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THE GENIUS OF SANITATION

PRESIDENTIAL ADDRESS BY CORDON M. FAIR,* BOSTON SOCIETY OF CIVIL ENGINEERS, MARCH 20, 1940

ACCORDING to Carlyle[1] "the history of what man has accomplished in this world, is at the bottom the History of the Great Men who have worked here. They were the leaders of men, these great ones; the modellers, patterners, and in a wide sense creators, of whatsoever the general mass of men contrived to do or to attain; all things that we see standing accomplished in the world are properly the outer material result, the practical realization and embodiment, of Thoughts that dwelt in the Great Men sent into the world: the soul of the whole world's history, it may justly be considered, were the history of these." Most certainly is this true of the history of sanitation which might well be recounted in the portraiture of successive great personages whose deep and peculiar interest in both man and his environment lifted them above "the general mass of men" in perception and leadership.

Such is not the objective of this address, however. A better scholar will have to add the heroes of sanitation to the six classes of heroes of Carlyle. Mine is the humbler portion of giving brief account of certain friendships that I have struck up, in the printed page, with men of fact or characters of fiction whose association with sanitary thought has appealed to me purely in a subjective way in its relation

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[1]Thomas Carlyle, "On Heroes, Hero-Worship, and the Heroic in History," (1841).

to water supply and drainage. But again as Carlyle has said, "Great men, taken up in any way, are profitable company."

Moses and the Pentateuch

Although the Freudians may have a nasty explanation and the Napoleonic Code forbids the searching out of fatherhood, I hold that Sanitation had a father: none less, in fact, than Moses, leader and law-giver of Israel. His name, taken by itself, would be significant in Sanitation, for the daughter of Pharaoh, when she found him at the river's edge, called him Moses because she had drawn him out of the water.

As a sanitary engineer, I like to picture Moses in his many hydraulic moods: as a babe gazing from his ark of bulrushes midst the flags by the river's brink; as a young man raising his staff above the waters of the Nile while they are turned to blood (undoubtedly by a sudden pulse of blue-green algae) and the fish die and the river becomes foul so that the Egyptians cannot drink its waters; later leading his people dry-shod across the Red Sea when a "seiche" of unusual amplitude is induced by a strong east wind that blew all night; in the wilderness smiting the Rock of Rephidim to draw water from it; and in his old age writing a sanitary code that still guides his people in their renewed wanderings in search of refuge. No modern sanitary ordinance can cover the desirable disposal of human excrement more completely than the Mosaic law. Sanitary engineers are so familiar with it that I hesitate to quote it:[2] "Thou shalt have a place also without the camp, whither thou shalt go forth abroad, and thou shalt have a paddle among thy weapons; and it shall be, when thou sittest down abroad, thou shalt dig therewith, and thou shalt turn back and cover that which cometh from thee." It seems strange that thousands of years had to elapse before the full wisdom of this statement had established itself in human consciousness, and fly-borne typhoid fever and other enteric diseases began to be controlled by the simple institution of the pit latrine and pit privy. As a sanitary institution the backhouse, far from passing away, as mournfully sung by James Whitcomb Riley, has only just come into its own. During a four-year period from 1933 to 1937, for example, about a million and a half sanitary privies were constructed under the general supervision

[2]Deuteronomy 23:12, 13.

of the United States Public Health Service or a sufficient number, if placed on 8-foot centers, to establish a "cordon sanitaire" of more than 2000 miles.

The Fifth Labor of Hercules

Still stranger, perhaps, than the reluctance of men to heed Mosaic authority is the lapse in time between the conception of the water-carriage system of waste disposal and its permanent institution in civilized communities—beginning with London in 1847. No one can set the date of its conception, because it lies within the dawning beauty of Hellenic thought. Then Hercules, son of Amphitryon and Alcmene, to expiate his sins, performed great feats of strength that are the more remarkable in that they were aided in large measure by the exercise of common sense. The fifth labor of Hercules, you will remember, was the cleaning of the Augean stables, and that tragically irascible Paul Bunyan of Greek folklore invented the water-carriage system for this purpose. In execution, the Herculean method was the prototype, in particular, of the Chicago Drainage Canal which, as recommended by Hering in 1887, diverted (reversed) the Chicago River that it might carry away the wastes from the stockyards as well as from the dwellings of our midwestern metropolis.

Rome

Proud though every engineer must be in contemplation of structures such as the Pont du Gard or the Aqueduct of Segovia, it is the evolution of thought in Sanitation, rather than deed, that I wish to pursue in this address. For this reason, there cannot be included in this roster of service to Sanitation the names of men like Vitruvius or Frontinus—may the shade of Clemens Herschel, patron of this Society and of my School forgive me.

Among Romans, I praise Belisarius, faithful general of the Emperor Justinian. According to Procopius, the diligent historian of his campaigns, Belisarius recognized the importance of safe disposal of excreta for the avoidance of camp (typhoid) fever. The great strategist of Western Rome became more real to me some years ago when, at a country auction, I bought an etching by Desnoyers that depicts Belisarius in his old age when he had lost Justinian's favor.[3]

[3]Edward Gibbon, "The History of the Decline and Fall of the Roman Empire" (1776-1782).

The Dark Ages and the Renaissance

The rift between godliness and cleanliness that characterizes the Middle Ages accounts for their barrenness of sanitary thought. Epidemic diseases cut wide swaths of destruction across the known world, and quarantine was the only measure of control reluctantly instituted by princes and potentates. Absorbed in speculation upon individual responsibility, the great men of the Renaissance, too, contributed but little of direct advantage. By contrast the magnitude of subsequent events is magnified even beyond their inherent greatness.

The Great Sanitary Awakening

"The scientific Renaissance" made its belated entry in the eighteenth century to fuse with the humanitarian spirit of this and the succeeding era into the Great Sanitary Awakening that swept over Britain and hurdled the Atlantic in the middle of the nineteenth century to make our own Boston the focal point for the sanitary awakening of America.

It seems important to stress the fact that the modern public health movement, of which Sanitation was a primary part, was not alone the outcome of scientific and engineering progress, but that it had its roots deep in an aroused humanitarianism, in a militant pity for the weak, the poor, the unfortunate, and the sick in body and in mind. This wellspring of our profession we are all too likely to forget in the brick and mortar, or reinforced concrete, of health units and sanitary works that gleam with stainless steel and are resplendent in flood-lit mechanical efficiency.

John Howard, Sheriff of Bedfordshire

It may be wholesome, too, for us to remember the humble beginning of the Great Sanitary Awakening in the campaign for prison reform by John Howard, who was elected Sheriff of Bedfordshire in 1773. Appalled at the conditions he found in his own county, he visited the gaols of his neighboring shires and of the Continent, only to find that they were no better than his own. In 1774, therefore, he presented his findings to Parliament, which passed a bill for the betterment of the sanitary conditions of prisons, in which, to be sure, whitewash seems to have played a disproportionately large part, but water supply and general cleanliness also received their share of regulation.

The laws of Massachusetts requiring the approval of places of detention by the Department of Public Health may well be a vestige of John Howard's campaign.

The Growth of Cities

Scientific discovery and engineering invention heralded the nineteenth century and with it the Age of Power and the Industrial Revolution. What they have meant to progress may be measured as a whole by the ability of the world, since their inception, to double its population. Power and invention created industry; industry, in turn, gave mass employment and its localization forced the herding together of people under conditions, at first not dissimilar from those encountered by John Howard in his circuit of the gaols of England. In particular did the need for a more abundant distribution of water and for more effective disposal of human excrement make itself felt. It must be realized that at this time fecal matter and urine were still being deposited in privy vaults in urban centers and that the discharge of these wastes into sewers was forbidden well into the nineteenth century. The great sewers of antiquity—the *cloaca maxima,* for example —were storm-water drains and not combined sewers. Only on occasion and then illicitly were waste matters emptied into them. Not until 1815 was the discharge of fecal matter into the drains of London permitted, while in Boston regulations kept even the liquid overflow from privy vaults out of the sewers until 1833.

Obviously such drains as were in existence had been constructed so as to empty into the nearest water course. When human wastes were discharged into them, therefore, it was not long before it was discovered that the new practice had not solved the problem. All it had done, in fact, was to shift the nuisance of inadequate waste disposal away from the immediate vicinity of habitations to the natural water courses that previously had received only the stormwater flow of the drains. In these receiving waters, the wastes from large numbers of people were suddenly concentrated to create conditions that are best described in the words of the times. A few excerpts from contemporary reports are given for this purpose.

Sanitary Conditions in Great Britain

The report on the "Sanitary Condition of the Labouring Population of Great Britain" (1842) records the following:

"In the parish of Modbury, many of the dwellings of the poor are arranged round narrow courts having no other opening to the main street than a narrow covered passage. In these courts there are several occupants, each of whom has accumulated a heap. In some cases, each of these heaps is piled up separately in the court, with a general receptacle in the middle for the drainage. In others a pit is dug in the middle of the court for the general use of all the occupants. In some the whole courts up to the very doors of the houses are covered with filth. Around this mass, the cottages of the residents are arranged, having no back outlet, no back windows, or other means of ventilation. The windows and doors of the houses open and look towards this mass; and all the air supplied to the inmates is obtained through these doors and windows. The residents I learnt were very frequently subject to fever, and were always regarded as the first to be affected by any epidemic disease."

In Budd's "Typhoid Fever" (1873) we may read about the condition of the Thames during the hot months of 1858 and 1859.

"For the first time in the history of man, the sewage of nearly three millions of people had been brought to seethe and ferment under a burning sun, in one vast open *cloaca* lying in their midst.

"The result we all know. Stench so foul, we may well believe, had never before ascended to pollute this lower air. Never before, at least, had a stink risen to the height of an historic event. Even ancient fable failed to furnish figures adequate to convey a conception of its thrice Augean foulness. For many weeks, the atmosphere of Parliamentary Committee-rooms was only rendered barely tolerable by the suspension before every window, of blinds saturated with chloride of lime, and by the lavish use of this and other disinfectants. More than once, in spite of similar precautions, the law-courts were suddenly broken up by an insupportable invasion of the noxious vapor. The river steamers lost their accustomed traffic, and travellers, pressed for time, often made a circuit of many miles rather than cross one of the city bridges.

"For months together, the topic almost monopolised the public prints. Day after day, week after week, the 'Times' teemed with letters, filled with complaint, prophetic of calamity, or suggesting remedies. Here and there, a more than commonly

passionate appeal showed how intensely the evil was felt by those who were condemned to dwell on the Stygian banks. At home and abroad, the state of the chief river was felt to be a national reproach. 'India is in revolt, and the Thames stinks,' were the two great facts coupled together by a distinguished foreign writer, to mark the climax of a national humiliation. But more significant still of the magnitude of the nuisance was the fact that five millions of money were cheerfully voted by a heavily taxed community to provide the means for its abatement. With the popular views as to the connection between epidemic disease and putrescent gases, this state of things naturally gave rise to the worst forebodings."

Sanitary Conditions in America

American experience did not differ greatly. The "Report of the Council of Hygiene and Public Health of the Citizens' Association of New York upon the Sanitary Condition of the City" (1865) gives the following account of sanitary conditions in the 4th and 16th inspection districts:

Fourth Inspection District.

"The number of inhabited basements and cellars is 224, occupied by 268 families, or about 1,400 persons. Their depth below the 'curb' or street level varies from 2 to 8 feet, averaging about 4½ feet."

"They are all damp, those in the least elevated localities, of course, being most so. In very many cases the vaults of privies are situated on the same or a higher level, and their contents frequently ooze through walls into the occupied apartments beside them. Fully one-fourth of these subterranean domiciles are pervaded by a most offensive odor from this source, and rendered exceedingly unwholesome as human habitations. These are the places in which we most frequently meet with typhoid fever and dysentery during the summer months."

Sixteenth Inspection District.

"Location and care of Privies.—These form one of the chief features of insalubrity. Nearly all of them are too small in size and too few in number, and without ventilation or seat-covers. About twelve were found full to the floor timbers, or within one foot of them. In some cases the doors were found locked securely,

and on procuring the key and inspecting the privy, such masses of human excrement were found on the seats and floors as would justify the locking of the door to protect unwary persons from injury. Occupants of rear buildings are the principal sufferers from this insalubrity. The proximity of privies is in some cases eight feet from the windows of rear houses; the odor in these is, especially at night, intolerable."

For Boston we may let Eliot C. Clarke's report on the "Main Drainage Works of the City of Boston" (1885) quote one of the Annual Reports of the Board of Health:

"Complaints of bad odors have been made more frequently during the past year than ever before.

"They have come from nearly all parts of the city, but especially and seriously from the South and West Ends.

"Large territories have been at once, and frequently, enveloped in an atmosphere of stench so strong as to arouse the sleeping, terrify the weak, and nauseate and exasperate everybody.

"It has been noticed more in the evening and by night than during the day; although there is no time in the whole day when it may not come.

"It visits the rich and the poor alike. It fills the sick-chamber and the office. Distance seems to lend but little protection. It travels in a belt half-way across the city, and at that distance seems to have lost none of its potency, and, although its source is miles away, you feel sure it is directly at your feet. . . .

"The sewers and sewage flats in and about the city furnish nine-tenths of all the stenches complained of.

"They are much worse each succeeding year; they will be much worse next year than this.

"The accumulation of sewage upon the flats and about the city has been, and is, rapidly increasing, until there is not probably a foot of mud in the river, in the basin, in the docks, or elsewhere in close proximity to the city, that is not fouled with sewage."

Coleridge on Cologne

Samuel Taylor Coleridge put his own observations of the City of Cologne, which he visited about 1798, into verse, and after recording "two-and-seventy stenches, all well defined, and several stinks," he asks this question:

"The river Rhine, it is well known,
Doth wash your city of Cologne;
But tell me nymphs! What power divine
Shall henceforth wash the river Rhine?"

Chadwick and Simon

Such is the record of conditions. The men who guided sanitary thought out of this morass were many: doctors, lawyers, engineers and statesmen. Towering above all was Sir Edwin Chadwick (1800-1890), a lawyer by training, a crusader for health by choice. His was the chief voice in the report on the "Sanitary Condition of the Labouring Population of Great Britain" (1842). Ingenuous as well as ingenious in his support of sanitary reform "he probably hoped to achieve in a few years the results which not ten times his few years could see achieved; and where on all sides were hanging back, his ardour seemed ready to undertake the work of all."[4] Engineers are indebted to him not only for his general contributions to the advancement of the public health but also for his specific interest in sanitary works including his advocacy of employing pipe sewers and separate systems of sewerage.

Closely associated with Chadwick was Sir John Simon (1816-1904), first Medical Officer of Health of London and author of "English Sanitary Institutions" (1890).

Drs. Snow and Budd

The labors of two outstanding medical men fall into this period of the Great Sanitary Awakening: those of John Snow (1813-1858) who demonstrated to a world that had not yet witnessed the discoveries of Pasteur (1822-1895) that fecal pollution of drinking water was a major factor in the conveyance of cholera; and those of William Budd (1811-1880) who from 1857 onward investigated the nature and mode of spreading typhoid fever.

Of Snow, his friend Richardson[5] writes:

> "For John Snow, as a representative man of medicine of the Victorian era, we may claim the poetic thought, less the poetic expression, combined with industry, perseverance, and the cour-

[4]Sir John Simon as quoted by C.-E. A. Winslow, "The Evolution and Significance of the Modern Public Health Campaign" (1923).
[5]B. W. Richardson, "John Snow, M.D." (1887).

age to express his opinions boldly when founded on what he honestly felt to be the truth, and, if not the whole truth, nothing but the truth."

Tyndall[6] has referred to Budd as "a man of genius withdrawn from the stimulus of the Metropolis and working alone at a time when the whole medical profession of England entertained views opposed to his." Snow's paper "On the Mode of Communication of Cholera" (1849 and 1854) and Budd's "Typhoid Fever, Its Nature, Mode of Spreading and Prevention" (1873) should be familiar to every sanitary engineer.

Shattuck and Smith

In this country, we find the counterpart of Edwin Chadwick in Lemuel Shattuck and of Dr. John Simon in Dr. Stephen Smith. Shattuck was the principal author of the "Report of the Massachusetts Sanitary Commission" (1850))which led eventually to the creation of the Massachusetts State Board of Health (1869). Stephen Smith was in charge of the "Report of the Council of Hygiene and Public Safety of the Citizens' Association of New York upon the Sanitary Condition of the City" (1865) which forced the passage of the Metropolitan Health Law (1866).

Of Lemuel Shattuck (1793-1859), like Chadwick a layman. Dr. Henry I. Bowditch, First Chairman of the Massachusetts State Board of Health, says:[7]

> "I remember him well. Calm in his perfect confidence in the future of preventive measures to check disease, he walked almost alone in the streets of his native city not only unsustained by the medical profession, but considered by most of them as an offense, for his earnest defense of what seemed to the majority of us physicians out of a layman's sphere, and withal, of trifling moment compared with our usual routine of so-called 'practice'."

Stephen Smith (1823-1922) one must let speak for himself in his book "The City That Was."

Conclusion

These are not all of my friendships, but they are enough to trace the ever-widening stream of sanitary thought. Because of the absence

[6]As quoted by W. T. Sedgwick in his Introduction to "Typhoid Fever" by George C. Whipple (1908).
[7]See George C. Whipple, "State Sanitation" (1917).

of fellow engineers, it might appear as if engineers could find scant comfort in this selection. If this be so, let us turn in closing to the admonition of one Great Man and to the encouragement of another. These may be of assistance, too, in calming the spirit of unrest and dissatisfaction that appears to be abroad among engineers, manifesting itself particularly in a desire for greater social recognition and for responsibilities beyond those of creating great and useful works for the benefit of mankind. St. Paul[8] admonishes: "And having gifts differing according to grace that was given to us, whether prophecy, let us prophesy according to the proportion of our faith; or ministry, let us give ourselves to our ministry; or he that teacheth, to his teaching; or he that exhorteth, to his exhorting: he that giveth, let him do it with liberality; he that ruleth, with diligence; he that showeth mercy, with cheerfulness." Should we not add: he that buildeth, let him do it well?

Dissatisfaction is by no means unusual nor is it to be deplored, within bounds. Does it not drive man to ever greater achievement! Dissatisfaction, according to Goethe's version of the legend of Dr. Faustus, sealed that Scholar's bargain with the Devil that he might find a single fleeting moment that he would care to arrest because its content truly satisfied. After running the gamut of human experiences —engineers should be encouraged to remember—Faust at last finds satisfaction in a great engineering undertaking that Goethe must have envisaged on his Italian Journey and that is but now being accomplished in fact: the draining and resettlement of the Pontine Marshes. These lands, long abandoned under the scourge of malaria, lie to the south of Rome between the spurs of the Apennines and the dunes of the Tyrrhenian Sea. To quote Faust:[9]

"Below the hills a marshy plain.
Infects what I so long have been retrieving;
This stagnant pool likewise to drain
Were now my latest and my best achieving.
To many millions let me furnish soil,
Though not secure, yet free to active toil;
Green, fertile fields, where men and herds go forth
At once, with comfort, on the newest Earth
And swiftly settled on the Hill's firm base,

[8]Epistle to the Romans 12: 6, 7.
[9]As translated by Bayard Taylor (1871).

Created by the bold, industrious race.
A land like Paradise here, round about:
Up to the brink the tide may roar without,
And though it gnaw, to burst with force the limit,
By common impulse all unite to hem it.
Yes! to this thought I hold with firm persistence;
The last result of wisdom stamps it true:
He only earns his freedom and existence,
Who daily conquers them anew.
Thus here, by dangers girt, shall glide away
Of childhood, manhood, age, the vigorous day:
And such a throng I fain would see—
Stand on free soil among a people free!
Then dared I hail the Moment fleeing:
'Ah, still delay—thou art so fair!'
The traces cannot, of mine earthly being,
In aeons perish,—they are there!—
In proud fore-feeling of such lofty bliss,
I now enjoy the highest Moment,—this!"

DISCUSSION OF PROBLEMS OF SEWERAGE AND SEWAGE DISPOSAL IN METROPOLITAN BOSTON

By Harrison P. Eddy, Jr. and Almon L. Fales*

(Presented at a meeting of the Boston Society of Civil Engineers held on January 24, 1940)

For many years the pollution of Boston Harbor by the sewage of Metropolitan Boston has been a matter of sufficient concern and complaint to have occasioned numerous investigations and reports by commissions and boards of engineers. Complaints have also been made of pollution of the rivers in the Metropolitan area by wastes from industries and overflows from combined and misused separate sewers.

Under the provisions of Chapter 79 of the Resolves of 1938 of the General Court of Massachusetts, a Special Commission was created to investigate the systems of sewerage and sewage disposal in Metropolitan Boston. In connection with its investigation, the Special Commission retained the firms of Greeley and Hansen and Metcalf & Eddy as consulting engineers to investigate and report upon the following two major subjects:

1. Pollution in the Mystic River and its major tributaries and in the Charles River, and methods of correction.
2. Proposed methods of sewage treatment for the three main outlets.

The problem involved the determination of the need of, and suitable methods for, abatement of the pollution of the rivers in Metropolitan Boston and of Boston Harbor, and the probable costs of needed remedial sewerage works.

In their investigation, the consulting engineers reviewed the extensive information and data on the subject, made available to them by the Metropolitan District Commission, the State Department of Public Health, and the City of Boston, and the evidence obtained by the Special Commission, and made personal examination of the pertinent parts of Metropolitan Boston and Boston Harbor, and of the

*Partners, Metcalf & Eddy, Engineers, 1300 Statler Building, Boston, Mass.

main structures of the sewerage works. The report of the consulting engineers was published in the Report of the Special Commission dated June 15, 1939 (House No. 2465). This discussion is based on that report.

General Conditions

The natural watershed of Boston Harbor has an area of about 645 sq. mi. (square miles), of which 350 sq. mi. are within the area ultimately to be tributary to the main outlets of the sewerage systems of Metropolitan Boston. In the entire area naturally tributary to Boston Harbor, there are 53 cities and towns of which 32 contribute sewage to the three main outlets in Boston Harbor, and service is available to one other town which now has no sewers. The principal streams tributary to Boston Harbor are the Neponset, Charles and Mystic rivers.

The Neponset River discharges into Dorchester Bay at the northerly limits of the city of Quincy. It has a drainage area of about 117 sq. mi. A number of industries discharge wastes into the Neponset River although the quantity is much less since the Neponset Valley Sewer was provided several years ago. The Neponset River is not much used for recreation.

The Charles River, which has a drainage area of 298 sq. mi., rises some 25 miles southwest of Boston and discharges into Boston Harbor at the dam between Charlestown and Boston proper. This river is used extensively for recreation. During the spring, summer and fall, there are many racing shells and sail boats on the waters of the Charles River Basin, and there is much canoeing on the upper reaches of the river.

The Mystic River which has a drainage area of about 72 sq. mi., discharges into Boston Harbor, after its junction with Chelsea Creek, between Charlestown and East Boston. Below the Cradock Dam in Medford, the river is an estuary of Boston Harbor. There are numerous wastes-producing industries within the drainage area of the Mystic River. The principal tributaries of the Mystic River are the Aberjona River with a drainage area of 28.5 sq. mi., Alewife Brook with a drainage area of 7.08 sq. mi. and Malden River with a drainage area of 11.0 sq. mi. The upper portions of these streams are extensively used for recreation and marginal parkways. Along the western boundary of Medford, the Mystic River expands into the Mystic Lakes which are much used for boating, bathing and general recreation.

General Description of Existing Sewerage Works

The main sewerage systems of Metropolitan Boston are shown in Fig. 1.

The Boston Main Drainage System, which was originally constructed during the period of 1877 to 1884, now receives the sewage from Boston proper, South Boston and parts of the Back Bay, Roxbury, Dorchester, West Roxbury, Squantum and Milton. This system was designed to intercept the sewage discharging into the harbor through many outlets and to divert it to an outlet off Moon Island, where there is a depth of about 5 ft. of water at mean low tide.

Sewage from the Boston Main Drainage System is conducted to a pumping station at Calf Pasture in Dorchester, where it passes through cage screens having openings 2¾ in. wide, the screenings being drained and burned under the boiler. The sewage is then lifted about 36 ft. to two deposit sewers each 8 ft. wide, 16 ft. deep and 1260 ft. long, providing a velocity of about 1 ft. per second at the average rate of sewage flow. The accumulation in the deposit sewers is blown into the harbor once a year and the material there deposited is dredged from time to time. From the deposit sewers, the sewage passes through the Dorchester Bay Tunnel to Squantum and thence through the outfall sewer to Moon Island. Here the sewage is stored in four large tanks with a total working capacity of about 35 mil. gal. from which it was originally intended to be discharged into the harbor only on the second and third hours of the outgoing tide. In recent years, however, the quantity of sewage has been so great that it has been necessary at times to discharge the sewage at other stages of the tide.

The South Metropolitan Sewerage System serves Waltham and Watertown on the north side of the Charles River and areas to the west and south of that served by the Boston Main Drainage System. The sewage from the South Metropolitan District is conducted to Nut Island in Quincy, where it passes through grit catchers and cage screens with openings 1 inch wide and then discharges through one or more of three 60-inch cast iron pipes to outlets located northwest of Peddock's Island. The depth of water at mean low tide is 30 ft. at two of these outlets and 20 ft. at the other which is considered an emergency outlet. The screenings are pressed and burned under the boiler.

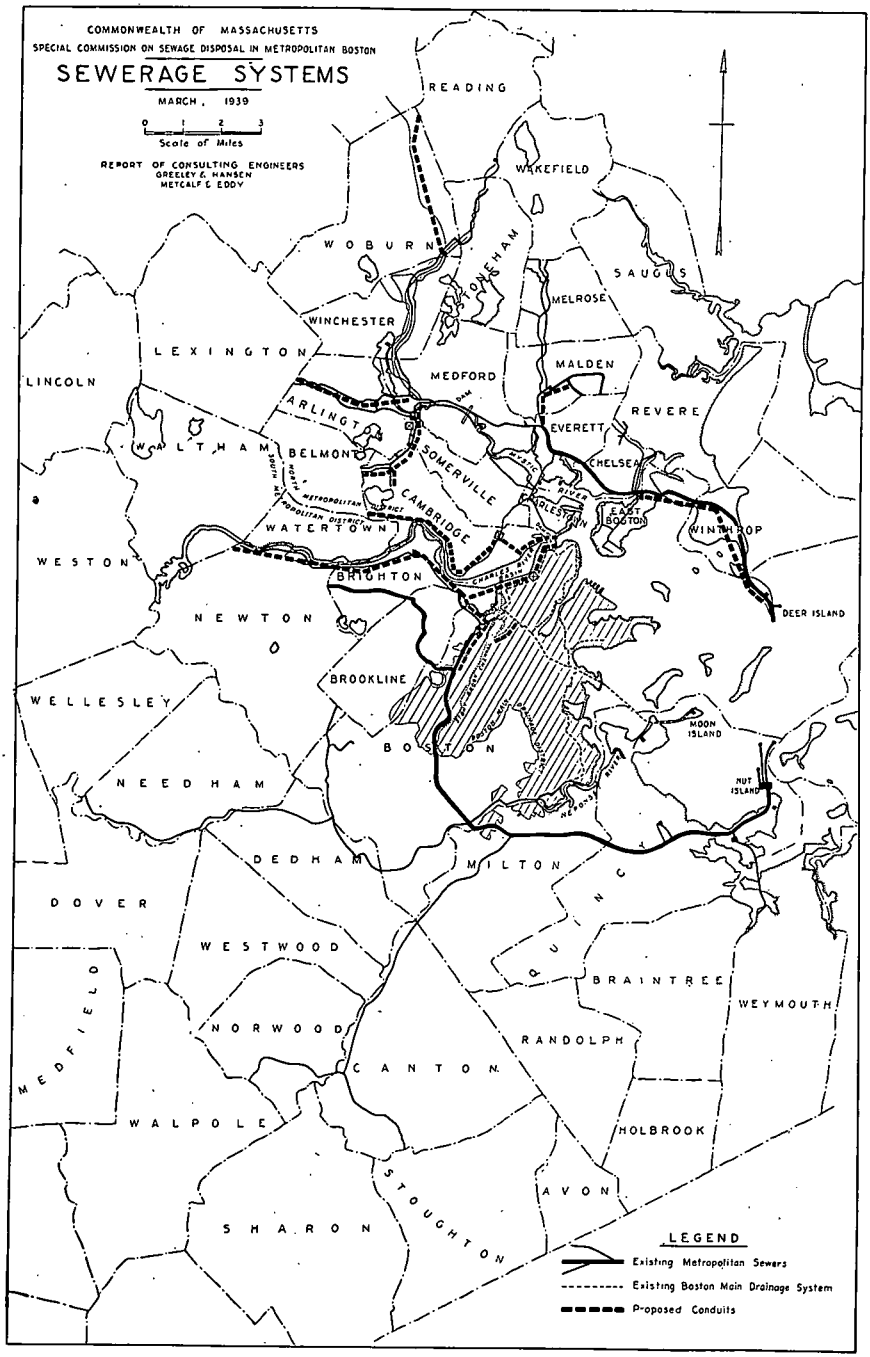

FIG. 1.—SEWERAGE SYSTEMS IN METROPOLITAN BOSTON

The North Metropolitan Sewerage System serves the area north of the Charles River, except Waltham and Watertown, with a system of trunk sewers extending up the north side of the Charles River and up the Mystic River and each of its tributaries. The sewage from the North Metropolitan District discharges to a pumping station in East Boston and is lifted about 15 ft. into a trunk sewer passing through East Boston, under Belle Isle Inlet, across Winthrop where it receives the sewage from this town and under the former location of Shirley Gut now filled in, to a pumping station at Deer Island. There it is lifted 6 to 17 ft., depending upon the stage of the tide, and flows by gravity to the outlet conduit passing into the harbor through multiple outlets near Deer Island Light. At both of these pumping stations, the sewage is passed through cage screens having openings 2¾-in. wide and the screenings are burned under the boilers.

Populations

The estimated 1935 resident population in each of the three sewerage districts and the estimated population in each contributing sewage, based partly on the Massachusetts State Census and partly on the estimates made jointly, late in 1938, by the Massachusetts State Planning Board and the Massachusetts Department of Public Health, were as follows:

Sewerage District	Resident Population in 1935	Population Contributing Sewage in 1935
North Metropolitan	740,585	696,470
South Metropolitan	844,318	643,690
Boston Main Drainage	415,524	415,524
Total	2,000,427	1,755,684

The estimates of future populations are shown graphically in Fig. 2 where they may be compared with the estimated future population of the State as a whole.

For the North Metropolitan District, consideration has been given to the estimate of the Metropolitan Planning Division based on a survey made in 1927 and 1928; an informal estimate by the birth-rate, death-rate and migration method; the estimate recently made jointly by the Massachusetts State Planning Board and the Massa-

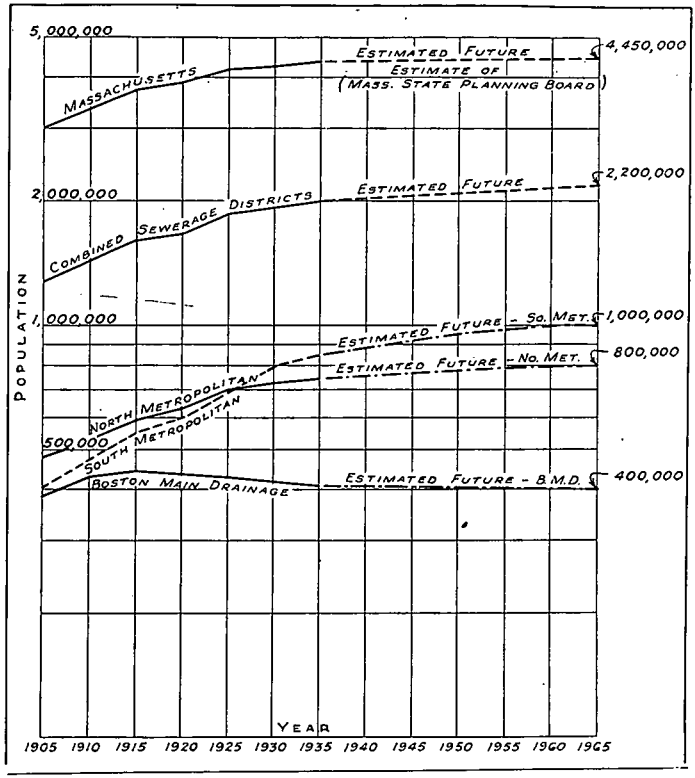

FIG. 2.—ESTIMATES OF POPULATION FOR EACH SEWERAGE DISTRICT OF METROPOLITAN BOSTON

chusetts Department of Health; and recent estimates of the Sewerage Division of the Metropolitan District Commission. For comparative purposes, these estimates are shown graphically in Fig. 3.

For purposes of design of conduits in the North Metropolitan District, the "most probable" estimates of the Sewerage Division of the Metropolitan District Commission for 1965 were adopted, but they were deemed applicable for the year 1975 for which conduits should be designed. For use in designing conduits, it was necessary to consider the future population, not only in the entire district but also in the individual cities and towns through which the conduits would be built.

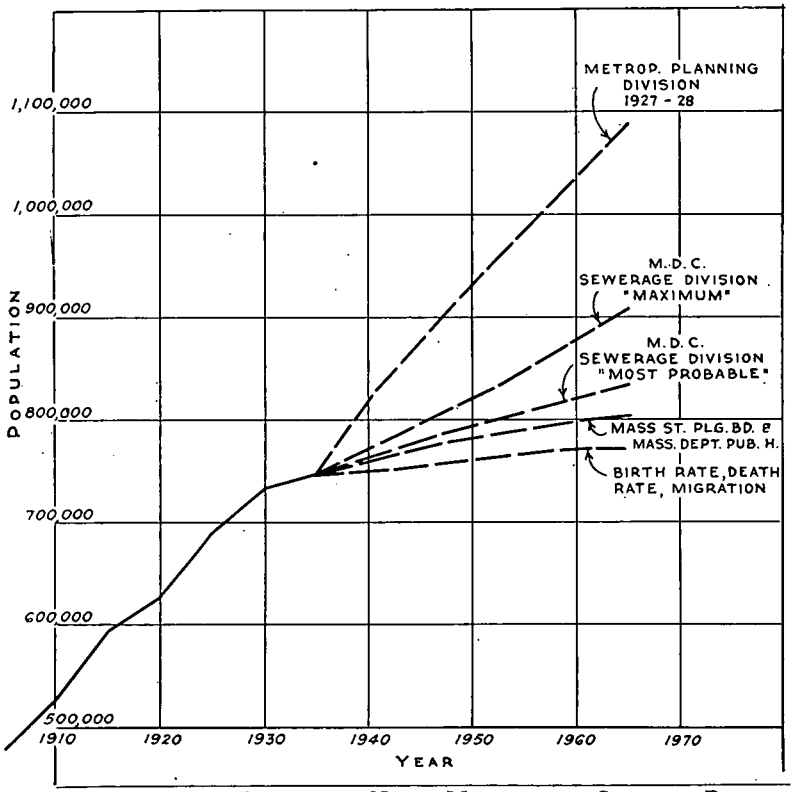

FIG. 3.—ESTIMATES OF POPULATION, NORTH METROPOLITAN SEWERAGE DISTRICT

RIVER POLLUTION PROBLEMS

In recent years, the waters of the Mystic River and its tributaries and of the Charles River have at times been found to be polluted in such degree as to raise the question whether their continued use for bathing should be permitted. At two beaches, the State Department of Public Health found it necessary to recommend that bathing be prohibited. Pollution of some of the areas was attributed to the overflow of sewage from the sewers. The water of the Charles River Basin was not found to be in an objectionable condition except when sewage was overflowing into it.

The recent construction of the Mystic River Relief Sewer and its extension downstream in the form of the North Metropolitan Relief Sewer is said to have effectively prevented overflows of sewage

into the Mystic River and Lakes along the course of these sewers, when operating normally. It is understood, however, that overflows still occur from the Alewife Brook sewer, the lower end of the Arlington sewer, the Malden River sewer, and the North Metropolitan sewer where it has not yet been relieved. It is also understood that the Aberjona River sewer of Woburn would have insufficient capacity if the industries connected with it were operating at normal production.

A large part of the North Metropolitan District is served by combined sewers intended to carry both storm water and sewage. The remainder of the area is served by separate sewers that have been misused to a greater or less extent by the admission of storm water which they were not intended to carry. These sewer systems are so designed that the flows in excess of the sewer capacity are discharged directly into the nearest watercourse, but intercepting sewers collect the dry weather flow for delivery to the outlets in the harbor. Since the capacity of the intercepting sewers is insufficient for much storm water, a large quantity of sewage in time of storm is discharged directly into the streams through numerous overflow channels provided for the purpose.

Similar conditions exist in the South Metropolitan District where combined sewers serve Boston, Brighton and a portion of Brookline, and where the separate systems in much of the remainder of the district have been misused by the admission of storm water.

Three possible methods of abatement of the pollution of the streams are:

(1) by local treatment of the overflows;
(2) by separation of storm water from the sewage so that existing intercepting sewers will carry sewage only for which they may already have adequate capacity; and
(3) by the construction of storm overflow conduits to intercept a large proportion of the storm overflows.

Consideration was given to the collection of the storm overflows, treating them locally and discharging the treated sewage into the streams. For various reasons, this method was not recommended. The solution of the problem by the separation of storm water from the sewage was considered impracticable under the existing conditions. The conclusion was reached that abatement of the pollution of the streams can best and most economically be accomplished by the con-

struction of storm overflow conduits of sufficient capacity so that no overflows into the streams will occur until the volume of storm water flowing in the sewers has provided sufficiently great dilution of the domestic sewage to prevent objectionable conditions from the overflows.

The dilution factors adopted were as follows:

Area	Dilution Factor
Tributary to the Mystic Lakes and the Mystic River above tidewater	10
Tributary to the Charles River and situated on the north side and on the south side above the Back Bay Fens	10
Tributary to the Charles River on the south side below the Back Bay Fens	15
Tributary to channels which discharge directly into tidewater	3

Proposed Storm Overflow Conduits

In the design of the proposed storm overflow conduits, consideration was given to the quantities of domestic sewage, industrial wastes, and ground water infiltration. It was assumed that the average flow of domestic sewage is equal to the average water consumption. The allowance made for the maximum rate of discharge of industrial wastes was 13,000 g.a.d. (gallons per acre per day) in areas now zoned for industrial purposes, where it seems reasonable to expect the location of industries producing liquid wastes. In some cases, however, special allowances were made either greater or less than 13,000 g.a.d. where it seemed advisable to do so. It was pointed out that the ground water which leaks into the sewers is just as effective as storm water for diluting the sewage.

The storm overflow conduits which were proposed for construction are shown in Fig. 1. In general they were planned to be built near the existing intercepting sewers.

The length and diameter of the proposed conduits and the estimated costs of construction, including pumping stations and force mains where required, are summarized in the following table, the total estimated construction cost being $14,695,000.

Description of Improvement	Length of Conduit or Sewer Mi.	Diameter of Conduit or Sewer In.	Estimated Cost of Construction
Alewife Brook conduit and pumping station	2.64	51-81	$ 875,000
Arlington conduit	1.18	36-66	380,000
Aberjona River conduit	4.24	42-54	675,000
Charles River works on north side, including pumping station	5.85	39-78	1,210,000
Malden River conduit	1.89	21-63	345,000
North Metropolitan relief sewer, including East Boston pumping station	5.76	126	4,160,000
Charles River works on south side, including pumping station	11.57	63-141	6,210,000
Stony Brook relief sewer	0.71	84-93	340,000
East Concord Street pumping station	——	——	500,000
Total			$14,695,000

Pollution of Boston Harbor

Fig. 4 is a map of Boston Harbor showing the location of the main sewer outlets.

The waters of Boston Harbor are extensively used for shipping, sailing, bathing, and, to some extent, for shellfish culture.

The principal effects of the discharge of sewage into Boston Harbor are the following:

(a) Sleek areas and sewage fields about the sewer outlets.
(b) Objects of sewage origin floating on the waters or stranded on the shores.
(c) Depletion of dissolved oxygen in the harbor waters.
(d) Sewage sludge deposits.
(e) Bacterial contamination of the harbor and shore waters.

Sleek, or calm oily areas, and sewage fields where the composition of the waters has been materially affected by the sewage, now extend over large portions of Boston Harbor and penetrate into Quincy Bay.

Although the bathing beaches in general are not greatly affected by grease balls and other visible objects of sewage origin in the waters

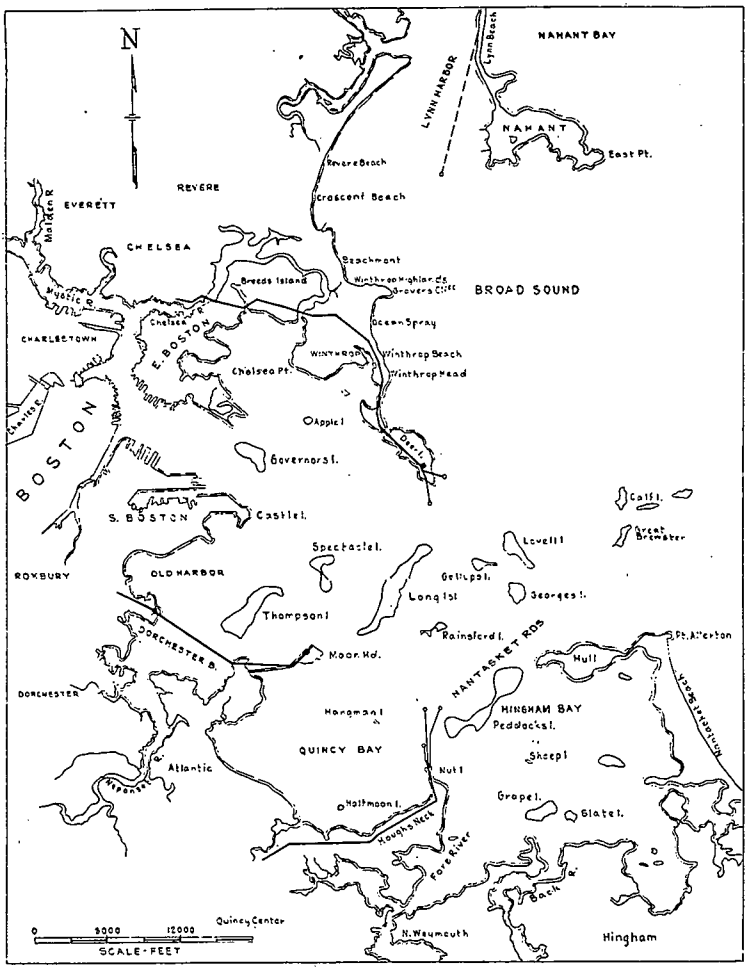

FIG. 4.—LOCATION OF MAIN SEWER OUTLETS INTO BOSTON HARBOR

or stranded along the shore, there are evidences that such pollution does occur in places and with sufficient frequency to impair some of the bathing beaches.

Except to a minor degree and for small areas only, the content of dissolved oxygen of the harbor waters is not so low as to indicate excessive organic pollution.

At practically all harbor sampling stations, the mud samples

contained many more bacteria characteristic of sewage pollution than did the water at the surface above. The stirring up of the mud by strong on-shore winds is a potential source of excessive bacterial pollution of the shore waters.

After consideration of standards for bacterial quality of bathing beach waters, proposed or adopted elsewhere, it was assumed that for the bathing beach waters of Boston Harbor, a single B.coli index of 1,000 per 100 c.c. (cubic centimeters) is a warning that excessive contamination may be present at times, and that an average index in excess of 3,000 B.coli per 100 c.c. shows that the waters may be dangerous to the public health.

A study of the available bacteriological data showed that the bacterial content of the shore waters of the harbor, as evidenced by the B.coli index, is in some places considerably higher at times than what is generally considered a reasonable upper-limit for the safety of bathing-beach waters. Furthermore, the proximity to the shore of harbor waters highly contaminated by sewage from the main outlets is a potential source of excessive bacterial pollution which is sure to increase in the future unless remedial measures are taken.

The conclusion was reached that the polluted harbor waters are not only objectionable in appearance but are potentially dangerous to the public health to such an extent that corrective and preventive measures should be undertaken as soon as practicable by the construction of sewage treatment works. It was considered economically inadvisable to attempt to remedy the objectionable conditions by extension of the outfall sewers.

Required Treatment of Sewage

In order to avoid the objectionable effects of discharging untreated sewage through the main outlets in Boston Harbor, it will be necessary to treat the sewage (1) to remove the floating solids; (2) to remove grease or oil; (3) to reduce the amount of suspended solids capable of forming sludge deposits; and (4) to prevent excessive bacterial pollution of harbor and shore waters during the recreational season.

The floating solids may be removed by suitable tanks provided with mechanical skimming devices, special precautions being required to prevent the escape of such matters in the effluent.

Some grease or oil will be removed with the floating solids on skimming the tanks. In order to increase the amount of grease which can be so removed, it is advisable to provide pre-aeration and chlorine treatment of the sewage in relatively small "aero-chlorinating tanks." The scum removed should be burned in a suitable incinerator.

Tanks for the removal of floating solids and grease will also accomplish the removal of a considerable proportion of the suspended solids in the form of sludge which should be continually removed from the tanks by mechanical means. The least expensive method of disposal of this sludge will be barging to sea where it may be discharged without causing complaint.

The excessive bacterial pollution of harbor and shore waters during the season of recreation can be prevented by disinfection of the sewage with liquid chlorine by means of suitable chlorinators.

The sewage should first be passed through coarse, hand-cleaned racks, having openings about 4 in. wide to protect pumps and other mechanical equipment.

In order to facilitate the handling of the sludge and scum, the sewage should then be passed through mechanically cleaned racks having openings about ¾-in. wide for removing coarse suspended matters and mechanically cleaned grit chambers providing a velocity of 0.5 to 1.0 f.p.s. (feet per second) for removing heavy material like sand. The mechanically cleaned racks would replace the existing cage screens which are obsolete. The screenings removed from the racks should be burned in a suitable incinerator. The material removed from the grit chambers may be used for fill in the vicinity of the sewage treatment plant, or it may be barged to sea with the sludge.

A suitable meter will be needed for indicating and recording the flow of sewage.

Sewage pumping station changes and additions must be made as required by the treatment and disposal of the sewage.

The aero-chlorinating tanks, or channels, should provide a detention period of three or four minutes at the average rate of flow. An average air supply of about 0.02 cu. ft. per gallon of sewage, using spiral circulation, and an average chlorine supply of 2 to 3 p.p.m. (parts per million) or about 17 to 25 lb. per million gallons, will be required for this treatment.

The sedimentation tanks should have a detention period of not

less than one hour at the average rate of flow. This will provide a detention period of somewhat more than 20 min. for storm flows three times the average dry weather flow. These tanks may be either round or rectangular in horizontal cross section, and in either case should be provided with mechanical means for skimming and for removal of sludge, as previously indicated.

For disinfection of the sewage during the season of recreation, chlorination equipment will be required capable of introducing 15 to 20 p.p.m., or 125 to 167 lb. per million gallons, at 150% of the average dry weather flow. The chlorine may be introduced into the influent of the sedimentation tanks which will provide ample contact period for disinfection.

Sludge pumping equipment will be required to pump the sludge to storage tanks from which it will be discharged to the sludge vessel or barges for disposal at sea. It is advisable to provide for a week's storage of the sludge to allow for unfavorable weather conditions for transportation to sea.

In the cost estimates, it was assumed that sea-going sludge vessels will be used, similar to those in use for New York City for the disposal of sludge at sea. A suitable ship channel, turning basin and dock should be provided at the treatment plant.

In the design of sewage treatment plants, provision will have to be made for control of odors, particularly from the sludge storage tanks.

It is proposed that the sewage treatment plants be built on existing land or land made by hydraulic fill as conditions may require. A suitable sea wall or embankment will be necessary.

It was considered reasonable to design the sewage treatment plants for the year 1955 and to enlarge them thereafter as found necessary. It was anticipated that the sewage treatment plants probably could not be completed before 1943. It was indicated that space and head should be provided for more complete treatment in the future if and when required.

Sewage Treatment Project for South Metropolitan District

The population of the South Metropolitan District that will be contributing sewage in 1955, the year for which it is proposed to design the sewage treatment plant, has been estimated at 900,000.

The average dry weather flow of sewage from the South Metropolitan District in 1955 has been estimated at 90 m.g.d. (million gallons per day) based on 100 g.c.d. (gallons per capita per day) which is about the same as at present. It has been assumed that storm flows will be treated up to three times the average dry weather flow or 270 m.g.d. It has been further estimated that the yearly average flow to be treated will be about 125 g.c.d. equivalent to 112.5 m.g.d.

A suitable area for the proposed sewage treatment plant for the South Metropolitan District can be made available by hydraulic fill to the west of Nut Island and provision made for discharging the treated sewage through the existing outlet conduits as shown by the location plan, Fig. 5.

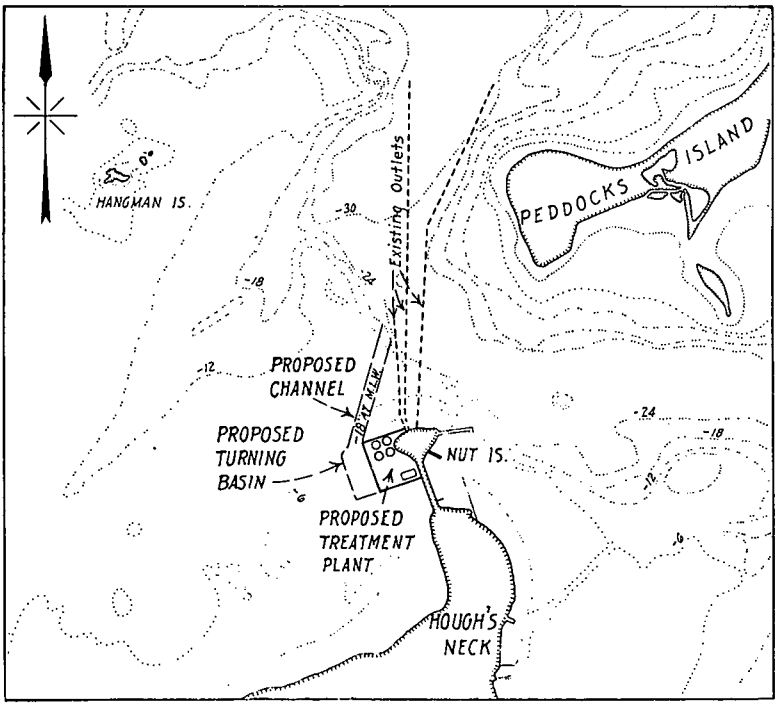

FIG. 5.—LOCATION PLAN OF SEWAGE TREATMENT PLANT AT NUT ISLAND

A preliminary layout for the sewage treatment plant at Nut Island is shown in Fig. 6.

The sewage is taken off the trunk sewer ahead of the existing grit

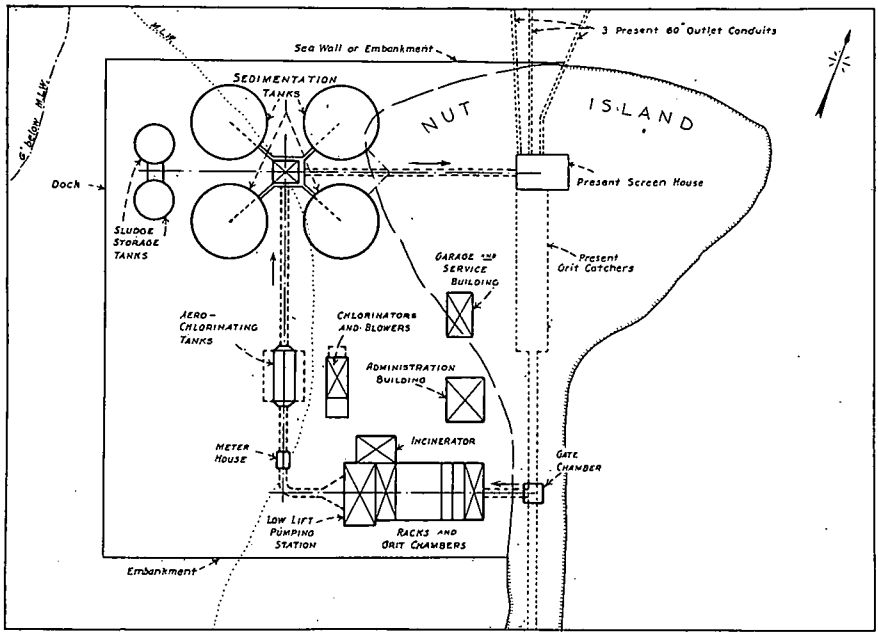

FIG. 6.—PRELIMINARY LAYOUT OF SEWAGE TREATMENT PLANT AT NUT ISLAND

catchers and screen house and passes through mechanically cleaned racks and grit chambers. The incinerator for burning the screenings is located nearby. After passing the racks and grit chambers, the sewage will flow to a new low-lift pumping station which is required to put the sewage through the remainder of the treatment plant and discharge the effluent through the existing outlet conduits. The sewage pumped will be measured by an indicating and recording flow meter.

The sewage is then passed through the aero-chlorinating tanks and thence to the sedimentation tanks which will also provide for removal of the floating solids and grease, which will be burned in the incinerator. The chlorinators and blowers for supplying chlorine and air, respectively, for the aero-chlorinating tanks are located in a building nearby. Chlorinators for disinfecting the sewage during the season of recreation will also be located in this building. Chlorine will be applied to the influent of the sedimentation tanks, thus serving for odor control as well as affording ample contact period for disinfection.

The sludge will be removed from the bottom of the sedimentation

tanks by mechanical scrapers and pumped to the sludge storage tanks adjacent to the dock. The clear liquor accumulating in the storage tanks, as a result of concentration of the sludge, will be returned to the influent of the sedimentation tanks. The concentrated sludge will be discharged as desired into the sludge vessel or barges for disposal at a suitable point beyond the Graves.

The sedimentation tank effluent will pass to the chamber at the existing screen house from which it will be discharged through the existing outlet conduits.

The estimated total cost of this plant is $3,058,000 with an allowance of $500,000 for sludge disposal equipment including one sea-going vessel of the type used at New York City. On the design basis, this total cost is equivalent to $27,200 per m.g.d. and $3.40 per capita.

The estimated annual cost of operation and maintenance of this plant in 1943, which is assumed to be the first year of operation, is $249,000, equivalent to $7.34 per million gallons of sewage treated and $0.33 per capita.

Sewage Treatment Project for Boston Main Drainage District

The population of the Boston Main Drainage District that will be contributing sewage in 1955, the year assumed for the design of the sewage treatment plant, has been estimated at 400,000, not including the large transient population.

The estimated average dry weather flow of sewage from this district in 1955 has been estimated at 70 m.g.d. and it has been assumed that storm flows will be treated up to three times the average dry weather flow, or 210 m.g.d. which is the computed capacity of the trunk sewer leading to the Calf Pasture in Dorchester. It has been further estimated that the yearly average flow to be treated will be about 85 m.g.d.

It will be advantageous to locate the mechanically cleaned racks and grit chambers ahead of the pumping station at the Calf Pasture, the incinerator for screenings within the boiler house, and the remainder of the treatment plant at Moon Island.

In order to put all of the sewage to be treated through the existing Dorchester Bay Tunnel and utilize the full capacity of the storage

tanks at Moon Island for discharging the effluent during the outgoing tide, it is proposed to abandon the existing deposit sewers, as such, at Calf Pasture and pump the sewage through pressure sewers leading to the Dorchester Bay Tunnel. It is proposed to install at the Calf Pasture pumping station two additional pumps, each having a capacity of 60 m.g.d. under a 50-ft. head. It is proposed to install at Moon Island a low-lift pumping station for lifting the sewage sufficiently to pass through the treatment plant and into the storage tanks. This low-lift pumping station is proposed to be located at Moon Island to prevent surcharging the outfall sewer between Squantum and Moon Island and to maintain suitable velocities in the outfall sewer.

A preliminary layout of the proposed structures at Calf Pasture is shown in Fig. 7.

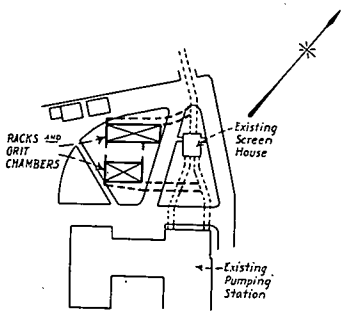

FIG. 7.—PRELIMINARY LAYOUT OF PROPOSED STRUCTURES AT CALF PASTURE

A preliminary layout for the sewage treatment plant at Moon Island is shown in Fig. 8.

The Squantum outfall sewer to Moon Island will lead to the new low-lift pumping station, and after being lifted 8 to 14 ft., the sewage will pass through the flow meter to the aero-chlorinating tanks and thence through the sedimentation tanks to the existing storage tanks from which the treated sewage will be discharged through the existing outlets during the outgoing tides. The building for the blowers and chlorinators will be located near the aero-chlorinating tanks. The scum from the sedimentation tanks will be burned in the incinerator nearby.

The sludge from the sedimentation tanks will be pumped to sludge storage tanks from which the clear liquor after concentration will be returned to the influent of the sedimentation tanks and the concen-

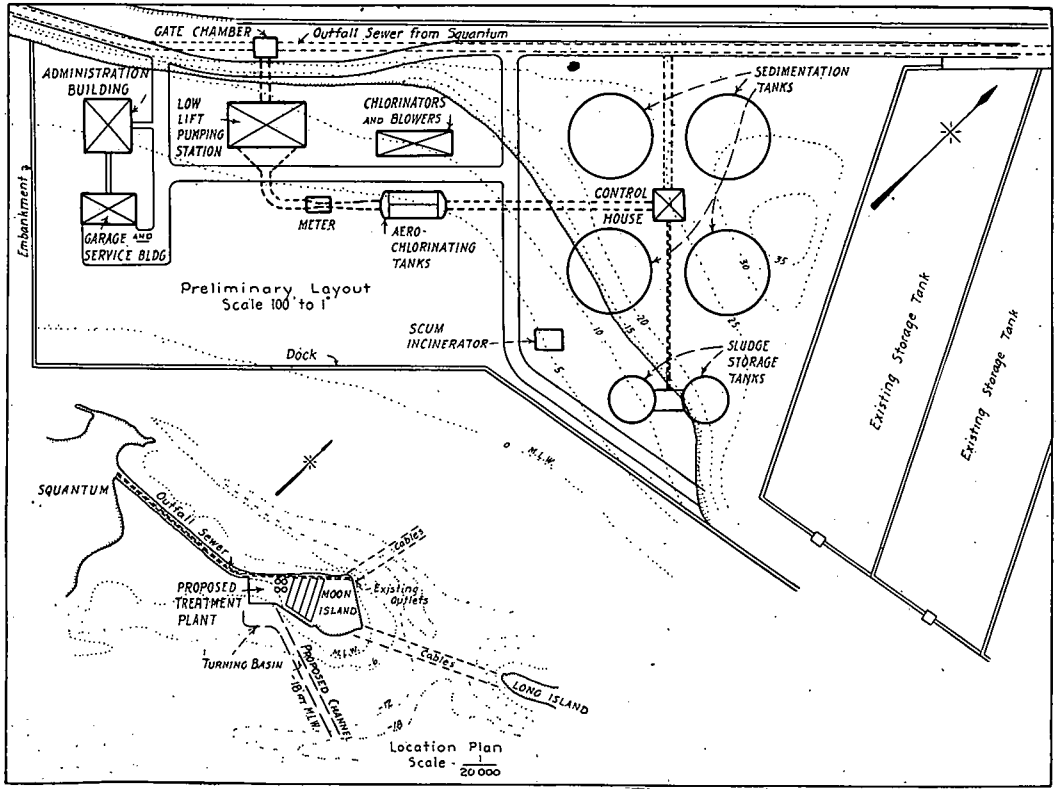

FIG. 8.—PRELIMINARY LAYOUT OF SEWAGE TREATMENT PLANT AT MOON ISLAND

trated sludge discharged to the sludge vessel or barges for disposal at sea.

The estimated total cost of the proposed sewage treatment plant for the Boston Main Drainage District is $3,180,000, including one sea-going sludge vessel as proposed for the South Metropolitan District. On the design basis, this is equivalent to $37,400 per m.g.d. and $7.95 per capita.

The estimated annual cost of operation and maintenance of the proposed sewage treatment plant, not including the Calf Pasture pumping station, based on the year 1943 which is assumed to be the first year of operation, is $240,000, equivalent to $7.74 per million gallons of sewage treated and $0.60 per capita.

Sewage Treatment Project for North Metropolitan District

The population that will be contributing sewage in 1955, the year assumed for the design of the treatment plant, has been estimated at 750,000. The average sewage flow to be treated in 1955, including an allowance for industrial wastes, has been estimated at 125 m.g.d. which is equivalent to 167 g.c.d., and it has been assumed that storm flows will be treated up to three times the average flow, or 375 m.g.d.

A suitable area for the proposed sewage treatment plant for the North Metropolitan District can be obtained at Deer Island by hydraulic fill to the southwest of the Island. It has been assumed that the sewage at East Boston will be pumped to the Deer Island sewage treatment plant through a new force main up to its capacity, and that excess flows will be pumped by low-lift pumps at East Boston to the existing gravity sewer to Deer Island. Upon this assumption, new pumps at the Deer Island pumping station will be used for pumping storm flows to the sewage treatment plant.

A location plan for the sewage treatment plant at Deer Island is shown in Fig. 9.

A preliminary layout for the sewage treatment plant at Deer Island is shown in Fig. 10.

The sewage from East Boston, either with or without pumping at Deer Island, will pass through the mechanically cleaned racks, grit chambers, flow meter, aero-chlorinating tanks and thence through the existing and proposed outlet conduits.

The chlorination and blower plant will furnish the chlorine and

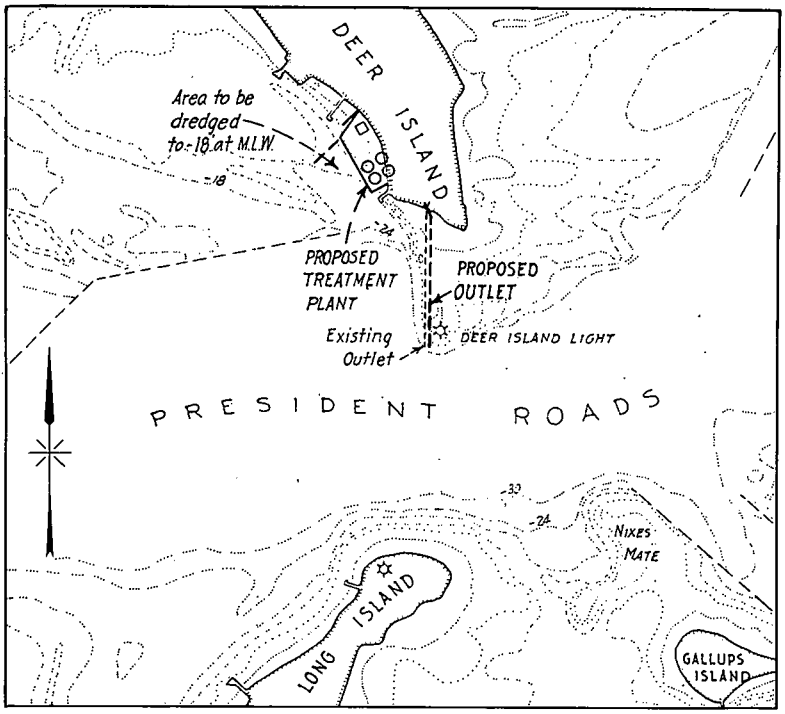

FIG. 9.—LOCATION PLAN OF SEWAGE TREATMENT PLANT AT DEER ISLAND

air supply for the aero-chlorinating tanks and the chlorine for disinfection of the sewage going to the sedimentation tanks, during the recreational season.

The screenings from the racks and the scum from the sedimentation tanks will be burned in the incinerator. The sludge from the sedimentation tanks will be pumped to the sludge storage tanks where, after concentration, the clear liquor will be returned to the influent of the sedimentation tanks and the concentrated sludge discharged to the sludge vessel or barges and disposed of at sea as in the case of the other two sewage treatment projects.

The estimated total cost of the proposed sewage treatment plant for the North Metropolitan District is $3,784,000 with allowance of $500,000 for sludge disposal equipment including one sludge vessel for disposal at sea as in the case of each of the other two projects.

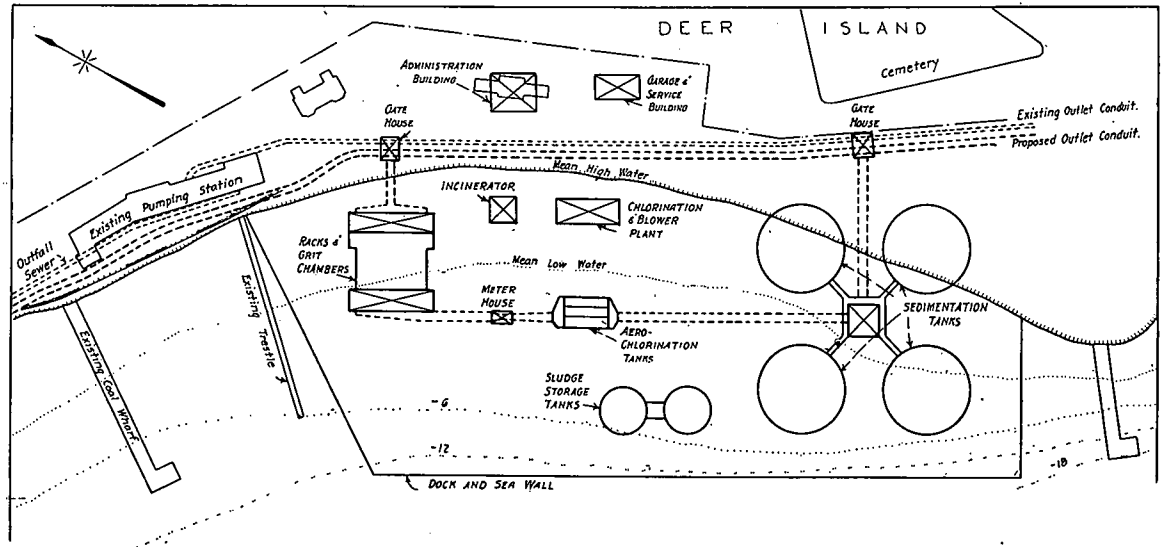

FIG. 10.—PRELIMINARY LAYOUT OF SEWAGE TREATMENT PLANT AT DEER ISLAND

On the design basis, this total cost is equivalent to $30,300 per m.g.d. and $5.05 per capita.

The estimated annual cost of operation and maintenance of the proposed sewage treatment plant, based on the year 1943 assumed to be the first year of operation, is $284,000 which is equivalent to $6.48 per million gallons of sewage treated and $0.40 per capita.

Construction Work Authorized by Massachusetts Legislature

Looking toward the solution of the problem of sewage pollution in Metropolitan Boston, the Massachusetts Legislature has passed an Act, approved August 12, 1939 (Chapter 512, Acts of 1939), making provision for the construction of certain projects at a total cost of $10,428,000, subject to the contribution of 45 per cent by the Federal Government, and authorizing the Metropolitan District Commission to have borings and surveys made and plans and specifications prepared for these projects. These projects include storm overflow conduits and pumping stations for abatement of the pollution of Charles River, sewage treatment works for the South Metropolitan District at Nut Island in Quincy, and an extension of the North Metropolitan Relief Sewer from East Boston to Deer Island, with a pumping station at East Boston.

POLLUTION OF BOSTON HARBOR

By Samuel A. Greeley*

(Presented at a meeting of Boston Society of Civil Engineers held on January 24, 1940.)

I am very grateful to the Boston Society of Civil Engineers for their pleasant reception and for the opportunity of taking part in this discussion. I propose to describe briefly the investigations made by the engineers regarding the pollution of Boston Harbor.

The proposed sewage treatment plants for the removal of pollution from Boston Harbor represent about 40 per cent of the estimated cost of the projects for sewerage and sewage disposal in Metropolitan Boston just described by Mr. Eddy and Mr. Fales. The sewage treatment works are, however, an important part of the problem and their determination includes the study of a number of more or less definite items as well as some intangible factors and their effect.

The five principal effects of the discharge of sewage into Boston Harbor have been stated by Mr. Fales, among them the bacterial contamination of the harbor and shore waters. In addition to the aesthetic values, the effect of the pollution on the public health is a matter of great interest.

During the past half generation there has been a rapidly increasing interest in outdoor bathing and recreation and in the cleanliness of outdoor bathing waters. There is a very interesting monthly journal entitled *Shore & Beach,* which is published by the American Shore and Beach Preservation Association. This publication is an evidence of the great use of shores and beaches.

In our work for the special commission created under Chapter 79, of the Resolves of 1938, of the General Court of Massachusetts, to investigate the systems of sewerage and sewage disposal in Metropolitan Boston, we studied quite carefully the bacterial evidences of sewage pollution in Boston Harbor in relation to yardsticks and experience elsewhere and reached the assumption that a single B-coli index of 1000 per 100 c.c. is a warning that excessive contamination

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may be present at times, and that an average index in excess of 3,000 B-coli per 100 c.c. shows that the waters may be dangerous to the public health. This may be compared with the conclusions of the State Conference of Sanitary Engineers as follows:

"Proposed bacteriological standards by various agencies have seemed to hit mainly upon two widely divergent limits for standards of acceptability for outdoor bathing waters, one of which is 50 B-coli per 100 c.c. and the other 1000 B-coli per 100 c.c. It is perhaps reasonable to conclude that, subject to interpretation of analytical studies from proper angles, waters better than

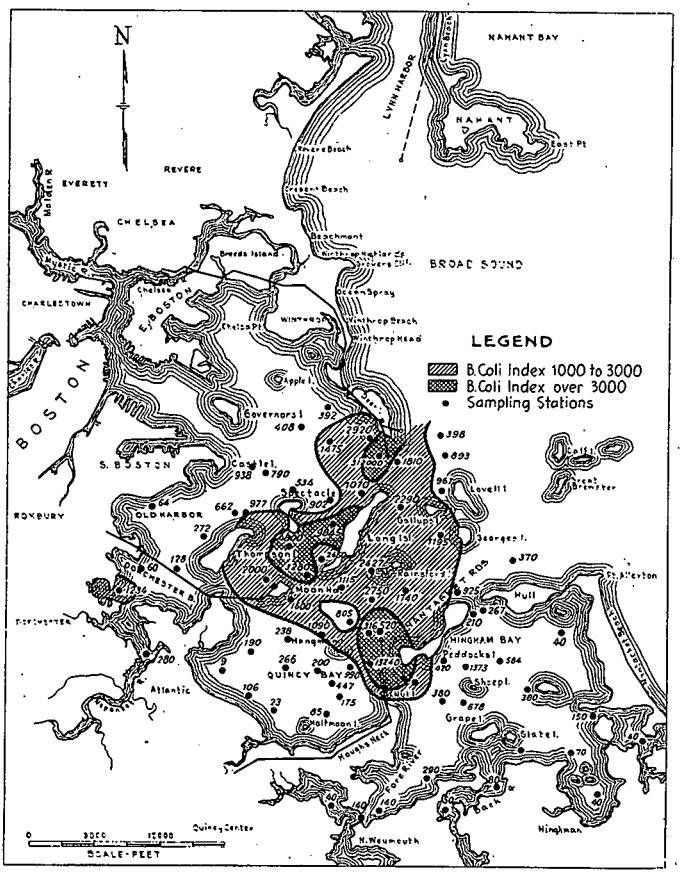


FIG. 1.—BOSTON HARBOR—B. COLI INDEX, FLOOD AND HIGH TIDE SAMPLES, 1929-1930 SERIES

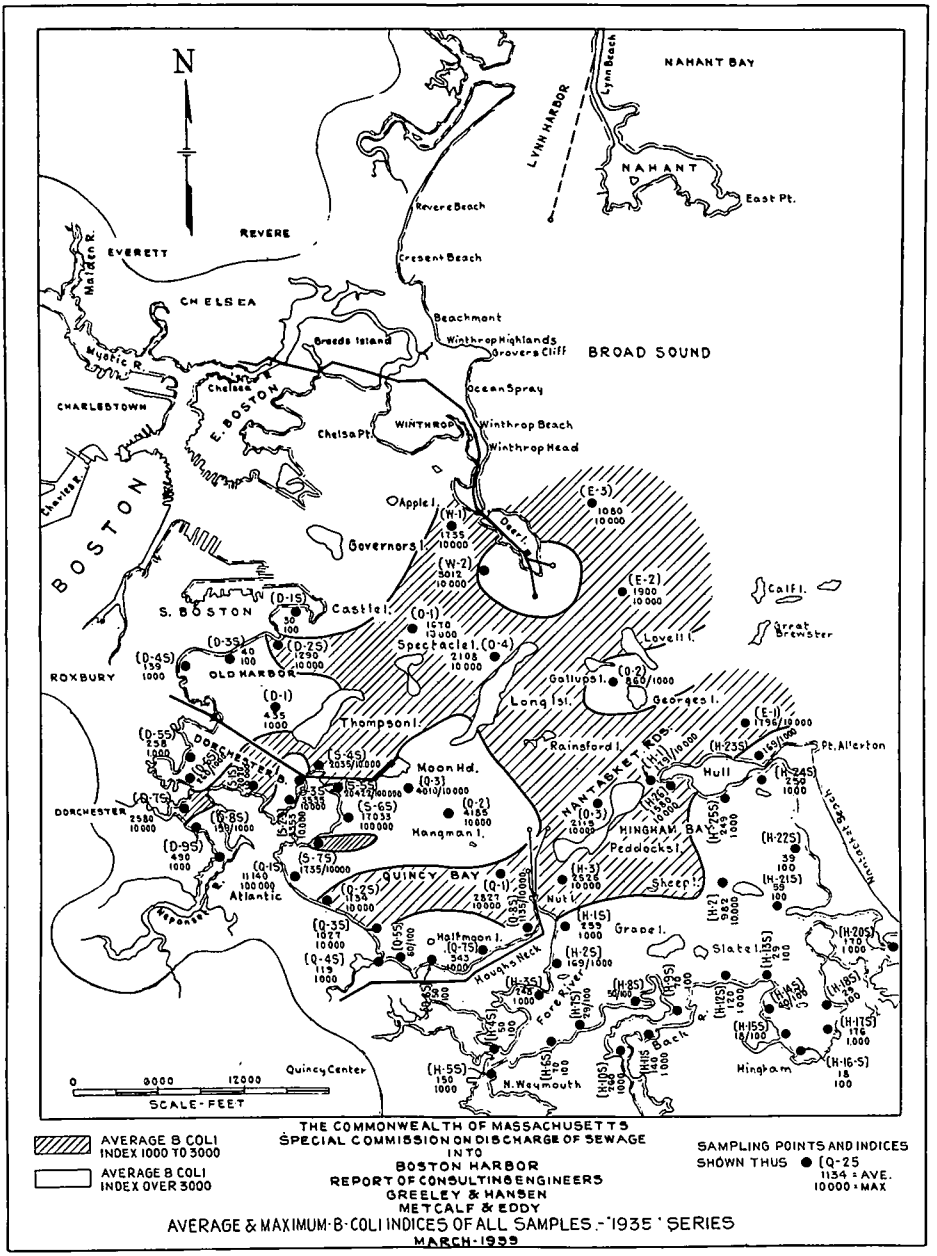


FIG. 2.—AVERAGE AND MAXIMUM B. COLI INDICES OF ALL SAMPLES—"1935" SERIES

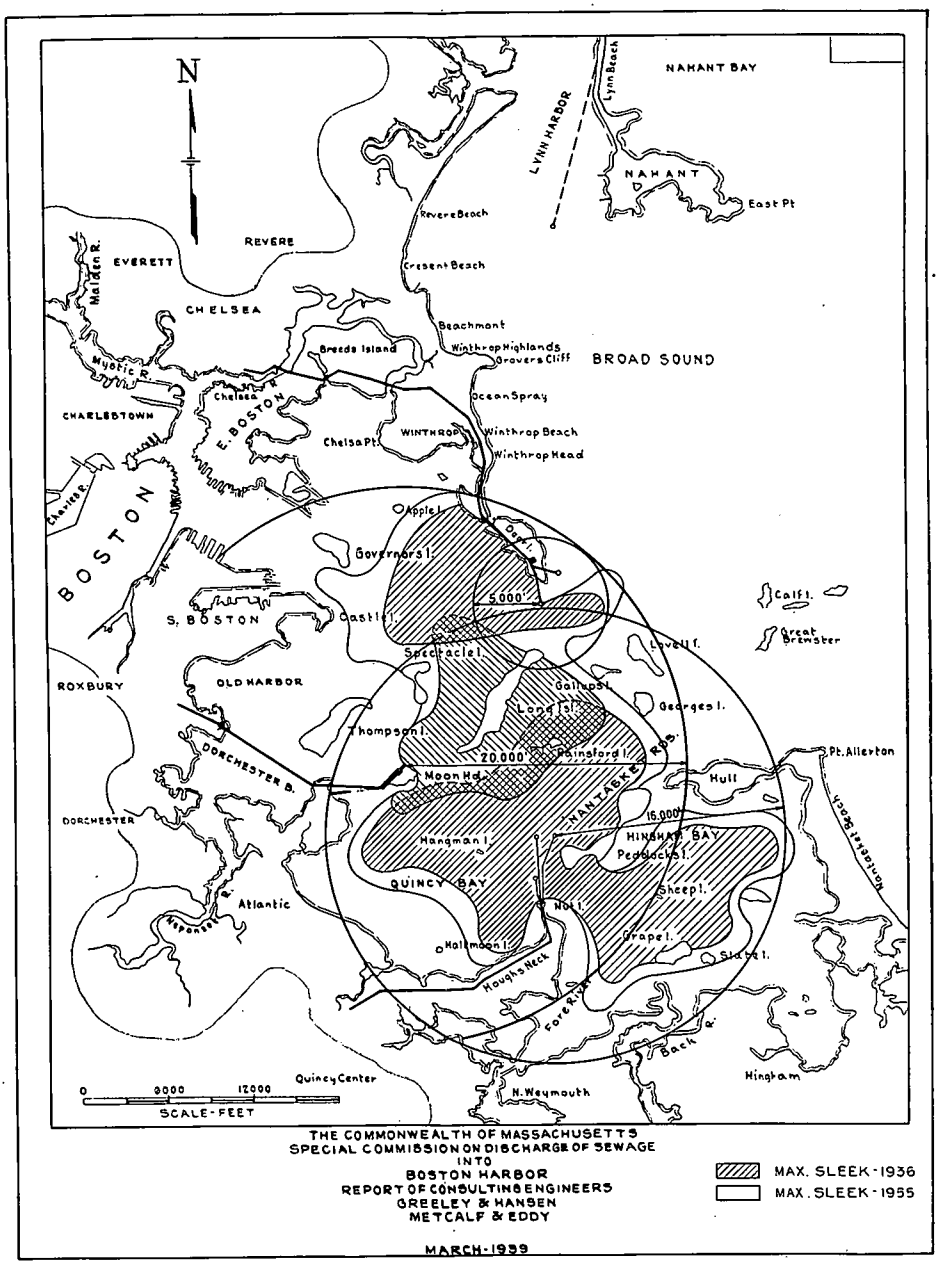


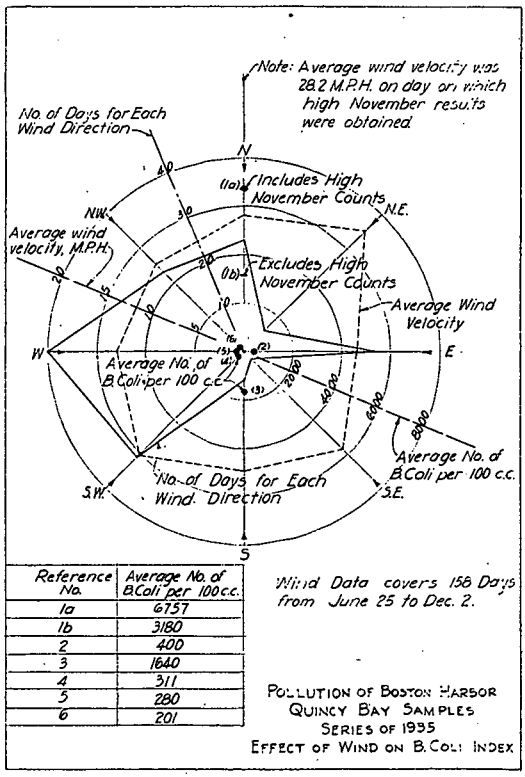
FIG. 3.—BOSTON HARBOR, SLEEK AREAS

the lower limit (1000 B-coli per 100 c.c.) are fairly acceptable."

With this general comment, a few illustrations are of interest. The bacteriological analyses made by the State Department of Public Health were reviewed by us for three series, designated as those of 1929-30, 1935 and 1936. While a large number of samples were taken, the area covered was also large, the data being as follows:

Series	No. of Sampling Stations	No. of Analyses Total	Per Station
1929-30	120	1433	12.0
1935	84	912	10.9
1936	162	1175	7.3

Many charts were made of Boston Harbor showing the intensity



Reference No.	Average No. of B.Coli per 100 c.c.
1a	6757
1b	3180
2	400
3	1640
4	311
5	280
6	201

FIG. 4.—EFFECT OF WIND ON B. COLI INDEX, SERIES, 1935

of bacteriological contamination as measured by the B-coli index. Two typical charts are shown as Figs. 1 and 2. Fig. 1 shows the flood and high tide samples during the entire 1929-30 series, and Fig. 2 shows the average of all samples in the 1935 series. There is clearly a large body of contaminated water "loose" in the Harbor.

The extent of this pollution is also shown by the sleek (Fig. 3). The area outlined is a composite of the maximum distances from the several sewage outlets at which sleek was observed in 1936, and these areas extended roughly in proportion to the present quantity of sewage and the quantity estimated for 1955. The sewage field as determined by chemical analyses of the Harbor waters appeared to extend somewhat beyond the sleek.

To illustrate what may happen to these contaminated bodies of

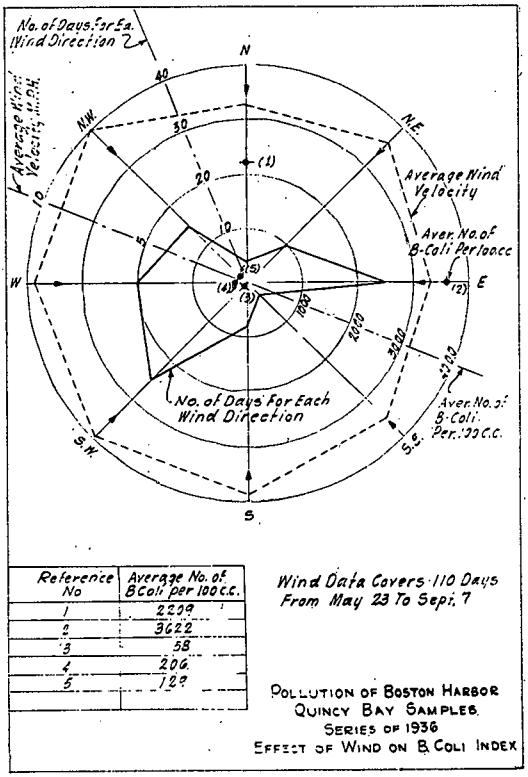


FIG. 5.—EFFECT OF WIND ON B. COLI INDEX, SERIES, 1936

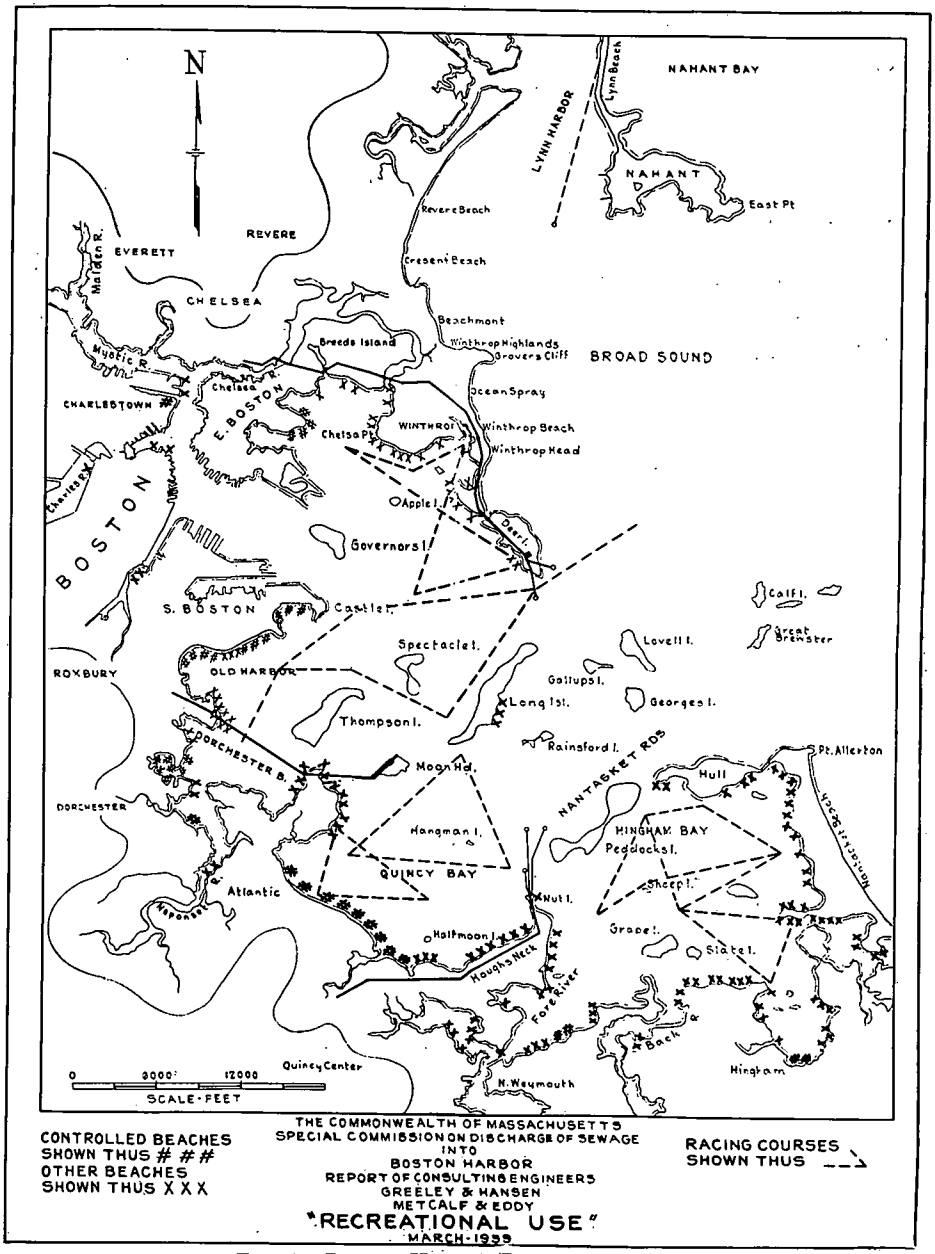


FIG. 6.—BOSTON HARBOR, RECREATIONAL USE

Harbor water under various wind conditions, two charts were prepared showing the average of all Quincy Bay samples for each wind direction for the 1935 and the 1936 series. The study is illustrated by Figs. 4 and 5 which include not only the wind direction but also the wind velocity. Analyses in November, 1935, of Quincy Bay samples with a north wind of 28.2 miles per hour indicate 10,000 to 100,000 B-coli per 100 c.c. which is a condition of serious contamination.

The importance of recreation and the desire for safe outdoor bathing and recreation waters prevails in many sections of the United States. Fig. 6 shows the recreational uses of the water in Boston Harbor. Sewage disposal projects in other large centers of population, whose object is in part a protection of waterways for recreational use, are underway or proposed, as for instance, at New York, Los Angeles, Toronto, Hampton Roads, Va., and elsewhere.

THE PITTSBURG CONSERVATION RESERVOIR DEVELOPMENT OF THE NEW HAMPSHIRE WATER RESOURCES BOARD

By Richard S. Holmgren,* Member

The construction of the Pittsburg Reservoir by the New Hampshire Water Resources Board marks the entry of the State of New Hampshire into the field of constructing dams for the conservation and distribution of water and the regulation of the flow of rivers and streams to lessen damages from floods and to promote the State's industrial and economic welfare. The circumstances leading finally to the establishment of this Board, and the difficulties encountered by it before construction began, would appear to have a very real place in any paper dealing with the project and a description of them has, therefore, been included.

The State of New Hampshire is not a large state, being the sixth smallest state in the Union, having an area of only 9,282 square miles, of which area about 13% is owned publicly, consisting principally of the White Mountain National Forest. The State is not a naturally wealthy state as its rugged hills and mountains contain very little valuable mineral wealth and leave all too little land suitable for economical farming. These same hills, however, combined with an ample rainfall, give to New Hampshire its major natural resource—water power. It was the presence of these rapidly running streams, capable of being easily developed for power, which early encouraged industry to settle in New Hampshire and to expand until this State became one of the principal industrial states.

The one big drawback of this resource is the wide variation from month to month in the natural flow in these streams. In a normal year the flows will range in the average stream from as low as 0.2 cfs per square mile in dry periods to over 10 cfs per square mile in times of flood. How best to overcome the deficiency of water during dry periods has been the continuous problem of all owners of water power

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from the time of the earliest development. Reservoirs in which the wasted flood flows could be stored, and later released and utilized during dry periods, were early recognized as an effective means of overcoming this drawback.

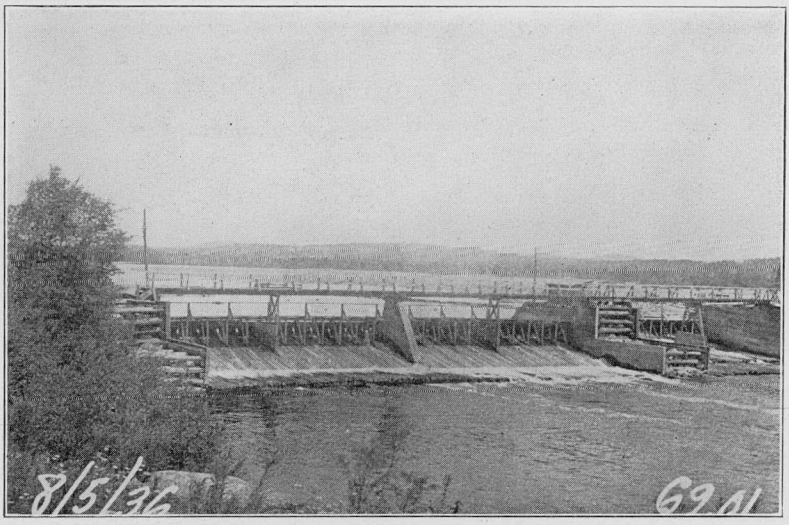

FIG. 1.—TYPICAL EARLY NEW HAMPSHIRE STORAGE DAM

The New Hampshire Legislature began very early in its history to grant private industrial firms and lumbering companies the right to construct dams across the outlets of State bodies of water, these being any natural body of water greater than ten acres in extent. These dams, usually inexpensive crib dams, raised the water level in these lakes from four to as much as ten feet and created a large amount of storage capacity with very little damage and at slight cost. Dams at the outlets of such large lakes as Winnipesaukee, Newfound, Squam, Ossipee and Mascoma were constructed under this authority, as well as dams at the outlets of many smaller bodies of water. The capacity provided by such dams did much to improve river conditions, but it was far from being enough to regulate completely the stream flow.

As time passed, all the easily constructed and inexpensive developments were completed. Further developments generally proved to be too expensive for any single company to undertake. A raising of the dam at the outlet of Merrymeeting Lake to increase its capacity was

successfully completed as a cooperative venture by owners of water power on the Merrimack River, but an attempt to construct additional projects by cooperative means failed. No additional projects were available which were sufficiently low in cost to warrant development except as a further reduction in cost might result by the use of lower cost State money or tax exemption.

Legislative Action for State Owned Reservoirs

In 1917 a "Commission on Water Conservation and Water Power" was appointed by the New Hampshire Legislature to study the possibilities of constructing additional storage reservoirs on New Hampshire streams. After a year of study this Commission submitted a report in which some 100 possible reservoir sites were tabulated and discussed, mostly smaller reservoirs. The report also recommended that the Legislature set up a State Authority under whose jurisdiction these reservoirs could be constructed, believing that under State guidance many of the difficulties of cooperative action could be eliminated.

No further legislative action was taken until a bill was introduced in the 1923 Legislature through the efforts of Ex-Governor Robert P. Bass, which authorized the construction and management of storage reservoirs by the State. The Bill was called "An Act to Authorize the Improvement of Water Powers in this State by the Construction and Management of Storage Reservoirs". This bill designated the Public Service Commission as the State Authority to make investigations of possible sites. The proposed Act stipulated that the reservoirs should be capable of storing surplus water in sufficient quantities to permit the making of contracts with water users for the use thereof, these contracts to produce an annual sum sufficient to defray the operating expenses and upkeep of the property, to pay the interest on the capital cost, and to amortize this cost within a period of fifty years from completion of the project. The usual approval by the Governor and Council of all contracts entered into by the Commission was required. A sum of $5,000 was provided with which to make the study and an additional $200,000 provided for construction purposes. This Bill passed the House but was defeated in the Senate by four votes.

The subject there rested until 1933 when the possibility of re-

ceiving Federal assistance in the form of a P.W.A. grant for part of the construction cost brought the subject up for discussion again. No previous report was in sufficient detail to satisfy the requirements of the application for funds. No State authority was available, duly authorized or capable of preparing a report on a proper scheme of reservoir developments. As speed was necessary if Federal funds were to be obtained, Governor Winant engaged H. K. Barrows and Metcalf & Eddy, Consulting Engineers of Boston, and directed them to review the subject and submit a report on a system of reservoirs which could be used as the beginning of a comprehensive development of additional storage facilities in the State. The results of these studies made individually, but with joint conferences, were given in a report by H. K. Barrows in November, 1933, and by Metcalf & Eddy in January, 1934.

Both reports recommended a system of five reservoirs, three in the Merrimack River Basin located on the Blackwater River at Webster, on the Suncook River at Suncook Ponds, and on the Pemigewasset River at Livermore Falls, and two in the Connecticut River Basin located on the Connecticut River at Pittsburg, and on the Mascoma River at West Canaan. The reports set forth that the construction of these five reservoirs would provide about 24,000,000,000 cubic feet of additional storage capacity at an estimated cost of about $11,000,000. The output from existing developments utilizing this stored water would be about 120,000,000 kwhrs. yearly at a cost of from 3 to 6 mills per kwhr. Were these reservoirs completed, the construction of hydroelectic plants on the Blackwater River at Webster and on the Pemigewasset River at Livermore Falls would become feasible with a total annual output of about 83,000,000 kwhrs. at a price of from 3 to 5 mills. The total output of electric power for public use in 1932 from all the New Hampshire plants was approximately 700,000,000 kwhrs.

As the New Hampshire Legislature meets biennially, no legislative action could be had until 1935. A bill was introduced by Governor Styles Bridges at the next regular session of the Legislature, which opened in January, 1935. This bill was basically similar to that introduced in 1923 but somewhat expanded to meet the new conditions prevailing. This bill was passed on July 18, 1935, and created the New Hampshire Water Resources Board. In its declaration of need, slightly amended in 1937, the Act reads:

"It is hereby declared that there is a state-wide need for the conservation and distribution of water and the regulation of the flow of rivers and streams and that the public interest, welfare and necessity require the construction of projects for the conservation, development, storage, distribution and utilization of water, and the corporation created hereunder shall be regarded as performing a governmental function in carrying out the provisions of this act. It is further declared that there is a special public need for dams and reservoirs at strategic locations for regulating the flow of rivers and streams to lessen damages resulting from floods and to promote the state's industrial and economic welfare, by enhancing the present and potential water power along the rivers and streams and the construction, maintenance and operation of such dams and reservoirs within the state is a primary purpose of this act."

The management of the Board was vested in five Directors, each holding office for five years. All the members serve without salary except the Chairman, who devotes his entire time to the work of the Board.

The Board was authorized to investigate possible storage projects, to acquire and sell land, to construct, maintain and operate projects, to make contracts with water users for fees and tolls for the use of water, and to borrow money and issue bonds to secure the payment of such obligations. There was appropriated $100,000 for the use of the Board in getting its program underway. The use of $900,000 of State credit for construction purposes was also granted.

This Act contains two interesting provisions. The old Mill Act which has governed the acquisition of lands for reservoirs in New Hampshire for many years, permits land to be taken for flowage, but first required ownership of the damsite. The Board is empowered to take any lands needed for a project, including damsite property, by eminent domain. State property is not ordinarily taxed by the municipalities in which it is located. All property and rights acquired by the Board are also exempt from taxation, but the Board must make payment each year to the town or towns in which a project is located, of such a sum as would have been assessed against the properties taken by the Board if they had been included in the tax list at the tax valuation of the property as it was on April 1, 1934. This provision assures the municipalities that no reduction in tax income will occur from

the construction of a State-owned reservoir which might endanger its corporate existence.

P.W.A. Cooperation

Immediately upon organization of the Board, individual reports were prepared on the five reservoirs named in the H. K. Barrows and Metcalf & Eddy reports, and on a group of smaller reservoirs, re-

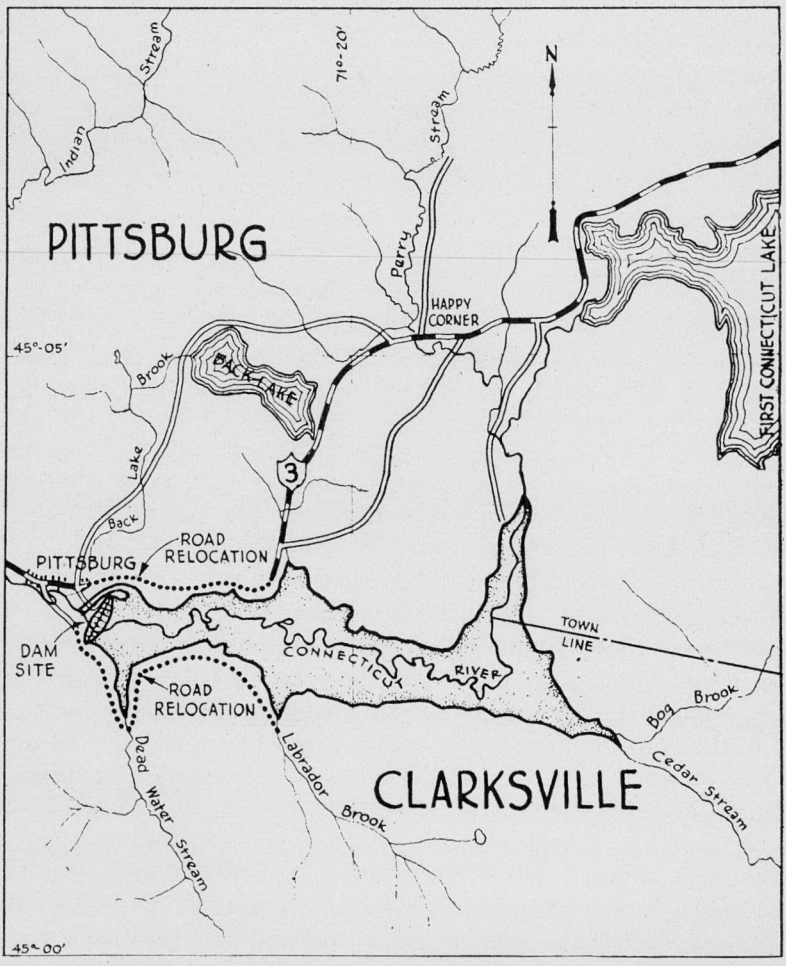

Fig. 2.—Locality Plan

quested by several water users. Applications based on these reports were submitted to P.W.A. for a grant and loan, which were finally given approval, but no funds were available. Additional information above that contained in the original reports and applications was constantly being requested and submitted, which kept alive the belief that funds would ultimately become available. The reduction in allotment of funds to P.W.A. soon made it evident, however, that no funds would be available from this source.

During these P.W.A. negotiations, further studies were made and conferences held with water users, to determine the possibility of proceeding with the construction of these reservoirs without P.W.A. funds. These studies showed that the Pittsburg Reservoir could be constructed without Federal funds, and it was finally decided to proceed by this method. The P.W.A. application for funds for this reservoir was therefore withdrawn.

General Features of the Project

In general, the Pittsburg Project created a conservation reservoir on the upper Connecticut River a short distance below First Connecticut Lake by the construction of an earth dam with full pond as fixed by its spillway crest at elevation 1,385, U. S. G. S. datum. (See Figure 2.) This reservoir when full will have a water surface area of 2,010 acres, equal to approximately one-half the area of Newfound

Fig. 3.—Looking Upstream Towards Pittsburg Dam Site

TABLE 1 —CONNECTICUT RIVER WATER POWER DEVELOPMENTS, DEVELOPED HEADS AND PLANT CAPACITIES

Owner	Head Developed—Ft.		Installed Capacity—KW.	
	Company Totals	Individual Plants	Individual Plants	Company Totals
Public Service Co. of N. H.	65			2,300
(1) Canaan		(35)	1,100	
(2) Lyman Falls		(30)	1,200	
Wyoming Valley Paper Co.	10			1,100
(3) Northumberland		(10)	1,100	
Gilman Paper Co.	25			3,300
(4) Dalton		(25)	3,300	
Conn. River Power Co.	235			178,000
(5) Comerford		(170)	140,000	
(6) McIndoes		(30)	10,000	
(10) Vernon		(35)	28,000	
Ryegate Paper Co.	15			1,400
(7) Bath		(15)	1,400	
International Paper Co.	35			6,300
(8) Lebanon		(35)	6,300	
Bellows Falls Hydro. Corp.	60			45,000
(9) Walpole		(60)	45,000	
Total in New Hampshire	445		237,400	237,400
Turners Falls Power Co.				
(11) Turners Falls, Mass.	60	—	—	57,000
Holyoke Water Power Co.				
(12) Holyoke, Mass.	55	—	—	42,000
Windsor Locks Co.				
(13) Windsor Locks, Conn.	30	—	—	—
Total on River	590	—	—	336,400

Lake in central New Hampshire. The water surface will have a maximum length of about 5.5 miles and a maximum width of 1.4 miles and will extend back to within 2.4 miles of the outlet of First Connecticut Lake. The capacity of this reservoir is equal to twenty inches of runoff from the 87 square miles of drainage area above the dam and below the outlet of First Connecticut Lake, or 4,330,000,000 cubic feet, equal to 99,500 acre feet. The total drainage area above the Pittsburg dam is 170 square miles.

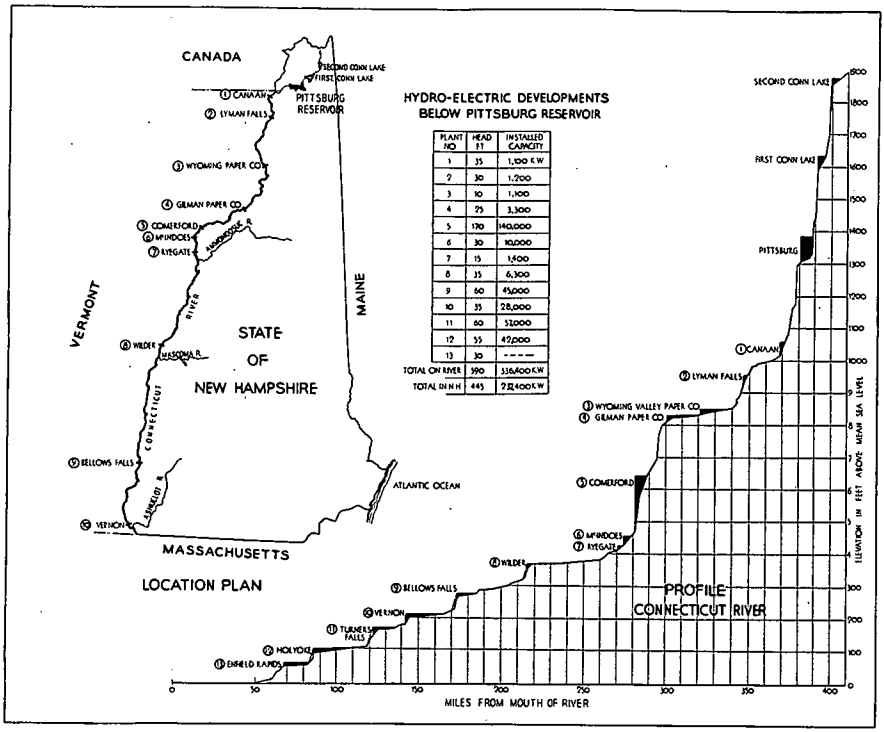

FIG. 4.—PROFILE OF CONNECTICUT RIVER, SHOWING EXISTING WATER POWER DEVELOPMENTS.

EXISTING CONNECTICUT RIVER DEVELOPMENTS

There are located on the Connecticut River below the Pittsburg dam, 13 hydroelectric developments with a total developed head of 590 feet and an installed capacity of about 336,000 KW. (See Figure 4.) A list of these plants with the head developed and the installed capacity in kilowatts at each plant is tabulated in Table 1.

Six of these developments located in the river bordering New Hampshire utilize 360 feet of head and are owned by the Public Service Company of New Hampshire, Connecticut River Power Company and the Bellows Falls Hydroelectric Company. These plants generate power primarily for public use. The remaining plants bordering on New Hampshire are owned by paper mills and most of the power is used at adjacent mills for the manufacture of pulp and paper.

Assuming complete utilization of the stored water from a full reservoir by 11 of these developments, omitting Lebanon and Windsor Locks, where there is insufficient capacity to utilize any substantial amount of this additional water, there would be developed by these stations an additional 41,400,000 kwhrs. At the six developments in New Hampshire of the three utilities, there would be generated 28,400,000 kwhrs.

Above the Pittsburg Reservoir, there is at present a storage capacity in First and Second Connecticut Lakes of about 88,000 acre feet controlled by the Connecticut River Power Company. Any discharge from these Lakes must be permitted to pass unchanged through the Pittsburg Reservoir, as the Water Resources Board Act specifically prohibits any interference by the Board with discharge of water from an upstream reservoir.

Legal Difficulties

The Water Resources Board Act requires that before commencing any project the Board

> " . . . shall submit to the Governor and Council a report including a detailed description and plan of the project, a detailed estimate of the total cost thereof and what revenues would be derived therefrom."

The Governor and Council are then instructed to determine by hearings or any other method, whether the project will be for the public use and benefit and within the authority conferred upon the Board. If so found, the Governor and Council shall issue a written order to the Board to proceed with the project.

A report on the Pittsburg Project was submitted to Governor Styles Bridges and Council late in 1936 and shortly thereafter an order was received by the Board to proceed with the project. This included the approval of negotiating contracts to be entered into with the water users in New Hampshire whereby they would agree to pay to the Board annually for the life of the bonds, about fifty years, a combined sum sufficient to pay interest on and amortize the bonds and to operate and maintain the reservoir. In negotiating for the sale of the bonds to finance the project, the question arose as to the constitutionality of the Water Resources Board Act and the right of the

Board to use State credit for financing the project. This question was referred to the Governor and Council who requested from the State Supreme Court an advisory opinion on the constitutionality of the Act and of the project. On February 2, 1937, the Supreme Court rendered an advisory opinion, declaring the Act to be constitutional and the use of State credit for the construction of this project constitutional if constructed in the public interest. The ruling was summarized as follows:

> "If development of electric energy in the use of the water of the river as promotive of the state's industrial and economic welfare is the controlling element of consideration and is in mind as the inducement and goal sought by the contracts, they may properly be entered into. If the particular utilities are in mind, to be aided in the improvement and increase of their water power, which they are to pay for through use of the state's credit, the agency's power to contract therefor has not been granted."

The Court would not render a decision as to whether the project was for the public benefit because of the lack of evidence.

A new report was prepared outlining the public benefits which would result from the existence of the Pittsburg Reservoir. The benefits considered were flood control, reduction in stream pollution, increased recreational facilities, agricultural benefits and an increase in the amount of available low cost power. This report was presented in July, 1937, to Governor Francis P. Murphy and Council, who on August 23, 1937, held a public hearing, at which no objection was raised to the project. As a result of their investigation, they found the project to be in the public interest and ordered the Board to enter into contracts with the water users, to float the necessary bonds and to proceed with the project.

On April 5, 1937, several owners of property which would be flooded by the proposed reservoir, had entered a bill in equity and petition for a declaratory judgment in the Superior Court of the State of New Hampshire against the Water Resources Board. This bill raised the issue of the constitutionality of the legislation and the right of the Board to take land by eminent domain in the execution of the project. On October 15, 1937, several taxpayers also brought suit in the Superior Court against the Governor and Council and the Water Resources Board, claiming the project was primarily for the benefit

of private individuals and firms. Evidence was heard on these suits concurrently and a decision was rendered favorable to the Board. This decision was immediately appealed to the State Supreme Court. On April 5, 1938, the Supreme Court upheld the decision of the lower court.

Several portions of this interesting decision are as follows:

"The State clearly may engage in undertakings to develop its resources. It is no less in its interest than to conserve them; what may be saved is not the limit of legislative power; what may be produced is also a proper subject of action."

"It is not required that in making water storage available for increasing power there should be allied with it any other objective of water control. For practical reasons, as here, alliance may be desirable and important, but a development solely to produce or enhance power would have valid standing."

"While the Board is a State agency, it has a distinct legal existance the same as a municipality."

"The legislation sets forth and defines its authority, and the project and contracts are authorized if the conditions and requirements for their respective construction and making have been observed. The finding that they have been adhered to is amply supported by the evidence."

With this last statement the bill and petition were dismissed and the last legal obstruction to the beginning of the project removed.

Federal Power Commission

A declaration of intention was filed with the Federal Power Commission on December 12, 1936, in accordance with the Federal Power Act. This Commission, on February 3, 1937, found "That the interests of interstate or foreign commerce would not be affected by the proposed construction." No license was therefore required from this Commission and one more obstacle was surmounted.

Financing

Negotiations were begun in 1936 to lay the groundwork for floating a bond issue to cover the cost of the project. The Commissioner of Internal Revenue had ruled early in 1936 that the revenue from New Hampshire Water Resources Board Bonds would be tax exempt

under the Revenue Act of 1934, which decision was expected to make them quickly salable at a good figure. However, due to the delay over legal matters, the Bonds were not ready for sale until after the decision of the United States Supreme Court on the Port of New York Authority Case in which the Court ruled that the income of employees of the Authority were taxable under the Federal Income Tax Law. This decision also raised the question as to whether or not the interest paid on bonds of the Authority were not also taxable although they had generally been considered tax exempt. These questions were immediately applied to the proposed bond issue of the Water Resources Board, it being a State agency quite similar in its relation to the State of New Hampshire as the Port of New York Authority is to the State of New York. No new decision could be obtained from the Commissioner of Internal Revenue, and as the question of tax exemption affected the price at which the bonds could be sold, the possibility of a delay in floating the issue seemed imminent until this question was definitely settled.

Finally, however, on June 27, 1938, a New Hampshire Water Resources Board bond issue of $2,300,000 was sold, consisting of Series A and B Bonds. The Series A Bonds totaling $1,400,000 with maturities running for 36 years from 1940 to 1976, are obligations of the Board generally and are secured by the contracts entered into with the water users and have no State backing. These bonds carry an interest rate of 3¼%. The Series B Bonds totaling $900,000, with maturities running for eleven years, from 1977 to 1987, are obligations of the Board generally and guaranteed as to the principal and interest by the State of New Hampshire. These bonds carry an interest rate of 2¾%.

With the financing completed, the project was ready to proceed with construction.

Subsurface Investigations

The first work on the project, aside from solving the legal and financing problems, began as soon as preliminary funds were available, and consisted of an investigation of subsurface conditions at the damsite and in the possible borrow pit areas. Mr. Irving B. Crosby, Consulting Geologist of Boston, and Professor A. Casagrande of Harvard University were retained to assist in the prosecution of this work,

to study the results obtained and to report on the feasibility of the site and the probable leakage by the dam.

Bids for exploratory drilling were received in April, 1936, from seven companies with total bids ranging from $2,792 to $8,384. The contract was awarded to Battle Brothers of Scranton, Pa. The prices bid for drilling through the earth overburden and for core boring in rock were identical at $3.14 per foot.

Work began May 26, 1936, with three drill rigs in operation and the contract was completed on August 22, 1936. During this period there was completed 1,520 feet of overburden drilling in which 185 undisturbed samples were obtained, and 541 feet of core boring in rock. The deepest hole sunk was number 8 located on the center line of the dam on the north bank of the river. (See Figure 5.) This hole was 137.8 feet deep, 20 feet of which was in ledge. In general, holes were drilled 20 feet into ledge in order to be certain that bed rock and not a boulder was encountered. Simultaneous with this drilling, 99 test pits were dug by force account on the damsite and borrow pit

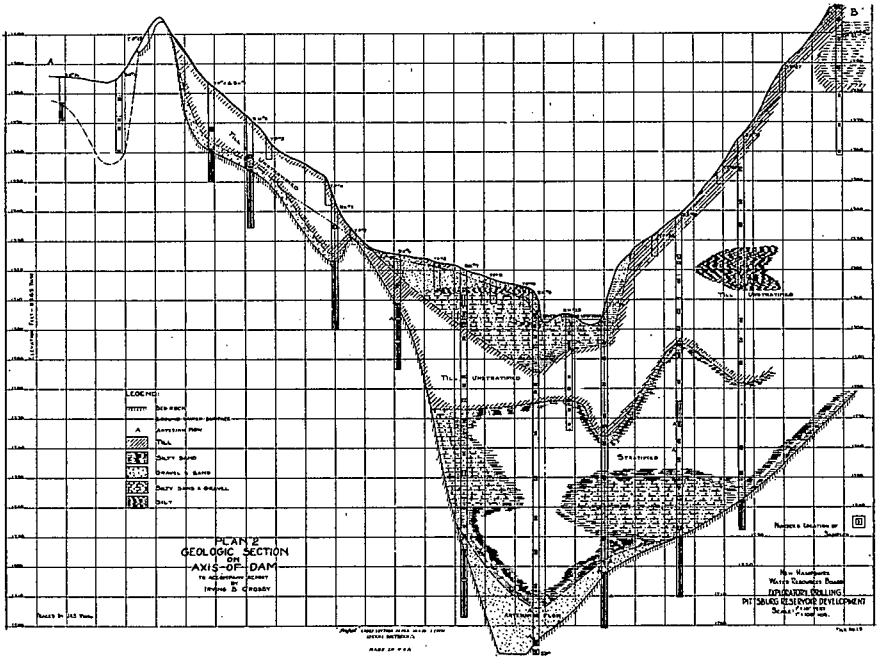

FIG. 5.—GEOLOGIC SECTION ON AXIS OF DAM

areas ranging in depth up to ten feet. Samples of the soil encountered in both drill holes and test pits were sent to a laboratory and tested for grain size, permeability and shear.

These explorations showed the bed rock to be a shist varying from slaty to massive with the strike varying from the North South to N 25° E and dipping steeply to the east. Bed rock was found comparatively close to the surface on the north side of the river with numerous outcrop at the higher elevations. The preglacial river bed was found just north of the present river bed and 115 feet below the present river level. Ledge continued to be very deep below the south hillside within the area of the damsite. An interesting feature of the drilling was that artesian flow was encountered in several of the deepest holes with sufficient head to force water as much as 20 feet above the surface of the river. At D. H. No. 16 the casing was left in place and a substantial volume of water continued to flow from this pipe until two years later when the casing was destroyed during construction operations.

The overburden consists mostly of glacial deposits. The samples from the lower depths showed deposits of silt and sand with some evidence of stratification. Above this was a layer of unstratified glacial till, which appeared to be continuous, with a minimum known thickness of eleven feet. Above this glacial till, principally in and near the present river channel, were layers of silty sands and gravels, the results of river action.

Frequent simple tests were conducted while sinking casings through the overburden to determine, if possible, variations in permeability. These tests consisted of filling the casing with water whenever work was halted and a careful record kept of drop in water level extending over periods as much as one hour. From these readings and permeability tests on undisturbed samples, Prof. Casagrande estimated that the seepage through the foundation of the dam would be less than 1 cfs.

As a result of this investigation it was decided that the site presented no serious difficulties to the construction of the dam.

General Design

Simultaneously with the subsurface investigations, a preliminary design of the dam was prepared and quantities estimated on which in-

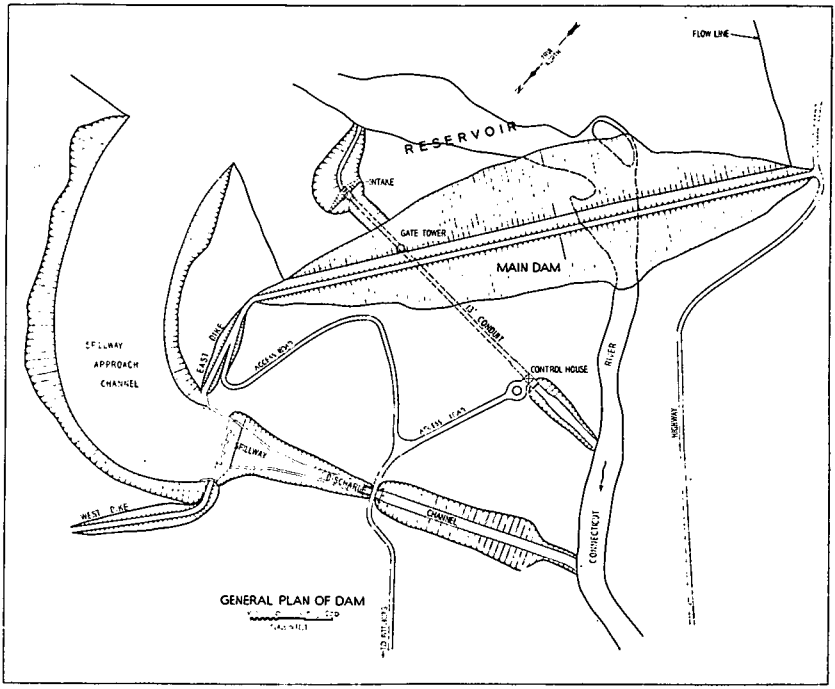

FIG. 6.—GENERAL PLAN OF DAM

formal proposals were received from several contractors. (See Figure 6.) The firm of Chas. T. Main, Inc., Consulting Engineers of Boston, was retained to prepare plans, specifications and estimates, which work was carried out under the direction of Mr. William F. Uhl, with Mr. Lawrence Ropes as his principal assistant. This firm later prepared contract and working drawings and acted in a consulting capacity throughout the construction period.

The dam as finally constructed consisted of an earth embankment across the main valley, a steel lined concrete conduit under the north end of the dam, and a spillway structure with approach and discharge channels located north of and entirely separate from the main embankment.

EMBANKMENT

The embankment is a rolled fill with a maximum height above the old river bottom of 100 feet and a total length of 2,200 feet.

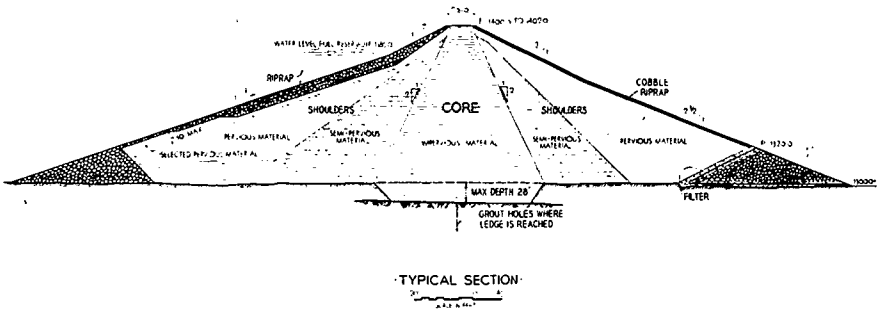

FIG. 7.—TYPICAL SECTION OF EARTH EMBANKMENT

The embankment section (see Figure 7) consisted of a central core of the most impervious material available in the vicinity and obtained mainly from borrow pits on the south hillside. On either side of this core was placed a slightly more porous material designated as semi-pervious and obtained principally from the required excavation in the spillway channel. The shoulders of the section consisted of the most pervious material available. This was a dirty gravel deposit about eight feet deep found in the river bottom directly upstream from the dam. A core trench was excavated through the surface sand, gravel, and stratified till and the impervious core carried down to the underlying unstratified glacial till or to bed rock. The greatest depth of core trench excavation occurred in the river bottom and was about 25 feet deep. Where bed rock was encountered, 134 grout holes about 15 feet deep were drilled approximately 5 to 10 feet apart and the rock thoroughly grouted before the core trench was backfilled. These holes were first drilled 20 feet apart and grouted, then intermediate holes drilled and again grouted and where it seemed necessary, additional intermediate holes were drilled and finally grouted.

Stone fills were constructed at both the upstream and downstream toes of the dam with a maximum height of about 25 feet. Where the downstream toe crosses the old river channel special precautions were taken and screened gravel and small cobbles placed on the bottom and upstream sides in such a manner as to provide a filter to permit seepage from the dam or foundation to come out into the rock toe without carrying with it the finer adjacent materials. The upstream and downstream slopes of the dam were built 1 to 3 and 1 to 2½ respectively except near the top where the slopes on both

FIG. 8.—VIEW OF EMBANKMENT FROM SOUTH END AT ELEVATION 1350

faces were increased to 1 to 2. Both upstream and downstream slopes were protected by riprap with a maximum thickness of five feet upstream at the normal full reservoir elevation.

The specifications required that the embankment material be placed in layers 8 inches thick after rolling, and satisfactory consolidation be obtained. A soils laboratory was established at the site and continuous tests made daily of the material being placed, its compaction and water content. Grain size analyses of the embankment materials showed the impervious and semi-impervious materials to be quite similar in size of particles above 0.1 mm. Below this size, there was a decided lack of fines in the semi-pervious, there being on the average only 8% finer than 0.01 mm. in the semi-pervious compared with 27% in the impervious. (See Figure 9.)

Considerable difficulty was encountered in obtaining the maximum compaction possible because of excessive moisture in the materials due primarily to the lack of proper predrainage of borrow pits. In general, the material in place averaged in weight from 120 lbs. to 130 lbs. per cubic foot dry weight with a moisture content varying from 10% to 15% with occasional samples showing as much as 20%. The optimum water content of the material was determined to be 12% for the impervious and 8% for the semi-pervious.

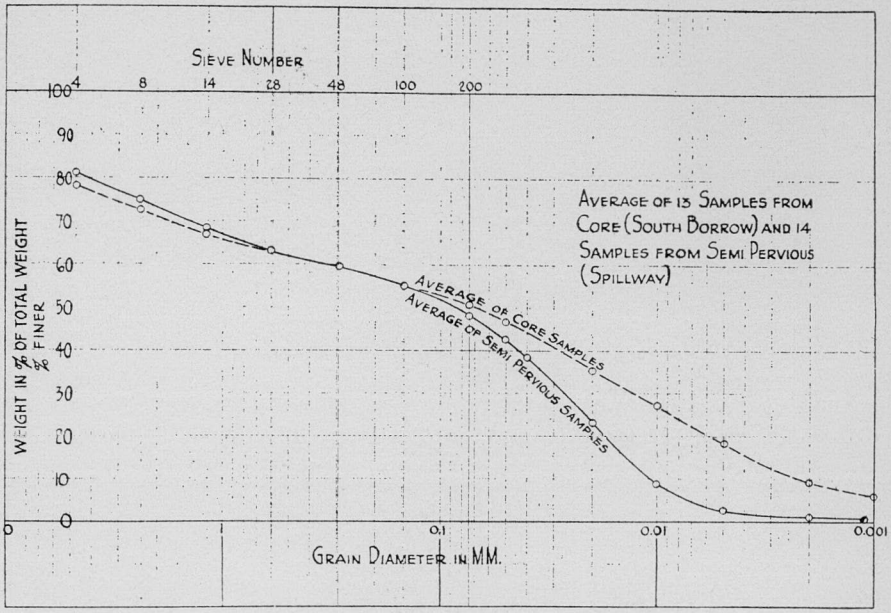

Fig. 9.—Grain Size Analysis of Embankment Materials

At the peak of construction, the contractor was using in the borrow pits for obtaining embankment material, 7 Diesel shovels ranging in capacity from 1½ to 2½ cy. For transporting the material, twenty-one Euclids were used ranging from 9 to 13 cubic yards in capacity. Several Athey Wagons drawn by tractors were used in the lower wetter areas. As many as 15 trucks with a capacity of 5 cy. were also used at times to augment the heavy hauling equipment. The maximum quantity of embankment placed in any one day was about 12,000 cubic yards on August 27, 1939. The maximum weekly quantity was placed the week of August 27 when about 67,000 cy. were placed. From May 16, 1939, to November 13, 1939, when freezing weather caused a shutdown, work on the embankment was continuous twenty-two hours a day seven days a week, weather permitting. During this period about 950,000 cubic yards of earth was placed. Unfortunately, the embankment was not completed, with only about 25,000 cubic yards yet to be placed. This will be completed early in 1940.

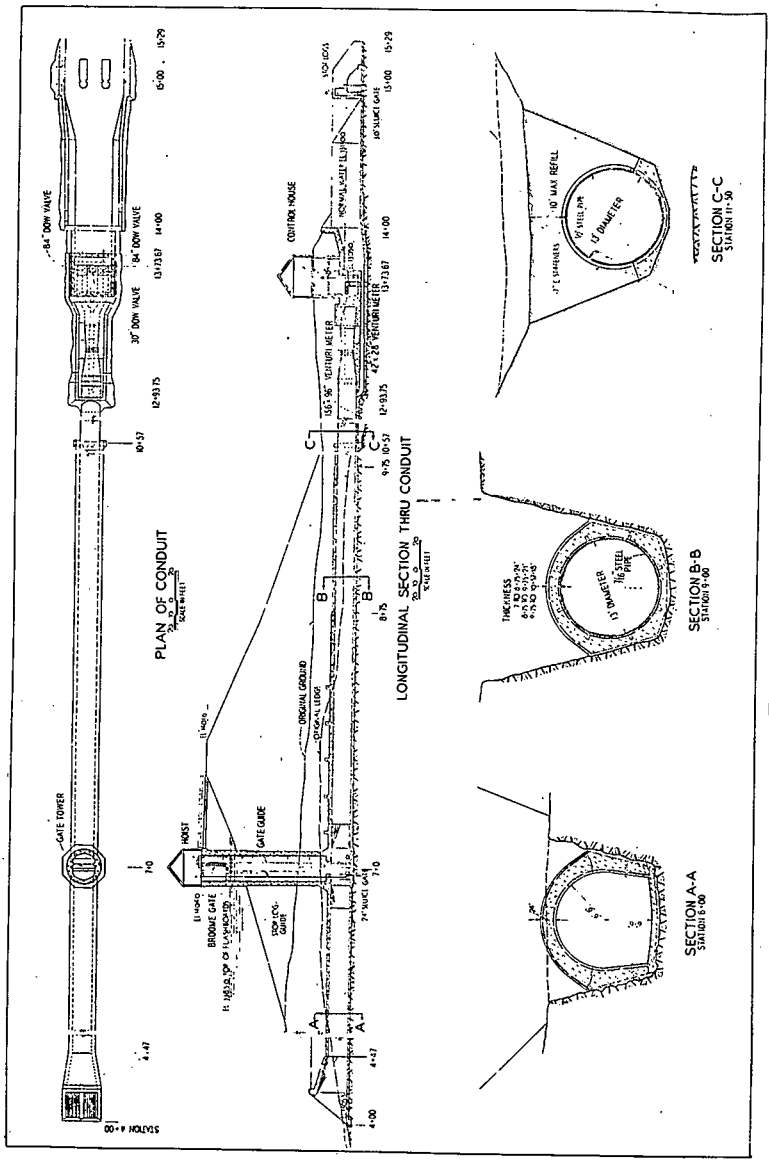

FIG. 10.—CONDUIT DETAILS

Conduit

The conduit consists of a waterway approximately 13 feet in diameter placed in a ledge trench north of the old river bed. (See Figure 10.) This conduit was designed with sufficient capacity to care for stream diversion during the placing of the earth embankment. Upstream from the center line of the dam is located a circular gate tower 18 feet in diameter inside of which is a 13 foot square Broome gate. This gate is operated by a 75 ton capacity gasoline engine driven hoist provided with Weston type mechanical load brake. This type of drive was adopted due to the unreliable source of electric current available at the time the gate was purchased. At that time, power to the community was supplied by an old belt driven generator housed in the Baldwin saw mill, which was often out of order. During the past summer the distribution line has been taken over by the New Hampshire Public Service Company and a transmission line has been constructed from Canaan, Vermont, to Pittsburg. This gate will ordinarily be open but available at all times for closing in case of an emergency or for an inspection of the conduit downstream from the gate.

The Broome gate hoist has sufficient capacity to operate the gate under full unbalanced head. However, a 24″ dram bypass with hand operated sluice gate has been provided so that the penstock below the gate can be filled and the pressure on the gate balanced before opening.

Upstream from this gate is an approach conduit of reinforced concrete with a horseshoe section 13 feet high and 13 feet wide at its widest point. The entrance to this conduit is protected by coarse racks.

Downstream from the gate tower the conduit consists of a 13 foot diameter steel pipe with that portion lying under the dam encased in reinforced concrete. A 24-inch air vent is provided directly below the gate. This portion of the conduit is placed in a trench cut out of solid rock (see Figure 11). The conduit continues for a distance of about 300 feet below the downstream toe of the dam, in which section the steel conduit is not encased but rests on a concrete cradle resting on earth. At its lower end the conduit is again tied to bed rock on which are placed the control house and discharge channels.

The discharge from the reservoir will be controlled by valves and meters located at the lower end of this conduit. In order not to

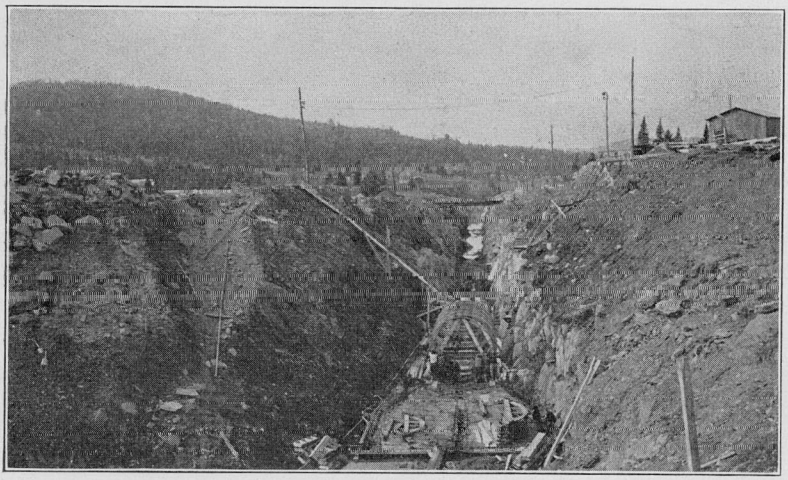

FIG. 11.—CONDUIT TRENCH EXCAVATION WITH BEGINNING OF CONCRETE FORM-WORK

constrict the conduit capacity in case of floods during construction, this equipment was not permitted to be placed until the embankment had reached elevation 1370. Two Venturi meters, one with an entrance diameter of 156 inches and a throat diameter of 96 inches, and the other 42″x28″ will be used to determine and record the discharge from the reservoir. Directly below the large meter the conduit separates into two pipes which lead to two 84 inch Dow Disc Valves, each weighing 50,000 lbs. The smaller Venturi bypasses the large meter and valves and is operated by a 30″ Dow Disc Valve. The throat of the large Venturi meter was built of cast iron in two sections with a total weight of 48,000 pounds. This Venturi tube rates as one of the largest in the country with a maximum capacity in excess of 2,000 cfs. The meters were built by the Builders Iron Foundry, Providence, Rhode Island.

The two 84″ Dow Valves were designed to be self-contained and were completely assembled in the shops. They are motor operated but can be operated by hand in case of power failure. Before dismantling, they were given a hydrostatic pressure test of 75 lbs. per square inch. The requirements were that leakage should not exceed 5 gallons per minute, which requirement was easily met. The Dow Valves were constructed by The Chapman Valve Company of Indian Orchard, Massachusetts.

These valves discharge into a concrete lined channel in which a pool is formed by a set of stop logs, maintaining water at elevation 1311 or at such elevation as gives best operation. This backwater will keep the valves completely submerged, forming a cushion for the discharged water and preventing the formation of ice around the valve during the winter, which might prevent their proper operation. The backwater will also always assure a full Venturi meter in times of low water. A bypass valve is provided around the stop log structure to permit draining of the channel for inspection of the valves, meter and conduit.

As the Pittsburg region is New Hampshire's best area for sport fishing, an 8″ pipe bypassing the valves is provided which will remain open at all times when necessary to supply water to the stream below for maintaining fish life.

Spillway

The spillway structure located separate from the dam and about

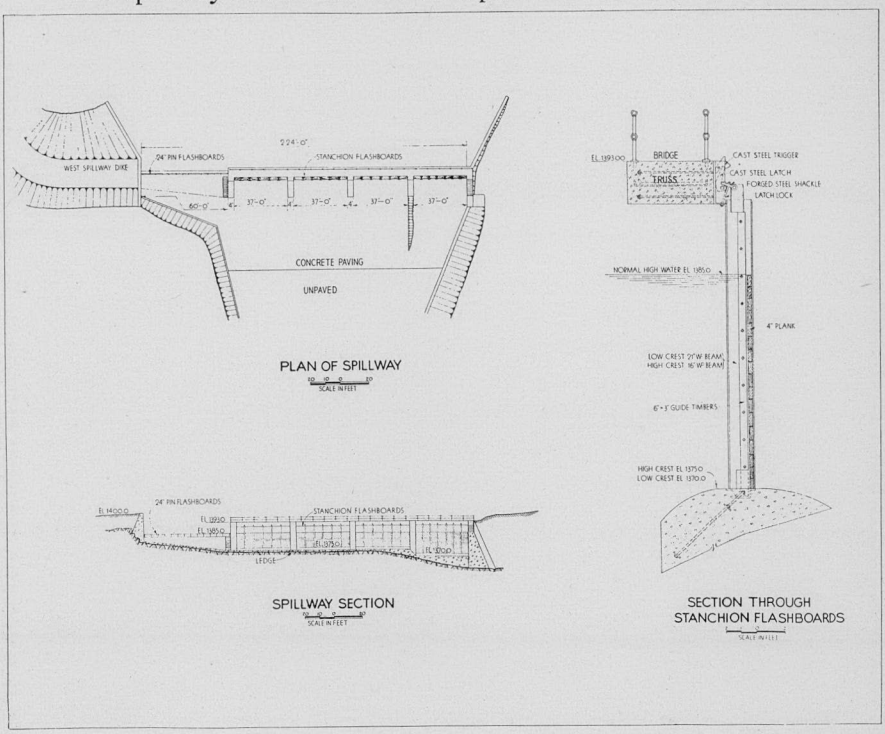

Fig. 12.—Spillway Details

600 feet to the north, consists of a 60 foot overflow section provided with 2 foot pin flashboards and 4 bays 37 feet long with needle beams. (See Figure 12.) Three of these bays have their permanent crest at elevation 1375 or 10 feet below water surface at full reservoir and the fourth section has a permanent crest at elevation 1370 or 5 feet lower. Needle beams are provided with a release mechanism which makes it possible to quickly remove all beams and flashboards in case of an emergency. It is not anticipated that needle beams will be very often released. With 3 feet over the flashboards, there would be 4,600 cfs discharged, which together with 2,500 cfs from the valves would give a discharge of 7,100 cfs or more than any known flood to date at this point on the river.

A channel 1,500 feet long and approximately 400 feet wide, with a maximum excavated depth of 30 feet, was required as an approach channel to this spillway. The channel leaves the reservoir about 700 feet above the dam and circles the north end of the dam. The excavation from this channel, most of which was in earth, was used in the embankment of the dam as semi-impervious material.

The spillway structure discharges into a channel 1,400 feet long excavated in rock and earth, which channel discharges its water into the river about 1,000 feet below the downstream toe of the dam. In places, the discharge channel required a ledge excavation of about 25 feet deep. The rock is protected in part by concrete side walls and paving.

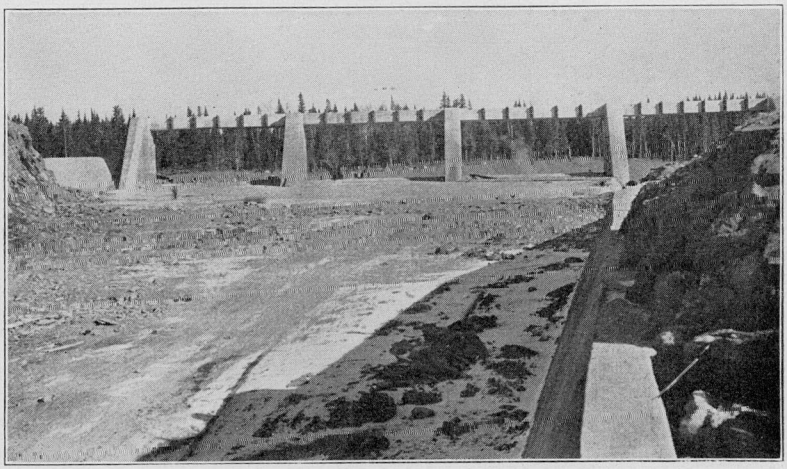

Fig. 13.—Downstream View of Spillway without Stantions in Place

The spillway and approach channel are designed to pass 36,000 cfs with a rise in water level in the reservoir of not more than to elevation 1.392 or eight feet below the top of the earth embankment. The capacity of the discharge channel is successively reduced from 30,000 cfs to 20,000 cfs and finally to 10,000 cfs as the channel becomes more distant from the dam and the possibility of damaging it by wash is reduced. The greatest flood height in the memory of the operator at the old Baldwin sawmill dam, located about one-half mile below the new dam, would indicate a maximum flood to date at this point of not exceeding 5,000 cfs.

Clearing

There were in the bottom lands directly above the dam several farms with good open land. The major part of the reservoir, however, was covered with a dense growth of spruce and fir, with some slash land from old lumbering operations. There was in addition, an exceptionally large number of huge elm and birch trees. All trees in the flowed area were felled and limbed and all small growth and branches burned. The larger tree trunks were left lying where they fell and a large number of these were removed by local people for firewood and other uses. It is anticipated that the remainder will float when the reservoir is filled but will soon sink or be blown ashore. As the prevailing winds are up the reservoir very few of these trunks are expected to reach the dam.

Highway Relocations

Previous to 1939 there was no road leading into Canada directly from New Hampshire, the road through Pittsburg ending at Second Connecticut Lake. In 1935 the State of New Hampshire was granted a strip of land 1,000 feet wide from the end of the existing road at Second Connecticut Lake to the border and the New Hampshire Highway Department with the help of C.C.C. labor, began the construction of a road in this area while Canadian officials began the construction of a connecting road in Canada. This road was finished and dedicated in the fall of 1939 and became an extension of the Daniel Webster Highway and U. S. Route No. 3 and the most direct route to Quebec City.

A portion of the old highway leading to this new road lay within the flowage of the Pittsburg Reservoir and required relocation. Be-

cause heavy traffic was anticipated over the relocated road, resulting from its connection to Canada, it was constructed as a Class A road in cooperation with the State Highway Department, with that Department bearing the cost in excess of the cost of a relocated road equivalent to the original road.

On the Clarksville side of the reservoir, about 3½ miles of Town Road was constructed. This road will be used mainly for logging and will permit travel by car approximately midway up the south shore of the reservoir. The original project called for a relocation of the River Road in Pittsburg. This road was not built, as it was possible to purchase all land served by the road for less cost than the road cost.

Cost

The project has not yet been completed and the final cost will not be available until some time next summer. The estimated cost of the project was $2,300,000 and it now appears that the final figure will be very close to this amount.

Contractors

Bids were first received for the construction of the dam on February 4, 1937. Due to legal difficulties no award was made. New proposals were received on May 31, 1938. B. Perini & Sons, Inc., of Framingham, Massachusetts, was low bidder and the contract was awarded to them on July 3, 1938. Their price for the dam based on the estimated quantities was $1,168,925. The date of completion was set at January 1, 1940.

The contract for the State highway relocation was awarded to the Littleton Construction Company of Littleton, New Hampshire, in the fall of 1938, and was completed early in the spring of 1939.

Board Personnel

The members of the New Hampshire Water Resources Board during the period of the construction of this Project have been Colonel John Jacobson, Jr., Chairman, and Messrs. William F. Sullivan, Laurence Whittemore, Milton Shapiro and Ernest D'Amours, Board Members. Mr. John J. Baker was Resident Engineer, with Mr. Arnold Blake as his principal assistant.

GEOLOGIC CONDITIONS AT PITTSBURG, N. H., DAM SITE

By Irving B. Crosby, *Member**

Introduction

The engineering, legal, and financial aspects of the Pittsburg Dam have been discussed in a most interesting manner by Mr. Holmgren and I will now describe briefly the geologic setting and the foundation problems.

This is a typical New England dam site in that it has a buried gorge partially filled with glacial deposits. It differs, however, in detail from other New England sites and was more difficult to explore than many of them.

From Connecticut Lake downstream, rapids and quiet stretches alternate on the Connecticut River, and the valley is alternately narrow and wide. At many of the rapids the stream falls over ledge, while in between, ledges are generally absent. These conditions are due to the fact that the river formerly flowed at a lower level and that it has had a complex geologic history. In preglacial time the river had widened its valley and was meandering on the floor of this valley when an uplift of the land caused the stream to cut down and intrench itself in a winding gorge. This downward erosion was cut short by the advance of the great ice sheet. When the ice finally melted, great quantities of debris, varying from clay to boulders, were deposited, partially filling the old valleys and burying the gorges in the old valley floors. In places, debris in the form of morainal ridges blocked the valleys, in other places they became partially filled with glacial lake deposits. New streams took their courses on the surface of this glacial debris, but did not follow the course of the buried channels. In the Connecticut Valley in New Hampshire, the present course of the river meanders from side to side of the partially filled valley. In places it is directly over the buried gorge, in other places it is at one side or the other. Where it is at one side of the old valley it has occasionally cut down upon buried rock ridges producing rapids

*Consulting Geologist, 6 Beacon Street, Boston, Mass.

or falls, as is the case at Pittsburg and many other rapids on the river.

In several places, as at the Comerford Dam, Fifteen Mile Falls, McIndoes Falls, Vernon Dam and Bellows Falls, the river has intrenched itself in a rock spur projecting into the buried valley and the pre-glacial channel is deeply buried at one side.

Where the valley was blocked by a moraine, the river cut a narrow valley through it and the concentration of boulders has generally caused swift water or rapids. Such is the case at the Pittsburg dam and at the Upper Fifteen Mile Falls dam site.

This general picture of geologic conditions applies to the Connecticut, Merrimack, Deerfield, Kennebec, and all other New England Rivers which I have examined, but with infinite variation of detail.

Geology of the Dam Site

At Pittsburg the river falls over ledges and the old gorge is deeply buried to the right of the present stream. The river cut down upon a rock ridge at Pittsburg, and has not been able to re-excavate its old valley upstream from Pittsburgh because it is held up by the rock sill. Above the falls at Pittsburg the old channel is buried more than 100 feet below the level of the present river. The old valley is filled with heterogeneous glacial deposits including silt, sand, gravel, and boulder clay. The exploration and interpretation of this material was one of the geological problems.

For some half dozen miles above the dam the valley is wide, forming an excellent reservoir basin. The only narrow place in the valley is at the dam site where the valley is partially blocked by a moraine. The glacier halted here in its retreat, readvanced over previous deposits of silty sand and gravel and deposited boulder clay upon these deposits in the buried gorge, thus forming a moraine which blocked the valley and formed a temporary lake in which sand and silt were deposited. The river has cut a narrow valley through the moraine draining the lake. The presence of the moraine has narrowed the valley and formed a dam site, but it has also produced very complex foundation conditions.

The lower part of the buried valley was filled with more or less silty sand and gravel before the moraine was formed. These sands were stratified and varied from relatively impervious to relatively pervious. At several points artesian flow was encountered in the test

borings indicating the presence of pervious layers. The most important of these lies directly on bed rock. Rain water evidently gets under the boulder clay where bed rock is exposed on the hills and passes down the slope of the rock under the river. Where tapped by borings artesian flow occurred. These pervious layers suggested the remote possibility of even more pervious layers which might have escaped detection by the test borings. Fortunately this sand was covered by a layer of boulder clay which extends across the valley about 10 feet below the river bed. This boulder clay is unstratified and is relatively impervious. Since it is not stratified there is, therefore, no possibility of pervious layers in it and it forms an impervious blanket which extends entirely across the valley, up both hill slopes, and for some distance up and down stream. The dam was connected with the layer of boulder clay by a cut-off trench which was filled with impervious material. The dam is thus connected with an impervious base of large extent. Water seeping under it must travel a very long distance through deeply buried sands, and would probably come out a mile away below the falls at Pittsburg.

No clay was found in the borings and the possibility of existence of large lenses of it at this site are practically nil, due to the geologic history. There was, therefore, no possibility of serious settlement of the dam due to compaction of underlying clay.

Material for the impervious section of the dam was obtained from the extensive deposits of boulder clay on the hillsides on both sides of the river. Materials for the pervious sections of the dam were taken from kame deposits of sand and gravel on the right side of the valley above the dam.

The bed rock of the dam site is schist striking on the average N 25° E and dipping steeply to the east. The surface of the schist is extremely irregular. The main earth dam comes in contact with the schist only at the right end, but the spillway structure is founded upon it and the excavation for the outlet conduit was excavated partly in schist. The tendency to open cracks in the schist with shooting was demonstrated in this excavation.

This was a good dam site with certain problems concerning seepage which were well met by the design of the dam. As New England dam sites go it required more thorough examination than some, but the conditions permitted satisfactory engineering treatment more easily than others.

LARGE VENTURI METER FOR PITTSBURG, N. H., RESERVOIR

By J. R. Hartley*

The large Venturi Meter Tube installed at the Pittsburg, New Hampshire, Reservoir is unusual in certain respects. It is, according to the records of the Builders Iron Foundry, the second largest Venturi Tube in this country of steel and cast iron construction; its inlet diameter of 13 feet being only 1½ in. smaller than a similar meter installed by the Southern California Edison Company. It has a throat diameter of 8 feet which is 3 in. larger than the throat size of the Venturi Meters installed in the Catskill Aqueduct which measures the water supply to the City of New York. When connected to a standard instrument having a differential capacity of 21 feet of water, this meter will measure 1,292,000,000 gallons per day, some 30% greater than the quantity consumed by our largest city.

The inlet and outlet sections of the Pittsburg meter are of riveted steel construction similar to the 13 foot pipe line. These cone sections were fabricated by the Walsh's Holyoke Steam Boiler Works in accordance with the engineers' specifications and to designs furnished by Builders Iron Foundry.

The throat piece weighing 48,000 lbs., is of cast iron in two sections with flanged joint downstream from the throat piezometer chamber. The interior of the throat at the piezometer holes is lined with bronze and is accurately bored to size.

There is also a 42 in. Venturi Tube placed in parallel with the larger tube. This smaller tube is of conventional flanged cast iron construction and is intended to measure flows below 180 second-feet.

Standard Type M Instruments will indicate, totalize and record the flow through the two Venturi Tubes. The Instruments will be placed on the upper floor of the Control House but because of limited head at times of low water in the reservoir, the mercury well actuators will be located on a lower floor using cable drive between actuator and instrument.

*Engineer, Builders Iron Foundry, Providence, R. I.

The largest sewage meters in the world are four 114 in. Venturi Meters installed at the Southwest Plant of the Sanitary District of Chicago, the world's largest sewage treatment plant. The entire inlet and throat portion of these tubes is cast iron, but the outlet cones are of concrete.

Undoubtedly the future will bring pipe lines of larger size and newer materials; experience indicates that the future will also bring Venturi Meters of equally advanced design "to conserve the water supply and eliminate water waste" as they have been doing for over half a century.

OF GENERAL INTEREST

PRIZES AWARDED AT ANNUAL MEETING ON MARCH 20, 1940

The Desmond FitzGerald Medal

To HOWARD A. GRAY, MEMBER

Presentation made by Prof. John B. Babcock, Chairman of Committee on Award.

The Desmond FitzGerald Medal was instituted and endowed in 1910 by the late Desmond FitzGerald, a Past President and honorary member of this Society, and is awarded annually for a paper, presented to the Society by a member, and published during the year, which is adjudged worthy of special commendation for its merit. The Committee on Award this year, consisting of Prof. John B. Babcock, E. Sherman Chase and A. E. Kleinert, selected from the list of a number of excellent papers one which was recommended to the Board of Government for the Award. The paper selected was entitled "Enlargement of L Street Steam-Electric Plant of Boston Edison Company", by Howard A. Gray, member, presented at a meeting of the Boston Society of Civil Engineers held on January 25, 1939, and published in the JOURNAL of the Society for April, 1939. On behalf of the Board of Government Prof. Babcock presented the Desmond FitzGerald Medal to Mr. Gray. Mr. Gray expressed his appreciation of the honor bestowed upon him by the presentation of this medal.

The Designers' Section Prize

To PROF. DEAN PEABODY, MEMBER

Presentation by A. E. Kleinert, Chairman of Designers Section Prize Award Committee.

On behalf of the Board of Government, A. E. Kleinert, Chairman of the Designers Section Prize Committee, presented the prize to Prof. Dean Peabody, member, for his paper entitled "Continuous Frame Analysis of Flat Slabs", presented at a meeting of the Designers Section held on March 8, 1939, and published in the July, 1939, JOURNAL. The prize consisted of books: "Theory of Statically Indeterminate Structures," by Walter M. Fife and John B. Wilbur; "Automatic Design of Continuous Frames in Steel and Reinforced Concrete," by Linton E. Grinter; "Theory of Modern Steel Structures," by Linton E. Grinter; and "Vibration Problems in Engineering", by Stephen Timoshenko.

Prof. Peabody accepted the prize with appropriate remarks.

The Clemens Herschel Prize Awards

To Otis D. Fellows and Charles E. Greene

Presentation by E. Sherman Chase, member of Committee on Prize Awards.

The Clemens Herschel prize was established by a gift from the late Clemens Herschel, a Past President and Honorary member of the Society, and is awarded for a paper which has been particularly useful and commendable and worthy of recognition. This year two prizes were awarded; one to Otis D. Fellows, for his paper on "Highways of the Boston Metropolitan District—Their Origin and Evolution", presented at a meeting of the Highway Section held on April 26, 1939, and published in the October, 1939, Journal. The second prize was awarded to Charles E. Greene, for his paper on "Mechanical Equipment for Refuse Incinerators", presented at a meeting of the Sanitary Section held on March 1, 1939, and published in the July, 1939, Journal. On behalf of the Board of Government, Mr. E. Sherman Chase presented the Prizes which consisted of the book, "Frontinus and the Water Supply of the City of Rome", by Clemens Herschel. Mr. Fellows and Mr. Greene each accepted the prize with appropriate remarks.

The Northeastern University Section Prize

To Louis G. Reiniger, Student Member

Presentation by Prof. John B. Babcock, Chairman of Prize Awards Committee.

In accordance with the recommendations of the Committee on Prize Awards a prize was given this year for an original paper prepared by a member of the Northeastern University Section and presented during the year at a regular student conference meeting at the University. This award was made to Louis G. Reiniger, member of this Section, for his paper on "How Combat Engineers Span a River", presented at a meeting of Students on November 3, 1939.

The prize consisted of books: "Geology and Engineering", by Robert F. Legget; "The Analysis of Engineering Structures", by A. J. S. Pippard and J. F. Baker; "Preparation of Engineering Reports", by Agg and Foster.

ARTHUR W. DEAN

Honored at Testimonial Dinner

More than three hundred public officials, engineers and friends attended a dinner on March 28 at the Boston Chamber of Commerce to honor Arthur W. Dean, of Winchester, Mass., this occasion marking his retirement from the position as Chief Engineer of the Massachusetts State Planning Board.

His long and notable career was briefly summarized by Arthur D. Weston, who served as Toastmaster. Mr. Dean was born in Taunton, Mass., and received his early education in the Taunton public schools. He graduated from Massachusetts Institute of Technology in 1892, and became City Engineer of Nashua, N. H. in 1896. In 1900 he was made chief engineer in the construction of an electric railway system in southeastern New Hampshire and northeastern Massachusetts. In

1904 he was appointed State Highway Engineer of New Hampshire and head of the New Hampshire State Highway Department, remaining in that position until January 1, 1910, when he became Chief Engineer of the Massachusetts Highway Commission. In 1919 he was made Chief Engneer of the Division of Highways of the Massachusetts Department of Public Works, when that department was organized and established in two divisions, highways and waterways. In 1929 he was appointed Chief Engineer of the whole department, and after 26 years of service in that position was, on October 5, 1935, made Chief Engineer of the Massachusetts State Planning Board, from which position he was retired on March 26.

During the course of his long public service Mr. Dean was also active in the conduct of the affairs of the engineering societies. He is a past president of the American Road Builders' Association, holds membership in the American Association of State Highway Officials, the American Society of Civil Engineers, of which he was a Director for several years, and is a member and past president of the Boston Society of Civil Engineers.

While Mr. Dean will retain a connection with public activities in the unpaid position of Chairman of the Metropolitan Planning Division, to which he was recently appointed by Governor Saltonstall, he has announced that he will carry on a Consulting Engineering practice jointly with Lewis E. Moore, specializing in highways, bridges and other structures, reports, estimates and general planning, with offices in Room 1106, 73 Tremont Street, Boston.

The committee on arrangements comprised Frederick H. Fay, Chairman, Richard K. Hale and Arthur D. Weston, with Agnes C. Conroy acting as Secretary.

The Arthur W. Dean Testimonial Dinner was a well-deserved tribute to an able experienced engineer, a man of many accomplishments in the public service, a gentleman and a scholar, and one whom it is a privilege to call friend. A merited tribute, also, to his helpmate, Mrs. Dean.

NEW HYDRAULICS SECTION, BSCE

Organized May 1, 1940

In order to occupy a field not previously covered in the Section activities of the Society and as a result of the wide interest shown in the series of lectures designated as the John R. Freeman Lectures on Hydraulics, which were proposed by Prof. Gordon M. Fair, President, 1939-40, with the cooperation of the John R. Freeman Fund Committee, the Board of Government voted on March 20, 1940, to authorize the establishment of a new section to be known as the Hydraulics Section, Boston Society of Civil Engineers. On April 11, 1940, the Board of Government designated a committee, consisting of Karl R. Kennison, Chairman, Harvey B. Kinnison, and Arthur L. Shaw, to inaugurate the steps necessary to organize the new section.

On May 1, 1940, the meeting for the organization of the Hydraulics Section was held at 715 Tremont Temple, Boston. Mr. H. B. Kinnison served as temporary Chairman of this meeting for the adoption of By-Laws for the Section and for the election of officers.

The following were elected officers for the current year:

For *Chairman,* Donald F. Horton; *Vice-Chairman,* Scott Keith; *Clerk,* M. T. Thomson; *Executive Committee,* Stanley M. Dore, Dr. Kenneth C. Reynolds, Dr. Harold A. Thomas.

Mr. Frank B. Walker, President, BSCE, on behalf of the members of the Board of Government extended con-

(Continued on Page 153)

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETING

Boston Society of Civil Engineers

JANUARY 24, 1940.—A regular meeting of the Boston Society of Civil Engineers was held this evening at the Engineers Club, and was called to order by the President, Gordon M. Fair. This was a joint meeting with the Sanitary Section of the Boston Society of Civil Engineers. One hundred thirty-five members and guests were present; one hundred persons attended the dinner preceding the meeting.

The Secretary reported the election of the following to membership on January 24, 1940:

Grade of Student: Edward L. Burke and William A. Hardy.

The President stated that the recommendation of the Board of Government relative to the use of current income of the Permanent Fund was acted upon favorably at the December 20th meeting of the Society and that final action is necessary at this meeting.

Voted, that the Board of Government be authorized to use as much as may be necessary of the current income of the Permanent Fund for current expenses.

The President stated that President Holcombe J. Brown, of ESNE, had requested a discussion and expression of opinion by members of the Society in the matter of legislation in this state that would provide for the registration of Engineers. In accordance therewith, there were distributed copies of a report. entitled, "Should the Commonwealth of Massachusetts have a registration for licensing the practise of Engineering?" prepared by Arthur D. Weston, Chairman of the Committee on Public Affairs, ESNE. President Fair announced that this matter would be discussed at the next meeting of the Society on February 14, 1940.

The President then introduced the speakers of the evening who presented a "Discussion of Problems and Sewerage and Sewage Disposal in Boston Metropolitan District". The speakers were, Harrison P. Eddy, Jr., and A. L. Fales, of Metcalf & Eddy, Engineers, Boston, and Samuel A. Greeley, of Greeley and Hansen, Engineers, Chicago.

The speakers outlined the project and recommendations made by them as consulting Engineers, as published in the report of the special legislative commission, dated June 15, 1939 (House No. 2465.) The Legislature subsequently passed an Act, Chapter 512, Acts of 1939, making provision for the construction of certain projects at a cost of $10.428,000 and authorizing the Metropolitan District Commission to have borings and surveys made and plans and specifications prepared for these projects.

These papers were illustrated by lantern slides.

A question period followed the talks.

The meeting adjourned at 9:30 P. M.

EVERETT N. HUTCHINS, *Secretary*.

FEBRUARY 14, 1940.—A regular meeting of the Boston Society of Civil Engineers was held this evening at the Engineers Club and was called to order by the President, Gordon M. Fair, at 7:00 P. M. This was a joint meeting with the Designers Section of the Bos-

ton Society of Civil Engineers. Eighty members and guests attended, seventy-three persons attended the supper.

The President announced the deaths of the following members:

Frederick A. Lovejoy, who had been a member since December 17, 1919, and who died December 21, 1939.

George H. Nye, who had been a member since June 18, 1890, and who died January 20, 1940.

Edward R. Hyde, who had been a member since October 20, 1909, and who died February 5, 1940.

The Secretary announced the election of the following members:

Grade of Member: Kirkwood B. Brown, Laurence G. Leach, Peter A. Murphy.

Grade of Junior: Charles G. Hunt Jr.,† Burritt F. Leighton,† John H. Manning.†

The President stated that with the approval of the Board of Government (December 20, 1939), and at the request of President Holcombe J. Brown, of the ESNE, the matter of the registration and licensing of Engineers in this State was presented for discussion at this meeting. An outline report by the ESNE Committee on Public Affairs, Mr. A. D. Weston, Chairman, was distributed at the previous meeting of the Society (January 24, 1940) and also at this meeting. Mr. A. D. Weston and Prof. W. C. White of that committee spoke briefly on this subject.

On the request of the President for an expression of opinion on the desirability of legislation in this State for the Registration and Licensing of Engineers, twenty-five members were in favor and six were not in favor of such legislation.

The President announced that the Board of Government, having in mind the large attendance at the John R. Freeman Lectures on Hydraulics, had authorized the appointment of a special committee to consider and to report on the matter of the formation of a Section on Hydraulics in the Society, to hold regular meetings similar to the other Sections.

The President then introduced the speaker of the evening, Richard S. Holmgren, Chief Engineer, New Hampshire Water Resources Board, Concord. N. H., who gave an illustrated talk on "The Pittsburg Conservation Reservoir of the New Hampshire Water Resources Board, Concord, N. H."

The Pittsburg Conservation Reservoir is located on the Connecticut River in northern New Hampshire. This reservoir is being constructed by the New Hampshire Water Resources Board for the purpose of conserving flood flows for use in times of low water. This reservoir will have a water surface area of 2.200 acres and a capacity of 96.000 acre feet. The dam consists of an earth embankment, 2,200 feet long and 100 feet high. This dam is practically completed.

The paper discussed the obstacles overcome previous to construction as well as the general technical features of the project.

Adjourned at 9:15 P. M.

EVERETT N. HUTCHINS, *Secretary.*

MARCH 20, 1940.—The ninety-second annual meeting of the Boston Society of Civil Engineers was held today at the Boston Chamber of Commerce, and was called to order at 4:30 P. M. by the President, Prof. Gordon M. Fair.

The minutes of all previous meetings of the year which have been printed in the various issues of the JOURNAL were approved as printed.

The annual reports of the Board of Government, Treasurer, Secretary, and Auditors were presented. Reports were also made by the following committees: Membership, Social Activities, Relation of Sections to Main Society, Welfare, Library, Floods of 1936, and John R. Freeman Fund.

Voted, That the reports be accepted

†Transfer from Grade of Student.

with thanks and placed on file, and that they be printed in the April, 1940, JOURNAL.

Voted, That the incoming Board of Government be authorized to appoint such committees as it deems desirable.

The report of the Tellers of Election, Stanley M. Dore, and Francis H. Kingsbury, was presented, and in accordance therewith the President declared the following had been elected officers for the ensuing year:

President—Frank B. Walker
Vice-President (for two years)—Albert Haertlein
Secretary—Everett N. Hutchins
Treasurer—Charles R. Main
Directors (for two years) Thomas R. Camp, Samuel M. Ellsworth
Nominating Committee (for two years)—Miles N. Clair, George W. Coffin, Arthur E. Harding.

The retiring President then delivered his annual address on "The Genius of Sanitation."

Sixty-eight members attended this part of the meeting.

The meeting adjourned to assemble at 7:30 P. M., the annual dinner being held during the interim. A music and singing program was provided during the dinner period.

The President then called the meeting to order, for the presentation of Prizes.

The President called upon Past-President, John B. Babcock, Chairman of the Committee on Award of the Desmond FitzGerald Prize, to present the Desmond FitzGerald Medal to Howard A. Gray, member, for his paper entitled "Enlargement of L Street Steam-Electric Plant of Boston Edison Company", presented at a meeting of the Society held on January 25, 1939, and published in the April, 1939, JOURNAL.

Mr. A. E. Kleinert, Chairman of the Committee on Award of the Designers Section Prize, presented this prize to Prof. Dean Peabody Jr., member, for his paper on "Continuous Frame Analysis of Flat Slabs", presented at a meeting of the Designers Section held on March 8, 1939, and published in the July, 1939, JOURNAL. The prize consisted of books: "Theory of Modern Steel Structures", by Linton E. Grinder; "Automatic Design for Continuous Frames in Steel and Reinforced Concrete", by Linton E. Grinder; "Theory of Statically Indeterminate Structures", by Walter M. Fife and John B. Wilbur; "Vibration Problems in Engineering", by Stephen Timoshenko.

Prof. John B. Babcock presented the Northeastern University Section Prize to Louis G. Reiniger, Student member, for his paper on "How Combat Engineers Span a River", presented at a meeting of Students held on November 3, 1939. The prize consisted of books: "Geology and Engineering", by Robert F. Legget; "The Analysis of Engineering Structures", by A. J. S. Pippard and J. F. Baker; "Preparation of Engineering Reports", by Agg and Foster.

Mr. E. Sherman Chase, member of the Prize Awards Committee, made the presentation of the Clemens Herschel Prizes to the following: to Otis D. Fellows, for his paper, "Highways of the Boston Metropolitan District—Their Origin and Evolution", presented at a meeting of the Highway Section held on April 26, 1939, and published in the October, 1939, JOURNAL; and to Charles E. Greene, for his paper on "Mechanical Equipment for Refuse Incinerators", presented at a meeting of the Sanitary Section held on March 1, 1939, and published in the July, 1939, JOURNAL. The prizes consisted of copies of the book "Frontinus and the Water Supply of the City of Rome", written by the late Clemens Herschel.

The newly elected President, Frank B. Walker, and other distinguished guests were introduced.

President Fair then introduced the guest speaker, Commander Henry E. Rossell, Professor of Naval Construction, M.I.T., who gave a very interesting talk on airships and battleships.

One hundred and twenty-eight members and guests attended the dinner.

The meeting adjourned at 9:45 o'clock.

EVERETT N. HUTCHINS, *Secretary.*

SANITARY SECTION

NOVEMBER 1, 1939.—A meeting of the Sanitary Section was held at 7:30 P. M. this evening in the Society Rooms. Twenty-two members and guests were present at the supper at Patten's Restaurant which preceded the meeting.

Speakers

Mr. Frank Bachmann, Director of Sanitary Sales, The Dorr Co., Inc., spoke on "Sewage Sludge-Digestion Equipment." Mr. Allan Craig, Engineer of Sanitation Division, Link-Belt Company, spoke on "Development of the Sludge Digestion Tank."

Mr. Bachmann described and explained in a most interesting manner the operation of some of the outstanding Dorr installations in this country, his talk being well illustrated with slides.

Mr. Craig traced the development of the digestion tank and explained the principle of these tanks and described some of the larger installations by the Link-Belt Company in this country. This paper was also illustrated with slides.

After an interesting discussion of these papers, the meeting adjourned at 9:15 P. M. 30 members were present at the meeting.

GEORGE W. COFFIN, *Clerk.*

JANUARY 3, 1940.—A meeting of the Sanitary Section was held at 7:30 P. M. this evening in the Society rooms. Thirty-three members and guests were present at the supper at Patten's Restaurant preceding the meeting.

It was *Voted* that the Chairman be authorized to appoint a nominating committee to nominate the officers and three members of the Executive Committee to be voted on at the annual meeting March 6th, 1940. Accordingly, Chairman Soule appointed the following members: Frank L. Flood, Richard S. Holmgren, Paul F. Howard.

Speakers

Mr. Louis J. Harrigan, Assistant Engineer of the Boston Transit Commission, spoke on "Problems Encountered in Sewer Construction in Connection with the Huntington Avenue Subway Extension", a $7,000,000 WPA project. His talk, well illustrated with lantern slides, described many of the difficulties of construction and maintenance of the numerous sewers and drains encountered in building the subway. Division Engineer Shea, of the Transit Commission, discussed the construction of some of the larger sewer siphons under the subway.

After a discussion of these papers, a general discussion on sewer design and maintenance was held. Mr. William L. Hyland, of Fay Spofford & Thorndike, descried briefly the Cranston, Rhode Island, sewer project now under construction and for which Fay Spofford & Thorndike are designing and consulting engineers. Messrs. Brosseau, Camp, Ellsworth, Fair, Joy, Sampson and Wright also took part in the discussion and contributed much valuable information from their experiences in sewer design and construction.

About 45 members and guests were present at the meeting which adjourned at 9 P. M.

GEORGE W. COFFIN, *Clerk.*

JANUARY 24, 1940.—A Joint Meeting of the Sanitary Section with the Main Society was held at 7 P. M. this evening at the Engineers' Club. One hundred members of the Society and guests, including about 20 of the regular attendants at the Sanitary Section meetings, were present at the dinner.

Subject.

"Discussion of Problems of Sewerage and Sewage Disposal in the Boston Metropolitan District."

Speakers

The speakers were introduced by President Fair of the Boston Society of Civil Engineers who first introduced Mr. Harrison P. Eddy, Jr. Mr. Eddy described the Metropolitan Sewerage System and discussed the general aspects of the report of the Special Commission, House 2465, 1939. (Metcalf and Eddy of Boston and Greeley and Hansen of Chicago were the Consulting Engineers for this Commission.)

Mr. Almon L. Fales read a well-prepared and very interesting paper describing in detail the design features of the several sewage treatment plants proposed for the Metropolitan Sewerage District, in House Report 2465.

Mr. Samuel P. Greeley of Greeley & Hansen, Sanitary Engineers, Chicago, discussed the pollution studies made in connection with the above report.

All three papers were illustrated by lantern slides.

After a brief discussion of these papers, a rising vote of thanks was given to Mr. Greeley for his talk. The meeting adjourned at 9 P. M. About 135 members of the Society and guests were present at the meeting.

GEORGE W. COFFIN, *Clerk.*

DESIGNERS' SECTION

FEBRUARY 14, 1940.—A meeting of the Designers Section was held this evening at the Engineers Club. This meeting was held jointly with the Boston Society of Civil Engineers. The meeting was called to order by the President of the Boston Society of Civil Engineers, Gordon M. Fair, at 7:00 P. M.

Professor Fair introduced the speaker of the evening, Mr. Richard S. Holmgren, Chief Engineer of the New Hampshire Water Resources Board, who gave an illustrated talk on "The Pittsburg Conservation Reservoir of the New Hampshire Water Resources Board, Concord, New Hampshire." The paper discussed the obstacles overcome previous to construction as well as the general technical features of the project.

Eighty members and guests attended.

The meeting adjourned at 9:15 P. M.

JOHN B. WILBUR, *Clerk.*

MARCH 13, 1940.—The annual meeting of the Designers' Section was held this evening in the Society's rooms. Chairman J. D. Mitsch called the meeting to order at 7:15 P.M.

The clerk's report of the last meeting was accepted as read. For the information of the members present, the report of the executive committee on the Section's activities for the year was presented by the clerk. This being the annual meeting, the nominating committee, composed of the three recent past chairmen of the section, submitted its report through Mr. Coombs, chairman of that committee. The report was accepted and, no nominations being received from the floor, the following officers were elected for the ensuing year:

Chairman, Kimball R. Garland; Vice Chairman, John B. Wilbur; Clerk, Emil A. Gramstorff; Members of the Executive Committee, Henry A. Mohr, Miles N. Clair, Manuel A. Benson.

Following this business session the speaker of the evening, Mr. Robert D. Chellis, was introduced. Mr. Chellis spoke on the subject of "Pile Driving Formulae", referring almost entirely to the Engineering News and Hiley formulae. After pointing out factors either ignored or inadequately provided for by the Engineering News expression, he presented the Hiley equation discussing the significance of the lost energy terms. To these terms he brought the results of observations conducted for the purposes of measuring these quantities under the variable conditions—different hammers and speed of operation, types of piles, effects of caps, anvil blocks, etc.

Following this very interesting and able presentation, comments were made

by Messrs. Howard T. Evans and Stuart J. Crandall.

Meeting was adjourned at 9:15 P.M. Attendance 65.

EMIL A. GRAMSTORFF, *Clerk.*

HIGHWAY SECTION

Minutes of the meeting held February 28, 1940

FEBRUARY 28, 1940.—A regular meeting of the Highway Section of the Boston Society of Civil Engineers was held in the Society's rooms, 715 Tremont Temple, this evening.

The meeting was called to order by the Chairman, Mr. Arthur E. Harding, at 7:25 P.M.

The reading of the minutes of the previous meeting was omitted.

The report of the nominating committee was made and accepted and the following were elected to serve as officers of the Section for the year 1940-1941:

Chairman—Donald W. Taylor
Vice-Chairman—H. R. Swartz
Clerk—Louis H. Smith
Executive Committee—Parker Holbrook, Arthur E. Harding, William C. Paxton, Jr.

The Chairman then presented Professor A. J. Bone of the Massachusetts Institute of Technology and a member of the Section, who spoke on the subject "Economic Significance of Traffic Delays on Congested Streets and Highways".

The speaker, with the use of graphs and tables projected upon the screen, gave a very interesting talk on his subject and expressed his appreciation of Professor Babcock's assistance.

A question period closed a most interesting evening, the meeting adjourned at 9:00 P.M. with an attendance of 27 members and guests.

PARKER HOLBROOK, *Clerk.*

NORTHEASTERN UNIVERSITY SECTION

NOVEMBER 23, 1939.—The Northeastern University Section held a meeting today at noon. Daniel Miles, Vice-Chairman of the Section, introduced the speaker, Mr. Albert Genaske, Junior Civil Engineer of the Metropolitan District Water Supply Commission.

Mr. Genaske showed colored motion pictures on the construction of the Lock Joint Concrete pipe in Natick and the laying of the pipe at different points along the new Metropolitan Pressure Aqueduct.

In accordance with the policy of the Northeastern University Section this year, this meeting was held prior to the field trip to the Lock Joint Pipe Co., in Natick.

The attendance was 45. The meeting adjourned at 12:50.

On NOVEMBER 25, 1939, the Northeastern University Section held a meeting at the Lock Joint Concrete Pipe Co., in Natick. The members gathered at 9:00 A. M. at Northeastern University and travelled in private cars to Natick. The party was divided into sections and taken through the plant. The methods used in the construction of the reinforced concrete pipe were explained by company engineers. A short trip was then taken to Framingham where the methods of excavating, handling of the concrete pipe and joint filling were observed.

The attendance was 51.

JOHN L. BEAN, *Clerk.*

DECEMBER 14, 1939.—The Northeastern University Section held a meeting at 5:30 P. M., in the BSCE room at Northeastern University.

Daniel Miles, Vice-Chairman, introduced the speaker, Joseph Higgins, who is employed by the Silas Mason Co., of New York, on the Metropolitan Sewer unit from East Boston to the Everett Line. The speaker discussed

the construction methods used on the North Metropolitan Sewer, thereby giving a background for the field trip to the sewer job on December 15, 1939.

The attendance was 15.

On DECEMBER 15, 1939, the Northeastern University Section met at the North Metropolitan Sewer shaft in Address Square, Chelsea, at 2:30 P. M., for a field inspection trip to the new Metropolitan sewer.

The party was divided into two sections, one of which was taken to the Everett end, and the other section to the East Boston end of the sewer. Each section was allowed to inspect operations from the shield platform, thereby seeing the actual excavation of material, the placing of the liner-plate by hydraulic power, the fastening of the liner-plate and the back filling which was done with an aggregate under pressure.

The attendance was 16.

JOHN L. BEAN, *Clerk.*

JANUARY 19, 1940.—The Northeastern University Section held a meeting in room 440-W, in the University Building. Mr. George Brock, Engineer with the Liberty Mutual Insurance Co., gave a talk on "Heavy Construction in the Oil Refining Industry".

The section also enjoyed an afternoon of bowling followed by a group dinner at the "Old France" Restaurant.

The attendance was 32. The meeting closed at 9:10 P. M.

JOHN L. BEAN, *Clerk.*

FEBRUARY 23, 1940.—A meeting of the Northeastern University Section of the B.S.C.E. was held today in Room 440-W.

The meeting was called to order at 7:30 P.M. by L. G. Reiniger, Chairman of the section. The minutes of the last meeting held on January 19, 1940, were read and accepted, after which the Chairman outlined the coming field trips.

Plans were made for an inspection trip on Friday, March 1, 1940, through the Huntington Avenue Subway. Also a trip was planned for the latter part of March to the scene of the construction of the new Jamestown, Rhode Island, bridge.

The speakers of the evening were Mr. Malcolm Rich, W.P.A. Supervisor of Engineering Parties, and Mr. Harry T. Carroll, Assistant Engineer of the Boston Transit Department. Their subject was the Huntington Avenue Subway. Mr. Carroll spoke on the preliminary work necessary in building a subway, and Mr. Rich explained the actual construction of the tube itself. A discussion period followed.

There were thirty-two present at the meeting, which adjourned at 9:00 P. M.

Preceding the meeting fourteen members and guests enjoyed a supper at the Lobster Claw after an afternoon of bowling.

WINFIELD B. KNIGHT, *Acting Clerk.*
LOUIS G. REINIGER, *Chairman of the Section.*

MARCH 1, 1940.—The Section sponsored a field trip to the Huntington Avenue Subway today.

Mr. Malcolm Rich, W.P.A. Supervisor of Engineering Parties, and Mr. Harry T. Carroll, Assistant Engineer of the Boston Transit Department, acted as guides.

The trip started at the location of the uptown portal near the Opera House. Here the construction was just beginning, and afforded a good chance to see the primary steps. Going back along the route, the more advanced stages were seen.

At Gainsborough Street, the inverted siphon that was built to carry the trunk line sewer beneath the subway was explained. At Massachusetts Avenue, the layout for the new underpass and subway stations was of particular interest.

The trip was made on top of the ground as far as the station in front of Mechanics Building. Here the work being done in the lobby of the station

was observed. The remainder of the trip consisted of a walk through the finished subway to the point where it joins the present Boylston Street Subway at the corner of Exeter Street. Attendance, 60.

WINFIELD B. KNIGHT, *Acting Clerk.*

APPLICATIONS FOR MEMBERSHIP

[April 20, 1940]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of fifteen (15) days from the date given.

For Admission

EDGAR F. COPELL, Jamaica Plain, Mass. (b. December 2, 1898, Jamaica Plain, Mass.) Graduated from Boston College High School, 1916; attended Franklin Union 1916-1918; Northeastern University evening classes 1918-1919: attended course in Electricity at M.I.T., in 1932. Experience: Transitman, lines and grades with Fay, Spofford and Thorndike, on Boston Army Supply Base; 1919-1920, with United Fruit Co., Preston Division, on lines and grades for irrigation; 1920-1922, with Fay, Spofford and Thorndike, survey, lines and grades and triangulation for Springfield Memorial Bridge; 1922-1925, with Mass. Department of Public Works on highway construction work 1925-1940, with same department on supervision of erection and maintenance of highway traffic signs and signals on State Highways and on town highways; 1931 appointed assistant traffic engineer; 1935 appointed traffic engineer, in charge of all traffic control, erection and maintenance of equipment for highway traffic control, and regulation, advice to cities and towns on traffic matter, and in charge of project of highway planning survey. Refers to *R. W. Coburn, E. F. Davis, G. H. Delano, E. N. Hutchins.*

EARL RICHARD FRENCH, Boston, Mass. (b. December 30, 1907, Worcester, Mass.). Graduated from Northeastern University, 1930, B.C.E. Northeastern University, 1939, B.S. degree. Experience: June, 1930, to January, 1934, with Richard French Iron Works, Millbury, Mass., as draftsman on structural steel and miscellaneous iron for building construction; January, 1934, to April, 1935, Engineering Dept., City of Worcester, Mass., chief of survey party on block survey of city; April, 1935, to June, 1937, Poughkeepsie Iron & Metal Company, Poughkeepsie, N. Y., structural steel and miscellaneous iron work; June, 1937, to January, 1938, Berlin Construction Company, Berlin, Conn., shop detailer and some estimating on structural steel; January, 1938, to April, 1938, with The Ornamental Iron Shop, Springfield, Mass., on shop detail of miscellaneous iron work; August, 1938, to December, 1938, with National Steel Products, Hartford, Conn., as draftsman-designer on structural steel and miscellaneous iron work; December, 1938, to July, 1939, with E. B. Badger & Sons, Boston, Mass., as structural draftsman; July, 1939, to present date, with New England Power Service Company, Boston, Mass., as

structural-draftsman designer. Refers to *O. J. Calderara, C. M. Durgin, E. A. Gramstorff, J. W. Greenleaf, Jr.*

DANIEL G. LACY, Brookline, Mass. (b. October 18, 1882, Brookline, Mass.). Graduated from Brookline High School in 1902. During vacation periods of 1901-1902, worked in survey division of Boston & Albany R. R. Company. Appointed clerk and time-keeper in the Highway Department in June, 1904. May, 1909, was appointed Superintendent of Forestry Department. 1914-1916, attended courses in dendrology at Harvard Forestry School as special student in sylviculture and entomology, including field work at Arnold Arboretum and laboratory work at Bussey Institute. In addition to the work of planting and maintenance of Brookline's trees and insect suppression, was likewise Superintendent of snow removal and collection of garbage. May, 1925, was appointed Superintendent of Streets and Sewers at which time the activities of the Forestry Department, Garbage Department, Sanitation, Sewers and Highways were consolidated under my supervision. As Superintendent of Sewers, have charge of the system of sewers and surface drainage in Brookline. As Superintendent of Highways, have charge of construction and maintenance of all public highways in the town, as well as the powers vested in the Surveyor of Highways by the General Laws, the duties comprising of all those functions usually carried on by a Commissioner of Public Works, including the design and construction of all highway and sewer work. Present position, Superintendent of Highways, Forestry, Sewer, Garbage and Sanitation Departments in the Town of Brookline. Refers to *C. F. Allen, A. W. Dean, J. M. Driscoll, T. F. Sullivan, H. A. Varney.*

CHARLES H. MOLOY, Woburn, Mass. (b. February 9, 1911, Woburn, Mass.). Graduated from Woburn High School, 1930, and graduated from Wentworth in 1932. Welding and plumbing, 1933-1934 attended, Franklin Union Institute. Two years of Surveying Field and Office Work. 1935, attended Northeastern University, special student, Highway Design and Construction. Attended State extension courses, Engineering Mathematics, 1936-1937. Public Speaking, 1936. Graduated from Franklin Union Institute, 1938, Surveying. Graduated, State Extension Courses in Highway Estimating, 1939. Attending State Extension course in Highway Maintenance. Experience: Massachusetts Department of Conservation, 1931-1937, Laborer-Foreman-Rodman-Transitman on Surveys of Roads and Dams. Massachusetts W.P.A., 1938-1939. Laborer, assistant to supervisor, draughtsman, engineer, supervisor, Massachusetts W.P.A., 1940. At present, draughtsman, estimator on spectroscopic Solar Eclipse data. Refers to *S. L. Connor, W. A. Grady, P. Holbrook, H. V. Macksey.*

CARROLL T. NEWTON, Cambridge, Mass. (b. May 2, 1911, Melrose, Mass.). Attended public schools in Melrose, Mass. Graduated from Massachusetts Institute of Technology in 1933, with the degree of Bachelor of Science in Architectural Engineering, and a commission as Second Lieutenant in the Organized Reserve Corps (Corps of Engineers). Experience: February, 1935, was ordered to active duty as a Reserve Officer with the Civilian Conservation Corps and was stationed at Fort Adams, R. I.; duty was mainly with the District Quartermaster and included superintendence of temporary construction, and assistant in charge of warehousing. July, 1936, as an applicant for a commission in the Regular Army, detailed to Fort Belvoir, Va., to undergo a year's training as an officer with the Regular Army Troops. July, 1937, was commissioned in the Corps of Engineers, Regular Army, and ordered to duty with the District Engineer, Fort Peck, Montana, in connection with the construction of the Fort Peck Dam, an earth fill structure. For the major part of two years there, was

with the Soils Engineer Division; one full year as chief of sub-section, employing directly from 75 to 250 men for field sampling by hand and power rigs and for office analysis of soils-laboratory data. September, 1939, was ordered back to Massachusetts Institute of Technology, for a graduate course in Civil Engineering leading to a Master of Science degree. Professional Societies: Junior Member of American Society of Civil Engineers; Member, Society of American Military Engineers. Refers to *C. B. Breed, W. M. Fife, W. H. Lawrence, J. D. Mitsch, K. C. Reynolds.*

EDWARD HERMANN REBHAN, Boston, Mass. (b. February 15, 1886, Vienna, Austria). Graduated from the Technical University in Vienna, December, 1909, obtained the diploma of Doctor of the Technical Sciences, 1912. Topic of the dissertation: Essay on a test of theoretic determination of the thickness of surcharged slabs. Worked at different places in Austria and Germany as engineer on concrete (reinforced and plain), sewerage, addits, highways, industrial buildings, etc., until the outbreak of the World War. Was engineering officer at the War Front from January, 1915, until November, 1917, then in the service for supplying of machines and tools for the army. After the War: organizer of two factories after the principles of scientific management, from September, 1921, to March, 1938, manager of the department of machine tools, constructing materials at the "Universale Redlich & Berzer" in Vienna; Co-operated on the Works of the Reichsbrucke in Vienna, "Glocknerstrasse" in Salsburg, Dams of the Mur in Styria, Justice-Palace in Vienna, Festival House, Salsburg, and many others. Worked in the scientific line. investigations, tests, lectures and courses for the higher education for engineers (Austrian Concrete Association, 1936-1938). At present: Engineer, Trimount Dredging Corporation, Boston, Mass. Refers to *H. T. Gerrish.*

NEW HYDRAULICS SECTION

(Continued from Page 143)

gratulations and best wishes to the new section, the fifth section to be formed in the Society. He referred briefly to the formation of the first four Sections whose By-Laws were approved by the Board of Government as follows: Sanitary Section, January 27, 1904; Designers' Section, May 19, 1920; Northeastern University Section, November 23, 1922; and Highway Section, May 21, 1924.

Through the courtesy of the Sanitary Section, Mr. Frederick C. Joy, Jr., Chairman, the new section was invited to join with the Sanitary Section, whose meeting was held on this same date, to hear a paper by Mr. William L. Hyland, Assistant Engineer, Fay, Spofford and Thorndike, on "Asbestos-Cement Pipe for Water Mains and Sewers".

Eighty-one persons attended this meeting.

ANNUAL REPORTS

REPORT OF BOARD OF GOVERNMENT FOR THE YEAR 1939-1940

Boston, Mass., March 20, 1940.

To the Boston Society of Civil Engineers:

Pursuant to the requirements of the By-Laws, the Board of Government presents its report for the year ending March 20, 1940.

Membership

Thirty-nine new members, 16 juniors, and 34 students have been added during the year, and 9 members, 1 junior and 1 student have been reinstated making a total addition of 100 members.

During the year 10 members have died, 5 have resigned, 4 members have had dues remitted and resignations accepted, 20 members have been dropped for non-payment of dues, and 4 dropped for failure to transfer, making a total deduction of 43.

The present net membership of the Society consists of 4 honorary members, 624 members, 48 juniors, 66 students, 7 associates, 1 member of Sanitary Section, making a total membership of 750, a net gain for the year of 57.

The honorary membership list is as follows:

Charles T. Main, elected January 28, 1932.
Dr. Karl T. Compton, elected February 17, 1932.
Prof. C. Frank Allen, elected March 16, 1932.
Joseph R. Worcester, elected February 21, 1934.

Deaths

Members:

Prof. Henry B. Alvord, April 20, 1939
G. Howard Perkins, August 1, 1938
Richard J. McNulty, March 14, 1939
Guy C. Emerson, July 17, 1939
Ephriam Harrington, July 20, 1939
Thaddeus Merriam, September 26, 1939
Stephen DeM. Gage, October 2, 1939
Frederick A. Lovejoy, December 21, 1939
George H. Nye, January 20, 1940
Edward R. Hyde, February 5, 1940

Remission of Dues and Extension of Time

The membership of the Society has been subject during recent years to the effects of the depression. During this period the Board of Government has

granted a number of members an extension of time for payment of dues and has remitted the dues of other members. With much regret the Board voted this year to drop from membership those who had not paid their 1939 dues, for which an extension had been granted. The Board has remitted dues and accepted resignations from four members. In the case of one member, dues for the year ending March 20, 1940, have been remitted.

The Board has granted twenty members an extension of time for payment of dues for year ending March 20, 1940.

Exemption of Dues

Eighty-seven members are now exempt from dues in accordance with By-Laws 8, which provides that "a member of any grade who has paid dues for forty years, or who has reached the age of seventy years and has paid dues for thirty years, shall be exempt from further dues".

Meetings of the Society

Eight regular meetings, since the Annual Meeting, have been held during the year.

The October meeting was the Annual Student Night, attended by Student Chapters, American Society of Civil Engineers, at Harvard, Massachusetts Institute of Technology, Tufts, Brown University, Rhode Island State College, New Hampshire University, Worcester Polytechnic Institute and the Northeastern University Section of the Boston Society of Civil Engineers.

The total attendance at all meetings was 1,851 persons; the largest attendance was 700 and the smallest 38. Suppers have been a feature at meetings and they were well attended.

The papers and addresses given were as follows:

March 15, 1939. Annual Meeting. Address of retiring President, Karl R. Kennison, "An Engineer Looks at Life Insurance"; followed by dinner and entertainment.

April 21, 1939. Joint Meeting, Boston Society of Civil Engineers, Northeastern Section, American Society of Civil Engineers, and Designers Section B.S.C.E. "The New York World's Fair", by Colonel John P. Hogan, Chief Engineer and Director of Construction, New York World's Fair, 1939. Illustrated.

May 17, 1939. "Shelter from Air Raids in Town Planning", by Dr. Martin Wagner, Assistant Professor of Regional Planning, Harvard Graduate School. Illustrated.

June 10, 1939. Joint Outing and Excursion to New 18-Mile Metropolitan Pressure Aqueduct, and Manufacturing Plant of Lock Joint Pipe, Company, Natick, Mass., made by the Boston Society of Civil Engineers and Sanitary Section B.S.C.E.

September 27, 1939. "The Overpass at Cottage Farm Bridge", by Lewis E. Moore. Illustrated.

October 20, 1939. "Tredgold Said It", by Professor Hardy Cross, Professor of Civil Engineering, Yale University. Student Night.

November 15, 1939. Joint Meeting with American Society of Civil Engineers. "America's Problem No. 1—Transportation", by Colonel William J. Wilgus, Honorary Member of American Society of Civil Engineers.

December 20, 1939. "Recent Developments in Hydraulic Model Studies", by Professor Harold A. Thomas, Professor of Hydraulic and Sanitary Engineering at Carnegie Institute of Technology, Pittsburgh, Pa. Illustrated.

January 24, 1940. Joint Meeting with Sanitary Section of the B.S.C.E. "Discussion of Problems of Sewerage and Sewage Disposal in Boston Metropolitan District", by Harrison P. Eddy, Jr., and A. L. Fales, of Metcalf & Eddy. Discussion by Samuel A. Greeley of Greeley and Hansen, Engineers, Chicago, Ill.

February 14, 1940. Joint Meeting with Designers Section of the B.S.C.E. "The Pittsburg Conservation Reservoir of the New Hampshire Water Resources Board", by Richard S. Holmgren, Chief Engineer, New Hampshire Water Resources Board, Concord, N. H. Illustrated.

Sections

Twenty-nine meetings were held by the Sections of the Society during the year. These meetings of the Sections, offering opportunity for less formal discussion, have continued to demonstrate their value to their members and to the Society. The variety of subjects presented has made an appeal to the members, as indicated by the general attendance at these meetings.

Sanitary Section Meetings. The Sanitary Section has held six meetings during the year, with an average attendance of 42. The papers and meetings are listed in the report of the Executive Committee.

Designers Section Meetings. The Designers Section has held eight meetings during the year, with an average attendance of 88. The papers and meetings during the year are listed in the report of the Executive Committee.

Highway Section. The Highway Section has held five meetings during the year, with an average attendance of 29. The papers and meetings are listed in the report of the Executive Committee.

Northeastern University Section. The Northeastern University Section held 10 meetings during the year, with an average attendance of 31. The present membership includes 66 now in attendance in the University. The meetings held are listed in the report of the Executive Committee.

Journal

The complete report of the Editor of the JOURNAL for the calendar year 1939 will be printed in the April, 1940, JOURNAL.

*Funds of the Society**

Permanent Fund. The Permanent Fund of the Society has a present value of about $50,000. The Society again authorized the use of as much as necessary of the current income of this fund in payment of current expenses.

John R. Freeman Fund. In 1925 the late John R. Freeman, a past President and honorary member of the Society made a gift to the Society of securities

*Details regarding the values and income of these funds are given in the Treasurer's report.

which was established as the John R. Freeman Fund, the income from which was about $1,400. The income from this fund is to be particularly devoted to the encouragement of young engineers. Mr. Freeman suggested several uses, such as the payment of expenses for experiments and compilations to be reported before the Society; for underwriting meritorious books or publications pertaining to hydraulic science or art; or a portion to be devoted to a yearly prize for the most useful paper relating to hydraulics contributed to this Society; or establishing a traveling scholarship every third year open to members of the Society for visiting engineering works, reports of which would be presented to the Society. No additional scholarship was authorized during the year.

The John R. Freeman Lectures on Hydraulics. The Society sponsored a series of eighteen lectures on hydraulics which were given in the rooms of the Society on Tuesdays and Thursdays from October 17, to December 19, 1939, open only to members of the Society. This series of lectures was supported by the income of the John R. Freeman Fund, with the approval of the Committee in charge of that fund and in keeping with the terms of the bequest from Mr. John R. Freeman, namely to advance the science of hydraulics. Dr. Kenneth C. Reynolds, a former holder of the John R. Freeman Travelling Fellowship of this Society, on the teaching staff at Massachusetts Institute of Technology, and Director of the River Hydraulic Laboratory, gave seventeen of these lectures, dealing with hydraulic problems and particularly the modern development in the value and use of model analysis for hydraulic problems; the final lecture was given by Prof. Harold C. Thomas, Professor of Hydraulics and Sanitary Engineering, Carnegie Institute of Technology, Pittsburgh, Pa., on "The Propagations of Stable Wave Configurations in Steep Channels". These lectures were attended by a maximum number of 90, with an average attendance of 86 members.

Edmund K. Turner Fund. In 1916 the Society received 1,105 books from the library of the late Edmund K. Turner, and a bequest of $1,000 "the income of which is to be used for library purposes". The Board voted to use $46 of the income for the purchase of books for the Library.

Alexis H. French Fund. The Alexis H. French Fund, a bequest amounting to $1,000, was received in 1931 from the late Alexis H. French of Brookline, a former Past President of the Society. The income of this fund is "to be devoted to the library of the Society". The Board voted to use $100 of the available income for the purchase of books for the library.

Desmond FitzGerald Fund. The Desmond FitzGerald Fund, established as a bequest from the late Desmond FitzGerald, a past President and honorary member of the Society, provides that the income from this fund shall "be used for charitable and educational purposes". The Board voted on January 25, 1939, to appropriate from the income of this fund the sum of $100, to be known as the Boston Society of Civil Engineers Scholarship in memory of Desmond FitzGerald, and to be given to a student of Northeastern University. Presentation of this scholarship was made by Vice-President Frank B. Walker, at a student meeting of the University on May 17, 1939, to Norman B. Cleveland, of Beverly, Mass., a senior student in Civil Engineering.

Tinkham Memorial Fund. The "Samuel E. Tinkham Fund", established in

1921, at the Massachusetts Institute of Technology by the Society "to assist some worthy student of high standing to continue his studies in Civil Engineering", had a value of $2,516.89 on June 30, 1939. Richard Joseph Eberle, of Kansas City, Kansas, a student in civil engineering in the class of 1940, has been awarded this scholarship for the year 1939-1940.

Clemens Herschel Fund. This fund was established in 1931, by a bequest from the late Clemens Herschel, a former Past President and honorary member of the Society. The income from this fund is to be used for the presentation of prizes for particularly useful and commendable papers presented at meetings of the Society. The present value of this fund is about $1,000. The expenditure made during the year from this fund was for prizes.

Edmund W. Howe Fund. This fund, a bequest of $1,000, was received December 2, 1933, from the late Edward W. Howe, a former Past President of the Society. No restrictions were placed upon the use of this money, but the recommendation of the Board of Government is that the fund be kept intact, and that the income be used for the benefit of the Society or its members. No expenditures from the income of this fund has been made this year.

Desmond FitzGerald Medal

The Desmond FitzGerald Medal (bronze) was provided for in 1910 as an endowed prize by the late Desmond FitzGerald, a former Past President and honorary member of the Society. The prize is awarded annually to a member who presents an original paper to the Society which is published in the JOURNAL for the current year.

In accordance with the recommendation of the Committee on Awards, the Board of Government voted to award the Desmond FitzGerald Medal to Howard A. Gray, Member, for his paper "Enlargement of L. Street Steam-Electric Plant of Boston Edison Company", presented at a meeting of the Society on January 25, 1939, and published in the April, 1939, JOURNAL.

Section Prizes

The Board of Government voted on April 12, 1924, to present a prize for a worthy paper given in each section by a member of that section, "this award to consist of books suitably inscribed".

Designers Section Prize. The Board adopted the recommendation of the Designers Section Prize Award Committee, and voted that the Designers Section Prize be awarded to Prof. Dean Peabody, Jr., for his paper on "Continuous Frame Analysis of Flat Slabs", presented at a meeting of the Designers Section held on March 8, 1939, and published in the July, 1939, JOURNAL. The prize consisted of the following books:

"Theory of Statically Indeterminate Structures". Fife & Wilbur.

"Automatic Design of Continuous Frames in Steel and Reinforced Concrete". L. E. Grinter.

"Vibration Problems in Engineering". Stephen Timoshenko.

"Theory of Modern Steel Structures", Vol. 1. L. E. Grinter.

Northeastern University Section Prize. The Board of Government voted on March 10, 1931, to provide for the award of a prize to a member of the Northeastern University Section.

The Board adopted the recommendation of the Committee on Awards and voted that the Northeastern University Section Prize be awarded to Louis G. Reiniger for his paper on, "How Combat Engineers Span a River", presented at a meeting of Students at Northeastern University, held on November 3, 1939. The prize consisted of the following books:

"Geology and Engineering". R. F. Legget.

"The Analysis of Engineering Structures". A. J. S. Pippard and J. F. Baker.

"Preparation of Engineering Reports". Agg & Foster.

Clemens Herschel Award. The late Clemens Herschel, a former Past President and honorary member, gave to the Society a number of copies of his book on "Frontinus and the Water Supply of the City of Rome", with the request that the Board award one or more of the books each year as prizes which have been particularly useful and worthy of grateful acknowledgement. On recommendation of the Committee on Awards, the Board voted to award two Clemens Herschel prizes as follows: to Otis D. Fellows, for his paper on "Highways of the Boston Metropolitan District—Their Origin and Evolution", presented at a meeting of the Highway Section held on April 26, 1939, and published in the October, 1939, JOURNAL; and to Charles E. Greene, for his paper on "Mechanical Equipment for Refuse Incinerators", presented at a meeting of the Sanitary Section held on March 1, 1939, and published in the July, 1939, JOURNAL.

Social Activities

Four of the regular meetings were held at the Engineers' Club; one meeting at New Lecture Hall, Harvard University; one was held at the Walker Memorial Bldg., M.I.T., and one at the Boston City Club, preceded by suppers, under the direction of the Social Activities Committee. As usual the most enthusiastic meeting was Student Night, held in October, and attended by members of the Student Engineering Societies of Massachusetts Institute of Technology, Harvard University, Tufts, Rhode Island State College, Brown University, Worcester Polytechnic Institute, New Hampshire State University and Northeastern University Section of the Boston Society of Civil Engineers. An excursion to "The Metropolitan Pressure Aqueduct", at Natick, was made on June 10, 1939, attended by 200 members and guests.

Library

The Report of the Committee on Library contains a complete account of the library activities during the past year.

Society Activities

The usual special committees dealing with the general activities and conduct of the Society have included the following: Program, Publication, Membership, Library, Social Activities, Relation of Sections to Main Society. Other special committees have included the following: 1936 Floods, Subsoils of Boston, Desmond FitzGerald and other prizes, the Welfare Committee, Investments, the John R. Freeman Fund, and the Committee on John R. Freeman Lectures on Hydraulics, also, a special Committee (Karl R. Kennison, H. B. Kinnison and A. L.

Shaw) was appointed to consider and has reported, recommending the establishment of a Section on Hydraulics. The present Board unanimously voted to authorize the formation of such a section. Each of these Committees has made a distinct contribution to the Society and has developed fields of endeavor which will prove a great benefit to the members.

The Society has co-operated with the Engineering Societies of New England, and many members of the Society have served on Engineering Societies' committees.

Your Board, in conclusion, wishes to express its appreciation of the excellent work done by the officers of the Sections and by the Committees of the Society.

GORDON M. FAIR, *President.*

REPORT OF THE TREASURER

Boston, Mass., March 11, 1940.

To the Boston Society of Civil Engineers:

The financial standing of the Society on March 10, 1940 at the close of the fiscal year is shown on the following:

Table 1. Distribution of Funds—Receipts and Expenditures.
Table 2. Record of Investments.

As shown by the following table the receipts from dues have been about the same as for the past two years, and are still insufficient to meet the current expenses of the Society. Consequently it has been necessary again to transfer a part of the income from the Permanent Fund to the Current Fund to meet this deficit. This year the amount transferred is $1,007.45 or about 43% of the income of the Permanent Fund, which is slightly more than last year. In spite of similar transfers for a number of years the Permanent Fund continues to grow at an average rate of over $1,000 a year.

Expenditures from the Current Fund less receipts other than from dues and from investments; also receipts from dues for the past five years are shown in the table below. The difference is the amount transferred from the Permanent Fund income.

	1935-36	1936-37	1937-38	1938-39	1939-40
Total expenditures from the Current Fund less receipts other than from dues and from investments	$6,333	$6,807	$6,622	$5,860	$5,860
Receipts from dues	5,115	5,358	4,886	4,874	4,853
Deficit	$1,218	$1,449	$1,736	$ 986	$1,007

Interest and dividends on investments were slightly lower the past year, totaling $3,686. This is a return on the total book value of investments as of March 10, 1939, of 4.09 per cent as compared with a return of 4.23 per cent the previous year and 4.57 per cent for the year ending March, 1938. The market value of all investments as of March 10, 1940, is $83,779.81 compared to a corresponding book value of $90,785.07.

The following table shows the standing of the two principal funds at the close of the past five fiscal years.

	Mar. 10 1936	Mar. 10 1937	Mar. 10 1938	Mar. 10 1939	Mar. 10 1940
Book Value:					
Permanent Fund	$52,695	$54,865	$55,064	$56,672	$58,137
John R. Freeman Fund	$27,359	$29,073	$26,679	$26,949	$26,522
Market Value in per cent of Book Value:	99.87%	103.90%	84.17%	92.75%	92.28%

The total book value of all holdings on March 10, 1940 is $92,552.52, not including the value of the library and furniture, which for many years has been carried at $9,905.11.

Respectfully submitted,

CHARLES R. MAIN, *Treasurer.*

TABLE 1.—DISTRIBUTION OF FUNDS—RECEIPTS AND EXPENDITURES

	Book Value March 10, 1939	Interest and Dividends	Net Profit (or loss) at Sale or Maturity	Transfer of Funds Purchased	Transfer of Funds Sold	Book Value March 10, 1940
Bonds	$32,279.96	$1,270.41	$—237.25	$2,250.00	$1,767.75	$32,524.96
Cooperative Banks	15,041.52	481.42		1,471.42		16,512.94
Stocks	41,747.17	1,934.15	10.81		10.81	41,747.17
				Net Decrease		
Cash (except Current Fund)	954.98			687.53		267.45
Total	$90,023.63	$3,685.98	$—226.44	$3,033.89	$1,778.56	$91,052.52

	Book Value March 10, 1939	Allocation of the Above @4.09%	Allocation of the Above @—0.25%	Miscel. Receipts	Miscel. Expenditures	Book Value March 10, 1940
Permanent Fund	$56,671.88	$2,320.21	$—142.53	$ 295.00	$1,007.45	$58,137.11
John R. Freeman Fund	26,949.40	1,103.37	— 67.78		1,462.85	26,522.14
Edmund K. Turner Fund	996.36	40.85	— 2.51		46.70	988.00
Desmond Fitzgerald Fund	2,041.62	83.65	— 5.14		101.25	2,018.88
Alexis H. French Fund	1,044.15	42.80	— 2.63		90.30	994.02
Clemens Herschel Fund	1,194.18	48.94	— 3.01		17.10	1,223.01
Edward W. Howe Fund	1,126.04	46.16	— 2.84			1,169.36
	$90,023.63	$3,685.98	$—226.44	$ 295.00	$2,725.65*	$91,052.52
Current Fund	1,500.00			7,616.52*	7,616.52	1,500.00
Total, All Funds	$91,523.63	$3,685.98	$—226.44	$7,911.52*	$10,342.17*	$92,552.52

*Includes transfer of $1,007.45 from income of Permanent Fund to the Current Fund.

TABLE 2.—RECORD OF INVESTMENTS

	Date of Maturity or Classification	Fixed or Current Interest Rate	During the Year March 10, 1939 to March 10, 1940				March 10, 1940		
			Interest Received	Additional Amount Invested	*Sold or Matured* Amount Received	*Sold or Matured* Profit (or Loss)	Par Value	Book Value	Market Value
BONDS									
Baltimore & Ohio RR	Aug. 1, 1944	4 %	$ 85.00	....	....	..	$ 2,000.00	$ 2,013.75	$ 1,100.00
The Boston Terminal Co.	July 1, 1950	4 %	33.33	....	$ 727.75	—$272.25	....	....	....
Canadian Pacific RR	July 2, 1949	4 %	177.64	....	....	..	5,000.00	5,342.50	3,500.00
Central Maine Power Co.	Oct. 1, 1960	4 %	80.00	....	....	..	2,000.00	2,035.36	2,165.00
Central Power & Light Co.	Aug. 1, 1956	5 %	31.94	....	1,040.00	35.00	....	....	....
Chicago & Northwestern Ry. Co.	Nov. 1, 1987	5 %	....	....	....	..	1,000.00	1,102.50	170.00
The Cleveland Union Term. Co.	Apr. 1, 1973	5 %	50.00	....	....	..	1,000.00	998.75	766.25
The Cleveland Union Term. Co.	Oct. 1, 1977	4½%	45.00	....	....	..	1,000.00	980.00	710.00
Illinois Power & Light Co.	Dec. 1, 1956	5 %	50.00	....	....	..	1,000.00	981.25	1,027.50
Louisiana Power & Light Co.	Dec. 1, 1957	5 %	50.00	....	....	..	1,000.00	835.00	1,073.75
Mississippi Power & Light Co.	Dec. 1, 1957	5 %	50.00	....	....	..	1,000.00	972.50	1,037.50

TABLE 2.—RECORD OF INVESTMENTS—*Continued.*

	Date of Maturity or Classification	Fixed or Current Interest Rate	During the Year March 10, 1939 to March 10, 1940				March 10, 1940		
			Interest Received	Additional Amount Invested	*Sold or Matured* Amount Received	Profit (or Loss)	Par Value	Book Value	Market Value
The Pennsylvania Railroad Co.	June 1, 1965	4½%	45.00	....	....	..	1,000.00	1,017.74	1,011.25
The Pennsylvania Railroad Co.	Apr. 1, 1970	4½%	45.00	....	....	..	1,000.00	971.58	880.00
Peoria Water Works Co.	Aug. 1, 1950	5 %	50.00	....	....	..	1,000.00	1,010.00	1,030.00
Southern California Water Co.	Oct. 1, 1960	4½%	90.00	....	....	..	2,000.00	1,875.00	2,080.00
Southern Pacific Co.	Mar. 1, 1977	4½%	45.00	....	....	..	1,000.00	955.00	488.75
Southwestern Gas & Electric Co.	Nov. 1, 1960	4 %	40.00	....	....	..	1,000.00	995.00	1,040.00
Standard Oil Co. of N. J.	July 1, 1953	2¾%	27.50	....	....	..	1,000.00	1,021.25	1,052.50
Texas Electric Service Co.	July 1, 1960	5 %	100.00	....	....	..	2,000.00	2,000.00	2,110.00
The Toledo Edison Co.	July 1, 1968	3½%	70.00	....	....	..	2,000.00	2,092.50	2,147.00
United States Savings	Jan. 1, 1950		....	$2,250.00	....	..	3,000.00	2,250.00	2,250.00
United States Steel Corp.	June 1, 1948	3¼%	65.00	....	....	..	2,000.00	2,092.50	2,105.00
Western Maryland RR Co.	Oct. 1,1952	4 %	40.00	....	....	..	1,000.00	982.78	840.00
Total Bonds			$1,270.41	$2,250.00	$1,767.75	—$237.25	$33,000.00	$32,524.96	$28,584.50

TABLE 2.—RECORD OF INVESTMENTS—*Continued.*

	Date of Maturity or Classification	Fixed or Current Interest Rate	During the Year March 10, 1939 to March 10, 1940				March 10, 1940		
			Interest Received	Additional Amount Invested	*Sold or Matured* Amount Received	Profit (or Loss)	Number of Shares	Book Value	Market Value
CO-OPERATIVE BANKS									
Codman Co-operative Bank	Series 37	3½%	$104.40	$ 344.40	....	..	20	$ 3,240.00	$ 3,240.00
Merchants Co-operative Bank	Ser. 140, 1940	3 %	183.75	603.75	....	..	35	6,463.80	6,463.80
Suffolk Co-operative Bank	Ser. 134, 1940	3 %	163.27	523.27	....	..	30	5,809.14	5,809.14
Suffolk Co-operative Bank	Mat. Shares	3 %	30.00	....	....	..	5	1,000.00	1,000.00
Total Co-operative Banks			$481.42	$1,471.42				$16,512.94	$16,512.94

TABLE 2.—RECORD OF INVESTMENTS—*Continued.*

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 10, 1939 to March 10, 1940				March 10, 1940		
			Dividends Received	Additional Amount Invested	*Sold or Matured* Amount Received	Profit (or Loss)	Number of Shares	Book Value	Market Value
STOCKS									
American Tel. & Tel. Co.	Common	$ 9.00	$ 414.00	....	....	..	46	$ 5,346.04	$ 8,038.50
Bankers Trust Co.	Common	2.00	60.00	....	....	..	30	1,590.00	1,800.00
Commonwealth & Southern Corp.	Cum. Pref.	3.00	24.00	....	....	..	8		
Commonwealth & Southern Corp.	Common	..	..	....	....	..	25	1,019.89	536.87
Commonwealth & Southern Corp.	Opt. Warrants	..	..	....	....	..	12		
Consolidated Gas of N. Y.	Common	2.00	40.00	....	....	..	20	1,906.50	620.00
General Electric Co.	Common	1.40	70.00	....	....	..	50	2,341.47	1,931.25
Hartford Fire Ins. Co.	Common	2.50	25.00	....	....	..	10	761.25	840.00
Home Insurance Co.	Common	2.00	62.00	....	....	..	31	1,245.00	1,023.00
Minnesota Power & Light Co.	Pref. 7%	8.60	86.00	....	.....	..	10	980.00	975.00
National Dairy Products Corp.	Common	.80	40.00	....	....	..	50	1,154.74	837.50
National Fire Insurance Co.	Common	2.00	40.00	....	....	..	20	1,240.00	1,200.00
New England Power Association	Pref.	5.50	110.00	....	....	..	20	1,815.00	1,320.00
New York Central RR Co.	Common	..	..	....	....	..	10	870.45	162.50
North American Trust Shares	Cum. July 15, '55	0.128	192.00	....	....	..	1,500	5,342.00	4,350.00

TABLE 2.—RECORD OF INVESTMENTS—*Continued.*

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 10, 1939 to March 10, 1940				March 10, 1940		
			Dividends Received	Additional Amount Invested	*Sold or Matured* Amount Received	*Sold or Matured* Profit (or Loss)	Number of Shares	Book Value	Market Value
STOCKS									
Pacific Gas & Electric Co.	Cum. 1st Pref. 6%	$ 1.50	$ 90.00	....	....	..	60	$ 1,922.02	$ 2,650.00
Pacific Gas & Electric Co.	Cum. 1st Pref. 5½%	1.376	27.52	....	....	..	20		
Pacific Gas & Electric Co.	Common	2.00	128.00	....	....	..	64	1,808.79	2,144.00
Southern California Edison Co. Ltd.	Cum. Orig. Pref.	1.75	70.00	....	....	..	40	1,161.22	1,800.00
Southern California Edison Co. Ltd.	Common	1.90	38.00	....	....	..	20	539.75	600.00
Standard Oil Co. of N. J.	Common	1.25	12.50	....	....	..	10	479.54	437.50
Standard Oil Co. of N. J.	Script. Cert.	..	..	....	$ 10.81	$10.81	..	....	....
Tampa Electric Co.	Common	2.24	67.20	....	....	..	30	1,151.25	840.00
Timken Roller Bearing	Common	2.75	41.25	....	....	..	15	1,018.97	761.25
Trimount Dredging Co.	Pref. C.	..	..	....	....	..	2	....	....
United States Smelting Refining & Mining Co.	Pref.	3.50	70.00	....	....	..	20	1,365.04	1,300.00
United States Steel Corp.	Common	..	..	....	....	..	10	860.75	581.25
United States Trust Co. of Boston	Conv. Pref.	.80	180.00	....	....	..	225	4,837.50	3,318.75
Utah Power & Light Co.	Cum. Pref.	4.668	46.68	....	....	..	10	990.00	615.00
Total Stocks			$1,934.15	....	$ 10.81	$10.81		$41,747.17	$38,682.37

REPORT OF THE SECRETARY

To the Boston Society of Civil Engineers: Boston, March 9, 1940.

The following is a statement of cash received by the Secretary, and of the expenditures approved by the President, in accordance with the Budget adopted by the Board of Government.

FOR THE YEAR ENDING MARCH 20, 1940

CURRENT FUND ACCOUNT

	Account Number	Expenditures Amounts	Expenditures Total	Cash Receipts Amounts	Cash Receipts Total
Office					
Secretary, salary and expense	(1)	$ 240.00			
Stationery, printing and postage	(2)	266.02			
Incidentals and Petty Cash	(3)	217.57			
Insurance and Treasurer's Bond	(4)	12.50			
Safety deposit box	(5)	11.00			
Quarters, rent, light, telephone	(7)	1,804.36		$600.00[a]	
Office, clerical	(8)	1,200.00			
Auditors for 1939 accounts and Investment Services	(9)	225.00			
Total			$3,976.45		$600.00[a]
Meetings					
Rent of halls, etc.	(11)	182.64			
Stationery, printing and postage	(12)	76.21			
Social Activities	(13)	200.75			
Stereopticon and Reporting	(14) (15)	13.00			
Annual Meeting (March, 1939)	(16)	97.85			
Total			570.45		
Sections					
Sanitary Section	(21)	16.20			
Designers Section	(22)	21.00			
Highway Section	(23)	8.00			
Northeastern University Section	(24)	9.25			
Total			54.45		
Carried Forward			$4,601.35		$ 600.00

REPORT OF THE SECRETARY (*Continued*)

	Account Number	Expenditures Amounts	Expenditures Total	Cash Receipts Amounts	Cash Receipts Total
Brought Forward			$4,601.35		$ 600.00
Journal					
Editor—Salary and Expense	(31)	308.00			
Printing and Postage	(32)	1,655.34			
Reprints	(33)	23.75			
Advertising, Commission and Receipts	(34)	245.75		759.00	
Sales of Journals and reprints	(35)			338.10	
Total			2,232.84		1,097.10
Library					
Librarian—Salary and Expense	(41)	$52.44			
Periodicals	(43)	94.25			
Binding	(44)	27.40	174.09		
Fines, Overdue books	(45)				4.26
Bank Charges	(53)		1.22		
Miscellaneous Receipts	(54)				14.50
Dues to Engineering Societies of N. E.	(59)		571.02		
Dues from B.S.C.E. members	(70)				4,853.37
Transfer of Income of Permanent Fund to Current Fund					1,007.45
Badges for Members			19.00		24.25
Binding Journals for members			17.00		15.59
Total, Current Fund, to be accounted for			$7,616.52		$7,616.52
Entrance Fees to Permanent Fund					$295.00
39 new members, 16 juniors, 34 students; 4 juniors transferred to members; and 4 students transferred to juniors; but 23 new members and 15 juniors were exempt from payment of entrance fees.					

The above receipts have been paid to the Treasurer, whose receipt the Secretary holds.

Respectfully submitted,

EVERETT N. HUTCHINS, *Secretary*.

[a]From E. S. N. E., $600.

REPORT OF THE AUDITING COMMITTEE

Boston, March 20, 1940.

We have reviewed the records and accounts of the Secretary and Treasurer of the Boston Society of Civil Engineers and the report of William J. Hyde, Certified Public Accountant, who has examined said records and accounts and we have examined the securities enumerated by the Treasurer.

We have accepted and present herewith our approval the signed report of the Auditor.

FREDERICK N. WEAVER,
H. B. KINNISON,

Auditing Committee of the Directors of the Boston Society of Civil Engineers.

STATEMENT OF CERTIFIED PUBLIC ACCOUNTANT

Boston, March 19, 1940.

MR. FREDERIC N. WEAVER,
Chairman of the Auditing Committee,
Boston Society of Civil Engineers,
Boston, Massachusetts.
DEAR SIR:

In accordance with your instructions, I have completed the annual audit of the financial records of the Society for the fiscal year ended March 10, 1940.

Securities held by the Society as at March 10, 1940, were examined and were found to correctly reflect the changes occurring within the year under review. All coupons for interest due were collected except eight of the Chicago and Northwestern Railroad, totalling $200.00, which are in default. The records of purchases and sales of securities were in agreement with the broker's statements. Dividends earned were correctly accounted for.

Receipts reported to have been received by the Secretary were in agreement with his records and were found to be correctly entered in the Treasurer's accounts.

All vouchers paid were approved by the President and Secretary and payment substantiated by examination of checks paid by the bank.

Cooperative bank earnings were verified and found correct.

A verified copy of your Treasurer's report is attached hereto, and summarizes the detailed accounts shown in his ledger.

I have checked the records in detail and found all of same in excellent condition.

Respectfully submitted,

WILLIAM J. HYDE, *Certified Public Accountant.*

REPORT OF THE EDITOR

Boston, Mass., January 10, 1940.

To the Board of Government,
Boston Society of Civil Engineers:

The JOURNAL for the calendar year 1939 (Volume XXVI), was issued quarterly, in the months of January, April, July and October, as authorized by the Board of Government on December 20, 1935.

During the year 1939 there have been published fifteen papers presented at meetings of the Society and Sections, and three other technical articles. The Table of Contents and Index for the year are included in the October, 1939, issue.

The four issues of the JOURNAL contained 393 pages of papers and discussions, 7 pages of Index, and 28 pages of advertising, a total of 428 pages. An average of 1075 copies per issue were printed. The net cost was $1,514.23 as compared with $2,505.74 for the preceding year.

The April JOURNAL appeared in two sections, Section 2 being the Section on Rainfall and Run-Off of New England, a paper by Arthur T. Safford, Member. By vote of the John R. Freeman Fund Committee the cost of printing ($584.08) the Hydraulic Section was paid from the income of that fund.

Table I includes a comparison of the costs for the JOURNAL from 1935-1939 inclusive. In table II details of cost for Volume XXVI of the JOURNAL for the calendar year 1939 are shown.

Respectfully submitted,

EVERETT N. HUTCHINS, *Editor.*

TABLE I—COMPARISON OF COSTS OF JOURNAL, 1935-1939, INCLUSIVE

Year	Vol.	No. of Pages*	Gross Total	Cost per page	Net Total	Cost per page	No. of cuts
1935	XXII	323	$2,628.16	$8.15	$2,091.41	$6.47	119
1936	XXIII	356	2,666.42	7.49	1,711.16	4.80	90
1937	XXIV	380	2,737.48	7.20	1,375.62	3.62	101
1938	XXV	566	3,869.49	6.83	2,505.74	4.42	142
1939	XXVI	428	2,561.58	5.98	1,514.23	3.53	125

*Includes Advertising Section and Annual Index. Gross cost includes editing, printing and mailing. Net cost equals gross cost less amounts received for advertising, subscriptions, and sales of JOURNALS.

TABLE II—1939 JOURNAL—VOLUME XXVI

	January	April Sections 1 & 2	Issue of July	October	Total
Number of Pages:					
Papers and discussion	66	217	70	40*	393
Advertising and	7	7	7	7	28
Advertisers' Index				7	7
Total Pages	73	224	77	54	428
Number of Cuts	23	71	23	8	125
Cost of JOURNAL					
Composition and Printing	$264.00	$894.61	$284.46	$198.10	$1,641.17
Cuts	107.18	312.44	95.78	42.99	558.39
Wrapping, Mail and Postage					54.02
Editing					300.00
Copyright					8.00
Total Gross Cost of JOURNAL					$2,561.58
Receipts					
Receipts from Subscriptions and sales of JOURNALS and Reprints				$362.90	
Receipts (net) from Advertising				784.45	
					1,047.35
Net Cost of JOURNAL					$1,514.23

*Includes 7 pages of Index of 1939 JOURNAL.

REPORT OF THE COMMITTEE ON MEMBERSHIP

Boston, March 20, 1940.

To the Boston Society of Civil Engineers:

During the current year, this Committee recommended to the Board of Government an amendment to the By-Laws which provided for waiving the initiation fee for new members in the case of employees of the Federal Government assigned to this district. This amendment was subsequently enacted by the Society.

Of the 55 new members and juniors who have joined the Society this year, 38 were men in Federal service—principally from the offices of the U. S. Engineers in Boston and Providence and the Water Resources Branch of the U. S. Geological Survey in Boston. In view of the small number of members in the Society formerly from these groups, it is believed that this modification of the By-Laws has served a useful purpose.

No other concerted membership activity has been carried on during the year.

A few years ago the Engineering Societies of New England established an

individual grade of Associate Member. It was specified that an Associate Member who was eligible for membership in any of the affiliated societies could only retain this E. S. N. E. associate membership for a period of three years. During the coming year, it will be necessary for a considerable number of Associate Members to drop their connection with engineering society activities unless they join one of the individual societies. It is recommended that our Society take this opportunity to bring to the attention of these E. S. N. E. Associate Members the advantages of joining the Boston Society of Civil Engineers.

Respectfully submitted,

J. B. BABCOCK, *Chairman.*

REPORT OF THE COMMITTEE ON SOCIAL ACTIVITIES

Boston, March 20, 1940.

To the Boston Society of Civil Engineers:

The Committee on Social Activities submits the following report for the year 1939-40.

Five regular meetings were held at the Engineers' Club during the year. The total number of members and guests served with suppers was 387, an average of 77 per meeting. This average is greater by 16 than for the previous year. An average of 15 additional persons attended the meetings following the supper.

One hundred and fourteen members and guests attended the annual dinner at the Chamber of Commerce Building. This was 24 less than for the previous meeting.

The April meeting was held at the New Lecture Hall, Harvard University, where 700 persons attended the meeting. Forty persons attended the dinner at the Faculty Club.

Two hundred and ninety were served at the Student Night meeting at Walker Memorial, Massachusetts Institute of Technology. This meeting included the Student Chapters of the American Society of Civil Engineers at Harvard, Tufts, M.I.T., Brown, Rhode Island State, New Hampshire State, Worcester Polytechnic Institute, and the Northeastern University Section of the Boston Society of Civil Engineers. The attendance at the meeting following the supper was 300.

The November meeting was held jointly with the Northeastern Section of the American Society of Civil Engineers at the Boston City Club. Eighty persons were present at the dinner.

Two hundred persons went on the excursion to the Metropolitan Pressure Aqueduct in June.

A total of ten meetings were held during the year, including the June excursion, as follows:

		Attendance Dinners	Attendance Total
March 15, 1939	Annual Dinner, Chamber of Commerce	114	114
April 21, 1939	Harvard Faculty Club	40	700
May, 1939	Engineers' Club	33	38
June 10, 1939	Excursion	200	200
Sept. 27, 1939	Engineers' Club	91	108
Oct. 20, 1939	Walker Memorial Student Night	290	300
Nov. 15, 1939	Boston City Club	80	90
Dec. 20, 1939	Engineers' Club	90	100
Jan. 24, 1940	Engineers' Club	100	135
Feb. 14, 1940	Engineers' Club	73	80
	Totals	1,111	1,865

The average attendance at meals for all these meetings was 111, an increase of 7 over the previous year. The average total attendance at the meetings was 156, an increase of 27 over the previous year.

Respectfully submitted,
JOHN H. HARDING, *Chairman.*

REPORT OF THE COMMITTEE ON WELFARE

Boston, March 20, 1940.

To the Boston Society of Civil Engineers:

During the past year no matters relating to the welfare of the members of the Society have come to the attention of the Welfare Committee for its action. It therefore has not been necessary to hold any meeting of the Committee during the year.

Those members of the Society who are desirous of obtaining employment are urged to make full use of the registration and placement facilities offered by the employment service of the Emergency Planning and Research Bureau, Inc.

Respectfully submitted,
RALPH W. HORNE, *Chairman.*

REPORT OF THE LIBRARY COMMITTEE

Boston, March 15, 1940.

To the Boston Society of Civil Engineers:

During the past year, the Library Committee increased the Society's collection by thirty-four recently published books. A list of the newly acquired books is appended to this report.

The number of books in circulation decreased to 130.

The amount collected in fines increased to $4.26.

The following books were acquired through purchase:

Steel Construction—H. J. Burt.
Engineering Law—E. Laidlaw.
Welded Steel Construction—S. Hale.
2nd Congress on Large Dams.
Management of Municipal Public Works—D. C. Stone.
Locomotive Encyclopedia, 10th Ed.
Pipe Corrosion & Coatings—Erick Larson.
General Cartography—E. C. Raisz.
Engineering Metallurgy—Bradley Stoughton.
Air Conditioning, Heating, Ventilating—J. R. Dalzell.
Design of Dams—F. W. Hanna.
Theory & Practise of Reinforced Concrete—C. W. Dunham.
Factory Equipment—Roe and Lytle.
Bulletin of the Seismological Society of America.
Reinforced Concrete Bridges—Taylor, Thompson and Smulski.
Geology & Engineering—R. F. Legget.
Public Speaking for Technical Men—S. M. Tucker.
Piping Handbook—Walker and Crocker.
Engineering Materials—A. H. White.
Trains, Tracks, Travel—T. W. Van Metre.
Railroads & Rivers—W. H. Clarke.
Railway Engineering & Maintenance Cyclopedia, 4th Ed., 1939.
Transactions of the International Engineering Congress, Glasgow, 1938.
A Treatise on the Law of Surveying and Boundaries—F. E. Clark.
Low Dams—National Resources Committee.
Geology for Civil Engineers—D. G. Runner.
Mathematical Methods in Engineering—T. V. Karman, and M. A. Biot.
Land Drainage & Reclamation—Q. C. Ayers and D. Scoates.
Engineering Metallurgy—B. Stoughton and A. Butts.
Rural Water Supply and Sanitation—F. B. Wright.
Highway Location & Surveying—N. W. Crosby and G. W. Goodwin.
Construction Estimates and Costs—H. E. Pulver.
Legal Aspects of Engineering—W. C. Sadler.
The Examination of Water and Water Supplies—J. C. Thresh, H. F. Beale, E. V. Suckling.

Respectfully submitted,
EUGENE MIRABELLI, *Chairman.*

REPORT OF THE COMMITTEE ON THE 1936 FLOOD

Boston, March 20, 1940.

To the Boston Society of Civil Engineers:

At the last Annual Meeting I reported that it had been decided to include a study of the 1938 flood with that of the 1936 flood originally proposed, that the data for the 1938 flood were then being collected, and that it was expected that the Committee's report would be completed for presentation to the Society at this meeting.

I regret that I have to come again before the Society with the report of a further postponement. Though expected soon, the data for the 1938 flood are not yet available in a comprehensive and usable form, and the members of the Committee could not be asked to spend the extra time required to do their work with scattered data. This does not mean that work on the various subjects being studied has been neglected. Much work has already been done, particularly on the 1936 flood, and some sections are nearly completed.

Today I can predict with confidence that, unless we have another large flood this year that requires consideration, the Committee will present a completed report at the next annual meeting.

Respectfully submitted,

HOWARD M. TURNER, *Chairman.*

REPORT OF THE COMMITTEE ON THE JOHN R. FREEMAN FUND

Boston, March 20, 1940.

To the Boston Society of Civil Engineers:

At the request of the Board of Government, the Freeman Fund Committee allocated from the income of the fund, $1,000 to be expended on a series of lectures on Hydraulics. This was a successful innovation. A more detailed account of the lectures is given in the report of the Secretary.

The balance of income of the Freeman Fund as of March 10, 1940, is $1,522.14. All commitments have been paid including $472.00 for printing the report of the Rainfall and Run-off Committee. The Committee will still give favorable consideration to payment from the Fund of a portion of the cost of preparing and printing the report of the Flood Committee, the amount to be determined later.

CHARLES T. MAIN, *Chairman.*
Freeman Fund Committee

REPORT OF THE COMMITTEE ON RELATIONS OF SECTIONS TO MAIN SOCIETY

Boston, March 15, 1940.

To the Boston Society of Civil Engineers:

The committee on Relations of Sections to the Main Society wishes to report that the regularly scheduled meetings of the Designers' Highway, Northeastern University and Sanitary Sections have been held during the year.

The papers and meetings are listed in the reports of the Executive Committees of the four sections. These reports indicate that the usual interest has been maintained and that the Sections are successfully fulfilling their designated functions.

In view of this successful operation of the Sections, this committee wishes to offer one recommendation to the Board of Government for their consideration.

It is recommended that the Society Rooms at 715 Tremont Temple be made more suitable and attractive as a meeting place for the Sections.

The present arrangements for holding meetings are not as satisfactory as they might be, in that the meetings are sometimes overcrowded, requiring the attending members to stand in the outside room in a position where they are unable to see either the speaker or the screen. The general arrangement of the room should be changed so the available floor space would be used more efficiently for all purposes for which the room is expected to serve. The lighting should be so wired that lights could be turned on or off at one central switch. A speaker's stand with proper lighting attachment should be added to the equipment.

The committee wishes to call attention to a few of the reasons why this proposal is offered.

In view of the recent tendency toward the development of Junior Forums in other associated societies and realizing that the Sections of the Boston Society were formed with the same objects in mind as in the Forums, it seems advisable to make the meeting rooms as usable and attractive as is possible within the limits of a reasonable expenditure of money.

Many of the persons who come as guests to the Section meetings are prospective members of the Society. The committee feels that an attractive headquarters and meeting place would serve to create a very favorable impression upon these guests and might well lead to many of them joining the Society. It might also be added that the engineering profession wishes to be held in high esteem by its friends and guests and that as engineers they are recommending modern improvements and equipment to their clients in their designs of all types of structures.

In view of these factors, this committee wishes to recommend, to the Board of Government, that serious consideration be given to this problem of making the meeting rooms of the Society more usable and attractive and more nearly representative of the high standing of the profession.

Respectfully submitted,

J. D. Mitsch, *Chairman.*

REPORT OF THE EXECUTIVE COMMITTEE OF THE SANITARY SECTION

Boston, March 6, 1940.

To the Sanitary Section, Boston Society of Civil Engineers:

During the past year this Section has held six meetings including one joint meeting with the Main Society. The attendance at the five Section meetings varied from 30 to 46 and averaged 42.

March 1, 1939. Society Rooms—Tremont Temple. Annual meeting and election of officers. Speakers, A. M. Thresher, Superintendent, Department of Garbage Disposal, New Bedford, Mass. Subject, "Twelve Years' Collection and Disposal of Garbage and Combustible Materials at New Bedford." Charles E. Greene, Consulting Engineer, Boston. Subject, "Mechanical Equipment in Refuse Incinerators." Attendance 44.

May 3, 1939. Northeastern University. Speaker, E. W. Moore, Assistant Prof. of Sanitary Chemistry, Harvard Graduate School of Engineering. Subject, "Recent Developments in Trade Waste Treatment." At the conclusion of the meeting, an inspection trip through the new chemical, mechanical and hydraulic laboratories of the University was made, this inspection being arranged through the courtesy of Professor Baird of Northeastern University. Attendance 43.

October 4, 1939. Society Rooms—Tremont Temple. Speaker, Donald F. Horton, Engineer, U. S. Engineer Office, Boston. Subject, "Flood Control and Its Relation to Problems of Stream Pollution." Attendance 46.

November 1, 1939. Society Rooms—Tremont Temple. Speakers, Frank Bachmann, Director of Sanitary Sales, The Dorr Co., Inc. Subject, "Sewage Sludge—Digestion Equipment." Allan Craig, Engineer of Sanitation Division, Link-Belt Company. Subject, "Development of the Sludge Digestion Tank." Attendance 30.

January 3, 1940. Society Rooms—Tremont Temple. Speaker, Louis J. Harrigan, Assistant Engineer, Transit Dept., City of Boston. Subject, "Problems Encountered in Sewer Construction in Connection with the Huntington Avenue Subway Extension." After the presentation of Mr. Harrigan's paper, a general discussion of sewer design and maintenance was held. Attendance 45.

January 24, 1940. Engineers' Club. Joint Meeting with the Boston Society of Civil Engineers. Speakers, Harrison P. Eddy, Jr. and Almon L. Fales, Metcalf and Eddy, Engineers, Boston, and Samuel P. Greeley of Greeley & Hansen, Sanitary Engineers, Chicago. Subject, "Discussion of Problems of Sewerage Disposal in Boston Metropolitan District." Attendance about 150 including about 45 of the regular attendants at the Sanitary Section meetings.

The annual outing was held on June 10, 1939, in conjunction with the Boston Society of Civil Engineers and the Northeastern Section of the American Society of Civil Engineers. The outing consisted of an inspection trip through the manufacturing plant of the Lock Joint Pipe Company, and to several of the construction sites of the new pressure aqueduct being constructed by the Metropolitan District Water Supply Commission. The inspection trip was arranged through

the courtesy of Chief Engineer Karl R. Kennison of the Commission, the Lock Joint Pipe Company and the various contractors engaged in the construction of the aqueduct. About 200 persons including guests were present at the outing. About 15 members of the Sanitary Section also made a brief inspection of the new Natick Sewage Disposal Plant on Speen Street, Natick, Mass.

Executive Committee meetings have been held prior to each Section Meeting.

Respectfully submitted,

For the Executive Committee,

GEORGE W. COFFIN, *Clerk.*

REPORT OF THE EXECUTIVE COMMITTEE OF THE DESIGNERS' SECTION

Boston, March 8, 1940.

To the Designers' Section, Boston Society of Civil Engineers:

The following is a list of the meetings which took place during the year, March, 1939, to March, 1940.

March 8, 1939. Professor Dean Peabody, Jr., spoke on "Design of Flat Slab Floors of Unequal Spans." *Attendance, 38.*

April 21, 1939. Colonel John P. Hogan spoke on "The New York World's Fair of 1939." This was a joint meeting with the Boston Society of Civil Engineers and the Northeastern Section of the American Society of Civil Engineers. *Attendance, 400.*

May 10, 1939. Mr. J. R. Nichols spoke on "The Proposed Boston Building Code." *Attendance, 18.*

October 11, 1939. Dr. Arthur R. Anderson spoke on "Design of Welded Bridges in Germany." *Attendance, 36*

November 8, 1939. Mr. Preston M. Putnam spoke on "Design of Concrete Mixtures for Concrete Pipe Construction." *Attendance, 42.*

December 13, 1939. Mr. Howard Williams spoke on "Design of the Skating Rink for the Boston Skating Club." *Attendance, 33.*

January 10, 1940. Commander J. P. Searles spoke on "The South Boston Drydock." *Attendance, 56.*

February 14, 1940. Mr. Richard S. Holmgren spoke on "The Pittsburg Conservation Reservoir of the New Hampshire Water Resources Board, Concord, New Hampshire." This was a joint meeting with the Boston Society of Civil Engineers. *Attendance, 80.*

The total attendance at the meetings was 703. The average attendance was 88.

Respectfully submitted,

JOHN B. WILBUR, *Clerk.*

REPORT OF THE EXECUTIVE COMMITTEE OF THE HIGHWAY SECTION

Boston, Mass., March 1, 1940.

To the Highway Section, Boston Society of Civil Engineers:

During the past year the Section held the following meetings:

March 2, 1939. Annual meeting, election of officers; Mr. Leslie Stuart, Chief Inspector, New England Testing Bureau, spoke on the "Development of Bituminous Concrete". *Attendance, 25.*

April 26, 1939. Mr. Otis D. Fellows, Chief Engineer, Division of Metropolitan Planning, Commonwealth of Massachusetts, spoke on "Highways in the Metropolitan District, Their Origin and Evolution". *Attendance, 25.*

October 25, 1939. Mr. Vincent K. Cates, Technical Service Engineer of the Universal Atlas Cement Company, spoke on the "Manufacture of Portland Cement". *Attendance, 57.*

November 22, 1939. Mr. H. R. Swartz, Editor of "New England Construction", spoke on "Developments in Methods and Equipment of Road Construction". *Attendance, 12.*

February 28, 1940. Annual meeting, election of officers. Professor A. J. Bone, Massachusetts Institute of Technology, spoke on "Economic Significance of Traffic Delays on Congested Streets and Highways". *Attendance, 27.*

The total attendance of all meetings during the year was 146. The average attendance was 29.

Respectfully submitted,
For the Executive Committee,
PARKER HOLBROOK, *Clerk.*

REPORT OF THE EXECUTIVE COMMITTEE OF THE NORTHEASTERN UNIVERSITY SECTION

Boston, March 13, 1940.

To the Northeastern University Section, Boston Society of Civil Engineers:

During the past year the Northeastern University Section has held the following meetings and field trips:

March 24, 1939. Division A Election of officers for the year 1939-1940.

May 11, 1939. Mr. J. Stuart Crandall spoke on "Dry Docks". *Attendance, 30.*

May 12, 1939. Three delegates and faculty advisor attended the Conference of New England Student Chapters, Am. Soc. C. E. held at the University of New Hampshire.

May 18, 1939. Division B election of officers for the year 1939-1940.

October 19, 1939. Mr. Joseph Higgins spoke on "The Construction of the North District Sewer." Division A. *Attendance, 8.*

October 20, 1939. A field trip to the North District Sewer in Chelsea. Division A. *Attendance, 17.*

October 20, 1939. The Section attended the B.S.C.E. Student Night held at M.I.T., and heard Professor Hardy Cross speak on the topic, "Tredgold Said It". *Attendance, 70.*

October 31, 1939. Dr. Albert S. Genaske lectured and showed moving pictures on the Metropolitan Pressure Aqueduct. Division A. *Attendance, 45.*

November 3, 1939. Mr. Louis G. Reiniger spoke on the topic "How Combat Engineers Span a River". *Attendance, 27.*

November 4, 1939. A field trip to the Lock Joint Pipe Co. and the Pressure Aqueduct in Natick. Division A. *Attendance, 20.*

November 9, 1939. Mr. R. C. Pitcher spoke on construction of the foundation of the New England Mutual Life Insurance Company Building. *Attendance, 17.*

November 10, 1939. A field trip to the New England Mutual Life Insurance Company building construction on Boylston Street. *Attendance, 17.*

November 23, 1939. Mr. Albert S. Genaske spoke on the Metropolitan Pressure Aqueduct. Division B. *Attendance, 45.*

November 25, 1939. A field trip to the Lock Joint Pipe Co. and the Pressure Aqueduct in Natick. Division B. *Attendance, 51.*

December 14, 1939. Mr. Joseph Higgins spoke on "The Construction of the North District Sewer". Division B. *Attendance, 15.*

December 15, 1939. A field trip to the North District Sewer in Chelsea. Division B. *Attendance, 16.*

January 19, 1940. Mr. George Brock spoke on the topic "Heavy Construction in the Oil Refining Industry." *Attendance, 32.*

February 23, 1940. Mr. Harry T. Carroll and Mr. Malcolm Rich spoke on "The Huntington Avenue Subway". *Attendance, 32.*

March 1, 1940. A field trip to the Huntington Avenue Subway. *Attendance, 60.*

The total attendance at meetings and trips was 502. The average attendance was 31.

Respectfully submitted,

JOHN L. BEAN, *Clerk.*

Vol. XXVII APRIL, 1940 No. 2

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

INDEX TO ADVERTISERS

The advertising pages of the JOURNAL aim to acquaint readers with Professional and Contracting Services and Sources of Various Supplies and Materials. You would find it of advantage to be represented here.

COMMITTEES

NOMINATING COMMITTEE

Past Presidents (Members of the Committee)

Arthur T. Safford
Paul F. Howard
Walton H. Sears
Donald W. Taylor
(Term expires March, 1941)

John B. Babcock, 3d
Harold K. Barrows
Miles N. Claire
George W. Coffin
J. Donald Mitsch
(Term expires March, 1942)

SPECIAL COMMITTEES

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Albert Haertlein
Herbert D. Hurley
Everett N. Hutchins
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George G. Bochen
Charles L. Coburn
George A. Sampson

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John H. Harding, *Chairman*
Joseph D. Guertin
Edward F. Kelley

Relations of Sections to Main Society

Kimball R. Garland, *Chairman*

Donald W. Taylor
C. Frederick Joy
L. G. Reiniger

1936 Flood Committee

Howard M. Turner, *Chairman*
(See April, 1936, Journal for Membership of Committee)

Welfare

Ralph W. Horne, *Chairman*

John R. Freeman Fund

Charles T. Main, *Chairman*

Charles M. Allen
Robert Spurr Weston
Howard M. Turner

Desmond FitzGerald Award

Carroll A. Farwell, *Chairman*

James E. Lawrence
Robert Spurr Weston

Sanitary Section Award

Robert Spurr Weston, *Chairman*

John P. Wentworth
Frank L. Flood

Designers Section Award

Carroll A. Farwell, *Chairman*

John C. Moses
Waldo F. Pike

Highway Section Award

James E. Lawrence, *Chairman*

Robert Evans
Arthur E. Harding

Subsoils of Boston

Henry A. Mohr, *Chairman*

Arthur Casagrande
Irving B. Crosby
Charles D. Kirkpatrick
Charles W. Robinson

Investment Committee

Charles R. Main, *Chairman*

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