A DESIGN FOR A SEWERAGE SYSTEM FOR WEYMOUTH, MASSACHUSETTS

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Course 1.

1915

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I N T R O D U C T I O N.

Weymouth is a typical New England town, situated among the hills of Norfolk County, and in the valley of the Weymouth Fore River, which flows into Hingham Bay a few miles beyond.

The town has grown slowly. In 1910, it had a population of 12,895 distributed over an area of 11,338 acres. The distribution of population is by no means uniform over the town. About half the population is concentrated in the four communities of North, East, and South Weymouth and in Weymouth proper. It contains no large industrial concerns that favor the rapid increase in population. Weymouth is chiefly a residential town of middle and poor class people, and conducts only such business as is necessary for supplying the daily wants of the inhabitants.

Like many up-to-date towns, Weymouth has a water supply; and it recognizes the value of a sewerage system, but is too poor to install one. The result is that the people have to rely upon the intolerable cess-pool and other objectionable methods of sewage disposal. However, from our study of the subject, we feel that, when the town will be in a position to build a sewerage system, there will be no large expense due to unusual circumstances in the system.

I. METHOD OF PROCEDURE.

1. Reconnaissance.

After our reconnaissance of the territory, we saw that it would be impossible, with the time at our disposal, to design a system for the entire town, because so large a part of the population was concentrated in several different places, each a few miles from the other. The most we could do was to design a system for one of the communities, namely Weymouth proper. This section borders on a narrow channel of the Weymouth Fore River, and extends back over a hilly country. Apparently no attempt was made to locate the streets to conform to this rough topography, for most of the streets have excessively steep grades as well as other undisirable features of location. The business thoroughfare is Commercial Street; the other streets are mainly residential.

2. Maps.

We were fortunate in securing maps of Weymouth, to a scale of 1 inch =100 feet, which contain every detail, but ~~but~~ which show no contour lines. Since the small scale maps of the United States Geologic Survey were not suitable for our purpose, we were obliged to prepare, from our level notes, a contour map on which we laid out the drainage areas for the sewers.

In order to show the system as a whole, and for convenience in working out the design, we also prepared a plan of the town to a scale of 1 inch = 200 feet.

We thus have three sectional maps (scale: 1 inch = 100 feet), showing the sewer lines in detail; one map (scale: 1 inch = 200 feet), showing the town and the sewerage system as a whole; and finally, one contour map (scale: 1 inch = 200 feet), showing the natural topography and the drainage areas.

3. Elevations.

We were obliged to run lines of levels along the streets in order to secure data for the profiles. Readings on the rod to the nearest tenth of a foot, were taken at all street intersections, and at places of marked change in grade. We established numerous bench marks on all streets so that we might check the accuracy of our work. In spite of the bitter cold weather in which we worked, we had the satisfaction of checking the lines of levels to a fair degree of accuracy. All elevations are referred to a datum plane which we established at the Weymouth Fore River.

II. T H E S E W E R A G E S Y S T E M.

1. Discussion of the System.

The sewerage system was designed to take care of domestic sewage only. It consists of an intercepting sewer, on Commercial Street, into which lead branch sewers from Washington, Front, Webb, Tremont, and Summit Street, while the lateral systems drain into the above mentioned branches. The intercepting sewer terminates in a disposal plant on the shore of the Weymouth Fore River.

We found it impracticable to drain some streets on account of the unfavorable topographical conditions; and in a few instances we had to cross private property to drain low places. We were also obliged, in several places, to use drop manholes, which necessitated some deep cuts. However, on the whole, no excessive cuts were encountered; no large sized pipes were needed; and no unusual difficulty had to be overcome in the design. The details of the system may be readily followed on the plans and profiles.

2. Population.

Census reports of the population of Weymouth, and of neighboring towns and cities were obtained, and the population plot shown in the appendix was constructed. We did not think it advisable to use the average line of all the cities plotted, since there is no likelihood that Weymouth will grow as rapidly as the plot indicates. It appeared more reasonable to omit such industrial cities as Brocton, Malden, and Newton, and construct an average line of the remaining cities which more nearly resemble Weymouth in character. This average plot shows that the probable population of Weymouth in 1940 will be 24,000 distributed over 11,338 acres. We assumed that in 1940 twelve thousand people will be concentrated in the four communities of North, East, and South Weymouth, and in Weymouth proper; and we further assumed that the twelve thousand inhabitants will be equally divided among the four localities. On this basis, Weymouth proper, with an ~~average~~ acreage of ~~two-hundred and eighty-five~~ Three hundred and fifteen will in 1940, have on the average a population of ten per acre(3000 / ~~285~~ 315 = ~~10.5~~ 9.5).

To design the system for twenty-five years in the future we regarded as a reasonable procedure.

3. Quantity of Sewage.

We could not obtain data on the water consumption of Weymouth, so we turned to other sources for suitable data.

Messrs. Metcalf and Eddy in their book: "American Sewerage Practice, Vol. 1" give a table for the maximum water consumption for sixty-seven Massachusetts cities and towns. The following figures are the averages for the above mentioned cities and towns.

Average daily consumption per person: 63.

Maximum monthly consumption:-

Gals. per person per day: 81.

Percent of average for year: 128.

Maximum Weekly Consumption:-

Gals. per person per day: 93.

Percent of average for year: 147.

Maximum Daily Consumption:-

Gals. per person per day: 123.

Percent of average for year: 198.

In addition to the above variations in flow, there is a variation for each day from hour to hour which must not be neglected. We assumed therefore, that 150 percent of the average daily water consumption was a fair estimate of the rate of water consumption at the time when the flow of sewage was at its maximum. Assuming further, that the ~~annular~~ annual average amount of consumption that reaches the sewers is 50 gallons per day, we find that the maximum rate of contribution from the water supply is 150 gallons per capita daily (50 X 1.98 X 1.50 = 148.5).

Messrs. Metcalf and Eddy, in discussing ground water leakage into the sewers, state that under the most favorable conditions the leakage may be as low as 5,000 or 10,000 gals. per day per mile of sewer. However they show that leakage sometimes amounts to from 20,000 to 40,000 gals. per day per mile of sewer; and it may even amount to 100,000 gals. or more. In the absence of any data on the subject as regards Weymouth, we assumed 50,000 gals. per day per mile of sewer, which we believe to be a safe and reasonable value.

We have in all about eight miles of sewer draining 285 acres. 50000 X 8 / ~~285~~ 315 = ~~1400~~ 1270 gals. per acre per day will then equal the ground water leakage, while 150 gals. X 10 =1500 gals. per acre per day will equal the flow from other sources. The total flow provided for will thus equal ~~1400~~ 1300 gals. plus 1500 gals.= ~~2900~~ 2800 gals. per acre per day.

4. Location of Sewers.

In order to equalize the length and cost of house drains the sewer lines were located in the centers of the streets, except where car lines made it more desirable to locate the sewers to one side. Invariably the houses on either side of the streets are situated on higher ground than the street; and for this reason we thought it safe to place the sewers at a minimum depth of six feet below the surface of the street. This depth is on the safe side as regards surface loads, since the loads from steam road rollers, traction engines, trucks , etc, are fairly well distributed over the entire width of the trench for depths of five feet or more.

5. Velocities, Grades, and Sizes of Pipe.

A sewerage system does not operate satisfactorily unless the minimum velocities assumed in the design of the system are adequate to keep it thoroughly flushed. It has been found that a mean velocity of two feet per second will ordinarily prevent deposits in sewers built upon the separate system. There is no necessity to establish a maximum velocity for sewers on the separate system, because domestic sewage is not of an erosive nature, and besides, vitrified sewer pipe is resistant to erosion.

We designed the pipes to carry the maximum flow when flowing half full. The following minimum grades for sewers, flowing half full and with a velocity of two feet per second, are taken from the regulations of the New Jersey State Board of Health.

Diameter, inches.	Minimum fall in feet per 100 feet.
8	0.40
10	0.29
12	0.22
15	0.15
18	0.12
20	0.10
24	0.08

The Gerhardt diagram was used in making the sewer calculations.

The minimum size pipe in our design is 8 inches, which is the minimum size used in the best practice.

6. Manholes and Flushing.

Manholes are used to facilitate the removal of grit and silt which collect in the inverts of sewers; and also, incidentaly, they serve to ventilate the sewers. In establishing manholes, we have followed the principle that a manhole should be placed at changes in line and grade in small sewers. We did think it advisable to use lampholes, since their use is not regarded with favor by most engineers. Manholes have also been placed in long stretches of straight pipe at a spacing of about 300 feet.

Extremities of the sewer pipe system have to be flushed to carry away the material deposited during minimum flow of sewage. The flushing is accomplished either by hand or with the help of automatic devices. In this case hand-flushing appears to be more economical than automatic flushing, and is generally accomplished by means of a hose from the nearest fire hydrant, inserted into the manhole at the end of the lateral or on the summit of the sewer to be cleaned.

III. D I S P O S A L O F T H E S E W A G E.

In disposing of sewage we aim to prevent the creation of a nuisance. We felt that, in the case of Weymouth, a decided nuisance would be created if the sewage was discharged directly into the Weymouth Fore River, because the stream is not of sufficient volume to prevent pollution and deposits. On the other hand there is no necessity for complete sterilization of the sewage, since the stream is not a source of water supply. The ~~first~~ best method of procedure, obviously, is to leave out of consideration bacteriological conditions, and simply to treat the sewage so that no nuisance will be created when it is discharged into the stream. To carry out this condition, we believe it will be necessary to install a plant for the physical removal of suspended matter by straining out the courser material by screens, by sedimentation, by surface adhesion, and by precipitating by adding a coagulant. This process makes it possible to discharge the matter into the stream without causing a nuisance.

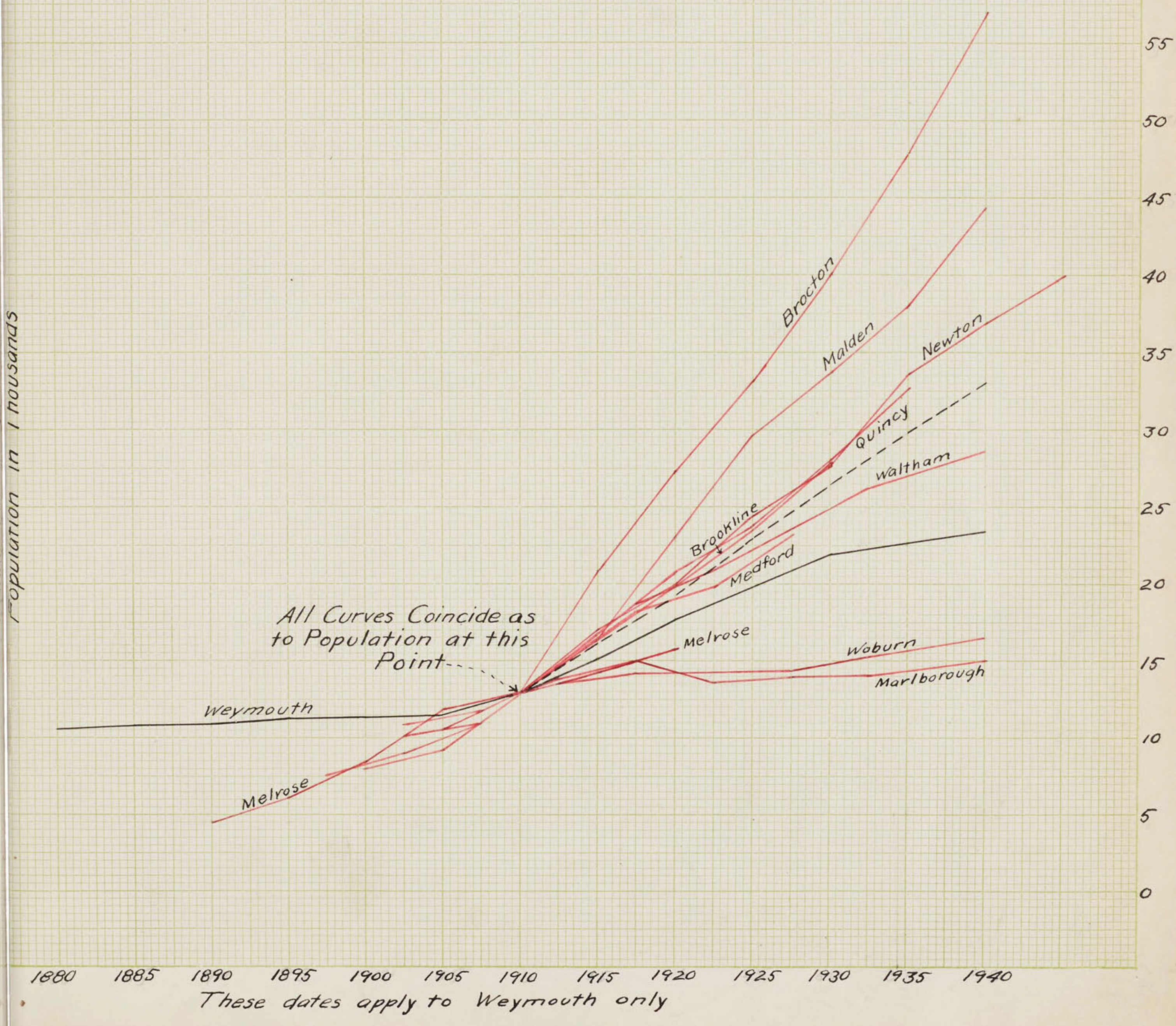
Conclusion.

In designing a sewerage system for Weymouth, we followed the principles established by the best practice, and which are embodied in that excellant book: "American Sewerage Practice, Vol. 1", by Messrs. Metcalf and Eddy. Our aim, throughout was to design a system which will be the most economical to construct, and yet be consistant with good practice. While our design is probably not the one on which a final decision would be made, it is one which is absolutely necessary for a preliminary estimate of the cost of the system, and it also serves as a basis for a final design.

Population Curves

Dotted black line represents Average of all Cities

Full black line represents Average of all Cities except Brocton, Malden, & Newton



Street.	Interval. Sta.	to Sta.	Tributary area in acres. (Note Sta.)	Assumed future population.	Assumed avge. sewage flow in gal. per 24 hours.	Assumed max. flow in gal. per 24 hours, including leakage.	Max. flow in c. f. p. min.	Size of Sewer.	Slope.	Capacity, ½ full, in c. f. p. min.
Front St.	0	6+50						8"	0.0045	29
	6+50	13+03						8"	0.004	28
	13+03	15+21						8"	0.018	60
	15+21	17+71						8"	0.044	100
	17+71	22+05						8"	0.031	80
	22+05	26+79						8"	0.014	56
	22+30		22.6	226	33900		5.87			
	26+79	31+59						8"	0.0083	40
	31+59	33+04						8"	0.030	78
	31+70		64.1	641	96200	179500	16.7			
	33+04	34+54						8"	0.015	57
	34+54	37+34						8"	0.004	28
	34+70		80.0	800	120000	224000	20.4			
	37+34	39+89						8"	0.004	28
	39+89	41+67						8"	0.026	74
	41+67	43+99						8"	0.022	63
	43+99	45+10						8"	0.053	100
	45+10	46+77						8"	0.062	108
	46+77	48+75						8"	0.073	
	48+75	50+67						8"	0.028	78

Street.	Interval. Sta.	to Sta.	Tributary area in acres. (Note Sta.)	Assumed future population.	Assumed avge. sewage flow in gal. per 24 hours.	Assumed max. flow in gal. per 24 hours, including leakage.	Max. flow in c. f. p. min.	Size of Sewer.	Slope.	Capacity, ½ full, in c. f. p. min.
Prospect St.	0	5+49						8"	0.004	28
	5+49	7+94						8"	0.022	63
	7+94	8+78						8"	0.0074	
	8+78	10+38						8"	0.048	93
	10+38	14+06						8"	0.035	83
	14+06	15+31						8"	0.127	
	15+31	19+26						8"	0.073	
Phillips St.	0	3+04						8"	0.031	80
	3+04	4+32						8"	0.081	
	4+32	5+56						8"	0.051	98
	5+56	7+10						8"	0.051	98
	7+10	8+35						8"	0.004	28
	8+35	9+50						8"	0.004	28
	9+50	12+38						8"	0.042	90
	12+38	16+08						8"	0.026	72
	16+08	19+06						8"	0.026	72
Worster Ter.	0	2+40						8"	0.042	90

Street.	Interval. Sta.	to Sta.	Tributary area in acres. (Note Sta.)	Assumed future population.	Assumed avge. sewage flow in gal. per 24 hours.	Assumed max. flow in gal. per 24 hours, including leakage.	Max. flow in c. f. p. min.	Size of Sewer.	Slope.	Capacity, ½ full, in c. f. p. min.
Norfolk St.	0	1+70						8"	0.021	62
	1+70	2+88						8"	0.048	96
	2+88	5+08						8"	0.050	100
Bakers Ave.	0	1+00						8"	0.004	28
	1+00	3+80						8"	0.039	85
Williams Ave	0	2+20						8"	0.004	28

Street.	Interval. Sta.	to Sta.	Tributary area in acres. (Note Sta.)	Assumed future population.	Assumed avge. sewage flow in gal. per 24 hours.	Assumed max. flow in gal. per 24 hours, including leakage.	Max. flow in c. f. p. min.	Size of Sewer.	Slope.	Capacity, ½ full, in c. f. p. min.
Keith St.	0	1+25							0.024	70
	1+25	4+05							0.077	
	4+05	8+10							0.0405	88
	8+10	10+31							0.038	85
	10+31	11+79							0.019	60
	11+79	12+79							0.095	
	12+79	14+39							0.0075	38
Richmond St.	0	1+94							0.005	30
	1+94	4+84							0.023	65
	4+84	7+94							0.046	92
	7+94	10+84							0.089	
	10+84	13+49							0.072	
Walker St.	0	1+50							0.054	100
	1+50	2+50							0.007	36
Franklin St.	0	6+92							0.004	28

Street.	Interval. Sta.	to Sta.	Tributary area in acres. (Note Sta.)	Assumed future population.	Assumed avge. sewage flow in gal. per 24 hours.	Assumed max. flow in gal. per 24 hours, including leakage.	Max. flow in c. f. p. min.	Size of Sewer.	Slope.	Capacity, ½ full, in c. f. p. min.
Summer St.	0	14+35						8"	0.004	28
	14+35	18+90						8"	0.025	70
Federal St.	0	7+25						8"	0.021	62
Congress St.	0	2+00						8"	0.026	72
	2+00	4+40						8"	0.0096	43
	4+40	6+50						8"	0.045	90
Hunt St.	0	8+30						8"	0.010	44
King Ave.	0	4+30						8"	0.004	28
	4+30	5+50						8"	0.029	78
Common St.	0	2+00						8"	0.049	98
	2+00	5+54						8"	0.014	52
Stetson	0	2+80						8"	0.018	60
	2+80	4+05						8"	0.040	88

Street.	Interval. Sta.	to Sta.	Tributary area in acres. (Note Sta.)	Assumed future population.	Assumed avge. sewage flow in gal. per 24 hours.	Assumed max. flow in gal. per 24 hours, including leakage.	Max. flow in c. f. p. min.	Size of Sewer.	Slope.	Capacity, ½ full, in c. f. p. min.
Kensington Rd.	0	2+80						8"	0.022	64
Vine St.	0	4+30						8"	0.004	28
	4+30	6+30						8"	0.034	80
	6+30	8+40						8"	0.0505	100
	8+40	13+15						8"	0.004	28
Clapp Ave	0	2+25						8"	0.025	70
	2+25	4+20						8"	0.005	30
Foye Ave	0	4+30						8"	0.061	108
Summit	0	6+20						8"	0.0245	70
	6+20	7+65						8"	0.055	104
	7+65	10+25						8"	0.027	72
	10+25	14+80						8"	0.145	
Tremont	0	2+10						8"	0.016	58
	2+10	4+10						8"	0.066	110

Street.	Interval. Sta.	to Sta.	Tributary area in acres. (Note Sta.)	Assumed future population.	Assumed avge. sewage flow in gal. per 24 hours.	Assumed max. flow in gal. per 24 hours, including leakage.	Max. flow in c. f. p. min.	Size of Sewer.	Slope.	Capacity, ½ full, in c. f. p. min.
Commercial St.	0	16+73						16"	0.0014	90
	0+20		222	2220	333000	621000	57.6			
	16+73	21+23						14"	0.005	140
	21+23	26+73						16"	0.0014	90
	26+73		296	2960	444000	830000	77			
	26+73	32+53						8"	0.0074	38
	32+53	35+85						8"	0.011	46
Webb St.	0	4+20						8"	0.016	58
	4+20	7+40						8"	0.042	90
	7+40	10+08						8"	0.0067	35
	10+08	12+16						8"	0.0067	35
	12+16	13+16						8"	0.017	58
	12+35		19	190	28500	53200	4.9			
	13+16	17+32						8"	0.034	82
	17+32	23+96						8"	0.060	105
	23+96	26+46						8"	0.093	
	26+46		315	3150	472000	882000	81.7			
Private way	0	2+50						8"	0.004	28
Private way	0	2+50						8"	0.0197	60

Street.	Interval. Sta.	to Sta.	Tributary area in acres. (Note Sta.)	Assumed future population.	Assumed avge. sewage flow in gal. per 24 hours.	Assumed max. flow in gal. per 24 hours, including leakage.	Max. flow in c. f. p. min.	Size of Sewer.	Slope.	Capacity, ½ full, in c. f. p. min.
Washington St.	0	13+50						8"	0.004	28
	13+50	25+70						8"	0.004	28
	20+20		50.9	509	70400	142300	13.2			
	25+70	31+90						8"	0.018	60
	25+80		64.2	642	96400	180000	16.7			
	31+90	38+10						8"	0.030	78
	38+10	45+20						8"	0.052	100
	38+30		94.5	945	142000	264500	24.6			
	45+20	48+00						8"	0.046	92
	45+40		104.9	1049	157000	294000	27.2			
Broad St.	0	3+85						8"	0.004	28
	3+85	10+05						8"	0.005	30
	10+05	13+50						8"	0.025	70
	13+50	20+10						8"	0.021	62
	20+10	22+35						8"	0.018	18
	22+35	24+35						8"	0.004	28
	24+35	28+15						8"	0.035	82
Granite St	0	0+50						8"	0.018	60
	0+50	1+50						8"	0.028	74
	1+50	3+08						8"	0.004	28
	3+08	7+28						8"	0.034	80

Design
for a proposed
Sewerage System
for the
Town of Weymouth
Mass
Scale 1in.=200ft.

Jacob Cohen

Drainage Area
for a proposed
Sewerage System
for the
Town of Weymouth
Mass.
Scale 1 in.=200 ft.

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"TEC" PROFILE PLATE. A.
"TEC" PROFILE PLATE. A.
"TEC" PROFILE

Profile for Sewerage System
for the
Town of Weymouth
Webb St.
Granite St.
Norfolk St.
Bakers Ave
Vine St.
Private way
Franklin St.
Congress St.
Kensington Rd.
Commercial St.
Federal St.
King Ave
Worster Ter.
X St.
Williams Ave
Stetson St.
Common St.
Clapp Ave
Faye Ave
Walker St.
Tremont St.
Summit St.
Hunt St.
"TEC" PROFILE PLATE. A.
"TEC" PROFILE PLATE. A.

PLAN OF A PART OF WEYMOUTH

SHEET 16.

PLAN OF A PART OF WEYMOUTH

SHEET 20.

PLAN OF A PART OF WEYMOUTH

SHEET 24.