DESIGN OF THE
NEWTOWN CREEK WATER POLLUTION CONTROL PROJECT
THE CITY OF NEW YORK

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ROBERT FEUER, P.E.

1967

PRESENTED AT THE WATER POLLUTION CONTROL FEDERATION
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I - INTRODUCTION

The City of New York is presently pursuing two programs to control pollution in its waterways. These are:

1. The Basic Water Pollution Control Program, which will ultimately provide treatment for all the City's wastewater in modern treatment plants.
2. The Auxiliary Water Pollution Control Program, which will provide for the retention, degritting and disinfection of combined flows during periods of rainfall. The objective of this program is to control combined overflow pollution and insure safe water quality where recreational facilities, particularly new bathing beaches, are planned. A prototype 'Auxiliary Water Pollution Control Plant', located at Spring Creek in Brooklyn, is scheduled to be constructed in 1967.

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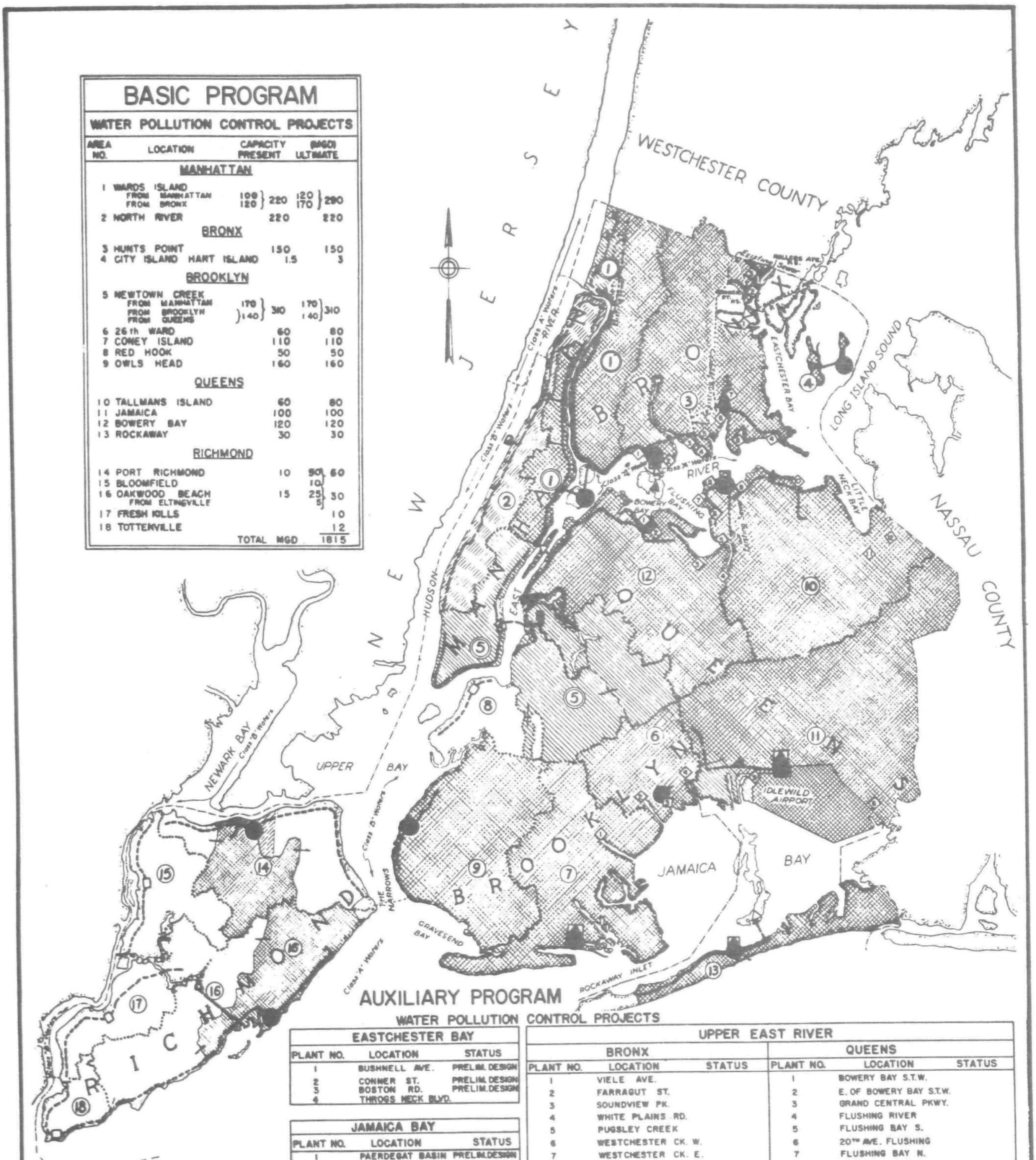
The implementation of the Basic Water Pollution Control Program, which dates to the beginning of work at the Wards Island Plant in 1931, has been delayed considerably by the depression of the early 1930's and two major wars. Availability of Federal and State construction aid grants in recent years has added momentum to bring this program to its conclusion by 1972, thereby allowing New York City to meet its commitments to regulatory agencies.

As originally proposed, the program envisioned 18 treatment plants and intercepting sewer systems located about the waterfront areas of the City. The total design capacity of the proposed plants is 1815 million gallons per day (MGD), based on mean dry weather flow.

Figure 1 (next page) - "Plan for Pollution Control", shows the number and locations of the projects involved in both the Basic and Auxiliary Programs, including a table of capacities of the Basic Water Pollution Control Projects.

The Newtown Creek Project, together with the 12 modern treatment plants presently in service, have a combined design capacity of 1346.5 MGD, thus accounting for approximately 74% of the total planned design capacity for the City's Basic Program. The 12 plants in service now treat about two-thirds of the City's dry weather wastewater.

The Newtown Creek treatment plant was placed in operation in 1967, with an initial flow from the Brooklyn and Queens drainage areas only. The flow from the Manhattan drainage area will be added when construction of the Manhattan Pumping Station, now in progress, is completed in 1968.



BASIC PROGRAM

WATER POLLUTION CONTROL PROJECTS

AREA NO.	LOCATION	CAPACITY PRESENT	(MGD) ULTIMATE
	MANHATTAN		
1	WARDS ISLAND FROM MANHATTAN FROM BRONX	100 120 } 220	120 170 } 290
2	NORTH RIVER	220	220
	BRONX		
3	HUNTS POINT	150	150
4	CITY ISLAND HART ISLAND	1.5	3
	BROOKLYN		
5	NEWTOWN CREEK FROM MANHATTAN FROM BROOKLYN FROM QUEENS	170 140 } 310	170 140 } 310
6	26th WARD	60	80
7	CONEY ISLAND	110	110
8	RED HOOK	50	50
9	OWLS HEAD	160	160
	QUEENS		
10	TALLMANS ISLAND	60	80
11	JAMAICA	100	100
12	BOWERY BAY	120	120
13	ROCKAWAY	30	30
	RICHMOND		
14	PORT RICHMOND	10	50 } 60
15	BLOOMFIELD		10
16	OAKWOOD BEACH FROM ELTINGVILLE	15	25 5 } 30
17	FRESH KILLS		10
18	TOTTENVILLE		12
	TOTAL MGD		1815

AUXILIARY PROGRAM

WATER POLLUTION CONTROL PROJECTS

EASTCHESTER BAY

PLANT NO.	LOCATION	STATUS
1	BUSHNELL AVE.	PRELIM. DESIGN
2	CONNER ST.	PRELIM. DESIGN
3	BOSTON RD.	PRELIM. DESIGN
4	THROGS NECK BLVD.	

JAMAICA BAY

PLANT NO.	LOCATION	STATUS
1	PAERDEGAT BASIN	PRELIM. DESIGN
2	FRESH CREEK	PRELIM DESIGN
3	HENDRIX ST.	PRELIM. DESIGN
4	SPRING CREEK	DESIGN
5	BERGEN BASIN	
6	THURSTON BASIN	

UPPER EAST RIVER

BRONX

PLANT NO.	LOCATION	STATUS
1	VIELE AVE.	
2	FARRAGUT ST.	
3	SOUNDVIEW PK.	
4	WHITE PLAINS RD.	
5	PUGSLEY CREEK	
6	WESTCHESTER CK. W.	
7	WESTCHESTER CK. E.	
8	FERRY POINT PK.	

QUEENS

PLANT NO.	LOCATION	STATUS
1	BOWERY BAY S.T.W.	
2	E. OF BOWERY BAY S.T.W.	
3	GRAND CENTRAL PKWY.	
4	FLUSHING RIVER	
5	FLUSHING BAY S.	
6	20TH AVE. FLUSHING	
7	FLUSHING BAY N.	
8	COLLEGE POINT	
9	POWELLS COVE	
10	LITTLE BAY	
11	ALLEY CREEK	
12	PROPOSED BASIN	

LEGEND OF SYMBOLS

POLLUTION CONTROL PLANTS — PUMPING STATIONS — INTERCEPTING SEWERS — DRAINAGE AREAS — STORM WATER TREATMENT PLANTS

IN OPERATION

UNDER CONSTRUCTION

UNDER DESIGN

FUTURE

EXPANSION UNDER CONST.

EXPANSION UNDER DESIGN

DRAINAGE AREAS

IN ONE BOROUGH

IN MORE THAN ONE BOROUGH

LIMITS OF DRAINAGE AREAS

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PLAN FOR POLLUTION CONTROL

MILES

0 1 2 3 4 5

FIGURE I

J.R. PEREZ

II - BASIC DESIGN DATA

1. The Newtown Creek Water Pollution Control Project Treatment Plant is located at Newtown Creek in the Greenpoint section of the Borough of Brooklyn and serves portions of the Boroughs of Manhattan, Brooklyn and Queens.

   The treatment plant utilizes the "High Rate" activated sludge process and has a design capacity of 310 MGD based on average sewage flow from an estimated equivalent contributing population of 2,500,000.

   The Plant provides for: screening, pumping, grit removal, aeration, sedimentation, sludge concentration, sludge digestion, disposal of digested sludge to sea by vessel, disposal of grit by barges, utilization of sludge gas for power and heating, and hypochlorination of plant effluent.

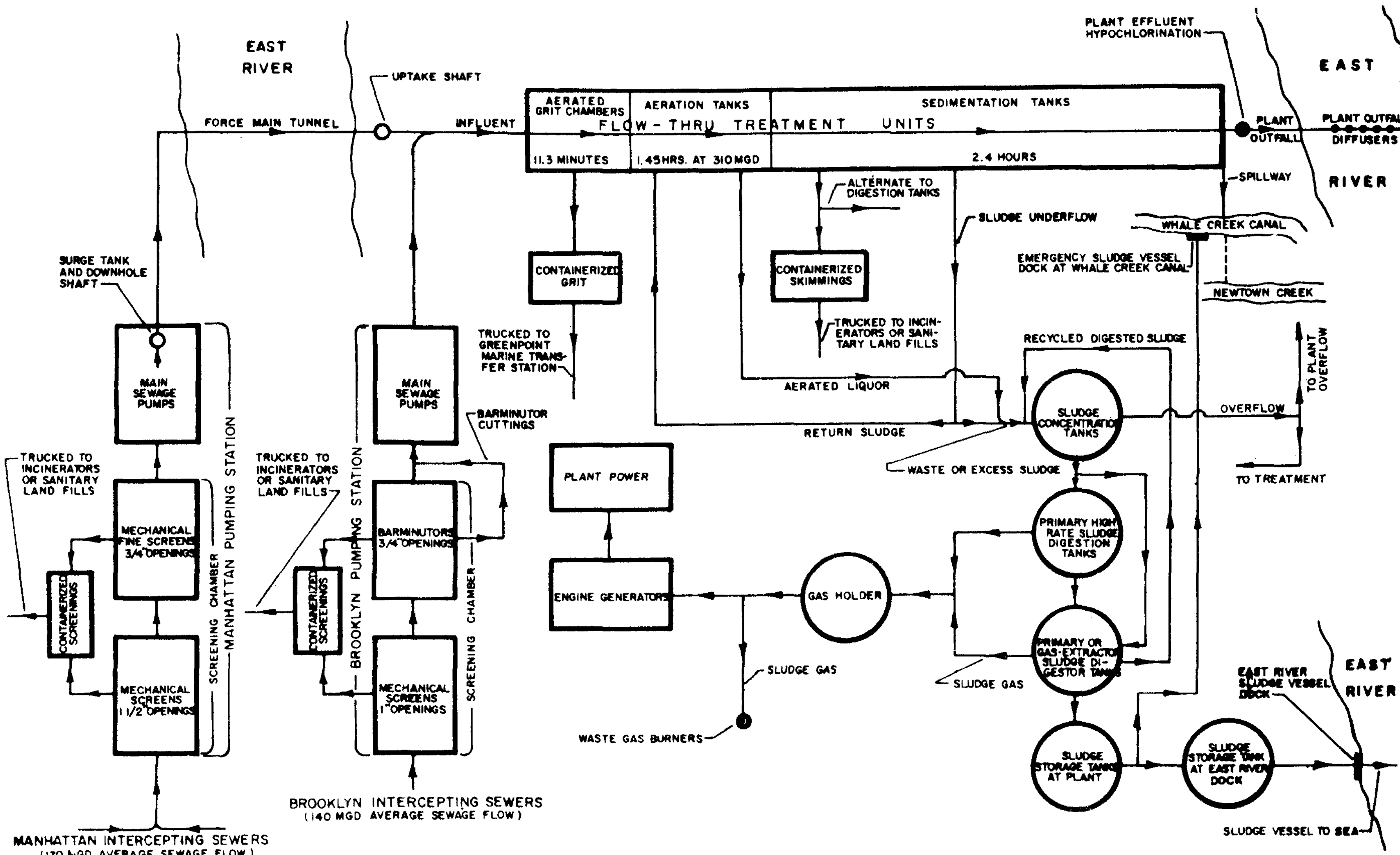
   The plant is expected to remove, on an average, approximately 70% of the suspended solids and approximately 60% of the B.O.D. from the raw sewage.

   Figure 2 (next page) - "Flow Diagram", shows the major operations at the treatment plant and at the sewage pumping stations.

2. DRAINAGE AREA

   The drainage area served includes portions of the Boroughs of Manhattan, Brooklyn and Queens, covering a total area of 15,389 acres.

   a. MANHATTAN - The Manhattan portion of the drainage area consists



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NEWTOWN CREEK POLLUTION CONTROL PROJECT

FLOW DIAGRAM - CAPACITY 310 MGD AVERAGE SEWAGE FLOW

FIGURE 2

of 4,162 acres of a widely varied character, including the lower west side of the Borough to West 11th Street and the lower east side to East 71st Street.

The section along the east side from Chambers Street to East 71st Street is mainly residential, but has in recent years undergone some change, as evidenced by the construction of the United Nations Buildings, new office buildings and several public and private housing projects. The Grand Central Section is occupied mainly by office buildings and hotels. The Midtown Section is predominantly occupied by office buildings, hotels, theatres, department stores and restaurants. Greenwich Village is a mainly residential area. From Canal Street to Chambers Street light industrial and mercantile establishments predominate. The section below Chambers Street, to the Battery, is occupied mainly by office buildings, including many skyscrapers and some residential buildings on the east side.

The Manhattan drainage area, due to its special character, has a large non-resident transient and working population. Another unique condition, particularly in the North Branch Section of the Manhattan interceptor system, is the large inflow of ground water. This inflow finds its way into the existing sewer system via infiltration into the sewers and pumping of seepage from large buildings. To allow for this condition, the treatment plant capacity has been increased by 27 M.G.D.

b. BROOKLYN - The Brooklyn portion of the drainage area covers 7,191 acres in the northwestern part of the Borough. Most of this area is predominately residential in character, consisting of small private homes, apartment houses and some low cost public housing projects. Portions of the Greenpoint and Newtown Creek areas contain numerous light industrial establishments.

c. QUEENS - The Queens portion of the drainage area is essentially similar in character to the Brooklyn portion, except that it contains fewer industrial establishments and is more sparsely populated. It covers 4,036 acres of the western part of the Borough.

Due consideration has been given in the design of the treatment plant to industrial wastes in the sewage to be treated from the Greenpoint and Newtown Creek areas.

3. INTERCEPTING SEWERS

The main intercepting sewer system, including the force main under the East River, has a total length of 16 3/4 miles, of which more than 8 miles involved tunnel construction.

These sewers intercept the flow which was formerly discharged from a total of 83 outlets, of which 70 were on the East River, 11 were on the Hudson River and 2 were on Newtown Creek.

a. MANHATTAN - The sanitary flow from the Manhattan drainage area, formerly discharged through fifty-four (54) sewer outlets into the East River and eleven (11) sewer outlets into the Hudson River. These flows are conveyed through two intercepting sewers that converge at a sewage pumping station on the east side of Manhattan. The flow is then pumped through a force main tunnel under the East River to the treatment plant in Brooklyn.

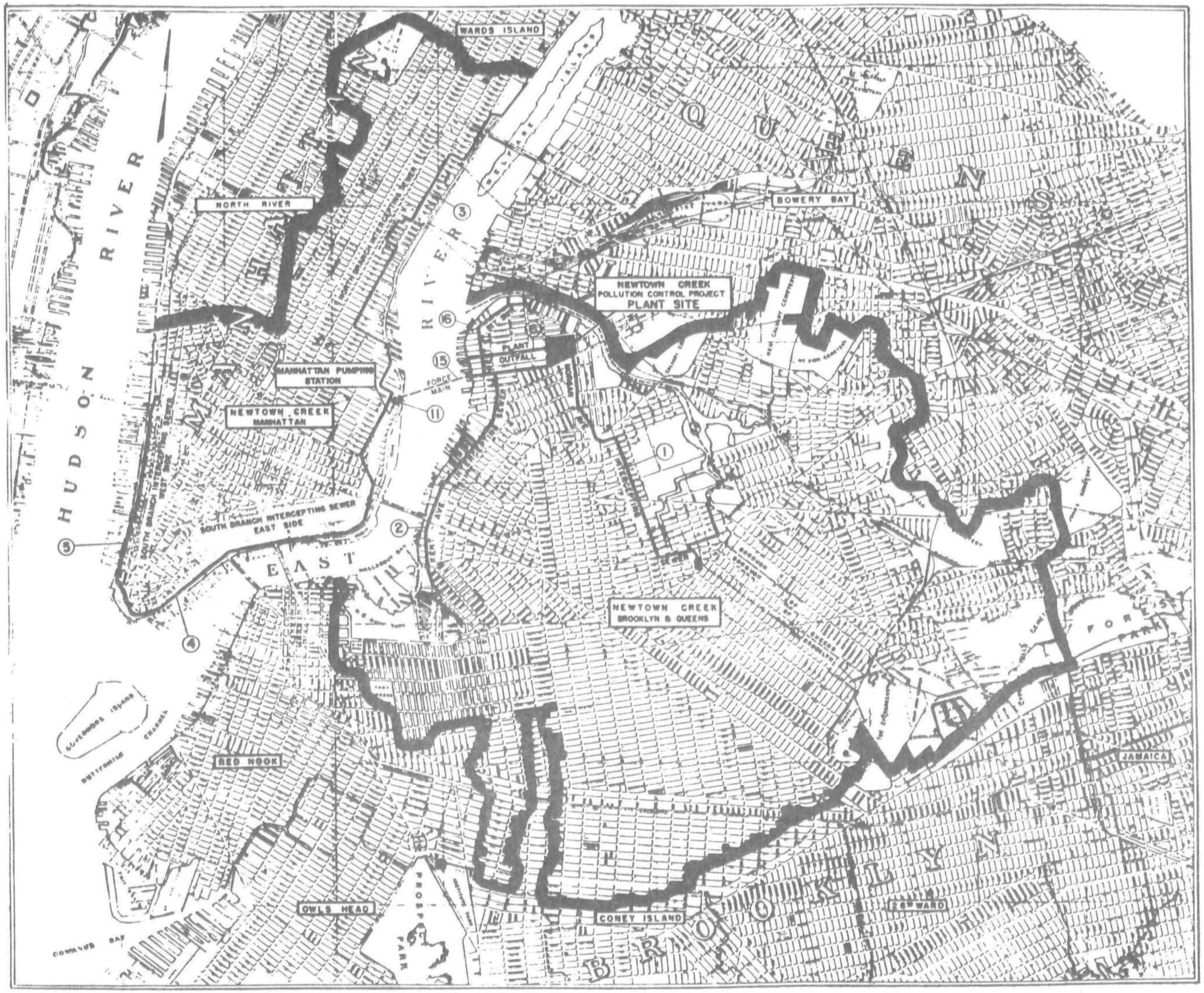
b. BROOKLYN AND QUEENS - The sanitary flow from the Brooklyn and Queens drainage areas formerly discharged through sixteen (16) sewer outlets into the East River and two (2) sewer outlets into Newtown Creek. These flows are conveyed through two intercepting sewers which meet at a junction chamber located inside the treatment plant site.

Regulators on the connecting sewers limit the flow to the interceptors to approximately twice the mean dry weather flow in the connecting sewers. The excess flows directly to the receiving waterway.

Excess capacity in the intercepting sewers permits some storage in the event of a power failure interrupting the operation of the pumping stations.

The details of the intercepting sewer system of the project will be the subject of a separate presentation.

Figure 3 (next page) shows the Drainage Plan, Intercepting Sewer System, Force Main, and the Sites for the Treatment Plant in Brooklyn and the Manhattan Pumping Station of the Project.



PW 53 NEWTOWN CREEK POLLUTION CONTROL PROJECT

CONTRACT NO.	DESCRIPTION
1	MORGAN AVENUE INTERCEPTOR SEWER - BROOKLYN
1A	JOHNSON AVENUE INTERCEPTOR SEWER - BROOKLYN
2	KENT AVENUE INTERCEPTING SEWERS - BROOKLYN
3	NORTH BRANCH INTERCEPTOR SEWER - EAST SIDE
4	SOUTH BRANCH INTERCEPTOR SEWER - EAST SIDE
5	SOUTH BRANCH INTERCEPTOR SEWER - WEST SIDE
6	PLANT OUTFALL
7	PLANT - STRUCTURES & EQUIPMENT
8	PLANT - PLUMBING
9	PLANT - HEATING & VENTILATING
10	PLANT - ELECTRICAL
11	MANHATTAN PUMPING STATION - STRUCTURES & EQUIPMENT
12	- PLUMBING
13	- HEATING & VENTILATING
14	- ELECTRICAL
15	FORCE MAIN TUNNEL - UNDER EAST RIVER
16	SLUDGE LINE, STORAGE TANK AND DOCK - STRUCTURES & EQUIPMENT
17	- PLUMBING
18	- HEATING & VENTILATING
19	- ELECTRICAL
20	FURNITURE & EQUIPMENT
21	SLUDGE VESSEL

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NEWTOWN CREEK POLLUTION CONTROL PROJECT

DRAINAGE PLAN
INTERCEPTING SEWER SYSTEM
SITES FOR PLANT & PUMPING STATION

FIGURE 3

4. POPULATION

The contributing population is influenced by the varied character of the drainage area. The Borough of Manhattan has a large non-resident transient and working population, whereas the Boroughs of Brooklyn and Queens have a relatively large industrial wastes contribution.

The population for project design purposes is essentially based on a combination of: (a) Resident; (b) Resident equivalent of transient and working population, and (c) Resident equivalent of industrial wastes contribution.

a. The ultimate resident population for the entire project drainage area is estimated at 1,525,000, of which Manhattan will contribute 575,000 and Brooklyn and Queens will contribute 950,000.

b. The resident equivalent for the Manhattan ultimate transient and working population is estimated at 450,000 (based on an estimated total transient and working population of 3,150,000 with water consumption rate one seventh that of the resident population.)

c. The resident equivalent for the Brooklyn and Queens industrial wastes contribution is estimated at 525,000 (based on an estimated industrial wastes flow of 22 MGD with a suspended solids concentration three times that of the resident wastewater, which is estimated at 125 gallons per capita per day).

The combination of (a), (b) and (c) results in an estimated ultimate equivalent population of 2,500,000 for the project design, of which Manhattan will contribute 1,025,000 and Brooklyn and Queens will contribute 1,475,000.

5. WASTEWATER QUANTITIES AND CHARACTERISTICS

It was hereinbefore indicated that the contributing population is influenced by the varied character of the drainage area. The same influences affect the wastewater quantities and characteristics.

Essentially, the wastewater is a combination of: (a) water consumption by the resident population, (b) water consumption by the resident equivalent of transient and working population, (c) industrial water usage and (d) special ground water infiltration and seepage. Records of water consumption as well as specific gaugings of sewers, pumping of seepage from large buildings and industrial water usage have been used for project design purposes.

The Manhattan design average flow is estimated at 170 MGD, of which 143 M.G.D. is based on an equivalent population of 1,025,000 (Section 4) and a per capita water consumption rate of 140 g/c/d, and 27 MGD is based on the special ground water infiltration and seepage from the Manhattan drainage area (Section 2).

The Brooklyn and Queens design average flow is estimated at 140 MGD, of which 118 MGD is based on a resident population of 950,000 (Section 4) and a per capita water consumption rate of 125 g/c/d, and 22 MGD is based on the special industrial wastes contribution from the Brooklyn and Queens drainage area (Section 2).

The average design flow for the entire project is the combination of the Manhattan and Brooklyn and Queens flows, or 310 MGD.

The maximum design flow for the Manhattan area is estimated at 300 MGD, and for the Brooklyn and Queens area at 280 MGD, resulting in a total maximum design flow of 580 MGD for the entire project. The daily peak flow for the project design is estimated at 450 MGD.

The wastewater characteristics vary considerably within the drainage area. The sewage is essentially domestic in character for the greater part of the area. However, the contribution from the industrialized areas of Brooklyn and Queens is highly concentrated due to the nature of the wastes.

The project design is based on overall average wastewater values of 200 ppm suspended solids and 200 ppm BOD for the entire drainage area. Total suspended solids and BOD average 517,000 dry pounds per day, which is equivalent to 0.21 dry pounds per capita per day, based on the design equivalent contributing population of 2,500,000.

The Manhattan Section of the drainage area is closely built up and hence contributes relatively low amounts of grit; on the other hand, the Brooklyn and Queens areas are more sparsely built up and hence contribute somewhat larger amounts of grit. Studies indicate that an overall removal of 4.0 cubic feet of grit per million gallons of average design flow for the entire project area is adequate for design purposes; average grit capture is expected to average 1240 cubic feet per day. Maximum capture is assumed at

12 cubic feet per million gallons of maximum design flow.

Screenings removal of 1.0 cubic feet per million gallons of average flow is considered adequate for the project design.

6. RECEIVING WATERWAY

The effluent from the treatment plant is discharged into Class "II" (N.Y.S.D.H.), or Class "B" (I.S.C.) waters in the East River through a 12'-0" diameter plant outfall sewer extending from the plant site to the East River, a distance of approximately 4,500 feet. The outfall is in India Street and terminates into deep water beyond the U.S. Pierhead Line. Diffusers are included for dispersion of the plant effluent into the receiving waters.

The plant outfall sewer is designed to discharge a maximum flow of 475 MGD, consisting of a daily peak flow of 450 MGD plus 25 MGD, maximum of Thickener Overflow, with a friction factor of n=.015, when the tide in the East River is at elevation +3.00. This tide level is reached on the average about once in two years.

A spillway is provided to discharge flows in excess of the hydraulic capacity of the plant outfall sewer into Whale Creek Canal which is tributary to Newtown Creek. During emergency operations, the entire maximum design flow may be discharged into Whale Creek Canal.

Provisions are included to disinfect plant effluent in advance of entry into the outfall sewer to control the bacteriological quality of the effluent as directed by regulating agencies. Sodium hypochlorite solution diffused at the head end of the plant outfall will be used for this purpose. The outfall has adequate length for contact time.

7. DESCRIPTION OF TREATMENT PLANT SITE

The treatment plant site in Brooklyn is bounded on the north by Green Street, Marginal Street and Whale Creek Canal; on the east by North Henry Street; on the south by Greenpoint Avenue, and on the west by Provost Street. The area of the plant site is approximately 32 acres.

The site originally was a generally open and flat area, except for a few run-down structures which were demolished in advance of the new construction. Former low lying and underwater portions of the area were previously filled in with earth, rock, debris, etc. The fill was in general placed directly over overlying mud which covered much of the low areas of the site. Timber bulkheads along portions of Whale Creek Canal were additional obstructions.

Site borings indicated subsurface ground conditions that generally required the use of pile foundations under the major plant structures.

The site is graded to suit the requirements of the various plant structures and in conformity with the established grades of the adjoining streets.

Trees, shrubs and lawns are provided to enhance the appearance of the site.

III - TREATMENT UNITS

The treatment plant utilizes the "High Rate" Activated Sludge Process for the treatment of a design average flow of 310 million gallons a day from an equivalent contributing population of 2,500,000 persons.

The treatment units include grit chambers, aeration tanks, sedimentation tanks and facilities for the hypochlorination of plant effluent. These units are designed to achieve removals of seventy percent of the suspended solids and sixty percent of the B.O.D. or 362,000 dry pounds per day and 310,000 dry pounds per day, respectively, from the wastewater. In addition, the plant is expected to remove 4 cubic feet of grit and 1 cubic foot of screenings from each million gallons of average flow, or grit removals of 1240 cubic feet per day and screenings removals of 310 cubic feet per day.

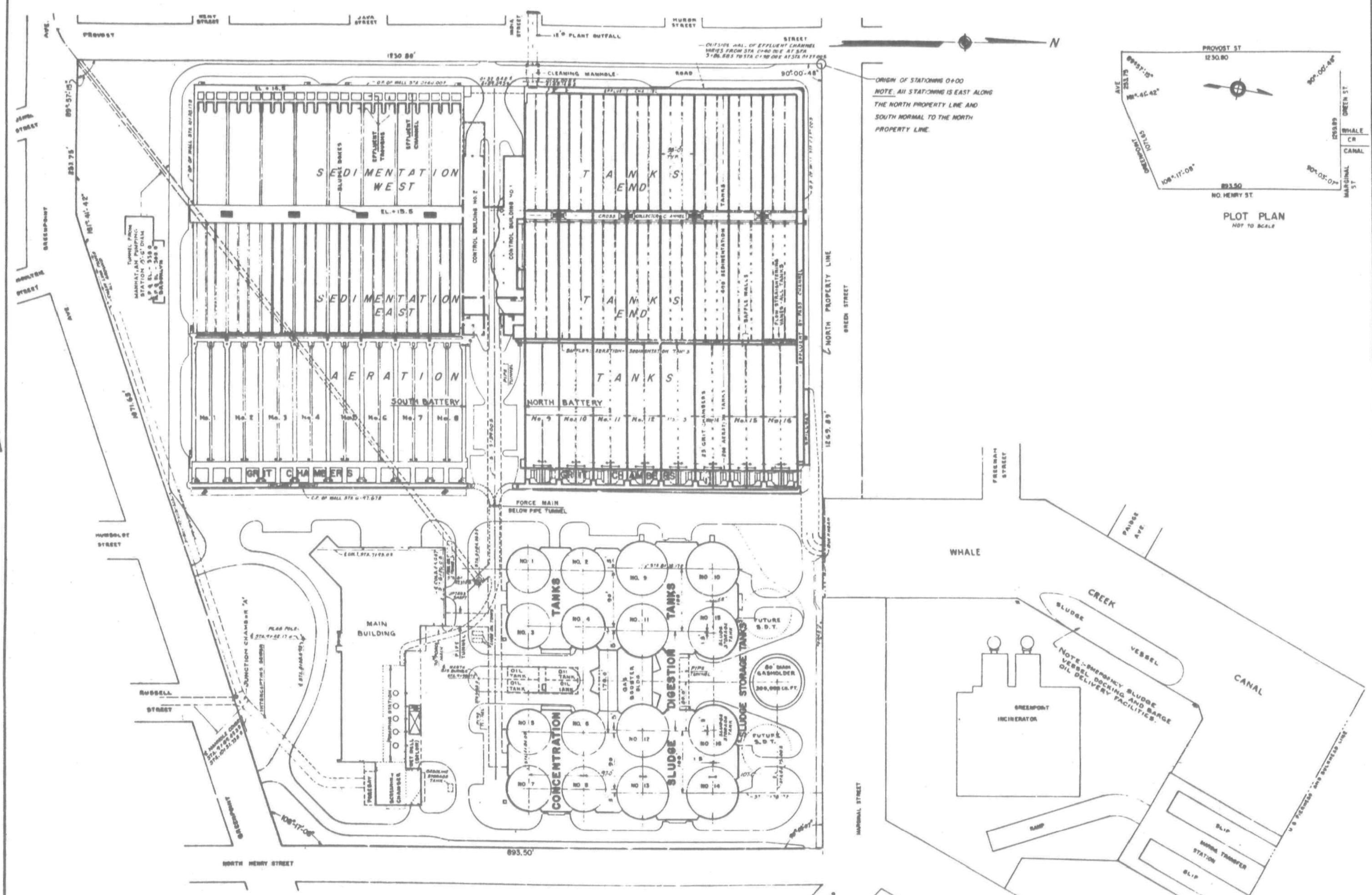
The treatment plant is distinguished by its unusually compact design in which all major plant units are grouped into a minimum number of structures in order to afford economies in construction and operation costs. In addition, the compact layout provides for centralized administration and for short connections for all major piping and conduits. Pipe and access tunnels connect the Main Building to operating centers at the several groups of tanks. The plant structures are of functional modern architectural design and are treated in such a manner as to enhance the area in which the plant is located.

Housed in the Main Building are the screening chamber and pumping station for the Brooklyn and Queens flow in addition to facilities for power generation, electrical control equipment, heating and ventilation equipment, air filters and process air blowers, a shop for the servicing of plant equipment, garage, plant administrative offices, plant laboratory, various storage and employee utility facilities and the administrative headquarters and laboratories for the Industrial Section of the Division of Plant Operations.

Two Control Buildings, one for each tank battery, house the return and excess sludge pumping stations, effluent water pumping station, chlorination facilities for sphaerotilus control, scum handling stations, diffuser tube cleaning facilities, electrical rooms, facilities for plant effluent hypochlorination, storage rooms and employee utility facilities.

The combination of grit chamber, aeration tank and sedimentation tank functions into a single tank structure, compartmented to provide for the foregoing functions in successive chambers is unique and constitutes a major development in the design of Water Pollution Control facilities. Two such tank batteries are provided. This combination of units eliminates the need for interconnecting conduits and inlet and outlet sluice gates and generally resulted in economies during construction. Further economies are affected in operation due to concentration of structures and in pumping power requirements made possible by minimizing hydraulic losses.

Figure 4 (next page) "Plant Plot Plan & Plant Layout" shows the major elements of the Treatment Plant.



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NEWTOWN CREEK POLLUTION CONTROL PROJECT
PLOT PLAN & PLANT LAYOUT
FIGURE 4

1. MAIN BUILDING

The following facilities are housed in the Main Building.

a. SCREENING CHAMBER

Sewage from Brooklyn and Queens is discharged via a 12'-0" x 9'-0" Intercepting Sewer into the forebay, which consists of four 3'-0" wide channels with stop planks provided at the forward ends. Flow continues to four 5'-0" wide screen channels each equipped with one 36" x 108" quick closing, hydraulically operated, float controlled and manually reset inlet sluice gate. The gates close automatically in the event of a power failure or an inflow of sewage in excess of the capacity of the main sewage pumps.

Temporary racks 3'-0" wide with bars 6" on centers are located in the forebay in order to safeguard against the passage of large objects at the start of plant operations.

The primary bar screens are 5'-0" wide with 1" clear openings. Barminutors, 8'-0" wide with 3/4" clear spaces between bars, serve as secondary screens. Cuttings are returned to the flow downstream of the barminutors.

Access to the Screening Chamber is facilitated by an automatic push-button operated passenger elevator.

Trash collected from the bar screens is manually sorted and placed in trash cans which are transported to trucks via a one ton electric hoist mounted on a monorail system. The trash is disposed at municipal incinerators or at sanitary landfills.

After screening, the flow enters a 20'-0" wide wet well shaped so as to inhibit the deposition of grit.

b. MAIN SEWAGE PUMPS

Five 70 MGD vertical, centrifugal or mixed flow type pumps direct driven by electric motors, are provided to pump the maximum design flow of 280 MGD with one pump held in reserve. Three of the pumping units are variable speed driven by 800 H.P. wound rotor induction motors with electrical control equipment to regulate pump speeds and discharge rates. The other two pumping units are constant speed driven by 800 H.P. synchronous motors. Strained plant effluent is used as flushing water for the wearing rings.

The Main Sewage Pumps discharge into a 7'-6" maximum diameter welded steel force main which is provided with a flow tube for measuring the Brooklyn and Queens flow. This force main joins a 7'-6" diameter reinforced concrete conduit outside the Pumping Station which in turn is connected to a conduit designed to convey the Manhattan flow. The two conduits join into a single conduit which conveys the total flow to the grit chambers.

c. AIR FILTERS

Two systems of air filters are provided, one to supply air to the engine air intake system and the other to the process air system. Engine air is filtered through seven (7) banks of filters, each consisting of 16 cells of permanent metal filter media and having a capacity of 12,000 c.f.m. Process air is filtered through six (6) banks of electrostatic precipitators behind which are glass filter bags. Each bank has a capacity of 31,080 c.f.m.

d. <u>PROCESS AIR BLOWERS</u>

Six (6) process air blowers are provided, each capable of delivering 30,000 c.f.m. of process air at a pressure of 7.75 p.s.i.g. These are multi-stage centrifugal type, direct-connected to 1250 H.P. squirrel cage induction motors. The blowers provide sufficient capacity, with one blower reserved as a spare, to deliver 0.66 cubic feet of air per gallon of sewage under aeration based on average sewage flow. With all six blowers in operation the capacity is 0.79 cubic feet per gallon of average sewage flow under aeration.

The process air main has a maximum diameter of 72"; the air has a velocity of 5300 ft./min. with five blowers in service and 6350 ft./min. with six blowers in service.

Normal process air requirements are not expected to exceed 0.50 cubic feet per gallon of average sewage flow which requires four blowers in service. The installation provides for all conditions of operation, including shock industrial wastes loadings.

e. ENGINE - GENERATORS

Seven (7) Engine-Generator units are provided, with a maximum of six (6) available for power generation and one (1) as a spare. The engines are 12-cylinder, V-type, 4 cycle turbo-charged diesels capable of operating on sewage gas having a heat value of 600 B.T.U. per cubic foot and on Diesel fuel oil. They can operate selectively as dual-fuel engines with any oil-gas ratio. The engines are rated at approximately 2800 H.P. at 327 R.P.M.

Seven 2500 KVA, 4160 volt, generators driven by the seven dual fuel engines supply electrical energy for the operation of the treatment plant.

f. ELECTRICAL INSTALLATIONS

A 4160 volt, metal-clad switchgear structure has been installed for the switching of the following equipment: seven generators, six 1250 H.P. blower motors, three 815 H.P. variable speed main sewage pump motors, two 840 H.P. constant speed, synchronous main sewage pump motors, two auxiliary transformers and four unit substation feeders.

Control benchboards located in a central control room in the Main Building provide for the control of the generators, blower motors and main sewage pump motors.

Unit substations consisting of 4160 volt disconnecting switches, 4160 to 480 volt transformers and 480 volt metal-clad switchgear have been installed for the feeding of 440 volt motor control centers, from which feeders extend to auxiliary plant motors.

The office, service and control areas are illuminated with fluorescent lighting. Operating areas, however, are illuminated with vapor proof or explosion proof lighting. Street lighting and floodlighting post-mounted units and handrail mounted units are provided for outdoor areas.

An alarm annunciator has been installed in the central control room to give audible and visible warning in the event of outage, malfunction of major installations, or the leakage or accumulation of combustible gases in hazardous areas.

An automatic telephone system and a coded call system have been installed for interior communication.

2. TREATMENT TANK UNITS

a. GRIT CHAMBERS

Thirty-two (32) aerated grit chambers are provided, arranged in such a manner so that two grit chambers lead to each of sixteen (16) aeration tanks. Each grit chamber unit is 27'-0" wide, 15'-0" S.W.D. at average flow and 25'-0" long. Diffuser tubes are provided to supply air at a maximum rate of 6 c.f.m. per foot of tank length. Center dividing walls the full length of the tank avoid the double spiral flow patterns that exist in the aeration tanks. A baffle wall between the grit chambers and aeration tanks is provided to minimize the carry-over of grit to the secondary treatment units. A continuous hopper under the diffusers is provided in each grit chamber unit for grit storage and to permit clam-shell bucket removal. "Swingfuser" aerators operated by motorized power units have been installed for air degritting.

The grit chambers, aeration tanks and sedimentation tank units are all designed for an average flow of 310 M.G.D. and a maximum flow of 580 M.G.D. The hydraulic design of the Grit Chambers is based on a maximum flow of 604 M.G.D. which includes 24 M.G.D. thickener overflow, passing through 24 grit chambers. The maximum flow-through velocity is about 0.1 ft./sec. The overflow rate at maximum flow of 580 M.G.D. with 32 tanks in operation is 26,900 gallons/s.f./day with a detention of 6.0 minutes. With the average design sewage flow of 310 M.G.D. and 32 tanks in operation, the overflow rate is 14,400 gallons/s.f./day and the detention is 11.3 minutes.

The average removal of grit is expected to be about 4 cu. ft. per M.G. or about 1,240 cubic feet per day.

b. <u>AERATION TANKS</u>

Sixteen (16) aeration tanks follow the grit chambers, so arranged that two grit chambers discharge into each aeration tank. Each tank is 55'-0" wide x 15'-0" S.W.D. at average flow x 200'-0" long. The aeration tanks have a total volume of

2,500,000 cubic feet or 18.7 million gallons. The hydraulic design is based on a maximum flow of 657 M.G.D. passing through twelve (12) tanks which includes 580 M.G.D. maximum sewage flow, 48 M.G.D. return sludge which enters the aerators individually at the head of each tank, 24 M.G.D. thickener overflow and 5 M.G.D. spray water for foam control.

Air is diffused through the sewage via about 18,820 ceramic type double air diffuser tubes located at 7½" centers along the two longitudinal walls of each tank and attached to fixed manifolds with disconnect fittings at the air headers. The double spiral flow pattern towards the center thus engendered in each tank is aided by a bottom center ridge.

The detention period with all sixteen (16) tanks in operation with an average flow of 310 M.G.D. and 24 M.G.D. (8% ±) return sludge is 1.34 hours. With 16% ± return sludge or 48 M.G.D., the detention period is 1.26 hours. The detention period based on 310 M.G.D. average flow is 1.45 hours.

The BOD Aerator loading is equal to 517,000 dry pounds/day which is equal to 206 dry pounds per 1000 c.f. of Aerator capacity. The aeration tanks are designed to operate with sludge ages varying between 0.2 and 0.4 day. With an 0.2 day sludge age, the BOD solids loading is 104,000 dry pounds, which corresponds to 5 pounds of aerator solids per pound MLSS. With an 0.4 day sludge age, the BOD solids loading is 208,000 dry pounds, which corresponds to 2.5 pounds of aerator solids per pound MLSS. The return sludge rates vary from about 8% (24 M.G.D.) to about 16% (48 M.G.D.).

Aerator solids concentrations vary from about 670 p.p.m. to about 1320 p.p.m. Return sludge and excess sludge solids concentrations vary from about 3710 p.p.m. to about 8550 p.p.m. Excess sludge flow to the thickeners normally vary from about 5.1 M.G.D. to about 11.7 M.G.D. when wasting return sludge. The maximum flow of waste sludge to the concentration tanks when purging the aerators is 24 M.G.D., based on eight concentration tanks in service with an overflow rate of about 800 gallons per square foot per day.

With three of the six installed blowers in service and average flow the air rate is 0.40 c.f. of air per gallon of sewage. Normally, air rate will not exceed 0.55 c.f. of air per gallon of sewage, which requires four blowers in operation. Higher air rates may be required, however, during periods of shock industrial wastes loadings which may occur periodically. With five of the six blowers in service an air rate of 0.66 c.f. of air per gallon of sewage can be delivered, based on an average flow.

With three blowers in operation, the air rates at average flow are 27 c.f.m. per foot of aeration tank, 169 c.f.m. per 1000 pounds BOD loading and 405 c.f. per pound BOD removed.

With five blowers in operation, the air rates, at average flow, are 45.1 c.f.m. per foot of aeration tank, 280 c.f.m. per 1000 pounds BOD loading and 816 c.f. per pound BOD removed.

A spray system utilizing strained plant effluent has been provided to control aerator foam or frothing.

c. SEDIMENTATION TANKS

The sedimentation tanks are of the same number (16) and width as the aeration tanks, of which they are a continuation. Each tank is 55'-0" wide x 12'-0" S.W.D. x 400'-0" long, with a total liquid volume of about 4,200,000 c.f. (or 31.1 M.G.), a total surface area of 362,000 s.f. and about 126 linear feet of weirs per tank at the effluent end. The spiral flow pattern and ensuing turbulence in the aeration tank flow is inhibited before entry into the sedimentation tanks by means of double wall baffles with staggered openings. Flow straightening vanes help provide a uniform distribution of flow.

Settled sludge is scraped mechanically from each of the tanks to cross collecting channels located at the center of the tanks. Sludge is withdrawn from sumps in the cross-collecting channels by hydrostatic lifts and is conveyed to wells. Return sludge is pumped to the head of the aeration tanks. Excess sludge is pumped to the concentration tanks.

Effluent from the sedimentation tanks passes over transverse and short longitudinal weirs at the far end of each tank at a rate of 154,000 gallons per day per foot of weir, based on 310 M.G.D. average sewage flow.

Scum and grease removal is effected mechanically by skimming and collecting mechanisms at the head end of the tanks and is conveyed to scum tanks, from which it can be disposed at City incinerators or sanitary landfills.

Stop planks and sluice gates are provided in the space between the baffle walls at the beginning of the sedimentation tank compartments to permit taking two aeration tank units out of service in each of the two tank batteries without taking the corresponding sedimentation tank units out of service, when operation at lower aerator detention periods is warranted.

With average sewage flow of 310 M.G.D. and sixteen sedimentation tanks in operation, the detention is 2.43 hours, the overflow rate is about 880 gallons per square foot per day and the sludge underflow rate varies from 30 M.G.D. to 60 M.G.D. The flow-through velocity in the units at average sewage flow plus 10% return sludge is about 3.0 feet per minute and the vertical settling velocity is about 0.09 feet per minute (about one inch per minute). The units are set so that the average W.S. level is at elevation +13.0, which allows discharge of a maximum flow of approximately 475 M.G.D., which includes 450 M.G.D. (daily peak flow) of plant effluent and 25 M.G.D. of thickener overflow, through the 12'-0" diameter outfall sewer when the tide in the East River is at elevation +3.0 and the friction factor n= 0.015.

Hydrostatic lifts are used for withdrawing sludge from the sedimentation tanks. A conduit conveys the sludge to a pump well from which return and excess sludge is withdrawn by centrifugal pumps. Return sludge is pumped to the head end of the aeration tanks and excess sludge is pumped to the concentration tanks. Excess sludge quantities, when wasting return sludge, range from about 5 M.G.D. to about 12 M.G.D. When purging the aeration tanks a maximum rate of about 24.0 M.G.D. may be reached. The flow to the concentration tanks is maintained more or less constantly at 24 M.G.D. by adding aerator effluent to the return sludge waste as required.

Plant effluent is discharged to the East River via a 12'-0" diameter reinforced concrete outfall sewer equipped with diffusers. An emergency spillway into Whale Creek Canal is provided for such times when the hydraulic capacity of the outfall sewer may be exceeded.

Disinfection of plant effluent is affected by the use of sodium hypochlorite which is added to the flow at the head end of the plant outfall sewer.

The hypochlorination equipment and storage tanks are located in the Aeration Control Building. No special contact chamber is required as the outfall sewer is of sufficient length to provide adequate contact time to affect optimum bacterial kill.

3. SLUDGE PROCESSING FACILITIES

a. CONCENTRATION TANKS

Two (2) independent excess sludge pumping stations pump the excess or waste sludge to eight (8) concentration tanks.

The concentration tanks,designed for "Dense Sludge" operation, are 70'-0" diameter x 10'-0" S.W.D. reinforced concrete tanks with 7'-0" deep center cones and are equipped with heavy duty Dorr-Oliver Company thickening mechanisms of the latest design for moving "dense" sludge to an annular trench in the center of the tank. Thickener overflow is discharged over peripheral V-notched weirs into effluent troughs and is processed for treatment with the screened sewage. Thickener overflow may also be discharged directly to the plant outfall sewer when quality permits.

Thickened sludge is removed from the concentration tanks and discharged through short lines to the digestion tank recirculation piping by positive displacement pumps located under the center annular sludge trench.

A new operating technique is used which was developed in New York City in recent years and which indicates that substantial reduction in digested sludge volume to be barged to sea is achieved by recycling up to about 50% of the digested sludge through the concentration tanks. The total solids to the concentration tanks when this procedure is used is 475,000 dry pounds per day, of which 362,000 dry pounds per day are raw excess sludge solids and 113,000 dry pounds per day are recycled digested sludge solids.

The surface area and volume of each tank (exclusive of the bottom cone) are respectively 3,800 square feet and 38,000 cubic feet.

The eight concentration tanks have a combined design solids loading of 11.2 lbs./s.f./day when thickening raw excess sludge only and 15.6 lbs./s.f./day when thickening raw excess sludge combined with recycled digested sludge for "Dense-Sludge" operation.

Aerator liquor is added to the return sludge waste to maintain liquid detention in the concentration tanks within reasonable limits. The maximum aerator effluent waste is 24 M.G.D. when purging the aerators, under which condition the overflow rate in the concentration tanks is 780 gallons per square foot per day.

The Sludge Volume Ratio (SVR) ranges from about 0.4 day to 1.1 days with the sludge blanket contained in the cone of the tank bottom. Liquid detention time in the concentration tanks at 24 M.G.D. is about 2.3 hours. Thickened sludge varies from about 12% solids to about 4% solids, with an average concentration of about 8%, in which case the flow of thickened sludge is about ~~550~~ 480 g.p.m., assuming the recycling of digested sludge.

The concentration tanks are located adjacent to the digestion tanks. Galleries interconnect the units and house equipment and piping. The tanks are arranged and piped to permit independent operation of two concentration tanks to one digestion tank, or any combination of units which may result in improved efficiency.

b. DIGESTION TANKS

Thickened raw sludge from the concentration tanks is digested in six (6) 80'-0" diameter x 42'-0" S.W.D. "High Rate" sludge digestion tanks equipped with fixed steel covers having a total liquid capacity of approximately 1,270,000 cubic feet. These tanks provide about one half cubic foot of tank capacity per capita of design equivalent contributing population.

All six (6) tanks have been equipped with four mechanical mixers and have been designed as primary digesters. Operation utilizing stage digestion is not provided for as such. However, two of the tanks are capable of dual operation to act as either primary or secondary (gas extractor) digesters. Accordingly, the two dual-operation tanks were constructed with inverts three feet lower than the rest in order to provide for gravity flow when operating as secondary tanks.

The average daily design input of raw excess sludge to the digestion tanks is about ~~[illegible]~~ 543,000 gallons. The daily solids input is about 362,000 dry pounds per day of raw sludge solids and 113,000 dry pounds per day of recycled digested sludge solids, for a total of 475,000 dry pounds of solids per day, of which 75% of the raw sludge solids is volatile solids. The volatile solids destruction is assumed to be 50% or 136,000 dry pounds per day, thus leaving a remainder of 226,000 dry pounds per day of solids in the digested sludge. The detention time utilizing all 6 tanks is 17.6 days, with the raw sludge having an 8% solids concentration. With 6 tanks in operation, the volatile solids added will be 6.4 dry pounds/c.f./month.

The solids concentration of the sludge barged to sea is 7.6% when recycling digested sludge to the concentration tanks. Otherwise the solids concentration is about 5.0%. The average quantity of digested sludge barged to sea is 356,000 gallons per day when recycling digested sludge and otherwise 543,000 gallons per day.

Raw and recycled digested sludge is discharged to each digester through an influent pipe extending to the middle of the tank and outletting six feet below the liquid level, or through any of the four down-draft tube mixers in each tank. Separate external sludge heaters and circulating heating pumping units are provided for the six tanks. Sufficient heat is provided for the maintenance of a 95° F temperature level, the influent sludge having a temperature of about 50° F.

Each digestion tank is equipped with four "downdraft" tube mixers of 7,500 g.p.m. capacity which are capable of turning the entire tank contents over once every half hour. Scum accumulation and foaming is inhibited by this design.

Sludge gas is withdrawn from the six Digestion Tanks at a normal rate varying from about 2,000,000 cu. ft./day to 3,000,000 cu. ft./day, with an average of about 2,500,000 cu. ft./day or about 1.0 cu. ft. per capita per day. About 90% of the gas is expected to be produced in the four "High-Rate" tanks and about 10% in the two secondary tanks (gas-extractors). The average quantity of gas withdrawn from one of the four "High-Rate" tanks is about 563,000 cu. ft./day. Gas piping in all tanks is sized to permit withdrawal at hourly rates up to 2½ times the maximum expected average rate. Excess gas not used by the engines or boilers is stored in a 300,000 cubic foot capacity Wiggins type gas holder. Excess gas will be burned by four (4) waste gas burners, each having a capacity of 20,000 cubic feet of gas per hour.

c. SLUDGE STORAGE TANKS

Digested sludge is stored in two 80'-0" Dia. x 21'-0" swd x 12'-0" cone sludge storage tanks located on the plant site and similarly sized sludge storage tank located at the East River, at which location a dock is provided to accommodate sludge vessels which barge the digested sludge to sea for disposal. A 16" sludge line conveys the sludge from the plant to the loading dock and adjacent storage tank. An emergency sludge loading facility is provided near the plant on Whale Creek Canal.

IV. MANHATTAN PUMPING STATION

Sewage from the Manhattan portion of the drainage area is conveyed via an interceptor sewer system to a pumping station located at East 13th Street and Avenue "D". This structure, presently still under construction, is expected to be completed in 1968. Hydraulic design and treatment statistics presented in this paper are predicated on this facility being in operation.

An average flow of 170 M.G.D. from the Manhattan drainage area will be discharged into the forebay of the Manhattan Pumping Station ahead of the Screening Chamber. The forebay consists of an expanding section leading to four 3'-6" wide channels with stop planks provided at the forward ends.

The Screening Chamber consists of four 5'-6" wide screen channels with one 42" x 108" quick closing hydraulically operated, float controlled, manually reset inlet sluice gate located in each channel. The gates will close automatically to protect the chamber against flooding which might occur during a power failure or during an inflow of sewage beyond the capacity of the sewage pumps. One 66" x 108" hydraulically operated manually controlled sluice gate is provided at the discharge end of each screen channel.

Three sets of screens are provided in each of the channels ahead of the main sewage pumps. These include temporary hand cleaned coarse racks and primary and secondary bar screens. The temporary racks are 3'-6" wide with bars 6" on centers and are located in the forebay in order to prevent the passage of large objects into the pumping station during start of operations.

The primary bar screens are 5'-6" wide with 1½" openings and the secondary bar screens are 5'-6" wide with 3/4" openings. The screenings handling system will be the first planned attempt to mechanize screenings handling. Previous designs have proven to be expensive and sloppy, with extremely high labor operating cost. Longitudinal and transverse conveyors are provided, with reversible operation. Screenings handling and conveyance is mechanized to afford efficiency in this phase of the operation, with the screens, skip hoist and horizontal conveyors automatically operated by pneumatic and other controls. Sorted screenings are containerized to facilitate trucking to disposal at municipal incinerators.

After screening, the Manhattan sewage will flow into a wet well suitably shaped to prevent grit deposition. The main sewage pumps will draw suction from the wet well and will discharge into a welded steel force main with a maximum diameter of 8'-6" located inside the pumping station. A flow tube is provided in this line to measure the flow. Readings will be transmitted to the treatment plant via leased telephone wires.

The Manhattan flow is expected to range from a maximum of 300 M.G.D. to a minimum of 90 M.G.D. with an average of 170 M.G.D. Five 100 M.G.D. pumps of the vertical centrifugal or mixed flow type with variable speed, direct driven by five 1500 H.P. wound rotor induction motors, are provided. These pumps are designed to operate under a head of 75 feet. Utility purchased electrical energy is to be obtained from a 277/460 volt 3 phase, 4 wire distribution bus erected by the Consolidated Edison Company. The bus is to be supplied by four 2000 KVA transformers installed under the sidewalk along Avenue D. Each transformer will be connected to a separate high voltage feeder.

A 30'-0" diameter surge tank located over the downtake shaft in Manhattan is provided to eliminate surges and protect the force main against undue pressures in the event of a power failure at the Manhattan Pumping Station which would instantaneously stop the main sewage pumps. The surge tank is designed so as to maintain continuously complete submergence of the force main, especially during the initial drawdown and forward surge.

The 8'-6" downtake shaft of the force main tunnel to the Treatment Plant in Brooklyn is located directly under the surge tank and descends to more than 300 feet below grade. The rock tunnel passes more than 300 feet beneath the East River to Brooklyn. The uptake shaft, at the plant site, is 7'-6" diameter. The shafts, tunnel and junctions are so designed as to permit the passage of a cleaning mechanism to restore the hydraulic efficiency of the conduit, if required.

V. PROJECT COSTS

The Newtown Creek Water Pollution Control Project, when complete, will have cost approximately $167,000,000 which expense has been financed with New York City capital budget funds and State and Federal Assistance under four different programs.

When the design of the project was initiated the only available State assistance program applicable was in connection with design and borings. In accordance with this law, New York City has received $595,000 for preliminary design, $1,785,000 for final design and $261,427 for borings, for a total of $2,641,427.

The only Federal Aid program in effect when Newtown Creek's first construction contracts were awarded afforded the City a grant of $250,000 in connection with only one contract, the Plant Outfall.

It was not until 1965 that any really meaningful State and Federal Aid programs were legislated. In accordance with Article 12, section 12636 of the State Health Law and 33 U.S.C. 466 et. seq. of the Federal law, New York City has contracted for an additional $38,596,507 in aid in connection with this project, on a "pickup" basis for contracts in progress or not awarded as of May 12, 1965. Accordingly, about $124,000,000 of New York City capital funds will have been spent on the Newtown Creek project with approximately $39,000,000 being financed with State and Federal Aid. Stated differently, the City will have paid almost 76% of the total cost of the project, with the State and Federal Governments paying 24%.

The design of the Newtown Creek Project was done entirely by the engineering staff of the Division of Plant Design, Bureau of Water Pollution Control of the Department of Public Works. The estimated $6,428,000 design costs, which include overhead and fringe benefit costs, represents only about 4.1 per cent of the total construction cost.

A carefully prepared design has kept the cost of change order work well below the magnitude and cost levels which were expected for this project, and most of these change orders were issued for the purpose of making design improvements or were in connection with unforseen and unforseeable subsurface conditions encountered by the contractors.

Figure 5 (next page) shows a breakdown of costs for the Newtown Creek Water Pollution Control Project.

FIGURE 5
NEWTOWN CREEK WATER POLLUTION CONTROL PROJECT
PROJECT COST

Contract NO.	Description	Bid Price	Change in Cost to 3/67	Estimated Add'l Cost Subsequent to 3/67	Estimated Total Cost
A.	Property Fence	$ 8,699.60	$ ----	$ ----	$ 8,699.60
	Borings F.M. (East River	70,221.00	----	----	70,221.00
1.	Morgan Avenue Intercepting Sewer	10,346,260.00	+ 52,760.60	----	10,399,020.60
1A.	Sec. in Johnson Avenue	----	----	1,000,000.00	1,000,000.00
2A. and B	Kent Avenue Intercepting Sewer	5,098,881.00	+ 90,279.03	----	5,189,160.03
2C.	Kent Avenue Intercepting Sewer	7,152,555.00	+ 233,831.57	----	7,386,386.57
3.	North Branch Intercepting Sewer	19,181,994.50	+ 370,190.10	500,000.00	20,052,184.60
4.	South Branch Int. Sewer East Side	21,939,520.00	+ 1,005,943.77	1,500,000.00	24,445,463.77
	South Branch Intercepting Sewer Battery Park Underpass	764,879.00	----	----	764,879.00
5.	South Branch Int. Sewer West Side	6,356,468.00	+ 378,852.31	----	6,735,320.31
6.	Plant Outfall	5,113,907.00	+ 352,035.24	----	5,465,942.24
XM.	Sewer Under Brooklyn Crosstown Manhattan Avenue and India Street	394,700.00	----	----	394,700.00
7.	Plant - Structures and Equipment	42,870,850.00	+ 288,595.31	350,000.00	43,509,445.31
8.	Plant - Plumbing	1,147,000.00	+ 1,250.00	1,000.00	1,149,250.00
9.	Plant - Heating and Ventilating	880,000.00	+ 42,893.41	200,000.00	1,122,893.41

FIGURE 5 (CONTINUED)

Contract NO.	Description	Bid Price	Change in Cost to 3/67	Estimated Add'l Cost Subsequent to 3/67	Estimated Total Cost
10.	Plant - Electrical Work	$ 3,884,000.00	$+ 16,184.47	$ 100,000.00	$ 4,000,184.47
11.	Manhattan Pumping Station Structures and Equipment	8,442,130.00	0	500,000.00	8,942,130.00
12.	Manhattan Pumping Station Plumbing	83,986.00	0	5,000.00	88,991.00
13.	Manhattan Pumping Station Heating and Ventilating	113,440.00	0	10,000.00	123,440.00
14.	Manhattan Pumping Station Electrical Work	938,000.00	0	30,000.00	968,000.00
15.	Force Main	6,463,949.75	- 575,460.53	----	5,888,489.22
16.	Sludge Line, Storage Tank & Dock Structures and Equipment	3,059,666.00	+ 89,320.31	5,000.00	3,153,986.31
17.	Sludge Line, Storage Tank & Dock Plumbing	38,250.00	0	750.00	39,000.00
18.	Sludge Line, Storage Tank & Dock Heating and Ventilating	89,900.00	0	1,500.00	91,400.00
19.	Sludge Line, Storage Tank & Dock Electrical	59,887.00	0	1,000.00	60,887.00
20.	Furniture and Equipment	324,000.00	0	0	324,000.00
21.	"Newtown Creek" New Sludge Vessel	3,837,000.00	0	50,000.00	3,887,000.00
	TOTALS (CONSTRUCTION)	$148,660,143.85	$+2,346,675.59	$ 4,254,250.00	$155,261,069.44
	DESIGN (INCL. ADMINISTRATION)	---	---	---	6,428,486.62
	SUPERVISION OF CONSTRUCTION (EST.)	---	---	---	5,265,382.06
	TOTAL PROJECT COST				$166,954,938.12

ACKNOWLEDGEMENTS

The Newtown Creek Water Pollution Control Project was designed and construction was supervised by personnel of the Department of Public Works, presently under Commissioner Eugene E. Hult and Deputy Commissioner and General Manager Frederic A. Davidson, Jr. The project was under the direct supervision of the Bureau of Water Pollution Control under Director, Martin Lang, Deputy Director, Joseph Cunetta and former Directors, R.H. Gould, W.A. O'Leary and S.W. Steffensen.