at the upper side of the sloping floor to 6 feet deep at the main underdrain gutters. Crushed limestone is specified as the filter material to be used in the filter bed.
The elevations of the orifices in the nozzles are placed at 42.50 the high water elevation in the dosing tank is at elevation 51.00 which is also the flow line elevation of the Imhoff tanks. The high point of the sprinkling filter floor is at elevation 37.00. The low point is placed at elevation 36.00. The top of the filtering material is at elevation 42.00.

The design of the reinforced concrete retaining walls about the filter bed is given in detail in Chapter X.
CHAPTER VII.
DESIGN OF DOSING TANK.

The size of the siphon to be used in the dosing tank is taken from Table "A", page 62, catalogue No. 14 of the Pacific Flush Tank Co. This table shows that an 1½ inch siphon will handle a maximum inflow of 2,000,000 gallons per 24 hours. In table "B", page 63 of the same catalogue the discharge of an 1½ inch siphon under a 7.00 foot head is given as 7,570 gallons per minute when discharging into an open trough. The size of the nozzles however limit this discharge to 3,042 G.P.M. or 6.76 Cu. Ft. per second.

The height of the bottom of the bell must now be placed in the dosing tank so that the discharge at the minimum head will be greater than the greatest possible inflow. If the inflow should ever be greater than the minimum discharge the siphon will go into continuous operation at low head and the distribution would not be uniform.

Let \( Q \) equal the discharge in cubic feet per second for any head \( x \). Let \( K \) equal the coefficient of discharge for the system. Then \( Q = K \sqrt{x} \)

for which the maximum head \( x \) equals 8.5 feet and \( Q = 6.76 \) cubic feet per second then;

\[
6.76 = K \sqrt{8.5}
\]

and

\[
K = \frac{6.76}{\sqrt{8.5}} = 2.31866
\]
The discharge then for any head $x$ would be

$$Q = 2.31866\sqrt{x}$$

The maximum rate of inflow for 2,000,000 gallons per day is 1389 G.P.M. or 3.09 cubic feet per second.

The pumps however will pump 1550 G.P.M. maximum rate. Increasing this quantity to 1650 G.P.M. or 3.68 cubic feet per second for safety and substituting in the above formula we have

$$3.68 = 2.31866\sqrt{x}$$

solving for $x$ we have

$$\sqrt{x} = \frac{3.68}{2.31866} = 1.586$$

$$x = 2.51$$ distance low water in dosing tank is to be placed above nozzle elevation. The nozzle elevation having been previously fixed at elevation 42.50 the low water elevation in the dosing tank would then be at 45.00. The bottom of the bell is 3 inches below the sniff point. The bottom of the bell would then be placed at elevation 44.75. The bell should clear the floor of the dosing tank by 6 inches (manufacturers directions) and the floor would then be at elevation 44.25. The dosing tank is designed with a taper so that the amount of sewage dosed on the bed at each increment of head will be uniform. A tank can be worked out with curved sides which will give
a uniformly distributed discharge theoretically but the wind, condition of the nozzles and other factors which interfere with uniform distribution makes it a useless refinement. The tank is therefore designed with one sloping side. This method makes it possible to utilize one end of the Imhoff tanks for one side of the dosing tank. The bottom was made large enough to contain the siphon, vent and regulating apparatus. The drawing depth is fixed at 6.00 feet. The top area was then calculated to be of such a size as to make the tank capacity 1125 cubic feet or 8,415 gallons. This tank was then investigated for time of dosing and rest period.

From fundamental formulae

\[ v = c\sqrt{2gx} \]

where \( v \) = velocity feet per second.

\( c \) = coefficient of discharge, \( g \) = acceleration due to gravity and \( x \) = head in feet.

Then \( Q = av = ac\sqrt{2gx} = ac\sqrt{2g}\sqrt{x} \) where \( a \) = area or areas of orifices and \( Q \) = discharge in cubic feet per second. Let the constant \( ac\sqrt{2g} = K \) then

\[ Q = K\sqrt{x} \]
Quantity of Discharge in time \( dt = dQ \)

\[
dQ = K\sqrt{x} \ dt \quad \text{"A"}
\]

Let \( S = \) area of surface of sewage in dosing tank at depth \( x \)
then when \( x = 8.5 \) \( S = 9 \times 32.67 \)

From Geometry

\[
\frac{S}{9.0 \times 32.67} = \frac{x}{H}
\]

or

\[
S = \frac{9.0 \times 32.67 \times x}{H}
\]

\[
dQ = S \ dx = \frac{9.0 \times 32.67 \times x \ dx}{H} \quad \text{"B"}
\]

Equating "A" and "B" and solving for \( dt \) we have

\[
dt = \frac{9.0 \times 32.67 \times x \ dx}{K\sqrt{x} \ H}
\]

Integrating between 8.5 feet high head and 2.5 feet low head we have

\[
t = \int_{2.5}^{8.5} \frac{9.0 \times 32.67 \times x \ dx}{K\sqrt{x} \ H}
\]

\[
t = \frac{9.0 \times 32.67}{K \ H} \left[ \frac{x^{\frac{3}{2}}}{\sqrt{x}} \right]_{2.5}^{8.5}
\]

\[
t = \frac{9.0 \times 32.67}{K \ H} \cdot \frac{2}{3} \left[ x^{\frac{3}{2}} \right]_{2.5}^{8.5}
\]
\[ t = \frac{23.061}{K} \left( \frac{x^3}{2.5} \right)^{8.5} \]

If the tank were dosing with no inflow the value of \( K \) would be

\[ K = \frac{6.76}{\sqrt{8.5}} = 2.32 \]

For an inflow of 1389 G.P.M. or 2,000,000 gallons per day the discharge rate at high head would be

\[ 6.76 - 3.09 = 3.67 \text{ cubic feet per second.} \]

Then \[ K = \frac{3.67}{\sqrt{8.5}} = 1.256 \]

For an inflow of 1042 G.P.M. or 1,500,000 gallons per day the discharge rate at high head would be

\[ 6.76 - 2.32 = 4.44 \text{ cubic feet per second.} \]

Then \[ K = \frac{4.44}{\sqrt{8.5}} = 1.52 \]

Substituting the value of \( K \) for no inflow in formula "C" we have \( t = 207 \) seconds or 3 minutes 27 seconds.

For inflow of 1389 G.P.M. \( K = 1.256 \)

substituting in "C" we have

\[ t = 382 \text{ seconds or 6 minutes 4 seconds.} \]

Likewise for inflow of 1042 gallons per minute or 1,500,000 gallons per day

\[ t = 316 \text{ seconds or 5 minutes 16 seconds.} \]
Since the tank capacity is 1125 cubic feet the rest periods for the various rates of flow would equal to the capacity of the tank or 1125 cubic feet divided by the rate of inflow in cubic feet per second.

For inflow of 2,000,000 gallons per day or 3.09 c.f.s. we have,

\[
\text{Rest period} = \frac{1125}{3.09} = 364 \text{ seconds or 6 minutes and 4 seconds.}
\]

For inflow of 1,500,000 gallons per day or 2.32 c.f.s. we have,

\[
\text{Rest period} = \frac{1125}{2.32} = 485 \text{ seconds or 8 minutes and 49 seconds.}
\]

The tank is not long enough to receive the flow from both Imhoff Tanks direct so a flume is built on the east end of the tank to carry the flow into the tank. This flume would cause quite a rush of sewage down the slope of the tank and would disturb the action of the siphon by getting air under it. To prevent this rush of sewage a small cross wall is built to deflect this rush from the siphon bell. The sewage coming through the wiers directly over the siphon bell is also collected in a short flume and led to the east side of the cross wall to prevent the
collecting of air under the bell which would cause the siphon to discharge at a different height each time.

The reinforcing rods and structural elements are all computed in Chapter X.
CHAPTER VIII.

DESIGN OF FINAL SETTLING BASIN.

The final settling basin is designed for a 1 hour detention of the average flow. The average flow is 1,500,000 gallons per day.

\[ 1,500,000 \text{ gallons per day} = 2.32 \text{ cu. ft. per sec.} \]

\[ 2.32 \times 60 \times 60 = 8352 \text{ Cubic Feet required.} \]

A size of top of 33.0 x 21.25 feet was selected. The sides are designed vertical above the hopper bottom so that the top of the hopper bottom will also be 33.0 x 21.25 feet. The bottom of the hopper bottom is made 3.0 x 3.0 feet. Let the top area be \( A \) and the bottom area be \( a \). Let \( h \) equal the distances between bases and \( V \) equal the total volume in the hopper in cubic feet. Then,

\[ V = \frac{A + a + \sqrt{Aa}}{3} \times h \]

\[ V = \frac{701.25 + 9.0 + 79.44}{3} \times 7.5 = 1974.22 \text{ Cubic Feet in hopper bottom.} \]

Now \( 8352 - 1974 = 6378 \text{ Cu. Ft. required in upper part above hopper.} \)

\[ \frac{6378.0}{701.25} = 9.09 \text{ feet depth of upper part below flow line.} \]

The flow line elevation was fixed at 34.50 feet.
The sludge pipe in the final settling basin passes into the wet well of the pump house. No storage capacity for sludge was allowed for in the final settling basin as it can be desludged every day. A cross beam was necessary to stiffen the east side of the basin and was utilized for the support of a walk. The basin desludges under a head of 5 feet.

The design of the reinforcing and structural elements is given in detail in Chapter X.
CHAPTER IX.
DESIGN OF SLUDGE BED.

The sludge bed is designed on the basis of service to a population of 13,300. The size is taken as 0.2 square foot per capita. Then

$$13,300 \times 0.2 = 2,660$$ square feet required.

A size of 51.5 feet $\times$ 52.0 was taken as most satisfactory as it fits the place in the area left for it. This size gave an area of 2,678 square feet which is 18 square feet over requirement and satisfactory.

The underdrain system is composed of vitrified drain tile laid on 5 foot centers. The filter material is crushed limestone $1^{4/10}$ deep and covered with 4 inches of sand or chats.

The distributing system consists of wooden troughs so arranged as to distribute the sludge over the surface of the bed as evenly as possible.

The bed is surrounded with a retaining wall of reinforced concrete to hold back the earth. The face of this wall is built vertical to facilitate the measurement of sludge drawn from the Imhoff tanks.

The design of the reinforced concrete retaining wall about the sludge bed is given in detail in Chapter X.
CHAPTER X.

DESIGN OF REINFORCED CONCRETE.

AND

STRUCTURAL ELEMENTS

IN

SEWAGE DISPOSAL PLANT AT INDEPENDENCE

KANSAS.
CALCULATIONS FOR REINFORCED CONCRETE DESIGN.

All Loading is Based on the Following:

Earth Pressure.

\[ p = \text{Intensity of pressure at any depth}. \]
\[ w = \text{Weight of earth per cubic foot. (100\#)} \]
\[ h = \text{Height of wall in feet}. \]
\[ \phi = \text{Angle of repose. (33°)} \]
Then
\[ p = \tan^{2}(45° - \frac{1}{2}\phi)w'h. \]
\[ p = \tan^{2}(28° - 30°)w'h. \]
\[ p = 0.2948\ w'h. \]

Hydrostatic Pressure.

\[ p = \text{Intensity of pressure at any depth}. \]
\[ W = \text{Weight of water per cubic foot. (62.5)} \]
\[ h = \text{Height of wall in feet}. \]
\[ H = \text{Total pressure against wall acting at a point two thirds distance from top of wall}. \]
\[ p = W'h. \]

The Reinforcing Design is taken from "Reinforced Concrete Design Tables" by Thomas and Nichols.

The following notations are used.

\[ A_s = \text{Area of steel in square inches}. \]
\[ F_c = 650\# \text{ Compressive unit stress in concrete}. \]
\[ F_s = 16,000\# \text{ Tensile unit stress in steel}. \]
\[ n = 15 \]
\[ b = \text{Breadth of beam}. \]
\[ d = \text{Depth of beam}. \]
\[ M = \text{Maximum Bending Moment}. \]
\[ l = \text{Length of span in feet}. \]
\[ V = \text{Total shear}. \]
\[ v = \text{Unit shear in pounds per square inch}. \]
\[ s = \text{Horizontal spacing of stirrups}. \]
\[ u = \text{Allowable bond stress. (20\#)} \]
\[ w = \text{Uniform load in pounds per foot of length}. \]
\[ W = \text{Weight of concentrated load in pounds}. \]
\[ R_1 = \text{Reaction at left support}. \]
\[ R_2 = \text{Reaction at right support}. \]
\[ j_d = \text{Distance between centers of tension and compression steel in inches}. \]
\[ X_1 = \text{Distance from support to point where stirrups are unnecessary}. \]
\[ v = \frac{V}{b'd} = 35\# \text{ per square inch Allowable unit shear without stirrups}. \]
\[ d' = \text{Depth to center of compression steel}. \]
DESIGN OF REINFORCED CONCRETE CONTROL MANHOLE.

Reinforcing for End Walls------------ 5'-0" Span.
From Elev. 32.00 to Elev. 36.00---Internal pressure
due to water. p = W.h. W = 62.5# h = 20'-0"
p = 62.5 x 20 = 1,250#

External pressure due to earth. p = .2948 W.h.
W = 100# h = 8'-0"
p = .2948 x 100 x 8 = 236#
1,250 - 236 = 1,014# Internal pressure.

\[ M = \frac{-Wl^2}{g} = \frac{1,014 \times 5^2}{g} = 3,168 \text{ Ft. Lbs. Moment.} \]

As = 0.51 Sq. inches steel per foot of width.
Use 5/8" \( \phi \) Bars 7" Centers. Outside edge of wall.

\[ M = \frac{-Wl^2}{g} = \frac{236 \times 5^2}{g} = 737 \text{ Ft. Lbs. Moment.} \]

As = 0.25 Sq. inches steel per foot of width.
Use 1/2" \( \phi \) Bars 10" Centers. Inside edge of wall.

***************************************************************

From Elev. 36.00 to Elev. 40.00
Internal pressure due to water -------- p = W.h.
p = 62.5 x 16 = 1,000#
External pressure due to earth -------- p = .2948 W.h.
p = .2948 x 100 x 4 = 118#
1,000# - 118# = 882# Internal pressure.

\[ M = \frac{-Wl^2}{g} = \frac{882 \times 5^2}{g} = 2,756 \text{ Ft. Lbs Moment.} \]

As = 0.46 Sq. inches steel per foot of width.
Use 5/8" \( \phi \) Bars 8" Centers. Outside edge of wall.

\[ M = \frac{-Wl^2}{g} = \frac{118 \times 5^2}{g} = 370 \text{ Ft. Lbs. Moment.} \]

As = 0.18 Sq. inches steel per foot of width.
Use 1/2" \( \phi \) Bars 12" Centers. Inside edge of wall.

***************************************************************

From Elev. 40.00 to Elev. 44.00
Internal pressure due to water.-------- p = W.h.
p = 62.5 x 12 = 750#

\[ M = \frac{-Wl^2}{g} = \frac{750 \times 5^2}{g} = 2,094 \text{ Ft. Lbs. Moment.} \]

As = 0.42 Sq. inches of steel per foot of width.
Use 5/8" \( \phi \) Bars 9" Centers. Outside edge of wall.
Use 1/2" \( \phi \) Bars 15" Centers. Inside edge of wall.
From Elev. 44.00 to Elev. 48.00
Internal pressure due to water ---- p = W.h.
\[ p = 62.5 \times 8 = 500\# \]
\[ M = \frac{w1^2}{g} = \frac{500 \times 5^2}{8} = 1575 \text{ Ft. Lbs. Moment.} \]
As = 0.35 Sq. inches per foot of width.
Use 1/2" ø Bars 7" Centers. Outside edge of wall.
Use 1/2" ø Bars 12" Centers. Inside edge of wall.

From Elev. 48.00 to Elev. 52.00
Internal pressure due to water ---- p = W.h.
\[ p = 62.5 \times 4 = 250\# \]
\[ M = \frac{w1^2}{g} = \frac{250 \times 5^2}{8} = 781 \text{ Ft. Lbs. Moment.} \]
As = 0.25 Sq. inches steel per foot of width.
Use 1/2" ø Bars 10" Centers. Outside edge of wall.
Use 1/2" ø Bars 20" Centers. Inside edge of wall.
Use same reinforcing for both ends of Manhole.

Reinforcing For Side Walls--------10'-0" Span.
From Elev. 32.00 to Elev. 36.00
Internal pressure due to water ---- p = W.h.
\[ p = 62.5 \times 20 = 1,250\# \]
External pressure due to earth ---- p = 29 4/8 W.h.
\[ p = 29\frac{4}{8} \times 100 \times 8 = 236\# \]
\[ 1,250 - 236 = 1,014\# \text{ Internal pressure.} \]
\[ M = \frac{w1^2}{g} = \frac{1,014 \times 10^2}{8} = 12,675 \text{ Ft. Lbs. Moment.} \]
As = 0.99 Sq. inches steel per foot of width.
Use 5/8" ø Bars 4" Centers. Outside edge of wall.
\[ M = \frac{w1^2}{g} = \frac{236 \times 1.0^2}{8} = 2,950 \text{ Ft. Lbs. Moment.} \]
As = 0.48 Sq. inches steel per foot of width.
Use 1/2" ø Bars 5" Centers. Inside edge of wall.

From Elev. 36.00 to Elev. 40.00
Internal pressure due to water ---- p = W.h.
\[ p = 62.5 \times 16 = 1,000\# \]
External pressure due to earth ---- p = 29 4/8 W.h
\[ p = 29\frac{4}{8} \times 100 \times \frac{1}{4} = 118\# \]
\[ 1,000 - 118 = 882\# \text{ Internal pressure.} \]
\[ M = \frac{w1^2}{g} = \frac{882 \times 10^2}{8} = 11,025 \text{ Ft. Lbs. Moment.} \]
As = 0.92 Sq. inches steel per foot of width.
Use 5/8" φ Bars 4" Centers. Outside edge of wall.

\[ M = \frac{W_{1}}{S} = \frac{118 \times 10^{2}}{g} = 1475 \text{ Ft. Lbs. Moment.} \]

As = 0.35 Sq. inches steel per foot of width.
Use 1/2" φ Bars 7" Centers. Inside edge of wall.

****************************

From Elev. 40.00 to Elev. 44.00
Internal pressure due to water ------- p = W.h.
\[ p = 62.5 \times 12 = 750' \]

\[ M = \frac{W_{1}}{g} = \frac{750 \times 10^{2}}{g} = 9,375 \text{ Ft. Lbs. Moment.} \]

As = 0.85 Sq. inches per foot of width.
Use 1/2" φ Bars 10" Centers. Inside edge of wall.

****************************

From Elev. 44.00 to Elev. 48.00
Internal pressure due to water ------- p = W.h.
\[ p = 62.5 \times 2 = 500' \]

\[ M = \frac{W_{1}}{g} = \frac{500 \times 10^{2}}{g} = 6,250 \text{ Ft. Lbs. Moment.} \]

As = 0.72 Sq. inches per foot of width.
Use 5/8" φ Bars 5" Centers. Outside edge of wall.
Use 1/2" φ Bars 12" Centers. Inside edge of wall.

****************************

From Elev. 48.00 to Elev. 52.00
Internal pressure due to water ------- p = W.h.
\[ p = 62.5 \times 4 = 250' \]

\[ M = \frac{W_{1}}{g} = \frac{250 \times 10^{2}}{g} = 3,125 \text{ Ft. Lbs. Moment.} \]

As = 0.51 Sq. inches steel per foot of width.
Use 5/8" φ Bars 7" Centers. Outside edge of wall.
Use 1/2" φ Bars 15" Centers. Inside edge of wall.

****************************

Reinforcing For Bottom Of Manhole.
Use the same reinforcing used for the first four feet of side wall reinforcing.
5/8" φ Bars 7" Centers, for 5'-0" Span.
1/2" φ Bars 12" Centers, for 10'-0" Span.
All vertical steel 1/2" φ Bars 2'-0" Centers in both sides of walls.
LOADING OF BEAMS IN WALLS OF WET WELL AND PUMP CHAMBER.

External pressure due to water \( p = W \cdot h \).
For Beam "A" \( p = 62.5 \times 6 = 375\)#
For Beam "B" \( p = 62.5 \times 15 = 938\)#
At Bottom \( p = 62.5 \times 23.5 = 1,470\)#

\[
R_2 \text{ on Beam } "A" = \frac{w1}{3} = \frac{375 \times 6}{3} = 750\#
\]
\[
R_1 \text{ on Beam } "A" \text{ for uniform load} = \frac{w1}{2}
\]
\[
R_1 = \frac{375 \times 9}{2} = 1,687\#
\]
\[
R_1 \text{ for uniformly increasing load} = \frac{w1}{6}
\]
\[
R_1 = \frac{563 \times 9}{6} = 845\#
\]

Total Reaction on Beam "A" equals \( 750\# + 1,687\# + 845\# = 3,282\# \) per foot.

Reactions on Beam "B"

\[
R_2 \text{ for uniform load} = \frac{w1}{2} = \frac{375 \times 9}{2} = 1,687\#
\]
\[
R_2 \text{ for uniformly increasing load} = \frac{w1}{3} = \frac{563 \times 9}{3} = 1,690\#
\]
\[
R_1 \text{ for uniform load} = \frac{w1}{2} = \frac{938 \times 6.5}{2} = 3,986\#
\]
\[
R_1 \text{ for uniformly increasing load} = \frac{w1}{6} = \frac{532 \times 6.5}{6} = 754\#
\]

Total Reaction on Beam "B" = \( 1,687\# + 1,690\# + 3,986\# + 754\# = 8,117\# \) per foot.
DESIGN OF BEAMS IN WALLS OF WET WELL AND PUMP CHAMBER.

Design of Beam "A"

Load = 3,282# per foot —— Long Span = 8'-6"

\[ M = \frac{W}{8} \times \frac{l^2}{2} = \frac{3,282 \times 8.5^2}{8} = 29,640 \text{ Ft. Lbs. Moment.} \]

Net size Beam = 12" Wide 16" Deep. As = 1.52 Sq.in

Use 5 — 5/8"  ø Bars.

\[ V = \frac{Wl}{2} = \frac{3,282 \times 8.5}{2} = 13,948 \text{# Shear.} \]

Taking allowable unit shear = \( V = \frac{40}{\text{Sq. in.}} \)

\[ XL = \frac{1}{2} - \frac{Vbld}{W} = \frac{8.5}{2} - \frac{40 \times 12 \times 1.5}{3,282} = 2.2 \text{ Ft.} \]

Using 3/8" ø Stirrups As = .1104 Sq. in.

\[ S = \frac{3}{2} x \frac{As \text{ Fs} \times 1d}{V} = \frac{3 \times 2 \times 1.104 \times 16,000 \times 1.5}{2 \times 13,948} = 5.31" \text{ Minimum Spacing of Stirrups.} \]

Use 4 — 3/8" ø Stirrups 5" and 6" Centers.

Design of Beam "A" Short Span = 5'-6"

\[ M = \frac{W}{8} \times \frac{l^2}{2} = \frac{3,282 \times 5.5^2}{8} = 12,410 \text{ Ft. Lbs. Moment.} \]

Net size Beam = 12" wide 10" Deep As = 0.99 Sq.in.

Using a Beam 12" Wide 16" Deep Net Moment = 29,300 Ft. Lbs. As = 1.52 Sq.in.

Steel required = \( \frac{12,410}{29,300} \times 1.52 = 0.65 \text{ Sq. in.} \)

Use 2 — 5/8" ø Bars.

\[ V = \frac{Wl}{2} = \frac{3,282 \times 5.5}{2} = 9,025 \text{# Shear.} \]

\[ XL = \frac{1}{2} - \frac{Vbld}{W} = \frac{5.5}{2} - \frac{40 \times 12 \times 1.5}{3,282} = .70 \text{ Ft.} \]

\[ S = \frac{3}{2} x \frac{As \text{ Fs} \times 1d}{V} = \frac{3 \times 2 \times 1.104 \times 16,000 \times 1.5}{2 \times 9,025} = 5.2" \text{ Minimum Spacing of Stirrups.} \]

Use 3 — 3/8" ø Stirrups 6" Centers.
Design of Beam "B"

Load = 8,117# per foot. Long Span = 8’-6"

\[ M = \frac{wL^2}{8} = \frac{8,117 \times 8.5^2}{8} = 73,306 \text{ Ft. Lbs. Moment.} \]

Taking a Beam 18” Wide the Moment is

\[ M = \frac{12L}{16} \times 73,306 = 48,800 \text{ Ft. Lbs. The nearest Moment is 49,700 Ft. Lbs. For which } A_s = 1.98 \text{ Sq. in.} \]

Steel required = \[ \frac{73,306}{49,700} \times 1.98 = 2.92 \text{ Sq. in. Steel.} \]

Net size of Beam 18” x 22” Use 5 - 7/8” φ Bars.

\[ V = \frac{wL}{2} = \frac{8,117 \times 8.5}{2} = 34,500# \text{ Shear.} \]

\[ X_l = \frac{1}{2} - \frac{vbjd}{w} = \frac{8.5}{2} - \frac{40 \times 18 \times 19}{8,117} = 2.57 \text{ Ft.} \]

\[ s = \frac{3}{2} \times \frac{AsFs}{V}jd = \frac{3 \times 2 \times 1104 \times 16,000 \times 19}{2 \times 34,500} = 2.91” \]

Use 8 - 3/8” φ Stirrups 3” and 4” Centers.

********************************************************************************

Design of Beam "B" Short Span = 5’-6”

\[ M = \frac{wL^2}{8} = \frac{8,117 \times 5.5^2}{8} = 30,692 \text{ Ft. Lbs. Moment.} \]

Taking a Beam 18” Wide the Moment is

\[ M = \frac{12L}{16} \times 30,692 = 20,460 \text{ Ft. Lbs. The nearest Moment for a 22” Deep Beam = 49,700 Ft. Lbs. As= 1.98 Steel required = } \frac{30,692}{49,700} \times 1.98 = 1.22 \text{ Sq. in. Steel.} \]

Net size of Beam 18” x 22” Use 2 - 7/8” φ Bars.

\[ V = \frac{wL}{2} = \frac{8,117 \times 5.5}{2} = 22,321 # \text{ Shear.} \]

\[ X_l = \frac{1}{2} - \frac{vbjd}{w} = \frac{5.5}{2} - \frac{40 \times 18 \times 19}{8,117} = 1.12 \text{ Ft.} \]

\[ s = \frac{3}{2} \times \frac{AsFs}{V}jd = \frac{3 \times 2 \times 1104 \times 16,000 \times 19}{2 \times 22,321} = 4.2” \]

Use 4 - 3/8” φ Stirrups 4” Centers.

********************************************************************************
Design of Beam "C"

Load = 8,117# per foot  
Span = 9'-0"

\[ M = \frac{W \cdot 1^2}{8} = \frac{8,117 \times 2^2}{8} = 82,182 \text{ Ft. Lbs. Moment.} \]

Taking a Beam 18" Wide the Moment =

\[ M = \frac{12}{18} \times 82,182 = 54,788 \text{ Ft. Lbs. The nearest} \]

Moment is 54,700 Ft. Lbs.  
As = 1.92 Sq. inches

Steel req'd = \( \frac{82,182}{54,700} \times 1.92 = 2.88 \text{ Sq. inches.} \)

Net size Beam 18" x 22"  
Use 5 - 7/8" φ Bars.

\[ V = \frac{W \cdot 1}{2} = \frac{8,117 \times 9}{2} = 36,500\# \text{ Shear.} \]

\[ x_1 = \frac{1}{2} - \frac{vbhd}{w} = \frac{9}{2} - \frac{140 \times 2 \times 12}{2 \times 8,117} = 2.82\]  

\[ s = \frac{3}{2} \times \frac{As \cdot Fs \cdot id}{V} = \frac{3 \times 2 \times 1.104 \times 16,000 \times 19}{2 \times 36,500} = 2.7" \]

Use 9 - 3/8" φ Stirrups 3", 4" and 5" Centers.

Design of Beam "D"

Load = 3,282# per foot.  
Span = 9'-0"

\[ M = \frac{W \cdot 1^2}{8} = \frac{3,282 \times 9^2}{8} = 33,230 \text{ Ft. Lbs. Moment.} \]

Net size 12" x 16"  
As = 1.61 Sq. inches.

Use 5 - 5/8" φ Bars.

\[ V = \frac{W \cdot 1}{2} = \frac{3,282 \times 9}{2} = 14,769\# \text{ Shear.} \]

\[ x_1 = \frac{1}{2} - \frac{vbhd}{w} = \frac{9}{2} - \frac{40 \times 12 \times 14}{3,282} = 2.45 \text{ Ft.} \]

\[ s = \frac{3}{2} \times \frac{As \cdot Fs \cdot id}{V} = \frac{3 \times 2 \times 1.104 \times 16,000 \times 14}{2 \times 14,769} = 5" \]

Use 6 - 3/8" φ Stirrups 5", 6", 7", and 9" Centers.
Design of Beam "E"

Weight of one foot of Brick wall 9'-0" high ... = 1,113#
" " " " Slab 6" Thick, 2.5# /s. = 187#
" " " " Beam .................................. = 225#
Live load of 150# per sq. foot.................. = 375#

Total Load on Beam .................. = 1,800#

Uniform load of 1,800# per ft. Span = 15'-0"
\[ M = \frac{w \cdot l^2}{8} = \frac{1,800 \cdot 15^2}{8} = 50,625 \text{ Ft. Lbs.} \]

Taking a Beam 18" Wide the Moment =
\[ M = \frac{12}{18} \times 50,625 = 33,800 \text{ Ft. Lbs. The nearest} \]
Moment is 34,800 Ft. Lbs. As = 1.66 Sq. inches.

Steel required = \[ \frac{50,625 \times 1.66}{34,800} = 2.42 \text{ Sq. in.} \]

Net size Beam 18" x 18" Use 4 - 7/8" φ Bars.
\[ V = \frac{w \cdot l}{2} = \frac{1,800 \cdot 15}{2} = 13,500 \# \text{ Shear.} \]
\[ v = \frac{V}{bd} = \frac{13,500}{18 \times 18} = 41.6\# \text{ per sq. inch.} \]

No Stirrups Required.

Design of Beam and Slab in Wet Well (Trash Platform)

Main Beam, between north and south wall.
Load = 530# per foot. Span = 15'-0"
\[ M = \frac{w \cdot l^2}{8} = \frac{530 \cdot 15^2}{8} = 15,000 \text{ Ft. Lbs.} \]

Taking a Beam 8" Wide the Moment =
\[ M = \frac{12}{8} \times 15,000 = 22,500 \text{ Ft. Lbs. The nearest} \]
Moment is 22,600 Ft. Lbs. As = 1.34 Sq. in.

Steel required = \[ \frac{15,000}{22,600} \times 1.34 = 0.89 \text{ Sq. in.} \]

Net size Beam 8"x 14" Use 2 - 3/4" φ Bars.
\[ V = \frac{w \cdot l}{2} = \frac{530 \cdot 15}{2} = 3,975 \# \text{ Shear.} \]
\[ v = \frac{3,975}{8 \times 14} = 35.5\# \text{ Unit Shear. No Stirrups Required.} \]
Design of Slabs in Wet Well (Trash Platform)

Large Slab. Load = 150# per ft. Span = 4'-0"

\[ M = \frac{W \cdot L^2}{8} = \frac{150 \times 4^2}{8} = 300 \text{ Ft. Lbs. Moment.} \]

Use 4" Slab. As = 0.16 Sq. in. Use 1/2" \( \phi \) 1/4" C'ts.

Small Slab. Load = 150# per ft. Span = 5'-6"

\[ M = \frac{W \cdot L^2}{8} = \frac{150 \times 5.5^2}{8} = 567 \text{ Ft. Lbs. Moment.} \]

Use 4" Slab. As = 0.23 Sq. in. Use 1/2" \( \phi \) 10" C'ts.

Design of Floor Slab in Motor Room.

Load = 250# per foot. Span = 9'-0"

\[ M = \frac{W \cdot L^2}{8} = \frac{250 \times 9^2}{8} = 2,531 \text{ Ft. Lbs. Moment.} \]

Use 6" Slab. As = 0.46 Sq. in. Use 1/2" \( \phi \) 5" C'ts.

Load = 250# per foot. Span = 4'-3"

\[ M = \frac{W \cdot L^2}{8} = \frac{250 \times 4.25^2}{8} = 565 \text{ Ft. Lbs. Moment.} \]

Use 6" Slab. As = 0.23 Sq. in. Use 1/2" \( \phi \) 10" C'ts.

Bottom of Pump pit and Wet Well to be Reinforced with 1/2" \( \phi \) Bars 12" Centers Both Ways.

Top Strut in Pump Chamber to be 12" Wide 12" Deep and 9'-0" Long. Reinforce with 4 - 5/8" \( \phi \) Bars.

Bottom Strut in Pump Chamber to be 12" Wide 12" Deep and 9'-0" Long. Reinforce with 4 - 5/8" \( \phi \) Bars.

For Temperature Bars in Motor Room Floor and Floor of Trash Platform Use 1/2" \( \phi \) Bars 24" Centers.
Design Of Curtain Walls Between Wet Well And Pump Chamber And West Wall Of Pump Chamber. (Both Walls Are The Same)

Section #1
Load uniformly increasing from 0# to 34$\frac{1}{4}$# per foot.
\[ \text{Span} = 5' - 6'' \]
\[ \text{Moment} = 0.0642 \times 1^2 \]
\[ M = 0.0642 \times 344 \times 5.5^2 = 668 \text{ Ft. Lbs. Moment.} \]

Use 12'' Wall \[ A_s = 0.23 \text{ Sq. inches.} \]

Use 3/4'' $\phi$ Bars Spaced 16'' Centers. (Vertical)
Use 1/2'' $\phi$ Bars Spaced 15'' Centers. (Horizontal)

Section #2
Uniform Load of 406# per foot. \[ \text{Span} = 8' - 0'' \]
Uniformly Increasing Load of 0# to 500# per ft.
\[ \text{Moment for Uniform Load} = \frac{W \times 1^2}{8} \]
\[ M = \frac{406 \times 8^2}{8} = 3,248 \text{ Ft. Lbs. Moment.} \]

\[ \text{Moment for uniformly increasing load} = \frac{0.0642 \times 500 \times 8^2}{2,054} = 2,054 \text{ Ft. Lbs.} \]

Total Moment = 3,248 + 2,054 = 5,302 Ft. Lbs.

Use 12'' Wall \[ A_s = 0.65 \text{ Sq. in.} \]

Use 3/4'' $\phi$ Bars 8'' Centers (Vertical)
Use 1/2'' $\phi$ Bars 12'' Centers (Horizontal)

Section #3
Uniform Load of 1,000# per ft. \[ \text{Span} = 7' - 6'' \]
Uniformly Increasing Load 0# to 470# per ft.
\[ \text{Moment for uniform Load} = \frac{W \times 1^2}{8} \]
\[ M = \frac{1,000 \times 7.5^2}{8} = 7,031 \text{ Ft. Lbs.} \]

\[ \text{Moment for uniformly inc. Load} = 0.0642 \times 470 \times 7.5^2 = 1,697 \text{ Ft. Lbs.} \]

Total Moment = 7,031 + 1,697 = 8,728 Ft.#

Use 12'' wall. \[ A_s = 0.83 \text{ Sq. in.} \]

Use 3/4'' $\phi$ Bars 6'' C'ts. (Vertical)
Use 1/2'' $\phi$ Bars 9'' C'ts. (Horizontal)

North Pump Chamber Wall Same As Above.
Design Of North Wall Of Wet Well.

Section #1

External Pressure due to Earth = .2948 W h
\[ p = 0.2948 \times 100 \times 4.5 = 133 \text{# per ft.} \]
\[ \text{Span} = 14' - 6" \]
\[ M = \frac{w \cdot l^2}{8} = \frac{133 \times (14.5)^2}{8} = 3,486 \text{ Ft. Lbs.} \]

Using a 10" Net Wall, \( M = 10,750 \text{ Ft. Lbs.} \) As = 0.92

\[ \text{Area Steel Req'd.} = \frac{3,486}{10,750} \times 0.92 = 0.30 \text{ Sq. in.} \]

Use 1/2" \# Bars 6" Centers. (Horizontal)
Use 1/2" \# Bars 24" Centers. (Vertical)

Section #2

External Pressure Due to Earth = .2948 W.h.
\[ p = 0.2948 \times 100 \times 7.5 = 221\text{# per ft.} \]
\[ \text{Span} = 14' - 6" \]
\[ \text{Moment} = \frac{w \cdot l^2}{8} \]
\[ M = \frac{221 \times (14.5)^2}{8} = 5,800 \text{ Ft. Lbs.} \]

Using a 10" Net Wall, \( M = 10,750 \text{ Ft. Lbs.} \) As = 0.92

\[ \text{Steel Req'd} = \frac{5,800}{10,750} \times 0.92 = 0.50 \]

Use 5/8" \# Bars 7" Centers (Horizontal)
Use 1/2" \# Bars 24" Centers (Vertical)

Section #3

External Pressure Due to Earth = .2948 W.h.
\[ p = 0.2948 \times 100 \times 10.5 = 310\text{# per ft.} \]
\[ \text{Span} = 14' - 6" \]
\[ M = \frac{w \cdot l^2}{8} \]
\[ M = \frac{310 \times (14.5)^2}{8} = 8,135 \text{ Ft. Lbs.} \]

Using a 10" Net Wall \( M = 10,750 \text{ Ft. Lbs.} \)
As = 0.92 \text{ Sq. inch Steel.}

\[ \text{Steel Required} = \frac{8,135}{10,750} \times 0.92 = 0.70 \]

Use 5/8" \# Bars 5" Centers (Horiz.)
Use 1/2" \# Bars 24" Centers (Vert.)
Design Of North And South End Walls Of Imhoff Tanks. (Both Ends Are The Same)

Design Of Beam "F"

External pressure due to earth = $0.2946 \text{ W.h.}$

$p = 0.2946 \times 100 \times 3 = 88\text{# per ft. at beam.}$

$p = 0.2946 \times 100 \times 13 = 383\text{# per ft. at bott'm.}$

$R_l$ for uniform load $= \frac{W}{2} = \frac{88 \times 10}{2} = 440\text{#}$

$R_l$ for uniformly increasing load $= \frac{W}{6}$

$R_l = \frac{383 - 88 \times 10}{6} = 492\text{# per ft.}$

Total $R_l = 440 + 492 = 932\text{# per foot.}$

Internal pressure due to water $= \text{W.h.}$

$p = 62.5 \times 14 = 875\text{# per foot at beam.}$

$p = 62.5 \times 24 = 1,500\text{# per ft. at bottom.}$

$R_l$ for uniform load $= \frac{W}{2} = \frac{875 \times 10}{2} = 4,375\text{# per foot.}$

$R_l$ for uniformly increasing load $= \frac{W}{6} = \frac{1,500 - 875 \times 10}{6} = 1,041\text{# per ft.}$

Total $R_l = 4,375 + 1,041 = 5,416\text{# per ft.}$

Net Internal pressure $= 5,416 - 932 = 4,484\text{# per foot.}$

$M = \frac{W}{8} = \frac{4,484 \times 14^2}{8} = 109,882 \text{ Ft. Lbs.}$

Beam Required $18''$ Wide $\times 24''$ deep for which $M = 61,900 \text{ Ft.Lbs.}$ As $= 2.21$

Moment without Compression Steel $= \frac{18}{12} \times 61,900 = 92,550 \text{ Ft. Lbs.}$

As (Without Compression Steel) $\geq 1.5$

As $= \frac{18}{12} \times 2.21 = 3.32 \text{ Sq. inches.}$

Total Moment minus Moment without Compression Steel equals Moment to be taken by Compression Steel.
Design of Beam "F" Continued.

109,882 - 92,850 = 17,032 Ft. Lbs. to be taken by compression steel. One sq. inch steel resists 13,010 Ft. Lbs.
then \( \frac{17,032}{13,010} = 1.31 \) Sq. in. compression steel required.

Area of Tension Steel to balance = \( \frac{M}{F_a (d - d')} \)

\( A_s = \frac{17,032}{16,000 \times 1.31} = 0.58 \) Sq. inches.

Total Tension Steel req'd = 3.32 + 0.58 = 3.90 Sq. in.
For Tension Side Use 5 - 1" φ Bars.
For Compression Side Use 3 - 3/4" φ Bars.

\( V = \frac{W l}{2} = \frac{5,417 \times 14}{2} = 37,900 \) # Shear.

\( X_1 = \frac{1}{2} - \frac{v b d j}{w} = \frac{14 - \frac{40 \times 16 \times 21}{5,417}}{2} = 4.25 \) Feet.

Using 3/8" φ Stirrups,

\( s = \frac{3}{2} \times \frac{A_s F_s j d}{V} = \frac{3 \times 2 \times 1104 \times 16,000 \times 21}{2 \times 37,900} = 2.93" \)

Use 3/8" φ Stirrups 3", 4", and 5" Centers.

Design of Curtain Walls

Section #1

\( p = W h = 62.5 \times 4.5 = 281 \) # Horizontal Span = 12'

\( M = \frac{W l^2}{8} = \frac{281 \times 12^2}{8} = 5,060 \) Ft. Lbs.

12" Net Wall \( A_s = 0.65 \) Sq. in.
Use 3/4" φ Bars 6" C'ts. (Horiz.)
Use 3/4" φ Bars 30" C'ts. (Vert.)

Section #2

\( p = W h = 62.5 \times 8.5 = 531 \) # Horizontal Span = 12 Ft.

\( M = \frac{W l^2}{8} = \frac{531 \times 12^2}{8} = 9,560 \) Ft. Lbs.

12" Net Wall \( A_s = 0.83 \) Sq. in.
Use 3/4" φ Bars 6" C'ts. (Horiz.)
Use 3/4" φ Bars 30" C'ts. (Vert.)

Section #3

\( p = W h = 62.5 \times 12.5 = 781 \) # Horizontal Span = 12 Ft.
Section #3 Continued.

\[ M = \frac{W \cdot l^2}{8} = \frac{761 \times 12^2}{8} = 14,058 \text{ Ft. Lbs.} \]

Use 12" Net Wall. \( A_s = 1.06 \text{ Sq. in.} \)
Use 3/4" \( \phi \) Bars 5" Centers (Horizontal)
Use 3/4" \( \phi \) Bars 30" Centers (Vertical)

Section #4

Uniform Load = 875# per ft. \( \text{Span} = 10' - 0" \)
Uniformly Increasing Load of 0# to 625# per foot.

\[ M \text{ for uniform load} = \frac{W \cdot l^2}{8} = \frac{875 \times 10^2}{8} = 10,940 \text{ Ft. Lbs.} \]

Moment for uniformly increasing load = 0.642 w.l^2.
\[ M = 0.642 \times 625 \times 10^2 = 4,012 \text{ Ft. Lbs.} \]
Total Moment = 10,940 + 4,012 = 14,952 Ft. Lbs.
Use 12" Net Wall. \( A_s = 1.11 \text{ Sq. in.} \)
Use 3/4" \( \phi \) Bars 5" Centers (Vertical)
Use 1/2" \( \phi \) Bars 30" Centers (Horizontal)

Use 1/2" \( \phi \) Bars 30" Centers Both Ways on Inside Face of Walls in all four sections.

Design Of East And West Walls Of Imhoff Tanks.
(Both Sides Are The Same)

Internal pressure due to water = W.h.
\[ \rho = 62.5 \times 14 = 875\# \text{ on bottom beam.} \]

\[ R_1 = \frac{W \cdot l}{6} = \frac{875 \times 14}{6} = 2,040\# \text{ per ft.} \]
\[ R_2 = \frac{W \cdot l}{3} = \frac{875 \times 14}{3} = 4,080\# \text{ per ft.} \]

Design of Beam "G"

Load = 2,040# per ft. \( \text{Span} = 9' - 6" \)

\[ M = \frac{W \cdot l^2}{8} = \frac{2,040 \times 2.5^2}{8} = 23,000 \text{ Ft. Lbs.} \]

Take a Beam 12" Wide 12" Deep Net.
Moment = 15,500 \( A_s = 1.11 \)
For compression steel the \( M = 23,000 \)
Beam without compression \( M = 15,500 \)

To be taken by compression M = 7,500
One Sq.in. steel resists a M = 4,240
Compression Steel Req'd =
Beam "G" Continued.

As Compression = \( \frac{7,500}{5,240} = 1.42 \) Sq. inches Steel.

Area Tension Steel to Balance = \( \frac{M}{Fs (d - d')} \)

\[ As = \frac{7,500}{16,000 \times .84} = 0.56 \text{ Sq. inches.} \]

Total Tension Steel = 1.11 + 0.56 = 1.67 Sq. in.

For Tension Side Use 4 - 3/4" φ Bars.

For Compression Side Use 4 - 3/4" φ Bars.

\[ V = \frac{W \times 1}{2} = \frac{2,040 \times 2.5}{2} = 9,690 \text{# Shear.} \]

\[ x_1 = \frac{1}{2} - \frac{Vbdl}{w} = \frac{2.5 - \frac{40 \times 12 \times 10.5}{2,040}}{2} = 2.28' \]

Using 3/8" φ Stirrups

\[ s = \frac{3}{2} \times \frac{As \times Fs}{V} = \frac{3 \times 2 \times 1104 \times 16,000 \times 10.5}{2 \times 9,690} = 5.75'' \]

Use 5 - 3/8" φ Stirrups 6" and 8" Centers.

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Design of Beam "H"

Load = 4,080# per foot. \hspace{1cm} Span = 9' - 6"

\[ M = \frac{W \times l^2}{8} = \frac{4,080 \times 2.5^2}{8} = 46,000 \text{ Ft. Lbs.} \]

Size Beam Required 16" Wide 16" Deep Net, for which Moment = 27,500 Ft. Lbs. and \( As = 1.48 \text{ Sq. in.} \)

\[ M = \frac{15}{12} \times 27,500 = 41,250 \text{ Ft. Lbs.} \]

As (Without Compression Steel) = \( \frac{18}{12} \times 1.48 = 2.22 \text{ Sq. inches.} \)

\[ 46,000 - 41,250 = 4,750 \text{ Ft.Lbs. to be taken by comp'n.} \]

One Sq. in. of steel resists 7,110 Ft. Lbs.

Compress. Steel Req'd = \( \frac{4,750}{7,110} = 0.67 \text{ Sq. in.} \)

Area of tension Steel to balance = \( \frac{M}{Fs (d - d')} \)

\[ As = \frac{4,750}{16,000 \times 1.17} = 0.25 \text{ Sq. in.} \]
Design Of Beam "H". Continued.

Total Tension Steel Req'd = 2.22 + 0.25 = 2.57 Sq.in.
For Tension Side Use 4 - 1" φ Bars.
For Compression Side Use 2 - 3/4" φ Bars.

\[ V = \frac{W}{2} = \frac{\frac{4,080 \times 2.5}{2}}{2} = 19,380 \text{# Shear.} \]

\[ X_1 = \frac{1}{2} \cdot \frac{Vb1d}{W} = \frac{9.5 - \frac{40 \times 18 \times 14}{4,080}}{4} = 2.28 \text{ Ft.} \]

Using 3/8" φ Stirrups

\[ s = \frac{3}{2} \times \frac{A_s F_s}{V} = \frac{3 \times 2 \times 1.104 \times 16,000 \times 14}{2 \times 19,380} = 3.8" \]

Use 6 - 3/8" φ Stirrups 4", 5", 6" Centers.

Design of Curtain Wall between Beams "G" and "H"
Internal pressure at top of beam "H" = \( p = \frac{W}{h} \)
Span = 12' - 6"
\( p = 62.5 \times 12.5 = 781.5 \text{# per ft.} \)
Load on Wall uniformly increasing from 0# to 781.5#
\( M = 0.0642 \times L = 0.0642 \times 781.5 \times 12.5 = 7,840 \text{ Ft. Lbs.} \)
Use 8" Net Wall
For Outside Face Use 5/8" φ Bars 5" C'ts. (Vertical)
For Inside Face Use 1/2" φ Bars 24" C'ts. (Horizontal)

Design Of Wall Below Beam "H"
Section #1

Vertical pressure from wall above 2,036#
Resultant of vertical load = 1,272#
Average Internal pressure = 1,000#
Average External pressure = \( \frac{133}{8} \)
Average Internal pressure = 867# per'
Taking wall as a cantilever with moments about "X" the moment for concentrated load = \( Wl = 1272 \times 3.5 = 4,452 \text{ Ft. #} \)

\( M. \text{ for uniform load} = \frac{Wl^2}{8} \)
\( M = 867 \times \frac{3.5^2}{8} = 5,310 \text{ Ft. Lbs.} \)
Total \( M. = 4,452 + 5,310 = 9,762 \text{ Ft.Lbs.} \)
Use 10" Net Wall
For inside face use 3/4" φ Bars 6" C'ts. (Vertical)
Section #1 Continued.
For Inside Face Use 1/2" φ Bars 24" Centers (Horiz.).
For Outside Face Use 1/2" φ Bars 24" C'ts. Both Ways.
There are four sections of the above, one at each side and two at center partition of tanks, all are reinforced the same.

Section #2
External pressure due to earth = 0.2948 W.h.
P = 0.2948 x 100 x 6 = 177# per ft. at top.
P = 0.2948 x 100 x 13 = 393# per ft. at bottom.
Uniform Load = 177# Span = 7'-0"
Uniformly increasing load of 0# to 206# per ft.

M. for uniform load = \[ \frac{wL^2}{8} = \frac{177 \times 7^2}{8} = 1,084 \text{ Ft. Lbs.} \]

Moment for uniformly increasing load = 0.0642 w.l^2
M = 0.0642 x 206 x 7^2 = 748 Ft. Lbs.

Total Moment = 1,084 + 748 = 1,832 Ft. Lbs.
Use 8" Net Wall As = 0.39 Sq. in.

For Inside Face Use 1/2" φ Bars 6" Centers (Vertical)
" " " 1/2" φ Bars 24" Centers (Horizontal)

Internal pressure due to water = W.h.
P = 62.5 x 17 = 1,063# per ft. at top.
P = 62.5 x 24 = 1,500# per ft. at bottom.
Internal pressure at top = 1,063 - 177 = 886# per ft.
Internal pressure at bottom = 1,500 - 393 = 1,107#
Uniform load = 886# Span = 7'-0"
Uniformly increasing load of 0# to 231# per foot.

M. for uniform load = \[ \frac{wL^2}{8} = \frac{886 \times 7^2}{8} = 5,430 \text{ Ft. Lbs.} \]

Moment for uniformly increasing load = 0.0642 w.l^2
M = 0.0642 x 231 x 7^2 = 727 Ft. Lbs.

Use 8" Net Wall As = 0.64 Sq. in.

For Outside Face Use 5/8" φ Bars 6" Centers (Vertical)
" " " 1/2" φ Bars 24" Centers (Horizontal)

There are four sections of the above, one at each side and two at center partition of tanks all are reinforced the same.

The entire Bottom of Imhoff tanks to be reinforced with 1/2" φ Bars, 8" Centers both ways.
Design Of Center Wall Between Imhoff Tanks.
Beam "G" same as Beam "G" of side wall.

Design of Curtain Wall.
Loading same as curtain wall between beam "G" and beam "H" in side of tanks. Wall is reinforced the same on both faces to carry full load of either tank when the other tank is empty.

Use 5/8" φ Bars 5" Centers (Vertical) Both faces of wall.
Use 1/2" φ Bars 24" Centers (Horiz.) " " " " " " .
The remaining portion of center wall is designed and reinforced the same as the corresponding sections in side walls of tanks.

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Compartment walls of Imhoff tanks are designed to be self supporting (Carry no load other than their own wt.) Reinforce with 1/2" φ Bars 6" Centers (Horizontal) and 1/2" φ Bars 30" Centers (Vertical). Put bars in center of wall.
*******************************************************************************

Design Of Top Tie Beams "I"
Load (Weight of beam 9"x 12") = 113# per ft. Span = 23' 
\[ M = \frac{Wl^2}{8} = \frac{113 \times 23^2}{8} = 7,472 \text{ Ft. Lbs.} \]
As = 0.78 Sq. in. Use 4 - 3/4" φ Bars, two in top and two in bottom of beam.

Top tie beams in both tanks are the same.
*******************************************************************************
Design Of Bottom Tie Beams "J"
Load (Weight of beam 9"x 18") = 170# Span = 23 Ft. 
\[ M = \frac{Wl^2}{8} = \frac{170 \times 23^2}{8} = 11,250 \text{ Ft. Lbs.} \]
As = 0.95 Sq. in. Use 4 - 7/8" φ Bars, two in top and two in bottom of beam.

Bottom tie beams in both tanks are the same.
*******************************************************************************
Design Of Cantilever Walk Across Top Of Imhoff Tanks.
Load including slab = 150# per ft. Span = 2' - 6" 
\[ M = \frac{Wl^2}{8} = \frac{150 \times 2.5^2}{8} = 470 \text{ Ft. Lbs.} \]
Use 4" thick walk. As = 0.28 Sq. in.
Use 1/2" φ Bars 9" Centers, Ends well hooked into wall.
For temperature steel use 2 - 1/2" φ Bars.
Design Of Inlet Flume For Imhoff Tanks.

Weight of outside lip = 75# per ft. concentrated 22" from support.

Weight of bottom of flume = 275# per ft. with a Moment arm of 11"

Weight of water in flume = 140# per ft. with a Moment arm of 9"

Moment for concentrated load = \( \frac{W \cdot l^2}{2} \)

\[ M = \frac{75 \cdot 1^2}{2} = 37.5 \text{ Ft. Lbs.} \]

Moment for uniform load = \( \frac{W \cdot l^2}{2} \)

\[ M = \frac{275 \cdot 11^2}{2} = 1612.5 \text{ Ft. Lbs.} \]

\[ M = \frac{140 \cdot 9^2}{2} = 637.5 \text{ Ft. Lbs.} \]

Total Moment = 37.5 + 1612.5 + 637.5 = 392 Ft.Lbs. \( As = 0.18 \)

For lip of flume use 4" wall with 1/2" φ Bars 10" C'ts.
For bottom of flume use 6" slab reinforced with 1/2" φ Bars 10" Centers.
For temperature steel use 3 - 1/2" φ Bars, lengthwise.

Design Of Baffle Walls Of Imhoff Tanks.

Walls are designed to be self supporting (Carry no load other than their own weight.) Wall 4" thick and 5'-0" high reinforced with 1/2" φ Bars 16" C'ts. (Horizontal) and 1/2" φ Bars 30" Centers (Vertical).

All four baffle walls are the same.
Design Of Reinforcing For Dosing Tank.

Design of Top Slab.
Load, including slab = 150# per ft. Span = 9 Ft.
\[ M = \frac{W \cdot L^2}{8} = \frac{150 \cdot 9^2}{8} = 1,520 \text{ Ft. Lbs.} \]
Use 6" Slab. \( A_s = 0.37 \text{ Sq. in.} \)
Use 1/2" \( \phi \) Bars 6" Centers.
Use 1/2" \( \phi \) Bars 18" Centers.

Design Of End Wall And Bottom.
Section #1
\[ p = \frac{W \cdot h}{62.5} = 62.5 \times 3.75 = 235# \text{ per foot.} \]
\[ \text{Span} = 9' - 0" \]
\[ M = \frac{W \cdot L^2}{8} = \frac{235 \cdot 9^2}{8} = 2,380 \text{ Ft. #} \]
Use 8" Net Wall. \( A_s = 0.46 \text{ Sq. in.} \)
Use 5/8" \( \phi \) Bars 8" C'ts. (Horiz)
Use 1/2" \( \phi \) Bars 24" C'ts. (Vert)

Section #2
\[ p = \frac{W \cdot h}{62.5} = 62.5 \times 5 = 500# \text{ per ft.} \]
\[ \text{Span} = 9 \text{ Ft.} \]
\[ M = \frac{W \cdot L^2}{8} = \frac{500 \cdot 9^2}{8} = 5,062 \text{ Ft. #} \]
Use 8" Net Wall. \( A_s = 0.74 \text{ Sq. in.} \)
Use 5/8" \( \phi \) Bars 5" C'ts. (Horiz)
Use 1/2" \( \phi \) Bars 24" C'ts. (Vert)

Section #3
\[ p = \frac{W \cdot h}{62.5} = 62.5 \times 8 = 500# \text{ per ft.} \]
Weight of slab = 125# per foot.
Total Load = 625# Span = 9 Ft.
\[ M = \frac{W \cdot L^2}{8} = \frac{625 \cdot 9^2}{8} = 6,330 \text{ Ft. #} \]
Use 8" Net Slab. \( A_s = 0.72 \)
Use 3/4" \( \phi \) Bars 7" C'ts.

Section #4
\[ p = \frac{W \cdot h}{62.5} = 62.5 \times 7 = 435# \]
Weight of slab = 125# per ft.
Total Load = 563# per ft.
\[ \text{Span} = 9 \text{ Feet.} \]
Section #4 Continued.

\[ M = \frac{W \cdot l^2}{8} = \frac{563 \cdot 9^2}{8} = 5,710 \text{ Ft. Lbs.} \]

Use 8" Net Slab. \( A_s = 0.68 \) Sq. in.
Use 3/4" φ Bars 8" Centers.

Section #5

\[ p = W \cdot h = 62.5 \times 5 = 313\# \quad \text{Weight of slab = 125#} \]
Total Load = \( \frac{438#}{\text{per ft.}} \) \quad \text{Span = 9 Ft.}

\[ M = \frac{W \cdot l^2}{8} = \frac{438 \times 9^2}{8} = 4,440 \text{ Ft. Lbs.} \]

Use 8" Net Slab. \( A_s = 0.60 \) Sq. in.
Use 5/8" φ Bars 6" Centers.

Section #6

\[ p = W \cdot h = 62.5 \times 3 = 188\# \quad \text{Weight of slab = 125#} \]
Total Load = 313# per ft. \quad \text{Span = 9 Ft.}

\[ M = \frac{W \cdot l^2}{8} = \frac{313 \times 9^2}{8} = 3,170 \text{ Ft. Lbs.} \]

Use 8" Net Slab. \( A_s = 0.50 \) Sq. in.
Use 5/8" φ Bars 7" Centers.

Temperature steel for Sections #3, #4, #5, and #6
Use 1/2" φ Bars 24" C’ts.

Design Of South Side Of Dosing Tank.

\[ p = W \cdot h = 62.5 \times 8 = 500\# \text{ per ft.} \quad \text{Span = 8 Ft.} \]
Load uniformly increasing from 0# to 500# per ft.
\[ M = 0.0642 \cdot \frac{W \cdot l^2}{8} = 0.0642 \times 500 \times 8^2 = 2,054 \text{ Ft.Lbs.} \]
Use 7" Net Wall. \( A_s = 0.42 \) Sq. in.
Use 1/2" φ Bars 6" Centers (Vertical)
Use 1/2" φ Bars 24" Centers (Horizontal)

Design Of Reinforcing For Portion Of Slab Over Outlet Weir In Imhoff Tank Discharge Flume.
Load including slab = 150# per ft. \quad \text{Span = 9 Ft.}
\[ R_1 = R_2 = \frac{150 \cdot 9}{2} = 675\# \text{ per ft. Load on end of slab.} \]
Span across Weir = 3'-6"

\[ M = \frac{W \cdot l^2}{8} = \frac{675 \times 3.5^2}{8} = 1,030 \text{ Ft. Lbs.} \]
Design of Slab Over Discharge Flume Con'ted.

Use 6" Slab. As = 0.30 Sq. in.

Use 2 - 1/2" φ Bars.

*****************************************************************

Design of Short Flume At End Of Dosing Tank.
For outside lip use 6" Wall reinforced with 1/2" φ Bars 12" Centers (Vertical) and 1 - 1/2" φ Bar (Horiz)
For top and bottom use 6" slab reinforced with 1/2" φ Bars 6" Centers, hooked into Imhoff Tank Wall, and 2 - 1/2" φ Bars for temperature Steel.

*****************************************************************

Design Of Final Settling Basin.

Loading for Top Beams.

External pressure due to earth = .2948 W.h.
p = .2948 x 100 x 15.5 = 457# at bottom.
p = .2948 x 100 x 2.5 = 73# at beam.

R2 for uniformly increasing load = \( \frac{w}{3} \cdot \frac{1}{2} \)

R2 = \( \frac{73 \times 2.5}{3} \) = 61# per ft.

R1 for uniform load = \( \frac{w}{2} \) = \( \frac{73 \times 12}{2} \) = 438#

R1 for uniformly increasing load = \( \frac{w}{6} \)

\( R1 = \frac{384 \times 12}{6} \) = 768# per ft.

Total external pressure = 61 + 438 + 768 = 1268#

*****************************************************************

Design Of End Beams.

Load = 1,267# per ft. Span = 9'-0"

\( M = \frac{w \cdot l^2}{8} \) = \( \frac{1,267 \cdot 9^2}{8} \) = 12,828 Ft.Lbs.

Use 11" Net Beam. As = 0.95 Sq.in.

Use 3 - 5/8" φ Bars.

\( V = \frac{w}{2} \) = \( \frac{1,267 \times 9}{2} \) = 5,700# Shear.

\( v = \frac{V}{b \cdot d} \) = \( \frac{5,700}{12 \times 11} \) = 43# per ft. Unit Shear.

No Stirrups Required.

There are four beams thus. (Two in each end).
Design Of Side Beams.

Load = 1,267# per ft. \hspace{1cm} \text{Span} = 15'-6''

\[ M = \frac{Wl^2}{8} = \frac{1,267 \times 15.5^2}{8} = 38,000 \text{ Ft.Lbs.} \]

Use 14'' Net Wall. \hspace{1cm} \text{As} = 1.71 \text{ Sq.in.}

Use 4 - 3/4'' \( \phi \) Bars.

\[ V = \frac{W}{2} = \frac{1,267 \times 15.5}{2} = 4,593# \text{ Shear.} \]

\[ V = \frac{V}{b \cdot d} = \frac{4,593}{12 \times 14} = 27# \text{ per ft. Unit Shear.} \]

No Stirrups Required.

There are two beams thus, (East Side of Basin)

For Side Beam next to Wet Wall, Reinforce both faces with 3 - 5/8'' \( \phi \) Bars.

Design Of Tie Beams Across Top.

Use a Beam 12'' Wide x 12'' Deep. \hspace{1cm} \text{Span} = 16'-0'' Beams carry no load other than their own weight.

Use 3 - 5/8'' \( \phi \) Bars. \hspace{1cm} \text{As} = .92 \text{ Sq.in.}

Design Of Main Beam Across Top.

Beam carries walk 3'-0'' Wide x 4'' thick = 150# per ft.
Live load on walk of 100# per sq. ft. = 300# per ft.
Estimated weight of beam = 250# per ft.

Total uniform load

Concentrated load at center (Tie Beams) = 2,400#

\[ \text{Span} = 21'-3'' \]

\[ M. \text{ for uniform load} = \frac{Wl^2}{8} = \frac{700 \times 21.25^2}{8} = 39,512 \]

\[ M. \text{ for concentrated load} = \frac{Wl}{4} = \frac{2,400 \times 21.25}{4} = 12,750 \]

Total Moment = 39,512 + 12,750 = 52,262 \text{ Ft. Lbs.}

Use 22'' Net Beam. \hspace{1cm} \text{As} = 2.04 \text{ Sq.in.}

Use 3 - 1'' \( \phi \) Bars.

\[ V = \frac{W}{2} = \frac{700 \times 21.25}{2} = 3,718# \text{ Shear.} \]

\[ V = \frac{W}{2} = \frac{2,400}{2} = 1,200# \text{ Shear.} \]
Main Top Beam - Continued.

Total Shear = 3,718 + 1,200 = 4,918# Shear.

\[
\frac{V}{b'd} = \frac{4,918}{12 \times \frac{22}{12}} = 18# \text{ Unit Shear.}
\]

No Stirrups Required.

Reinforce Wall with 1/2" \( \phi \) Bars 12" Centers and 4 - 1/2" \( \phi \) Temperature Bars.

*******************************

Design Of Curtain Wall (Same All Around)

Uniform load = 73# per ft. 
Span = 12 Ft.
Uniformly increasing load of 0# to 384#

\[
M = \frac{W \cdot l^2}{8} = \frac{73 \cdot 12^2}{8} = 1,314 \text{ Ft. Lbs.}
\]

Moment for uniformly increasing load = .0642 w. l\(^2\)
\[
M = .0642 \times 384 \times 12^2 = 3,550 \text{ Lbs.}
\]

Total Moment = 1,314 + 3,550 = 4,864 Ft. Lbs.

Use 6" Net Wall. 

As = 0.62 Sq. in.

Use 5/8" \( \phi \) Bars 6" Centers, (Vertical)

Use 1/2" \( \phi \) Bars 24" Centers, (Horizontal)

*******************************

For Wall next to Wet Well and Imhoff Tanks

Use 5/8" \( \phi \) Bars 6" Centers, (Vertical - Both Faces)

Use 1/2" \( \phi \) Bars 24" Centers, (Horiz. - Both Faces)

*******************************

For entire bottom of Settling Basin Use 1/2"

\( \phi \) Bars 8" Centers Both Ways.

*******************************
Design Of Retaining Wall Around Filter Bed.

Weight of earth = \(2 \times \frac{1}{4} \times 100 = 800\) #

Weight of stem = \(\frac{1}{4} \times 75 \times 150 = 450\) #

Weight of base = \(3.5 \times 75 \times 150 = 400\) #

Total weight = 1,650# per ft.

Taking Moments about Rl.

For earth \(M = 800 \times 1 = 800\) Ft. Lbs.

For stem \(M = 450 \times 2.375 = 1,068\) Ft. Lbs.

For base \(M = 400 \times 1.75 = 700\) Ft. Lbs.

Total Moment = 2,568 Ft. Lbs.

Center of gravity = \(\frac{\text{Total Moment}}{\text{Load}}\) = \(\frac{2,568}{1,650} = 1.5\) Ft. from Rl.

The horizontal pressure on wall = \(0.1474\) W. h. = \(0.1474 \times 100 \times 4^2 = 236\) # applied at a point 2'-8" from top of wall.

The tangent of the angle made by the vertical force and the resultant = \(\frac{236}{1,650} = .1430\)

Tangent \(0.1430 \times 16 = 2.28"\) say 2 1/4" from center of gravity to point where resultant intercepts top of base of the section. As the resultant falls within the middle third the section is "O.K." for stability.

******************************************************************************

"Reinforcing"

Taking the rear projection of base as a cantilever with a load of 400# per ft. \(M = \frac{w \times 1^2}{2} = \frac{400 \times 2^2}{2} = 800\) #

\(A_s = 0.25\) Sq. in. Use 1/2" \(\phi\) Bars 18" Centers.

Taking stem as a cantilever loaded with a concentrated load of 236# applied at a point 2/3 h. \(M = W (1 - a)\)

\[M = 236 \times (4.0 - 2.67) = 313\) Ft. Lbs.

\(A_s = 0.12\) Sq. in. Use 1/2" \(\phi\) Bars 24" Centers.

Use 1/2" \(\phi\) Bars 24" Centers for temperature steel.
Design Of Retaining Wall Around Sludge Bed.

Weight of earth = \( 2 \times 3.5 \times 100 = 700 \) #
Weight of stem = \( 3.5 \times 0.5 \times 150 = 262 \) #
Weight of base = \( 2.7 \times 0.5 \times 150 = 206 \) #

Total weight = \( 1,168 \) # per ft.

Taking moments about R1.

For earth \( M = 700 \times 1 = 700 \) Ft. Lbs.
For stem \( M = 262 \times 2.3 = 590 \) Ft. Lbs.
For base \( M = 206 \times 1.4 = 284 \) Ft. Lbs.

Total Moment = \( 1,574 \) Ft. Lbs.

Center of gravity = \( \frac{\text{Total Moment}}{\text{Load}} = \frac{1,574}{1,168} = 1.35 \) Ft. from R1.

The horizontal pressure on a surcharged wall = \( 3517 \) W. h. \( ^2 \) = \( 3517 \times 100 \times 3.5^2 = 430 \) # applied at a point \( 2.4'' \) from top of wall.

The tangent of the angle made by the vertical force and the resultant = \( \frac{430}{1,168} = 0.3679 \)

Tangent \( 0.3679 \times 20 = 7.36'' \) say \( 7\frac{3}{8}'' \) from center of gravity to point where resultant intersects bottom of base of section. As the resultant falls within the middle third the wall is "O.K." for stability.

******************************************************************************

"Reinforcing"

Taking the rear projection of base as a cantilever with a load of \( 350 \) # per ft. \( M = \frac{W \cdot 1^2}{2} = \frac{350 \times 2^2}{2} = 700 \) Ft. Lbs.

As = 0.25 Sq. in. Use 1/2" # Bars 10" Centers.

Taking stem as a cantilever loaded with a concentrated load of \( 430 \) # applied at a point 2/3 h. \( M = W \left( 1 - a \right) \)

\[ M = 430 \times (4.0 - 2.33) = 500 \text{Ft. Lbs.} \]

As = 0.21 Sq. in. Use 1/2" # Bars 12" Centers.

Use 1/2" # Bars 24" Centers for temperature Steel.
Design Of Stairs To Motor Room and Imhoff Tanks.
Live load on stairs = 100# per ft. Long Span = 7'-0"
Weight of stairs (Taken as a 9" slab) = 113#
Total load = 100 + 113 = 213# per foot.

\[ M = \frac{W}{2} = \frac{213 \times 7^2}{2} = 1,300 \text{ Ft. Lbs.} \]

As = 0.32 Sq. in. Use a 6" Slab (Without steps)
Use 1/2" ø Bars 6" Centers.
For Temperature Steel use 1/2" ø Bars 12" C'ts.

Design Of Middle Beams Carrying Stairs.
Both beams are designed and reinforced the same.
Reaction on left side, (Lower side of Beam) =

\[ R_1 = \frac{W}{2} = \frac{213 \times 6}{2} = 639\# \text{ per foot.} \]

Reaction on right side, (Upper side of Beam) =

\[ R_2 = \frac{W}{2} = \frac{213 \times 7}{2} = 745\# \text{ per ft.} \]

Weight of beam = 150# per ft.
Total load on beam = 1,534# per ft. Span = 3'-0"

\[ M = \frac{W}{2} = \frac{1,534 \times 3}{2} = 2,300 \text{ Ft. Lbs.} \]

Use 8" Wide x 12" Deep Beam. As = 0.44 Sq. in.
Use 3 - 1/2" ø Bars.

Design Of Top Stair Beam, Carrying Stairs.

\[ R_1 \text{ from Stairs} = \frac{W}{2} = \frac{213 \times 6}{2} = 639\# \text{ per ft.} \]

\[ R_2 \text{ from Landing} = \frac{W}{2} = \frac{150 \times 3}{2} = 225\# \text{ per ft.} \]

Weight of Beam = 150# per ft.
Total load on beam = 1,014# per ft. Span = 3'-0"

\[ M = \frac{W}{2} = \frac{1,014 \times 3}{2} = 1,521 \text{ Ft. Lbs.} \]

Use 8" Wide x 12" Deep Beam. As = 0.35 Sq. in.
Use 3 - 5/8" ø Bars in Top.
Use 2 - 1/2" ø Bars in Bottom.

For Reinforcing for Stair Landing, Use 1/2" ø Bars
6" Centers both ways.
CHAPTER XI.

INSTRUCTIONS TO BIDDERS

PROPOSAL BLANKS

CONTRACT AND SPECIFICATIONS

FOR

SEWAGE DISPOSAL PLANT

AT

INDEPENDENCE, KANSAS.
INSTRUCTIONS TO BIDDERS.

1. All bids must be made upon forms to be obtained at the office of the City Engineer, and enclosed in a sealed envelope, directed to the City Clerk, Independence, Kansas and endorsed on the outside "Proposal for the construction of a sewage disposal plant at Independence, Kansas."

2. Each bid must be accompanied by cash or a certified check in the sum of five percent (5%) of the total bid, made payable to the City Treasurer, Independence, Kansas, as a guaranty that the contractor will enter into a contract with the city of Independence, Kansas, within fifteen days after being awarded the contract.

3. The proposal must state the lump sum for which the contract will be completed according to the plans and specifications and also the unit price for all classes of work embraced in the contract. All prices must be stated plainly in words and figures.

4. The place of residence of the bidder must be given after his signature. When firms bid, the individual names of the members shall be signed in full and the firm name added.

5. The name of the contractor must be filled in the blank left for that purpose.

6. The City of Independence reserves the right to reject any and all bids or to waive any irregularity if the City will be benefitted thereby.

7. Bidders are requested to be present at the opening of the bids.

8. Bidders must satisfy themselves, by personal examination of the location of the proposed work and by such other means as they may prefer, as to the accuracy of the estimated quantities and shall not at any time after the submission of a bid, dispute or complain of such statement or estimate of the Engineer, nor assert that there was any misunderstanding in regard to the nature or amount of the work.

9. The successful bidder will be required to furnish a good and sufficient "Corporation Bond" in the amount of the contract conditioned upon the faithful performance of the contract and to protect the City against any and all
liens for labor and materials also a Corporation Bond in
the sum of Ten thousand dollars ($10,000) to indemnify the
city against any or all loss to person or property arising
or growing out of the construction of said Disposal Plant.

PROPOSAL

To The Honorable Mayor and Commissioners,
Independence, Kansas.

Gentlemen:— The undersigned hereby proposes to furnish all
materials, and do all work required to complete such amount
of the work herein described as shall be awarded by the
City of Independence, Kansas, in a first class manner, in
accordance with the specifications hereto annexed and the
plans and drawings of the same as are on file in the office
of the City Engineer, at the following prices, to-wit:

For furnishing all labor and material, doing all excavating
and placing same in levee around site of disposal works,
constructing control manhole and six drainage manholes
shown on General plan, pump pit and housing and installing
pumps, motors and equipment, constructing Imhoff tank in-
cluding the furnishing of all piping and installation of
same as shown on plans, dosing tank including the siphon,
by-pass valve and Cast Iron By-Pass sewer as shown on plans,
Sprinkling filter including the furnishing of all material
and doing all work connected with installation of walls,
distributinn system, underdrain system and filtering mater-
ial, all labor and material necessary to construction of
the sewers connecting different parts of plant, final set-
tting basin including all piping as shown on plans, sludge
bed, including underdrain system, filtering material and
wood trough distribution system, the City of Independence
to furnish the pumps, motors, shafts connecting the same
and electrical control apparatus the same to be installed
and put in working condition by the undersigned for the
lump sum of

<table>
<thead>
<tr>
<th>Price in Words</th>
<th>Price in Figures</th>
</tr>
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<tbody>
<tr>
<td>$--------------</td>
<td>-----------------</td>
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</tbody>
</table>

In case of any extra work not shown on plans the following
unit price will be charged.

Excavation of earth placed in embankment or wasted not
over 500 feet from point of excavation $ per c. y.
Rock Excavation per cu. yd.

Reinforced Concrete with out
the steel but including all
form work necessary to same per cu. yd.

Reinforcing Steel, cut, bent
and put in place per pound

Trenching and Backfilling for
sewers for drainage
0 to 5 feet deep per lin. ft.
5 to 7 feet deep per lin. ft.
7 to 10 feet deep per lin. ft.

1-1/4" Iron Pipe Handrail
as shown on plans, in place
and given one coat of metal
paint per lin. ft.

Plaster on metal lath in-
cluding metal lath per sq. yd.

Painting with lead and oil per square.

10" V.S.P. laid per lin. ft.
12" V.S.P. laid per lin. ft.
18" V.S.P. laid per lin. ft.

6" C.I.P. in place in
distribution system of
sprinkling filters per lin. ft.

8" ditto per lin. ft.
10" ditto per lin. ft.
12" ditto per lin. ft.
14" ditto per lin. ft.
18" ditto per lin ft.

4" W.I. Lateral distribution
system per lin. ft.
<table>
<thead>
<tr>
<th>Item Description</th>
<th>Unit Price</th>
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</thead>
<tbody>
<tr>
<td>3&quot; W. I. Riser Pipes</td>
<td>per lin. ft.</td>
</tr>
<tr>
<td>4&quot;x4&quot;x3&quot; C.I. Screw Tees</td>
<td>each</td>
</tr>
<tr>
<td>4&quot; C. I. Plugs</td>
<td>each</td>
</tr>
<tr>
<td>6&quot; Hub and L.W. Gate Valves</td>
<td>each</td>
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<tr>
<td>8&quot; ditto</td>
<td>each</td>
</tr>
<tr>
<td>12&quot; ditto</td>
<td>each</td>
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<tr>
<td>18&quot; ditto</td>
<td>each</td>
</tr>
<tr>
<td>6&quot; L.W. Gate Valves Flanged &amp; Drilled</td>
<td>each</td>
</tr>
<tr>
<td>8&quot; ditto</td>
<td>each</td>
</tr>
<tr>
<td>10&quot; ditto</td>
<td>each</td>
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<tr>
<td>8&quot; Swing check Valve F.&amp; D.</td>
<td>each</td>
</tr>
<tr>
<td>10&quot; ditto</td>
<td>each</td>
</tr>
<tr>
<td>10&quot; W.I. Pipe in Pump Chamber</td>
<td>per lin. Ft.</td>
</tr>
<tr>
<td>8&quot; ditto</td>
<td>per lin. ft.</td>
</tr>
<tr>
<td>6&quot; ditto</td>
<td>per lin. ft.</td>
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<tr>
<td>8&quot;x8&quot;x10&quot; Tee F&amp;D</td>
<td>each</td>
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<tr>
<td>10&quot;x10&quot;x12&quot; Tee F.&amp;D.</td>
<td>each</td>
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<tr>
<td>6&quot; Base Ell F.&amp;D.</td>
<td>each</td>
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<tr>
<td>10&quot; Base Ell F.&amp;D.</td>
<td>each</td>
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<tr>
<td>6&quot; to 8&quot; Reducer F.&amp;D.</td>
<td>each</td>
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<tr>
<td>8&quot; Base Ell F.&amp;D.</td>
<td>each</td>
</tr>
<tr>
<td>6&quot; Plain Ell F.&amp;D.</td>
<td>each</td>
</tr>
<tr>
<td>Cast Iron Fittings, Crosses, Tees, Bends etc</td>
<td>per pound</td>
</tr>
<tr>
<td>Sewage Screen in wet well</td>
<td>each</td>
</tr>
</tbody>
</table>
3"X2" C.I. Reducers each
Full spray nozzles each
Half spray nozzles each
Counting Device for dosing tank each

The undersigned hereby agrees to enter into a contract within fifteen days from the date of your acceptance of this proposal, to finish and complete the said work by the day of , 192.

In default of the performance of any of the conditions on part to be performed, the aforesaid certified check in the sum of dollars and cents, which have this day deposited with the City Clerk, shall at the option of the City Commissioners, be absolutely forfeited to the City of Independence, otherwise the said certified check shall be returned to when the contract is signed, accepted, and the bonds made as by law provided.

Dated at Independence, Kansas, this day of , A. D. 192.
ARTICLES OF AGREEMENT

Between the City of Independence, Kansas, party of the first part, and ______________________________ contractor, party of the second part.

This agreement, made and entered into this ______ day of ________ in the year of One Thousand Nineteen Hundred and ________(192__) by and between the City of Independence, Kansas, of the first part and ______________________________ Contractor, of the second part, Witnesseth: Whereas, the City of Independence, Kansas, by virtue of the authority vested in the City Commissioners by the Legislature of the State of Kansas, governing cities of the second class, and by ordinance of the city, agree to let unto said ______________________________ Contractor, the work of constructing a Sewage disposal plant, as per plans, profiles and specifications on file in the office of the City Clerk. Now, therefore, in consideration of the payments and covenants hereinafter mentioned, to be made and performed by said party of the first part, the said ______________________________ Contractor, party of the second part, hereby covenants and agrees to do the work mentioned, in a substantial and workmanlike manner in conformity with the plans, profiles and specifications
of said work on file, and to conform with the stakes given by the Engineer or his duly authorized assistants, and in accordance with the specifications hereto annexed.

GENERAL STIPULATIONS.

Art. 1. The Contractor shall commence the work as soon after the approval of this contract by the Board of Commissioners as the Engineer may direct and shall fully complete the contract within ___ working days after such notification. And it is mutually agreed that for each and every day any portion of the work remains unfinished after the day herein fixed for its completion, the City shall deduct and retain out of the money which may be due or become due said contractor, under this agreement, the sum of Ten dollars ($10) which said sum is, in view of the difficulties of estimated such damages, hereby agreed and fixed and determined by the parties hereto as liquidated damages that the said city will suffer by reason of the failure of the contractor to complete the work within the time agreed upon, and such daily forfeiture shall apply to each portion of the said work after the date herein agreed upon for its completion.

Art. 2. The Contractor shall commence the work herein contracted to be done within ___ days from the date of this contract, and the rate of progress of his work shall be such as, in the opinion of the Engineer, is necessary for completion within the time herein specified and shall so conduct the said work that on or before ___ 192 ___, the whole work shall be entirely complete.

Art. 3. At all times when work is in progress, there shall be a foreman or head workman on the ground and also copies of plans and specifications. Instructions given to such foreman or head workman shall be considered as having been given to the contractor. The Contractor shall employ only competent, skillful men to do the work, and whenever the Engineer shall inform said Contractor, in writing, that any man on the work is, in his opinion, incompetent or unfaithful or disorderly, such man shall be discharged from the work, and shall not again be employed on it.

Art. 4. The Contractor is to use such methods and appliances for the performance of all the operations con-
nected with the work embraced under this contract as will
secure satisfactory quality of work and a rate of pro-
gress which in the opinion of the Engineer will secure the
completion of the work within the time herein specified.

Art. 5. Whenever the contract, in the opinion of the
Engineer and Commissioners shall be completely performed
on the part of the contractor, the city shall proceed
with all reasonable diligence to make payment for the same.

Art. 6. Payments will be made as by law provided, in
bonds or in cash, as soon after the completion of the work
and acceptance of same as bonds can be legally issued there
for. Bonds to bear percent interest per annum from date
of issue.

Art. 7. All work under this contract shall be done to
the satisfaction of the Engineer, who shall determine all
questions respecting the true construction of or meaning
of the plans and specifications, and his determination
thereon shall be final and conclusive.

Art. 8. It is further agreed, if evidence is produced
before final settlement of the balance, that the said con-
tactor has failed to pay his laborers employed on the
work, or for materials used therein, the city of Independ-
ence may withhold such balance until they are satisfied
that all such claims for labor and material have been paid.

Art. 9. The contractor shall not be entitled to any
claims for damages for any hindrance or delay from any
cause whatever in the progress of the work or any portion
thereof, but said hindrance may entitle said contractor
to such extension of time for completing the contract as
may be determined by the Engineer, provided he shall have
given notice in writing to the cause of the detention.

Art. 10. All loss or damage arising out of the nature
of the work to be done or from any detention or other un-
foreseen obstruction, or difficulties which may be encoun-
tered in the prosecution of the work, or from the action of
the elements, shall be borne by the contractor.

Art. 11. The contractor will be held responsible for
any and all materials, or work to the full extent or pay-
ments made thereon, and they will be required to make good
at their own expense, any injury or damage which said mater-
ials or work may sustain from any source or cause what-
soever, before final acceptance thereof.
Art. 12. The contractor shall put up and maintain such barriers and red lights as will effectually prevent any accident in any manner resulting from or caused by the prosecution of the work herein provided for, and he shall be liable for all damages occasioned in any way by his acts or neglect, or that of his agents, employees or workmen.

Art. 13. Said contractor further agrees he will give personal attention constantly to the faithful prosecution of the work, and will not assign or sublet the work or any part thereof, except for furnishing materials or any of the moneys or orders payable under this contract without the previous written consent of the Board of Commissioners, of said city endorsed on this contract, but will keep the same under his personal control; that no right under this contract, nor any moneys or orders due or to become due hereunder shall be asserted against said city, or any department, officer, or officers thereof, by reason of any so called assignment, in law or equity, of this contract or any part thereof or of any moneys or orders payable thereunder, unless such assignment shall have been authorized by the written consent of the Mayor and Commissioners indorsed on this contract; that no person other than said contractor now has any claim thereunder, and that no claim shall be made excepting under the specific clause of this contract.

Art. 14. The contractor further agrees that if the work to be done under this contract shall be abandoned, or if this contract shall be sublet or assigned by said contractor or any of the moneys or orders payable thereunder shall be assigned, otherwise than as herein provided, or if at any time said Engineer shall be of the opinion and shall so certify in writing to said Board of Commissioners that the said work is unnecessarily or unreasonably delayed, or that said contractor is willfully violating any of the terms, covenants and agreements of this contract, or is not executing this contract in good faith, or is not making such progress in the execution of said work as to indicate its completion within the required time, the city shall have the power and right to notify said contractor to discontinue all work or any part thereof under this contract, and upon such notification said contractor shall discontinue all work or such parts thereof as the city may designate; and the city shall thereupon have the power to employ by contract, or otherwise, and in such manner and at such prices as it may determine, such labor, appliances, tools, implements and material which it may deem necessary to complete the work herein described and deduct the expense for the same from the moneys that may be due or be-
come due the contractor, or the city may annul this contract and relet the work or any part thereof, not shall affect the right of the city to recover damages which may arise from such abandonment, neglect or failure.

Art. 15. Suitable privy conveniences shall be erected as directed by the Engineer, for the use of the workmen, and their use be made obligatory. The committing of nuisance is prohibited on all parts of the premises.

Art. 16. The contractor shall obey and conform to all ordinances of the city now in force, or that may be in force during the progress of such work.

Art. 17. All surplus materials shall be stored in such a manner that they will not deteriorate and all earth rubbish and stones shall be removed from the site as the work progresses. After the completion of the work no surplus material of any kind shall be left on or near the site.

Art. 18. Defective work and material may be condemned by the Engineer at any time before the final acceptance of the work, and when such work has been condemned it shall be immediately taken down by the contractor, and rebuilt in accordance with the plans and specifications. When defective material has been condemned, it shall be at once removed from the site of the work and stored as directed by the Engineer or otherwise disposed of to his satisfaction. In case the contractor shall neglect or refuse to remove or replace any rejected work or material after a written notice, within the time designated by the Engineer, such work or material shall be removed or replaced by the Engineer at the contractor's expense.

Art. 19. The contractor is required, so far as possible to arrange his work and to dispose of his materials as will not interfere with the work or storage of materials of other contractors engaged upon the work. He is also required to join work to that of theirs in a proper manner, and in accordance with the spirit of the plans and specifications, and to perform his work in the proper sequence in relation to that of other contractors, and as may be directed by the Engineer.

Art. 20. The contractor shall make suitable and adequate provision for the safe and free passage of persons and vehicles along the road on the east while the work is in progress. Such provision to be made to the satisfaction of the Engineer.
Art. 21. No claim for extra work shall be allowed, unless such extra work shall have been previously ordered by the City Engineer, in writing. The claims for extra work, when so ordered, shall be presented to the Commissioners on or before settlement is made on the contract, and said order must accompany said claims for extras. If extra work ordered by the Engineer is of a class for which no price is provided in this contract, then the price for same shall be the actual cost of the work plus ten per cent.

Art. 22. Whenever the word "Engineer" is used herein, it shall be and is mutually understood to refer to the Engineer in charge of the work and to his properly authorized assistants, limited by the particular duties entrusted to them. Whenever the word "Contractor" is used herein, it shall be and is mutually understood to refer to the party or parties contracting to perform the work to be done under this contract, or the legal representatives of such party or parties contracting to perform said work.

Art. 23. It is understood by the contracting parties that the following documents are essential portions of the complete contract:

The advertisement; the instruction to bidders; the proposal; all drawings, maps, and plans hereto attached or herein described; the specifications; the specific contract and the contractor's bond.

The plans accompanying these specifications and made a part thereof are as follows:

Sheet No. 1. General Layout and surface drainage.
Sheet No. 2. Control Manhole.
Sheet No. 3. Pumping Equipment & Screen Details.
Sheet No. 4. Imhoff Tank and details.
Sheet No. 5. Dosing Tank and details.
Sheet No. 6. Sprinkling Filter and details.
Sheet No. 7. Final settling basin & stairway.
Sheet No. 8. Sludge Bed.
Sheet No. 9. Details of Beams.

The Engineer at his discretion, furnish additional plans to which the contractor will be required to conform.

Art. 24. If the contractor should be unavoidably delayed because of weather or other conditions over which the contractor has no control, this contract may be extended for the number of working days equal to the number of working days he has been thus unavoidably delayed.

Art. 25. For the purpose of this contract, the term
"working day" as used herein, is intended to and shall mean any legal working day in which the contractor may perform eight hours labor.

Art. 26. Said contractor hereby admits that he has read each and every clause in this contract, and fully understands the meaning of the same, and hereby agrees that he will comply with all the terms, covenants and agreements herein set forth.

IN WITNESS WHEREOF, the city of Independence, Kansas, has caused these presents to be signed by its mayor, and attested by its clerk, with the seal of said City affixed;

and said second party

by

this day of , 1923.

Attest

City Clerk Mayor.

Contractor

By
Specifications.

1. The Sewer disposal plan consists of a control manhole, Sewage screen, Pump pit, Pumps, Housing, Imhoff and dosing tanks, Sprinkling Filter with complete Distribution and underdrain system and filter material, settling tank, sludge bed and all auxiliary equipment connected with same; earth and rock excavation, embankment around the site of the plant, and connecting sewers shown on plan of general lay out sheet No.1, and all built according to the plans and specifications.

2. The sewage will flow by gravity from the control Manhole to the screen, through the screen to the pump pit and will then be pumped by float controlled centrifugal pumps to the Imhoff tanks. From the Imhoff tank the sewage will flow by gravity to the dosing tank from where it will be dosed intermittently by a siphon to the sprinkling filter through the distribution system. Passing downward through the sprinkling filter it will be collected by the underdrain system into gutters from which it will flow to a flume and thence to a final settling basin. From the final settling basin it will pass back through the control manhole to the outfall sewer and from thence to the creek.

3. Cement. All cement used in the work shall be high grade Portland Cement of well established and approved brands and shall pass the latest specifications of the American Society for Testing Materials, for Portland Cement.

4. Sand. The sand shall be clean, free from dirt, loam, mica, and organic matter, and shall contain not more than 5% by volume of clay, and no clay shall be artificially added.

5. Stone. The stone used in the concrete work shall be hard, sound and durable and shall not contain loam, clay, organic matter, objectionable quantities of dust or other improper material. Stone shall be the run of the crusher that will pass through an screen with circular openings of 1 1/2 inches in diameter and be retained on a screen with circular openings of 3/4 inch in diameter.

6. Brick. All brick used shall be sound and hard burned throughout and of uniform size and quality. Brick that are known as No.2 pavers will be allowed in all brick work shown on the plans.
7. Cement Mortar. All cement mortar for brick work shall be in the proportions of one part cement to two parts sand by volume. Lime may be used to temper the mortar in brick work above the ground only and then not in excess of 5 percent by volume of the cement used.

8. Reinforcing steel. All steel used for reinforcing shall be made by the open-hearth or bessemer process and shall be of such shape as to afford an approved mechanical bond with the concrete and shall conform to the latest revised specifications of the American Society for Testing Materials.

9. All concrete used in the different parts of the Disposal Plant shall be made of one part cement, two parts of sand and four parts of broken stone by volume.

10. Measuring Ingredients. For the purpose of determining the proportions of the materials for concrete, each bag of cement shall be considered as containing one cubic foot and other ingredients shall be measured by an approved method.

11. Water. Only clean fresh water shall be used for concrete.

12. Mixing. Concrete shall be mixed in approved mechanical batch mixers, so constructed and operated that the ingredients of the concrete may be accurately measured and will be thoroughly mixed. Mixing time for each batch shall not be less than one minute. Enough water shall be added during the mixing to bring the concrete to the required consistency which will be that consistency produced by six and one half gallons of water to each sack of cement when the aggregates are perfectly dry.

13. Placing Concrete. Concrete shall be mixed only in such quantities as is required for the work in hand, and any that has sufficiently set to require retempering shall not be used. The concrete shall be so deposited in the work so as to prevent the separation of the stone from the mortar. It shall be deposited in as nearly a continuous operation as practicable, and shall be worked, tamped, spaded or rammed with suitable tools to produce a dense and compact mass. When the operation of placing the concrete is interrupted, the concrete in work shall, if required, be confined by suitable temporary form or bulkheads. When concrete is to surround reinforcing rods, it shall be so deposited as to work closely around such material. The concrete shall be so placed in the forms that the top may be
kept approximately level so that the concrete will not run from one part of the form to another and thus deposit leas from all in one place.

14. Joining Old and New Concrete. When fresh concrete is to be laid on or adjoining concrete that has already set, the surface of the latter shall be thoroughly cleaned washed and roughened, and coated with a grout of neat cement before the fresh concrete is deposited. At any construction joint, either vertical or horizontal, provision is to be made to make a groove not less than 2" x 4" in the joint to assist in making it water tight.

15. No Concrete shall be mixed or placed in the work when the temperature is below 32 degrees Fahr., and the contractor shall use every precaution possible to prevent finished concrete from freezing, before it has thoroughly set.

16. Forms. The contractor shall provide all necessary forms for shaping concrete. They shall be true to the required shapes and sizes, strong enough and so secured in place as to withstand all operations incidental to placing the concrete, and watertight, and the faces against which the concrete is to be placed shall be smooth and clean.

When lumber is used in forms for exposed faces it shall be of seasoned stock and shall be coated with an approved lubricant.

17. Removal of Forms. Forms shall be left in place until the concrete has sufficiently set to permit their removal without danger to the structure and until so much of the backfilling or embankment as may be directed has been put in place. No forms or centers shall be struck until permission has been given to do so by the Engineer.

18. Exposed surfaces. Special care shall be used to secure smooth and uniform finish to the surfaces of the concrete which will be exposed in the completed structure. Immediately after the removal of the forms such surfaces if uneven shall be rubbed smooth to a uniform finish. All exposed edges shall be neatly rounded and inside corners shall be chamfered one inch. If any voids, projections be found, such defects shall at once be corrected tooling, cutting out and filling with mortar, or otherwise as directed.

19. Protection. Concrete shall be protected from the drying effects of the sun and wind by covering it with canvas, bagging, hay or other suitable materials.
20. All floors and the tops of walls shall have a top finish of 3/4" of 1 : 2 cement mortar troweled smooth.

21. Valves. All gate valves shall be Chapman Valves or their equal and shall be iron body, bronze mounted, double disc valves designed for light working pressures.

22. Piping. All piping in the Sprinkling Filter shall be Class A. Cast Iron Pipe, bell and spigot joints for all sizes from six to eighteen inch inclusive. The four inch laterals may be put in of wrought iron pipe of good quality and also the three inch risers to the nozzles. All piping in the pump house and pit must be good quality wrought iron or wrought steel pipe coupled with flange couplings.

23. Vitrified Pipe. All vitrified pipe used in connecting sewers, drainage sewers and underdrains in the sprinkling filters shall be of No.1 Standard grade and shall pass all specifications for sewer pipe of the American Society for Testing Materials.

24. Control Manhole. The control manhole shall be built of reinforced concrete as shown on plans. All iron work shall be given one coat of black asphalt metal paint after installation. All measurements of control apparatus is based upon Chapman Flap valves Fig. 487F of their No.38 catalog.

25. The pumps, motors and control apparatus will be furnished by the City of Independence, but will be installed by the contractor. The I-Beam supports for the shafting will be furnished by the contractor. All piping, check valves, gate valves, flanged fittings, concrete foundations for pumps and pipe supports will be furnished by the contractor.

The pump house will be built of a good quality of building brick or of No.2 paving brick. The top of the wall will be carried level and finished with 9 inch coping tile. At the proper height above the roof flashing blocks will be inserted in the wall. The roof is to be built of metal joists and hy-rib with two inches of concrete and topped with a four-ply composition roof. The underside of the metal lumber joists to be lathed with metal lath and plastered. The whole inside of the motor room to be given two coats of lead and oil. Metal window frames shall be furnished of the size shown on drawings. The doors shall be as shown, upper portion glazed and hung on three butt hinges. Doors shall be furnished with Yale or equivalent lock sets. Doors shall be given three coats of paint as directed by Engineer. Proper porcelain conduits shall be
placed in the wall and a three wire bracket shall be secured to the wall to hold the power lines entering the building.

26. The Imhoff tank shall consist of all concrete walls, reinforcing, walks, hand-rails, flumes, baffles, sludge pipes and weirs, as shown on plans. After erection, iron pipes-handrails shall be given one coat of black asphaltic metal paint.

27. The dosing tank shall be built as shown by plans.

28. The Distribution system for the sprinkling filters will consist of one 18" dosing siphon as shown on the plans, with the exception that it shall be provided with adjusting apparatus by which the high and low water levels in the dosing tank may be adjusted. The dosing tank is to be provided with a good float counter so that the dosings will be recorded. The piping for the distribution system shall be cast iron and wrought iron of a quality herefore specified and as shown on the plans. The nozzles shall be brass nozzles with spindles which lock in the nozzle with one quarter turn to facilitate cleaning. The nozzles shall have a 13\16 inch opening and shall discharge 23 gallons per minute under a head of 7 feet at the nozzle. Twelve of the 138 nozzles required shall be half spray nozzles. Nozzles shall be of a type that throw a circular spray.

29. The underdrain system of the sprinkling filters shall be made up of special half sewer pipe, ventilating risers at ends of gutters of 15 inch sewer pipe with hardware cloth cemented in the top bell, vitrified coping covers and gutters in the filter floor all as shown on the plans. All tile shall be laid with open joints.

30. The filtering material in the sprinkling filter shall be of crushed limestone of such a size that all of it will pass a 3 inch screen and be retained upon a 1 inch screen. In placing the filtering material the coarser rock shall be placed at the bottom around the under-drain pipe to a point 3 or four inches above the top of the under-drain. In all other parts of the filter the filtering material shall be placed that it will not be in stratified layers of the same size. Wheelbarrows used in hauling filtering material over parts of filter already filled shall be provided with plank runways. Great care shall be taken in placing filtering material about under-drain pipes and distribution system particularly the risers.
31. The final settling basin shall be built as shown on plans. The hopper bottom shall be trowled smooth to allow sludge to slip down sides. Sludge pipes shall be installed as shown with yarnded and leaded joints. The discharge end of the sludge pipe shall be furnished with a gate valve as shown with a hand wheel and stem extending above the trash floor in the pump pit.

32. The sludge bed shall be built as shown on plans. The ground around the top of the slope shall be so graded that the surface drainage will be carried to the catchbasin at the north east corner and will not flow into the bed.

The distribution system shall be built as shown on plans. The troughs shall be built of Yellow Pine or Cypress planed on the side next to the sludge. The tile in the under-drain system shall be No. 1 vitrified sewer pipe laid with open joints. The filtering material shall be the same as shown on plans.

34. Excavation. The site of the plant will be brought to the elevation 40.00 with the exception of around the combination manholes and catch basins which are to be set at the elevation of 39.50. The ground elevation at the south side of the sprinkling filter bed shall be brought to the elevation 40.50 at the center of the south side so that the surface drainage will be carried to the catch basins on the east and west sides. The whole site shall be graded smooth so that no water will stand in any part. The excavation shall be placed in the levee around the plant which will be carried up to the elevation shown plus 10 percent allowed for shrinkage. The levee shall have a top width of five feet on top and side slopes of 1 2 to 1. The ditch on the west side of the plant shall be excavated to drain the borrow pit along the Missouri Pacific Switch to the west. The ditch shall have a bottom width of 2 feet and run on a uniform grade from elevation 42.00 at the borrow pit to elevation 40 on the south side of the plant. No rock will be found under the area of the sprinkling filter. The highest rock found at the site of the Imhoff Tank and Final Settling basin was at the Elevation 29.50 as shown on the plans. Two or three of the boreings struck rock at two or three inches lower than this. The rock is limestone and is of suitable quality to be used in the sprinkling filter if thoroughly separated from the clay.
CHAPTER XI.
SPECIFICATIONS
FOR
SEWAGE PUMPS
FOR
SEWAGE DISPOSAL PLANT
AT
INDEPENDENCE, KANSAS.
INSTRUCTIONS TO BIDDERS
ON
PUMPING EQUIPMENT

1. All bids must be made upon forms to be obtained at
the office of the City Engineer, and enclosed in a sealed
envelope, directed to the City Clerk, Independence Kansas
and endorsed on the outside,"Proposal for the furnishing of
pumping equipment for Sewage disposal plant at Independence
Kansas.

2. Each bid must be accompanied by cash or certified
check in the sum of five percent (5%) of the total bid,
made payable to the City Treasurer, Independence Kansas, as
a guaranty that the bidder will enter into a contract with
the City of Independence, Kansas, within fifteen days after
being awarded the contract.

3. The proposal must state the lump sum for which the
equipment will be furnished according to the plans and spec-
ifications on file in the office of the City Clerk, Indepen-
dence, Kansas. All prices must be plainly stated in words
and figures.

4. The proposal must be accompanied by a statement of
the make or brand of each part of the material and equip-
ment to be furnished and a statement of the guaranteed over-
all efficiency of the pumps and motors.

5. The place of residence of the bidder must be given
after his signature. When firms bid the individual names
of the members shall be signed in full and the firm names
added. The name of the bidder shall be filled in the blank
left for that purpose.

6. The City of Independence, Kansas, reserves the
right to reject any or all bids or to waive any irregularity
if the city will be benefitted thereby.

7. Bidders are requested to be present at the opening
of the bids.

8. The successful bidder will be required to furnish
a good and sufficient "Corporation Bond" in the amount of
the contract running to the State of Kansas conditioned up-
on the faithful performance of the contract and the payment
of all bills for labor and material performed and furnished
under the contract, which might be a basis for liens. Also
a bond in the sum of one thousand dollars ($1000.00) indemni-
ifying the City against all debts, claims, demands or judge-
ments made, had, or obtained against said city in any manner resulting from or growing out of said furnishing of the pumping equipment provided for in this contract.

PROPOSAL

TO THE BOARD OF CITY COMMISSIONERS,
CITY OF INDEPENDENCE, KANSAS.

GENTLEMEN:

The undersigned hereby proposes to furnish to the City of Independence, Kansas, f.o.b. cars said city, all the pumps, motors, shafting, shaft couplings, bearings and all bearing supports except I-Beam supports for steady bearings, base plates for motors and pumps, brackets, float switches, switches, floats, float pipes, float rods, chains, pulleys and counterweights, self-starters, panels, pit-drain connections and everything connected with the pumping equipment except the suction and discharge piping and all valves and fittings connected therewith, according to the plans and specifications on file in the office of the City Clerk, for the lump sum of ($_______________.)

在上海 dollars and____ cents.

and hereby agrees to enter into a contract with the city within fifteen days from the date of your acceptance of this proposal, and to furnish detail plans of the installation of the equipment in the pump house within 30 days and to make shipment of all pumps, motors, and equipment within days from the date of the signing of this contract. In default of the performance of any of these conditions on part to be performed, the aforesaid certified check in the sum of dollars and____ cents($_______________.) which have this day deposited with the City Clerk, shall at the option of the City Commissioners, be absolutely forfeited to the City of Independence, Kansas, otherwise the said certified check shall be returned to____ when the contract is signed, accepted and the bonds made as by law provided.

Dated at Independence, Kansas this __________________ day of __________________ A.D. 1923

__________________________

__________________________

__________________________

__________________________

Contractor.
ARTICLES OF AGREEMENT.

Between the City of Independence, Kansas, party of the first part, and ____________________________

Contractor, party of the second part.

THIS AGREEMENT, made and entered into this ______ day of _____________________ A.D. 192 ______ by and between the City of Independence, Kansas, of the first part, and ____________________________

Contractor, of the second part, WITNESSETH: Whereas, the City of Independence, Kansas, by virtue of the authority vested in the City Commissioners by the Legislature of the State of Kansas, governing cities of the second class, and by ordinance of the city, agree to let unto said ____________________________

Contractor, the furnishing of all pumping equipment for the Sewage Disposal Plant to be built at said city as per plans and specifications on file in the office of the City Clerk.

Now, therefore, in consideration of the payments and covenants hereinafter mentioned, to be made and performed by said party of the first part, the said ____________________________

Contractor, party of the second part, hereby covenants and agrees to furnish the equipment mentioned, of first class quality and in conformity with the plans and specifications of said equipment.

GENERAL STIPULATIONS.

1. The contractor agrees to furnish within 30 days after being awarded the contract complete plans for the installation of his equipment.

2. The contractor guarantees that all materials used throughout in the construction of the pumps, motors, and equipment shall be of first quality, new and unused when shipped from the factory and that he will be responsible for and will pay the cost of all repairs or alterations due to accident or breakage on account of defective design material or workmanship, for one year after starting oper-
ations.

3. The duty of the pumps and motors shall not be less than that specified or guaranteed by the contractor.

4. A trial test of the duty and capacity of the pumps will be conducted by the city, in the presence of the engineer and with the assistance of the contractor or his representative within two (2) months after the pumps have been put in service.

5. The capacity of the pump will be computed from the time and rise in a tank of known volume.

6. Whenever this contract in the opinion of the Engineer and Commissioners shall be completely performed on the part of the contractor, the City shall proceed with all reasonable diligence to make payment for same.

7. Payment will be made as by law provided, in bonds or in cash, as soon after the completion of the contract and acceptance of same as bonds can be legally issued, therefore. Bonds to bear percent interest per annum from date of issue.

8. It is further agreed, if evidence is produced before final acceptance of the contract, that the said contractor has failed to pay his laborers employed on the work or for the materials used therein, the City of Independence Kansas, may withhold such moneys as may be due until they are satisfied that all such claims for labor and materials have been paid.

9. The contractor shall not be entitled to any claims for damages for any hindrance or delay from any cause whatever in the progress of the work or any portion thereof, but said hindrance may entitle said contractor to such extension of time for completing the contract as may be determined by the Engineer, provided he shall have given notice in writing to the cause of the detention.

10. The contractor further agrees that if the work to be done under this contract shall be abandoned, or the contract shall be assigned or sublet by the contractor, or any of the moneys or orders payable thereunder shall be assigned otherwise than as herein provided, or if at any time said Engineer shall be of the opinion and shall so certify in writing to said board of Commissioners that the said work is unnecessarily or unreasonably delayed, or that said contractor is wilfully violating any of its terms, covenants,
and agreements of this contract, or is not executing this contract in good faith, the city shall have the power and right to notify said contractor to discontinue all efforts toward furnishing equipment or parts thereof as the city may designate; and the city thereupon have the power to buy by contract, or otherwise, and in such manner and at such prices as it may determine, such appliances and material which it may deem necessary to complete the equipment herein described and deduct the expense for same from the moneys that may be due or become due the contractor, or the city may annul this contract and relet the work or any part thereof, nor shall affect the right of the city to recover damages which may arise from such abandonment, neglect or failure.

11. No claims for extra work or material furnished shall be allowed, unless such extra work or materials shall have been previously ordered by the City Engineer in writing. The claims for extra work or material, when so ordered, shall be presented to the Commissioners on or before settlement is made on the contract, and said order must accompany said claim for extras.

12. Whenever the word Engineer is used herein, it shall be and is mutually understood to refer to the Engineer in charge of the work and to his properly authorized assistants limited by the particular duties entrusted to them. Whenever the word contractor is used herein, it shall be and is mutually understood to refer to the party or parties contracting to perform the work to be done under this contract, or the legal representatives of such party or parties contracting to perform said work.

13. It is understood by the contracting parties that the following documents are essential portions of the complete contract; The advertisement; the instructions to bidders; the proposal; the plans and specifications; the specific contract and the contractor's bond.

14. If the contractor shall be unavoidably delayed because of any conditions over which he has no control, this contract may be extended for the number of days equal to the number of days he has been thus unavoidably delayed.

15. Said contractor hereby admits that he has read each and every clause in this contract, and fully understands the meaning of the same, and hereby agrees that he will comply with all the terms, covenants and agreements herein set forth.
IN WITNESS WHEREOF, the City of Independence, Kansas, has caused their presents to be signed by its mayor and attested by its clerk, with the seal of said city affixed;

and said second party__________________________

__________________________ by__________________________

this__________ day of__________________________, 1923.

Attest:

__________________________ City Clerk. ____________________________ Mayor.

__________________________ _________________________________

__________________________ _________________________________

__________________________ _________________________________

__________________________ Contractor.

By__________________________
SPECIFICATIONS
FOR
SEWAGE PUMPS.

1. Three pumps will be purchased by the city and are to be installed and connected up by the general contractor. Pumps shall be vertical open impeller centrifugal single-stage pumps, two units of which are to have a capacity of 775 gallons per minute of crude sewage each against a total discharge head of 22 feet 4 inches neglecting friction and the third a capacity of 1550 gallons per minute against the same head. The smaller pumps shall have 6 inch discharge and 8 inch suction openings, the large pump shall have 10 inch discharge and suction openings. All pumps shall be designed with liberal water passages, wide yoke split thrust bearing mounted on pump volute, so that top plate can be raised to gain access to interior working parts. Impeller shall be centered by thrust bearing on yoke with double thrust collar and ring and groove attachment to shaft. Thrust collars with set screws only will not be approved. Pumps shall be provided with feet or brackets cast on the volute and shall be provided with all necessary castings and sole plates to anchor to concrete piers. Anchor bolts shall be set in pipe thimbles and after the pumps are lined and leveled up they shall be grouted in place.

Rigid flanged couplings shall be provided at pumps to connect impeller shafts to vertical shaft extensions and one intermediate coupling of the same type shall be provided for each shaft between pump coupling and motor floor. These couplings shall be securely keyed to and shrunk on shafts and shall be refaced after attaching to shafts. Motors shall be connected to shaft extensions by flexible pin and buffer couplings, accurately keyed and fitted to shafts. All shafting shall be of machinery steel tested in lathe for true running before making up with couplings, and shall be of size not less than those indicated on drawings. Vertical shaft extensions shall be furnished by pump manufacturers and shall be supported by self-aligning thrust bearings located on motor base plates at motor floor level, with double thrust collars with screw adjustment and ring and groove attachment to shaft. These thrust bearings shall be provided with automatic oiling device. Three intermediate guide bearings of the automatic oiling type shall be provided for each shaft, these bearings to be mounted on 8 inch I-Beams let into the walls of the pump chamber as indicated. The beams shall not be grouted into the walls until after all shafting is set up and bearings shown to be in perfect alignment. The 8" I-Beam bearing supports are to be furnished by general contractor.
2. The two smaller pumps shall be driven by a two twenty (220)volt, three phase, 60 cycle, squirrel-cage, vertical motor, General Electric make or its equal, not less than 10 H.P., continuous duty, 40 degree temperature rise, not over 720 revolutions per minute. The 1550 gallon per minute pump shall be driven by a 20 Horse Power, 50 degree temperature rise, vertical motor, with same current as above and operating at not over 550 revolutions per minute.

Motors shall be furnished with suitable machine finished tripods to raise stator frames at least 18" above motor floor level and with heavy machine finished cast iron base plates, which shall be properly grouted to motor floor and which shall support the thrust bearings for shafts.

3. The pump manufacturer shall furnish with each motor a suitable slate panel on angle iron frame with floor supports on which will be mounted one primary resistance type time limit acceleration self-starter and one three pole time limit overload phase protective oil circuit breaker. For each unit there shall be provided also one single pole butt contact fully enclosed automatic float switch mounted on substantial flanged pipe support on floor over wet well. Each float switch shall be operated by a reinforced copper column float running in 8 inch float pipe which shall be suspended from side of wall in wet well. The floats shall be connected to float switches by means of direct brass rods running in one inch guide pipes from 8 inch float pipes to a point above the motor floor level and provided with adjustable buttons, chains, pulleys and counterweights.

4. The 6 inch pumps shall be provided with 8 inch flanged suction elbow, flanged gate valve and connection to wet well as shown in drawing. The discharge of each 6 inch pump shall be provided with 8"x6" flanged cast iron reducer, 6 inch flanged bronze mounted horizontal swing check valve, 6 inch flanged bronze mounted gate valve, 6 inch base elbow and riser to connect to 10 inch header. The 10 inch pump shall be provided with 10 inch flanged elbow on suction, 10 inch gate valve and connection to wet well, 10 inch flanged bronze mounted horizontal swing check valve, and 10 inch flanged bronze mounted gate valve on discharge, 10 inch base elbow and riser to connect to 12" discharge line. Base elbows shall be supported on concrete piers. All gate valves shall be provided with extension stems to motor floor above, these stems being provided with suitable braces midway between upper and lower floors. All piping in pump chamber shall be either wrought iron or cast-iron, with the exception of pit drain connections.

For draining the pump chamber, there shall be provided on each of the two six inch pumps, a two inch tapped opening
in the suction elbow of which will be connected a 2 inch brass gate valve with extension stem to motor floor level properly braced and 2 inch brass horizontal swing check valve in small sump in floor of pump pit. The finished floor in bottom of pump chamber shall be sloped to this sump.

5. Each bidder on pumping equipment shall furnish a statement of the make and description of all motors, pumps, switches and control apparatus which he proposes to use and file same with his proposal. Also a statement of the guaranteed overall efficiency of the pumps and motors.
CHAPTER XIII.

INSTRUCTIONS FOR OPERATING PLANT.

For economical and efficient operation of a sewage plant it should have attention every day. The State Board of Health furnishes blanks for reports which if they are faithfully kept will require an attendants time and presence at least 2 hours each day.

CONTROL MANHOLE.

The float mechanism in the control manhole should be oiled and operated at least once a week to insure its operation in times of high water. No sewage should ever be by-passed at the control manhole except when absolutely necessary. All metal parts to float mechanism should be kept painted with an asphaltum paint to prevent corrosion.

SCREEN CHAMBER.

The screen in the screen chamber should be cleaned every day and the screenings dried and burned in an incinerator. All screenings should be washed from the trash floor and not left to decay and draw flies and insects.

PUMP EQUIPMENT.

All pumps should be operated each day and great care should be taken to see that all oil reservoirs are full at
all times. The shaft bearings must be inspected at least once a week to see that they are getting a proper amount of oil. All valve stems should be kept oiled and easy turning.

IMHOFF TANKS.

The inlet channel of the Imhoff tanks shall be cleaned at least once a week or oftener if necessary. Care shall be used to see that the deposits shall not be washed into the tank. Floating material on the settling compartments shall be skimmed off daily and either buried or burned. All vertical and sloping walls in settling compartments should be cleaned with rubber squeegees slowly, forcing the deposits through the slots. Care should be taken that the deposit is not stirred up and carried into the dosing tank.

The scum in the gas vents should be broken up daily by agitating with a water hose or a pole to release entrained gases. Any material which cannot be made to settle should be removed and burned. If foaming occurs it may sometimes be stopped by drawing some sludge from the tank. Generally the tank should be thrown out of operation a few days until foaming ceases. Sometimes seeding the gas vents with sludge from a tank which does not foam will give good results.

Sludge should not be allowed to get nearer than 2 feet to the slots at the bottom of the settling chamber. The height of sludge in the sludge compartment may be easily
determined by means of a metal disc attached to a wire. Sludge should be removed at intervals by opening valves on sludge pipes. It is better to remove small amounts of the sludge frequently than large amounts infrequently. In no case should the sludge be drawn out on the sludge bed to a greater depth than one foot. Sludge should be drawn off slowly to allow settlement around the base of the sludge pipe; only well digested sludge should be withdrawn from the sludge compartment. Well digested sludge may be known by its brownish black appearance and faint tarry or rubbery odor as opposed to the grayish color, sticky and pasty appearance and foul odor of partly digested sludge. In the late fall all of the digested sludge should be withdrawn from the tanks to provide storage capacity for the winter months. The sludge pipes should be filled with water or a settled sewage after withdrawing sludge.

SLUDGE BED.

Sludge should not be drawn upon the bed until all dried sludge has been removed. Well digested sludge only should be withdrawn upon the bed to a depth of 6 or 8 inches and never over 12 inches. When thoroughly dried the sludge should be removed. Care should be taken to remove as little of the sand as possible. From time to time sand should be applied to the bed in thin layers to replace that removed with sludge.
DOSSING TANK.

Before starting, the siphon should be filled with water and all pipe connections to the siphon kept continuously tight. The sides and bottom of the dosing chamber should be cleaned down occasionally, and all floating material should be skimmed off daily.

SPRINKLING FILTER.

The nozzles of the sprinkling filter should be examined daily and kept clean. The valves on the ends of the distribution system should be opened occasionally and the distribution system flushed. The underdrain system should be flushed occasionally from the ends.

The surface of the filtering material should be kept free from papers, leaves and vegetable growth. In case of organic growth in the bed and moth and flies with their larvae become troublesome, chemicals such as caustic soda, copper sulphate or hypochlorite of lime may be used for their control. These chemicals should be mixed with water and placed in the dosing tank so that they may be distributed uniformly on the filter bed.

FINAL SETTLING BASIN.

The sludge from the final settling basin should be withdrawn daily, to prevent its becoming septic. The inlet flume should be cleaned occasionally.
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