1892

Proposed water works for Rolla

Frank L. Tyrrell

Proposed
Water Works for Rolla

In supplying a city with water there are two things to be considered. The quality of water and the cost of supply.

When water is used from our large rivers, it is pumped into basins, allowed to stand, etc. and is then passed to other basins where it undergoes same process or it is filtered by being passed through several feet of material composed of lime, gravel and sand. Either of these methods are expensive and resorted to only by large cities, which can not be supplied in other ways at a reasonable expense. Smaller cities and towns use other means, viz. [illegible] streams artesian wells and storage basins as locality demands.

A storage basin is an efficient way of supplying a city with water. The ordinary manner of forming these basins consists of closing some valley by a dam of earth; it was not until recently that masonry was used for that purpose. This method seems to have been first adopted in Spain where large reservoirs were used for irrigation. A combination dam is used extensively in this country consisting of a core wall of masonry extending to the desired height of the water, reinforced by earth embankments upon either side, generally standing at a slope of 1 1/2 to 1. In choosing a location we are governed by the amount of water we are required to supply, and ulso on the cost of supplying it.

The water depends upon the water shed, amount of rainfall, whether the surface is impervious or not, and whether the underlying strata of rock, if near the surface is inclining toward, or from the valley chosen, The cost depends upon the value of the land, and expense of clearing and making it suitable for the proposed purpose, also its distance from the city.

The city of Rolla can be chiefly supplied upon the storage basin plan, The site chosen for basin is in a small valley North of Rolla extending N & S and about three fourths of a mile distant, The valley is narrow and has very steep sides, The West side is covered by a thick growth of timber which extends to water shed, The South side has a small clearing on shed extending down about way, the balance of South side has thick undergrowth, The East side has been cleared for pasture and contains yet many small trees and numerous stone fences.

The Water shed commenced at a point at W. side of Rollen & Keely road marked by a stone placed 10 feet E of junction of wire & rock fence, E of house North of Mr Menuwether, line running N. 56°30' W 173.3, S 18° W. 501.4, S 12 E 512.7 thence deflecting 46° run 653.1, defel: 49°20' 767.8, defel 18°55', 211.8, defel 58°3' run

1232.4, defl 58° 5', 300', S 65° 30' E 518.8 to starting point.

The site for dam is in valley W. of Mr Merriwether's house at a pt where the valley is most narrow (shown in Plate I) and will extend in a line perpendicular to the centre line of valley.

We are depending for the most part upon the rain fall, though not entirely, there being several springs which combined yield about 5 thousand gal. per day through several months of the year, and some last the year around.

The following are the statistics taken from the agricultural report of 1891 upon the rain fall of Missouri, and Rolla especially, for the last

10 years.

Report for Rolla

Jan.	2.34	July	5.14
Feb.	2.83	Aug.	3.46
Mar.	3.41	Sep.	3.27
Apr.	4.36	Oct.	2.42
May.	4.57	Nov.	2.28
June	4.03	Dec.	2.26

average 40.4

Each months mean average for 10 years. The mean taken for 34 stations through out Missouri is 38.18 as yearly rain fall.

According to survey there are 57 acres of drainage, there will fall upon this land 61,892,775 gal. Allowing the reliable amount (6/10) for storage we have 37,135,785 gal. per year, 5% of this will be lost by

evaporation which will leave
35,778,976 gallons per year to storage.

Rolla covers a large area in comparison with her population. Families living in houses which contribute largely to their water supply, not mentioning wells,

It is estimated that 30 gal per capita a day, would be sufficient with an assumed population of 3000,

This would make a daily supply of 90,000 gal.

At this rate a reservoir would be required to hold over 17000000 gal.

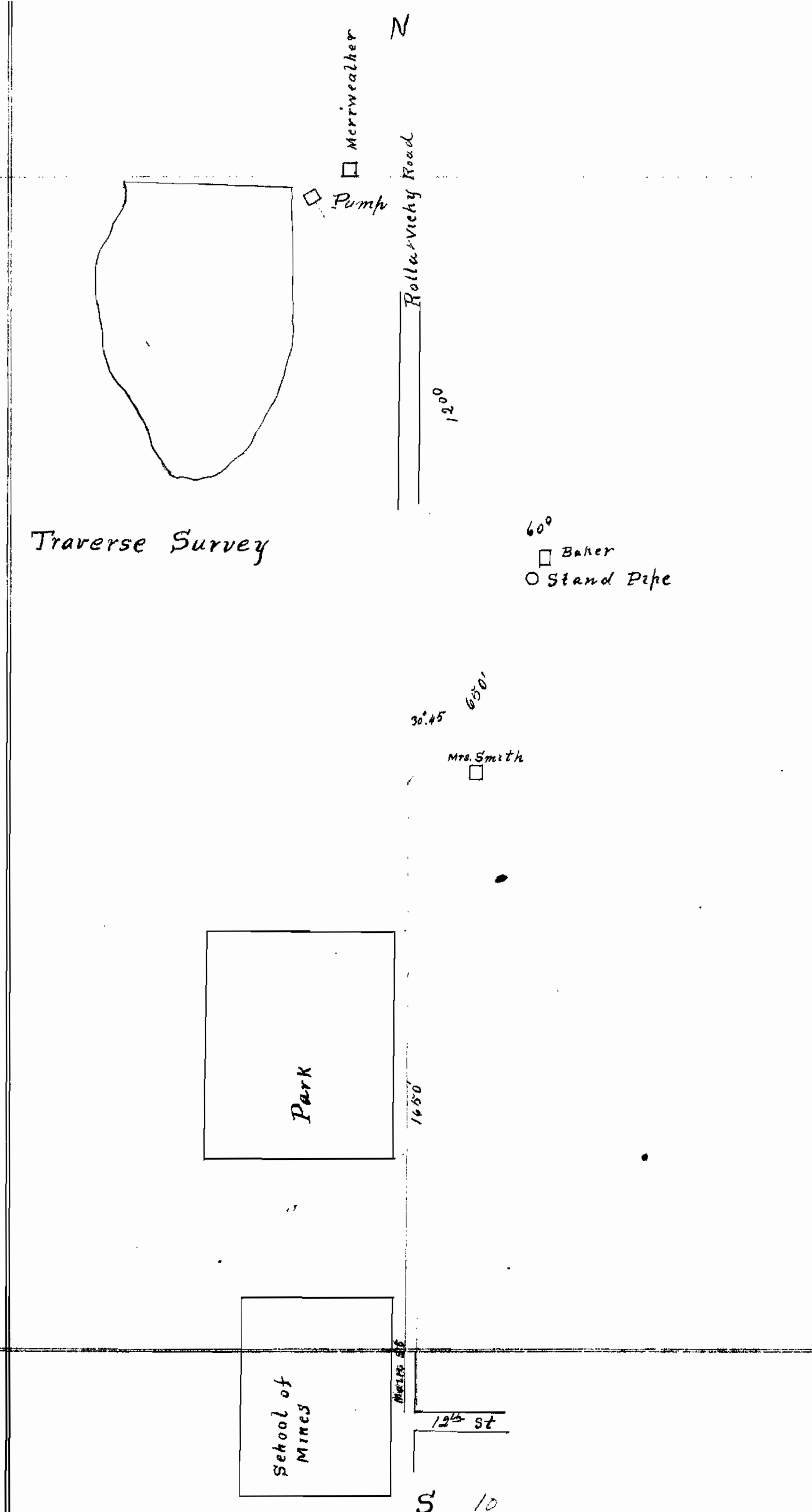
The first step is to determine the height of dam. From a contour survey made of dam site Oct 1891 Plate II, the following calculations

is made, Drawing the plat lie ex
act scale, the Planimeter was run
around each contour commencing
with the innermost circle, The reading
of the Planimeter, gave the area
in sq. feet which multiplied by
the column of water (2 feet,) gave Cu.
contents enclosed within each
contour, The operation was re
peated successively until the re
quired amount was reached.

The dam being in lowest por
tion, its height is determined by
the required column of water, which
we find to be 22 feet, But we
will design a dam 25 feet high.

It is required to design a
water system from above data
for the City of Rolla, From survey

made in April 1892, the Course
is as follows Commencing at
0. foot pine driven flush with
surface, at a point 158' due W. from
N.E. Cor Main & 12 St. running W.
N. 1650, deflecting 30°, 45', extends
650' (Station 22) W. in stand pipe
site, shown in Plate I, deflecting
60°, line runs direct to pump
1200 feet: From station 0. Main
& 12 St, line extends S on Main to
10th, E on 10th to Pine, thence South
on Pine to Second St, A branch
main to run W on 2nd St to Cedar
street; A branch to extend from
10th South on Main to 4th St
Another to connect with Main
on 8th & Pine, extend East on 8th
to Olive, thence South to fourth


N
Merriwealher
Pump
Rolla-Vichy Road
120°
Traverse Survey
60°
Baker
Stand Pipe
650'
30°45
Mrs. Smith
Park
1650'
School of Mines
Main St
12th St
S

as shown in map, City of Rolla, Plate II

From level surveys made in April & May 1892, the Profile was made (Plate III) by which the following elevations were derived, taking the City's elevation from the Gulf of Mexico, (B.M. on Masonic door step (1100.05)

Station 0, 1134.95

Stand Pipe, 1179.69

Pump 1047.86

10th & Main Sts 1115.30

8th & Pine 1107.01

Stand Pipe

When a City is supplied with water it is necessary to have head enough to force the water to every portion of the highest building. To do this the Engineer uses gravity as his power, by pumping to some high point and allowing the water to flow through pipes to the city. Where a city has no hills upon which to place a reservoir she erects a Stand Pipe.

This is variously constructed, though generally it is made of boiler iron, and can extend to any desired height; some going as high as 150 feet

The City of Rolla has no hills high enough to give sufficient pressure, but by putting a 50 ft stand pipe upon the highest neighboring hill a sufficient head can be obtained.

The diameter (10 feet) is taken so that it will act in a small way as a storage. The pipe will hold 29,377.8 gal.

The calculation is as follows.

From equation

$$Pd = 2St$$

where P-pressure, d-dia in in. S-strength of iron, t-thickness, or

$21.7 \times 120 = 2 \times 8000 \times t$, ∴ S-8000

or $t = \frac{1}{50}"$ = bursting thickness of plate, giving a safety factor of 10 to meet all resistances thickness is 1/5".

The first 25 feet of pipe is taken

at 1/4". 2nd 25 feet as 3/16"
Making allowance for lap in both directions and supposing plates of iron to be about 8' long and 3' wide we have

917 sq feet @ 3/16"
917 " " @ 1/4"
Rolled iron per sq ft 3/16 weighs 7.5#
" " " " " 1/4 " 10#

917 - 3/16 @ 7.5 lbs =	6877
917 - 1/4 @ 10 "	9170
Total	16047
Rivets	500

or abt 8 1/4 tons, which at $50. per ton = $412.5

Excavation & Foundation	100.0
Sundries	100.
Total	$612.50

Water Mains

Pipe for water mains is cast in lengths of 12 feet for all sizes from 3 in dia to 48" dia. and weigh from 15 lbs for 3 in to 5 to 7 hundred for a 48 in, per foot. There is a flange or socket upon one end: for sizes from 3 in to 10 in, this is 4 in, Larger sizes increase proportionally to 5½ in

When the pipe is laid and each straight end fits well into the socket of the other, the joint is wrapped and filled with melted lead, This joint is capable of resisting great pressure.

Pipe from standard firms are tested by an hydraulic pressure of 300# per sq in.

Pipe Line A.

Main A is 1200', and extends from pump to stand pipe, difference of elevation 131.8'

The pipe will be designed to carry 3½ times as much as daily demand or 1 cu ft per second. By calculation a six in pipe is chosen.

6 in pipe weighs 35 lbs per lin. ft. An assumed price of $23. per ton is taken, though the regular price will not vary ~~far~~ from this.

12 ft @ 35 = 420#

420# @ 1.15 per hund. =	$4.83
8# Lead @ 5	.40
9 # yarn	.30
Labor of filling	.10
	5.63

103 lengths @ 5.63 = $579.89

Main B.

Main B. extends from stand pipe to 10th street, distance of 2800 feet dif. of elevation 65.5', stand pipe 50', Total 115.5 feet

It is designed to deliver at Main & 10th 4?3,?74 gal per day or 1.25 cu ft per sec. A 10 in pipe is adopted.

The lost head is calculated as follows

Lost head = $(h_1 + h_{11} + h_{111})$

$= (1.5 + f\frac{l}{d})\frac{v^2}{2g}$,

$v = \frac{Q}{A} = \frac{1.25}{.7854 \times (83)^2} = 2.3$

g - 32.16 - gravity

$L.h = (1.5 + .02\frac{2800}{.83})\frac{5.29}{64.32} = 5.5$ feet

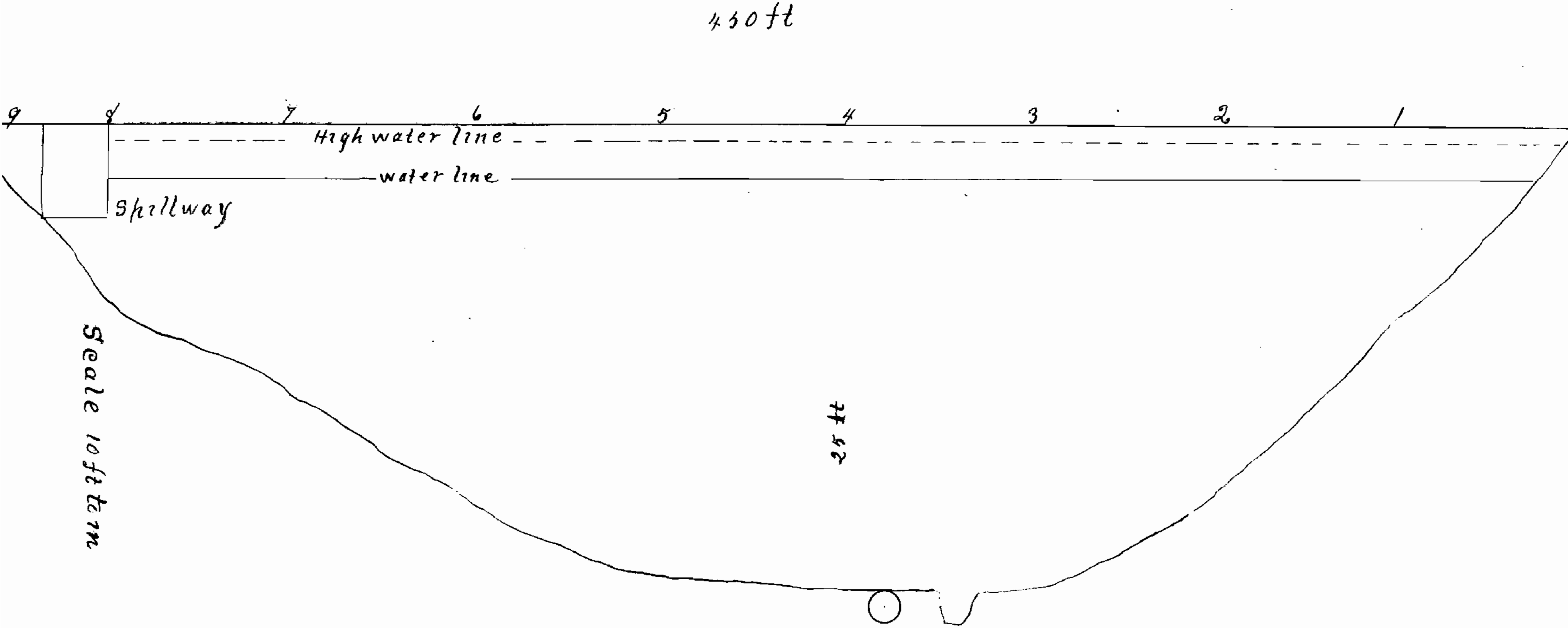
Where $l = 2800$. d - 10 in. $f = .02$. v - velocity

The Pressure head at 10th is 110 feet.

10 in pipe 70# per foot = 840 @ 1.15	9.66
Lead per joint (15#) @ .5	.75
Yarn & Labor	.55
	10.96

240 lengths @ 10.96 = $2630.40

PLATE IV



Profile of Surface for Dam

Scale 50 ft to in

F L Tyrrell

June 1892

Main C.

Main C. extends from 10th & Main st to 8th & Pine as shown in Plate II a distance of 1155 feet; Difference of elevation 8.33 feet; Lost head 2.33 ft. or the pressure head at 8th and Pine street is 116 ft

98 lengths @ 10.96 = $1074.08

Main D.

Main D. extends South on Pine st to Second st distance 1900 feet Population 1500, Pipe to deliver, or be drawn from at all points; To deliver 161.596.6 gal per day or * .5 cu feet per sec.

A 6 in pipe gives a velocity of 2.6

Lost Head = $f\frac{l}{3d}\frac{8^2}{2g}$ or 3 feet,

Dif. of elevation 3 flt. pressure height 141.'-3 = 138',

* Double the value

Cost per length \$5.63

127 lengths @ 5.63 = \$715.00

Main E.

Main E is designed to deliver 193703 gal. per day or .3 cu ft per sec and extend from junction at Pine & 8th street to Olive, South on Olive to 4 street a distance of 1800'. Elevation same as 8th & Pine. A pressure head is wanted of 110 ft.

Calculation of diameter

$$d = .479\left(\frac{7}{3}\right)^{1/5}\left(\frac{l q^2}{h}\right)^{1/5}$$

or 4 in. is desired size

Weight per length = 24# per ft = 288#

288# at 1.15 =		3.31
Lead	4½ lbs @ .5	.22
Yarn	7 oz	.17
Labor @ 2.50		.10
		\$3.80

83 lengths @ 380 = \$315.40

Main A.

Main A extends from junction at Main & 10 st, S on Main to 4th distance, 1600 ft, a 3 in. pipe will be sufficient to meet all demands on this line, Population 500

3 in pipe weighs per lin. ft 15 lbs.

180# at 1.15 –	$2.07
Lead 3 1/2# at .5	.16
Yarn & Labor	.22
Total Cost per joint, –	$2.45

130 lengths @ 2.45 = 318.5

Main G.

Main G. is branch running West on 2nd st joining Pine, It is one which will not be counted in this work.

Engine & Pump

The engine & pump must have sufficient capacity to deliver in stand pipe 1 cu ft per second. To do this it must not only be able to lift the weight of one cu ft through 181.8 feet but must over come all resistances, the greatest of these are loss of head at entrance & friction. Stated in formula

$$K = wqH + wqH(h' + h'')$$

$$K = wqH + wq\left(m + f\frac{l}{d}\right)\frac{v^2}{2g}$$

$w = 62.5$, q = discharge (1), f coef. of friction .02
$m = 0.5$, $l = 1200$, d = dia of pipe = .5, v = below

$$K = 62.5 \times 1 \times 181.8 + 62.5 \times 1\left(.5 + .02\frac{1200}{.5}\right)\frac{13}{\text{B}2.16}$$

$$K = 11362.5 + 1225 = 12,587.5 \text{ foot lbs}$$

$$H.P = \frac{K}{55} = \frac{12,587.5}{550} = 23. \qquad v = 3.6$$

But will assume a 30 H.P. Engine & Pump
The probable cost of which will be
\$1800.

Dam

The site chosen for dam has at the depth of three feet a stratum of blue clay which seems to be impervious to water, this is a good substitute for rock and upon this the foundation of the dam will depend. The large quantities of material on each side of valley and close at hand afford the best of opportunities for a well built, and cheap structure.

The dam is 450 ft. top measurement 25 ft high, with a core of puddled earth 5 ft wide and extending entire length and height of dam, The sides slope at 1 1/2 to 1. From survey made June 4 1892 there will be 2000 yds to be removed and puddled for foundation. There is about [illegible] cu. yds of earth in entire dam, the estimated cost est. $[illegible] .71.

819 cu yds in core wall
6400 " " " Side "

Removing 2660 yds @ 25 $665.
Puddling 2660 " @ 20 532.
Total for foundation $1197.

Puddling interior wall @ 50 - 409.5
Hauling 6400 @ 35 2240 -
Total for Dam (earth) $3846.5

The dam has a 20 ft spillway the bottom of which will have riprap for a distance of 20 feet each side of wall. Wall will be of stone masonry six feet high, the top coming even with general surface of dam. There will be two gates 3 ft below average water line, to be opened in case of freshet. The entire opening is 6x20'

The Spill way will cost $325.
Dam " 3846.50.
Total $4171.50

Land.

It would be necessary to buy the land from which the water would drain. This is necessary for two reasons, 1st. So that the City would never be without resource, 2nd It could clean and place it in the proper condition for a healthful supply of water. The valley above dam should be cleared of every thing of an organic nature, to make the water better, and to offer less resistance to flowing water.

Sld. be covered by vegetation?

There is about 30 acres of cleared land included within watershed. This would cost about $15 per acre

The uncleared land would cost about $8 per acre. It would cost about $7 per acre to clear the land for trees.

Estimate

27 acres (trees)	@ $7.		189.
30 "	cost	15.	450.
27 "	"	8.	216.
General Clearing 57 @ 3			171.
Total for land.			$1026.

The pipe line laid not less than three feet would cost as follows.

4000 feet out of City @ 30 cts cu yd.	270.
6455 Inside of City @ 40 cts	573.60
Bends	300.
Excavating	$1143.60

100 feet of 24" pipe with value $257.
This is placed as shown in profile to drain the lake.

Grand Total

Land	$ 1026
Dam	4171.50
3755 ft 10 in pipe	3704.48
3100 " 6 " "	1294.87
1800 " 4 " "	315.40
1600 " 3 " "	318.50
Engine	1800.00
Stand Pipe	612.50
Excavating	1143.00
100 ft 24 in Pipe	257.00
Sundries	600.00
	$ 15,243.27

A comparison of the water rates of Cities is one of the most accurate methods, that can be employed in judging the management of the different systems, since the main tenance is largely met by the revenue derived from consumers.

This is more especially true when the works are owned by the City in which they are placed, as the only object is for the consumer to pay for the expense of operation.

Companies of course furnish water for profit, and therefore a comparison of their rates, with each other, and with those of public works is desirable, in order to ascertain whether they are furnishing water at reasonable figures.

another advantage is of obtaining the relative advantages of public and private ownership, The Engineering News (1890) gives exhaustive tables of rates of 800 Cities, from all parts of the United States and Canada, and we find that the private concerns charge a few cents more to the 1,000 gal. than public, but it is affirmed that their plants are more costly.

The average for the whole U.S. show a cost of 102.07 for all public against 117.28 for private concerns.

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