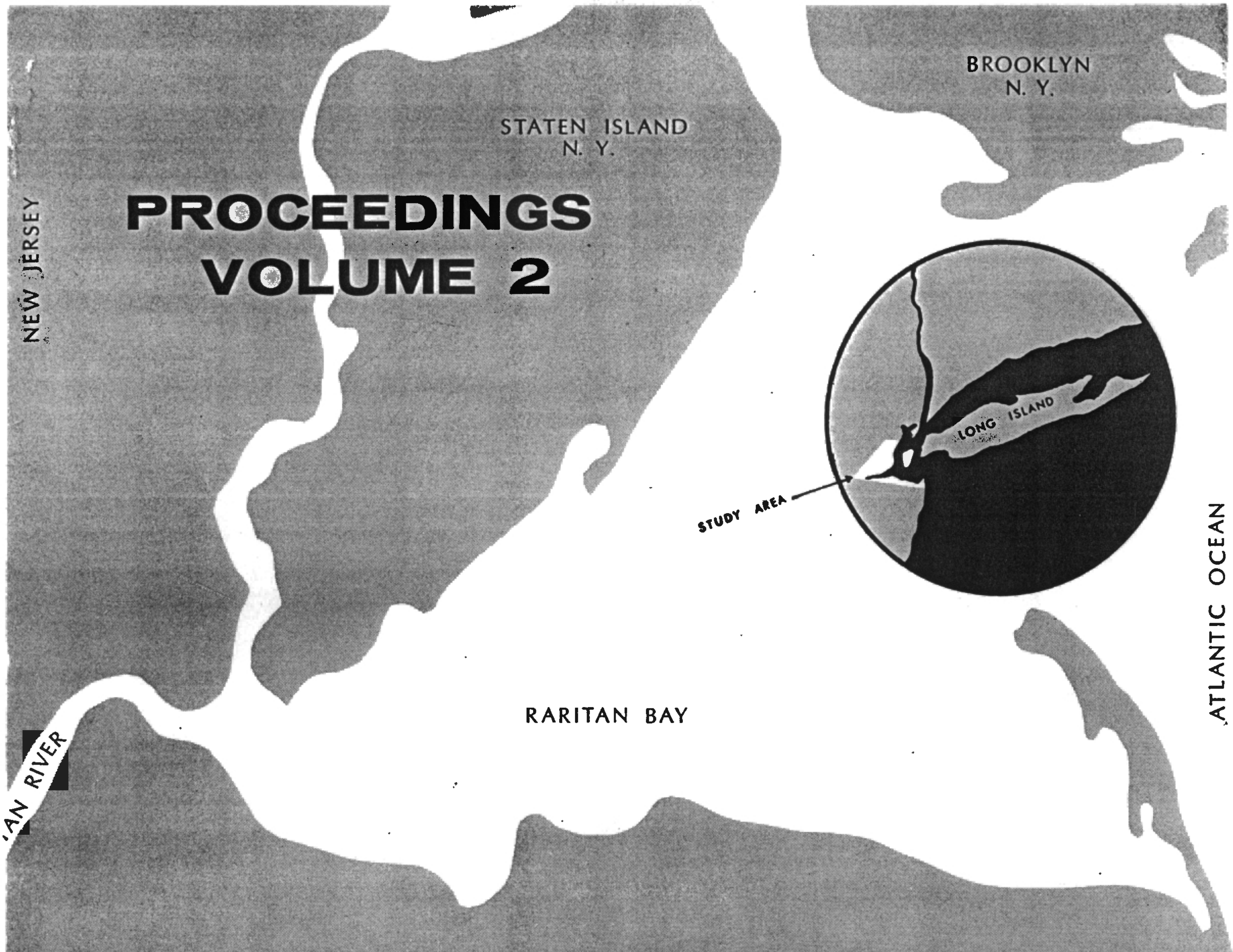
PROCEEDINGS
VOLUME 2



CONFERENCE

Pollution of Raritan Bay and adjacent Interstate Waters

THIRD SESSION
NEW YORK, NEW YORK
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FEDERAL WATER POLLUTION CONTROL ADMINISTRATION • U. S. DEPARTMENT OF THE INTERIOR

16b

WASTE CONTROL

All sanitary and process wastes are discharged to a two-celled lagoon with a detention time of about one week. The blending section (approximately 50,000 gal. capacity) allows for chemical flocculators to be added if necessary. The settling section has a capacity of approximately 560,000 gallons. About once every three years sludge is removed and used for land fill. The lagoon discharges to Woodbridge Creek at a point about 3 miles from the Arthur Kill.

Effluent samples, collected once a week, have the following average results:

pH	- 7
Total solids	- 2800 ppm
Volatile solids	- 250 ppm
Suspended solids	- 40 ppm
Turbidity	- 120 JCU
5-day BOD	- 80 ppm

Analyses of the effluent are sent to the New Jersey State Department of Health on a monthly basis.

General Aniline and Film Corporation, Dyestuff & Chemical Division, Linden, New Jersey

1. Organization:

17b The Linden Plant of the Dyestuff & Chemical Division, General Aniline & Film Corporation, was obtained by the corporation in 1928. The plant occupies approximately 145 acres in southeastern Linden, New Jersey, in an industrial area adjacent to the Arthur Kill. Approximately 1,600 people are employed at this facility.

A map supplied by the company shows the layout of all production and service buildings.

2. Products:

This plant produces a wide range of organic and inorganic chemicals including dyes, pigments, surface active agents and a wide variety of chemical specialities.

3. Raw Materials, Capacity, Operations:

A simplified discussion of the raw materials, processes and finished products can be made by outlining the two continuous plants, each separately, and then the older section of the plant:

Chlor-Alkali Plant

This plant uses ordinary salt water and electricity to produce chlorine, sodium hydroxide, muriatic acid, sodium hypochlorite and hydrogen. The plant has a design capacity of 235 tons of chlorine per day. Allocated to this plant is 12.0% of the fresh water or about 325,000 gpd; and 10.4% of

18b the salt water or about 1.15 mgd. About 45,000 gpd of the fresh water is included in the final products so that the total effluent from this operation is 1.43 mgd. (Water use figures based on 50 ton/day plant - replaced in 1962 with 235 ton/day facility.)

Discharge from the plant is at two points, as shown on the company supplied map. The first stream, which is processed through the waste treatment plant, amounts to about 954,000 gpd. The second stream discharges directly to the final effluent and is about 454,000 gpd of uncontaminated salt cooling water and 22,000 gpd containing about 0.06% chlorine. The plant operates continuously around the clock on a seven-day week.

Ethylene Oxide Plant

Air and ethylene gas are reacted to form ethylene oxide. In a second step, ethylene oxide and water are reacted to make ethylene glycols. The plant has a design capacity of 60 million pounds of ethylene oxide per year, and 35 million pounds of ethylene glycols. This plant uses only fresh water and consumes an average of 15.1% or about 410,000 gpd. About 215,000 gpd is the make-up in the cooling water and in steam losses. This leaves 195,000 gpd discharging to two places as shown on the company supply exhibit. About 193,000 gpd to streams No. 9 and No. 10, and 2,000 gpd to the main discharge system through No. 5. This plant operates continuously, around the clock, on a seven-day week.

Remaining Plant

The remainder of the plant, exclusive of service buildings, is comprised of seven production buildings designed for multi-purpose chemical manufacture. The heart of each of these buildings is a series of reaction vessels known as kettles, which in most cases occupy the entire second floor. The kettles are not interconnected in any fixed fashion, but may be connected in any variety of patterns, depending on the end product or products of a given time. Other areas of each building are devoted to auxiliary equipment required for these reactors, such as, tanks for bulk storage of raw materials and of intermediates, filters and filter presses, mixers, tubs, dryers, grinders and mills, packaging devices, etc. These auxiliaries may be interconnected and cross-connected with the other equipment to establish the desired flow pattern. Decisions as to flow may be determined by equipment availability, equipment capability or capacity, material of construction of equipment, or by product or intermediate to be produced.

Although these seven production areas are similarly laid out in most respects, each area is usually devoted to a given type of product. This assignment is established from a production control point of view or due to the availability of certain specific auxiliaries. As production or sales requirements vary, changes can be and are made with respect to assignments of specific areas.

The list of basically different chemical or physical final products produced in these areas, at any one time, would number about 2,000. Many of these final products are compounded or blended to specific customer requirements, giving a product breakdown of possibly three times that number.

The raw materials used in quantity for these productions number over 500. Some of the major bulk raw materials are:

Raw Material

1. Sulfuric Acid
2. Acetic Acid
3. Nitric Acid
4. Sodium Chloride
5. Aluminum Chloride
6. Sodium Carbonate
7. Sodium Bicarbonate
8. Sodium Sulfate
9. Sodium Hydrosulfide
10. Sodium Acid Sulfite
11. Potassium Hydroxide Flake
12. Sodium Hydroxide Flake
13. Urea

Identification of even these basic raw materials with any specific final products would be impossible since, for example, Sulfuric Acid is handled in 5 different concentrations, supplied to 6 different production areas and is used in the production of more than 300 products.

Most of these final products are evolved through the plant in a step-wise procedure, that is, by producing from two to sixteen "pre-step" products or intermediates before the final product is obtained. These pre-steps are frequently combined with other pre-steps or raw materials, resulting in "families" of related final products known as "trees." Pre-steps, intermediates and final products in this type of chemical work are produced in a series of batches (e.g. 3 batches per day for two weeks) known as "campaigns." The production of a given campaign at a given level or pre-step is drummed and stored until a campaign of the next level of production can be scheduled. In order to provide for a desired final warehouse stock level of a given final product requires, in many cases, planning and initiating production of the first pre-step or level for that product as much as 16 months in advance of requirements. The over-all production of finished goods for a given year as well as the production of important intermediates and pre-steps, known as the "annual production schedule" is determined on the basis of sales anticipation and, also, to maintain a predetermined "minimum inventory standard" (quantity) in the various warehouses. This annual production schedule is updated quarterly and monthly area production requirements are established from this. These requirements are transmitted to the respective production areas and area production schedules are developed. Raw materials are then obtained based on the anticipated production. From here on the scheduling of the actual production is handled on a day-to-day basis depending upon: -

1. Equipment availability (of the required size, capability and material of construction).
2. The immediate urgency for this particular material as compared to others on the production schedule.
3. The availability of pre-step materials for the production.

It may be concluded that it is not possible to maintain a fixed operational schedule but, like managing a baseball team, decisions are made as the immediate situation dictates and in keeping with an overall goal or purpose.

The active processes available at any one time for the production of the pre-steps, intermediates and final products number over 4,000 with probably a thousand more under research or development, awaiting development of sales interest from customers or being revised and improved. Attempts have been made to list the active processes at a given time, break them down for a specific type of information and to correlate this information. These attempts, due to the changes and variables mentioned, have proven fruitless.

Against this background, obtaining significant information with respect to process water requirements, cooling water requirements or effluent evolved by taking the requirements of the individual processes in production at any one time and attempting to arrive at a sum total has proven equally fruitless. The process water requirements for any one process are usually specific, however the time cycles of the processes vary widely, the time cycle of a given process is not fixed and, therefore, the number of batches produced per day or week are not constant. The cooling water requirements vary with the above as well as depend upon the season of the year and the rate of reaction of the process so that no correlation based upon the number of processes in production at a given time may be obtained.

The effluent evolved is the result of the combined variables and, as has been previously stated, the effluent from each building is not segregated but rather combined in a common sump before discharge. This combining of effluents, however, has a particular advantage, in that, although the greater number of processes have an acid effluent, many result in a highly alkaline effluent. The initial combining of effluents provides a long period for mixing and equalization before reaching the waste treatment plant, resulting in a reduction in treatment required and in operational costs.

4. Water Supply:

The Linden plant utilizes both fresh and brackish water for its operations.

Fresh Water

Fresh water is obtained from the Elizabethtown Water Company and enters the plant at two points as shown on the company supplied drawing. The high monthly consumption for 1961 expressed in average gallons per day was 3.1 million gallons and the low 2.21 million gallons. The total consumption for 1961 was 1.01 billion gallons.

Usage of water by the various buildings and areas (with the exception of the ethylene oxide plant which has a separate meter) is determined monthly on an allocation basis. More precise determinations were found to serve no particular purpose. The total allocations by areas for 1961 are shown in the table.

Water Allocations for 1961

Production	Fresh Water	Salt Water
Dyes, Dye Intermediates and Pigments	31.6%	27.3%
Chemical Intermediates and Specialties	10.8	29.6
Surfactants and Chemical Specialties	5.8	18.0
Chemical Specialties and Iron Carbonyl	2.5	5.4
Chlor-Alkali Plant	12.0	10.4
Ethylene Oxide Plant (Metered)	15.1	—
Total	77.8%	90.7%
Service		
Service and Utility Buildings	5.1%	9.3%
Steam and Ice	17.1	--
Total	22.2%	9.3%

Fresh water is used for process water, equipment and area cleaning, cooling, manufacture of steam and ice, laboratories and drinking and sanitary purposes. When the original plant was built no provision was included for the conservation of fresh water. As alterations are made, on all recent and new construction, provisions have been made to recirculate fresh cooling water and to collect and reuse steam condensate. This action is necessarily revolutionary since repiping of old areas of the plant for this purpose, is economically out of the question.

Salt Water

Salt water is obtained from the Arthur Kill. Since most of the water is used for cooling purposes, the consumption is considerably higher during the summer months. The high monthly consumption for 1961 expressed in average gallons per day was 15.15 mg and the low was 8.4 mg. The total annual consumption for 1961 was 4.02 billion gallons.

The salt water usage by the various buildings and areas is determined on an allocation basis similar to that used for fresh water. The total allocations by areas for 1961 are shown in the previous table.

Salt water is used mainly for cooling but also for cleaning, where practical, and for fire protection. As the shift continues toward fresh water recirculating cooling systems, the salt water consumption as well as fresh water consumption should begin to decrease.

WATER POLLUTION ABATEMENT PROGRAM

5. Waste Treatment Facilities

The Linden plant is built on filled marshland and all of the major buildings are constructed on piles. The mean elevation of the plant is approximately 10 feet above mean low tide, such that at high tide brackish water is 3 to 5 feet below ground level. For this reason all utilities, where practical are carried on overhead trestles. Before the advent of plastic sewer pipe, construction and maintenance of an underground sewer system was either impractical or impossible. Thus the discharge from all but the most recent buildings is collected under the buildings in a common sump and conveyed by wooden sheet-piled culverts to a wooden sheet-piled collection trench system. A schematic drawing of the culverts and the trench system is shown on a company supplied drawing.

Streams or discharges which are not presently connected to the system have been intentionally diverted, since they are not considered contaminated, and also to reduce the total load on the waste treatment facilities.

For more than 12 years, the effluent from the Linden plant has been treated to neutralize the general acid condition of the waste, to skim any oils or other floating materials discharged, and to settle solids. This treatment was revised and improved continually to meet increased requirements and restrictions and to compensate for changes in effluent quality. The expanded Chlor-Alkali plant made necessary the relocation of these treatment facilities. Since it was generally agreed that the old facilities were operating at the limit of their capabilities, the management of the corporation decided to include in the relocation adequate provision for treatment under the current regulations and restrictions, as well as to provide excess capacity and room for expansion.

Construction of the new waste treatment plant was started in the spring of 1961 and completed during March of 1962. Following the usual minor start-up problems the plant was fully onstream by June 1, 1962.

The plant, which provides equalization, solids settling, oil and floating material skimming and neutralization reflects an expenditure of about $500,000, including the new outfall. Operating expenses are estimated at about $200,000 per year with an additional $20,000-$30,000 spent each year for research and development work. Drawings supplied by the company show a plot plan and a flow sheet of the treatment facility. The capacities indicated in the drawing were obtained from the mean and maximum water throughput of the Linden plant. The neutralization plant is designed to handle the maximum throughput under the most acid condition anticipated and automatically control the outfall pH to 5.0.

Since there is no retention of water in the manufacturing plant for more than a few minutes, or at the most a few hours, the total effluent is considered to be the total water consumption less 5-10 percent due to evaporation and steam losses, plus surface drainage during rains. By this reasoning, the maximum average daily effluent for a month is estimated to be about 17 to 18 mgd. Separate studies made in the past indicate that the mean daily requirement during the summer months was 18 mg and the maximum daily consumption was 26.3 mg.

The above discussion of the operations at this facility is a summation of a more detailed report sent to Federal Water Pollution Control Administration by the General Aniline & Film Corporation. Included in this report are detailed drawings showing layout of the plant facilities and the waste treatment facilities. Also included, are test results of the effluent collected both by the New Jersey State Health Department and by the company.

Armour Agricultural Chemical Company

Carteret, New Jersey

1. Organization:

This plant of Armour Agricultural Chemical Company, occupying approximately 7.5 acres, is located on the eastern edge of Carteret, New Jersey. The facility, which began operation in 1909, employs approximately 45 to 150 people, depending upon the season of the year. The company's corporate office is located in Atlanta, Georgia. The parent company is Armour & Company, Chicago.

2. Products:

This plant of Armour Agricultural Chemical Company produces over 50 different types of commercial and specialty fertilizers. Approximately 80 percent of its output is for commercial purposes. The only other product is superphosphate (quantity not used internally for production is sold).

3. Raw Materials:

Raw materials used include:

Phosphate rock - 20,000 tons per year;

Potash - 4,000 tons per year;

Ammonium sulfate - 2,500 tons per year;

Triple superphosphate - 2,000 tons per year;

Limestone - 2,400 tons per year;

Sulfuric acid;

Liquid nitrogen;

Magnesium sulfate;

Potassium chloride.

All raw materials are delivered by tank truck or by barge. The limestone, phosphate rock and triple superphosphate are delivered approximately four times per year by barge.

4. Capacity:

This facility has the capacity for producing 44,000 tons per year of fertilizer and 20,000 tons per year of superphosphate. Fifteen years ago production was almost double the above mentioned values. The reasons for the decrease are geographical location of the plant, and changes in fertilizer utilization.

5. Operations:

Essentially, the bulk of the operations at this facility consist of blending various quantities of nitrogen, phosphorus and potash to form desired fertilizers. This batch operation, having a cycle time of approximately three minutes, produces 1.25 tons of fertilizer, which is stored until such time as bagging is desired.

The only other operation at this plant is the manufacture of superphosphate, which is used internally and also sold. This process involves unloading PO_4 rock from a barge; grinding it to a dust; and mixing it with H_2SO_4 to give superphosphate.

Operations at this plant, because of the nature of the use of fertilizers, is highly seasonal. During March through May the work force triples. The normal operating day is 16 hours; however, during the winter months this goes down to eight hours. This plant operates on a five-day-per-week basis.

Prior to November 1965, this plant also produced sulfuric acid. This operation has been completely discontinued and it is almost certain that the manufacturing facilities will be dismantled within the next few months.

6. Water Supply:

Two sources of water supply are available, namely, the Arthur Kill and the municipal system from the Middlesex Water Company. Fresh water, consumed at a rate of 12,000 cubic feet per month or 3,000 gpd, is used for drinking and sanitary purposes; air-conditioning; and in a scrubber system in the superphosphate department. When the sulfuric acid plant was in operation, total fresh water consumption was equal to approximately 3.4 million gallons per year, or 9,300 gpd.

Salt water from the Arthur Kill can be used at the rate of 110,000 gpd. This water, which was used for cooling in the sulfuric acid operations, is presently on a standby basis.

7. Sewage:

During the past year the company has conducted dye tests and examined several drawings to determine how their sanitary wastes are handled. As of this date, no knowledge exists on this subject. The only thing known for sure, however, is that it does not connect to the city sewer system.

8. Principal Processes:

The principal processes at this plant are blending.

9. Waste Treatment Sources:

When the acid manufacturing facility was in operation, effluent, which included cooling and process water, was discharged to the Arthur Kill through a small tributary stream. An analysis of this discharge, performed routinely by the company, is given in the table.

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EFFLUENT ANALYSIS FOR H_2SO_4 PLANT

	Plant Shut Down Kill Pump Operating 10/26/65		Plant Operation Kill Pump Running 11/31/65		11/19/65	
	IN	OUT	IN	OUT	IN	OUT
Suspended Solids	18	36	7	11	46.0	5.0
pH	6.6	2.2	6.6	2.5	6.3	2.7
Temp °F	62	60	44	40		
Total N mg/l	4.4	10.5	3.9	9.7	3.1	7.8
Nitrite N mg/l		1.2	0.6	1.3	0.0	0.7
Nitrate N mg/l	0.8	0.2	1.5	0.6	0.8	0.2
Free N mg/l	4.4	9.3	3.5	8.4	3.1	7.0
Total P205 mg/l	3.0	20.0	3.2	24.0	2.8	34.0
COD mg/l	144.0	152.0	72.0	160.0	160.0	192.0

Reportedly, the area near the sulfuric acid plant and Arthur Kill once contained nitric acid manufacturing facilities. It is claimed by company officials that the low pH shown in the October 26, 1965, analysis is due to leaching from the surrounding areas. No samples of this effluent have ever been taken by the State Health Department or the Interstate Sanitation Commission.

With the shutting down of the sulfuric acid plant it appears that the major source of pollution from this installation has been eliminated. The only other waste being discharged by this facility, and this is going to a lime-lined lagoon area and not directly to the Kill, is water used for scrubbing in the superphosphate department. This diked lagoon is susceptible to tidal flooding and, therefore, is a potential source of pollution.

Another potential source of pollution is runoff from the plant property. The production areas and buildings are heavily coated with dust, and, therefore, during rain periods runoff would be discharged to the Arthur Kill.

Sinclair-Koppers Company, Inc.
Port Reading, New Jersey

1. Organization:

The Sinclair-Koppers Company, Inc., Port Reading, Plant is located in Port Reading, New Jersey, approximately 1/2 mile inland of the Arthur Kill.

The plant was constructed in 1958 and began operations early in 1959. Employment is approximately 200 persons.

This plant was formerly known as Koppers Company, Inc., Plastics Division Plant. The name was changed to Sinclair-Koppers Company, Inc., early in 1965. Home office for the plant remains at the Koppers Building in Pittsburgh, Pennsylvania.

2. Products:

This plant produces one product, high density polyethylene. The final product is in the form of 1/8" diameter pellets.

3. Raw Materials:

The raw material for this plant is ethylene, which is delivered by pipeline from the Humble Oil Company, Bayway Refinery. Additional materials used in the processes are catalysts and carrier hydrocarbons.

4. Capacity:

The plant has been rated at 30 million pounds per year of product by several published magazines in the field.

5. Operations:

The Port Reading Plant of Sinclair-Koppers Company, Inc., produces high density of polyethylene by the Ziegler process. According to extracts from the patents, the process is essentially as follows: The catalyst is $TiCl_4$ in the presence of aluminum triordiakls. Along with ethylene gas, alcohol is fed to the reactor in order to terminate the polymer. Aliphatic hydrocarbons, such as hexane, kerosene, isooctane, or cyclohexane, may be used as the reaction medium. A slurry of 20-30 percent polymer is produced in the reactor. The polymer is separated by centrifuging and extraction of the cake with C_4 or higher alcohols. The polymer is recovered from the solvent and dried to produce a fluffy polymer which is formed into small cubes. The waste process water from this plant has been in contact with the solvent alcohol.

The plant operates on a 24-hour-per-day, 7-day-per-week basis.

6. Water Supply:

All water used is purchased from the Middlesex

Water Company. A 1962 survey indicated consumption as 530,000 gpd. Since that time some reduction has occurred and plant consumption now is 450,000 gpd. Of this approximately 75,000 gpd is used in the process itself. Process water in 1962 was reported to be 100,000 gpd. The majority of water use is for cooling tower purposes. A normal high volume water user, the steam distillation process, is not utilized in this plant's adaption of the Ziegler process.

7. Sewerage:

Sanitary wastes flow to a septic tank 16' long by 8' wide by 10' deep. Septic tank effluent is discharged to a ditch which flows to the Arthur Kill.

Process water flows to a main sump consisting of two bays 24' long, 6' wide and 5' water depth. From the sump the water is pumped to the same ditch utilized for the septic tank effluent. The point of discharge of process water in the ditch is approximately 1/2 mile from the Arthur Kill. Additional waste water emanates from the cooling tower blow-down which discharges into the septic tank outfall. Plant storage tanks are diked so as to prevent discharge of material in the event of spills.

8. Solid Wastes Disposal:

All solid waste is removed by truck.

WASTES CHARACTERISTICS

The waste sources from an operation such as that of the Sinclair-Koppers Company, Port Reading Plant, can be divided into three categories: the sanitary wastes; contaminants in waste process water; and additives utilized in the cooling towers which may be discharged in the cooling tower blow-down water. The untreated process water from the Ziegler process would be expected to contain alcohol as well as traces of catalyst residue. The untreated cooling tower blow-down water will include those chemicals added for slime control and other required treatment for satisfactory coolant operations.

9. Water Sources and Treatment:

Alcohol is recovered from the process water as an in-plant process. Used process water is conducted to a sump described previously. The sump has a baffled inlet and outlet with discharge occurring by flow under the outlet baffle so as to skim off any hydrocarbons. The effluent pH is checked two times per shift. Caustic neturalization is used to maintain pH 6 to 8. A heavy mat of hydrocarbon with the appearance of wax forms on the surface of the sump and is removed by hand once or twice per year. The outlet end of the sump discharges to a wet well with a float actuated pump discharge.

Visual observation of the sump effluent indicates a relatively turbid material with high suspended solids. According to Mr. Tallon this is mainly aluminum hydroxide. Water in the cooling tower system is treated with chrome for slime control. In addition, an annual application of a proprietary chemical from Dearborn Chemical is applied to the tower. No treatment is provided the discharge of blow-down water from the tower.

10. Analytical Results:

Limited analyses are available of the waste water from this plant. On May 8, 1962, the Interstate Sanitation Commission performed analysis of a grab sample at the sump with the following results:

BOD	80 mg/l
Settleable Solids	422 mg/l
Total Suspended Solids	518 mg/l

On July 24, 1962, the Koppers Company performed several analyses with results as follows:

Composite Sample at Sump

BOD	670 mg/l
Settleable Solids	413 mg/l
Total Suspended Solids	442 mg/l
COD	995 mg/l
pH	9.7 mg/l

Composite at mouth of ditch with outgoing tide

BOD	60 mg/l
Settleable Solids	64 mg/l
Suspended Solids	82 mg/l
pH	9.0 mg/l

Grab sample at mouth of ditch at low tide

BOD	80 mg/l
Settleable Solids	68 mg/l
Suspended Solids	76 mg/l
COD	40 mg/l
pH	7.6 mg/l

As noted previously, water consumption at the time of the above analyses amounted to 530,000 gpd. The sump discharge volume was estimated as 1/5 of this total, or

100,000 gpd.

WATER POLLUTION ABATEMENT PROGRAM

The Sinclair-Koppers Company has a continuing effort in waste control and water pollution abatement. The company has engaged the local firm of Goodman, Alger & Scott to prepare cost estimates for connection of the septic tank and process water discharge to the Woodbridge Sewer System for treatment by the municipality.

Union Carbide Corporation, Plastics Division
Bound Brook, New Jersey

1. Organization:

The Plastics Division of Union Carbide Corporation is located on the northern edge of Bound Brook, New Jersey, along the Raritan River. The facility, which employs approximately 2,700 to 2,800 employees, covers an area of 150 acres.

The Bound Brook location is the Division's main office for manufacturing, research, development, general engineering, accounting, electronic data processing, and distribution. The Fibers and Fabrics Division, also located at Bound Brook, is operated by the Plastics Division.

2. Products:

This facility produces over 500 distinct synthetic resins and plastics; however, they can be grouped into four major categories:

Phenolic resins;

Polystyrene;

Polyethylene;

Vinyls.

Chemicals, such as formaldehyde, are manufactured at this location for use within the plant. Approximately one-half to two-thirds of the product line is made to order; the remainder is "stock" business.

3. Raw Materials:

Major raw materials used include:

*Phenol;

Styrene;

Resins - vinyl, polyethylene;

Solvents - alcohols, toluene (type purchased depends on end product).

*Phenol will be produced at this plant within the next 8 months. This will not increase plant capacity, but rather eliminate the purchasing of the raw material - phenol. The Cumene Process is to be used. (Allied Chemical patent).

4. Capacity:

This plant of Union Carbide has a total capacity of 350 to 400 million lbs. per year. Exact capacities on individual products are not available.

5. Operations:

Essentially there are four separate operations at this plant.

Phenolic resins - condensation reaction; batch operation. Formaldehyde-produced by reaction of methanol and air - plus phenolic compound yields desired phenolic resin. Ratio of raw products determines type of resin produced.

Polystyrene - polymerization reaction; continuous operation.

Vinyl & Polyethylene - physical combination; batch operation.

The facility operates 24 hours per day, 7 days per week, 52 weeks per year. There is no noticeable seasonal fluctuation in operation.

6. Water Supply:

Three sources of water supply are available,

Paul DeFalco

namely, Elizabethtown Water Company, private wells, and Delaware and Raritan Canal.

Elizabethtown - approximately one million cu. ft. per month, or 249,000 gpd, is purchased from the municipal system. This water is used for potable and sanitary needs, and for special processing where a high quality water is needed.

Private wells - used only in summer -- May through September -- on a once-through basis for jacketed cooling. Eleven wells -- average depth 300 feet -- on property; however, only using six. Temperature of water 68°F reduces refrigeration needs. Well yield is 400,000 gpd. Extremely hard -- 30 grains -- water.

Jacketed cooling water is used mostly in the phenolic and polystyrene sections. It is used in other areas for blenders, and compounding equipment. After use -- once through -- water discharged directly through storm sewer to Raritan River.

Delaware & Raritan Canal - average withdrawal - 1.3 mgd; maximum -- 1.8 mgd. Used for general plant use -- boiler feed, cooling tower makeup.

Prior to use, water is chlorinated and settled.

7. Cooling Water:

Three cooling water systems, supplied by the Delaware & Raritan Canal, serve the facility:

System B - phenolic, styrene:	12,000 gpm;
System C - vinyl, polyethylene:	11,000 gpm;
System D - research, development:	9,000 gpm.

Makeup water to these systems is approximately 5 percent.

8. Sewerage:

All wastes, industrial, domestic and roof drainage, in the wet processing areas -- phenolic production -- go to the Middlesex County Sewerage Authority. All sanitary wastes in the dry processing areas also go to MCSA. Roof drainage and runoff in these areas go to the storm sewers. MCSA receives daily approximately 800,000 gallons from the Union Carbide complex.

There are presently three storm sewers -- conveying cooling and runoff waters -- discharging to the Raritan River. Average flow figures, as supplied by Union Carbide, are given below:

Sewer	Flow-gpd
North	100,000
Center	350,000
South	350,000

9. Analytical Data:

The three storm sewers discharging to the Raritan River are sampled routinely by both the company and MCSA. Results of these samplings are shown in the tables which follow:

Union Carbide - Sample period 1/12/65 - 2/8/66

Parameter		Sewer	
	North	Central	South
BOD (mg/l) Max	685	240	90
Min	2	3	2
Avg	50	51	14
No. Samples	21	22	22
Phenol (mg/l) Max	0.71	36.2	38.4
Min	0.01	0.05	0.01
Avg	0.2	4.9	2.8
No Samples	9	22	22

MCSA - BOD, COD sampled 1/4/66; phenol samples June 1965.

Sewer	Flow mgd	BOD mg/l	COD mg/l	phenol mg/l
North	.04	11.9	50	0.02
South	.09	25.8	400	0.04
Center	.490	20.7	58	0.13

National Lead Company, Titanium Division
South Amboy, New Jersey

1. Organization:

The National Lead Company's Titanium Division occupies approximately 580 acres in the Borough of Sayreville, New Jersey. The facility is located on the south shore of the Raritan River just above the Garden State Parkway Bridge. There are over 1,900 employees engaged at this location in production, maintenance, process control, engineering and research.

2. Products:

Titanium dioxide -- an inert non-toxic white pigment -- in some 33 different grades is the principal product of this plant. This pigment is used by paint, paper, plastic, ceramic and drug industries.

3. Raw Materials:

Titanium dioxide is manufactured from Ilmenite ore which is received by rail or deep water vessel.

4. Capacity:

The capacity of this facility is considered confidential.

5. Operations:

Ilmenite ore is received in sandlike consistency containing 40 to 60 percent titanium and the balance is largely iron with silica and some traces of various elements. The ore is reacted in concentrated sulfuric acid. The iron-titanium sulfate solution is clarified to remove inert materials which are collected for disposal at sea via barge.

The clarified solution is crystallized and filtered to remove most of the iron as ferrous sulfate. The ferrous sulfate or copperas is either sold in dry or wet state or repulped with spent acid for disposal at sea via barge.

The clarified titanium sulfate solution is hydrolyzed. The resultant white titanium hydrate is washed to remove the spent acid. This acid is disposed of at sea via barge. The titanium hydrate is then calcined and milled to develop final properties as required for the various grades of titanium dioxide.

6. Water Supply:

Two sources of water are available; namely, the Raritan River and the Duhurnal supply -- industry operated (National Lead, Dupont, Hercules). Approximately 50 mgd of water are required for the chemical processing of raw ore into pigment -- 44 mgd from the river and 6 mgd from the fresh water source.

7. Sewerage:

All sanitary wastes from this installation either go directly to the Middlesex County Sewerage Authority or to septic tank systems on the plant property.

8. Principal Processes:

The principal unit processes used for the manufacture of titanium dioxide pigment are clarification, filtration; crystallization, settling, conditioning, roller and hammer milling and drying. A flow diagram showing the inter-relationship of these processes has been supplied by the company.

9. <u>Waste Treatment</u>:

The initial plant installation at South Amboy, N. J., included a system for recovery of spent acid and iron sulfate. This system was unable to economically provide the degree of control needed to meet increasing standards for stream quality. A study of alternate methods developed a proposal for barging the wastes to sea for disposal. After several years of investigation into the effects of such disposal an application was filed through regulatory agencies and approval was granted for disposal at sea. This method was put into operation in 1948 and is still the primary means of waste disposal for the company.

Since 1948, a program has been in effect to improve waste control procedures at the plant and to keep these wastes out of the effluents going to the river. These efforts have required:

1. Construction of a series of settling basins for clarification of one effluent stream.

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2. Collection of certain waste streams and neutralization before transmission to the Middlesex County Sewerage Authority for disposal.

3. Monitoring of effluent streams -- pH only -- to the river to provide for further refinement in the control of plant wastes.

Most of the water obtained from the Raritan River and used for processing is returned to the river. Liquid wastes from the plant operations are segregated from this stream, and depending upon their characteristics, are either handled by facilities of the Middlesex County Sewerage Authority, the company's barge disposal system, or the company's sedimentation facilities.

Wastes which are not recovered are discharged to the Raritan River. These wastes are the result of leaks or spills occasioned by malfunction of equipment and failure of controls.

The company has not undertaken steps to measure the exact quantities of waste materials discharged in the plant effluent, as it would require expensive sampling and flow measurement. National Lead feels that such a program is not warranted considering the nature and quantity of emissions.

Company supplied data indicate that the discharge of waste materials amounts to approximately 5,000 pounds of sulfuric acid and 3,000 pounds of iron sulfate on an annual daily average.

WATER POLLUTION ABATEMENT PROGRAM

Capital expenditures to date for control of emissions to the Raritan River exceed $7.75 million. Current direct operating costs are $1.4 million annually. Approximately $100,000 is spent each year for control measurement, and engineering studies for further improvements.

American Cyanamid Company

Bound Brook, N. J

1. Organization:

The Bound Brook plant, located in Bridgewater Township, is presently the second largest of Cyanamid's 103 United States and foreign manufacturing facilities. As headquarters of the company's Organic Chemicals Division, the location is the administrative, research and sales center for eight plants and four commercial departments.

In the fall of 1915 the firm, then known as the Calco Chemical Company, began producing aniline and beta naphthol in three small buildings on an 18-acre site in Bridgewater, adjoining Bound Brook. This small aniline facility was one of the first in the country. As the plant grew, its products multiplied. By 1920, spurred on by successful research, and wartime demand, its products had increased from the original two to some 50 dyes and intermediates.

In early 1929, the plant was manufacturing more than 400 different chemical compounds, which included a full line of dyes, a host of intermediates, rubber processing chemicals and a variety of pharmaceuticals. By 1940 the number of products had increased to 500, and 2,500 people were at work in the plant's operations.

When war came in the early '40s every resource was quickly committed to the needs of the military. Output soared to new levels in all product lines, employment climbed to the all time peak of 4,500 and the Bound Brook facility became the world's largest make of life-saving sulfa drugs.

The present complex, located on 575 acres along the north bank of the Raritan River, employs approximately 3,000 people. Manufacturing operations are carried out in 150 buildings on a site of 150 acres.

2. Products:

Product lines consist essentially of the following:

Dyes

Rubber Chemicals

Elastomers

Textile Chemicals

Intermediates

Pigments

Pharmaceuticals

3. Raw Materials:

Information on this subject is considered confidential by the company.

4. Capacity - Operations:

Company officials consider information on these subjects confidential.

5. Processes:

Approximately 800 different processes are in use at this plant. Information on individual systems is considered confidential.

6. Water Supply:

Four sources of water, namely, Raritan River, Company owned wells, the Somerville and Bound Brook Water companies are available.

Raritan River Water

Approximately 22.5 mgd of Raritan River water is presently diverted for use within the plant. Actual water needs for current operations at Bound Brook approach 55 mgd. The additional 32 mgd is obtained by recirculating water in towers and ponds.

Water which is diverted from the river goes into a concrete lined flume through a screen which removes floating debris, and then into a chamber in which the suction pipes from four 10" centrifugal pumps are located. The water pumped is discharged into a single 24" pipe and chlorine is added to prevent algae and slime from building up in the pipe. The 24" pipe runs a distance of 1,400 feet into the plant water distribution system.

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Part of the water is treated further since the water coming from the river cannot be used "as is" The multi-step treatment includes addition of alum to coagulate solids which are allowed to settle out in one of two large ponds; it received further chlorination, then passes through sand filters and then through a water softening material such as zeolite. The treated water is used for the steam boilers to produce steam for plant use and for direct use in chemical processes, sanitary facilities, laundry, and ice making. The remainder of the water is used directly for cooling, scrubbing of vapors to prevent air pollution, etc.

All of the water mentioned, after use and re-use, goes to the waste treatment plant.

Well and municipal water

Approximately 2.0 mgd of deep well and municipally supplied water are used at the Bound Brook complex. Somerville and Bound Brook water is used essentially for drinking purposes.

7. Sewerage:

All sanitary wastes are handled by the company's waste treatment facilities.

POLLUTION ABATEMENT PROGRAM

8. Wastes Treatment:

American Cyanamid began working on its industrial waste problem about 30 years ago in cooperation with the Raritan Valley restoration program of the State Department of Health. In 1940, after careful and successful investigations for development of a suitable treatment process, Cyanamid constructed a $500,000 treatment plant comprising a large lagoon and neutralization system. This system furnished treatment consisting of equalization, neutralization and solids sedimentation. These units have been in service since that time and have been incorporated as the primary treatment portion of the present expanded waste treatment facility.

This early treatment plant was effective in correcting those features of the raw wastes which it was designed to control. In 1949 the company began fundamental investigations of biological methods of waste treatment. In 1950 the State Department of Health issued new and more stringent requirements for waters discharged into the Raritan River.

After nearly a ten-year chemical, biological and engineering project, carried out jointly with consultants and the New Jersey State Department of Health, and an expenditure of over $1,000,000, a reliable activated sludge waste treatment process was developed and approved by the State Department of Health.

Ground was broken for the new facility in March 1957, and the plant was put into operation in May of 1958. The plant cost $4,500,000 and has an annual operating cost of nearly $1,000,000.

The treated used water is returned to the Raritan River at a point about 140' downstream from the raw water pumping station in a quantity equal to, or greater than the intake volume of 22.5 mgd. Approximately 2 mgd of used city water and deep well water, treated at the company's plant, is included in this total discharge.

9. Treatment Plant Operation:

A sump and pumping station deliver all plant wastes to a lagoon. In this basin settleable materials are removed from the waste; however, the main function of the unit is to provide equalization of acid discharges prior to neutralization with lime.

After neutralization, wastes flow through a 60 mg lagoon, which serves a dual treatment function. Materials precipitated from the wastes during neutralization are removed by settling in this basin. In addition, the various colors in the influent intermix. Solids which have accumulated in the basin are periodically removed by dredging. This treatment plant has been operated continuously since 1940.

Flow is transmitted from the 60 mg lagoon through a 48-inch pipeline to a 36-mgd pumping station, which is located in the pipe gallery under the main building. Wastes are then pumped into six aeration tanks which may be operated in several flow patterns. These tanks provide an average detention period which is from three to six times the aeration period normally provided for treatment of municipal sewage.

Six 8--foot diameter sedimentation basins have been provided for removal of the biological sludge, which is returned to the aeration tanks for treatment of the incoming wastes. Effluent is discharged into a small brook leading to the Raritan River. Wastes can be chlorinated in accordance with the requirements of the New Jersey State Department of Health.

Operation of the Bound Brook treatment facility is unique, in as much as it is also designed to provide secondary treatment for up to 5.0 mgd of municipal wastes from the Somerset-Raritan Valley Sewerage Authority. The Authority, serving 45,000 people in Bridgewater, Somerville and Raritan, is presently discharging approximately 3.0 mgd into the American Cyanamid system.

10. Analytical Data:

Two tables - "Raritan River Data" and "Pounds BOD Discharged from Wastes Treatment Plant" -- have been provided by the company.

RARITAN RIVER DATA

1964	River Flows - MGD Daily Average	Dissolved Oxygen* Daily Average Above ACCO Dam	Dissolved Oxygen* Daily Average Queens Bridge
January	1341	14.1	13.5
February	694	13.3	12.7
March	856	12.6	12.0
April	1302	11.0	10.4
May	620	8.3	7.5
June	203	6.8	5.2
July	263	5.8	5.5
August	72	6.1	4.4
September	70	5.3	3.1
October	128	8.5	7.1
November	108	9.1	7.2
December	502	12.7	12.1

* Based on single daily grab sample taken at approximately 8:00 a.m.

RARITAN RIVER DATA (Cont's)

1965	River Flows - MGD Daily Average	Dissolved Oxygen* Daily Average Above ACCO Dam	Dissolved Oxygen* Daily Average Queens Bridge
January	426	13.8	13.0
February	1045	13.3	12.8
March	785	12.3	11.7
April	592	11.0	10.0
May	246	6.8	5.4
June	89	5.4	2.6
July	83	4.7	3.8
August	101	5.7	4.0
September	111	6.0	4.2
October	133	7.6	6.3
November	113	9.2	7.7
December	149	11.7	10.3

*Based on a single daily grab sample taken at approximately 8:00 a.m.

POUNDS BOD DISCHARGED FROM WASTE TREATMENT PLANT

Month	Daily Average 1964	Daily Average 1965
January	9,200	14,900
February	13,700	18,500
March	23,000	28,000
April	26,100	17,500
May	20,500	15,600
June	24,100	17,800
July	5,900	3,600
August	8,200	6,400
September	8,500	7,500
October	8,700	11,100
November	8,900	10,700
December	8,400	7,600

The great reduction in BOD load to the river during the summer months, is claimed by company officials, to be due essentially to higher wastes temperatures -- organisms more active, therefore, greater removals -- and to changes in production.

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Hatco Chemical Division, W. R. Grace & Co.

Fords, New Jersey

1. Organization:

The Hatco Chemical Division of W. R. Grace Company, is located on the western shore of the Raritan River, approximately one mile upstream from the Victory Bridge. The facility, located on 90 acres in Woodbridge Township, employs approximately 275 people.

2. Products:

This plant produces essentially two products: Plasticizers and Phthalic Anhydride. The major plasticizer produced is Dioctylphthalate which accounts for more than 50 percent of the production.

3. Raw Materials:

Raw materials include napthalene, which is used in the anhydride process, and organic alcohols, used in plasticizer production. These raw materials are brought in by tank trucks.

4. Capacity:

This plant has the capacity to produce approximately 44 million pounds per year of Phthalic Anhydride.

Plasticizer production capacity is confidential.

5. Operations:

This plant is operated on a seven day per week, 24 hour per day basis. Approximately eighty percent of the employees work on a shift basis. The remaining twenty percent are mainly administrative or maintenance people, working only during the normal eight hour day time shift.

The two principal operations in this plant are as follows:

Phthalic Anhydride

Produced by the reaction of napthalene with air at high temperature. There are no waste products from this continuous operation, and therefore, the amount of production is equal to the quantity of raw material - napthalene - used.

Plasticizers

Most of the Phthalic Anhydride manufactured is used internally for the production of plasticizers. An organic alcohol is combined with the anhydride to form the product. The type of plasticizer produced depends upon the type of organic alcohol used, and as a result, a large variety of alcohols are used.

6. Water Supply:

Approximately 2.5 million cubic feet per month of water, or 625,000 gallons per day, is purchased from the Middlesex Water Company. No other sources of water are available.

7. Sewerage:

Sanitary wastes from the production facilities are presently handled by seven septic tanks and leaching fields. Sanitary discharges from the executive offices, located in Fords, N. J., are connected to the Municipal sewer system.

8. Industrial Wastes:

On October 15, 1965, Hatco signed an agreement with the Middlesex County Sewerage Authority to discharge all their industrial wastes, with the exception of cooling water, to the Authority. The contributary flow to MCSA is estimated to be 200,000 gpd.

Legal problems, regarding acquisition of right-of ways, has delayed construction of a sewer line, pre-treatment facilities, and sampling and metering facilities. It is expected, however, that the connection to the MCSA will be completed no later than January 1, 1967. This date will most likely be met, as Hatco is paying the Authority $5,500 per quarter, for interest and amortization. To date, approximately 50 percent of the construction program has been completed.

Tenneco Chemicals, Inc., Heyden Division
Fords, New Jersey

1. Organization:

Heyden Chemical was a division of the Heyden-Newport Chemical Corporation until 1963 when the company was acquired by Tennessee Gas Transmission. Tenneco maintains executive and operating offices in New York City.

Heyden Chemical, located on 242 acres in Fords, N. J., is presently operated as a division of the parent company. Present plans call for expanding certain facilities and adding new processes sometime during 1966-67.

2. Products:

Organic intermediate chemicals comprising over 200 final products.

Major products include:

Strobane - (chlorinated terpene -- boll weevil control)

Hexamethylene tetramine - used in resins and explosives

Pentaerythritol - used in paint

Maleic anhydride - used in resins

Pthalic anhydride - used in plasticizer (Production stopped 2/65)

Chlorotoluene - used in herbicides and drugs

Benzaldehyde - essential oils, flavorings and insecticides

Hydrochloric acid

Formaldehyde

Benzotrifluoride -- soaps and control of lamprey eel

(A company supplied list gives a further breakdown of products)

3. <u>Raw Materials</u>:

Methanol

Ammonia

Formaldehyde

Acetaldehyde

Caustics

Benzene

Orthozylene

Chlorine

Toluene

Terpenes

Hydrogen fluoride

4. Capacity:

Capacity of the facility is considered confidential.

5. Operations:

Production operations at this plant are essentially continuous. The only major batch operation is in the production of terpene derivitives.

Approximately 400 people are employed by this plant, which operates 24 hours per day, 7 days per week, 365 days per year. Fifty percent of the staff works on a shift basis.

6. Water Supply:

Two sources of water are available, namely, Middlesex Water Company and a pond (west lagoon), located on plant property, which receive land drainage.

Average monthly plant city water usage is in the area of 56,000,000 gallons/month. Distribution and usage of this water is as follows:

a. Sold in products - 250,000 gallons/month.

b. Cooling tower evaporation - 9,000,000 gallons/month.

c. Process Waste and Sewage - 24,000,000 gallons/month.

d. Ground Drainage - Non returned steam condensate - 8,300,000 gallons/month.

e. Cooling water returned to ponds with pond water - 13,500,000 gallons/month.

f. Exhaust steam -- 1,000,000 gallons/month.

Total --- 54,000,000 gallons/month.

The pond cooling water pumping rate from the West lagoon, the source of surface cooling water, is 2,000 gallons per minute.

The Fords installation presently has in operation four cooling towers whose effluent (overflow) is being discharged to MCSA. Water evaporation rates calculated from heat loads indicates an average of 210 gallons per minute evaporation rate for the four units.

7. Sewerage:

The plant presently has in use ten septic tanks, eight of which are tied into MCSA and two of which discharge into drain fields.

8. <u>Processes</u>:

With more than 200 products from the plant, there are many individual processes that are used. They could best be classified as oxidation processes as in the air oxidation of benzene to produce maleic anhydride.

<u>WASTE SOURCES</u>

a. Hexamethylenetetramine - no process waste water, only cooling water which goes to West Pond.

b. Pentaerythritol - process water to Middlesex County Sewerage Authority. Cooling water goes to West Pond.

c. Maleic anhydride - process water recirculated through cooling tower. Any waste discharged goes to MCSA.

d. Phthalic anhydride - same as c. (no longer in operation)

e. Chlorotoluene - chemical wastes go to MCSA and cooling waters go to West Pond.

f. Benzaldehyde - same as above. (e)

g. Strobane - no process waste and cooling water goes to West Pond.

h. Hydrochloric acid - any process waste goes to MCSA.

i. Formaldehyde - water kept in the product with no cooling water discharged.

j. Two cooling towers overflow at times into the West Pond.

k. Barometric condensers - cooling in this manner most likely produces a carry-over of the product into the cooling water.

POLLUTION ABATEMENT PROGRAM

Approximately 0.8 mgd of process wastes are discharged to the Middlesex County Sewerage Authority. Based on water use information, 0.7 mgd is discharged to the Raritan River as cooling water. Flow studies conducted by MCSA, however, indicate this flow averages approximately 1.0 to 1.5 mgd. Tests conducted by MCSA and the Raritan Bay Project indicate that this "cooling water" is carrying a heavy pollutional load. (BOD: 60-2 -- ppm; COD: 120 ppm; phosphate: 1.0 ppm)

Investigations undertaken by the company in 1965 indicate that the flow averages 0.82 mgd; BOD 61-65 mg/1;

pH 6.5-7.5; and phosphates .002-0.005 mg/l.

It would appear, based on the above information, that all wastewaters are not being discharged to MCSA. Elimination of the barometric condensers, which is being planned in the hexamethylene tetramine and formaldehyde processes, will probably reduce some of this pollutional load.

E. I. du Pont de Nemours & Company, Photo Products Division Parlin, New Jersey

1. Organization:

This photographic materials plant has been operated at this site since about 1926. The plant is located on Minnisink Avenue, Parlin, New Jersey.

2. Products:

Photographic film is produced for medical purposes, X rays, graphic arts, and motion pictures. Nitrocellulose film was last produced in 1949 and no acetate film was produced in 1964. Present production is a polyester base film known as "Cronar."* A by-product methanol is shipped off the premises for recovery.

*Reg. Du Pont Trademarks.

3. Raw Materials:

Dimethyl terephthalate (also used in "Dacron"*)

Ethylene glycol

Silver Nitrate

Gelatin

Ammonium Bromide

Potassium chloride

Potassium iodide

Supplies:

Algicide

Humiclean, 4-5 gpd

5% Dowicide G

Possium pentachlorophenol

Miticide

Hycol (lysol) 3-5 lbs/day of liquid

Hydroquinone developers from lab

5 lbs/day

Phenolics

2 lbs/day

4. Capacity:

The production capacity was not reported.

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*Reg. Du Pont Trademarks.

5. Operations:

This plant operated 168 hours per week.

6. Employees:

Employment if provided for 2500 people.

7. Water Supply:

Water is obtained from the Duhernal Water Supply, a private water company. Normally 2 mgd are consumed, with a peak demand of 3 mgd.

8. Sewerage:

Domestic sewage is discharged to the Boro of Sayreville and then to Middlesex County Sewerage Authority.

All plant effluent is discharged to the South River except that used for irrigating the lawns. A ditch about 2 miles long extends from the plant through the Hercules property to the River.

WASTE SEGREGATION

9. Strong Wastes:

From 5000 to 8000 gallons per week of strong wastes are collected in drums and barged to sea for disposal in the 12-mile dumping ground. Future plans provide for incinerating these wastes at the plant site.

10. Waste Solvents:

Waste solvents are collected and incinerated.

11. Cooling Water:

The remaining wastes, referred to as cooling water, are discharged to the ditch to the South River. Water supplied to the plant averages about 55° F and plant effluent averages about 80° F.

FUTURE WASTEWATER TREATMENT

12. Treatment of Total Flow:

Tentative plans call for treating all of the plant wastewater in a 5-acre lagoon. The nominal holding time would be 5 days. Floating aerators were being considered. The lagoon would have a wide spillway in order to accommodate yard runoff. The design load would be 1000 lbs of BOD_5 per day. The expected reduction would be 80% at 3-day detention.

13. Diversion:

Under an alternate proposal, 150,000 gpd, representing 800 lbs. of BOD_5, would be diverted to the sanitary sewer to Sayreville. The balance of the flow with 200 lbs. of BOD_5 would be discharged to the proposed lagoons. With this reduced load on the lagoons, the aerators would probably not be required.

E. I. Du Pont de Nemours & Company, Fabrics & Finishes Department Parlin Finishes Plant, Parlin, New Jersey

1. Organization:

Initially a powder plant was constructed at this site about 1890. The facilities were purchased in 1910 by du Pont. Since about 1945 a polymers and plastics plant has been operated at this site. The plant is located on Washington Road in Parlin, New Jersey.

2. Products:

This plant manufactures paint, polymers, and plastic finishes.

3. Raw Materials:

The raw materials are:

Plasticizers

Adhesives

Resins

Alcohols

Esters

Paint Solvents

Vegetable Oils

Water

4. Capacity:

This plant produces about 5 million gallons of pigmented material and 20 million pounds of polymers and plastics per year.

5. Operations:

The plant operates 120 hours per week.

6. Employees:

Employment is provided for 700 people.

7. Water Supply:

Water is obtained from the Duhernal Water Supply, a private water company established in 1938. Water use is 1.5 mgd.

8. Sewerage:

Domestic wastes are discharged to the Boro of Sayreville and Middlesex County Sewerage Authority.

The deep sewer system and the open ditch discharge wastes to the South River.

9. Principal Processes:

Production is divided into two areas:

a. The enamel and clear area, where paint materials are mechanically mixed and containers are filled.

b. The polymers and plastics area, where products are produced by polymerization and esterification.

WASTE SEGREGATION

Process, cooling, and reaction water wastes are segregated into three collection systems.

10. Deep Sewer System:

Roof drainage and part of the cooling water is collected in the deep sewer system and discharged to the South River. Cooling water is discharged at about 75-80° F, a rise of about 22-27° F. Approximately 120 to 360 pounds of BOD are discharged per day in this sewer.

Water from Hercules Powder is added to this system before discharge to the river.

11. Open Ditch:

The balance of the cooling water and yard drainage is collected in the open ditch and discharged to the South River. The concentration of BOD is reported to be less than 10 mg/l.

12. BOD System:

About 20,000 gallons per day of waste process water is discharged to the BOD system for treatment. This water is from the polymers and plastic area.

WASTEWATER TREATMENT

13. Separation:

The water collected in the BOD system is treated in a small non-mechanical decanter. Floatable solvents are pumped to a solvent reclaim tank. Water from below the solvent level flows continuously to a pump pit where it is intermittently discharged to a gravity line to the evaporation lagoons. Sludge is removed manually at intervals and stored in drums for incineration.

14. Evaporation Lagoons:

The separated water is discharged to one of three lagoons where seepage and evaporation take place and there is not any overflow.

15. Solvent Reclaiming:

Wash solvent from the enamel and clear area is discharged to two small settling tanks. Sludge is removed from these tanks and drummed for incineration. Settled solvent is transferred to a solvent reclaim tank. This waste solvent is hauled off site to be reclaimed and returned for use.

16. Incineration:

An open pit incineration with provision for forced air is under construction. This will be used for destruction of sludges and solid wastes.

17. <u>Future Waste Disposal</u>:

At the present time negotiations are under way to discharge the waste water from the decanter (item 16) to Boro of Sayreville and Middlesex County Sewerage Authority, replacing the evaporation lagoons.

Hydroscience, Inc., prepared a report on "Pollution Analysis of the South and Lower Raritan Rivers" which considered the deep sewer and open ditch discharges to the South River, excluding the decanted waste water which is presently being discharged to the evaporation lagoons. Decisions to continue discharge of the open ditch and deep sewer to the South River were based on this report.

Hercules Powder Company
Sayreville, New Jersey

1. <u>Organization</u>:

The Parlin plant of Hercules Powder Company, occupying 800 acres, has been located in Sayreville, N. J since 1914. The company's main engineering and executive offices are in Wilmington, Delaware.

Paul DeFalco

2. Products:

Polyethylene (Hifax) - 50 million pounds per year

Nitro cellulose

Chlorinated rubber (Parlon)

Nitric acid

Acetic acid - 40 million pounds per year

Chlorinated polyethers (Penton)

Esters

3. Raw Materials:

a. Polyethylene process: ethylene (piped in); catalysts

b. Nitrocellulose process: nitric acid; cellulose (brought in by rail); sulfuric acid

c. Parlon process (used in paints and printing inks): rubber (brought in by truck); chlorine (brought in by tank car); carbon tetrachloride (recycled)

d. Nitric acid process (used in nitrocellulose production): ammonia (brought in by tank car)

e. Acetic acid process: ethyl alcohol (brought by rail)

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4. Capacity:

Production capacity from most of the processes is confidential.

5. Operations:

The plant is divided into two sections; plant #1 produces nitrocellulose, Parlon, Penton and nitric acid; plant #2 produces Hifax and acetic acid. The individual processes are covered in Section II.

The plant employe 1350 people, 50% of which are on shift work 7 days per week, 24 hours per day, 50 weeks per year.

6. Water Supply:

The only major source of water is a 5.5 mgd withdrawal from the Duhernal Water System, a joint venture between the DuPont, Hercules and National Lead Companies. Incoming raw water is adjusted for pH, settled, filtered and chlorinated. Iron is also precipitated out. Six wells are on the premises, however, they are used only approximately 6 days a year.

A large recirculating cooling water system is maintained by the company. Makeup water averages 5 percent.

7. Sewerage:

Sanitary wastes from Plant #2 are discharged to the Middlesex County Sewerage Authority system, while sewage from Plant #1 is discharged to the Borough of Sayreville.

8. Processes:

a. Nitrocellulose:

Cellulose is treated with nitric and sulfuric acid, purified and then adjusted for viscosity by heat. It is then dehydrated by pressing, with the water being replaced by alcohol. Water is used for washing, the alcohol recovered, and the water reused for washing. The true dehydration water which is high in BOD, is discharged to the Middlesex County Sewerage Authority.

b. Parlon:

Consists of the chlorination of rubber in carbon tetrachloride. This product is then precipitated and washed with water. The material is then dried. All washwater is discharged to the MCSA.

c. Hifax:

Consists of the polymerization of ethylene in

88a a kerosene-like material, which is later removed. The product is dried and then extruded into pellets. Water is used in steam distillation and cooling. Process waters go to MCSA and some cooling water to a brook which empties into South River.

d. Nitric Acid:

Water is removed to concentrate the acid. This water is neutralized and discharged to a sewer which empties into the South River, a tributary of the Raritan River.

POLLUTION ABATEMENT

9. Waste Sources:

30" chemical sewer - discharges to South River

Line carries approximately 3.3 mgd of wastes -- 3.0 mgd is washwater from nitrocellulose process. BOD averages 35-40 ppm. Analysis of this discharge is given at end of report.

Number 1 Brook

No direct discharge, possible leakage from lagoon areas. DuPont drainage plus small discharges also in brook. MCSA data shows flow - .87 mgd; BOD - 7.0; DO - 8.7; pH - 8.1.

Number 2 Brook -- discharges to South River

Approximately 363 gpm of cooling water from the Parlon process is discharged to this brook.

Studies conducted by both MCSA and the Raritan Bay Project indicate that flow in this stream is approximately 5.5 mgd. Hercules' flow contribution is about 10%.

Analysis of the stream, before it enters, and after it leaves Hercules' property is given below:

Location	BOD	COD	Total Solids	Total Fixed Solids	Total Sus Solids	Total FSS	Phenols	
Before	44	121	171	93	13	2	.04	.08
After	37	131	219	127	37	37	.04	.03

All results, reported in mg/l, are averages of eight hour composites collected over a 24 hour period. The second phenol column is based on an average of three grab samples collected over a 24 hour period.

Number 3 Brook -- discharges to South River

Receives approximately 290 gpm of cooling water from Hifax and Power House. MCSA data indicates BOD - 0.7; DO - 6.4; pH - 6.2; flow - .32 mgd.

Process Wastes

Approximately 900,000 gpd of process wastes are discharged to the Middlesex County Sewerage Authority.

10. Waste Treatment:

Wastes being discharged to the 30" sewer are first treated in the company's private neutralization plant which was approved by the State of New Jersey in 1948. Reports on operation are sent to the State once a month. (See end of report.) Treatment consists of neutralization with lime, aeration, settling, cooling and reaeration. During peak periods, some of the incoming flow is diverted to a storage lagoon.

Sludge, which is composed of calcium sulfate and lime is removed every three months and used for landfill. **Effluent analysis, supplied by Hercules, follow:**

SAMPLE ANALYSES OF NO. 1 CHEMICAL SEWER (30" DIA.)

Date	pH [a]	D.O. [a]	B.O.D [b]	Temp. °C. [b]	Remarks [a]
1/22/64	5.7	8.61	34		8-hr. composite
2/12/64	5.7	7.35	44	24°	8 " "
3/19/64	9.0	6.59	43	20.5°	8 " "
4/22/64	7.8	7.30	36	26.5°	8 " "
5/20/64	6.2	3.33	71		8 " "
5/27/64	7.1	5.83	28		8 " "
6/23/64	3.2	2.31	55 64	29°	8 " "
7/22/64	5.1	6.68	30		8 " "
8/19/64	8.6	7.04	40	27°	8 " "
8/20/64	6.8	6.80	29		24 " "
9/16/64	7.0	6.64	38		8 " "
10/29/64	6.9	5.50	28	25°	8 " "
11/24/64	9.0	6.00	45	22°	8 " "
12/ 8/64	8.6	6.69	51	18°	8 " "
1/12/65	8.4	6.41	39		24 " "
1/21/65	8.2	6.70	37		8 " "

(a) Sampled at inlet to spray lagoons.

(b) Sampled discharge of spray lagoons.

SPRAY LAGOONS' EFFLUENT ANALYSES

Date	pH	B.O.D. mg/l	Temp. °C	D.O. mg/l	Remarks			
1/28/65	8.6	40			8-hr.	grab	composite	
2/ 2/65	7.3	40	12°	8.80	8	"	"	"
3/ 3/65	6.9	33			8	"	"	"
4/29/65	6.7	48			24	"	cont.	"
5/12/65	7.7	35			8	"	grab	"
5/24/65	7.3	30			24	"	cont.	"
5/26/65	5.1	40	36°	5.20	24	"	"	"
5/27/65	7.1	64			24	"	"	"
5/28/65	6.3	38			24	"	"	"
5/29/65	7.2	43			24	"	"	"
5/31/65	6.8	25			24	"	"	"
6/ 1/65	6.7	18			24	"	"	"
6/ 2/65	6.8	53			20	"	"	"
6/ 3/65	6.5	42			24	"	"	"
6/ 4/65	6.6	36			24	"	"	"
6/ 5/65	6.9	33			24	"	"	"
6/ 6/65	5.5	34			24	"	"	"
6/ 7/65	6.5	54			24	"	"	"
6/ 8/65	7.0	52			24	"	"	"
6/ 9/65	6.7	41			24	"	"	"
6/10/65	6.9	48			24	"	"	"
6/11/65	4.7	36			24	"	"	"
6/15/65	8.0	53			24	"	"	"
6/22/65	6.5	34			24	"	"	"

SPRAY LAGOONS' EFFLUENT ANALYSES

Date	pH	B.O.D. mg/l	Remarks
6/23/65	7.3	25	24-hr. cont. composite
6/24/65	7.5	27	24 " " "
6/25/65	7.2	46	24 " " "
6/29/65	7.3	26	24 " " "
6/30/65)	7.4	24	9:30 A.M.-1:30 P.M. cont. composite
6/30/65)	7.2	22	1:30 P.M.-5:30 P.M. cont. composite
6/30/65-7/1/65)	7.1	14	5:30 P.M.-7:30 A.M. cont. composite
7/ 1/65	7.2	20	24-hr. cont. composite
7/20/65	7.6	34	24 " " "
7/21/65	8.1	40	24 " " "
7/22/65	7.2	28	24 " " "
7/28/65	7.2	20	24 " " "
7/29/65	7.5	24	24 " " "
8/ 3/65	7.0	39	24 " " "
8/ 4/65	7.2	29	24 " " "
8/ 5/65	6.9	37	24 " " "
8/19/65	7.5	30	24 " " "
8/24/65	7.1	22	24 " " "
8/25/65	6.9	23	24 " " "
8/30/65	7.0	35	24 " " "

SPRAY LAGOONS' EFFLUENT ANALYSES

Date	pH	B.O.D. mg/1	Remarks
9/ 1/65	7.1	29	24-hr. cont. composite
9/ 9/65	7.1	28	24 " " "
9/14/65	7.3	34	6 hourly grabs "
9/15/65	7.3	77	7 " " "
9/21/65	8.0	40	8 " " "
9/23/65	5.2	37	8 " " "
9/27/65	6.8	36	8 " " "
9/28/65	7.2	44	8 " " "
10/ 5/65	8.0	31	8 " " "
10/ 6/65	6.5	31	8 " " "
10/ 7/65	8.1	67	8 " " "
10/19/65	7.8	83	8 " " "
10/26/65	7.4	60	8 " " "
11/ 3/65	7.5	39	8 " " "
11/ 9/65	7.3	58	6-hr. cont. comp.
11/16/65	6.9	52	6 " " "
11/16/65	7.1	43	8 hourly grabs "
11/17/65	7.2	33	8-hr. cont. comp.
12/ 8/65	8.2	38	8 " " "

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American Smelting and Refining Company

Perth Amboy, New Jersey

1. Organization:

American Smelting and Refining Company is located on the eastern edge of Perth Amboy, New Jersey, adjacent to the Arthur Kill. The facility occupies a total of 145 acres: 70 for operations and 75 for slag dumping. Approximately 1,400 people, 75 percent of which are on a day shift basis, are employed. The company's main executive and operating offices are located in New York City.

2. Products:

The following is a list of finished products and quantities produced:

Refined copper (bar, rod, cake)	13,500 tons per month
Brass alloys	600 tons per month
Antimonial alloys and oxides	175 tons per month
Refined gold	30,000 ounces per month
Refined silver	3,500,000 ounces per month

3. Raw Materials:

Raw materials used include:

Copper bullion	11,000 tons per month
Scrap copper and brass	5,000 tons per month
Antimonial crudes	50 tons per month
Precious metal scrap	40 tons per month

4. Capacity:

Plant capacity is given under the subheading 2. Products.

5. Operations:

Given below is a flow diagram of all processes at this facility. Each is broken down with the following information: Name and description; raw materials; quantity of cooling and process water (fresh and salt); finished product location of discharge and sizes of effluent channels or pipes; operation schedule (hours per day, days per month).

A. Refined Copper

Raw material - copper bullion

scrap copper and brass

↓

melt and cast to anodes

↓

electrolyze anodes

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2,000,000 cu. ft. condensate water per month

↓ ⟶ copper slimes

refined electrolytic copper

No effluent channels or pipes.

Water added to compenssate for evaporation

Mould cooling water recirculated through cooling towers

B. Brass Alloys

Raw material - refined copper

" tin

" lead

" zinc

brass ↓

finished product

Melt and cast into special sizes
and shapes of rods and tubes
conforming to rigid chemical
and physical specifications.

Mould cooling water recirculated through cooling tower

No effluent channels or pipes

Operating 24 hr./day, 30 days/month

C. Antimony Alloys and Oxides

Raw material - crude antimonial lead alloys

↓

process in steel kettles

at high temperature

↓

finished product

Specification alloys of lead and antimony

and antimony oxide.

No water required -- salt or fresh

No effluent channels or pipes.

Operating 24 hrs./day, 30 days/month

D. Refined Gold and Silver

Raw material - copper refinery slimes

precious metal scrap

↓

smelt in furnace to produce metal

↓

cast metal into anodes

↓

electrolyze

↓

finished product

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99a Fresh water -- 2,000 cu. ft./month replacement for evaporation

No effluent channels or pipes.

Operating 24 hrs./day, 22 days/month

6. Water Supply:

Two sources of water supply are available, namely Arthur Kill and the municipal supply from the City of Perth Amboy. Fresh water, used at a rate of 3,500,000 cubic feet per month, or approximately 875,000 gallons per day, is used for steam production, sanitary and drinking purposes, and for makeup water in the plant's recirculating cooling water system.

Salt water from the Arthur Kill, used at a rate of 5,000 gpm, or 7.2 mgd, is used mainly for jacketed cooling in condensers and furnaces.

7. Sewage:

All sanitary wastes from the facility go to the Perth Amboy sewer system. Process wastes discharged to Perth Amboy amount to 500,000 cubic feet per month, or 124,000 gpd.

8. Principal processes:

Refining is the principal process at this facility.

WATER POLLUTION ABATEMENT PROGRAM

The plant has five sewers, the location of which are shown on a company supplied map, which discharge either directly to the Kill or to small tributaries. The only wastes reportedly being carried by these conduits are cooling waters, condensate waters, and overflow water from the plant's cooling pond. As mentioned previously, all sanitary wastes and processing water goes to the city sewer system.

Analyses have never been performed on these discharges by either the company, Interstate Sanitation Commission, or the New Jersey State Health Department.

United States Metals Refining Co.

Carteret, New Jersey

1. Organization:

This refinery is a solely owned subsidiary of American Metal Climax and is part of the United States Metals

Refining Division of the parent company. The other unit of the division is the Pyron Plant at Niagara Falls, New York, which produces iron powder. This metal refinery was initially established at this location in 1902. The refinery is located on Arthur Kill near Tufts Point at the south edge of Carteret, New Jersey.

2. Products:

This metal refinery produces copper, tough pitch, powdered, and oxygen free in various shapes and alloys. Crude zinc oxide and crude nickel sulfate as well as a variety of precious metals are also produced. The production of germanium and germanium oxide has been discontinued.

3. Raw Materials:

The two principal raw materials at this refinery are scrap copper and foreign blister. Foreign slimes from copper refineries and jeweler's waste are also purchased. This refinery no longer receives copper sulfide.

4. Capacity:

From approximately 15 to 18 thousand tons of scrap materials and contract blister from other smelters per month the refinery produces 15 to 18 thousand tons per month of copper.

5. Operations:

The blast furnace and tank house operate at 168 hours per week. The anode and wire bar furnaces operate continuously except for varying periods on weekends. The copper powder operations operate 5 to 6 days per week.

6. Employees:

This refinery employs from 1500 to 1700 people.

7. Water Supply:

For the past four calendar years the metal refinery has purchased an average of 9,280,000 gallons per day of fresh water from the Middlesex Water Company. Approximately 50.3% is feed water makeup for generation of steam, 4.8% is used for sanitary purposes, and the balance (44.9%) is used for process cooling and heat exchangers and makeup for the cooling ponds of the Bosh water system.

Approximately 36 million gallons per day of brackish water is withdrawn from the Arthur Kill. About 46% is used for shell and tube and barometric condensers in condensing steam at prime movers, 5% is used for jet ejectors producing vacuum for the electrolyte evaporators, 41% is used for other plant processes, cooling by means of shell and tube heat exchangers, and the balance (8%) is used for direct contact cooling.

8. Sewerage:

Three sewage ejectors are used to pump the sanitary sewage into the Carteret sewage system. In case of ejector failure the sanitary sewage is bypassed to the Arthur Kill. These stations are inspected daily and the maximum outage is 24 hours. This occurs perhaps once a month.

All of the waste water and yard drainage are discharged to the Arthur Kill through two outlets, one of which is 30 inches in diameter and the other is 18 inches in diameter.

9. Outline of Process:

All nonferrous scrap which is not calssified as No. 1 or No. 2 scrap is sent to the blast furnace for smelting with coke. Black copper is produced in the blast furnace and sent to the converter. The slag from the blast furnace is quenched with salt water and discharged to a slag pit from where it is recovered and sold for shot blasting and aggregate. The gases from the blast furnace are filtered in a bag house and crude zinc oxide is recovered and shipped off the premises for further processing.

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In the converter air is blown through the molted black copper and blisters are cast from the converter. Gases from the converter are discharged to an acid spray tower and then go to a Cottrell precipitator before being discharged to the waste gas stack. When this refinery formerly received sulfide ores from Cuba it was desirable to recover the dust from the converter in the Cottrell precipitator. Since the sulfide ores are no longer received the Cottrell precipitator is to be replaced with a bag house dust collector system.

The No. 2 scrap is baled and charged along with locally produced blisters and foreign blisters to the reverbatory furnaces. From these furnaces all copper is cast into anodes.

All the copper, except No. 1 scrap, is electrolytically refined in the tank house.

Cathodes are produced in the tank house. The slimes which accumulate in the bottom of the tanks are sent to the precious metal refinery. Part of the recirculating electrolyte is pumped to the nickel salts plants.

Some of the cathodes are used in the tough pitch casting operations. Here the cathodes are melted with all of the No. 1 scrap and cast into the products ingots, wire bars, and billets.

A second portion of the cathodes are melted in a low frequency induction melting furnace in a reducing atmosphere to produce oxygen free copper which is cast either continuously or in wheel castings to form billets and wire bars.

A third portion of the cathodes are used in plating tanks with greased lead cathodes where the copper ions agglomerate into fine copper powder and fall to the bottom of the tanks. From here the powder is recovered as a slurry and filtered before being further processed by drying in a reducing atmosphere and grinding to form copper powder.

The electrolyte which is sent to the nickel salts plants is evaporated in batch evaporators and sent to crystalizers. The other liquor from the crystalizers which is acid is returned to the tank house. The nickel sulfate crystals are washed in a continuous centrifuge to produce crude nickel sulfate.

The slimes from the tank house and any purchased slimes from other copper refinery operations are processed in the precious metal refinery to produce precious metals in various shapes.

SOURCES OF WASTE WATER

10. Slag Pit:

When the slag is drawn from the blast furnace it is quenched with sea water and discharged to the slag pit which is similar to those used in steel making operations. Surface over-flow from this slag pit is discharged to the 30-inch outlet to the Arthur Kill. Half of the water used for quenching is from the power house condensers.

11. Surface Condensers:

Two of the four basic circuits in the tank house are supplied by a direct current generator in power house No. 1, which is driven by a condensing steam turbine. Salt water is used on these surface condensers and returned to the Arthur Kill. About 3 or 4 years ago shot chlorination was installed at the pumping station for all of the salt water supplied from the Arthur Kill and this has reduced the down-time for condenser cleaning by about one-fourth. Chlorine is applied for about 5 minutes once every 8 hours.

12. Bosh Water System:

In all of the casting operations except the continuous castings, copper is poured into copper molds which are mounted on a wheel revolving in a horizontal plane. The molds are dressed with a white powder which contains some phosphate. As soon as the copper is poured into the molds water is poured over the copper and the molds to quickly cool them. The castings are removed from the molds and the molds are washed and dressed again ready to form another casting. This water system is known as the Bosh Water System and the water recirculates to two spray cooling ponds or reservoirs. Make-up water for this system is purchased fresh water. Occasionally some of this water is bled off or overflows to the 30-inch diameter outlet to the Arthur Kill. This water may be high in phosphates and copper. About once every 3 years, these reservoirs are cleaned and the residue is returned to the smelter.

13. Nickel Salts Evaporators:

The barometric condensers on these evaporators are cooled with salt water. There is a possibility of carry-over of acid and nickel solutions from these evaporators. The waste waters are frequently checked with methyl orange for an indication of acidic waste. This waste water from the barometric condensers discharges to the Arthur Kill through the 18-inch diameter outlet. The flow is estimated to be about 1.5 million gallons per day.

14. Cutting Oil:

Adjacent to the continuous casting operations it was noticed that metal chips were being discharged to a bin and that the associated cutting oils were being discharged with these chips and drained through the bottom of the bin to the ground surface from where they had been discharging to the storm sewer. These wastes would be discharged through the 18-inch outlet.

15. Lubricating Oil:

Various reciprocating steam driven equipment in this refinery is a potential source of lubricating oils in the condensates from these machines.

16. Demineralizer:

Boiler feed water is treated in a demineralizer at this refinery. Approximately 244 gallons at 60° Baume sulfuric acid is used every two days in regenerating the demineralizer resins.

17. Waste Heat:

Besides the surface condensers previously referred to, many of the furnaces and continuous molds are water cooled by heat exchangers. Most of this cooling is accomplished with salt water which is eventually discharged to the Arthur Kill. On the day of this plant visit the blast furnace and the converter were not operating. The intake water temperature from Arthur Kill was reported to be 70° F and the outlet temperatures were reported to be 77° on one outlet and 82° on the other outlet.

WASTE CONTROL

18. Tank House:

There is not any gravity drain line from the cellar of the tank house. During rainy periods the cellar may become flooded. If the water is not acid it is pumped to the storm sewer system with two gasoline driven emergency pumps. If the water in the cellar of the tank house is acid, indicating that it may be a spill from the electrolytic tanks, it is pumped to storage tanks in the tank house and used for make-up in the electrolytic tanks.

19. Analytical Results:

Samples collected in October 1964 were analyzed by Rutgers University and reported as follows:

Sample No.	Description.	pH	Setteable Solids mg/l	Suspended Solids mg/l	BOD mg/l
1	30" Inlet	6.9	nil	52	4.2
2	30" Outlet	7.1	nil	31	3.6
3	18" Inlet	7.0	nil	95	3.4
4	18" Outlet	7.2	nil	33	3.2

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Phelps Dodge Copper Products Corporation

Elizabeth, New Jersey

1. Organization:

The Phelps Dodge Copper Products Corporation Plant is located at the eastern edge of Elizabeth, New Jersey, between the Arthur Kill and the New Jersey Turnpike. This facility presently employs approximately 950 people. The company's main executive and operating offices are located at 300 Park Avenue, New York City.

2. Products:

This plant produces essentially copper products in the following form:

Hot rolled rods

Drawn wire, bare and tinned

Flat wire, and bus bar

Stranded wire

Pipe, tube, drawn rods and shapes

3. Raw Materials:

Principal raw materials include:

Copper

Tin

Lead

Zinc

Nickel

Non-ferrous metals

Cable seal compound

For the most part, bulk copper bar is brought in by barge. Small quantities of this metal are brought in by truck and rail. All other raw materials are brought in by truck.

4. Capacity:

The capacity of this plant is reported to be more than one million pounds of copper per day. The company does not wish to reveal exact capacities.

5. Operations:

Basically, this plant operates on a 16 hour, five day per week basis.

Principal operations are outlined below:

Hot Rolling - Wire bars or alloy billets are heated in a suitable furnace to 1,300 - 1,600° F; hot worked for forming rolls to a suitable, useable or marketable copper rod; and then furnished black or cleaned by pickling in a sulfuric acid solution and rinsed. Approximately 2,000 to 3,000 gpm of recirculated fresh cooling water is used in the process. Temperature of the cooling water, depending upon the time of the year, is 90 to 110°F. This process operates on a five day, two shift basis.

Billet Casting - Copper scrap or ingot copper is melted in an induction type furnace. The melt is cast into water cooled molds forming billets. Recirculated fresh water is used for mold cooling at a rate of approximately 1,500 gpm. The temperature varies, depending upon the time of year, from about 90 to 120°F. The casting shop usually operates on a one shift, five day per week basis.

Extrusion Mill - Copper or alloyed billets are heated in a suitable furnace to a temperature of 1,300 - 1,700° F; discharged into the container of a 2,200 ton hydraulic extrusion press, and with a plunger attached to the hydraulic ram, forced through a suitable die for the forming of rod, tube, shell, or any regular or irregular shape that is presently extrudable. Occasionally, a small amount of fresh water is used for quenching the finished product. The finished stock is pickled and cleaned before passing to other operations. The extrusion department usually operates on a one shift, five day per week basis.

Wire Drawing - Clean rod is passed through various types of machines which will cold reduce the cross section through dies. This cold work hardens the wire. In the reducing process it is necessary to anneal (re-soften) the wire when it becomes too hard for further reduction. The wire drawing machines have recirculating systems of drawing compounds which are generally soluble in water. These solutions are recirculated and only changed in cases of emergency. Wire is drawn in many sizes from drawn rod. These products are sold as is, or sent to other departments for further processing. The wire mills operate on a two shift, five day per week basis.

Cold Rolling - Cleaned wire from the wire mill or cleaned rectangles from the extrusion presses are cold reduced by mechanically working them through rolls which reduce their size. This size reduction also increases the hardness, and thus annealing may be needed, depending on the size and temper of the required material. These cold reducing flats are finished in all sizes and are sent out in reels, coils, or cut to straight lengths as required by the customer. The folling mills operate on a two shift, five day per week basis.

Tinning - This is a process for coating copper wire with tin or tin alloy. It is accomplished by passing the wire through a fluxing tank; through a molten tin bath at approximately 850° F; through a series of wipes to remove the excess tin and form a smooth coat; through cooling water; and then wound on take-up reels.

This material is either shipped direct to the customer or else used elsewhere in the plant for further processing. This department usually operates two shifts, five days per week.

Stranding - This process merely mechanically twists small wire into cable to make the flexible equivalent of solid wire or bus bar. This material is either sold as is, or sent for further processing (insulating) elsewhere. This department normally operates two shifts, five days per week.

Tube and Shape Drawing- Here, material from the extrusion presses is mechanically reduced in size by pulling it through dies on draw benches. This drawing and rolling hardens the material, and depending upon the number of reductions and the physical characteristics required in processing, annealing may be necessary. The finished material from the draw benches may require mechanical straightening and hydrostatic testing. This department would normally operate on a one shift, five day per week basis.

6. Water Supply:

Two sources of water are available, namely Arthur Kill and the municipal supply from the city of Elizabeth. Fresh water is used for drinking and sanitary purposes, and for makeup water in recirculating cooling systems used in the hot rolling, billet casting, tinning and cold rolling processes. Small quantities are also occasionally used for quenching in the extrusion mill process. Approximately 3,500 gallons per day of fresh water are used by this installation.

Salt water from the Arthur Kill is used for cooling at a rate of 1.3 mgd. Two separate systems, one with a capacity of 500 gpm and the other 1,000 gpm are in use. The smaller quantity of salt water is pumped through copper coils for cooling the drawing solutions and for minor cooling throughout the plant. This water is used on a once through basis before being discharged to a city sewer system. The remainder of the salt water, used in jacketed condensers for cooling process water in the hot rolling process, is discharged back to the Kill. This again is on a once through basis.

7. Sewerage:

Approximately 25 percent of the installation's sanitary wastes go to the city sewer, while the remainder discharge directly to the Arthur Kill through any one of the six sewers.

8. Principal Processes:

Principal processes at this plant are hot rolling, billet casting, extrusion, wire drawing, cold rolling, tinning, stranding, and tube and shape drawing.

9. Waste Treatment:

This plant of the Phelps Dodge Corporation provides no treatment of its industrial or domestic wastes. At the present time, there are six discharges going directly into the Arthur Kill. Outlined below is a brief description of the discharges into each sewer.

Discharge	Sewer
Hot rolling	4,5
Billet casting	6
Extrusion Mill	6
Wire Drawing	1,2,3
Cold rolling	1,2,3
Tinning	1,2,3
Domestic wastes	1,2,3,4,5,6

10. Analytical Results:

At the request of the Interstate Sanitary Commission, the following analyses were performed on the raw discharges:

ANALYSIS, PPM

Sewer No.	Solids, SS	Oil	Cu.	pH	Flow gpm
1	119.4	48.7	0	6.8	72.4
2	149.3	46.5	11.8	6.9	7.1
3	47.7	13.0	0	7.3	8.8
4	179.0	48.2	74.6	5.5	50.2
5	163.2	12.1	189.1	3.0	13.0
6	18.7	30.1	27.6	2.5	118.2

119a The above listed analyses were run on composite samples collected over an eight hour period. Flows were measured with a V-notch weir. The flow figures reported are average discharges, and therefore, could be used in computing loads. Only three of these discharge points (4,5,6) are readily accessible for sampling.

WATER POLLUTION ABATEMENT PROGRAM

On November 5, 1965, Phelps Dodge received a letter from the Inter-State Sanitary Commission, advising them to set up an abatement program on the following basis: Diversion of all sewage to the city sewer system; consideration of a closed circulation system, or some other means to eliminate oil and fine copper solids from being discharged to the Arthur Kill; removal of all floating and settleable solids; and elimination of any precipitant which might form in the Arthur Kill as a direct result of the plant's discharges. The dealine set by I.S.C. for this abatement program is September 1967.

On the basis of this request the plant has already taken steps to eliminate the discharge of domestic sewage, by moving to another location, their locker and toilet facilities. In addition, all recirculating systems which provide wash and cooling water for the rod mills are being extended and improved. Other inplant modifications designed to reduce quantities of wastes being discharged to the Kill are in the planning stage.

Nassau Smelting and Refining Company, Inc., Tottenville Staten Island, N Y.

1. Organization:

Nassau Smelting and Refining Company, Inc., wholly owned subsidiary of Western Electric Corporation has been at this location since 1905. Nassau became part of Western in 1931.

This Facility, located on approximately 42 acres in Tottenville, Staten Island, employs 654 people, 525 of which are in production work.

2. This plant handles approximately 40 percent of the one million pounds per day of scrap generated by the Bell Telephone system. The finished products of this plant are as follows:

Copper bar

Brass and bronze ingots

Lead pigs

Resin core and wiping solder

Lead sleeving

3. Raw Materials:

Raw materials include scrap cable, insulated and non-insulated wire, all types of telephone equipment and apparatus including relays and booths, and all materials that contain non-ferrous metals. Much of this raw material contaminated with wood or plastic. Approximately 400,000 pounds per day is handled at this plant; the remaining 600,000 is handled on a contract basis.

4. Capacity:

This plant has a capacity for turning out the following:

Copper wire bar	50 tons per day
Brass, bronze & ingots	50 tons per day
Lead pigs	90 tons per day
Solder, resin core	7,000 pounds per day
Bar solder	12,000 pounds per day
Wiping solder	15,000 pounds per day
Lead sleeving	40,000 pounds per day

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5. Operations:

This facility can best be described as a secondary smelting and refining plant because it does not use ores as its source of raw materials.

Essentially, there are five operations: Sorting, stripping, burning and sweating, melting and refining, casting and extrusion.

The plant operates three shifts per day, seven days per week, 52 weeks per year. Approximately 90 percent of the employees work the 16 hour day shift and the remainder the night shift (12 Midnight to 8 A.M.).

The company is presently conducting break-in tests for a new unit designed to produce copper wire directly from copper bar. The equipment developed in Italy, is known as a Properzi Machine. It is anticipated that this unit will be in full production operation by June 1966.

6. Water Supply:

Two sources of water supply are available; namely Arthur Kill and the municipal supply of New York City. Salt water is used as a cooling spray in the plant's rotary hearth furnace at a rate of 250 gpm. This water is used on a once through basis only. The quality of the Arthur Kill water presently satisfies the needs of the plant. No problems have been encountered with corrosion or clogging as a result of these waters being used for cooling.

New York City water, consumed at a rate of 68,000,000 gal./yr., is used for sanitary and drinking purposes, fire protection, spray cooling in the Cottrell unit, and for make-up water in the plant's cooling water systems.

Combined consumption for cooling and operation of the Cottrell unit amounts to 45,000,000 gal./yr. Input to the Cottrell system, which operates 350 days/yr., is 12,250,000 gal./yr. Steam and water loss in this unit amounts to 1,750,000 gal./yr.

The plant's recently installed recirculating water-type cooling system, serving the red metal or copper production shop, has a capacity of 36,000 gpm. Reportedly, this system which is presently operated at 12,000 gpm, has no blowdown or waste. Make-up water is approximately five percent of the system maximum capacity.

It is claimed that much of the water used throughout the plant including the bosh water...a possible pollutant, is collected and put back into the recirculating cooling water system. The quality of this recirculated water is checked monthly by an outside contractor who treats the water with an organic chromate solution to prevent incrustations, slime growths, etc.

The cooling system serving the white metal shop or solder operations also uses city water for make-up. This system, however, has a constant overflow which discharges to a 36 inch storm sewer.

7. Sewerage:

All sanitary wastes from the facility either go directly to the Arthur Kill via a small tributary creek or are handled by a septic tank system. Domestic wastes from the executive offices and from the operations buildings go directly to the creek, while sewage from the warehouse is handled in a septic tank system and leaching bed.

Three 36 inch sewers, which reportedly carry storm water and cooling water, are located on the plant property. These conduits discharge directly to the creek.

8. Principal Processes:

The principal processes at this plant are secondary smelting and refining.

9. Waste Treatment:

Nassau Smelting and Refining Company, Inc., for all practical purposes discharge their industrial wastes without treatment. A pit has been provided in one area to receive waste from the Cottrell unit where large quantities of water are used for spray cooling. The effectiveness of this settling pit, at present, cannot be demonstrated.

WATER POLLUTION ABATEMENT PROGRAM

At the present time, steps are being taken by Nassau Smelting to eliminate the use of Arthur Kill water. A new distillation procedure, which will char and crush the material will eliminate the need for the rotary hearth furnace; and thus the need for Arthur Kill water. Municipal water, connected to the plant's main cooling water system will be used in this new process.

It is the company's intent to connect all of their industrial and domestic discharges to the city sewer system when the city provides sewer elevations. As of this writing there is no indication as to when the City of New York will provide this information.

Public Service Sewaren Generating Station

Sewaren, N. J.

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1. Organization:

The Sewaren Generating Station, located adjacent to the Arthur Kill in Sewaren, N. J., is owned and operated by the Public Service Electric and Gas Company, Newark, N. J. The installation, employing 235 people, operates 24 hours per day, 365 days per year. This facility was first put into operation in 1948.

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2. Capacity:

This installation has a gross electrical output capacity of 975 megawatts. This includes a 140 megawatt gas turbine unit -- the first of its kind in the United States.

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3. Operations:

The plant produces electrically with five steam boiler-condenser-type generating units, and one gas turbine unit. The turbine unit does not require cooling water.

During peak operating periods all units are functioning. However, under normal daily operating conditions, only the five steam-type units are used.

4. Plant Design Capacity:

Electrical - 975 megawatts

Demineralizer Plant - designed to take water at approximately 1,000 micromhos and total dissolved solids of approximately 750 ppm and produce water of:

Total dissolved solids - 0.4 ppm

Dissolved silica - 0.02 ppm

Conductivity - 2.0 micromhos

Fuel Usage - (Quantity that would be used if units charged with only one of these fuels)

1. Coal - Grade: high bituminous
   - Consumption: 192 tons/hr on No. 1 thru 4 at rated load

2. Fuel Oil - Grade: Bunker "C" (used in units No. 1-5)
   - Consumption: 1140 bbls/hr
   - Grade: "Hi Vis" pitch (used in No. 5 only)
   - Consumption: 510 bbls/hr

3. Natural Gas - Burned on No. 1-4 units at rate of 4,500,000 cu. ft/hr. Gas turbine uses 2,000,000 cu. ft/hr.

During average year fuel is used in the following manner: Coal - 75%; fuel oil - 24%; gas - 1%.

5. Water Supply:

A. Sources of water and rate of consumption:

1. Salt water - Pumped from Arthur Kill by:

#1 Unit - 2 circulating pumps rated at 47,000 gpm each

#2 Unit - 2 circulating pumps rated at 47,000 gpm each

#3 Unit - 2 circulating pumps rated at 47,000 gpm each

#4 Unit - 2 circulating pumps rated at 47,000 gpm each

#5 Unit - 2 circulating pumps rated at 129,000 gpm each

Total circulating pumps - 634,000 gpm

Service water also pumped by four salt water pumps rated at 2,500 gpm each.

2. Fresh water - Source from two city water lines from Middlesex Water Company.

Average consumption: 748,000 gpd.

B. Use of water and rate of consumption:

1. Salt Water

Cooling - Used for cooling #1-#5 condensers. Maximum consumption of 634,000 gpm, water

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tapped off #5 circulators for cooling #5 air auxiliary coolers. Water from four salt water service pumps used for cooling in #1-#4 condensate coolers, #5 air compressor cooling, #5 pump water cooler, Hi-Vis condensate return pump heat exchanger, heating boiler de-aerator vent condenser. These four pumps are rated at 2,500 gpm each. No. 1 gas turbine auxiliary cooling at 1850 gpm. Salt water used for cooling in #1-5 condensers is treated with chlorine. Chlorine is dispersed into #1-#5 pumps on a cycle of 40 minutes duration when the circulators are running. Only one pump is treated at a time. Rate can be varied from 0-8000 lb/day on No. 1-4, 0-12,000 lbs/day in No. 5. Residual chlorine at outlet of condenser is 0.5 ppm. Chlorination is provided three times per 24 hr. day.

Process - Water from the four salt water service pumps is used for fire protection, ash sluicing, #51 & #52 air heater washing,

#51 & #52 traveling screen washing nozzles, and sewage ejector pit.

2. Fresh Water - treated in demineralizer plant for use in steam cycle #1-#5 units. Portion used for drinking, cooking, showers, and other service facilities. Approximate consumption of 99,900 cu. ft/day.

6. Sewage:

Sanitary wastes from this facility are discharged to the Sewaren municipal treatment plant.

WASTE SOURCES AND TREATMENT

7. Demineralizer Waste:

Wastes from the demineralizing plant consists of dilute solutions of sulfuric acid and caustic soda used to regenerate the ion exchange resins in the make-up demineralizing and the mixed bed condensate polishing units.

8. Quantity of Waste:

At design conditions, the combination of acid and alkaline waste from the make-up demineralizing plant and condensate purification plant produces a net acid excess of

1,160 pounds per day. The details of the waste flows from the demineralizing plant are shown in Table I entitled, "Regeneration Waste Data, Sewaren Generating Station", dated December 7, 1961.

9. Method of Disposal:

The waste from the demineralizing plant is collected in a basin where the acid and alkaline wastes are air mixed. From this basin, the waste is fed to the flowing water in the circulating water discharge canal at a controlled rate. This circulating water is taken from the Arthur Kill and pumped through the condenser and then into the canal through which it is discharged back into the Kill. Normally, five condensers are in service and the flow through the canal is 634,000 gpm. With the waste flows shown in Table I, this controlled rate is 80 gpm and results in a decrease in alkalinity of .153 ppm in the canal under normal operating conditions.

10. Description of Facilities:

The waste disposal basin has a capacity of 152,000 gallons. This design if predicted on a condition where peak waste flows from a mixed bed unit and a primary cation-anion make-up unit occur simultaneously. The maximum surge that occurs at this time is 52,000 gallons. Therefore, the mixing tank surge capacity is set at 53,000 gallons with a retention volume of 52,000 gallons, for a total mixing section of 105,000 gallons. The volume of the effluent section is 47,000 gallons so that with an empty basin there is a total surge capacity of 100,000 gallons. The effluent section prevents short circuiting between the inlet and outlet. If the maximum waste flows occured simultaneously from all units, the maximum surge would be 87,000 gallons.

The basin is constructed of concrete with a caustic and acid proof brick lining. Piping to and from the waste basin is rubber lined and, where necessary, rubber or mastic coated. The control valve provided in the waste basin outlet can be adjusted to maintain any desired outlet flow rate.

To give adequate mixing of the waste solutions, air is introduced through a grid in the mixing section. This grid is designed to provide a maximum of 700 scfm of air into a full basin to aerate as well as mix the waste prior to disposal. A pressure regulating valve reduces the 300 psi or 125 psi compressor air discharge to 50 psi for the air grid supply pressure. A locally installed plug valve is used for the final setting of air required to produce a gentle rolling motion of the basin solution. Cut outs on both compressor pressure controllers have been provided so as to trip the basin air supply if the station air pressure decreases due to abnormally high demand.

A pH indicator-recorder is provided to monitor the water in the discharge canal below the point of chemical waste addition. Provision is made on the recorder to add pH indication upstream of the injection point at a later date, if it should become desirable.

11. Boiler Acid Cleaning Waste:

Provision is made for carrying spent acid (HCl) solutions used in boiler chemical cleaning to the waste disposal basin. The waste basin holds approximately four boiler volumes, which is enough capacity to accommodate all boiler drains from any boiler cleaning operation. These solutions are completely neutralized by adding caustic soda directly to the waste basin prior to discharge into the canal. Boilers are cleaned, based on condition, every 1 to 10 years.

12. Solid Wastes - Slag and Fly Ash:

Slag and fly ash from units No. 1-4 is either sent to the waste ponding area adjacent to the plant site, or to the breaker house where it is sold in bag or bulk form. The ponding area, consisting of two interconnected earthen diked lagoons, discharges to the Arthur Kill.

13. Thermal Pollution:

Cooling waters discharged to the Arthur Kill are at a temperature 15° F higher than that of the intake water. Information on how far up or downstream this temperature elevation is detectable is unavailable.

TABLE I

REGENERATION **WASTE** DATA
SEWAREN GENERATING STATION
PUBLIC SERVICE ELECTRIC AND GAS COMPANY

	Number Installed	Service Cycle Hours	Regen. Cycle Minutes	Maximum Normal Regen. Per Day	Gallons To Waste Basin Per Regen.	Gallons to Waste Per Day	Pounds Chemical Per Regen.	Pounds Chemical to Waste Per Regen.	Pounds Acid Waste Per Day	Pounds Caustic Waste Per Day
Primary Cation	2	16	167	2.56	25,570	65,200	1,000	600	1,538	-
Primary Anion	2	16	167	2.56	12,280	31,400	443	150	-	384
Secondary Cation	3	119	100	0.596	6,600	3,940	800	550	328	-
Secondary Anion	2	34	124	1.33	4,915	6,560	320	200	-	266
Mixed Bed	2	336	280	0.143	54,900	7,850	1,800 1,000	1,600 800	228	 114
						114,950			2,094	764

Effluent valve setting - 114,950 gal/day times 1 day/24 hr times 1 hr/60 min = 80 gpm.
One pound NaOH will neutralize 1.225 pounds H_2SO_4.
Seven hundred and sixty-four pounds NaOH will neutralize 935 pounds H_2SO_4.
Acid excess per day = 2,094 - 935 = 1,160 pounds
Normal discharge canal flow (five units) = 7,600,000,000 pounds per day
Ppm = 1.160/7,600 = 0.153 H_2SO_4 = 0.156 as $CaCO_3$.

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Public Service, Linden Generating Station

Linden, New Jersey

1. Organization:

The Linden Generating Station, located adjacent to the Arthur Kill in Linden, New Jersey, is owned and operated by Public Service Electric & Gas Company, Newark, New Jersey. The installation employing 175 people, operates 24 hours a day, 365 days per year. This plant was first put into operation in 1956.

2. Capacity:

This installation has a gross electrical capacity of 510 megawatts. On a yearly basis, the electrical production of the plant is 62.4 percent of the design capacity.

3. Operations:

Construction of the Linden Generating Station adjacent to the Esso Bayway Refinery is a mutually advantageous combination of two industrial processes; namely, the processing of crude oil to refined petroleum products and the conversion of refinery residuals to electric energy. The refinery uses the generating station's low

2a level heat energy effectively; and the generating station makes good use of the residuals of the refining process. The contractual agreement provides that Public Service will deliver to Esso, the entire steam requirement of the Bayway Refinery, in exchange for fuel and raw water.

The linden plant consists of one automatic double-extraction and one automatic single extraction turbine-generator. Unit number one, with a capacity of 260,000 KW gross, has three boilers on a header, serving both the turbine and the pressure reducing and desuperheating equipment, which bypass the turbine for delivery of steam from the boilers directly to the refinery. The plants second generating unit, with a capacity of 250,000 KW is designed so that it too can furnish extraction steam to the refinery at an extraction pressure of 150 psi during peak periods. This unit is provided with only one boiler.

Because of the contractual arrangement with Bayway, only two fuels are burned at the Linden Generating Station: Bunker "C" - 1,500,000 bbls/years and "Hi-Vis" - 3,700,000 bbls/year.

4. Water Supply:

Essentially, three sources of water are available, namely Elizabethtown Water Company - 1.73 mgd;

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Humble Oil and Refining Company - 1.15 mgd; and salt water from Arthur Kill - 345 mgd.

All of the fresh water, 2.88 mgd, with the exception of a very small quantity used for sanitary and drinking purposes, is used to produce steam for the Bayway Refinery of the Humble Oil and Refinery Company.

Salt water, used for cooling two condensers, is pumped from the Arthur Kill by four units; two rated at 70,000 gpm and two at 50,000 gpm. Kill water is chlorinated primarily to control slime growths. Two units, each with a capacity of 8,000 lbs/day, are used. A residual of 1.0 mg/l at the condenser effluent is maintained whenever possible. During an eight hour period, a circulator pump will receive one hour and fifty minutes of chlorination. Chlorination is practiced 24 hours per day.

Fresh water supplied by Elizabethtown and Humble Oil is treated in a two stage water treatment plant: Primary treatment and demineralization. Operation of these stages is described below.

PRIMARY TREATMENT

Water from Esso's reservoirs is delivered by refinery pumps to a 500,000 gallon raw water tank. An automatic chlorine demand meter controls a chlorine feeder to supply chlorine in breakpoint quantity for reduction of organic impurities to a minimum. From the storage tank water passes to a 15,000 gallon flash mixing tank where it receives coagulating chemicals of alum, coagulant aid; and when conditions warrant, powdered activated carbon and acid or caustic soda. From the mixing tank the now chemically treated water flows by gravity to two all steel solids contact clarifiers each 62' diameter by 18' high.

Clarified water flows into four gravity filters which contain deep beds of anthracite filter medium. These filters are annular segments, two being constructed at the periphery of each clarifier. Filtered water flows into storage tanks (clearwells) located below each pair of filters in which level is controlled and from which the filtered water pumps take their suction.

Water is precious at Linden and no water is wasted that can be reclaimed for use. The 100,000 gallons of water required to surface wash and backwash each filter is reclaimed by draining to a large compartment at the periphery of one of the clarifiers from where it is repumped to the flash mixing tank. Filtered water storage (379,000 gallons) is available from similar compartments in both vessels.

The entire primary plant is designed to operate unattended, by remote, manual or automatic control. It is

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capable of producing 3,750 gpm of water essentially free of turbidity, color, oil and organic matter so that the next treating process, demineralization, can function unhampered by such impurities.

DEMINERALIZER

Water is delivered from the primary plant to seven cation resin exchangers, each 12' diameter by 18' high for removal of calcium, magnesium and sodium. These units are regenerated with sulfuric acid when the resin beds are exhausted. Automatic effluent throttling valves accurately divide the flow through the cation units. Cation cycle lengths are determined by an electronic conductivity difference control system. Both the cascade flow control and regeneration on the basis of cation effluent conductivity are fully automatic, but push-button manual control of regeneration is available for operator's use.

Acid water from the cation units flows to a three-stage rubber lined vacuum degasser, 14' diameter by 40' high for removal of soluble carbon dioxide and oxygen. The degasser is held under vacuum by mechanical vacuum pumps and water is pumped from the storage section of the degasser by stainless stell pumps to the combination anion exchangers.

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Anion exchangers are of double deck design, six in number, each 12' diameter by 29' high and contain weak base resin in the upper deck for removal of sulfate, chloride and nitrate components from the cation free water. The lower deck of the anion unit has a 36" bed of strong base resin for removal of silica and residual carbon dioxide. Conductivity controls on both weak base and strong base anion effluents govern length of cycles by automatically removing units from service when water quality falls below a predetermined set point.

Water quality at the outlet of the anion exchangers is very high, in the usual sense, since the water has now been demineralized. However this quality is not considered high enough for the Linden equipment, and the treating process is continued in five 12' diameter by 14' high, flat bottom, mixed bed demineralizer units. In these vessels, water is redemineralized or "polished" and attains a high purity. Each vessel is capable of handling approximately 5,000,000 gallons of water before being exhausted by residual solids from the preceding demineralizing units. Cycle control is volumetric, with conductivity backup.

The demineralizing plant is designed to produce continuously 3,200 gpm of water of guaranteed quality.

Provisions have been made for future expansion of the plant to 4,800 gpm capacity.

Water from the outlet of the mixed bed demineralizers flows to two 500,000 gallon demineralized water storage tanks from which feedwater makeup is drawn as required.

Automatic regeneration facilities for cation, anion and mixed bed units are installed in duplicate. Concentrated sulfuric acid and caustic soda are stored in liquid storage tanks for regeneration requirements.

At the present time, water production is operating at approximately 55 percent of design.

SOURCES OF POLLUTION

5. Demineralizer Wastes:

Wastes from the demineralizer plant consists of dilute solutions of sulfuric acid and caustic soda which is used to regenerate the ion exchange units. At the present time, approximately 1,500 to 3,000 lbs/day -- 1,200 lbs/day average -- of excess acid is discharged. The maximum discharge capacity is 7,500 ppd of excess sulfuric acid.

6. Primary Treatment Unit:

Sludge from the primary treatment units

amounts to approximately 9,640 gallons. It is discharged at a rate of 482 gpm for a 20 minute period, to the plant's cooling water canal. Filter backwash is held in a storage compartment in the base of the sedimentation unit and fed back into the raw water supply.

7. Ash and Slag Wastes:

Because the Linden Generating Station burns all liquid fuel there is no resulting coal ash or slag, Ash resulting from the liquid fuel, which is low in ash quantity, is removed from the boilers during overhaul in dry form and usually sold for its vanadium content.

8. Thermal:

Cooling waters discharged to the Arthur Kill are at a temperature 15° higher than that of the intake water. Information on how far up or downstream the temperature elevation is detectable is unavailable.

WASTES TREATMENT

Wastes from the demineralizing plant are air mixed in a neutralization basin constructed of concrete, with a caustic and acid proof brick lining. Piping to and from the basin is rubber lined and where necessary, rubber or mastic coated. A control valve in the basin can be adjusted to maintain any outlet flow rate (present rate is 411 gpm) to the salt water discharge canal.

Spent hydrochloric acid solutions, used for cleaning boilers - approximately once per year - are completely neutralized by adding caustic soda directly to the basin.

<u>Consolidated Edison, Arthur Kill Generating Station</u>

<u>Staten Island, N. Y.</u>

1. <u>Organization</u>:

This generating plant of the Consolidated Edison Company of New York, Inc., built in 1959, is located on the Staten Island shore of the Arthur Kill opposite the mouth of the Rahway River.

A total of 126 people -- based on around-the-clock operation -- are employed.

2. <u>Capacity</u>:

Gross electrical output of this facility is 360,000 KW. Net output is 349,000 KW.

3. <u>Operation</u>:

A single generating unit -- cross compound machine -- consisting of two separate generators electrically linked together provides the total output of this station. It is impossible to operate one generator without the other.

Coal, used at a rate of 2,500 tons per day, is the main fuel source. Number 6 oil is normally used for starting and emergency purposes.

4. Water Supply - Treatment:

Two sources of water, namely, Arthur Kill and the New York municipal supply, are available at this plant.

Salt water from the Arthur Kill, used for condenser cooling, is pumped at a rate of 244,000 gpm -- 351 mgd. Two pumps, each with a capacity of 122,000 gpm are used for this purpose. Two 16,000 gpm salt water service pumps -- used for supplying washwater for screens, clean-up, etc. -- have also been provided.

In order to keep heat transfer tubes clean it is necessary to chlorinate the condenser cooling water. Fifteen percent sodium hypochlorite, fed at a rate of 5 gpm during the winter and 10 gpm during the summer, is used for this purpose. The dosage time for each condenser pump is 30 minutes, three times per day. During winter the residual at the condenser effluent is 2.0 mg/1, while in the summer, it is difficult to maintain 1.0 mg/1.

Ferrous sulfate solution is also added three times a day for a 40-minute period to produce a 1 ppm concentration in the cooling water. The total Fe added is about 20 lb during each addition.

Fresh water from the New York City system is used at an average rate of 120,000 gpd. Treatment plant throughputs between regeneration periods are as follows: Softener -- 4 to 5 million pounds (540,000); demineralizer -- 1.2 - 1.5 million pounds (162,000 gallons).

Throughout the year the softener will be regenerated approximately once every six and one-half days. Thirteen hundred pounds (1,300 lbs.) of dilute 66^{o} Be sulfuric acid are used for each regeneration. The demineralizer, regenerated every seven days, uses 160 pounds of H_2SO_4 and 180 pounds of sodium hydroxide.

5. Sewerage:

All sanitary wastes are discharged to a municipal sewer, which in turn, empties into the Kill.

WASTE SOURCES - TREATMENT

6. Softener:

Acid wastes from the softener are discharged into the canal carrying the plant's cooling water, which flows at a rate of 244,000 gpm. Acid is discharged over a one hour period, starting with a concentration of 5% H_2SO_4 in the rinse, and ending with zero percent H_2SO_4. Reportedly, the pH in the canal is 7.1 during the rinse cycle.

7. Demineralizer:

Caustic and acid are discharged to the canal for a one hour period during the rinse cycle. The pH in the canal water during this period is reported to be 7.4 to 7.5.

8. Boiler Acid Cleaning Wastes:

The boiler is acid cleaned approximately once a year. The total hydrochloric acid drained to the discharge canal is about 27,000 pounds over a one-hour period at a strength of about 3% HCl. During the draining period the pH in the discharge canal is lowered to approximately 6.0.

9. Fly Ash and Slag:

Fly ash and slag are discharged to two separate diked lagoon areas adjacent to the plant. Overflow from these lagoons empties directly into the Arthur Kill.

An analysis of the fly ash, made by Con Edison, follows:

	Percentage Range
Silica (SiO_2)	31-44
Iron Oxide (F_2O_3)	17-34
Aluminum Oxide (Al_2O_3)	24-34
Calcium Oxide (CaO)	3.5-6.1
Magnesium Oxide (MgO)	1.1-3.0
Sulfur Trioxide (SO_3)	0.8-1.2
Sodium Oxide (Na_2O)	0.1-0.3
Potassium Oxide (K_2O)	0.3-0.4
Carbon (C)	3.5-5.8

The phosphorous content of the ash, analyzed by Con Edison at the request of the Raritan Bay Project, was 0.1% by weight.

Settling time in the fly ash lagoon is estimated to be 3 to 7 days.

10. Temperature Elevation:

Cooling water, obtained from the Arthur Kill, is elevated in temperature 12.5°F. Information on how far up or downstream a temperature increase is detectable, is not available.

Jersey Central Power and Light Company, E.H. Werner Generating Plant

South Amboy, N. J.

1. Organization:

The E. H. Werner Generating Station, is located adjacent to the Raritan River at a point 0.5 miles from its STORET mouth. It is owned and operated by the Jersey Central Power and Light Company and employs 112 people. It first began operations in 1930 and operates 24-hr. per day, 365 days per year.

2. Capacity:

This installation has a gross electrical output capacity of 118.75 megawatts with a net output of 108.4 megawatts.

3. Operations:

The plant produces electricity with 3 steam boiler-condensor turbo-generator units. The plant has a total of four boilers.

4. Plant Design Capacity:

Electrical -- 118.75 megawatts

Unit #4 - 62.5 megawatts

Unit #1 - 28.125 megawatts

Unit #3 - 28.125 megawatts

Demineralizer Plant - has a capacity of 22 gpm. Produces a water with conductivity range of 5-15 micromhos.

Fuel Usage (1965 operating values)

1. Coal - Bituminous, high volatile, low fusion grade. Consumption was 421 tons average per operating day in 1965.
2. Fuel Oil - Units #1 and #3 burn fuel oil only - Unit #4 can burn either coal or fuel oil. Consumption is 300,000 to 350,000 barrels per year.

Evaporators

This plant uses three evaporators to provide the bulk of its boiler makeup water requirements. #1 has a capacity of 1,000 gallons/hour, #3 has a capacity of 1,000 gallons/hour, and #4 has a capacity of 2,500 gallons/hour.

5. Water Supply:

A. Sources of water:

1. Salt Water - pumped from the Raritan Bay by:

#1 unit - 2 circulating pumps at 21,000 gpm each

#2 unit - 2 circulating pumps at 21,000 gpm each

16b #4 unit - 2 circulating pumps at 35,000 gpm each and a 2,000 gpm pump for slag quenching and transport

2. Fresh Water

Source is own well with a capacity of 200 gpm located on the plant grounds and the City of South Amboy for 30,000 gallons per month.

B. Use of Water

1. Salt Water:

The salt water is used for condensor cooling, bearing cooling, slag quenching and washing. The condensor cooling water is chlorinated to maintain a 1 mg/1 residual in the effluent. The chlorine is added as a gas every 8-hours during the warmer months from April through November or December. Approximately 2/3 of a ton per day is used.

2. Fresh Water

Used for boiler makeup water, and employee use. The boiler makeup averages 1% of the total use. The total fresh water requirement is approximately 251,000 gallons per day. (250,000 well plus 1,000 city)

WASTE SOURCES AND TREATMENT

6. Demineralizer Waste:

Wastes from the demineralizing plant consists of dilute solutions of sulfuric acid and caustic soda used to regenerate the ion exchange resins in the makeup demineralizing units.

7. Quantity of Waste:

The demineralizer is regenerated with 36 gallons of a 5% HCL acid solution 3 times per week for the cation unit and with 65 gallons of a 4% caustic solution 3 times per week for the anion unit. Both cation and anion beds are backwashed at 15 gpm 3 times per week for 15 minutes each wash. The demineralizer will provide 25,000 gallons of finished water from each cycle.

8. Method of Disposal:

The wastes from the demineralizer plant are discharged without treatment to the condensor cooling water discharge canal.

9. Boiler Acid Cleaning Waste:

It has been 6 years since this plant last cleaned a boiler. When cleaning, they use an ammoniated citric acid solution. The spent acid solution is put in the river with the condensor cooling water.

10. Solid Wastes -- Slag & Fly Ash:

Both of these wastes are collected and transported to the settling ponds adjacent to the plant. The plant sells the slag and fly ash to a local contractor who uses the material in paving.

11. Thermal Pollution:

Cooling waters discharged to the Raritan Bay are at a temperature 8 to 10°F higher than that of the intake water. Temperature data on the influent and effluent condensor cooling water for year 1966 and 1965 is given below in °F:

Month	Inf.	Eff.	Month	Inf.	Eff.	Month	Inf.	Eff.
1966			1965			1965		
Jan.	36.9	42.8	April	48.7	55.9	Aug.	76.5	84.3
Feb.	37.4	45.5	May	67.3	72.7	Sept.	72.6	80.1
March	40.6	47.9	June	68.9	76.1	Oct.	60.7	69.4
			July	76.3	84.2	Nov.	49.4	58.4
						Dec.	44.3	52.1

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Jersey Central Power and Light, Sayreville Generating Station

Sayreville, New Jersey

1. Organization:

The Sayreville Generating Station, located adjacent to the Raritan River approximately 6.20 miles from its STORET mouth, is owned and operated by Jersey Central Power and Light. The installation employs 160 people and operates 24 hours a day, 365 days per year. The plant was first put in operation in 1930.

2. Capacity:

The plant has a gross electrical output capacity of 376 megawatts, and a net electrical output capacity of 354 megawatts.

3. Operations:

The plant produces electricity with 4 condensing turbine units and 1 topping turbine unit. The topping unit requires no cooling water per se. In essence, the plant consists of three plants. Units 1, 2 and 3 called the old plant were installed in the early thirties, and have a combined gross output of 100 megawatts. These units have six boilers (#5 and #6). The new plants, units 4 and 5 each have a gross capacity of 138 megawatts and one boiler each (#7 and #8 respectively).

In normal operation, units 4 and 5 are used continuously with the old units 1, 2 and 3 used for peak power demands.

4. Plant Design Capacity:

Electrical - 376 megawatts

Following is the name-plate capacity of each generator:

	Gross Output Megawatts	Temp°F	Pressure psig
Unit 1	33.75	600	300
Unit 2	33.75	600	300
Unit 3	25.974	900	875
Unit 4	122.5	1050	2000
Unit 5	125.0	1050	2000

Demineralizer Plant

This plant utilizes city of Sayreville water and consists of 4-two bed systems (cation and anion units in series) and 2-mixed bed systems (cation and anion resins homogeneous mixture). The mixed bed units are used as polishers after the two bed units. Each unit has a 60 gpm capacity. The cation units are regenerated with

1,230 gallons of 1.6% solution of H_2SO_4 and the anion units with 1,136 gallons of a 1.6% solution of caustic (sodium hydroxide). Each two bed unit will pass approximately 70,000 gallons of water before regeneration is required and the mixed bed units will pass approximately 1,000,000 gallons. The finished water has a quality of 0.5 to 7.0 micromhos conductivity, depending on the quality of the resin.

Fuel Usage

Following is the actual fuel consumption for the year 1965:

Coal: 542,391 tons Bituminous grade

Fuel Oil: 395,460 gallons #2 grade

Natural Gas: 4,504,155 million cubic feet

5. Water Supply:

A. Sources of Water

1. Salt Water - from Raritan River

#1 unit - 2 circulating pumps each rated at 23,500 gpm

#2 unit - 2 circulating pumps each rated at 23,500 gpm

#3 unit - Topper unit with no cooling water required - steam exhausts into steam header for units 1 and 2.

#4 unit - 2 circulating pumps at 37,700 gpm each

#5 unit - 2 circulating pumps at 37,700 gpm each

Total circulating pump capacity -- 244,800 gpm

In addition to the condenser cooling water pumps, salt water is pumped for ash transport.

#1, 2, 3 units - 3 pumps rated at 1200 gpm

#4 unit - 2 pumps rated at 1000 gpm

#5 unit - 2 pumps rated at 700 gpm

2. Fresh Water - source from city of Sayreville. The average water use for 1965 was 0.32 mgd and varied monthly as follows for the year 1965:

Jan.	0.295	May	0.255	Sept.	0.361
Feb.	0.267	June	0.356	Oct.	0.409
March	0.325	July	0.325	Nov.	0.296
April	0.355	Aug.	0.297	Dec.	0.306

B. Use of Water

1. Salt Water

Cooling - used for cooling #1, #2, #4 and #5 condensers. The maximum usage would be 244,800 gpm or 353 mgd. During the year the pumps are operated as follows:

Units 1 and 2 - During 4 winter months (Dec., Jan., Feb., and March) two of the 23,500 gpm pumps do not operate at all. For eight months per year all 4 - 23,500 gpm pumps will not be operated during the weekends. During the week days, for 10 hours each day, 2 of the 23,500 gpm pumps are off for 12 months per year. Approximately 7 weeks of the time, 2 are out for 24 hours per day. On a yearly basis, the pumps for units 1 and 2 average 55 mgd. During the 8 warm months they average 65 mgd while during the 4 winter months they average 12 mgd. The maximum pumpage would be 106 mgd and would occur for a 5-day duration.

For units 4 and 5, during approximately 3 months of the year when the water temperature is below 40°F only 2 of the 37,700 gpm pumps are operated. The remainder of the time both are operated.

The total maximum warm weather pumpage is then approximately 323 mgd. During the winter months the rate would be approximately 150 mgd.

The ash transport pumps for units #1, 2 and 3 operate approximately 2 hours per day during the gas season (April through September) and 4 hours a day during the remainder of the year. The #4 unit pump operates 3 hours per day during the gas season and 6 hours per day otherwise. The #5 unit operates 12 hours per day regardless of season. The warm weather pumpage then averages 0.88 mgd while the cool weather average is 1.2 mgd.

The salt water is used for condenser cooling and ash transport.

The salt water used for the condenser cooling is chlorinated at the rate of 1 mg/1 with an average residual of 0.5 mg/1 in the effluent resulting. Units 1 and 2 are chlorinated every 4 hours with 34 pounds of chlorine gas when the water temperature is about 45°F. Below 45°F the treatment is every 6 hours.

Units 4 and 5 are treated at the same frequency with 50 pounds of chlorine gas per treatment. Each treatment takes 20 minutes. In 1965, 75 tons of chlorine were used.

2. Fresh Water

Treated in the demineralizer plant for use in the steam cycle of units 1 through 5. Portion used for drinking, washroom facilities, etc.

6. Sewage:

Sanitary wastes from this plant are discharged to a 3,000 gallon septic tank with a 100' x 66' tile drainage field. This field lies to the east of the main plant. There is no direct discharge to the river.

WASTE SOURCES AND TREATMENT

7. Demineralizer Waste:

Wastes from the demineralizing plant consist of dilute solutions of sulfuric acid and caustic soda used to regenerate the ion exchange resins in the two-bed and mixed-bed units.

8. Quantity of Waste:

The quantity of waste produced by the demineralizer consists of 2,230 gallons (1,230 regeneration w/1.6% H_2SO_4 followed by 1,000 gallons rinse water) for each cation bed; 2,636 gallons (1,136 regeneration w/1.6% caustic followed by 1,500 gallons rinse water) for each anion bed. Approximately 300 gallons of water are used in each bed for backwash. The combination of the waste waters gives an alkaline mixture.

9. Method of Disposal:

The waste from the plant is collected in a sump. From here it is pumped into the condenser cooling water intake canal. It then flows through the condenser and is discharged with the cooling water.

10. Description of Facilities:

The disposal facilities consist entirely of the sump storage area and pumps to the condenser cooling lines.

11. Boiler Acid Cleaning Waste:

An ammoniated citric acid solution fortified with 0.2% sodium nitrite and a wetting agent is used for acid cleaning the boilers. Boilers are cleaned, based on condition, every 1-10 years. The cleaning waste, approximately 30,000 gallons, flows to the condenser cooling water lines before cooling the condensers.

12. Solid Wastes - Slag and Fly Ash:

Slag and fly ash from all five units is sent to the waste ponding area adjacent to the plant site. The solid wastes settle out and the water is returned to the Raritan River. Approximately 28,000 yards of slag and ash per year is collected and carted away by a contractor.

13. Thermal Pollution:

Cooling waters discharged to the Raritan River are at a temperature 10 to 15°F higher than that of the intake water. The following table gives the average monthly temperatures in °F for the condenser outlet and inlet lines and for units 1, 2, 3 and 4/5. This data is for year 1965.

27b

	Influent		Effluent	
MONTH	Units 1,2,3	Units 4,5	Units 1,2,3	Units 4,5
Jan	38.2	36.0	46.7	49.1
Feb.	37.0	35.6	46.6	48.7
Mar	43.2	43.2	51.3	54.7
Apr	52.9	51.0	59.6	64.1
May	68.5	67.5	76.1	80.1
June	74.2	73.8	82.5	86.6
July	80.3	79.5	88.3	93.1
Aug	80.0	79.5	88.8	93.2
Sept	74.9	74.6	83.3	87.0
Oct	62.4	62.3	71.1	76.5
Nov.	51.1	49.2	60.7	62.1
Dec	44.0	43.6	54.1	56.5

International Flavors and Fragrances Incorporated

Union Beach, N. J.

1. Organization:

This plant of International Flavors and Fragrances, Inc., is located on the southern shore of Raritan Bay at Union Beach, New Jersey. The facility employs approximately 350 people and is operated on a 24 hour, six day per week basis. Approximately 75 percent of the force works during the day and the remainder at night. The company's main executive and operating offices are located in New York City.

2. Products - Operations:

This installation is engaged in the production of intermediate essence and essential oils. The manufacture of these products involves compounding, processing, reacting and distillation of various chemical products. The operations are usually batch type and involve the use of in excess of 400 separate chemicals. In excess of 300 separate production materials are produced during the calendar year. Two products - Myrcene and Phenyl Ethyl Alcohol - are produced almost continuously.

3. Water Supply:

International Flavors and Fragrances maintains its own domestic and industrial water supply. At the present time three wells are on the property. However, only two of these sources are active. The combined capacity of these two wells is 635 gpm, with one having a capacity of 500 gpm. In the event of a breakdown within the plant - pressure maintained at approximately 80 psi - city water at approximately 55 pounds will cut in automatically.

29b The well water, which is obtained from a depth of 300 feet, is extremely soft, and high in hydrogen sulfide, carbon dioxide, and ferrous iron. A Zeolite softener reduces the iron content from 9 ppm to .1 ppm; chlorine is used to remove the remainder. H_2S and CO_2 are removed by aeration.

The total water consumption at the plant site has been shown to average 130 gallons per minute and may be accounted for in the following table:

	gpm
Boiler House makeup	35
Cooling Tower consumption	30
Domestic usage	10
Flow to waste treatment plant	25
Dilution water for experimental waste treatment plant	10 to 20
Miscellaneous losses, production retention and untreated discharge	10

4. Sewage:

All sanitary wastes are treated in septic tanks. At the present time there are five different systems with tile fields serving the plant.

5. Waste Characteristics:

30b The waste reaching the treatment plant is an intermediate strength acid solution containing small amounts of lost aromatic chemicals and solvents. Stable salts of reactive materials are also present in the flow. Analytical determinations to specifically identify various forms of materials present have been unsuccessful. The strength of the waste has therefore been generally described in terms of its total dissolved solids, suspended solids, BOD and COD.

6. Treatment Facilities:

The present waste treatment plant consists of primary sedimentation and oil separation followed by chemical coagulation and precipitation. The effluent from these processes is then equalized for four days before discharge. The separated oils are drummed for disposal off site while the precipitated sludge is lagooned within company property. The effluent from the plant is discharged to a diffusion field on company property. During the summer months some leaching into Raritan Bay has been reported. Present treatment provides total removal of floating oils, 95% reduction in suspended solids and approximately 50% BOD reduction. The discharge from the treatment works averaged 25 gallons per minute flow, 2,530 lbs. BOD per day and less than 50 lbs. per day suspended solids during the period August 1964 to August 1965. Influent samples to the plant are not obtained on a routine basis due to analytical and collection problems.

In an effort to develop feasible methods of improving waste treatment in the plant, the company has, for the past 3-1/2 years, been engaged in extensive research and experimentation. It is recognized that the next step in the development of treatment is the establishment of a biological system to further degrade the wastes. Experimentation has indicated that the total dissolved solids concentration of the waste is in itself an inhibiting agent to effective biological treatment. The company has, however, developed a process, similar in concept to an aerated lagoon treatment, which is capable of reducing the remaining waste load to less than 300 lbs. BOD per day during the warm weather months. The present process has the marked disadvantage of requiring three gallons of water for each gallon of waste treated. Experimentation is proceeding to eliminate or greatly reduce this water requirement. The company's present experimentation is on a pilot plant capable of providing 95% reduction for approximately one fourth of the plant flow.

7. Untreated Wastes:

Two other waste sources have been identified in the plant that do not reach the combined treatment system. The first of these involves a stream containing high concentrations of aluminum chloride. This stream, although low in volume, causes significant difficulties when admixed with other wastes in the treatment system. At present, the largest portion of this waste is stored and periodically removed by truck from the plant site. The dilute washings from the process are discharged directly into the plant dispersion field. Studies are presently underway to provide pretreatment for this waste so that it may be discharged to the waste treatment plant. The remaining source of discharge is a small intermediate chemical process which sometimes produces a dilute chromate solution. Chromium present in this stream is always converted to the trivalent form before discharge to the ground.

S. S. White Company, Prince Bay
Staten Island, N. Y.

1. Organization:

This plant is a solely owned non-affiliated firm, with executive offices in Philadelphia, Pennsylvania. It was known formerly as the S. S. White Dental Manufacturing Company. The plant owns 15 acres in Prince Bay, Staten Island, of which 5 acres are occupied. Approximately

350,000 square feet of floor space is in use. There are a total of 650 employees, including office personnel and operating staff, at this plant.

2. <u>Products</u>:

This plant of S. S. White produces annually the following:

Dental Burs and Handpieces - 4,500,000

Dental furniture -- Chairs: 2,000; Dental Units: 1,200

Nitrous oxide - 110,000,000 gallons

Dental filling and impression materials - 76,000 lbs.

Molded plastics - 48,000,000 pcs.

Resistors - 100,000 pcs.

Flexible shafting - 40,000,000 feet

Flexible shafting - fittings 50,000 pcs.

3. <u>Raw Materials</u>:

Raw Materials - annually used - include:

Iron: Pig 25 tons - Scrap 15 tons - Steel 90 tons

Brass 30 tons

Chromic Acid	- 1000 lbs
Nickel salts	- 800 lbs
Copper	- 500 lbs
Cadmium	- 100 lbs

34b

Zinc	-	200 lbs
Cyanides	-	500 lbs
H_2SO_4 - Sulfuric acid	-	5000 lbs
Potassium permanganate	-	500 lbs
NaOH - Sodium hydroxide	-	200 lbs
Ammonium nitrate	-	1500 tons
Plastics	-	90 tons

Aluminum: Bar & sheet 11,000 lbs - Castings 85,000 lbs.

4. Capacity:

Quantities listed in Section 5 represent about 85% of plant capacity.

5. Operations:

The plant is in operation 5 days per week, 8 hours per day, on a year long basis. Some departments work 16-22 hours a day but no appreciable waste discharge takes place during these extended shifts. During a normal day the only continuous discharges are in the plating and rinsing sections.

6. Water Supply:

Fresh water from New York City is used at a rate of approximately 57,000 gallons per day. Salt water, pumped from Raritan Bay at a rate of 1,000 gpm, is used for cooling purposes.

7. Sewerage:

Two separate sewer systems serve this facility. Sanitary wastes flow by gravity through a 12-inch sewer to a 1,800 gallon chlorine retention tank. The chlorinated effluent is then mixed with the cooling water return prior to being discharged to Raritan Bay.

Industrial wastes are collected in 12-inch sewers and discharged directly to the Bay without treatment.

Approximately 100 lbs. per month of chlorine is used for disinfection. The effectiveness of this treatment is questionable since the contact tank is subject to flooding during high tides. Also, no attempt is made to maintain a "bacteria killing residual" -- chlorine is fed at the same rate, regardless of flow.

8. Principal Processes:

Because of the variety of products, no one outline completely describes the process. In general terms, however, it would include casting, plating, rinsing, painting, machining, assembly, mixing and preparing chemical products.

WASTE SOURCES

9. General:

Treatment of a metallic surface prior to the application of a metallic coating such as copper, nickel, chrome, gold, cadmium, zinc, etc., or prior to the application of paint or lacquer, usually involves the use of an alkali cleaner as one of the initial steps. Proprietary cleaners are usually used which may contain one or more of the following chemicals. sodium hydroxide, sodium carbonate, silicates of soda, sodium phosphate, and detergents.

Being strongly alkaline these materials are followed by water rinses and, in some cases, neutralizing acid dips before further treatment. Where removal of rust or heavy coatings of oxide is required, very strong acids are used. Water rinses follow these acid treatments. Water rinses of unknown quantities from both acid and alkaline cleaning processes are continuous discharges to the sewers. Such rinses are not shown on the following list of processing solutions used in the various departments. (See A below and B through M on following pages.)

Solutions, suspensions, or solids marked with an asterisk are normally only temporarily contained in vessels or are discharged directly into sewers. Alkali cleaners are used for one to four weeks before being discarded. Plating solutions, cyanide dips and acid dips generally have a much longer life before being discarded. Alkali cleaners and the latter group of solutions are periodically replenished in concentration of constituents since a certain amount of depletion takes place due to chemical or electro-lytic action, and to "drag-out" by parts in process. Heat treating baths are similarly replenished in concentrations over rather extended periods of time.

An average of about 50,000 gallons per day of combined process wastes are discharged to the Bay.

A. Metallurgical Department

1. Surface preparation and plating solutions

Alkali Cleaner

Nickel Strick

nickel chloride and hydrochloric acid

Copper Plating

copper sulfate and sulfuric acid

Nickel Plating

nickel sulfate, nickel chloride, boric acid, organic brighteners and wetting agents

Chromium Plating

chromic acid and traces of silico-fluorides

Bright Dip

nitric and sulfuric acids

Gold Plating

gold cyanide, potassium cyanide,

potassium carbonate

2. Processing Solutions

Sulfuric Acid - 5%*

Methyl alcohol*

Hydrochloric acid

Detergents*

B. <u>Engineering Division</u>:

Acetic acid*

Ammonia*

Sodium sulfite*

Potassium Ferrocyanide*

Photographic developing and printing*

C. <u>Chemical Department</u>:

(residues washed from processing equipment)

Detergents*

Zinc oxide*

Arsenic tri-oxide*

Aluminum oxide*

Acetic acid*

Phosphoric acid*

Alginates*

39b Alcohols*

Toothpaste*

D. Chemical Laboratory:

Samples of all plating solutions, anodizing solutions and bonderizing solutions*. Solutions from general laboratory analyses containing mainly nitric, hydrochloric and sulfuric acids*.

E. Bur Department:

Copper Plating

copper cyanide, sodium cyanide, sodium carbonate

Cyanide Dip

sodium cyanide

Alkali Cleaners

proprietary

Chromium Plating

chromic acid, traces of silicofluorides

Copper Strip

chromic acid, sulfuric acid, copper

Hydrochloric Acid

Steel Blackening

alkaline nitrate (proprietary)

Heat Treating Bath

molten sodium cyanide

F. Chemical Packaging:

Glue, paste (from cleaning of equipment)*

G. <u>Handpiece Department:</u>

Heat Treating Baths

molten sodium cyanide, cyanate and carbonate

molten barium salt bath (neutral)

Alkali Cleaner

proprietary

H. <u>Plating Room:</u>

Alkali Cleaners (10)

proprietary cleaners containing hydroxides, silicates, borates and detergents

Acid Dips

hydrochloric (4) (1-1 by volume)

sulfuric (5) 5 to 35%

nitric (2) 2% and 20%

nitric-sulfuric (1-2 by volume)

Cyanide Dips (3)

sodium cyanide

Dichromate Dip

proprietary - dichromate and nitric acid

Copper Plating (2)

copper cyanide, sodium cyanate, sodium carbonate, Rochelle Salt, potassium cyanide, potassium carbonate, potassium tartrate, organic brighteners and wetting agents.

Nickel Plating (3)

nickel chloride, nickel sulfate, boric acid, organic brighteners and wetting agents

Chromium Plating

chromic acid, traces of silicofluorides

Zinc Plating (2)

zinc cyanide, sodium cyanide, sodium hydroxide, sodium carbonate

Cadmium Plating (3)

cadmium cyanide, sodium cyanide, sodium hydroxide, sodium carbonate

I. <u>Japan Shop</u>:

Anodizing Process

alkali cleaner

Bright Dip

chromic acid, sulfuric acid

Anodizing Solution

sulfuric acid

Dye Solution

organic dyes

Acetate Sealer

nickel acetate

Dichromate Sealer (2)

potassium dichromate (1-5%)

Stripping Solution

chromic acid, phosphoric acid

J. Bonderite Process:

Alkali Cleaners (2)

Parcolene Z

titanium phosphate

Bonderite Solution

boric acid, ferrous sulfate, sodium fluoride, phosphoric acid, zinc and manganese phosphates

Parcolene (8)

chromic acid

K. Paint Strippers: (3)

Alkali Solutions

Hydrochloric Acid (conc.)

L. Gas Department:

Sulfuric Acid (1%)

Alkaline Potassium Permanganate

Salt Water*

Nitric Acid - ammonium nitrate solution* - 80 gallons per hour per generator (approximately 1.7 lb HNO_3 per 80 gallons)

Alkali Cleaners

M. Power Plant:

Regeneration of Hydrogen Zeolite water softener (weekly) - 83 lbs sulfuric acid, discharged at about 2.5% solution

Sulfuric Acid

Sodium Sulfite

Di-sodium Phosphate

Sulfamic Acid Cleaners

WASTE TREATMENT

All industrial wastes - 50,000 gpd - are discharged without treatment other than dilution. A survey made in 1964 by the New York City Health Department reported that the company treated its cyanide wastes with copperas. No mention was made of this type treatment during the December 1965 meeting.

WATER POLLUTION ABATEMENT PROGRAM

An order to abate pollution was sent to the company by the New York City Health Department in 1962. Based on this order a consulting engineer was hired to develop an abatement program. The proposed solution included combining the industrial and domestic wastes discharges and treating them together in a septic tank system with a total capacity of 16,000 gallons. A 30 minute

44b chlorination period at peak flow was also provided. The effluent from this system would be mixed with the cooling water return before discharge to Raritan Bay.

During the past year the Health Department has "loosened up" on their abatement order since a sewer is planned for the area. As the situation stands now S. S. White is waiting to connect to a city sewer and will not proceed with their original plans. As of this writing, no estimate is available as to when the city will provide the sewer.

Procter and Gamble Manufacturing Company
Port Ivory, Staten Island, N.Y.

1. Organization:

The Port Ivory plant of Procter and Gamble Manufacturing Co., is located at the northern end of the Arthur Kill in Port Ivory, Staten Island, N. Y. The facility, which employs approximately 1200 people, first began operation in this area in 1907. The plant presently occupies 122.5 acres.

2. Products:

The products of this plant are broken down into the following four categories:

Paul DeFalco

45b

Cake Mix - Duncan Hines

Shortenings-Oils - Crisco, Fluffo, Primex, Flakewhite (latter two industrial)

Synthetic Detergents - Duz, Tide, Cheer, Oxydol, Ivory Flakes

Soap-Bar: Lava, Camay, Ivory, Zest

Liquid: Mr. Clean, Top Job

Cleanser: Comet

3. Raw Materials:

Raw materials used include:

Cake Mix - flour, sugar

Shortening - Oils - Soy bean oil, cotton seed oil, hydrogen

Synthetics - Linear Alkyl benzenes, H_2SO_4, sodium phosphate

Soap - Animal fats, sodium and potassium hydroxide

Raw materials are delivered by both tank cars and trucks.

4. Capacity:

Figures on plant capacity or output are confidential; figures on raw product quantities are also unavailable. Reportedly, however, there is no seasonal fluctuation in output.

5. Operations:

Essentially there are four separate operations at this plant.

Cake Mix: flour, sugar and shortening are mixed to provide desired mix. Material is then packaged and shipped.

Shortenings-Oils: Raw oils are refined, hardened by passing hydrogen through the oil, deoderized under vacuum, chilled and then packaged in cans or bottles.

Soap: Fats are split, yielding fatty acid; neutralization with caustic follows. Dry "plastic" product formed is extruded and cut into bar lengths, cured, stamped, and packaged.

Synthetics: neutralize LAS with H_2SO_4; add phosphate, builders and mix; spray dry, then package.

6. Water Supply:

Two sources of water are available, namely Arthur Kill and the municipal system of New York City.

Fresh water, used at a rate of 1,800,000 gpd is used for steam generation, drinking and sanitary purposes, and for processing.

Salt water from the Arthur Kill is used on a once through basis for cooling at a rate of 4,000,000 gpd. Quality of Arthur Kill water presently satisfies the needs of the plant. No problems have been encountered with corrosion or clogging as a result of these waters being used for cooling.

7. Sewerage:

The Port Ivory Plant now has combined sewers discharging at a number of points -- eight -- into Bridge Creek, and one directly into the Arthur Kill where it joins Newark Bay. The total plant effluent includes wastes streams from:

1. Processing equipment used primarily in the manufacture of:

   a. Household soaps and detergents

   b. Shortenings, edible oils and prepared baking mixes

2. Sanitary wastes from toilets and locker rooms

3. Plant cafeteria

4. Plant chemical laboratory

The average dry weather flow of wastewater from all sources, measured in June 1963 during five consecutive operating days, was 5,450,000 gallons per day. The combined sewers also collect and discharge storm water run-off from much of the 122.5 acres of plant property.

WATER POLLUTION ABATEMENT PROGRAM

Background

Procter & Gamble realized many years ago that it would become necessary to stop discharging raw wastes to Bridge Creek and the Arthur Kill. A survey of Port Ivory wastes was completed in 1954 and updated in 1963 -- See Table I - in preparation for negotiations with the New York City Department of Public Works to accept these wastes for treatment in the Port Richmond Sewage Treatment Plant. Tests at the University of Wisconsin showed that Procter & Gamble wastes could be treated satisfactorily in conjunction with domestic wastes.

The city agreed in principle with this joint treatment at a time when an interceptor sewer would be available to bring Port Ivory wastes to the Port Richmond treatment plant. Subsequent negotiations with the Department of Public Works confirmed the agreement in principle for joint treatment. Procter & Gamble will pay treatment charges to the city in accordance with the established city schedule based on volume, suspended solids and biochemical oxygen demand.

Procter & Gamble received an order dated April 11, 1963, from the Commissioner of Health, City of New York, to cease discharging untreated wastes by April 26, 1964. The Commissioner of Public Works on May 23, 1963, wrote to the Commissioner of Health requesting an extension of the order to Procter & Gamble on the basis that it would be in the best interest of the city to treat Port Ivory wastes at the Port Richmond Treatment Plant and that it would take both the city and Procter & Gamble longer to complete the necessary engineering and construction. The date for compliance with the order now has been extended to June 1, 1967. There will probably be another extension of the order until mid-1968, which is the present New York City target date for completion of the Richmond Terrace interceptor.

Summary of Plans

Procter & Gamble proposes to segregate dirty wastewater from clean wastewater with the installation of a new plant sewer system to collect all sanitary wastes and the industrial wastes which contain significant pollution. Detergent-bearing wastewaters will continue to be discharged to the kill through a special sewer line.

A. Clean Water

The existing sewer system will be reserved for storm water run-off and the discharge of clean cooling water, most of which is salt water. This system will continue to discharge through existing outfalls to Bridge Creek and the kill. Table II shows the expected flows and characteristics of these flows.

B. Detergent-Bearing Wastewater

Salt water used for scrubbing the exhaust air from the synthetic detergent spray drying tower and water used for periodic wash-down of the tower will be piped to the end of Pier No. 3 where the wastewater will be discharged into the kill through a distributor submerged below low tide level.

C. Dirty Water

A new sewer system will collect all sanitary wastes and those process wastewaters which are significantly polluted. Since certain limited outdoor areas in the plant, representing less than one percent of the total area, are subject to leaks and spills, storm water run-off from these areas also will join the sanitary sewers.

These polluted waters will be collected in a gravity sewer system ending in an underground sump. The wastes will be pumped out of the sump through a force main and discharged into a manhole of the city's projected interceptor sewer at the corner of Richmond Terrace and Western Avenue.

A detailed description of the new dirty water sewer system including pretreatment, anticipated flows and waste characteristics is given in the company supplied report. Pretreatment includes the use of fat traps, neutralization of acid wastes, and the use of flow limiting devices to reduce fluctuations in volume and BOD pumped to the city sewer.

D. Pollution Abatement Effects

This sewer segregation project reportedly will have the following effects on the plant's discharge to Arthur Kill:

1. Remove all floating matter

2. Remove settleable solids

3. Remove color, taste and odor producing materials

4. Remove more than 85% of the present BOD contribution to Arthur Kill. Compared to 1954 loads the reduction reportedly may be as much as 96%.

The existing waste discharges contain no toxic materials or immediate dissolved oxygen demand.

Status of Program:

Procter & Gamble has already begun its program of reducing wastes loads -- eliminated Hydrolizer wastes in December 1965. Completion of the full pollution abatement program is expected to coincide with the date that New York City provides a sewer to the facility, mid-1968.

TABLE I - 1963 SURVEY OF EXISTING WASTES

Summary of Results of Sampling and Metering Program

		Average Pounds/day		
Outfall	gpd-Flow	S.S.	B.O.D.	ABS
A	596,000	1,100	3,335	--
B	Abandoned	--	--	--
C	14,200	--	--	--
D	122,000	166	2,670	--
E	Abandoned	--	--	--
F	75,500	--	--	--
G	2,770,000	1,400	1,215	--
H	691,000	706	3,530	--
I_1	6,800	2	3	1
I_2	200,000	592	269	239
J	962,000	665	943	--
Totals	5,437,500	4,631	11,965	240

TABLE II - PROPOSED DRY WEATHER FLOWS TO ARTHUR KILL
(see Appendix, Section 1 for additional detail)

Outfall	gpd Flow	P&G Report Average Pounds/Day S.S.	B.O.D.	ABS
A	131,000	-	-	-
C	14,000	-	-	-
D	65,600	-	-	-
F	75,400	-	-	-
G	2,460,000	-	491	-
H	278,000	-	3	-
I_1	5,800	-	-	-
I_2*	201,000	592	269	240
J	1,065,000	22	15	-
Totals	4,295,800	614	778	240

For Comparison
Wastes to Arthur Kill from:

1963 Survey	5,437,500	4,631**	11,965**	240
1954 Survey	5,610,000	14,500	18,500	

Reduction From:

1963 Survey	21%	87%	93%
1954 Survey	23%	96%	96%

* Detergent-bearing waters to be discharged at the end of Pier No. 3 instead of to Bridge Creek.

** Reductions in SS and BOD from 1954 to 1963 are the result of removing spent bleaching earths from the plant effluent and technological changes in processing.

General American Transportation Corporation, Terminals Div.

Carteret, New Jersey

1. Organization:

The Terminals Division of General American Transportation Corporation is located at the eastern edge of Carteret, New Jersey, adjacent to the Arthur Kill. The facility, located on 57 acres, employs approximately 200 people.

2. Products:

This facility of General American Transportation Corporation is a warehouse for a wide variety of liquid chemicals, naphthas, petroleum products and plastic pellets. The organization is essentially in the business of leasing storage tanks and providing manpower necessary for the shipment of these products. Approximately 20 to 25 chemical or petrochemical industries are participants in this operation.

Materials for this operation are brought in and distributed by ship, barge, truck or tank cars.

3. Capacity:

This plant has the capacity of storing approximately 2.5 million barrels of liquid.

4. Operation:

Essentially, this plant operates eight hours per day, five days per week. The waterfront operation, however, operates 24 hours a day, seven days per week.

5. Water Supply:

The only source of water is the Middlesex municipal supply. Approximately 100,000 gpd is used during the winter months -- 60,000 during other periods. Sixty percent of the water purchased is used for steam production; the remainder being used for cleanup, washdown and sanitary purposes.

Steam is used for heating approximately 20 percent of the tanks, normal heating, and for various smaller operations.

6. Sewage:

Sanitary wastes from the facility, with the exception of one building, are treated by septic tank systems. The area not being handled is discharged to the plant's oil-water separator system described below.

WASTE TREATMENT

7. Oil-Water Separators:

This plant of General American Transportation Corporation has two oil-water separators which receive run-off from the diked storage areas, plus any other cleanup or washdown waters. It is estimated that the flow to each unit is 4 gpm.

Reportedly, the sole source of wastes during dry periods is condensate from the steam system, and water lines which are kept running for reasons of safety. During the winter some of the plant's lines are kept running in order to eliminate freezing.

There are no analytical results available on the characteristics of the wastes which now discharge into the Arthur Kill.

WATER POLLUTION ABATEMENT PROGRAM

At the request of the Interstate Sanitary Commission, the Terminals Division of General American Transportation Corporation, initiated studies to determine whether or not it would be economically feasible to treat their own wastes. Infilco, which is owned by General American Transportation Corporation, provided the technical assistance on this problem. The final decision reached was that it would be more economical, because of the low flows, At the present time, the company has completed the design and has had plans approved for this tie in. It is anticipated that by no later than June 1, 1966, this connection will be completed. This arrangement is being made with the cooperation of FMC Corporation, who is permitting the Terminals Division to tie into their sanitary sewer, which in turn is connected to the municipal system.

Archer Daniels Midland Company
Elizabeth, New Jersey

1. Organization:

The Marine Oil Division plant of the Archer Daniels Midland Company is located at the eastern edge of Elizabeth, New Jersey, between the Arthur Kill and South Front Street. The facility, which employs approximately 50 people, began operation in this area about 80 years ago. The company's main executive and operating offices are located in Minneapolis, Minnesota.

2. Products:

This plant of the Archer Daniels Midland Company is essentially a fish and sperm oil processing plant. Production is by batch operations. The principal finished products are:

<u>Fish Oil</u>

Pressed

Refined -- used in paint and varnish industry

<u>Sperm Oil</u>

Pressed

Refined -- used as lubricating oil

<u>Wax</u> - used in cosmetic industry

<u>Vegetable Oil</u> - oxidized body used in paint and varnish industry

3. <u>Raw Materials</u>:

Raw materials used include:

Fish oils - 45% of crude

Sperm oils - 45% of crude

Vegetable oils - 10% of crude

Caustic soda, used for refining, 300,000 lbs per year

Sulfuric acid, used for neutralizing; 275,000 lbs per year

Sperm oils are delivered approximately five times per year by tankers, and fish oils are brought in approximately eight to ten times per year by barges. Tank cars are used for supplying the crude vegetable oils. Crude is stored in tanks which have a total capacity of six million gallons.

4. <u>Capacity</u>:

The plant has the capacity of processing approximately 40,000 to 48,000 gallons per day of oil. There is no seasonal fluctuation in output.

5. Operations:

Essentially, there are three separate operations at this plant: Filtration of crude oils; oxidation of oils; and refining.

Filtration of Crude Oils: Crude fish and sperm oils are chilled and then filtered on a rotary-type vacuum filter.

Oxidation of Oils: A small quantity -- 1% to 2% -- of the filtered fish oils, filtered sperm oils and vegetable oils are applied to the plant's blow tanks. The finished products from this process are blown oils and oxidized oils.

Refining Process: Filtered sperm oils and filtered fish oils, along with caustic, acid, steam and vacuum, are applied to the refining tank. The finished product from this unit is refined oils. The soap and wash water from the refining tank is further treated in a split tank to produce soap stock. Sweet water from the split tank is discharged to the separator. This waste will have a high BOD because of the glycerine content.

The refining process, presently a batch

operation, is being converted to a continuous operation. This change-over is expected to be completed by July 1, 1965.

The plant operates 24 hours a day, 7 days a week, 12 months a year. The availability of crude oil is the controlling factor in the plant's operation. All three crudes -- fish, sperm, and vegetable oils -- are generally run simultaneously.

6. Water Supply:

Two sources of water supply are available, namely, Arthur Kill and the municipal supply from the City of Elizabeth. Fresh water is used for steam generation, cooling oil processing kettles, refining, drinking and sanitary purposes. Water which is used for steam generation -- maximum output 17,000 lbs/hr -- is not condensed and re-used, as the company has found it desirable to let it go off as free steam rather than taking the chance of contaminating the condensate. Approximately 200,000 gallons per day of fresh water are used by this installation.

Salt water from the Arthur Kill is used at a rate of 240,000 gallons per day. This water is used on a once-through basis for the condensers in the plant's refrigeration system. The quality of the Arthur Kill water presently satisfies the needs of the plant. No problems have been encountered with corrosion or clogging as a result of these waters being used for cooling.

When comparing existing fresh water intake records with fresh water use -- based on pump capacity and steam generating capacity -- there is a large quantity of unaccounted-for water. Reportedly, a maximum of 22,200 gallons per day of fresh water is used in the filtration process; 3,000 gallons per day in the blow tanks; and 3,000 gallons per day in the refining tanks. The total capacity of the steam generating plant, as previously mentioned, is 17,000 lbs. per hour, which is equivalent to 35 gallons per minute (50,400 gallons per day). Therefore, the maximum total accountable for-fresh water is 77,600 gallons per day, which is far below the 165,000 gallons per day figure recorded by the company's water meter.

7. Sewerage:

All sanitary wastes from the facility go to the municipal plant -- Elizabeth Joint Meeting. Processing waters and wastes are collected in open concrete lined trenches, which discharge to the separators.

8. Principal Processes:

Principal processes at the Archer Daniels Midland Company are filtration, oxidation and refining.

WASTES TREATMENT

9. Oil-Water Separators:

This plant of the Archer Daniels Midland Company has two oil-water separators. The larger of the two units -- 10'6" X 19'11" X6' SWD -- is used continuously except for period of cleaning when flow is diverted to the small -- 5' X 14' X 6' SWD -- oil water separator. During the past year, the larger unit has only been taken out of service once.

Skimmings from the separators are pumped back to the plant for processing. Sludge is removed by scavenger approximately once a year.

There is presently no flow indicating or recording device at the plant. Flow records are based on water use data, which as previously mentioned, are questionable. It is estimated that wastes flows are approximately 15 gallons per minute with peaks reaching as high as 50 gallons per minute. Effluent from the treatment units is discharged to the Arthur Kill through 15 inch and 12 inch diameter submerged pipes.

10. Analytical Results:

Only parameter checked routinely -- once a day -- is pH of the effluent. Past records indicate that the change in temperature for the cooling water is approximately 8 - 10°F.

On July 19, 1962, a series of samples were taken by the New Jersey State Health Department and the Interstate Sanitation Commission. Results of these grab samples are as follows:

	Point I - Separator Effluent			Point II - Cooling Water Effluent		
Sample No.	DO	BOD	Ether Soluble	DO	BOD	Ether Soluble
1	0.8	82	289	5.5	<11	18.1
2	6.9	127	349.7	5.7	<10	11.8
3	1.6	117	64.4	5.6	<7	20.1

COMPOSITE

	Separator Effluent I	Cooling Water Effluent II	Raw Water Intake
DO	0.8	5.9	0.4
BOD	104	<15	64
Alkalinity	58	118	---
COD	412	173	2,506
Phenols	Trace	Trace	0.05
Sulfides	Neg	Neg	--
Settleable Solids	18.0	2.0	8.0
Salinity	--	2.12%	1.19%
Chlorides	33.0	--	--

WATER POLLUTION ABATEMENT PROGRAM

In 1963, the firm engaged Roy F. Weston, Inc., consulting engineers, for professional assistance and guidance with regards to water pollution control. The service provided involves quarterly review with the plant management of pollution control problems. Following such reviews, recommendations are made for maintaining and up-grading continuing control program. Recommendations from the consulting engineers have resulted in the following:

1. The broadening of the effluent sampling (pH) and observation program from once per week to once daily.

2. Design modifications of the oil water separator, which include changes in the inlet design and removal of all baffles but the final.

3. An inspection schedule to insure proper operation of the oil water separators -- visits now made on an hourly basis.

4. Installation of an in-plant separator-holding tank to equalize water discharges and trap oily "heels" from batch treatment tanks. These units have reportedly prevented oil slugs and flow surges to the separator unit.

Koppers Company, Inc., Forest Products Division

Port Reading Plant, Port Reading, New Jersey

1. Organization:

The Port Reading Plant of the Forest Products Division of Koppers Company, Inc., is located at the eastern edge of Port Reading, New Jersey, adjacent to the Arthur Kill. This facility, located on 55 acres, 13 of which are in Carteret, was purchased by Koppers in 1956. The installation, built in 1910, was previously owned and operated by the Port Reading Railroad. At the present time, approximately 30 to 35 people are employed, with peaks of 50 being reached during the summer period.

2. Products:

This plant is essentially a wood preserving - creosoting - facility. Production is on a batch basis. The principal products are pilings, telephone poles and railroad ties.

3. Raw Materials:

Raw materials include wood - pine, oak or mixed hardwoods - in either pole or plank shape. Creosote and No. 6 fuel oil are used for preserving the wood.

Raw wood products may be either purchased by the company or supplied by a contractor, such as a railroad.

4. Capacity:

This plant has the capacity of processing or preserving 3,000,000 cubic feet per year of wood. Present output is approximately 1.5 million cubic feet per year.

5. Operations:

This plant can operate 24 hours a day, seven days a week, 12 months per year; at the present time, however, it is operating on a two shift, five day per week basis.

Wood, prior to impregnating, is dried either in the atmosphere or in a steam atmosphere in the plant's treating cylinder. After this pretreatment the wood is handled in the following manner:

1. Tram cars loaded with dried wood are placed inside the treating cylinder - 88 inches in diameter by 144 feet long.

2. Cylinder is sealed at both ends and filled with air in order to occupy the voids in the wood.

3. Cylinder is then filled with either creosote or a mixture of creosote and oil, at a temperature of 200°F. and at a pressure of 185 psi. Detention under

these conditions, depending on the type wood and product desired, varies from 2 - 2-1/2 hours.

4. Impregnating solution is removed from treating cylinder.

5. A vacuum is pulled on the whole cylinder in order to remove excess oil from the voids.

6. Wood is then removed and stored, ready for shipment.

Under normal conditions, 12 pounds of oil are applied per cubic foot of wood. If extra protection is needed, such as for salt water pilings, the wood contains upwards of 25 pounds of oil per cubic foot. Under these conditions the wood in the treating cylinder is initially placed under vacuum so as to permit greater absorption of the oil into the voids. (Step 2.)

6. Water Supply:

Only one source of water is available at this plant, namely, the Middlesex Water Company. Fresh water is used at a rate of approximately 1,000 gpd, with peaks running as high as 1,500 gpd. This water is used for makeup water in the recirculating cooling water system; cooling the air compressor; for vacuum units in the treating cylinder; and for sanitary and drinking purposes.

Steam, used in heating and processing, is purchased from the Sinclair Koppers Plant on the adjacent property.

Since the major source of wastewater is that volume of water which is trapped in the voids of wood - under normal conditions, 85 to 90 percent of the wood by weight is water - no comparison can be made between fresh water consumption and waste discharge volumes.

7. Sewage:

It is presumed that all sanitary wastes from this facility discharge to a septic tank. No plans or drawings are available to document this fact.

WASTE TREATMENT

8. Oil Water Separators:

Sources of wastewater are as follows: Steam condensate; water removed from the wood in the treating cylinder; floor washings; and water accumulations from pump drains. The average total flow is 5,000 to 7,000 gpd.

The plant's separator-type system consists of the following: Blowdown tank - most of settling takes place in this unit; dehydrator; two interconnected, heated, cylindrical settling units; and two rectangular-shaped settling tanks equipped with baffles to trap oil. (See diagram-FWPCA Files)

Oil recovered from the bottom of the blowdown tank goes to the oil dehydrator where steam is injected to boil off the water. The reclaimed oil is either sold or used within the plant. Decant from this tank then passes through the other settling-separating units before being discharged to a small tributary creek to the Arthur Kill.

9. Analytical Results:

The plant, because of its size, does not maintain continuous surveillance of its effluent. The task of checking the discharge is the responsibility of the company's research center at Monroeville, Pennsylvania. Results of a study conducted by this group on July 24, 1962, are as follows:

COD	6,300 ppm
BOD	2,500 ppm
Phenol	130 ppm
pH	5.8
Chloride	145 ppm
Turbidity	2,200 JCU
Total solids	2,280 ppm
Fixed solids	360 ppm
Suspended solids	880 ppm

Settleable solids	0.2 ml per liter

Samples were collected on a composite basis over an eight hour period and analyzed at the Monroeville Research Center.

The following are average wastes characteristics as supplied by the company:

Flow	3,000 to 5,000 gpd
BOD_5	1,500 to 3,500 ppm
pH	5.5 to 6.5
Chlorides	100 to 200 ppm
Total solids	2,000 to 3,000 ppm
Fixed solids	300 to 1,000 ppm
Phenol	100 to 150 ppm
COD	4,000 to 6,300 ppm
Oil (ether extraction)	500 to 1,000 ppm

The average figures supplied by the company are based on previous samplings at this plant and on effluent data from other company owned plants of the same capacity.

10. Pollution:

Wastes presently being discharged by Koppers are highly polluted. During the visitation, it was noticed that sludge from the creosote storage tanks was disposed of in an undiked area adjacent to a stream tributary to the Arthur Kill. During a storm period, it is felt that leaching from these sludge deposits could produce a noticeable phenolic load on the Arthur Kill.

Johns-Manville Products Corporation, Manville, New Jersey

1. Organization:

The Johns-Manville complex is divided into two sections: Research and Engineering Center at Finderne, New Jersey, and the Manville Plant, which is the production facility, at Manville, New Jersey. The Research Center, built in 1946, is located on 96 acres and employs approximately 850 people. The Manville Plant, located approximately two miles above the confluence of the Millstone and Raritan Rivers, was built in 1912 and presently employs 3,150 people. The actual plant site occupies 185 acres; however, Johns-Manville owns an additional 210 acres west of the plant.

2. Products:

Research and Engineering Center

Pilot production only, on new products and processes, is carried out at this location.

Manville Plant -- Water-Formed Production

Roofing felt (organic)

Asbestos paper

Flex-board (asbestos cement product)

Transite pipe

Cerro-form (ceramic fibers in wet medium)

Manville Plant -- Dry-Formed

Asbestos Textiles

Asbestos packings (sheet, coil)

Friction materials (brake linings, clutch facings)

Floor tile

Insulation (high temperature)

Lime-silica insulation (steam lines and boilers)

Asphalt roofings (rolls and shingles)

Asbestos cement shingles

3. Raw Materials:

Research and Engineering Center

None, other than those needed for pilot operations

Manville Plant -- Wet-Formed Production

Raw materials used include:

Asbestos fiber

Portland cement

Celite

Silica

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Hydrated lime

Wood (Jersey Pine)

Waste paper

Starch

Acrylic emulsion

Polyvinyl chloride emulsion

Silicate of soda

Separan*

Nalco-21S*

No. 2 fuel oil*

* Used to treat process water.

4. Capacity:

Water-formed production during 1964 amounted to 170,700 tons. This type production accounts for approximately 50-60 percent of total plant production.

5. Operations:

Research and Engineering Center

This facility functions on an 8 hour day, 5 day week. Operation consists primarily of pilot studies on new products and processes.

Manville Plant

Operation of this complex is on a 24 hour per day, 5-7 day per week, 52 week per year basis.

6. Processes:

Research and Engineering Center

None, other than various experimental processes.

Manville Plant

Only the two major water-formed products are described:

Transite Pipe - Mixing of cement, asbestos and silica to form a mat which is rolled on a mandrel until the desired thickness of pipe is attained. Mandrel is removed; pipe then cured in steam atmosphere for 20 hours - equivalent to 28 days; hydrostatic test performed on each pipe prior to shipment.

Roofing Felt (Organic) - Half of raw material from mixed papers processed in hydrapulper; other half comes from chipped Jersey pine processed through defibrators operating at 180 psi steam pressure. After blending and refining, the combined pulp is diluted to vat consistency of about 1%; screened and then formed on a single 120-inch face cylinder mold. Resulting web passes through wet pressing equipment to rotating steam drier rolls and intermediate and final calendering units which produce porous finished product.

Two paper machines, Number 5 -- with a capacity of 100 tons/day -- and Number 4 -- with a capacity of 50 ton/day -- are used for felt production. Bleed off from these machines - white water - averages approximately 20 gpm. It is estimated that the BOD of this waste equals 2,000 mg/1.

7. Water Supply:

Three sources of water, namely, Raritan River, Borough of Manville, and wells located on company property, are utilized.

Raritan River - Water used essentially for cooling and wet processing: Present total use - 13 mgd; maximum withdrawal 18.0 mgd.

Water used for power house cooling -- approximately 7.0 mgd of the 13.0 total - is discharged back to the Raritan with a temperature elevation of about 20°F. Manville Plant uses approximately 4.0 mgd for processing. An additional 0.5 mgd, obtained from the filtration plant which services the Research Center, is used as boiler feed.

The Research and Engineering Center withdraws approximately 1.0 mgd for processing and for washroom use at the Center. As mentioned above, half of this total goes to the Manville Plant. Treatment of this water consists of rapid sand filtration and chlorination.

Borough of Manville - Approximately 0.33 mgd for drinking purposes and special manufacturing operations.

Well Water - Approximate use - 40,000 gpd.

Well capacity is 0.3 mgd. Water used for high pressure jet cleaning.

A detailed water balance is given in Table I at the end of this report.

8. Sewerage:

Each section of the Johns-Manville complex - Manville Plant, Research and Engineering - maintains and operates its own wastewater treatment plant. Domestic wastes, however, are handled separately at the Borough of Manville Sewage Treatment Plant.

POLLUTION ABATEMENT PROGRAM

9. Wastes Treatment:

Research and Engineering Center

Primary plant, designed for maximum flow of 1.4 mgd. Sludge dewatered on vacuum filters. Chlorinated effluent discharged to Raritan River approximately 100 feet downstream from water intake for Research Center.

During the period January 1, 1965, to October 31, 1965, flow averaged 0.515 mgd; BOD influent - 24.6 mg/1, effluent - 14.4 mg/1; SS influent - 246 mg/1, effluent - 22 mg/1. Spot checks indicated coliform organisms were absent in effluent.

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Manville Plant

Treatment Consists of clarification, neutralization and chlorination. Facilities are designed for a maximum flow of 6 mgd. Detention time in sedimentation units -- two earthen diked basins used on an alternating basis -- averages 7 hours. Effluent is combined with Borough of Manville's, prior to being discharged below the confluence of the Millstone and Raritan Rivers.

During the period January 1, 1965 -- October 31, 1965, flow averaged 4.6 mgd; BOD influent -- 33.4 mg/1, effluent - 20.6 mg/1; SS influent - 469 mg/1, effluent - 17.2 mg/1; pH reduction 10.9 to 8.0; coliform organisms - none.

TABLE I

RARITAN RIVER USE - 1964

JOHNS-MANVILLE PRODUCTS CORP.

MANVILLE PLANT AND RESEARCH & ENGINEERING CENTER

	Manville Plant		Research & Engineering Center		Total	
A. Average Use-MGD	Intake col. 1	Discharge col. 2	Intake col. 3	Discharge col. 4	Intake col. 5	Discharge col. 6
1. Process						
a. Raritan	3.95	3.95	1.0	.5	4.95	4.45
b. Raritan	-	.5*	-	-	-	.5
c. Non-Raritan	.35	.35**	-	-	.35	.35
d. Metered ****	-	(4.8)	(1.0)	(.5)	-	(5.3)
2. Power Generation						
Raritan	7.0	7.0	-	-	7.0	7.0
3. Sanitary Sewage to Boro of Manville Sewers - Raritan	.2	-	.1	-	.3	-
Total Raritan	11.15	11.45	1.1	.5	12.25	11.95
Total Non-Raritan	.35	.35	-	-	.35	.35
Grand Total	11.5	11.8	1.1	.5	12.6	12.3
B. Peak Use - MGD						
1. Process-Raritan Only	4.9	5.5	1.2	.6	6.1	6.1
2. Power Generation	7.0	7.0	-	-	7.0	7.0
3. Sanitary Sewage	.2	-	.1	-	.3	-
4. Fire Protection	4.3	4.3	1.4	-	4.3	4.3***
	16.4	16.8	1.3***	.6	17.7	17.4

*Transfer from Research & Engineering Center
**Non-Raritan Water .3MGD from Boro of Manville and .05 MGD from Plant We
***Total includes Manville plant fire pumps only - (assumed that fires would rarely occur simultaneously at both locations)
****Not included in totals - explanatory only

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Philip Carey Manufacturing Company

Perth Amboy, New Jersey

1. Organization:

The Philip Carey Manufacturing Company is a publicly owned company occupying 43 acres in Perth Amboy, New Jersey. Main offices are in Lockland, Cincinnati 15, Ohio.

Approximately 250 people - 60 percent day shift, 25 percent second shift, 15 percent night shift - are employed on a round-the-clock basis. During the summer months the plant operates 6 or 7 days per week. A 5-day week is observed during other periods of the year.

2. Products:

Asphalt and asbestos building and roofing materials.

3. Raw Materials:

Waste paper	17,000 tons/year
Cord wood	11,000 tons/year
Jute	600 tons/year
Sawdust	900 tons/year
Asphalt	47,000 tons/year
Tar	5,000 tons/year

Roofing granules	26,000 tons/year
Sand	8,000 tons/year
Limestone	21,000 tons/year
Asbestos	1,800 tons/year
Portland cement	6,000 tons/year

4. Capacity:

To be supplied by company.

5. Operation and Processes:

The plant is divided into two sections -- asphalt and asbestos. In the asphalt section a mechanical pulp is made, pressed and dried. Asphalt and roofing granules are then applied to the rolled sheets.

In the asbestos section a mechanical asbestos pulp is produced. The remainder of the process is the same as in the asphalt section.

6. Water Supply:

Approximately 600,000 gpd of water are purchased from Perth Amboy's municipal supply.

7. Sewerage:

Three sewers carry all sanitary wastes to the City of Perth Amboy.

82b 8. Waste Sources:

Asphalt pulp section - 72 mg per year of process waste

- 33.3 mg per year of boiler water

Asphalt application section - 57.2 mg per year of process waste

Asbestos section - 48.6 mg per year of process waste

POLLUTION ABATEMENT PROGRAM

9. Wastes Treatment:

The operation sections of the plant are served by a Dorr-Clarifier treatment unit. A variable pH as well as high concentrations of solids and ether soluble material led to the installation of these treatment facilities. Present plans call for bringing wastes from the asbestos section to the treatment unit so as to obtain neutralization of the wastes.

10. Analytical Results:

Results of analyses, made before the clarifiers were installed, are as follows:

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5-day BOD	18-42 ppm
10-day BOD	32 ppm
ether soluble	trace to 11.4 ppm
total solids	178-287 ppm
suspended solids	39-144 ppm
dissolved solids	139-143 ppm
pH of asphalt section	6.5
pH of asbestos section	10.0

Effluent from both units is presently discharged to the Raritan River and sludge is disposed of at a land fill site.

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Paul DeFalco

REPORT

for

THE CONFERENCE ON POLLUTION OF

RARITAN BAY AND ADJACENT

INTERSTATE WATERS

THIRD SESSION

VOLUME III-APPENDICES

U. S. DEPARTMENT OF THE INTERIOR

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

NORTHEAST REGION - RARITAN BAY PROJECT

METUCHEN, N.J.

MAY 1967

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APPENDIX A

SHELLFISH RESOURCE - RARITAN BAY

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE, BUREAU OF STATE SERVICES

Division of Environmental Engineering and Food Protection

Shellfish, Sanitation Branch

NORTHEAST RESEARCH CENTER

Narragansett, Rhode Island

A Report on the

SHELLFISH RESOURCES OF RARITAN BAY, NEW JERSEY

Prepared by

Robert Campbell

Marine Research Biologist

2 July 1964

(Revised May 1965)

4m

Paul DeFalco

A REPORT ON THE SHELLFISH RESOURCES OF RARITAN BAY

Abstract

Cases of infectious hepatitis traced to clams harvested from Raritan Bay in 1961 stimulated a cooperative State-Public Health Service study of water and shellfish sanitary quality in the bay.

The present report describes the distribution of only two species of clams, the Soft Shell Clam, *Mya arenaria*, and the Northern Quahaug, *Mercenaria mercenaria*. Quantitative features of population sampling permitted statistical evaluation of the clam resource of Raritan Bay. This information, coupled with the bacteriological information being processed for a separate report, describes the clam-water relationship in Raritan Bay.

Density-distribution charts illustrate the diverse patterns of array found in the northern and southern sectors of the bay. A more evenly and widely distributed population is evident on the New York side while the contrasting New Jersey population is notably spotty in appearance. The distribution of these shellfish is further emphasized by this

survey and is no doubt related to hydrographic and substrate conditions inherent in the bay.

Consideration of the population on a State basis shows that New York possesses the greater density of quahaugs (hard shell clams) -- 1.05 individuals per square foot compared with 0.47 for New Jersey. In the standing crop estimates, New York contains almost a three-to-one ratio in millions of bushels over New Jersey.

Quantitative estimates for the various size categories show that "large" size quahaugs are two times more abundant than "necks." "Sub-legals" are the least abundant.

Soft shell clams appeared to be more abundant in the deeper waters. The majority of those in the western sector of Raritan Bay and coves of Sandy Hook were of smaller size compared with other areas of the bay. Instances of 50 or more individuals per square foot were not an uncommon occurrence.

A REPORT ON THE SHELLFISH RESOURCES OF RARITAN BAY

INTRODUCTION

Historical reviews of natural resources in m

estuarine environments recount the decline of the resource as being directly proportional to an increase of both domestic and industrial pollution. Over the years, however, it has become increasingly evident that overfishing of a resource, coupled with an increase of pollution and other man-caused environmental changes, may be considered the major agents responsible for an actual decrease or eventual extinction of a fishery (McHugh, 1964). Such has been the case of at least one important shellfish resource in Raritan Bay, New Jersey.

During the oyster's relatively short economic history within the confines of Raritan Bay, it has declined from a species of major commercial importance to a nonentity. Of the two clam varieties endemic to the area -- soft shell clam, *Mya arenaria*, and Northern Quahaug, *Mercenaria mercenaria*, the soft-shelled clam, although having declined considerably, has nevertheless managed to maintain a population in the western portion as well as the Sandy Hook section of the bay. Predictions relevant to the fate of the quahaug fishery are more difficult to form, due to the area-confining aspects pollution has had on the fishery. Until the below-described shellfish resource survey was completed, any estimates of the commercial shellfish resource in the whole of Raritan Bay were opinions based on conjecture.

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From an historical standpoint, the shellfish resources of Raritan Bay have been adequately summarized on several occasions over past decades as indicated by Dr. Julius Nelson's (1909) records on oyster production; Cumming, Purdy, Ritter (1916); and Cumming (1917) exhaustive studies of pollution of growing areas. Cumming and his associates confined their studies to the effect of domestic waste on shellfish waters, while Dr. Nelson (1916), during the same period, investigated the effect of industrial pollution in the form of metallic copper upon the oyster itself. Within a few years, following Dr. Nelson's studies, the oyster industry in Raritan Bay became virtually extinct due to this predicted effect of metallic copper on the environment (Nelson 1916).

Between the time of these major contributions and the present, ecological studies were initiated to evaluate the relationships of pollution to marine animals. An earlier study by Udell (1951) was concerned with the effect of pollution on shellfish. Later, a combination biological-oceanographic study was conducted to determine the distribution and diversity of planktonic organisms, as well as nutrients, in conjunction with current patterns and related pollution (Patten, 1959; Jeffries, 1962).

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Closely related to the sanitary quality of the waters of Raritan Bay is the related decrease in the availability of the shellfish resources. Over the span of 60 years more and more shellfish grounds have been closed due to sewage pollution, resulting in a rather steady decline in the fishery. Finally, by 1961, almost 90 percent of the original grounds had become unavailable.

As a result of public demand in the early part of the century, oysters were accorded a much higher rank than any other shellfish in Raritan Bay. According to Cumming (1917), about 20,000 acres on the New York side of the bay contained oysters, 8,000 of which were under cultivation by private industry. New Jersey, in comparison, accounted for much less in total productivity. Cumming also reported that "flats and foreshores have many extensive hard clam and soft clam producing areas." Sandy Hook was the most noticeable of these as a continuous producer of soft clams. Shellfish growing and shipping in New Jersey during this period was asserted to be one of the most important industries in the State with the annual oyster catch alone valued at from two to four million dollars.

Post-World War II evaluations of the shellfish resources in Raritan Bay are few in number and these are confined to investigations conducted by Rutgers University biologists on particular sections of the bay, with emphasis equally divided between life history studies and population studies. New Jersey waters, therefore, have received the bulk of the attention on the two commercial species. The soft clam, Mya arenaria, received considerable attention in the vicinity of Sandy Hook (Durand, 1950; Aldrich, 1951; Shuster, 1952), while all of New Jersey commercial grounds were evaluated for density and distribution of the hard clam, Mercenaria mercenaria (Haskin, 1962). Shellfish resource data are nonexistent for the New York section of the bay, except for hearsay and assumptions based on past catch records.

Considerable attention was focused on Raritan Bay in 1961 as a result of "an epidemic of infectious hepatitis traceable to the consumption of raw clams from the Raritan Bay which led, on May 1, 1961, to the closing of the Bay to the harvesting of clams," (First Conference Session, 1961). As a result of this epidemic an intensive study of the environment and shellfish resources was initiated to evaluate the existing conditions in order to make formal recommendations for the best use of the waters in the future.

Due to the general lack of an adequate resource inventory in Raritan Bay, it was necessary to plan and execute a survey of the clam population in conjunction with a consideration of the sanitary quality and human health aspects of the shellfish resource. It was also desirable that the resulting data could be used to provide information pertinent to the commercial shellfish industry of Raritan Bay and to resource-management agencies of New York. It is believed that the survey data can be useful in connection with consideration of activities affecting the standing crop and in predicting recruitment and projected value of the fishery in the near future.

The above statements reflect the objectives and interests of the Northeast Shellfish Sanitation Research Center in the shellfish resources of Raritan Bay. The study reported herein was conducted through cooperation with the Raritan Bay project of the Division of Water Supply and Pollution Control, Public Health Service, U. S. Department of Health, Education, and Welfare.

METHODS

The area under consideration, collectively referred to as Raritan Bay, is a triangular body of water with Lower Bay in the northeast sector, Raritan Bay located at the apex, and Sandy Hook Bay in the southeast sector. The bay extends inland for about ten miles between Staten Island, New York, to the northwest, and the east-west shoulder of

New Jersey to the south. The eastern base of the enclosure is a ten-mile base opening to the Atlantic Ocean. The boundary between the two States passes approximately from east to west through the middle of the bay area to the western end (Figure 1).

The area of Raritan Bay which came under direct consideration during the survey was inside an imaginary line from the northern tip of Sandy Hook to the easternmost point of Staten Island at the Narrows. The western limit was an imaginary line from Ward Point, Staten Island, southwest to the pier of the Jersey Central Power and Light Company in New Jersey (Figure 2). The northern and southern boundaries were the shorelines of Staten Island and New Jersey, respectively. Sampling was conducted to the mean low water mark and, through necessity, channel areas, restricted areas, and cable areas were excluded. The calculated sampling area totaled approximately 50,000 acres.

The assay techniques used for this survey were modification of those developed by the U. S. Fish and Wildlife Service, clam investigations, in Narragansett Bay (1956). The variations occurred only in the methods of selecting sampling stations. Instead of using a sampling pattern based on a perfect grid with stations an equal distance apart, the stations were chosen by means of table of random numbers and

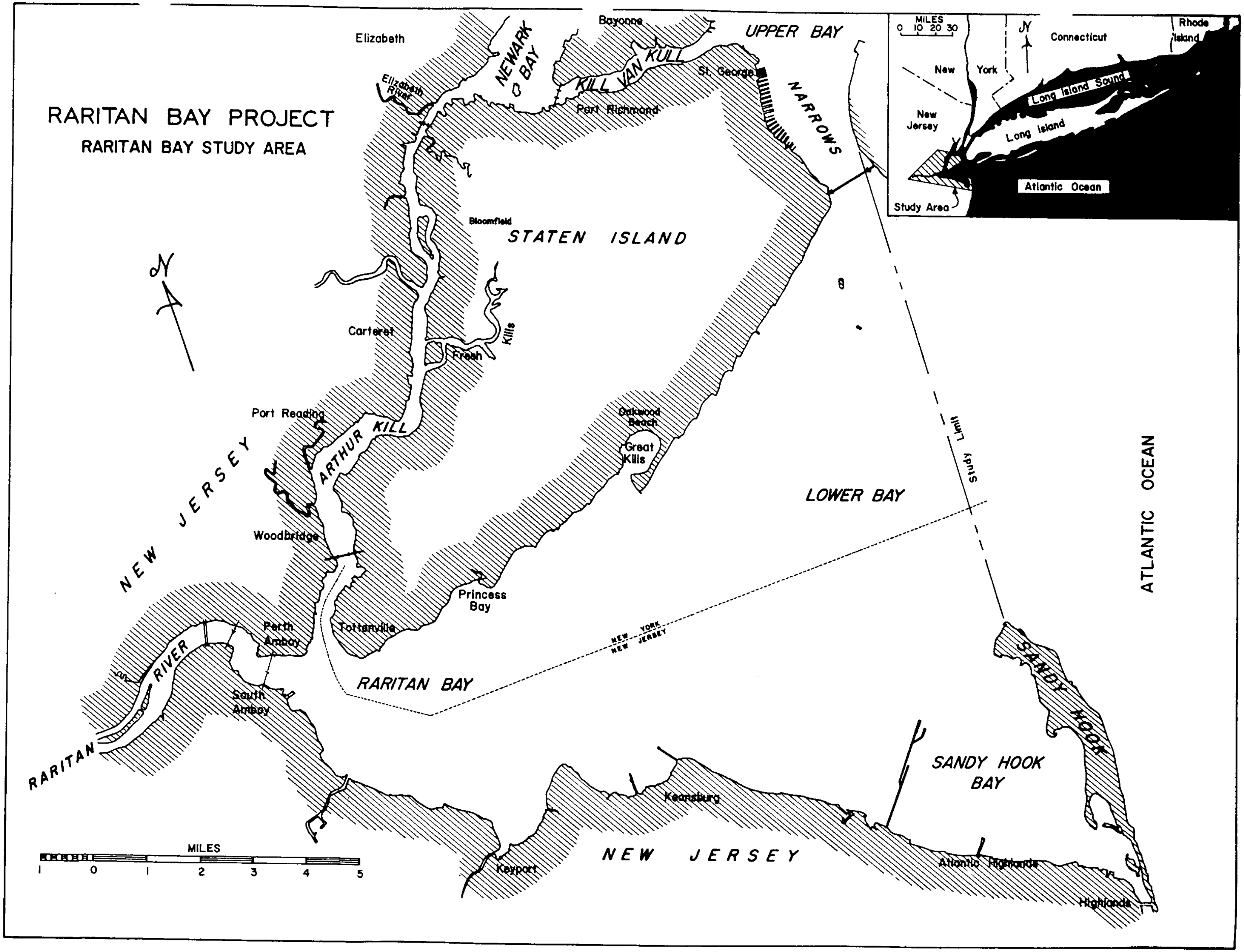

FIGURE I

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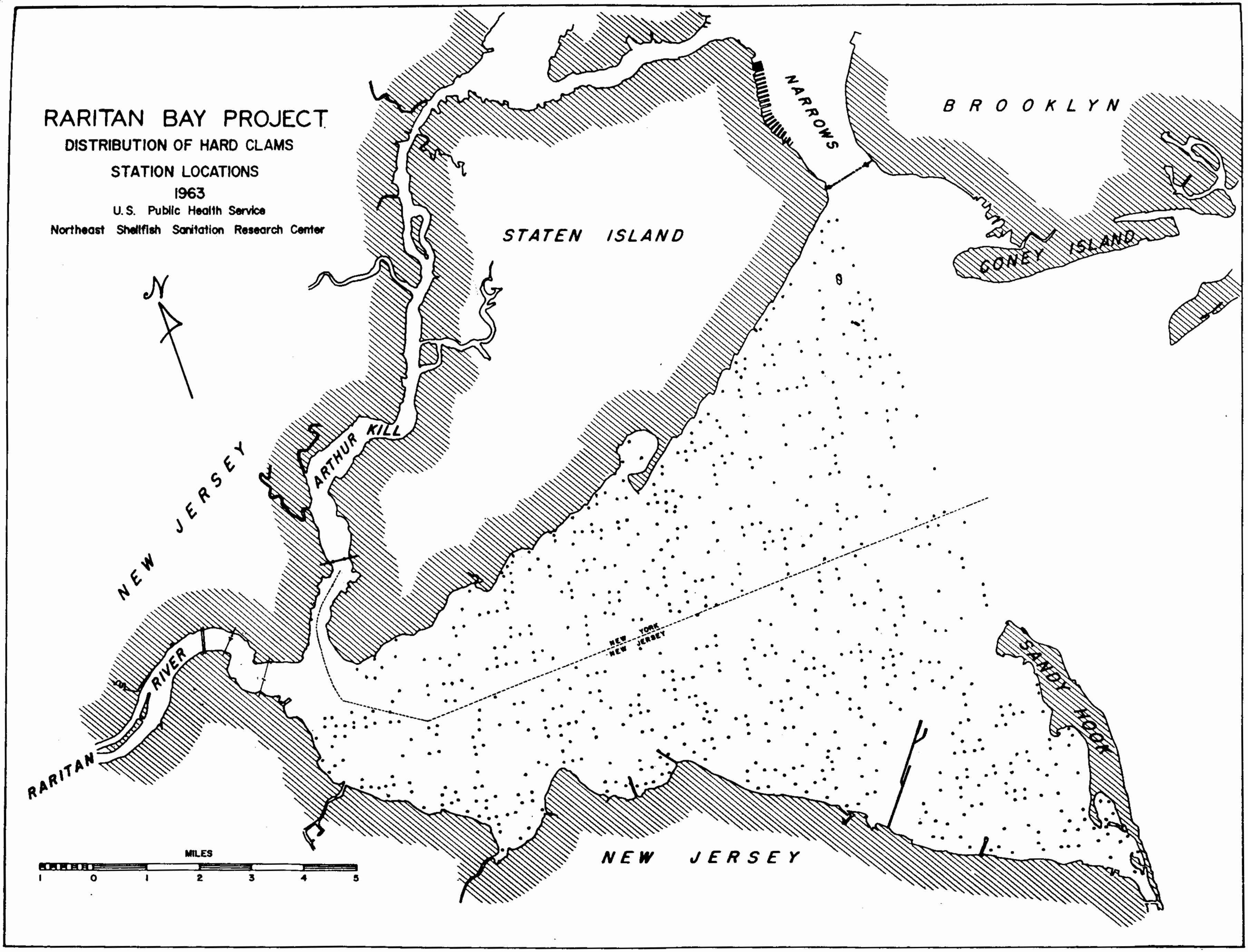

FIGURE 2

GPO 956-592

applied to the numbered basic pattern. Economically, from a project cost standpoint and time considerations, this method was considered more feasible because of the large size of the area, which prohibited a small grid internal for a useful grid system, and because it removed any bias or tendency to select stations based on previous knowledge of shellfish distribution.

To locate the randomly distributed stations, it was first necessary to grid the area on the U. S. Coast & Geodetic Survey Chart #369 in 300-yard intervals oriented north and south and east and west along the lines of latitude and longitude. From the resulting 3026 squares, 535 were randomly selected to represent offshore stations, and 210 numbers to represent inshore stations. Thus, the population estimate is dependent upon these 745 stations. The results of this procedure indicate a rather evenly distributed sampling structure, as shown in Figure 2.

In the field, stations were located using shore bearings (sextant) and calculated running time of the vessel. While on station, a sample was obtained with a one-half yard construction-type, clam-shell bucket operated from a double-drum hydraulic winch aboard the U. S. Public Health Service R/V B. W. Brown. The bucket covers a surface area of approximately five square feet and digs to a maximum depth of 18 inches. Experience indicated that the bucket sampled satisfactorily in most types of bottom except rocks. The sediment, after being brought aboard and dumped into a sorting box, was washed through a 1/2-inch mesh screening with salt water from the vessel's deck pump. Areas too shallow for the research vessel, draft 5', were sampled from a skiff using 16-foot, 12-tooth tongs. The samples taken within the 6' contour were classified as the inshore survey. The baskets of the tongs were enclosed with 1/2-inch wire screening and the handles modified to allow only restricted expansion. Two "grabs" with these altered tongs roughly equaled one "grab" with the clam-shell bucket (U.S.F.W.S. 1956).

Log sheets were kept for each station; data were recorded for bottom type and for the number and size of all commercially important shellfish in the sample. Measurements were made using vernier calipers on the longest diameters (lengths) of both hard and soft clams and recorded in millimeters.

Density-distribution charts (Figures 3-6) were prepared to present diagrammatically a general picture of how the three size groups of hard clams were arranged on the bottom: "sub-legals" -- 15 to 46 millimeters in length; "necks" -- 47 to 66 millimeters long; and "large" -- over 66 millimeters. The density-distribution patterns are shown

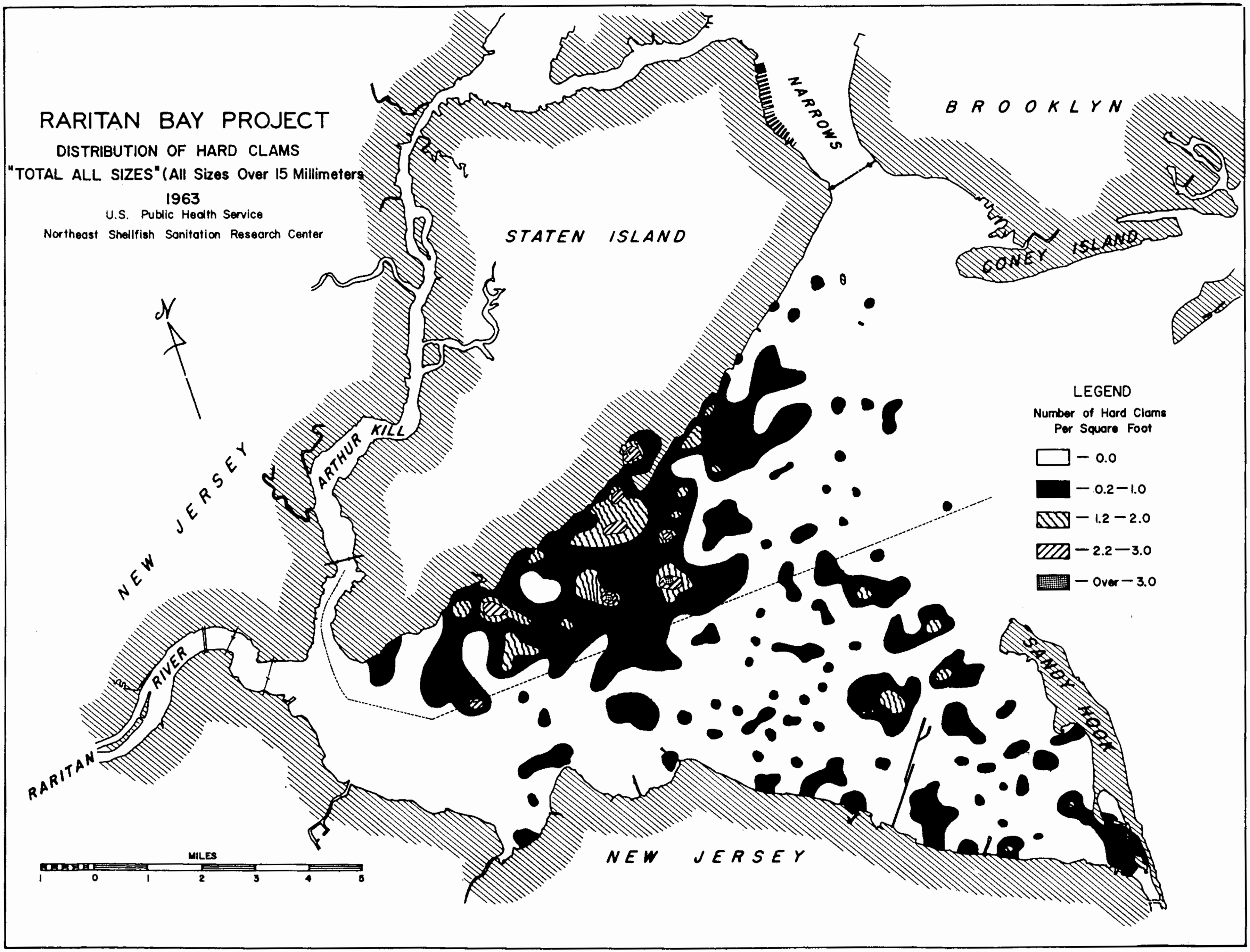

FIGURE 3

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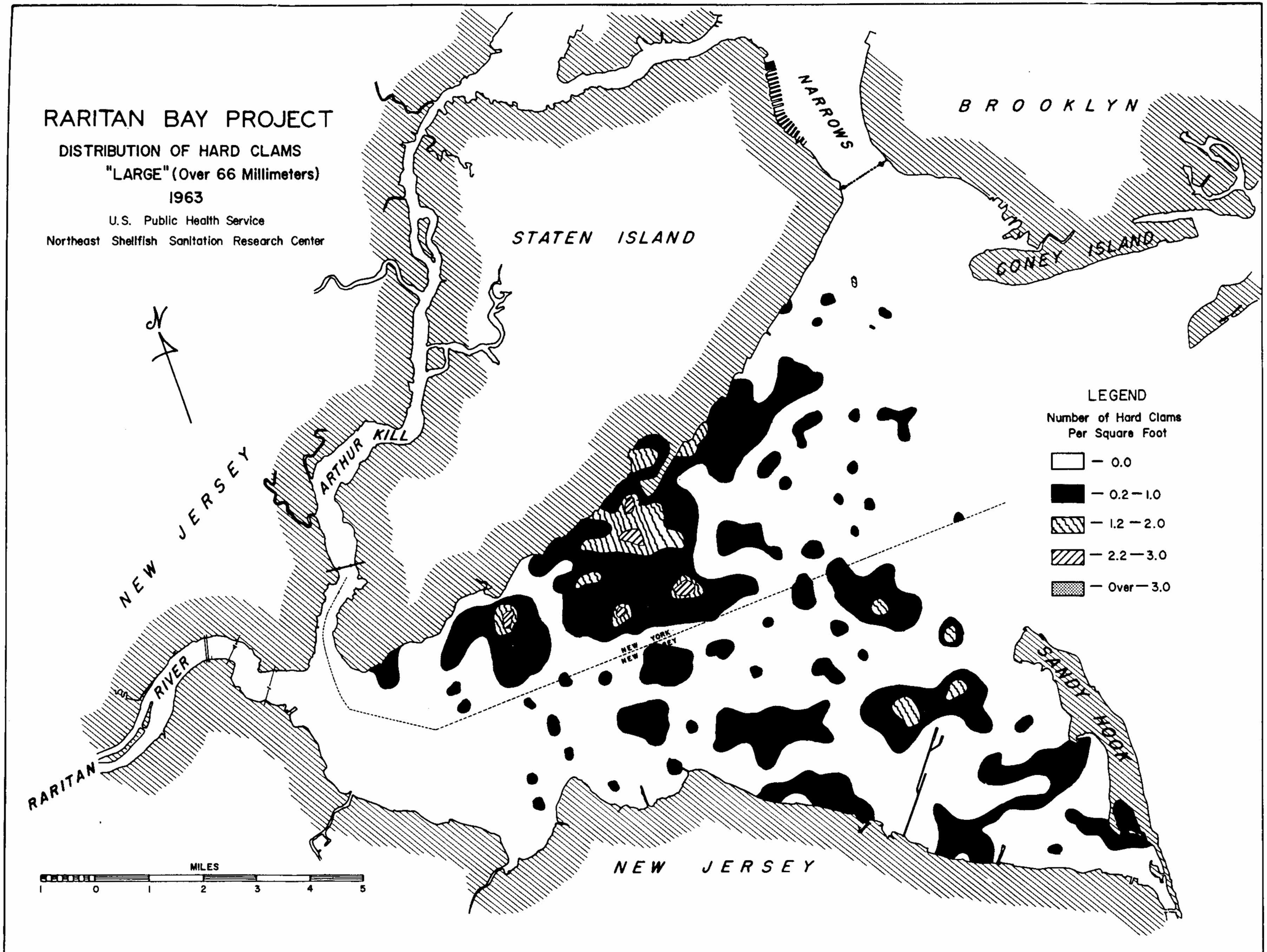

FIGURE 4

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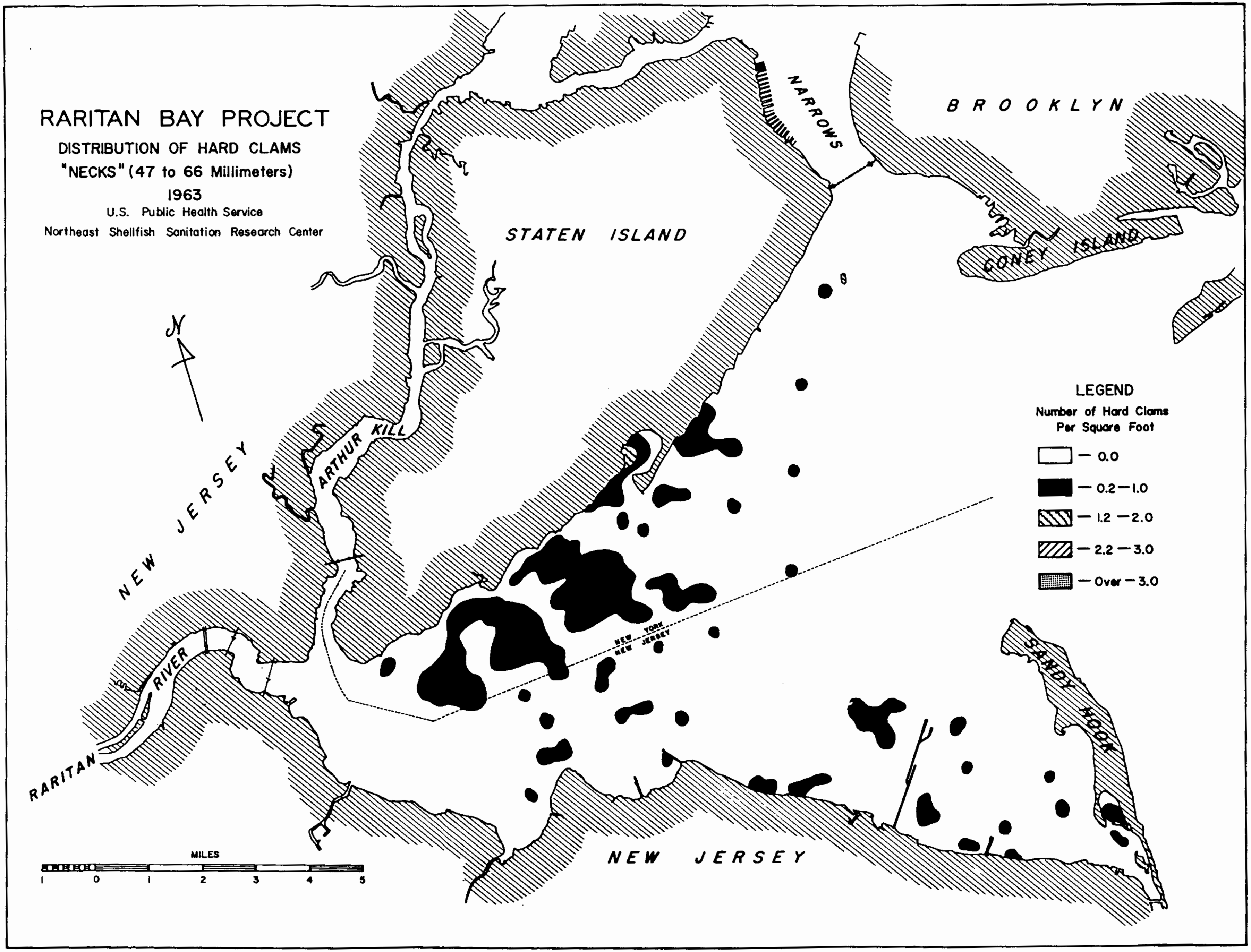

FIGURE 5

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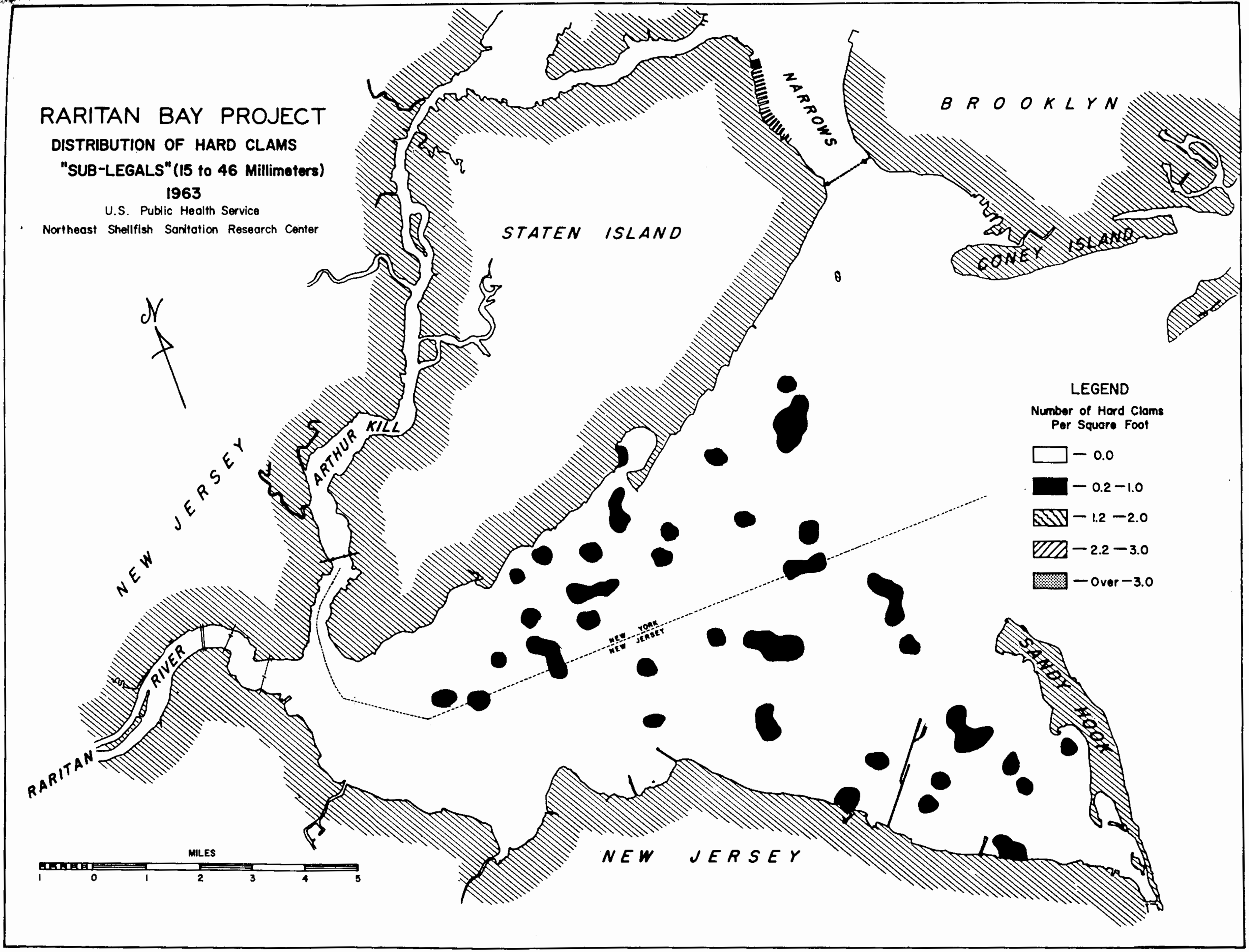

FIGURE 5

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by "iso-clam" contours based upon categories of the number of hard clams per square foot (0.0, 0.2-1.0, 1.2-2.0, 2.2-3.0, and over 3.0) at each sampling station.

The data were analyzed at the University of Rhode Island Computer Laboratory, utilizing programs written for the IBM 1620 Data Processing System. We gratefully acknowledge the assistance of Dr. Saul B. Saila, Director of the Computer Laboratory, and his associates.

Sampling in the above-described area began on 17 July 1963 and continued to 23 August 1963. A total of 745 stations were occupied during this period. The survey was conducted by Mr. Robert Campbell, Marine Research Biologist, assisted by Capt. Arthur W. Smith, and three summer assistants from the Raritan Bay Project.

RESULTS

DISTRIBUTION - Two sub-areas of the shellfish resource survey were established by use of the boundary line between New York and New Jersey running in a general east-west direction almost through the center of the bay. This boundary provides almost equal division of the water area -- the New York sector comprising half of Raritan Bay and practically all of Lower Bay, while New Jersey makes up half of Raritan Bay, all of Sandy Hook Bay and a small portion of the Lower Bay. Presentation of the survey results according to State waters permits application by the State agencies concerned with these matters.

The general hard clam distribution is well illustrated in the "all-sizes" chart (Figure 3) and the pattern is rather closely adhered to, but to a lesser degree, by charts for each size category (Figures 4, 5, 6). The most outstanding feature of the "all-sizes" chart is the more even distribution of hard clams north of the State boundary in contrast to the "spotty" concentrations south of the line. The same holds true with respect to the distribution of heavier concentrations. The New York sector of Raritan Bay is, by far, more widely covered with commercial-size hard clams than its southern counterpart. "Sub-legals," however, are almost equally divided and contribute in a very minor degree to the overall pattern of total distribution. The general distribution patterns, particularly those for "sub-legals," are noticeably irregular and may be interpreted as being directly related to setting intensity and other factors. The observed distribution pattern "may be influenced by current patterns, bottom sediments, or general hydrographic conditions," (U.S.F.W.S. 1956).

A previous resource survey in New Jersey (Haskin, 1962), although using different equipment and techniques, shows close similarity in total hard clam distribution. The only difference between the two surveys is the "spottiness" of hard clams revealed by the recent assay compared with the relatively large areas of evenly distributed individuals in the former. This variability in assay may be attributed to the sampling technique, this method being one of random sampling where the tendency to locate stations based on previous knowledge is reserved.

DENSITY - The observed density of Mercenaria mercèneria differed greatly on the two sides of the bay. Thus, an independent estimate was made for both the New Jersey and New York sides of Raritan Bay. It was assumed, however, that the sampling distribution of the population was similar in each of the two bay areas.

An IBM 1620 computer program was used to test the fit of the observed frequency distribution to the negative binomial distribution. Past experience in a Narragansett Bay hard clam survey suggested fitting the negative binomial rather than some other sampling distribution. The following table (I) gives the chi-square values for the -5% and -95% levels of significance, and those calculated for the various sub-classes, testing the goodness of fit of the negative binomial.

TABLE I

	Chi-x^2	Degrees of Freedom	-5%	-95%
New York:				
All sizes	11.82013	9	16.9	3.33
Large	3.24130	6	12.6	1.64
Necks	4.90236	2	5.99	.103
New Jersey:				
All sizes	1.74016	4	9.49	.711

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22m It is clear from the table that the -5% value is not exceeded in any instance, and that a relatively good fit is provided by the negative binomial to the observed distribution. Conventional analysis of observations distributed in a manner such as that indicated by the quahaug is possible only after a suitable mathematical transformation. To this end the inverse hyperbolic sine transformation (Beale, 1954) was used. The means, variances and standard errors of estimate were computed from the transformed data. These values were then retransformed for use in the estimates according to the method suggested by Quenouille, 1950. The confidence limits (where appropriate) were computed and the population estimates were made with respect to the bay and station areas provided by the sampling.

The abundance of hard clams is a reflection of the natural variability of distribution found in the northern and southern sections of Raritan Bay. As would be expected from observing the density-distribution patterns of the "all-sizes" category, the New York area proves to be more heavily populated, as indicated by an average density of 1.05 individuals per square foot compared to 0.47 individuals per square foot for New Jersey. From the standpoint of commercially important shellfish, New York possesses a 3:1 ratio for the "large"-size group compared with the "necks," whereas

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New Jersey contains a more equal concentration between the two. The "sub-legal" group is the least abundant of the three divisions throughout the entire area and numerical values were not computed since the low frequency of occurrence of this group did not permit application of the statistical methods employed for other groups.

Total population estimates for each area were calculated only for the commercially important shellfish for which conversion factors are available. In the case of the "large" size hard clam a factor of 250 individuals per bushel was used, whereas a factor of 850 was used for the "neck" size category.

Establishing the value of the standing crop of any area, in the form of bushels per acre, is subject to error because of the size range of the individuals encountered and the inaccuracy of estimating the total area involved.

When interpreting the population size, using the above conversion factors, the ratio with respect to bushels are more pronounced. The difference in number of bushels becomes greater and is, in reality, a more comprehensive picture of the standing crop value of the resource. New York, in the case of "large" size hard clams, has almost triple the quantity New Jersey has, but only about equal quantities of "neck" size clams. The comparative resource values are contained in Table II.

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TABLE II

STANDING CROP ESTIMATES FOR HARD SHELL CLAMS IN RARITAN BAY

	New York	(Confidence Limits)
Bushels of "Necks"	291,200	±212,702
Bushels of "Large"	3,153,000	±454,818
Total Bushels	3,444,200	±667,520

	New Jersey	(Confidence Limits)
Bushels of "Necks"	353,000	Point estimates
Bushels of "Large"	1,040,000	Point estimates
Total Bushels	1,393,000	Point estimates

SOFT CLAM DENSITY-DISTRIBUTION - The soft clam, *Mya arenaris*, proved to be more widely dispersed in the western sector of the bay than was expected. Patches of sub-legal animals were also apparent in Sandy Hook Bay, as well as protected coves within Sandy Hook peninsula. The general distribution illustrated in Figure 7 suggests a rather evenly but widely scattered pattern of "sub-legal" size (/2") soft clams and appears quite surprising considering the depth of water involved. "Legal" size shellfish were less abundant and appeared more or less confined to specific locations; in most instances they were intermixed with large quantities of "sub-legal" animals. No attempt was made to assign a quantitative figure to the soft clam resource because of the ineffectiveness of the clam shell bucket and tongs to obtain an equally representative sample of soft clams in the extreme type bottoms encountered in the bay. The soft clam results, therefore, are somewhat biased toward the smaller sizes. It is of interest to note that samples from some areas contained from 1 to 284 animals, of which 90 percent or more were of the "sub-legal" category.

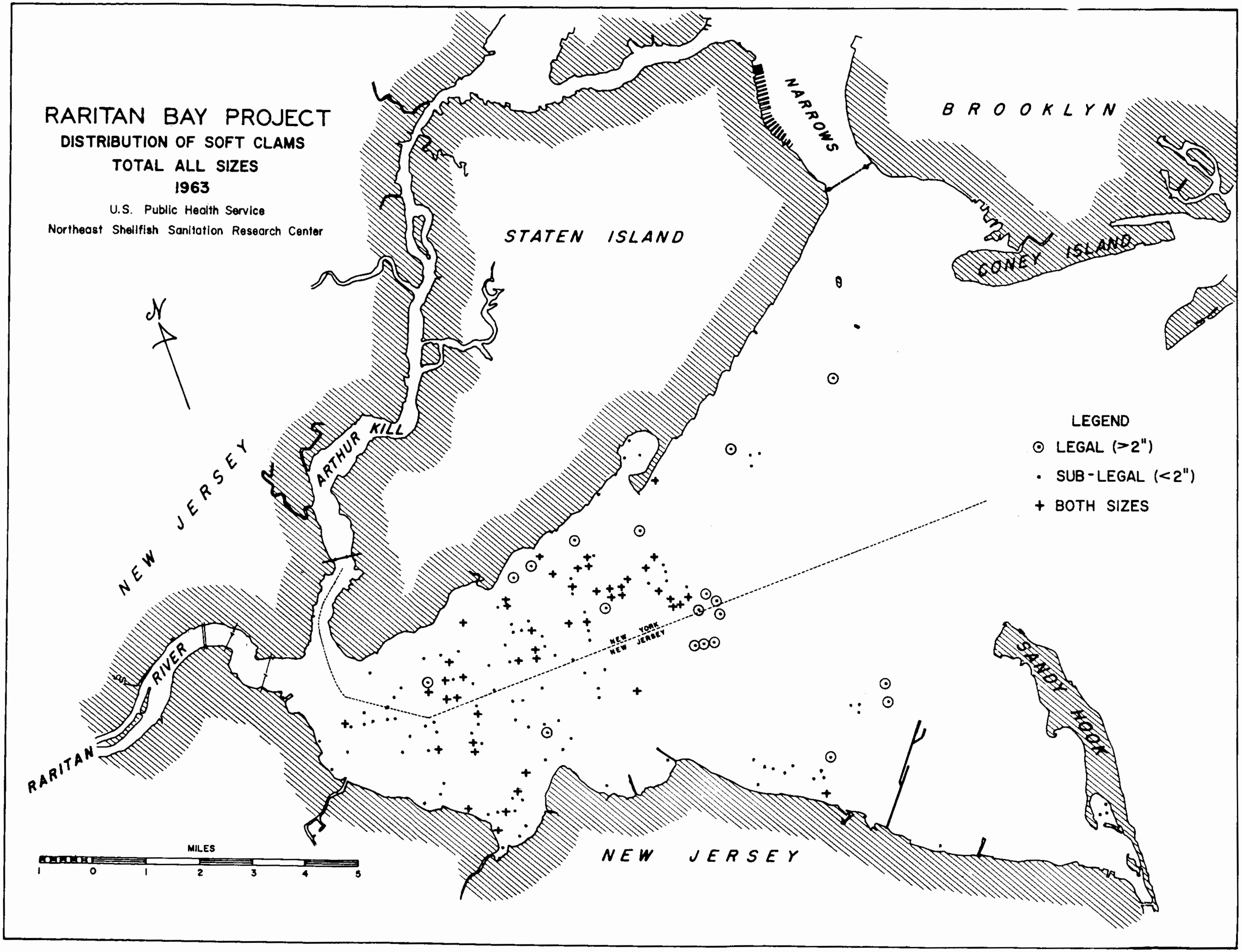

FIGURE 7

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APPENDIX B

FISH AND WILDLIFE - RARITAN BAY

UNITED STATES

DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

59 Temple Place

Boston, Massachusetts 02111

October 28, 1964

Mr. Earl J. Anderson

Regional Program Director

Public Health Service

42 Broadway

New York City, New York

Dear Mr. Anderson:

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This report provides information on the fish and wildlife resources of the Raritan, Lower New York, and Sandy Hook Bays, located in Richmond County, New York, and Monmouth and Middlesex Counties, New Jersey, as related to your comprehensive water quality studies in this area. It has been prepared in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-666 inc.), in cooperation with the New Jersey Divisions of Fish and Game and Shell Fisheries and the New York State Conservation Department. Those agencies concur in the report as indicated in their letters of October 9, October 10, and October 19, 1964, respectively.

We understand that your studies are directed toward developing maximum benefits from a program to abate domestic, municipal, and industrial pollution in the project area. This report evaluates the present fish and wildlife resources and presents data on the effect of improved water quality on these resources.

The tidal flats, channels, and wetland areas of the Raritan Bay area offer a variety of extremely productive habitats for waterfowl, finfish, and shellfish. The project area includes Raritan Bay, Sandy Hook Bay, and that part of Lower New York Bay west of a line from the tip of Sandy Hook to the eastern tip of Staten Island. It is characterized by a rich biological productivity and is located in close proximity to the most concentrated urban and industrial complex in the United States. The chemical industry concentration is the largest in the country. The central area, primarily in Lower New York Bay, averages around 21 feet deep. The project area is bisected by one of the most heavily traveled shipping channels in the world.

Commercial Shellfishery

The commercial shellfish resources presently consist of hard clams, soft clams, and blue crabs. The history of the shellfish resource in the project area indicates that the harvest reached a peak in the late 1800's and maintained that level until about 1945 when it began a gradual decline to reach the present low level. Oyster production was once a major activity in this area. At present, due to the destruction of seed beds, increased salinity due to channel dredging, and the increased pollution load, the oyster has disappeared.

Hard Clams

Hard clams are the most important species from the commercial standpoint. About 50 percent of the project area is considered to be commercial hard clam habitat. Due to the present pollution conditions, only a portion of Sandy Hook Bay is open to commercial clamming.

Many factors influence the distribution of the hard-clam resources. Of the four bottom types (1) sand, (2) sand and mud (sticky), (3) shell or gravel bed, and (4) black mud, only the latter is not always considered productive for shellfish. Other factors, such as sunlight, which directly influences microscopic plant production, water temperature and water evaporation; rainfall, which affects salinity and water exchange; winds, which affect the movement of the water within the bay and between the bay and its tributaries, all have an influence on the distribution of hard-clam resources in the bay.

The history of the commercial fishery for hard clams in the Raritan Bay project area is one of steadily decreasing harvests as the spread of pollution closed the hard-clam beds to exploitation. No specific data are available to indicate the total harvests in the early years. Limited data indicate that as recently as 1958, harvests of hard clams worth about $500,000 annually were being taken. At the present time the limited area open to clamming in Sandy Hook Bay provides an annual harvest of about $40,000.

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There are no present plans to increase this harvest. Methods of chemical purification have not been worked out for the hard clam, and data are not available at the present time that would indicate any procedure would be developed in the near future. Plans for transplanting of hard clams are being developed by the State of New York as part of their present program of depletion of restricted areas. It is estimated that such a program will include clams valued at $750,000 annually which will eventually be marketed from the beds on which they have cleansed themselves.

A recent study by the U. S. Public Health Service revealed a standing population of 3,444,000 bushels in the New York section of the project area and 1,393,000 bushels in New Jersey. Based on a current average price of $7.00 per bushel, the standing crop is presently worth over $34,000,000. Under optimum water quality conditions for this resource the potential harvest would be about 550,000 bushels annually with a value of about $3,850,000. While it is obvious that water quality conditions are such that these shellfish cannot be released for harvesting at the present time, at least half of this quantity could be absorbed by the market now and the entire amount utilized annually with proper promotion and market development.

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Soft Clams

In the past, soft clams were taken commercially along the New Jersey coast from Conaskonk Point to the northern tip of Sandy Hook. In New York the production area included the entire south shore of Staten Island. This species is found throughout the project area except in the extremely deep waters.

The history of the soft clam follows that of the hard clam in that deteriorating habitat conditions resulted in a decline of the fishery. The latest commercial harvest data reveal that in 1948 about 175,000 bushels of soft clams valued at over $600,000 were taken. At the present time there is no significant commercial harvest.

Under optimum conditions the soft-clam beds can produce a sustained average annual yield of 300 bushels per acre of habitat. It is estimated that about 40,000 acres of the project area are soft-clam habitat. This analysis indicates a potential commercial value of about $18,000,000 annually, or about seven times the value of current landings of soft clams for the entire Atlantic Seaboard.

It is assumed that before any effort is made to market soft-clam products from this area, there must be complete agreement on the part of the U. S. Public Health Service, the various State departments of health, and the State conservation departments that the soft clam product meets the requirements of quality and wholesomeness.

Although soft-clam production in this area would likely have a naturally slow development, increase in soft-clam production would have to be geared to a program of market development and promotion to avoid the creation of soft-clam marketing problems in other areas. It is considered that the development of new markets is possible inasmuch as new preservation techniques are being developed for fishing products and a marketing potential of inland distribution is available.

Blue Crabs

Formerly, the entire project area was considered blue crab habitat. At the present time the outer portions of the project area are still in good condition but the beach erosion and navigation improvements in the upper portions have caused deterioration of the habitat.

The commercial crab fishery in the project area is largely a winter dredge fishery. During spring, summer and fall, the crab population spreads out to the shallow waters. During the period November to March the crabs concentrate in the deeper waters and hibernate in the muddy bottom. At this time they are taken by the large dredge boats and by the smaller one-man garvey dredge boats.

The commercial blue crab fishery is subject to violent fluctuations throughout its range. While there are no specific data for blue crab harvests in the early days of the fishery in the project area, data covering adjoining areas indicate that the blue crab harvests are continuing these fluctuations. The 1960 blue crab harvest in New Jersey, for instance, was the second largest on record. In view of this it is difficult to connect any effect on the commercial blue crab fishery with the water quality conditions in the project area.

Commercial Finfishery

The commercial finfishery exhibits the same history in the Raritan Bay project area as the commercial shellfishery. Peak catches, with an estimated value of $2,000,000, were reported about the turn of the century and, on the average, have declined to the present time. Certain finfish species, such as the scup and black sea bass, are now taken in greater quantity than in the past, but this is believed to be due to the smaller supply of more favored food fishes and the resultant change in fish harvests.

In the recent past, the method of harvesting commercial finfish has changed in the project area. Formerly, the area supported an abundance of finfish that could be taken in commercial quantities by a single operation in a small boat. Most of these fishermen worked on a part-time basis. As the supply of these fish diminished due to destruction of habitat, pollution, and overfishing, this type of operation became uneconomical. The change to large vessels with crews began about 1945 and is continuing to the present. Table 1 reflects the number of commercial fishermen, vessels, boats, and major gear as recorded in 1950 and 1960, the latest date for which these data are available.

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Table 1

Commercial Fisherman Vessels, Boats, and Major Gear

Raritan Bay Project Area

	1950	1960
Fishermen		
On vessels	297	459
Boats and shore		
Regular	204	209
Casual	463	227
Total	964	895
Motor vessels	32	83
Motor boats	345	311
Other boats	65	23
Pound nets	76	68
Purse seines	11	13
Otter trawls	2	45
Gill nets	94	14
Clam dredges	38	94
Crab dredges	38	23

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The present commercial finfish harvest in the project area is estimated to be about $200,000. This includes those fish actually taken in the project area and those caught outside the project area, but are dependent on the inshore bays for part of their life cycle. The most valuable fish is the porgy followed in order by the Atlantic menhaden. American shad, whiting, bluefish, black sea bass, summer flounder, herring, eels, mackerel, striped bass, winter flounder, and butterfish. Other species are taken from time to time but are not considered significant in the commercial catch.

It is expected that with the trend to larger boats and more efficient gear the catch would increase over the long term trend to about $300,000 under present plans and programs to improve water quality conditions. Under optimum conditions of water quality and assuming that overfishing and physical destruction of habitat will not occur, it is estimated that the potential commercial finfishery would approximate $400,000 in annual value.

Marine Sport Fishery

Due to its proximity to the New York Metropolitan area, the sport fishing use in the project area is high. Sport fishing activity begins as soon as the weather breaks in March, starting with the winter flounder. In succession striped bass, tautog, porgy, and summer flounder enter the fishery. By midsummer the porgy and summer flounder dominate the catch. Among other fish caught are kingfish, black sea bass, weakfish, American shad, and northern puffer, which recently has been discovered to be quite a delicacy. Early in July, bluefish enter the bay and striped bass are again in evidence. By mid-September the summer flounder begin to drop out of the catch to be replaced by tautog and winter flounder. Fishing for bluefish and especially for striped bass continues on into autumn. These same species of fish form a part of the commercial fishery of the bay.

The number of pleasure boats which are berthed in the New Jersey section of the project area totals about 8,000. There are about 3,000 inboard and 5,000 outboard and sailboats. The New York section has a total of about 1,200, of which 400 are inboard and 800 are outboard and sailboats. About two-thirds of these boats are used for marine sport fishing. Most of the large inboard boats go outside project area limits to fish for porgies, bluefish, and other species. The smaller boats are usually restricted to the bay area.

A recent sport fishing survey conducted by the New Jersey Division of Fish and Game indicated that there were about 330,000 fisherman-days use of the New Jersey section of the project area during 1963. This is an increase of 30 percent from the year 1953. The sport fishery in the New York section of the project area is confined mostly to shore fishing for striped bass and bluefish. The party boats which operate out of Great Kills Harbor generally go out of the project area to fish for porgies, bluefish, and other species. An estimated 25,000 fisherman-days were expended on this sport in 1963 in the New York section of the project area.

The total sport fishing use of the project area is about 355,000 fisherman-days. At $1.50 per fisherman-day the present annual value is about $530,000. Present pollution control programs will be beneficial in the future and will double present values. Under optimum water quality conditions it is estimated that fishing use would at least triple to a value of about $1,590,000. In large measure this would be due to the improved quality of the fish from the human use standpoint. At the present time, due to the noxious taste in the meat of the fish, it is reported that relatively few are eaten.

Recreational Shellfishery

Blue crabs, soft clams, and hard clams, in that order, provide some recreation activity in the project area. In prior years a trip to the bay in pursuit of these shellfish was a favorite sport of thousands of people. Most of these have shifted their operations to the unpolluted areas of Long Island and Barnegat Bay in New Jersey.

About 7,000 recreational clamming licenses were sold in New Jersey in 1964 and it is estimated that about 10 percent of these were used in the project area in the open unpolluted waters in Sandy Hook Bay. No license is required for the taking of blue crabs in either State. Since the crab is not as susceptible to the effects of pollution, it is taken along the shoreline except in those upstream areas that are usually too roily for successful crabbing. At the present time it is estimated that about 35,000 man-days are spent in recreational shellfishing. At an average value of $1.00 per recreation day, the present value would be about $35,000. It is not expected that this sport would increase significantly in the future under present conditions. However, under optimum water quality conditions throughout the entire project area, it is estimated that this activity would increase at least five times and have an annual recreational value of about $175,000.

Wildlife

Except for waterfowl, the Raritan Bay project area is not significantly important to wildlife. The principal value to waterfowl is as a resting and feeding area during migration periods. There is little nexting activity dependent on the bay waters, although in mild years a considerable number of ducks spend the winter in the area.

Present hunting use of the waterfowl resource is limited. About 1,000 acres of salt marsh border the bay and, except for the wetlands in Cheesequake State Park, it is under constant threat of development. It is estimated that about 1,000 man-days worth approximately $3,000, constitute the present waterfowl hunting value. Improvement in water quality conditions would improve waterfowl habitat by increasing the food supply of small fish and shellfish but would have little effect on hunting opportunity.

Summary

The Raritan Bay project area was once a leading producer of commercial and sport fish and shellfish. Human activity in the interests of navigation, beach erosion control, hurricane protection, mosquito control, residential and industrial development, have destroyed or altered adversely a considerable reach of the shoreline and the adjacent bay waters. Much of this adverse activity cannot be reversed to return the original conditions favorable to fish and shellfish. However, one of the major adverse factors is the effect of pollution on water quality. The increase in the pollution load in the waters of the project area has had a significant adverse effect on most of the fish and shellfish species. As a result, the productivity and the economic value of these resources are far below the potential productivity as is proven by past records of fish and shellfish harvest.

Present pollution control programs are increasing the value of these resources. This report also provides an optimum value of the resource if all sources of pollution are controlled. The question of defining values of a lesser degree of control is dependent to a degree on the type of control and the waste products to be controlled. The shellfish industry, for instance, could not be reinstated until the water quality conditions met the required 70 M.P.N. standard. This Service and the States of New York and New Jersey will be pleased to work with you and will attempt to provide data that may be required in the course of your study.

Sincerely yours,

/s/ Fred L. Jacobson

Acting Regional Director

Bureau of Sport Fisheries & Wildlife

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Paul DeFalco

/s/ John T. Gharrett

Regional Director

Bureau of Commercial Fisheries

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Paul DeFalco

APPENDIX C

RECREATIONAL BOATING - RARITAN BAY

SUMMARY

The Raritan Bay Project, Federal Water Pollution Control Administration, U. S. Department of the Interior (formerly Public Health Service, U. S. Department of Health, Education, and Welfare) conducted a survey of recreational boating in Raritan Bay during July and August 1963. The purpose of this survey was to determine the magnitude of use, and the present and possible future economic values associated with recreational boating in Raritan Bay.

The survey found 63 marinas and 15 yacht clubs along the shores of the Raritan River, Raritan Bay and Arthur Kill. These facilities had a gross annual income of nearly

$2,500,000 as a return on capital investment of approximately $10,500,000. The 5,480 boats surveyed represented a capital investment of nearly $22,000,000. With allowances for transit and trailed boats, recreational boating in 1963 provided an estimated 506,000 recreation days with a value of $760,000.

Future projections indicate a substantial increase in recreational boating. By 1985, the effects of population growth alone should increase this activity to over 1,000,000 recreation days, worth more than $1,500,000 annually.

INTRODUCTION

A survey of recreational boating was conducted during the period July 17 - August 10, 1963, as a part of the overall study of Raritan Bay by the Raritan Bay Project. The purpose of this survey was to determine the magnitude of use and the present and future economic value of recreational boating in the study waters.

According to Marion Clawson, "Recreation is a vital need in today's world. It is perhaps the greatest opportunity for self expression, for doing what one really wants to do, not what one is forced to do to earn a living. The very phenomena which have brought leisure and income

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have also brought serious tensions for every-day life. Both working and living take place hurriedly, under crowded and often noisy conditions. Recreation under conditions of one's choosing is necessary to relieve these tensions. For many, the physical activity of outdoor recreation is vital in building and maintaining physical fitness and in discharging nervous energy." (1) Recreational boating fulfills all these requirements and is a family-type of recreation enjoyed by all, regardless of age. Boating is also a natural adjunct to the enjoyment of such allied sports as swimming, fishing, skin-diving and water skiing.

The number of boats and outboard motors in use provides an index on the growth of recreational boating. The number of outboard motors in use in this country has risen rapidly from 1.8 million in 1947 to 6.4 million in 1963. Of the 1963 figure, nearly 900,000 motors, or 15 percent of the total in use, were located in the three States of New York, New Jersey and Connecticut. The number of boats in use has risen also, from 2.4 million in 1947 to 7.7 million in 1963.(2)

SURVEY PROCEDURES AND RESULTS

Procedures: The survey was limited to

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recreational boating. Boats used for commercial fishing or for carrying passengers for profit, such as party and charter boats, were not included. The bodies of water included in the survey, as shown in Figure 1, are Sandy Hook, Raritan and Lower New York Bays, the Raritan River, and Arthur Kill. The study area was divided into eight sections as shown in Figure 2. Areas A, B and C were located on the southern shore of Staten Island, New York; Areas D, E and F, the New Jersey shore of Raritan and Sandy Hook Bays; Area G the shores of the Arthur Kill, and Area H the navigable portion of the Raritan River.

Marinas, boat yards, and yacht clubs were located by contacting major oil companies supplying oil products in the area, by consulting phone directories, and by shoreline surveys. The United States Coast Guard was contacted for additional information. A total of 63 marinas and 15 yacht clubs were included in the survey. A staff visit was made to each of these facilities to obtain the needed information. The survey included only those activities directly related to recreational boating, such as rental of dockage space, repairs, and sales of equipment, fuel, bait, and tackle. Restaurants and boat yards specializing in major overhauling or construction were not included. In this survey, boats and yachts were classified and evaluated as follows:

Prams	- non-motorized	150
Sailboats	- non-motorized	1,500
Class A boats	- less than 16 feet	1,700
Class 1 boats	- 16 to less than 26 feet	3,000
Class 2 boats	- 26 to less than 40 feet	7,000
Class 3 boats	- 40 to not more than 65 feet	18,000
Boats over 65 feet		200,000

<u>Results:</u>

The results of the survey are summarized in Tables 1 through 4. Data were tabulated by individual areas, with sub-totals for both New York (Areas A, B and C) and New Jersey (Areas D through H). Although Area G, the Arthur Kill, includes both New York and New Jersey, all of the activity noted during the survey was on the New Jersey shore. Therefore, this area was included in the New Jersey sub-totals. No values are shown for Area A, since this is a public beach area with no boating facilities.

Table 1 presents the number of boats counted during the survey, by area distribution and by size classification.

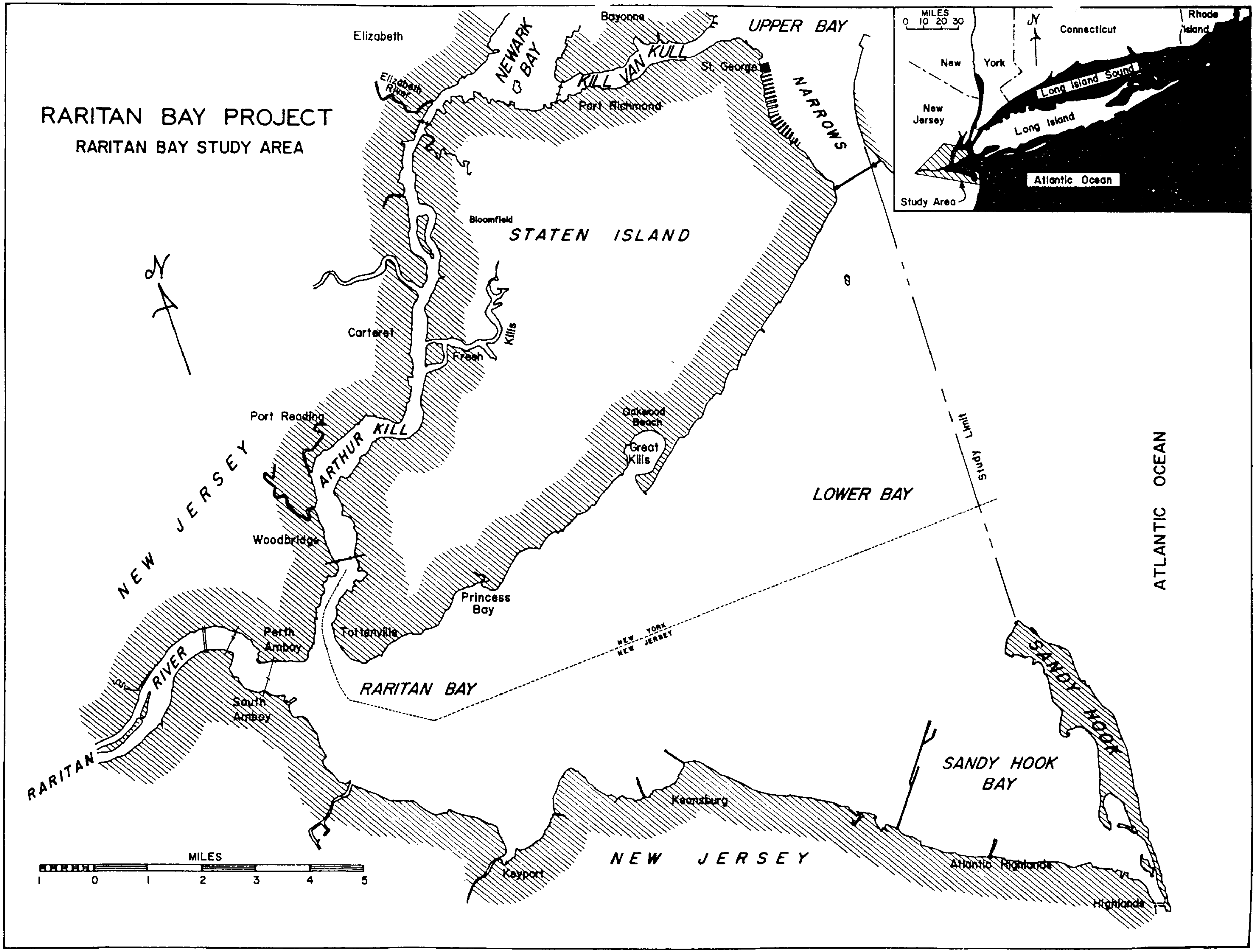
RARITAN BAY PROJECT
RARITAN BAY STUDY AREA
Elizabeth
Elizabeth River
NEWARK BAY
Bayonne
KILL VAN KULL
UPPER BAY
St. George
Port Richmond
NARROWS
Bloomfield
STATEN ISLAND
Carteret
Fresh Kills
Port Reading
ARTHUR KILL
Oakwood Beach
Great Kills
NEW JERSEY
Woodbridge
LOWER BAY
Study Limit
ATLANTIC OCEAN
Princess Bay
Tottenville
Perth Amboy
RARITAN RIVER
South Amboy
RARITAN BAY
NEW YORK
NEW JERSEY
SANDY HOOK
SANDY HOOK BAY
Keansburg
Keyport
Atlantic Highlands
Highlands
MILES
1 0 1 2 3 4 5
MILES
0 10 20 30
Connecticut
Rhode Island
New York
New Jersey
Long Island Sound
Long Island
Atlantic Ocean
Study Area

FIGURE I

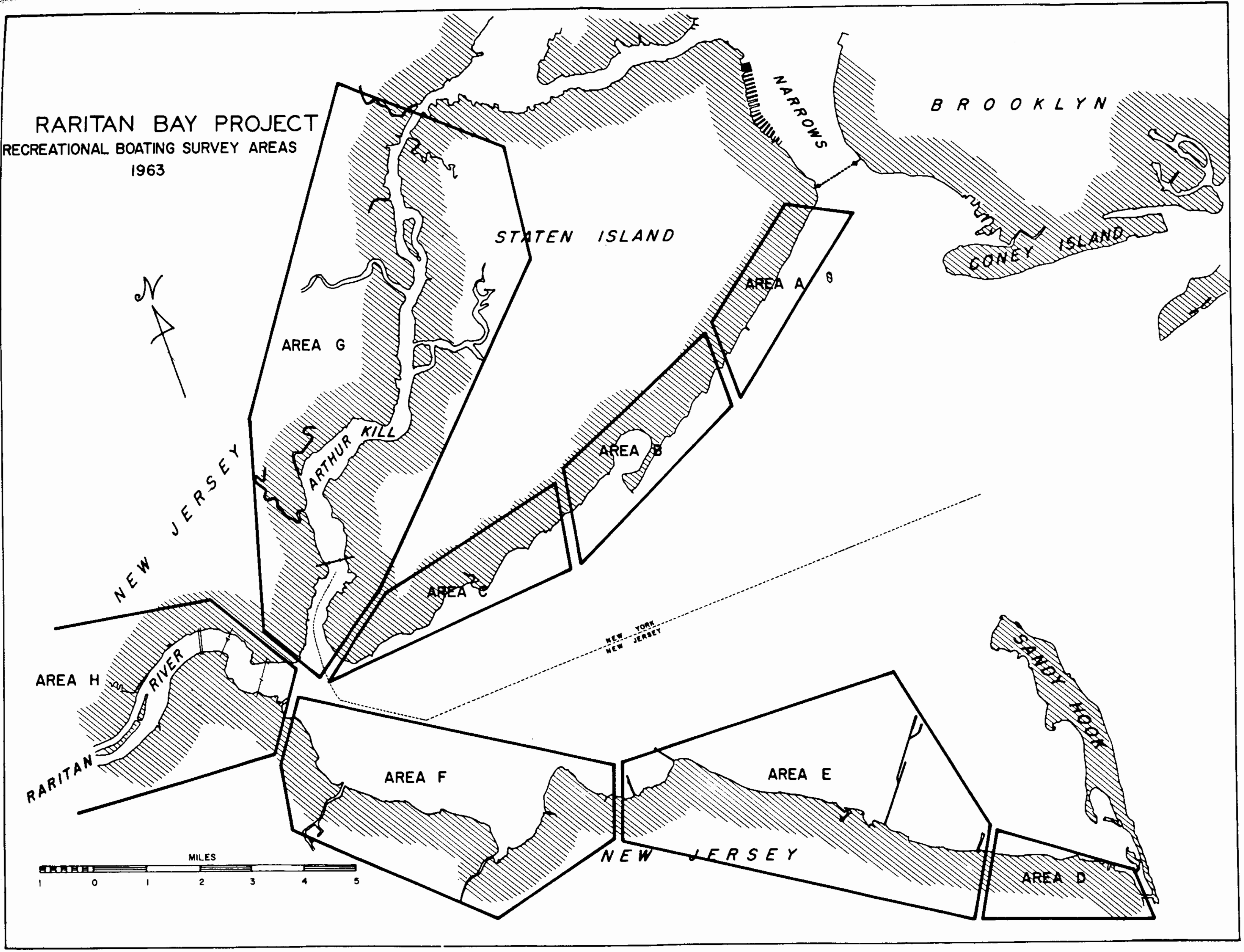

FIGURE 2

GPO 956-592

TABLE I

RECREATIONAL BOATS IN RARITAN BAY

Area	Prams	Sailboats	Class A	Class 1	Class 2
A	-	-	-	-	-
B	38	2	157	140	22
C	53	109	283	504	249
Sub Total - NY	91	111	440	644	271
D	140	4	70	272	201
E	193	41	48	170	399
F	59	31	243	569	231
G	40	157	126	217	98
H	21	15	78	275	87
Sub Total - NJ	453	248	565	1503	1016
Total	544	359	1005	2147	1287

Area	Class 3	Over 65 ft.	Total	Rental Boats*	Value of Boats ($)
A	-	-	-	-	-
B	3	-	362	43	-
C	58	1	1257	33	-
Sub Total - NY	61	1	1619	76	6,055,150
D	9	-	696	130	-
E	28	4	883	136	-
F	6	-	1139	5	-
G	-	-	638	-	-
H	26	3	505	-	-
Sub Total - NJ	69	7	3861	271	15,663,450
Total	130	8	5480	347	21,718,600

*These boats are also included in their respective categories.

TABLE 2

RECREATIONAL BOAT USE IN RARITAN BAY - 1963

Class	No. of boats Surveyed	Days of Usage	Average Population	Man days Use
Non Powered	903	10	2	18,060
A	1,005	20	2	40,200
1	2,147	20	3	128,820
2	1,287	25	4	128,700
3	130	30	5	19,500
Over 65 feet	8	30	10	2,400
Total Surveyed	5,480			337,680
Estimated Transit and trailed vessel use				168,840
Total Estimated Use				506,520 Man days use

TABLE 3

ECONOMICS OF RECREATIONAL BOATING IN RARITAN BAY

Area		Gross Income ($)	Concessions[1] ($)	Fuel ($)	Dockage ($)	Boat Rental ($)	Repairs[2] ($)	Misc. ($)	Employment (Man-Yrs)	Salary ($)	Investment ($)
	A	-	-	-	-	-	-	-	-	-	-
	B	112,850	36,000	15,000	6,950	25,000	19,000	10,900	9	29,250	693,000
	C	584,000	148,640	35,000	195,750	20,000	157,750	26,860	49	218,400	2,219,000
Sub Total NY		696,850	184,640	50,000	202,700	45,000	176,750	37,760	58	247,650	2,912,000
	D	387,900	59,200	54,000	114,900	16,300	128,500	15,000	35	122,600	1,535,000
	E	353,000	56,000	64,000	115,000	27,000	2,000	89,000	20	70,700	2,300,000
	F	789,850	15,000	98,000	165,050	1,000	492,300	18,500	28	127,580	1,725,000
	G	107,200	26,000	4,000	28,200	-	12,000	37,000	14	40,000	1,422,000
	H	106,000	12,000	12,000	40,800	-	34,200	7,000	14	50,960	501,000
Sub Total NJ		1,743,950	168,200	232,000	463,950	44,300	669,000	166,500	111	411,840	7,483,000
TOTAL		2,440,800	352,840	282,000	666,650	89,300	845,750	204,260	169[3]	659,490	10,395,000

1/ Concessions include snack bars, bait and tackle shops.

2/ Repairs include repairs of boats and equipment, sales and service.

3/ Based on 117 full-time and 156 part-time (4 months per year) employees.

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TABLE 4

DOCKAGE FACILITIES IN RARITAN BAY

Area		Berths		Moorings	
		Present	Anticipated	Present	Anticipated
	A	-	-	-	-
	B	322	336	44	116
	C	832	1269	337	449
Sub Total NY		1154	1605	381	565
	D	657	712	6	6
	E	788	2838	56	150
	F	1045	1745	107	352
	G	406	406	0	0
	H	247	927	96	500
Sub Total NJ		3143	6628	265	1108
TOTAL		4297	8233	646	1673

NOTE: Anticipated berths (or moorings) are the total number that are planned or proposed for future expansion by the marina owners.

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A total of 5,480 boats were found, 4,577 of which were powered and subject to registration. These boats had an estimated total value of $22,000,000.

The State of New Jersey Department of Conservation and Economic Development reported that about 90,000 boats were registered in that State in 1963. Of these, 36,000 were Class A, 43,000 Class 1, 10,000 Class 2, 1,000 Class 3 and five were over 65 feet in length. The Department estimated that 8,000 of these boats were in Raritan Bay and adjacent waters, including the Navesink and Shrewsbury Rivers.

The State of New York Conservation Department estimated that 350,000 boats were registered in New York State in 1963, and that approximately one-half of these were located in the Long Island-New York City area. The Department's records showed 262,500 of these boats were Class A, with the remaining 87,500 in larger size categories.

In addition to the boats counted during the survey, other boats used the Raritan Bay waters during 1963, either as transient visitors from outside the survey area, or as trailed boats. It was estimated that vessel use in this category was approximately one-half that attributed to the boats surveyed. Table 2 indicates approximately 506,000 recreation days were involved in this phase of recreation in 1963. The Ad Hoc Water Resources Council has suggested a value of $0.50 to $1.50 per recreation day for general outdoor recreation (3). Assuming the upper value of $1.50 per recreation day spent in recreational boating, the estimated value of this activity in 1963 was $760,000.

The investment in real estate and improvements, and the gross income associated with recreational boating in Raritan Bay is represented in Table 3. The employment figures were based upon the total number of employees found in the survey, 273, of whom the 156 summer or part-time help were assumed to work 4 months per year. Recreational boating in 1963 provided a gross annual income to the area of $2,440,000 on a capital investment of $10,400,000.

A comparison of the gross annual income for recreational boating in Raritan Bay and the upper value of $1.50 per general recreation day recommended by the Ad Hoc Water Resources Committee suggests the latter value is conservative. Based upon the observed gross annual income of $2,440,000 for 506,000 recreational days, a closer value estimate would appear to be in the order of $4.50 per recreational day spent in recreational boating.

Table 4 presents the existing number of boat berths and moorings, and the additional number anticipated by marina operators for expansion in the foreseeable future. These data show that the operators plan to more than double the existing facilities.

PROJECTIONS

Any projection of future growth of recreational boating in the study area must consider a number of factors. Certainly for this form of recreation to increase, water quality must be suitable for this use. Obnoxious odors, objectionable esthetic floating matter, and oil slicks would not tend to lure people to relaxation. Assuming suitable water quality is available, other essential growth factors are population, income, leisure and mobility.

The 1955 and 1960 Census figures as well as projected populations made by the Metropolitan Regional Council for 1965, 1975 and 1985, for the United States, the New York Metropolitan Region, and the five counties bordering Raritan Bay, are:

Population in Millions

	1955	1960	1965	1975	1985
United States	165	179	196	235	286
N.Y. Metrop. Reg.	15	16	18	21	24
Five Counties*	1.4	1.6	2.2	3.2	4.3

*Richmond County (Staten Island), New York; Middlesex, Monmouth, Somerset and Union Counties, New Jersey.

A gradual population decrease is expected in New York City as a whole, with borough decreases in Manhattan, Brooklyn and the Bronx, stability in Queens and an increase in Richmond (Staten Island).

Personal annual income in the United States in 1955 was $1,865 per capita and is expected to rise to $3,285 (both in 1955 dollars) by 1985. During the same period, personal annual income in the New York Metropolitan Region is expected to increase from $2,470 to $4,350 (1). As incomes and purchasing power increase, more money will be available for recreation.

Leisure time in this country will be greatly enhanced. It is anticipated that the present 40-hour work week will be reduced to about 32 hours by 1985. Such a reduction in work hours could result in a six-and-one-half-hour day, a four-day week, a two or three-month paid vacation, or more likely some combination of these. At the same time, there will be more leisure for the non-working portion of the population, due to earlier retirements and continued mechanization of household chores.(1)

People are expected to become even more mobile. Around 1900 the average American traveled only 500 miles annually. By 1955, largely because of the automobile, this figure rose 10 times to 5,000 miles per year. A further increase to 7,700 miles is expected by 1985. The potential for increased mobility in the New York metropolitan region in one important respect surpasses that for the Nation, since this is the most mass-transit-oriented metropolitan area in the country, with correspondingly fewer automobiles per capita. It is anticipated that passenger cars in the region will increase from 3,900,000 to 8,600,000 between 1955 and 1985, a 120 percent rise in contrast to a population increase of 60 percent during the same period.(1) The increased mobility among the people in the region, together with improved accessibility with completion of the Verrazano Narrows Bridge and other public works, will no doubt result in large increases in the recreational uses of the Raritan Bay by residents of the New York City metropolitan region.

Adequate water quality combined with the expected changes in population, income, leisure, and mobility will result in a great increase in recreational boating in Raritan Bay. Since the population in the five counties adjacent to the bay will virtually double by 1985, it would appear that recreational days in boating should at least double. On this basis, the annual use in 1985 would amount to slightly over 1,000,000 recreation days, with an estimated annual value in excess of $1,500,000 using a conservative figure of $1.50 per recreation day, or $4,500,000 using the value of $4.50 per recreation day for this activity as noted during the survey.

FINDINGS AND CONCLUSIONS

1. A survey of recreational boating found 5,480 recreational boats, with an estimated capital value of $21,700,000 in the study area. In addition, an undetermined number of trailed and transient vessels used the bay waters.

2. In 1963, recreational boating in Raritan Bay provided approximately 506,000 recreation days, with an estimated annual value of $760,000.

3. Capital investment in the 63 marinas and 15 yacht clubs surveyed amounted to $10,440,000. Gross annual income to these facilities in 1963 was estimated at $2,440,000.

4. Planned or proposed moorings and berths will more than double the present capacity of the facilities surveyed in the near future.

5. Increases in population, income, leisure and mobility will result in a large growth of recreational boating in Raritan Bay. On the basis of population projections alone, it is estimated that in 1985 recreational boating will provide over 1,000,000 recreation days, valued at more than $1,500,000.

REFERENCES

1. RPA Bulletin No. 94 - "The Dynamics of Park Demand" by Marion Clawson, 1960 for Metropolitan Regional Council and Regional Plan Association, Tri-State New York Metropolitan Region.

2. "Boating 1963," by the National Association of Engine and Boat Manufacturers, 420 Lexington Ave., New York 17, N. Y. and the Marketing Division of the Outboard Industry Association, 307 North Michigan Avenue, Chicago 1,

Illinois.

3. "Supplement No. 1, Evaluation Standards for Primary Outdoor Recreation Benefits" by the Ad Hoc Water Resources Council, Washington, D. C., June 4, 1964.

APPENDIX D

RECREATIONAL BATHING - RARITAN BAY

SUMMARY

The Raritan Bay Project, Federal Water Pollution Control Administration, U. S. Department of the Interior (formerly Public Health Service, U. S. Department of Health, Education, and Welfare) conducted a survey of recreational bathing in Raritan Bay in 1963. The purpose of the study was to determine the present value of the bathing industry, and its potential for future growth.

The survey found 59 active bathing beaches in Raritan Bay and the Arthur Kill, 17 of which were municipally owned. The beaches had a land value of more than $23,000,000 with capital improvements in excess of $4,000,000.

Bather usage was light, with a density of only

10 persons per acre. Based upon $.50 per bather day, the industry had an annual value of $500,000 in 1963. Water quality was poor at many of the beaches, with geometric mean confirmed coliform MPN's at three sampling stations in excess of the maximum limits for bathing established by the New York City Department of Health.

Assuming adequate water quality is attained, the bathing industry in Raritan Bay has a future potential annual value, based upon $.50 per bather day, of $12,000,000 a year.

INTRODUCTION

An important facet of water use is recreational activities, such as bathing. Hence, as part of its overall study of Raritan Bay, the Raritan Bay Project conducted a survey of recreational bathing during the summer of 1963.

The objectives of the bathing survey were to locate the beach areas; determine investments, bather usage and gross income to the industry; and to estimate the future growth of this water use.

The study included all municipally owned beaches, as well as privately owned beaches which were accessible to bathers other than the owners, within the Raritan Bay

Project study area. This area, shown in Figure 1, includes the south shore of Staten Island, the shores of the Arthur Kill, and the New Jersey shore of Raritan Bay from the Raritan River to the Shrewsbury River.

SURVEY PROCEDURES AND RESULTS

Procedures: The beaches in the area were located by field reconnaissance. Each beach property was visited and the manager and/or owner contacted to obtain the needed information. The number of bathers in supervised beaches was obtained from records kept on the premises, while those in unsupervised beaches were estimated from inquiries in the area, and by counting the bathers at the time of the visits.

Values of beach land and improvements were determined from tax assessments. The land considered in the evaluation included both the beach proper and those adjacent areas used in conjunction with the beach operation. Tax-exempt land was evaluated on the basis of values of representative properties as estimated by local tax boards, resulting in the following capital values:

Cottage	$2,000 each
Hotel	$1,000/room and $2,000/apt.
Pool	$25,000 each
Bathhouse	$2,000 each
Private House	$15,000 each
Picnic Shelter	$1,000 each
Refreshment Stand	$2,000 each
Club Building	$25,000 each
Restaurant	$25,000 each
Bar	$25,000 each

Information on the number of employees, salaries and income from the industry was obtained from the management.

Data on the water quality in the bathing areas during the bathing season for 1963 were as determined by the Raritan Bay Project.

Results

The 59 active beaches surveyed are listed in Table 1 and located on Figure 2. Of the total number of beaches found, 42 were privately owned and 17 were municipally owned.

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Table 2 presents the total area, frontage and value of the beaches surveyed. The total frontage is over 15 miles, virtually all located on the shores of Raritan Bay. The total beach land area was 1,450 acres. The value of land occupied by these beaches was $23,600,000, while improvements, which excluded the value of erosion control works by the U. S. Army Corps of Engineers and other public works, amounted to $4,200,000.

Table 3 indicates the bathing usage, gross income, employees and salaries for the 59 beaches. The total number of bathers was estimated at 1,070,000 during the summer of 1963, equivalent to a bather density of only 10 persons per acre per day for the 73-day season June 22-September 2 (Labor Day). The Ad Hoc Water Resources Council has suggested a value of $.50 to $1.50 per general recreation day, to include bathing (1). Based on $0.50 per bather day, the value of bathing in Raritan Bay in 1963 was slightly in excess of $500,000.

The gross income at all the beaches and accompanying facilities surveyed totaled approximately $750,000 for the year ending September 2, 1963 (Labor Day). The income at the municipally owned beaches was augmented by municipal appropriations. The 65 year-around and 464 summer employees received salaries totaling $748,000.

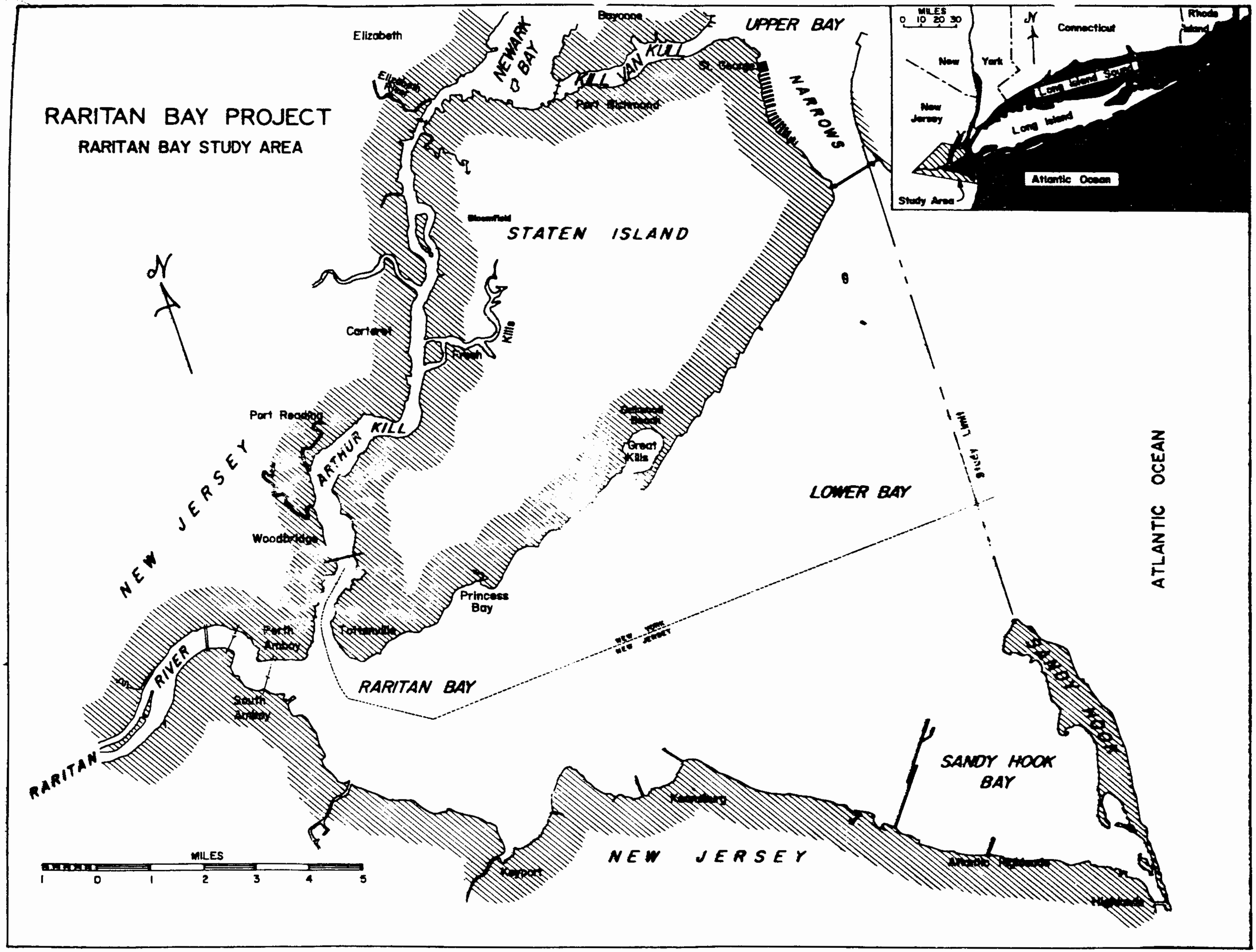

FIGURE 1

GPO 955-949

Table 1

Bathing Beaches Surveyed

1. South Beach
2. Ocean Edge Colony, Inc.
3. Clearwater Beach
4. Cedar Grove Beach Club
5. Great Kills Park
6. Great Kills Beach
7. Groton Street Beach
8. Seacrest Avenue Beach
9. Prol's Beach
10. Bennet Place Beach
11. Barclay Avenue Beach
12. Lippset Avenue Beach
13. Poillon Avenue Beach
14. Arbutus Beach
15. Huguenot Beach
16. Wolf's Pond Park
17. Seguine Point Beach
18. Princess Bay Cabana Club
19. Mount Loretto Beaches
20. Tottenville
21. Chelsea (Staten Island)
22. Sewaren Beach
23. James Street (E. Perth Amboy)
24. Perth Amboy
25. South Amboy
26. Paul's Beach
27. Laurence Harbor Beach
28. Open Beach @ Laurence Harbor
29. Cat 'N Fiddle Beach
30. Keyport - Broad Street
31. Keyport - Cedar Street
32. Union Beach
33. Laurel Avenue - Keansburg
34. Pinewood Ave-Carr Ave-Keansburg
35. Keansburg Public Beaches #1,2,3,4,5
36. Lighthouse Beach
37. Beacon Beach
38. Ideal Beach
39. Pews Creek
40. Barret Avenue Beach
41. Cullom's Beach
42. Bayside Way
43. Middletown Township Beach
44. Franklin Avenue Beach
45. Brevent Avenue Beach
46. Camp Happiness Beach
47. Atlantic Highlands Municipal Beach
48. Harborview Drive Beach
49. Torok's Beach
50. Doris 'N Ed's Picnic Beach
51. Mt. Mitchell Beach
52. Lynch's Beach
53. Conner's Hotel Beach
54. Cravely Point Beach
55. Waterwitch Beach
56. Atlantic Street Beach
57. Alley Avenue West Beach
58. Alley Avenue East Beach
59. Highlands Public Beaches #1,2,3

Note: Numbers refer to beach locations in Figure 2.

Table 2

Area Frontage and Value at Bathing Beaches

	MUNICIPALLY-OWNED BEACHES				PRIVATELY-OWNED BEACHES			
Zone	Frontage (Ft)	Land Area (Acres)	Land Value ($)	Improvement Value ($)	Frontage (Ft)	Land Area (Acres)	Land Value ($)	Improvement Value ($)
A	830	3.50	50,940	2,600	4,945	39.35	207,300	233,900
B	3,606	8.56	119,300	41,000	14,650	122.87	375,528	842,500
C	6,500	107.37	305,800	78,000	13,800	15.80	244,000	0
D	3,000	229.00	2,100,000	121,000	5,517	43.76	616,180	238,400
E	28,675	877.93	19,543,400	2,620,000	0	0	-	-
F	650	0.30	16,500	0	80	0.46	1,265	0
Total	43,261	1226.66	22,135,940	2,862,600	38,992	222.24	1,444,273	1,314,800

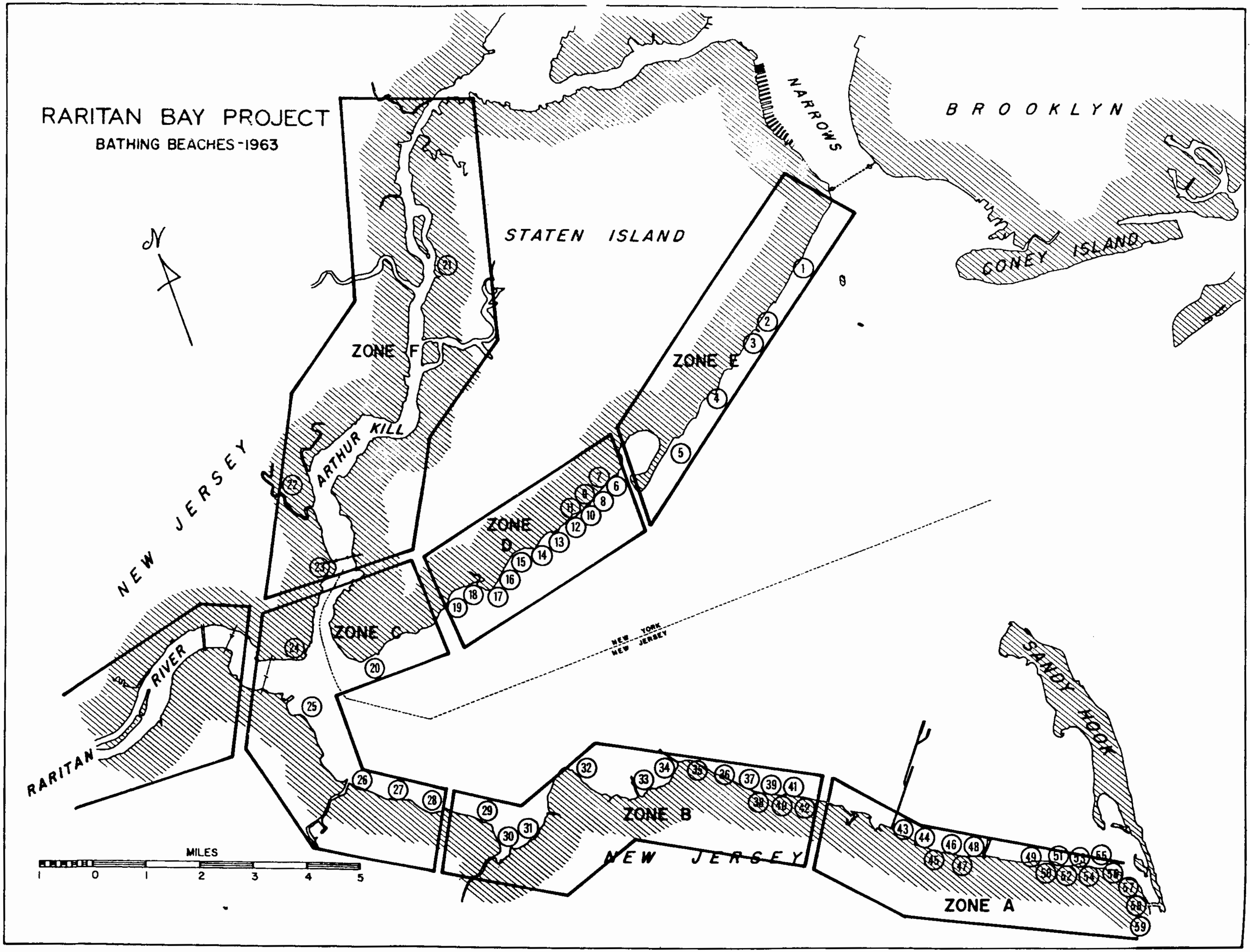

FIGURE 2

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Table 3

Income, Bathers and Employees in the Bathing Beaches

Zone	No. Employed Year Round	No. Employed Summer	Gross Income Per Year ($)	Bathers Per Season	Salaries ($)
A	4	14	78,060	80,860	35,500
B	13	151	261,575	157,940	138,414
C	0	18	2,000	38,000	12,600
D	26	44	188,246	206,125	106,702
E	22	237	219,966	581,868	401,023
F	0	0	0	4,350	0
Total	65	464	749,847	1,069,143	748,239

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Table 4 presents a summary of bacteriological data on the water quality at the Staten Island beaches, Areas D and E in Figure 2 for the periods May through August 1963 and 1964. The sampling station locations are shown in Figure 3.

The geometric means of confirmed coliform MPN's at Stations 601, 602, 603 and 604 exceeded the recommended limits for bathing waters of 1,000 per 100 ml as adopted by the New York City Department of Health. Three of these stations had confirmed MPN coliform geometric means in excess of 2,400 per 100 ml, the maximum limit allowed for bathing waters by the New York City Department of Health.

As a result of high bacteriological counts observed in the water, the New Jersey State Department of Health has closed the Perth Amboy bathing beach.

Area F where three bathing beaches were located consists of the Arthur Kill. The waters of the Arthur Kill have been classified as Class B by the Interstate Sanitation Commission, which does not provide for recreational bathing. Hence, the three beaches in this area are in contravention of existing legal classification standards for these waters.

Table 4

Summary of Bacteriological Data, May-August 1963

Shore Stations

Zone	Station	Confirmed Coliform			Fecal Coliform		Fecal Streptococcus	
		No. Samples	Geom. Mean /100 ml	No. of samples Greater Than 1000/100 ml	No. Samples	Geom. Mean /100 ml	No. Samples	Geom. Mean /100 ml
A	701	18	48	0	14	15	18	16
	702	19	208	4	15	40	19	33
	703	18	34	0	15	10	19	13
	704	19	57	1	15	20	19	28
B	705	19	151	3	15	30	19	53
	706	18	178	2	15	40	19	52
	707	19	324	3	15	30	18	46
	708	18	497	4	15	90	18	130
	709	17	390	5	15	30	18	82
	710	19	361	4	16	30	19	39
	711	17	295	4	16	30	18	48
	712	18	302	2	16	25	18	85
C	713	18	938	8	16	40	18	132
	714	17	532	4	15	30	17	178
	715	17	399	4	16	50	18	137
	716	17	5,478	13	16	330	17	82
	615	8	400	2	5	40	8	126
	616	14	566	4	11	60	14	376
	617	13	160	-	10	70	13	226

Table 4 Cont'd.

Zone	Station	Confirmed Coliform			Fecal Coliform		Fecal Streptococcus	
		No. Samples	Geom. Mean /100 ml	No. of samples Greater Than 1000/100 ml	No. Samples	Geom. Mean /100 ml	No. Samples	Geom. Mean /100 ml
D	611	17	348	3	14	40	17	155
	612	17	410	4	14	50	17	138
	613	17	205	1	14	30	17	169
	614	13	403	4	11	80	13	214
E	601	15	14,044	15	14	1,600	16	174
	602	17	7,895	15	15	700	18	63
	603	18	4,908	15	15	700	19	79
	604	17	2,219	13	14	220	17	23
	605	17	476	3	15	60	18	51
	606	17	627	6	15	40	18	44
	607	18	174	2	15	30	18	31
	608	17	153	1	14	20	17	49
	609	14	97	2	11	25	14	25
	610	-	-		-	-	-	-

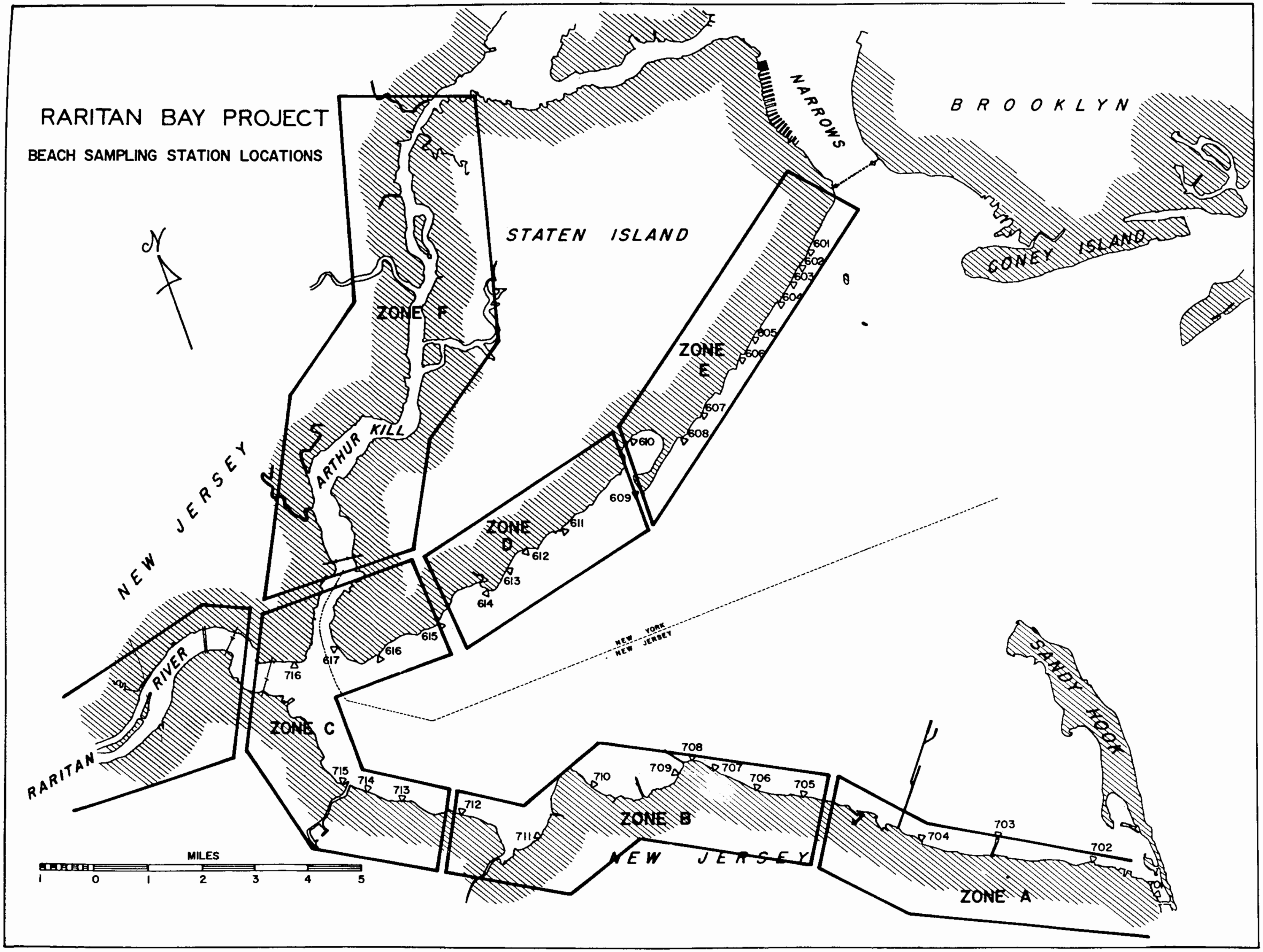

FIGURE 3

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PROJECTIONS

On a regional, as well as a national basis, recreational bathing is receiving increased attention and growth. Between 1945 and 1955, attendance at bathing parks in Nassau and Suffolk Counties in Metropolitan New York nearly quadrupled while the combined population only doubled. (2) Studies by the Federal Outdoor Recreation Resources Review Commission indicate that by the year 2000, recreational bathing will be the most popular single outdoor recreation, exceeding even automobile driving for pleasure, which now holds first place. (3)

The usefulness of a given body of water for recreational bathing depends on four factors: water quality, proximity of population, accessibility, and suitability for use. Assuming adequate water quality is attained, the large population adjacent to Raritan Bay should result in increasing use of this water for bathing.

Past and projected populations for Staten Island (Richmond County), New York, and the four counties in New Jersey closest to Raritan Bay are as follows: (2)

	Population in Millions			
	1955	1965	1975	1985
Staten Island, N. Y.	0.20	0.32	0.42	0.48
Four N. J. Counties*	1.18	1.87	2.76	3.79
TOTALS	1.38	2.19	3.18	4.27

*Middlesex, Monmouth, Somerset and Union Counties.

Construction of the Verrazano Narrows Bridge has resulted in making the beaches of Staten Island readily accessible to persons living in Brooklyn. Hence, the figures above could be revised upward to make allowance for an additional 1,000,000 or more persons in close proximity to the beaches of Raritan Bay.

It is estimated that over 40 percent of the population prefer water based recreation.(3) On this basis, by 1985, more than 2,000,000 persons in the immediate area and Brooklyn will be looking to Raritan Bay waters for recreation. Increased population throughout the metropolitan region, coupled with better highways and more rapid transportation, will place an ever increasing demand for water based recreation in the area.

Experience in the New York metropolitan region shows bather densities vary rather widely, from five persons per acre at Orient Beach State Park on Long Island to 4,000 persons per acre at Coney Island. [2] Sandy Hook State Park, just south of the Project study area had an average bather density of more than 200 bathers per acre per day for the bathing season included in the period July 1, 1963, to June 30, 1964. Hence, if adequate water quality were attained, a future density of at least 150 persons per acre per day, similar to the conditions now found at Jones Beach State Park in New York, can be projected for the Raritan Bay beaches. With the currently active bathing beaches, this would result in nearly 16,000,000 bather days for a 73-day season, as experienced in 1963, equivalent to a value of nearly $8,000,000 per year based upon $0.50 per recreation day. In addition, the development of additional beach areas to meet the demands of an increasing population, especially in the undeveloped areas of Middlesex and Monmouth Counties, New Jersey, could easily increase the projected value to $12,000,000 annually.

FINDINGS AND CONCLUSIONS

1. In 1963, there were 59 active bathing beaches on Raritan Bay and the Arthur Kill; of these 17 were

municipally owned, and 42 were privately owned.

2. These bathing beaches had a land value of $23,600,000, while improvements totaled $4,200,000.

3. Use of these bathing areas was light, with an average density of only 10 persons per acre. Based upon $0.50 per bather-day, the value of recreational bathing in 1963 was only $500,000.

4. Water at many of the Raritan Bay beaches was of a low quality. Geometric means of confirmed coliform counts at three stations exceeded the minimum limits for bathing established by the New York City Department of Health.

5. If suitable water quality were attained, the bathing industry in Raritan Bay could expand to a value of $12,000,000 annually, based upon $0.50 per bather-day.

REFERENCES

1. "Supplement No. 1, Evaluation Standards for Primary Outdoor Recreation Benefits" by the Ad Hoc Water Resources Council, Washington, D. C., June 4, 1964.

2. RPA Bulletin No. 96 - "The Race for Open Space" (Final Report of the Park, Recreation and Open Space Project of the Tri-State New York Metropolitan Region),

1960, for Metropolitan Regional Council and Regional Plan Association.

3. "Outdoor Recreation for America," a report to the President and Congress by the Outdoor Recreation Resources Review Commission, January 1962, Washington, D.C.

APPENDIX E

BOAT POLLUTION - RARITAN BAY

SUMMARY

As part of its program to collect scientific data on pollution of the waters of Raritan Bay, the Raritan Bay Project, Federal Water Pollution Control Administration, U.S. Department of the Interior (formerly Public Health Service, U. S. Department of Health, Education, and Welfare), studied available information to determine the effects on water quality of commercial navigation in the bay and conducted a survey of recreational boating to estimate the magnitude of pollution from this source.

This study showed that the New York - New Jersey Channel which traverses Raritan Bay is an important part of New York Harbor. Approximately one-fourth of the larger vessel traffic entering or departing the port traverses this channel. In both 1960 and 1961, annual totals of more than 120,000 vessel trips were made through Raritan Bay channels. Of these, 4,000 trips annually were made by ships of 20 feet draft or larger.

Projections of future commercial traffic indicated that by 2015, the New York - New Jersey Channel will handle 200,000 vessel trips annually, of which 6,000 trips will be made by ships of 20 feet draft or larger.

The evaluation indicated the major pollution problems associated with commercial navigation in the bay, both now and in the future, are local problems in the area of docks and berths rather than pollution in transit and anchorages.

INTRODUCTION

Purpose and Scope

As a part of its overall mission to collect and evaluate scientific data related to water pollution and its control in Raritan Bay, the Raritan Bay Project reviewed and evaluated existing information on the extent of commercial navigation within the study area, so as to determine the magnitude of the water pollution problem associated with such shipping. In addition, the Project conducted a survey of recreational boating within the study area to determine the effects of such boating upon water quality. The study area is shown in Figure 1.

Sources of Data

Information on the present commercial vessel traffic and industry trends was obtained from the published records of the U. S. Army Corps of Engineers. From these data, the present and future pollution loads associated with this water use were estimated.

Information on recreational boating within the study area was obtained as a result of a survey conducted in 1963 by the staff of the Project. Details on this survey have been reported in Appendix C.

Present and Future Navigational Use

Present Traffic

The study area is adjacent to, and forms a portion of the Port of New York, one of the world's busiest seaports. The shipping channels in the study area are shown on Figure 1. All of these channels have depths at mean low water in excess of 30 feet. In addition to the channels, the study area contains 11 designated anchorage areas, all unimproved.

Table 1 presents the vessel trips in the New York Harbor Entrance Channels for the period 1952 to 1961. These data are counts of vessels passing the outer bar of Ambrose and Bayside Channels, the two ocean entrances to New York Harbor. The number of trips annually has shown only minor variation during this decade, and averages 36,000 vessel trips per year. Of this total, one-half is due to vessels with drafts of less than 20 feet, made up of coast-line traffic adjacent to New York Harbor, such as large tows and dump scows which unload beyond the channel outerbar. While the total annual vessel trips have remained constant, there has been a large decrease in the number of trips by vessels under 20 feet draft, with an accompanying increase in larger vessels, especially in the 34 to 38-foot draft category.

Table 2 shows vessel trips for 1960 and 1961 through the New York and New Jersey Channel, which runs

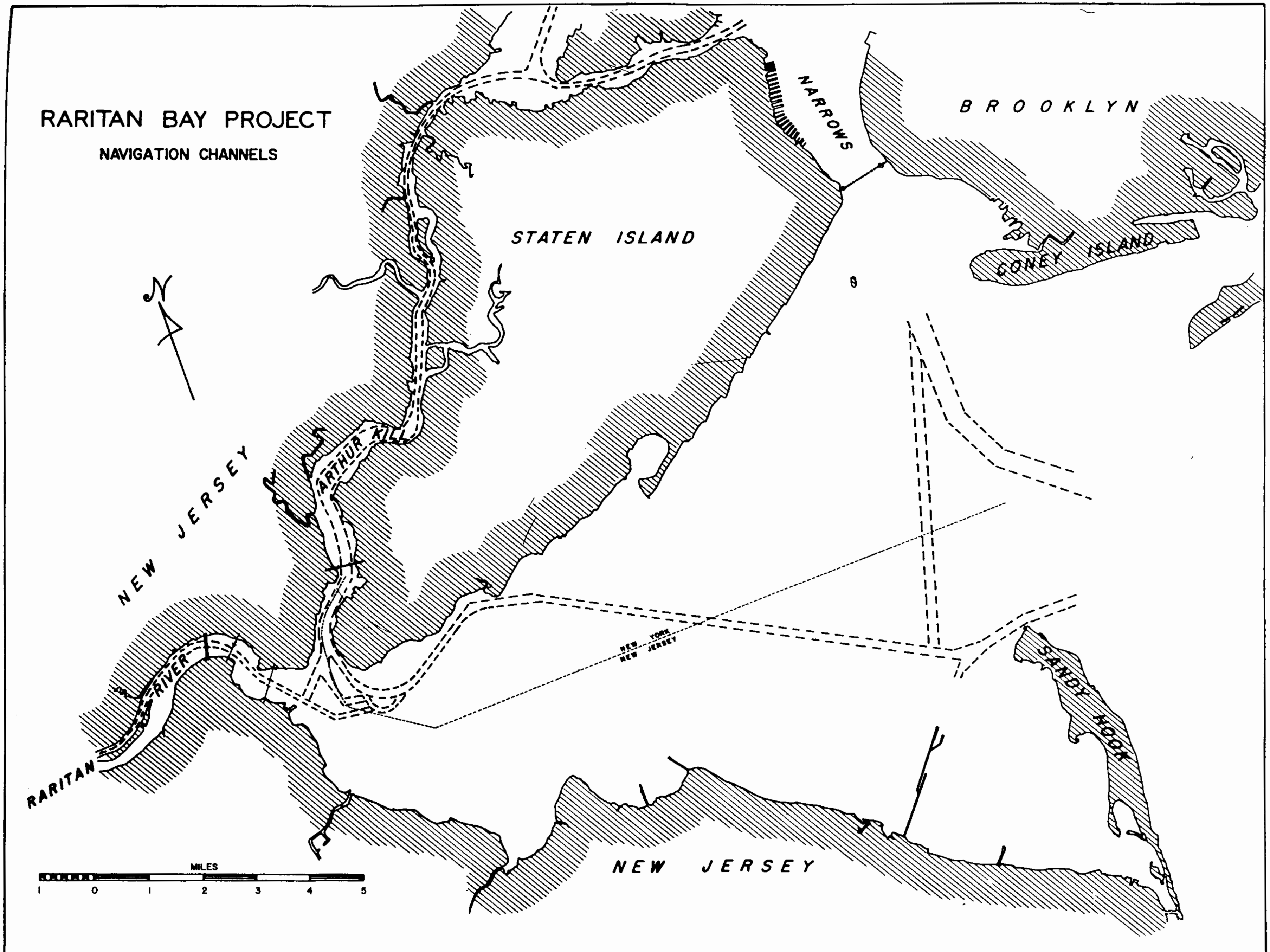

FIGURE I

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Table 1

New York Harbor Entrance Channels
Trips of Vessels of Various Drafts - 1952 to 1961

(Ambrose and Bayside - Gedney Channels)

Year	38 and Over	34 to 37.9	30 to 33.9	25 to 29.9	20 to 24.9	Less Than 20	All Drafts
	Number of Vessel Trips for Indicated Drafts in Feet						
1952	72	101	2,678	4,479	7,555	21,029	35,914
1953	73	86	2,859	4,507	8,172	23,842	39,539
1954	84	104	2,868	4,180	7,850	23,232	38,318
1955	73	188	3,134	4,845	8,140	19,065	35,405
1956	86	219	3,373	5,047	7,923	20,206	36,854
1957	71	401	3,092	4,912	8,326	18,546	35,348
1958	69	553	2,783	4,705	8,940	17,256	34,306
1959	79	596	2,801	4,880	9,352	18,691	36,399
1960	69	757	2,661	4,850	10,161	18,376	36,874
1961	71	985	2,414	4,758	10,303	14,888	33,419
Average	75	399	2,866	4,716	8,668	19,513	36,237

Table 2

New York & New Jersey Channel Traffic, 1960 and 1961

Number of Vessel Trips for Indicated Draft in Feet

Type of Vessel	Inbound: 38 and Over	Inbound: 34 to 37.9	Inbound: 30 to 33.9	Inbound: 25 to 29.9	Inbound: 20 to 24.9	Inbound: Less Than 20	Inbound: All Drafts	Outbound: 38 and Over	Outbound: 34 to 37.9	Outbound: 30 to 33.9	Outbound: 25 to 29.9	Outbound: 20 to 24.9	Outbound: Less Than 20	Outbound: All Drafts
CALENDAR YEAR 1960														
Self-Propelled Vessels														
Passenger & Dry Cargo	-	-	4	74	95	16,413	16,586	-	-	1	27	30	16,466	16,524
Tanker	4	594	1,441	177	142	11,601	13,959	-	6	126	260	1,153	12,410	13,955
Tow or Tug Boat	-	-	-	-	-	22,559	22,559	-	-	-	-	-	22,559	22,559
Towed Vessels														
Dry Cargo	-	-	-	-	9	8,220	8,229	-	-	-	-	27	8,217	8,244
Tanker	-	-	-	-	64	10,883	10,947	-	-	-	-	20	10,927	10,947
Totals 1960	4	594	1,445	261	310	69,676	72,280	-	6	127	287	1,220	70,579	72,229
CALENDAR YEAR 1961														
Self-Propelled Vessels														
Passenger & Dry Cargo	-	-	4	79	122	12,336	12,541	-	-	3	19	68	12,356	12,446
Tanker	9	665	1,132	191	116	9,659	11,772	-	6	81	347	1,243	10,436	12,113
Tow or Tug Boat	-	-	-	-	-	18,950	18,950	-	-	-	-	-	19,175	19,175
Towed Vessels														
Dry Cargo	-	-	-	-	7	6,064	6,071	-	-	-	-	13	6,004	6,017
Tanker	-	-	-	-	20	9,925	9,945	-	-	-	-	32	10,284	10,316
Totals 1961	9	665	1,136	270	265	56,934	59,279	-	6	84	366	1,356	58,255	60,067

	1960	1961
Total Vessel Trips, All Drafts	144,509	119,346
Total Vessel Trips, Drafts 20 feet or more	4,254	4,157
Tanker Vessel* Trips, Drafts 20 feet or more	3,903	3,790
Total Self-Propelled Vessel Trips, All Drafts		86,997

*Self-propelled only

through Raritan Bay from the Bayside Channel to the Arthur Kill. Total vessel traffic for each of these years amounted to over 120,000 trips. However, only 4,200 of these trips were made by vessels of 20 feet or more draft.

Possible routes for vessels entering and leaving the New York Harbor complex can be seen by the configuration of shipping channels in Figure 1. Vessels entering from the ocean via the Ambrose and Bayside Channels can proceed either through the Narrows into New York Harbor proper, or to the Arthur Kill and Raritan River via the New York and New Jersey Channel. Departing vessels would travel the same routes, except for a tendency to avoid turning the larger vessels in the Arthur Kill due to the narrow channel width. Larger vessels generally enter the Kill from Raritan Bay and continue so as to depart through Newark Bay, Kill Van Kull and the Upper Harbor, or travel the reverse direction.

A comparison of data for 1960 and 1961 in Tables 1 and 2 indicates the general proportion of traffic movement. In each year, 18,500 trips were made by vessels of 20-foot draft or larger. Only 4,200, or one-fourth, of these trips utilized the New York and New Jersey Channel, while the remainder generally traveled through the Narrows.

Additional vessel traffic in the area which is not included in Tables 1 and 2 is that flowing between the

Raritan River and the Arthur Kill, and that in the area of Sandy Hook Bay. The traffic in these areas, for vessels of 20-foot or more draft, is known to be small in comparison to the channels discussed above, although considerable traffic does exist for smaller vessels.

Future Projections

The trend over the past decade toward larger vessels is shown by Table 1. Trips by vessels with drafts of 34 to 37.9 feet increased nearly tenfold during the period 1952 to 1961, while there was a gradual reduction in trips by vessels of less than 20-foot draft. At present, about one-half of the tankers entering the New York Harbor complex are of the T-2 class, built during World War II. These vessels generally have a draft of 30 to 31 feet, and a capacity of 17,000 dead weight tons. The remaining tankers are generally post-World War II, with capacities of 20,000 to 40,000 tons. In recent years, tankers as large as 100,000 dead weight tonnage have been constructed. Table 3 presents the size of tankers under construction as of July 1, 1962, for three maritime nations, and illustrates the trend toward tankers larger than the T-2 class.

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At present, the dry cargo ships entering New York Harbor range in length from less than 300 to 600 feet and in draft from 20 to 33 feet. Table 4 presents data on typical dry cargo ships ordered as of June 1961 by United States operators, and illustrates that these new vessels, while large, are still within the range of ships now in service.

Studies of tanker trends made by the Corps of Engineers, the Suez Canal Company and others indicate that the majority of tankers in the New York Harbor complex over the next 50 years will be of the medium size, i.e., 45,000 dead weight tonnage. Hence, although the petroleum commerce is expected to increase over this period of time, these larger vessels will require fewer trips to carry this commerce. It is estimated that 3,100 round-trips, or 6,200 vessel trips, will be made annually by tankers to and from the New York Harbor complex 50 years from now.

On the basis of average annual prospective dry cargo commerce in New York Harbor for the next 50 years, it is anticipated that about 10,000 freighters with drafts over 20 feet will enter New York Harbor annually, i.e., 20,000 vessel trips through the Ambrose and Bayside Channels.

Table 5 presents a projection of traffic for the year 2015 in the New York and New Jersey channel through

Raritan Bay, based upon the above estimates of total New York Harbor commerce. The assumptions used in this projection were that the present percentage of total traffic for vessels of 20 feet draft and larger which use the New York - New Jersey channel would remain constant, and that trips of vessels with less than 20 feet draft and towed vessels would increase proportionately with the larger vessel traffic. These assumptions result in a projected commercial navigation load in 2015 of 200,000 vessel trips annually through the New York - New Jersey Channel bisecting Raritan Bay. Of this total, 6,000 vessel trips will be made by vessels of 20 feet and more draft.

Table 3

Tankers Under Construction for U.S., Liberian & Panamanian Flags, 1962

Dead-weight Tonnage	Approx. Draft Ft.	No. of Vessels U.S.	Liberian	Panama	Total	% of Total Vessels
18,000	31	0	1	0	1	1
25,000-36,000	33-36	6	1	3	10	16
36,001-45,000	36-38	0	0	0	0	-
45,001-55,000	38-40	4	27	2	33	55
55,001-66,000	40-42	0	0	0	0	-
66,001-70,000	42-43	0	10	0	10	16
70,001-80,000	43-45	0	7	0	7	11
150,000	45+	0	1	0	1	1

Table 4

Cargo Vessels Ordered by United States Operators
(As of June 1961)

Vessel Type	Length Feet	Beam Feet	Draft Feet	Dead-Weight Tonnage	No. of Vessels
C3-S33a	484	68	28.5	12,300	8
C3-S37b	495	69	28	11,000	17
C3-S38a	492	73	27	11,000	4
C3-S46a	493	73	27	12,800	8
C3-S43a	506	70	28	13,100	3
C4-S19	564	76	30	14,000	2
C4-S1a	564	76	27	15,000	3
C4-S1t	565	76	30	13,700	2
C4-S49a	545	79	27	9,300	3
C4-S11u	565	76	30	14,300	6
C4-S58a	574	75	30.5	12,600	6
C4-S57a	560	75	28.5	12,000	11

Table 5

PROJECTION OF TRAFFIC IN NEW YORK & NEW JERSEY CHANNEL IN YEAR 2015

Total Trips, Vessels 20' draft & larger, Ambrose & Bayside Channels, 1960	18,498 1/
Total Trips, Vessels 20' draft & larger, New York & New Jersey Channels, 1960	4,254 2/
Percent of Ambrose-Bayside Traffic to NY-NJ Channel	23%
Estimated Trips, Vessels 20' draft & larger, Ambrose & Bayside Channels, 2015	26,200 3/
Projection Trips, Vessels 20' draft & larger, New York & New Jersey Channels, 2015	6,000 4/
Percent Increase in NY-NJ Channel Trips for Vessels 20' draft and larger, 2015	41%
Present Traffic, Vessels less than 20' draft, NY-NJ Channel, 1960	140,255 2/
Future Traffic, Vessels less than 20' draft, NY-NJ Channel, 2015	198,000 5/
Total Vessel Trips, NY-NJ Channel, 2015	204,000

1/ From Table 1.

2/ From Table 2.

3/ From Text, 6200 tanker and 20,000 dry cargo.

4/ 23% of 26,200.

5/ Assuming same percentage increase for small vessels as that for vessels 20' or more draft.

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POLLUTION FROM COMMERCIAL NAVIGATION

No field studies were made of the pollution from vessels engaged in commercial navigation. Calculations were made to estimate the order of magnitude of water pollution from this source.

Table 6 was prepared to suggest the size of the problem of fecal pollution from commercial vessels in Raritan Bay, based upon the data in Table 2. In preparing Table 6, it was assumed that self-propelled vessels of less than 20 feet draft were generally tugs, which did not use the anchorage or dockside areas to any significant extent. Similarly, towed vessels of all sizes were considered as barge traffic with one-man crews and were eliminated from use of anchorage and berth areas.

On the basis of these assumptions, Table 6 indicates the major problem of fecal pollution from commercial vessels is concentrated in the berthing area, where the equivalent population was estimated as 600 persons. Pollution while in anchorage, or from vessels in transit, was equal to a population of less than 100 persons.

With the projected increase of 50 percent in vessel trips with draft of 20 feet or more, a proportionate projection of the figures in Table 6 would indicate the major future problem would also be localized in the berthing areas.

The Interstate Quarantine Regulations govern the discharge of polluting materials from commercial vessels engaged in interstate traffic. A special committee appointed to investigate the pollution problems associated with commercial vessels has proposed the following be included in the regulations:

> "SEWAGE TREATMENT. New vessels undergoing major conversion, that will operate in interstate traffic under the terms of these regulations, that are contracted for after the effective date of this section, shall be equipped with facilities to treat wastes from toilets, urinals, facilities in hospital areas handling fecal material and wastes from garbage grinders when such grinders are installed. In lieu of treatment, these wastes may be collected in holding tanks properly equipped with pumps and piping, so that the wastes can be discharged to approved shore-based or floating installations, or on the high seas."

Table 6 does not include pollutional loads which occur as a result of the discharge of oil and other bilge waste, discard of trash, garbage and other debris, and spillages at dockside during cargo transfer. No evaluation was made of these sources, as existing laws controlling this pollution are in effect at all levels of governments -- State, interstate and Federal.

PRESENT AND FUTURE RECREATIONAL BOATING

A survey of recreational boating in Raritan Bay by the staff of the Raritan Bay Project found a total of 5,480 recreational boats located at marinas and berths within the study area. In addition, a further vessel use of one-half that surveyed was estimated as attributable to transient visitors from outside the survey area either via water or as automobile trailed boats.

Based upon expected changes in population, income, leisure, and mobility, recreational boating in the bay is expected to be greatly increased. Since the population in the five counties adjacent to the bay will virtually double by 1985, it would appear that recreational boating would also at least double over this period. Estimates of future pollution loadings were made on this basis.

POLLUTION FROM RECREATIONAL BOATS

Pollution of water by recreational boating may occur in a number of ways: discharge of human wastes; fuel and oil from spillage and engine exhaust; discard of trash and garbage; and chumming when the boats are used for fishing.

Of the 5,480 boats surveyed in 1963, 1,845 had toilet facilities aboard. Only 46 of these had some provision for treatment of the waste before discharge, generally chlorination.

Estimates were made to determine the order of magnitude of the problem of fecal pollution from recreational boats, on the assumptions that all of the boats surveyed with toilet facilities were in use, and that an additional 50 percent of this number were present as transient visitors from outside the survey area, as would occur on a weekend or a holiday. The calculations are presented in Table 7. The present BOD load from this activity is 725 pounds per day, equivalent to a municipality of 4,300 persons. After deducting the waste from those boats which provide treatment, i.e., chlorination, the bacterial loading is equivalent to the raw sewage discharge from 5,900 persons.

TABLE 6

ESTIMATED FECAL POLLUTION FROM COMMERCIAL NAVIGATION - 1961

(NY - NJ Channel)

Vessel Category	1961 Vessel Trips 1/	Estimated Crew Size	Man days in Transit 2/	Equivalent Transit Population 3/	Man days in Anchorage 4/	Equivalent Anchorage Population 3/	Man days at Dockside 5/	Equivalent Dockside Population 3/
Self-Propelled, Draft 20 feet or more	4,085	35	2,970	8	23,800	65	220,000	600
Self-Propelled, Draft less than 20 feet	82,912	15	25,900	71	6/	6/	6/	6/
Towed, all Drafts	32,349	1	675	2	6/	6/	6/	6/
TOTALS	119,346	-	-	81		65		600

1/ From Table 2.

2/ Assuming 30 minute channel transit time.

3/ Man days ÷ 365 to convert to 365 day year population.

4/ Assuming 1/3 of vessels use anchorage area for 12 hours each.

5/ Assuming 3 day tie-up at dock for each pair of vessel trips (i.e., incoming - 3 day berth - outgoing).

6/ No value calculated on the assumption that self-propelled vessels less than 20 feet draft and towed vessels consist of tugs and barges and do not utilize the anchorage and dockage facilities.

Table 7

FECAL POLLUTION RESULTING FROM RECREATIONAL BOATING

Number of Boats Surveyed	5,480	
Number Surveyed with Toilets	1,845	
Estimated Transit with Toilets	900	
Total Boats with Toilets		2,745
Average Population Per Boat	4.4	
Estimated Hours of Use	12	
Tributary Population, capita-days	6,040	
BOD Load in lbs per Day 1/	725	
BOD Equivalent Population 2/	4,300	
Number of Boats with Toilets but No Treatment	1,799	
Estimated Transit with Toilets but No Treatment	880	
Total Boats with Toilets but no Treatment		2,679
Coliform Equivalent Population 3/	5,900	

1/ Assuming a per capita contribution for domestic sewage of 0.12 lbs (Fair & Geyer, Water Supply and Waste-Water Disposal, Wiley & Sons, 1954, Pg. 563).

2/ At 0.17 lbs per capita for municipal sewage.

3/ Assuming boat population and hours of use given for BOD calculations.

Assuming that recreational boating doubles by 1985, the pollutional load on this activity will become even more significant than at present. If the present proportion of boats with treatment remains constant, the resulting equivalent population by 1985 would be more than 10,000 persons.

Although this pollution source is spread over the bay rather than concentrated at a particular point, the magnitude of this pollution is sufficient to warrant control. In particular, the discharge of raw wastes from recreational boats directly over open shellfish areas presents a sanitary problem with definite public health significance. Further study of this problem and the development of adequate treatment facilities are required to insure proper control of pollution from recreational boating.

CONCLUSIONS AND RECOMMENDATIONS

On the basis of available data and field surveys of present commercial vessel traffic and recreational boat use in Raritan Bay, and projections of future growth of such uses, the following conclusions were reached:

1. Raritan Bay is traversed by several commercial shipping channels and forms an important part of the Port

of New York complex.

Approximately one-fourth of the larger vessel traffic entering or departing the Port of New York travels the New York-New Jersey Channel through Raritan Bay. In both 1960 and 1961 an annual total of approximately 4,200 vessel trips were made through this channel by vessels with drafts of 20 feet or more.

3. It is expected that by the year 2015, 6,000 vessel trips will be made annually through the New York-New Jersey Channel by vessels with drafts of 20 feet or more.

4. Present and future fecal pollution from commercial navigation is of greatest concern in local dockside areas. Pollution from these vessels while in transit or in anchorage is much less significant.

5. There are existing pollution control laws at all levels of government which forbid the discharge of oil and pumping of bilge wastes by commercial vessels while in these waters.

6. The present fecal pollution from recreational boating is estimated to be equivalent to 4,300 persons on a BOD basis and 5,900 persons on a bacterial loading basis.

7. Projected increases in recreational boating indicate that by 1985 the equivalent population from this source will be more than 10,000 persons.

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With the proposed clean-up of the waters of the Raritan Bay as an outgrowth of the existing and proposed programs of State, interstate and local agencies, the problem of pollution from commercial vessels and from recreational boating becomes more significant. In the light of this the following recommendations are made:

1. Existing laws regulating oil discharge and bilge waste pumping continue to be enforced at all levels of government;

2. Provisions be made within commercial vessel docking areas for the transfer of fecal wastes to shore-based treatment and disposal systems;

3. The proposed changes to the Interstate Quarantine Regulations requiring adequate treatment facilities or in-transit storage facilities for commercial vessels be adopted;

4. Further study and development of adequate treatment means be made so as to control the discharge of sewage from recreational boats.

APPENDIX F

GEOLOGY OF RARITAN BAY

SUMMARY

During July and August 1963, the Raritan Bay Project, Federal Water Pollution Control Administration, U. S. Department of the Interior (formerly Public Health Service, U. S. Department of Health, Education, and Welfare) conducted a geological investigation of Raritan Bay to define water movement in the bay by the sediment pattern.

The study included a review of available chloride data, as well as sampling and analyses of the bay sediment. Sediment samples were subjected to size analyses

and determinations of water, organic matter and carbonate content. The distribution of these readily identifiable sediment particles, the mineral muscovite, the shell of the small clam Mulinia lateralis, and detrital coal, was studied to determine net movement of such particles in the bay.

Major conclusions from this investigation include the following:

1. The shoreline of the Raritan estuary has reached early maturity in the geomorphic cycle of shoreline development.

2. Movement of high chlorinity water is centered in the northerly portion of the bay, while fresher water moves through the southern portion.

3. The bay floor is made up of four major sediment bodies, referred to as the Lower Bay and Keansburg Sands, and the Sandy Hook Bay and West Raritan Bay muds.

4. The high organic carbon content found in West Raritan Bay is due to small particles of organic matter, probably the result of organic matter introduced through pollution.

5. Sediment particles originating at various locations in the bay are moved progressively toward the area bounded by Sequine Point, Great Kills, Keyport and Keansburg.

Paul DeFalco

INTRODUCTION

As part of its work in gathering scientific data relating to pollution of the waters of Raritan Bay, the Raritan Bay Project investigated the geology of Raritan Bay. During July and August 1963, sampling and analysis was carried out to determine sediment types and distribution, as well as sediment water, organic and carbonate content.

In addition to providing general knowledge to the Bay area, the purpose of the study was to attempt to define water movement in the bay as evidenced by the general sediment pattern.

DESCRIPTION OF AREA

GENERAL

Raritan Bay is a triangular-shaped estuary which opens eastward to the Atlantic Ocean. It lies directly adjacent to the New York metropolitan area, as shown in Figure 1. Although collectively referred to in this report as Raritan Bay, the estuary is actually composed of three bodies of water: Raritan Bay proper in the western and southern area, Lower New York Bay in the north, and Sandy Hook Bay in the southeast. The principal external sources of water entering the bay in addition to the Atlantic Ocean are the Raritan River, Arthur Kill and the Narrows.

BEDROCK GEOLOGY

The geologic formations and their areas of exposure are shown in Figure 2. Rocks of less than 1 million years age form the shores of a large portion of Raritan Bay. The terminal moraine of the latest continental glacier, the Wisconsin Ice Sheet, bounds the bay to the north in the area from Perth Amboy to Great Kills. From Great Kills east to the Narrows the Staten Island shore consists of sands of less than 1 million years,i.e., of Quaternary age. The New Jersey shore from Keyport to Leonardo as well as Sandy Hook are also composed of Quaternary sands.

The older sands, gravels and clays underlying Raritan Bay and the rocks exposed along the shore of the bay in the areas not described above are all of the Upper Cretaceous age and were deposited between 100 and 70 million years ago.

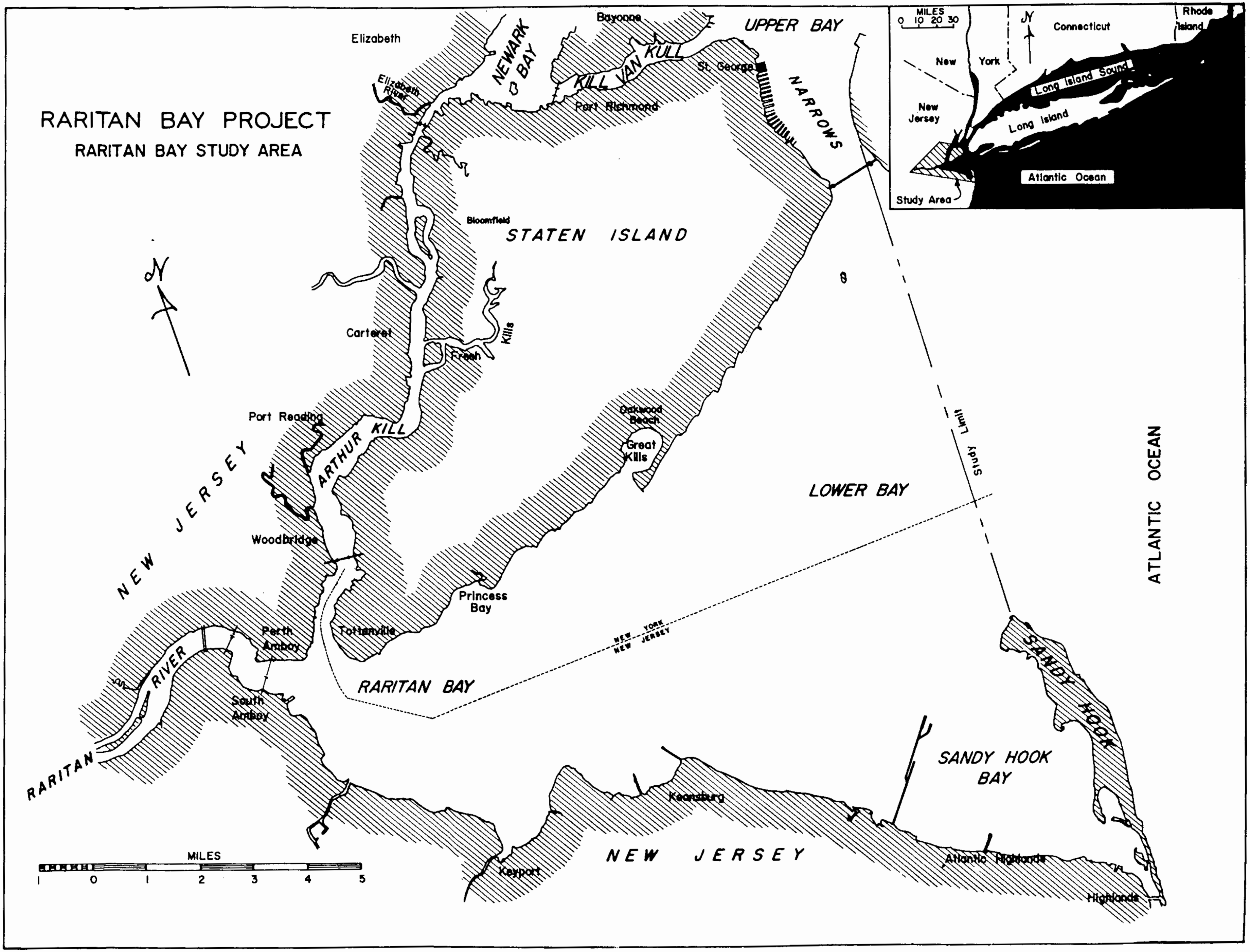
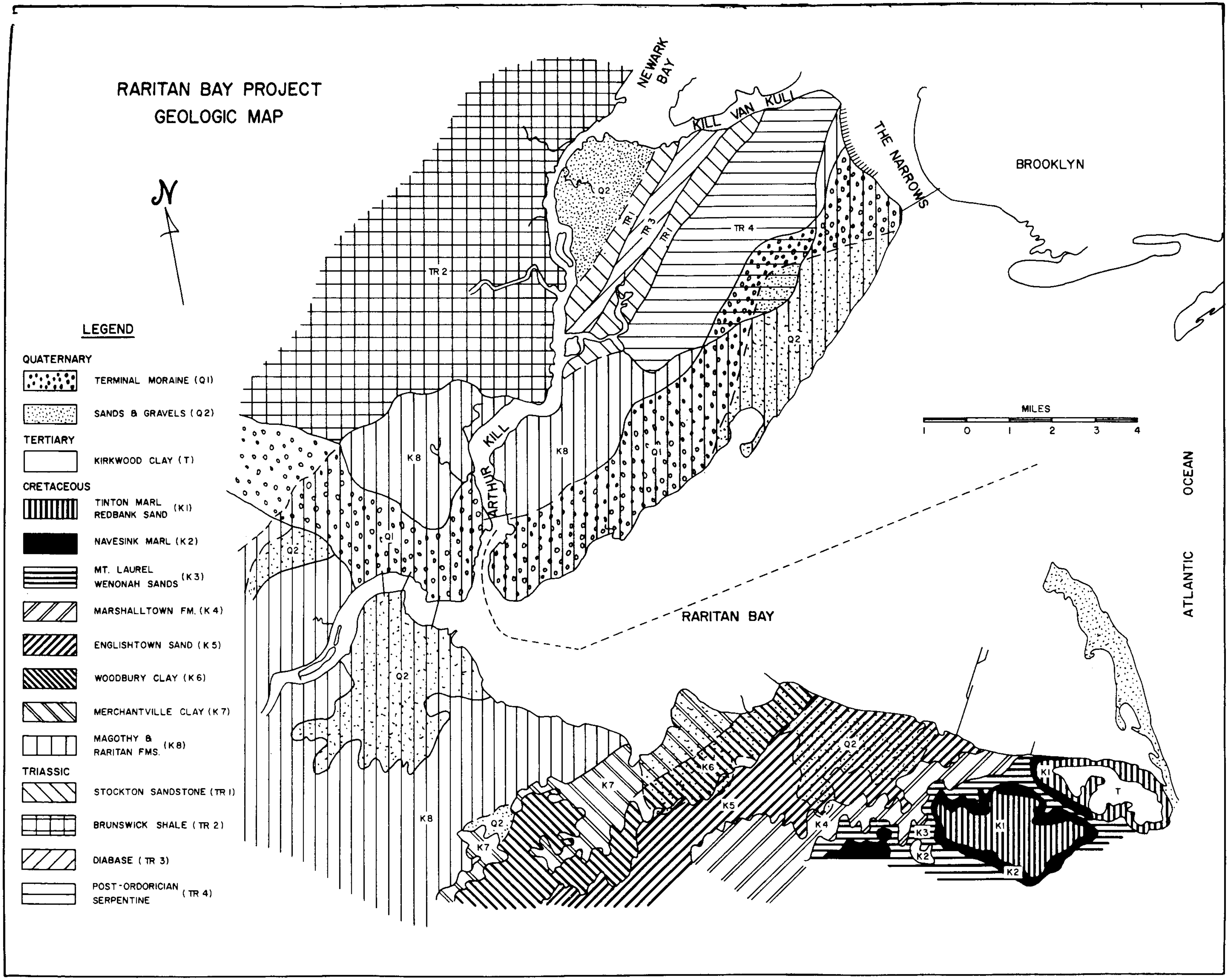


FIGURE 1

GPO 955-949



RARITAN BAY PROJECT
GEOLOGIC MAP
N
LEGEND
QUATERNARY
TERMINAL MORAINE (Q1)
SANDS & GRAVELS (Q2)
TERTIARY
KIRKWOOD CLAY (T)
CRETACEOUS
TINTON MARL
REDBANK SAND (K1)
NAVESINK MARL (K2)
MT. LAUREL
WENONAH SANDS (K3)
MARSHALLTOWN FM. (K4)
ENGLISHTOWN SAND (K5)
WOODBURY CLAY (K6)
MERCHANTVILLE CLAY (K7)
MAGOTHY &
RARITAN FMS. (K8)
TRIASSIC
STOCKTON SANDSTONE (TR 1)
BRUNSWICK SHALE (TR 2)
DIABASE (TR 3)
POST-ORDORICIAN
SERPENTINE (TR 4)
NEWARK BAY
KILL VAN KULL
THE NARROWS
BROOKLYN
ARTHUR KILL
RARITAN BAY
ATLANTIC OCEAN
MILES
1 0 1 2 3 4

FIGURE 2

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PHYSIOGRAPHY

Sea cliffs are shoreline features resulting from marine erosion.[1] On the Raritan Bay shore, these cliffs are found on Staten Island, westward from Seguine Point to the Arthur Kill and on the New Jersey shore between Cliffwood and the Raritan River and between Leonardo and Highlands.

Wide beaches are shoreline features which result from marine deposition.[1] Sections along Raritan Bay with such beaches are the Staten Island shore from Seguine Point eastward to the Narrows, the New Jersey shoreline between Keyport and Leonardo, and Sandy Hook.

The shorelines of Raritan Bay are relatively straight compared to those of most Atlantic Coast estuaries. Shorelines of erosion and deposition show linear continuity with one another.

The bay is relatively shallow and its floor slopes fairly uniformly and gently toward the center of the bay, where its maximum depth is about 27 feet. The mouth of the bay is marked by a north-south series of shoals and bars, including Sandy Hook, Flynn's Knoll, Romer Shoal and West Bank. None of the beach areas show offshore bars. Tidal marshes are present on the New Jersey shore.

115m

Paul DeFalco

Since sea level has risen several hundred feet in the past 10,000 years, Raritan Bay is of rather recent submergence. The bay has reached early maturity in the cycle of shoreline development along submergent coasts. The straight shorelines, uniform slope of the floor and the absence of offshore bars satisfy the conditions for maturity, although the presence of tidal marshes indicates that full maturity has not yet been attained.(1)

HYDROGRAPHY

Previous studies have shown that ocean water enters the bay on the north, river water moves along the south shore, and mixing occurs along the long axis of the bay. (2) The seaward drift of fresh water on the southern part of the bay is horizontally separated from the landward counter drift in the area where the bay widens. Surface waters are of lower salinity than bottom waters.(3) Water from the east enters the bay off Staten Island, moves westward toward Staten Island, but then is recirculated along the beach in a northeasterly direction. (4)

STUDY PROCEDURES

Specific sampling and analysis for this investigation was conducted during July and August 1963. In addition, results of general sampling for chloride, salinity, temperature and wind directions, as described in Volume I, were used for this report.

Field stations used for this investigation were these established by the Project for chemical and bacteriological studies of the bay. The stations are shown in Figure 3. Stations 31, 64, and the shore stations (600 and 700 series) were not sampled during this geology study.

SAMPLE COLLECTION

Bottom samples were obtained with a Petersen Grab Sampler. Contents of the sampler were emptied into a large enamel pan, where the sample was examined for color, stratification, texture, mass properties and unusual odor. A quart of sediment was preserved in 10 percent formalin for later mechanical and paleontological analyses in the Project laboratory. When stratification was noted in the sample, at least 50 ml was taken from each layer and

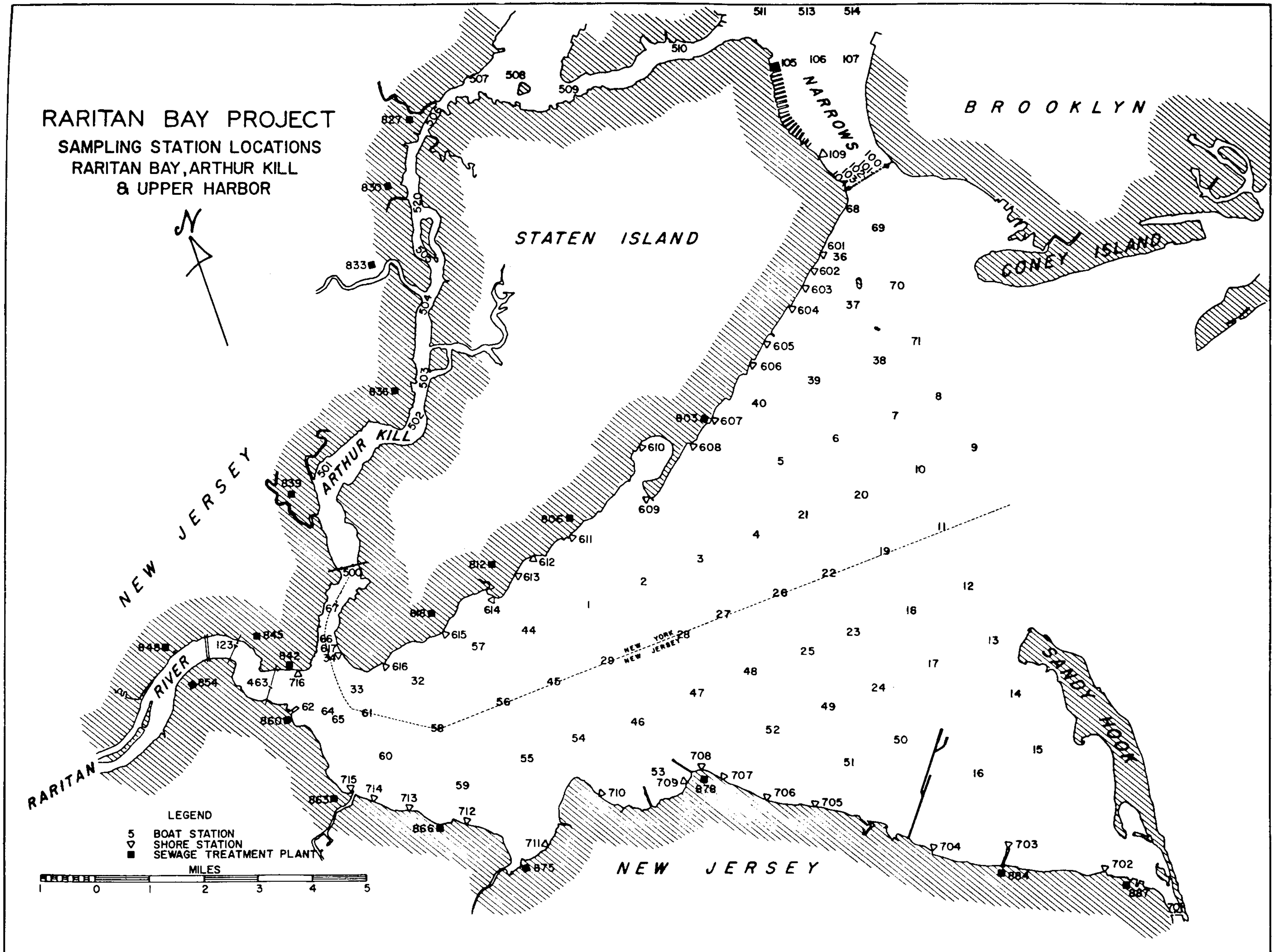
RARITAN BAY PROJECT
SAMPLING STATION LOCATIONS
RARITAN BAY, ARTHUR KILL
& UPPER HARBOR
N
STATEN ISLAND
BROOKLYN
CONEY ISLAND
NARROWS
ARTHUR KILL
NEW JERSEY
RARITAN RIVER
SANDY HOOK
NEW YORK
NEW JERSEY
LEGEND
5 BOAT STATION
▽ SHORE STATION
■ SEWAGE TREATMENT PLANT
MILES
1 0 1 2 3 4 5

FIGURE 3

preserved in small containers for later analysis. At the time of each bottom sampling the temperature, salinity and pH were taken of water at 5' below the surface and 5' above the bottom.

MECHANICAL ANALYSIS

Samples were analyzed for size distribution by passing through a series of graded sieves, with the fraction retained by each sieve weighed. After weight of each fraction was measured or calculated, the weight of all fractions were added to obtain the total sediment weight in each sample, and the percentage of total weight represented by each fraction was determined. The cumulative weight percent was then plotted on a cumulative curve with sediment size as the abscissa and cumulative weight percent as the ordinate.

From the cumulative curve, three size measurements were directly determined, the median and the first and third quartiles. The median size is the diameter, of the sediment particles at the midpoint in the cumulative curve, while the first quartile (Q_1) and third quartile (Q_3) sizes are the diameters of sediment particles at the 25 and 75 percent points respectively on the cumulative curve.

The sorting coefficient, S_o, was then calculated from the relationship: $S_o = 1/\sqrt{Q_1/Q_3}$, where Q_1 is always the coarser quartile. The sorting coefficient provides an index to the uniformity of sediments.

Bulk density was determined by dividing the mass of each sample, as determined in the sieve analysis, by the volume of sample, generally one liter. Because of compaction, the volume of the one liter sample collected actually varied by about 5 percent, so that density determinations were marked by an error of this magnitude. However, since densities were generally either over 1.0 kilogram per liter, or less than 0.5 kg/l, the error is relatively insignificant.

CHEMICAL AND MINERALOGICAL ANALYSES

Chemical analyses of the sediments included water content, organic matter content, and carbonate content. In addition, the minerology of the samples was determined to classify the sediment.

Water and organic content were analyzed chemically by weight. A sample was weighed, dried, washed to remove dissolved salts, redried and weighed, with the difference in initial and final weight representing the water content. The dry sediment was then washed with hydrogen peroxide to remove organic matter by oxidation and the organic content determined by loss in weight.

Microscopic point count analyses were performed to determine the weight of organic debris, carbonate content and minerology.

MOLLUSK DETERMINATION

Approximately one quart of preserved bottom sample was screened and all organisms picked out of the coarse size fractions. Live shellfish were counted, measured and weighed. Empty shells were weighed. Only the distribution of common mollusks caught in the #5 screen was determined.

SEDIMENT DISTRIBUTION DETERMINATION

Sediment distribution studies were made for three types of particles. (1) a clastic particle introduced by natural physical processes, the mineral muscovite; (2) a clastic particle produced within the bay, the empty shells of a small clam Mulinia lateralis; (3) a clastic particle introduced by man, detrital coal. For these studies the weight of particles under consideration caught in the largest screen, was taken for all stations and plotted on a chart of the bay.

The same process was then repeated for all sieves down to the smallest in which the particles under study were retained. The distribution of particles caught in the larger screens was compared to that for the smaller screens to determine origin and distribution of the sediment particles.

The muscovite particle distribution was done by point count percent. To find point count percent, a large number of mineral grains are counted and the grain minerology determined. The number of muscovite grains per 100 grain of sediment is then calculated. This procedure was done for particles retained in the #20, #40, and #100 sieves at each station.

Detrital coal caught in the #5 sieve was weighed directly. The amount caught in the #20, #40, and #100 sieves was calculated by volume percentage timer density ratio, and expressed in grams of coal per liter of sediment retained for each sieve size.

Mollusk shell determination was made by measuring and comparing total weight of shells at each station.

RESULTS

WATER MASSES

Chlorinity: Plots of chlorinity determinations performed by the Project were made to define the limits of water masses in the bay. To eliminate effects of other variables, limits were imposed as follows: (1) Temperature, $\pm 1.5°C$; (2) Wind directions, one major compass point $\pm 45°$; (3) Tidal cycle, and last half of one cycle to the first half of the next; (4) Time of year, for all stations restricted to a period of five weeks.

Figure 4 shows the average chloride content for the period June to December 1962 at 5-foot depth, and indicates that there is: (1) a mass of relatively high chlorinity water (13.8 parts per thousand or greater) extending from Seguine Point to Sandy Hook; (2) a more relatively low chlorinity water extending along the southeast part of the bay; and (3) an intermediate zone between these two masses which extends southeast to Highlands. Figure 5 shows the average chloride content 5 feet from the bottom for the same period.

Figures 6, 7 and 8 show average chloride concentrations at 5 feet depths in May 1963, July 1962 and October 1962 respectively. These indicate the same pattern of water mass distribution noted in Figure 4, but with these additions: (1) In Sandy Hook Bay, a tongue of high chlorinity water projects southward just west of Sandy Hook. Lower chlorinity water appears west of this tongue (Figure 7): (2) The high chlorinity water projecting into Lower Bay is divided into two lobes. The major lobe extends westward from the mouth of the bay toward Seguine Point, and a smaller lobe projects landward toward New Dorp on Staten Island (Figures 6 and 7); (3) A mass of low chlorinity water projects northeastward from the area between Keansburg and Shoal Harbor, on the New Jersey shore (Figure 8).

Figures 9 and 10 show positions of deepwater masses in June-July 1962 and October 1962 respectively. A comparison of these with previous figures show that the position of deep water masses corresponds closely to that of shallow water masses for October 1962 and July 1962. The displacement noted for the period June-December 1962, Figures 4 and 5, may be due to increased fresh water run-off during the period. The less dense fresh water would override the heavier sea water, moving the surface water mass eastward of the bottom mass.

In a shallow bay, such as Raritan Bay, wave motion normally has an important effect on distribution of water masses. The predominant incoming waves at the entrance to New York Harbor are from the east and northeast. With a west wind, the main tongue of higher chlorinity water was closer to the Staten Island shore. However, stream flow entering the bay from the Raritan River and other tributary streams was not a controlled variable during the study. Hence, insufficient data are available to determine how much of this mass location is attributable to winds as opposed to increased fresh water run-off.

SEDIMENT BODIES

Sediment Size: Size analysis showed four distinct sediment bodies in Raritan Bay, two of which are sands and two of which are predominantly silts, referred to here as "muds." The location of these four bodies are shown in Figure 11.

A prominent sand body, here called the Keansburg sands, occurs north of Keansburg, at Stations 44, 45, 46, 51, 52, 53, 54 and 55. These sands are fairly coarse, averaging 300 microns in diameter. The median size increases westward to the area north of Keyport where the body ends abruptly. The boundary of this body roughly parallels the New Jersey shoreline between Leonardo and Keyport.

The other sand body, designated the Lower Bay Sands, occupies the northeastern three-quarters of Lower New York Bay. These sands are found east of Stations 2, 26, 18, 13 and 24 and extend to the channels marking the eastern end of the Raritan Bay area. The average median diameter of these sands is 250 microns, increasing seaward.

West of Sandy Hook, the sediment consists of coarse to medium silts ranging in size between 15 and 60 microns. These Sandy Hook Bay muds are found at Stations 1, 14, 15, 16, 17, 27, 28, 29, 48 and 49 and extend from Sandy Hook toward Seguine Point.

The predominant sediments in Raritan Bay proper are coarse silts, ranging in size between 20 and 60 microns. This sediment, referred to here as West Raritan Bay muds, is found west of an imaginary line between Keyport and Seguine Point.

For many of the stations both the entire sample and the clastic particles were analyzed. Figure 12 presents the median size for the entire sample, while that for the clastic particles are shown in Figure 13. The difference between the median sizes for these two determinations is due to organic matter and shells in the entire sample.

Sorting coefficients are closely related to sediment types, with lower values indicating greater uniformity of grain size. The sorting coefficients for entire samples are plotted in Figure 14. Sorting coefficients for clastic particles are shown in Figure 15. The sands are better sorted than the silts. For the entire sample, the Keansburg and Lower Bay Sands generally show a sorting coefficient less than 2.0, while the muds show coefficients greater than 2.0, often greater than 3.0. For the clastic particles only, the sands showed a coefficient of less than 1.5, while the muds were greater than 1.5. Clastic particle sorting coefficients of the Keansburg Sands are strikingly similar, with nearly all ranging from 1.2 to 1.3. The sorting of the lower Bay sands was less consistent.

The bulk density of sediments is shown in Figure 16. The sands were relatively dense, over 1.0 kg/l, while the muds showed a consistently lower density, generally less than 0.5 kg/l.

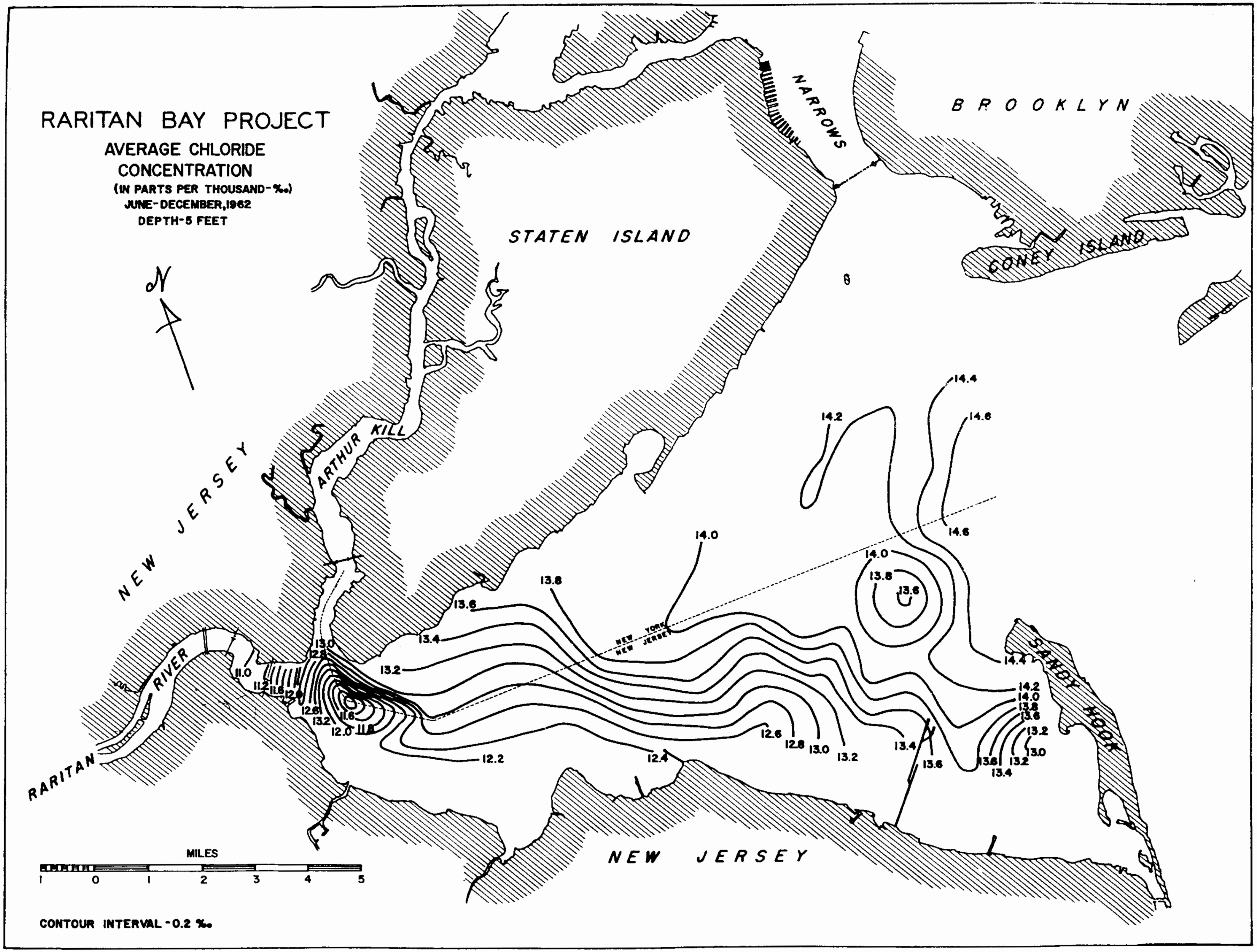

FIGURE 4

GPO 956-592

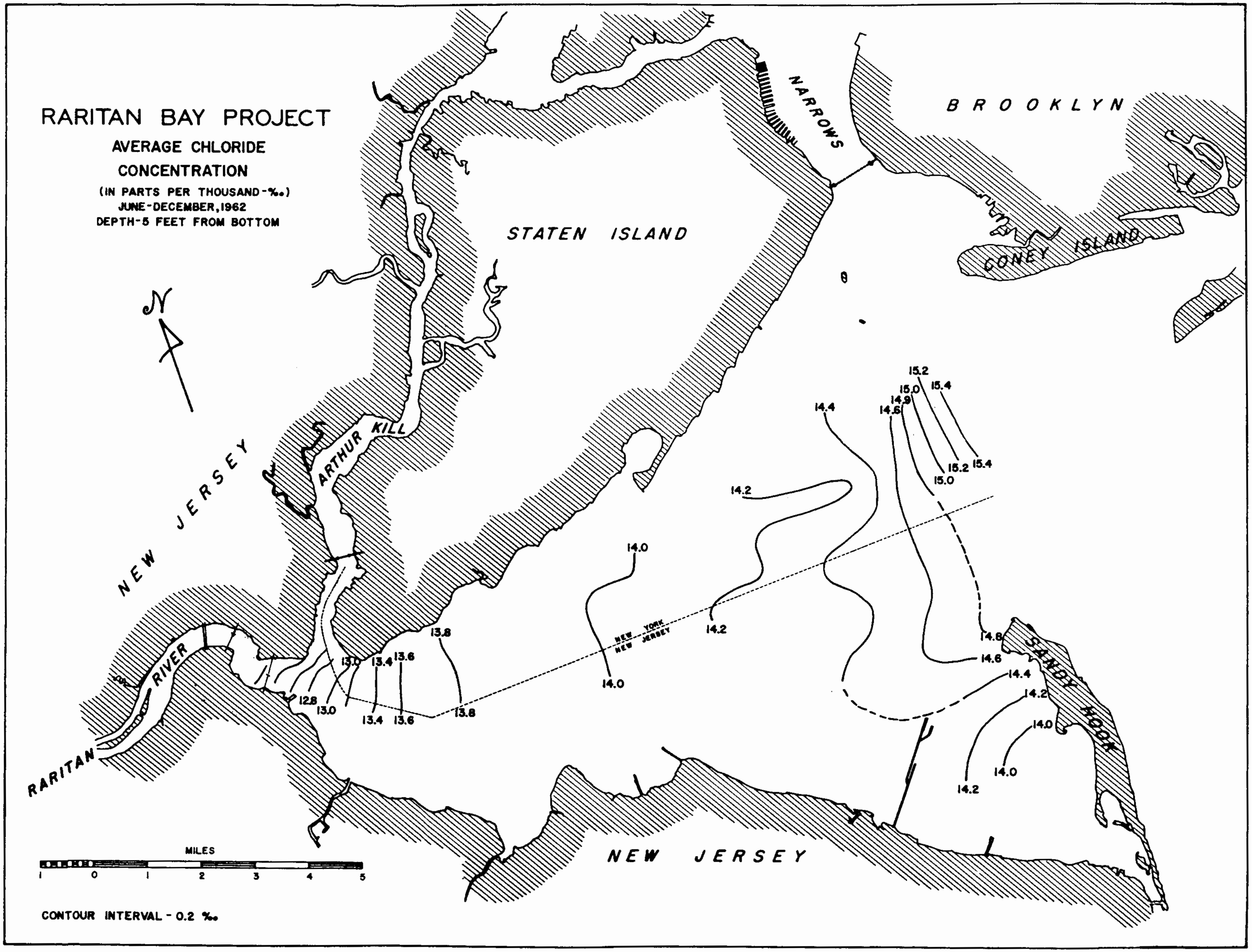

FIGURE 5

GPO 956-592

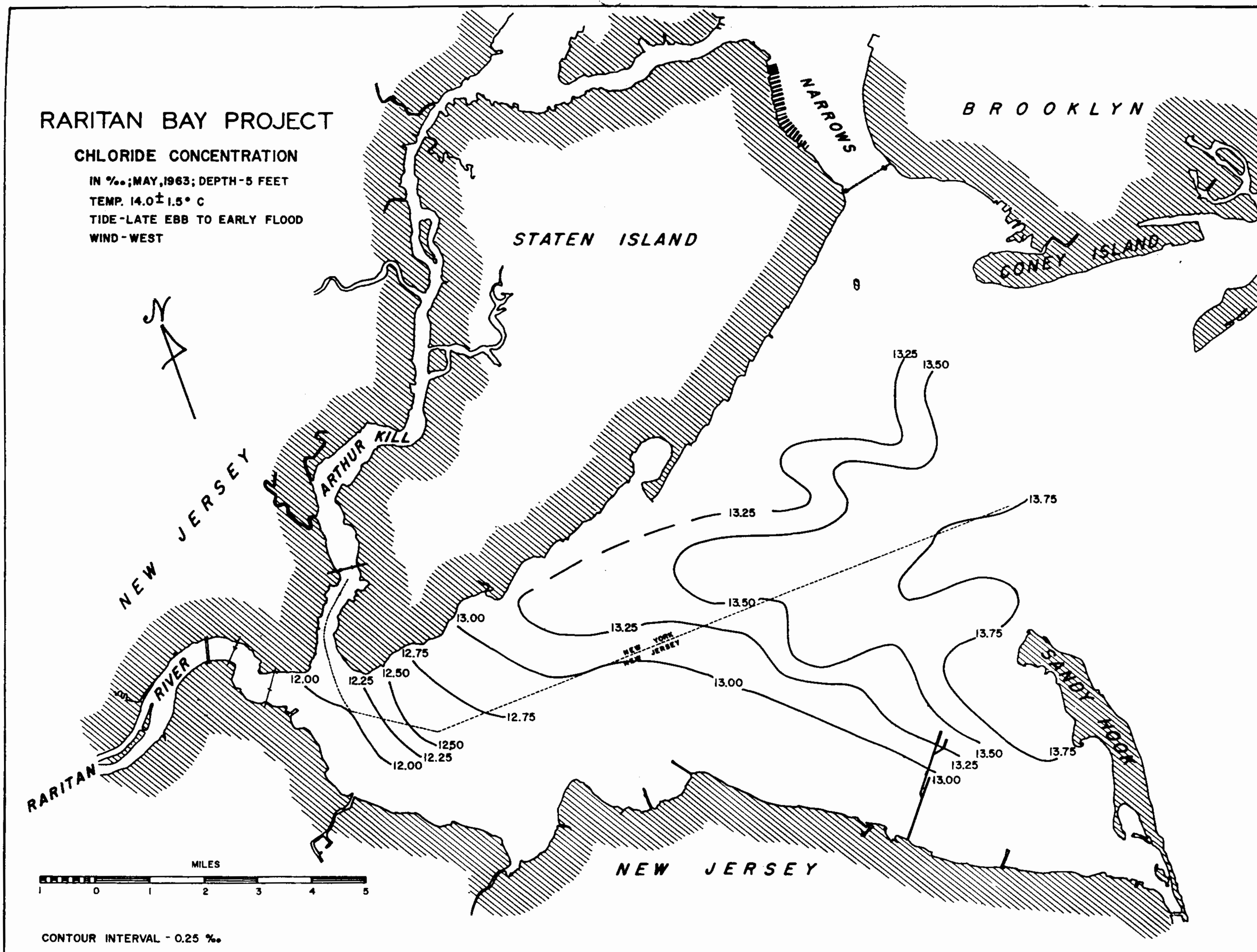
RARITAN BAY PROJECT
CHLORIDE CONCENTRATION
IN ‰; MAY, 1963; DEPTH - 5 FEET
TEMP. 14.0 ± 1.5° C
TIDE - LATE EBB TO EARLY FLOOD
WIND - WEST
N
STATEN ISLAND
NARROWS
BROOKLYN
CONEY ISLAND
NEW JERSEY
ARTHUR KILL
RARITAN RIVER
SANDY HOOK
NEW JERSEY
NEW YORK
NEW JERSEY
13.25
13.50
13.75
13.25
13.50
13.25
13.00
13.00
12.75
12.50
12.25
12.00
12.75
1250
12.25
12.00
13.00
13.25
13.50
13.75
13.75
13.00
MILES
1 0 1 2 3 4 5
CONTOUR INTERVAL - 0.25 ‰

FIGURE 6

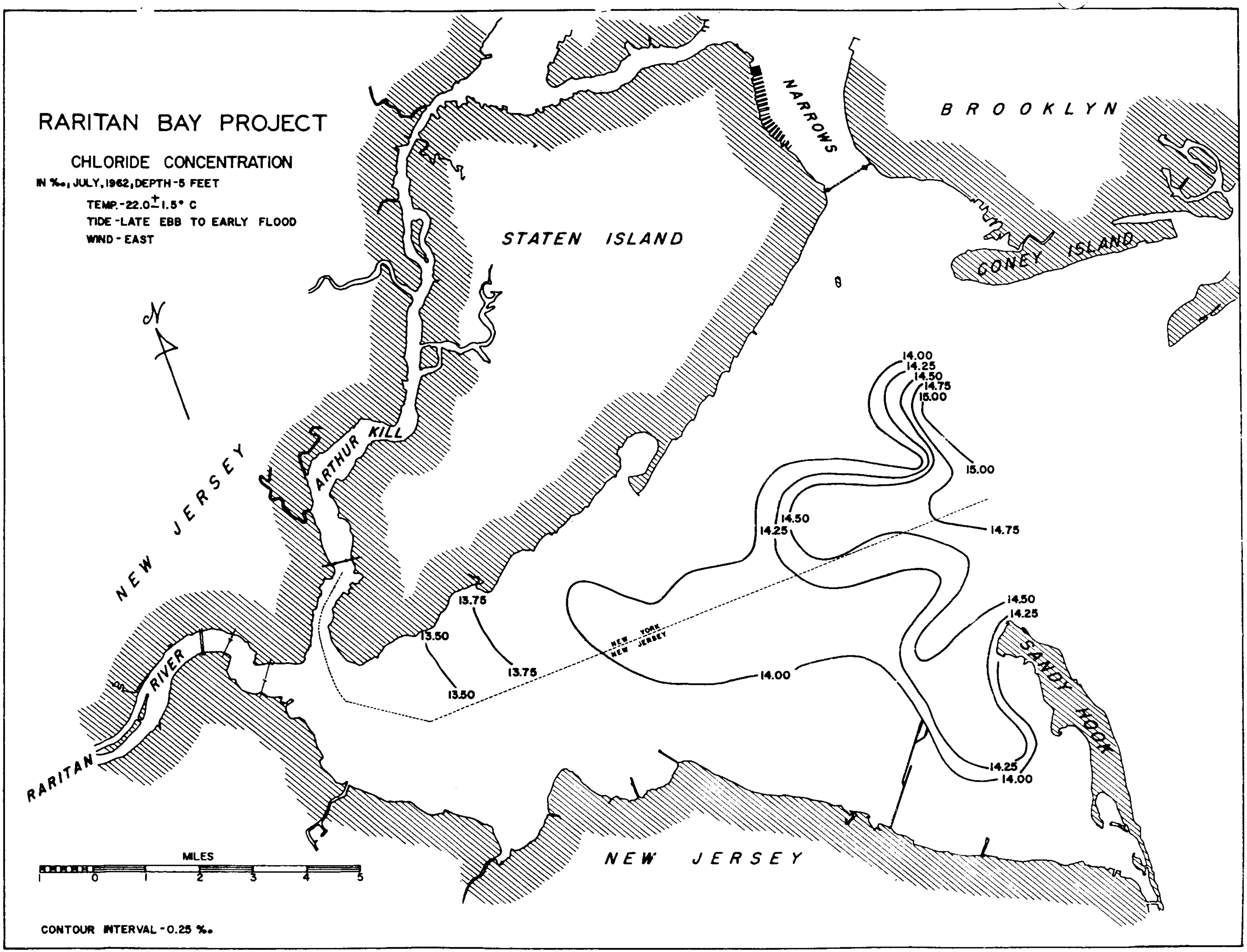

FIGURE 7

GPO 956-592

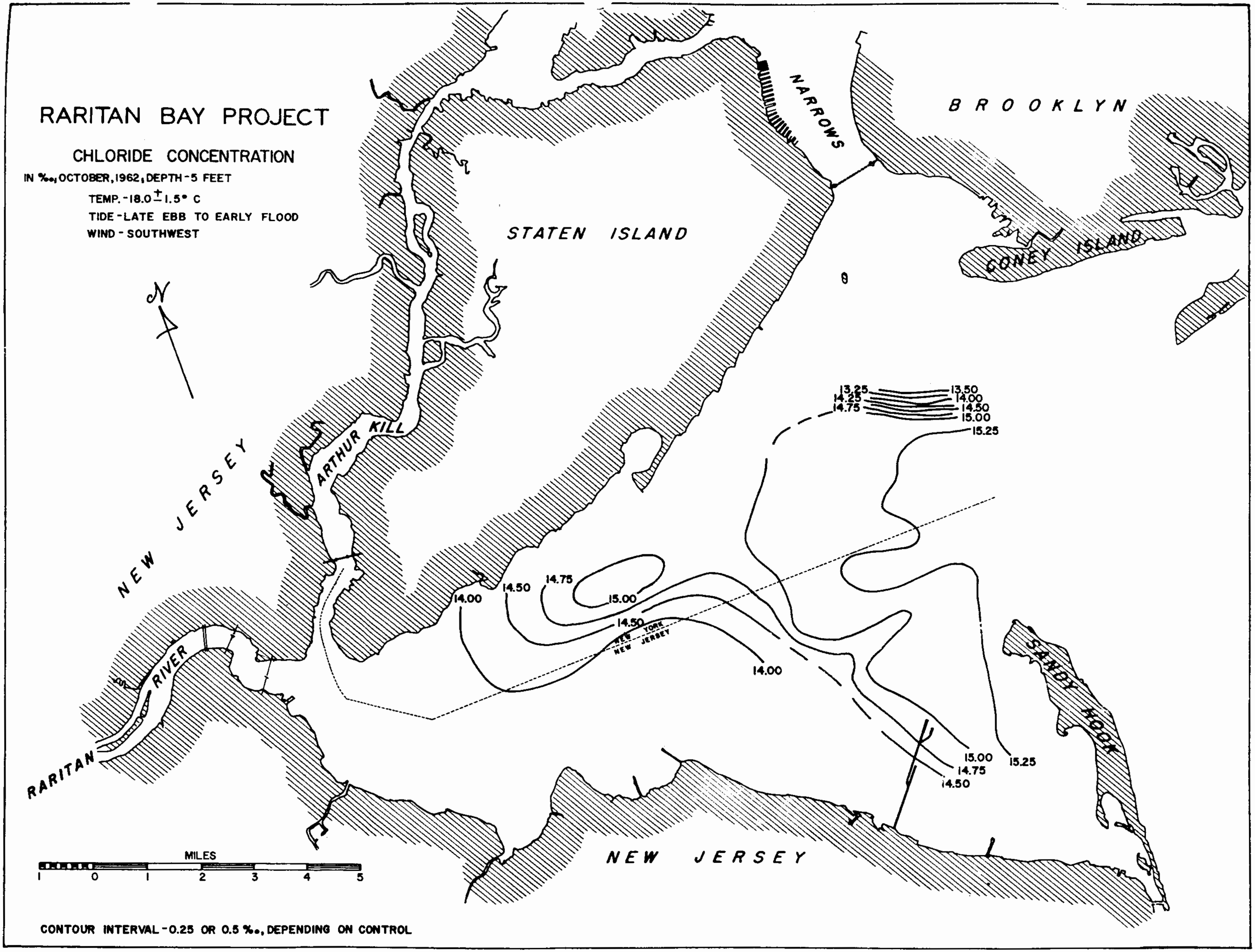

FIGURE 8

GPO 956-592

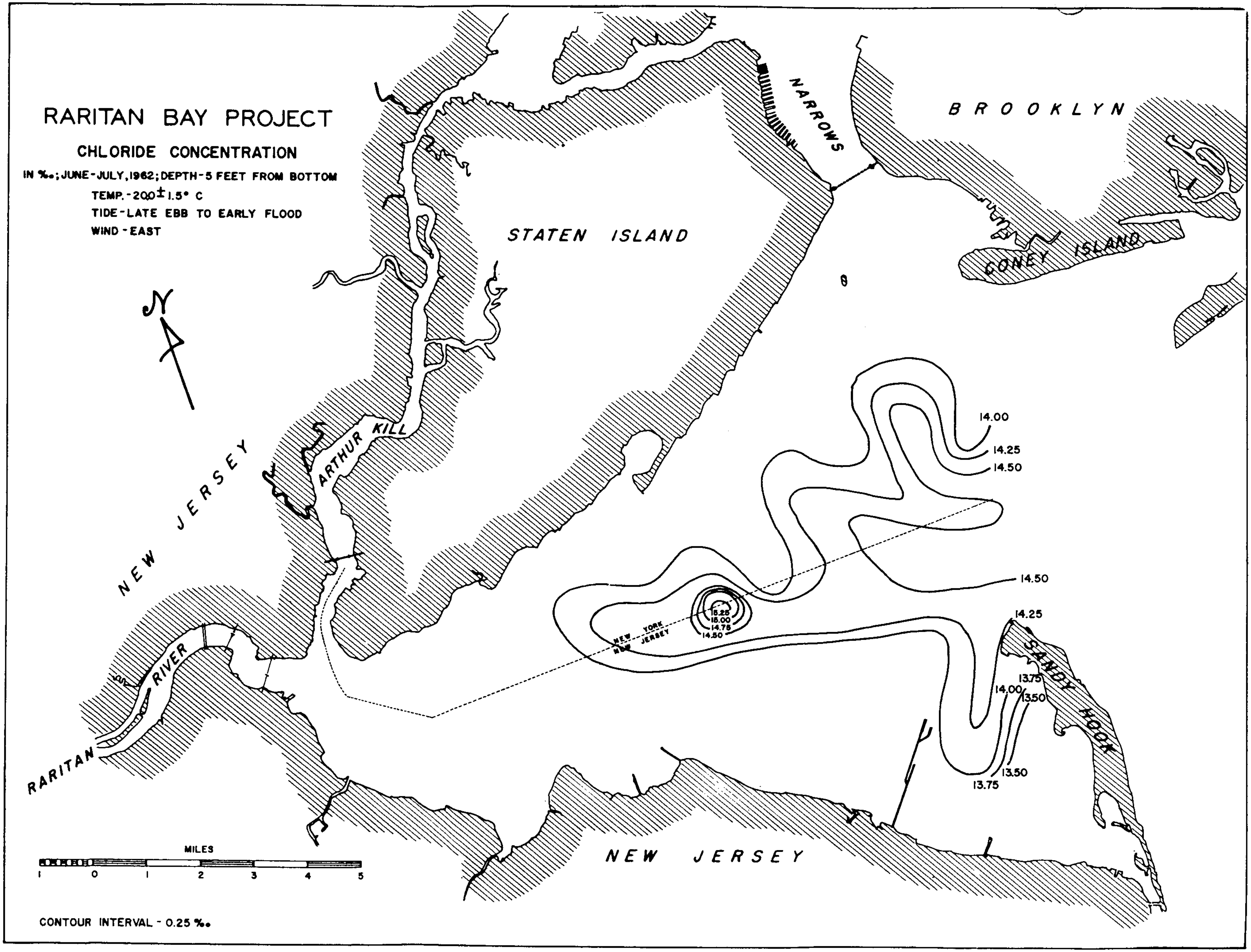
RARITAN BAY PROJECT
CHLORIDE CONCENTRATION
IN ‰; JUNE-JULY, 1962; DEPTH-5 FEET FROM BOTTOM
TEMP.-20.0 ± 1.5° C
TIDE-LATE EBB TO EARLY FLOOD
WIND-EAST
N
STATEN ISLAND
NARROWS
BROOKLYN
CONEY ISLAND
ARTHUR KILL
NEW JERSEY
RARITAN RIVER
SANDY HOOK
NEW JERSEY
NEW YORK
NEW JERSEY
14.00
14.25
14.50
14.50
14.25
15.25
15.00
14.75
14.50
13.75
14.00
13.50
13.50
13.75
MILES
1 0 1 2 3 4 5
CONTOUR INTERVAL - 0.25 ‰

FIGURE 9

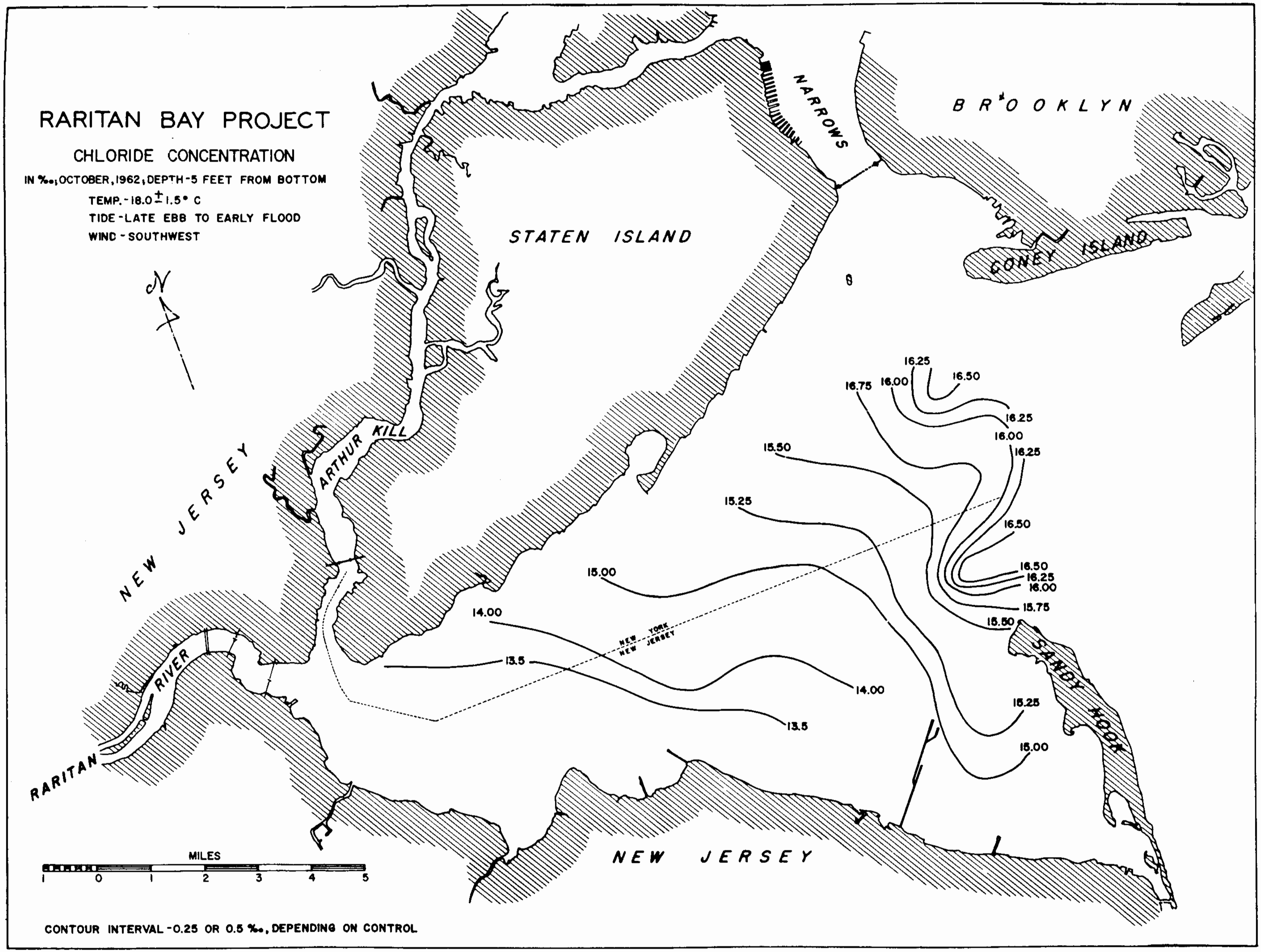

FIGURE 10

GPO 956-592

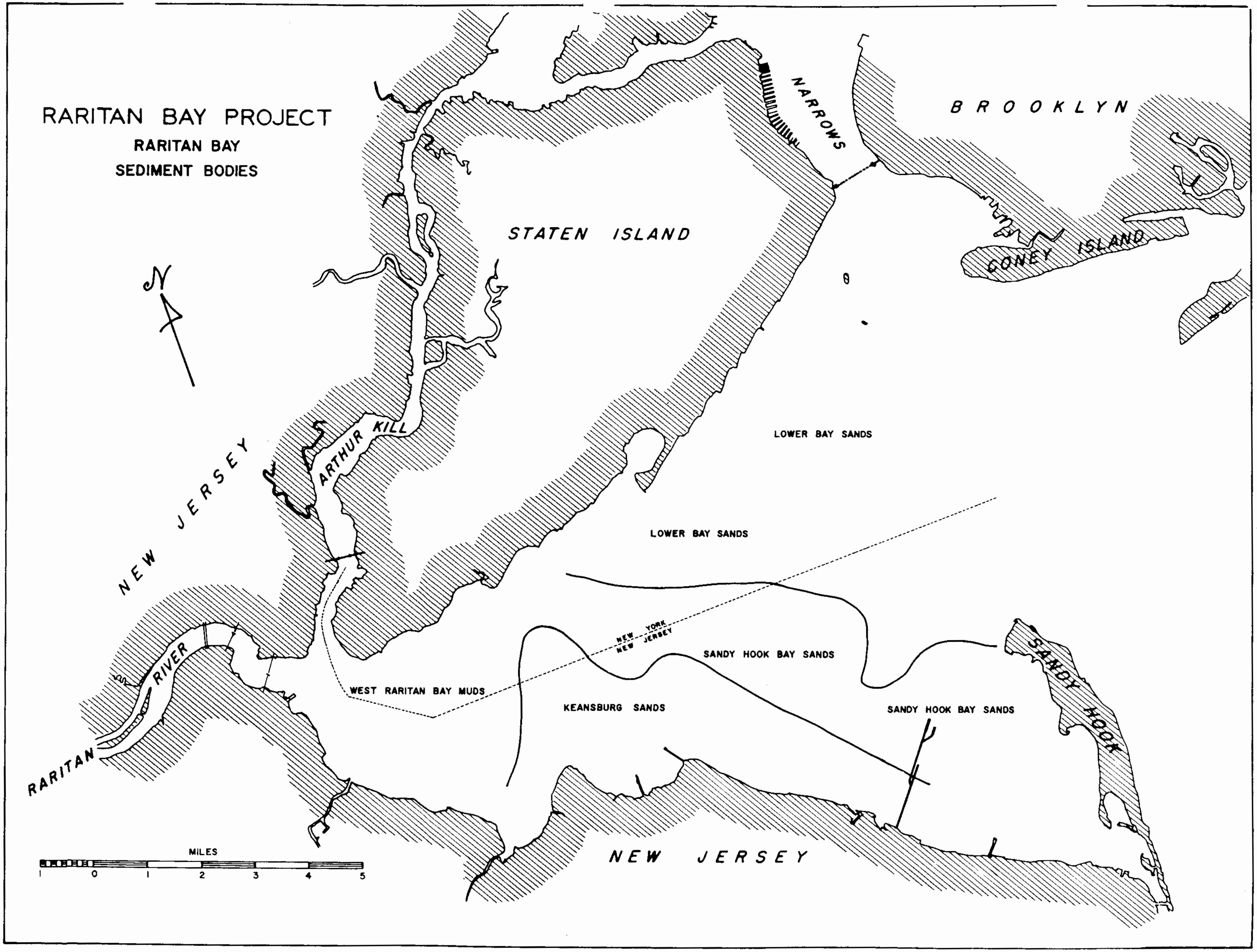

FIGURE II

GPO 956-592

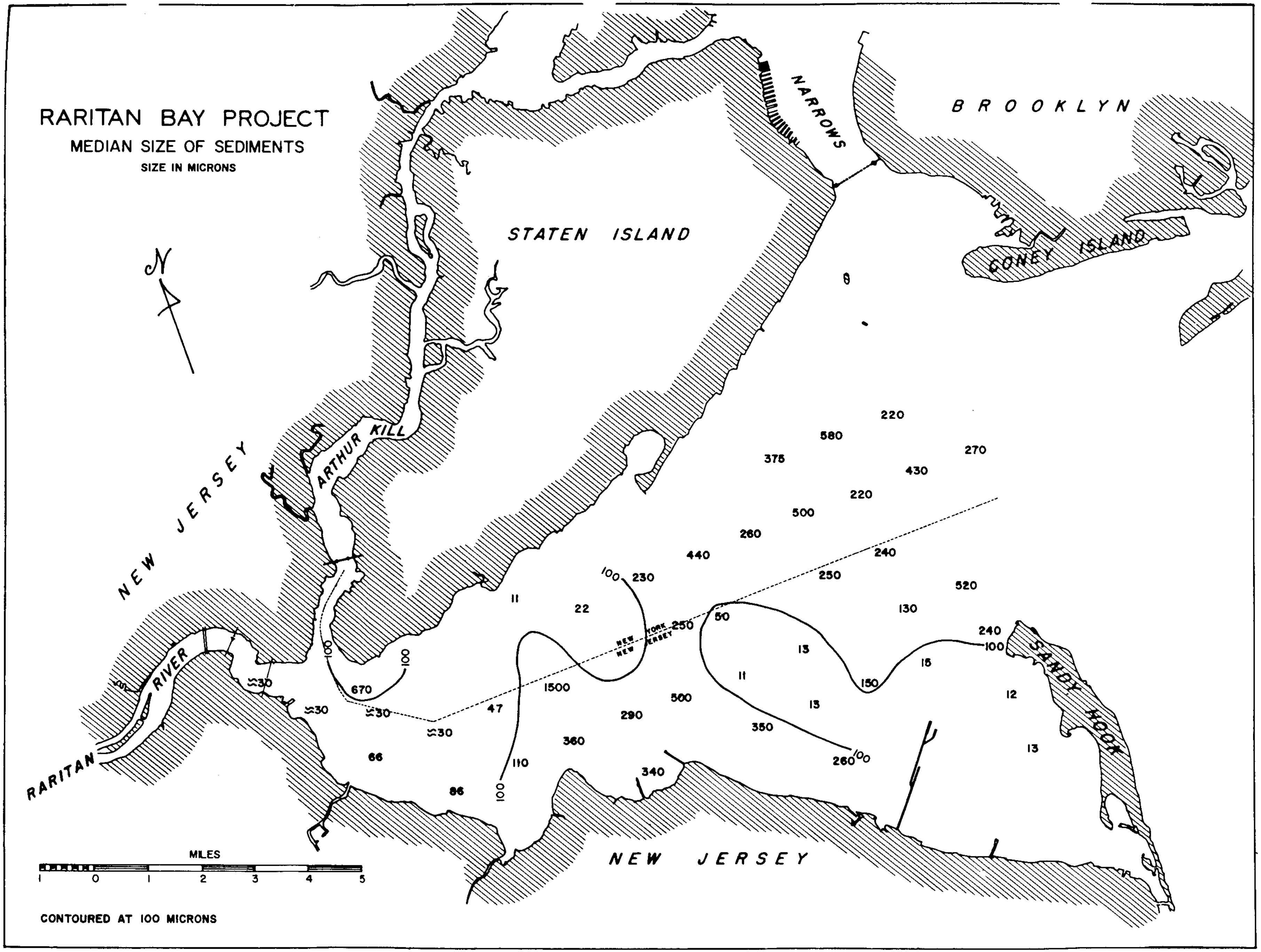

FIGURE 12

GPO 956-592

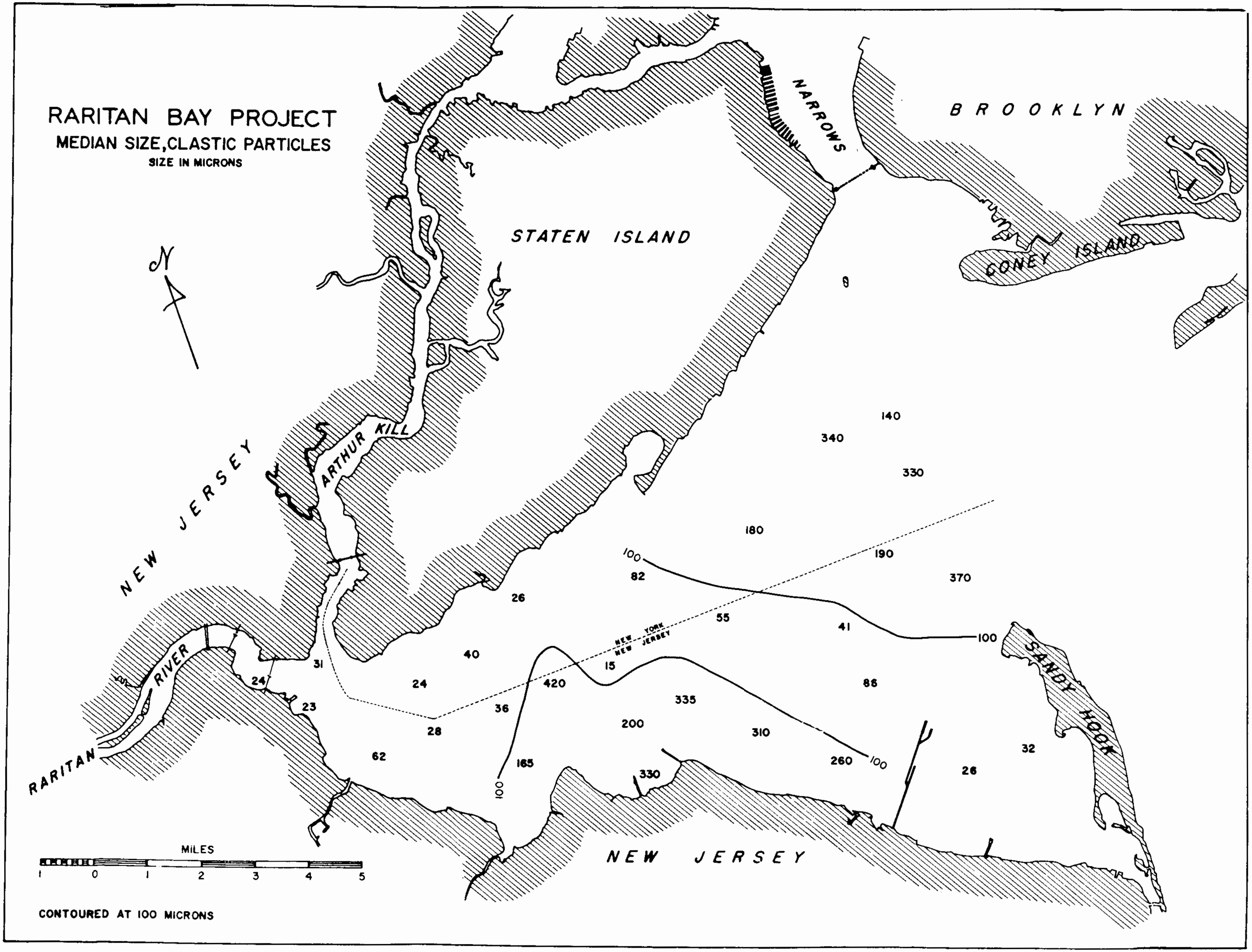

FIGURE 13

GPO 956-592

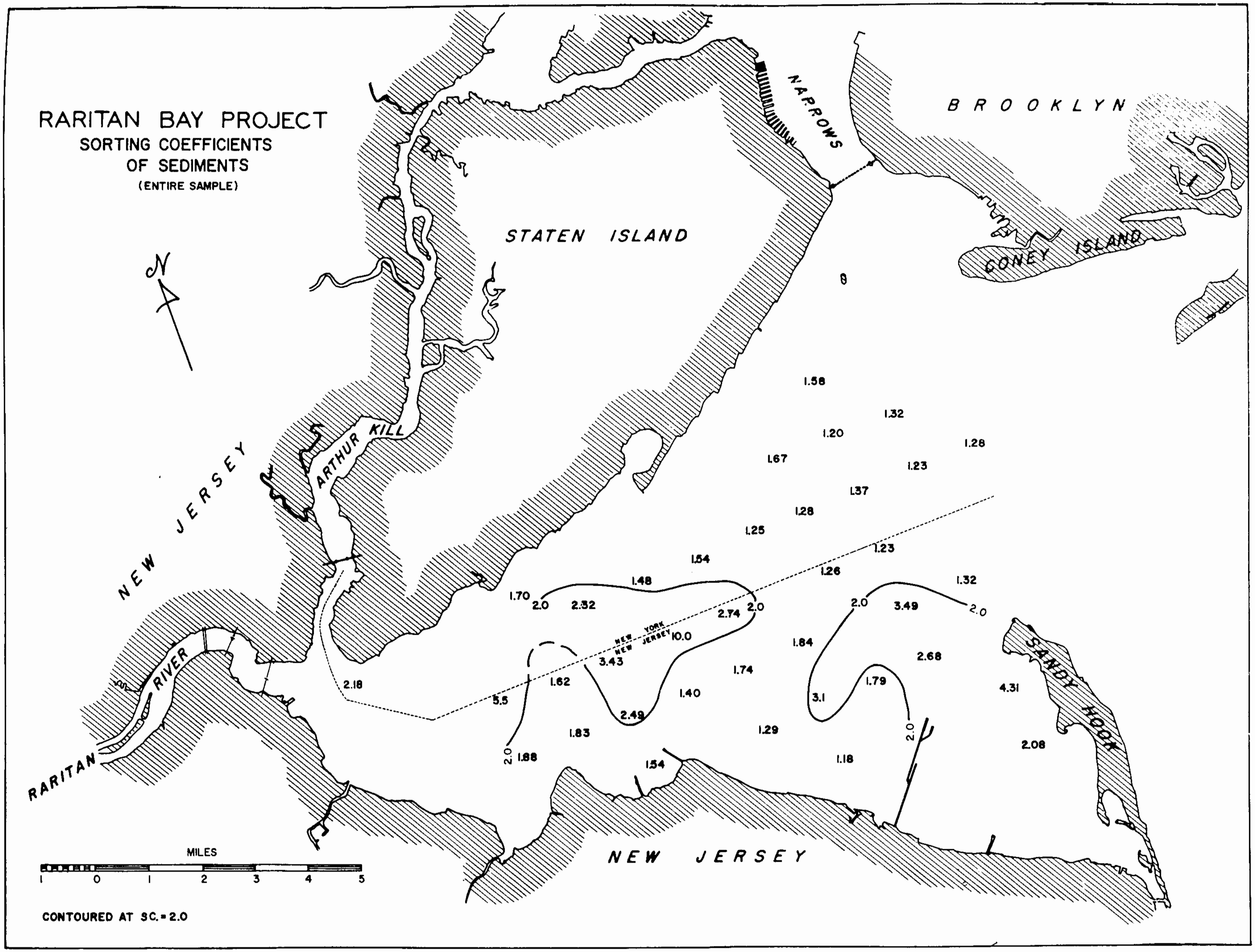

FIGURE 14

GPO 956-592

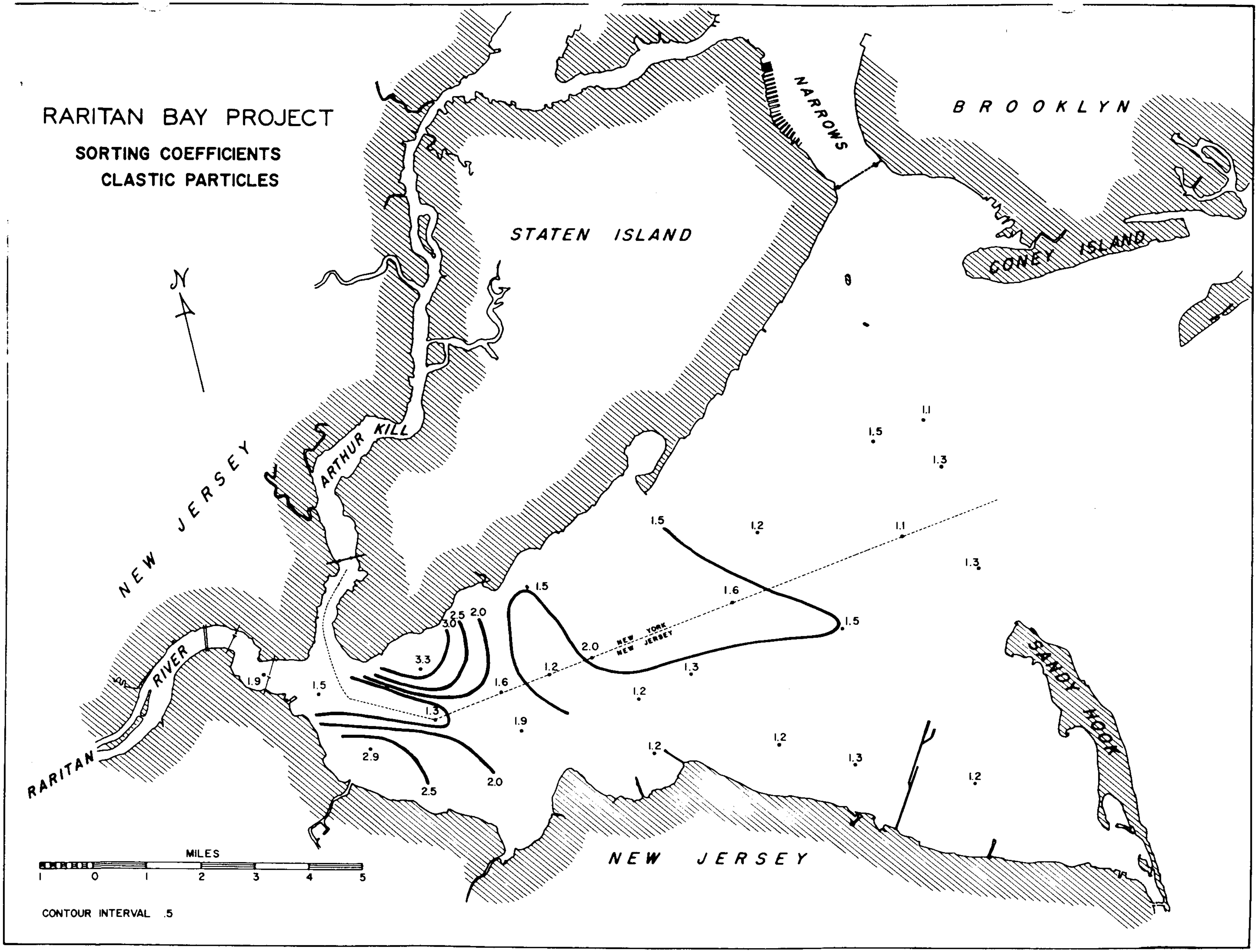
RARITAN BAY PROJECT
SORTING COEFFICIENTS
CLASTIC PARTICLES
STATEN ISLAND
NARROWS
BROOKLYN
CONEY ISLAND
SANDY HOOK
NEW JERSEY
ARTHUR KILL
RARITAN RIVER
NEW JERSEY
NEW YORK
NEW JERSEY
N
1.1
1.5
1.3
1.5
1.2
1.1
1.3
1.6
1.5
1.5
2.0
1.3
1.2
3.3
2.5
3.0
2.0
1.2
1.6
1.9
1.5
1.3
1.9
2.9
2.5
2.0
1.2
1.2
1.3
1.2
MILES
1 0 1 2 3 4 5
CONTOUR INTERVAL .5

FIGURE 15

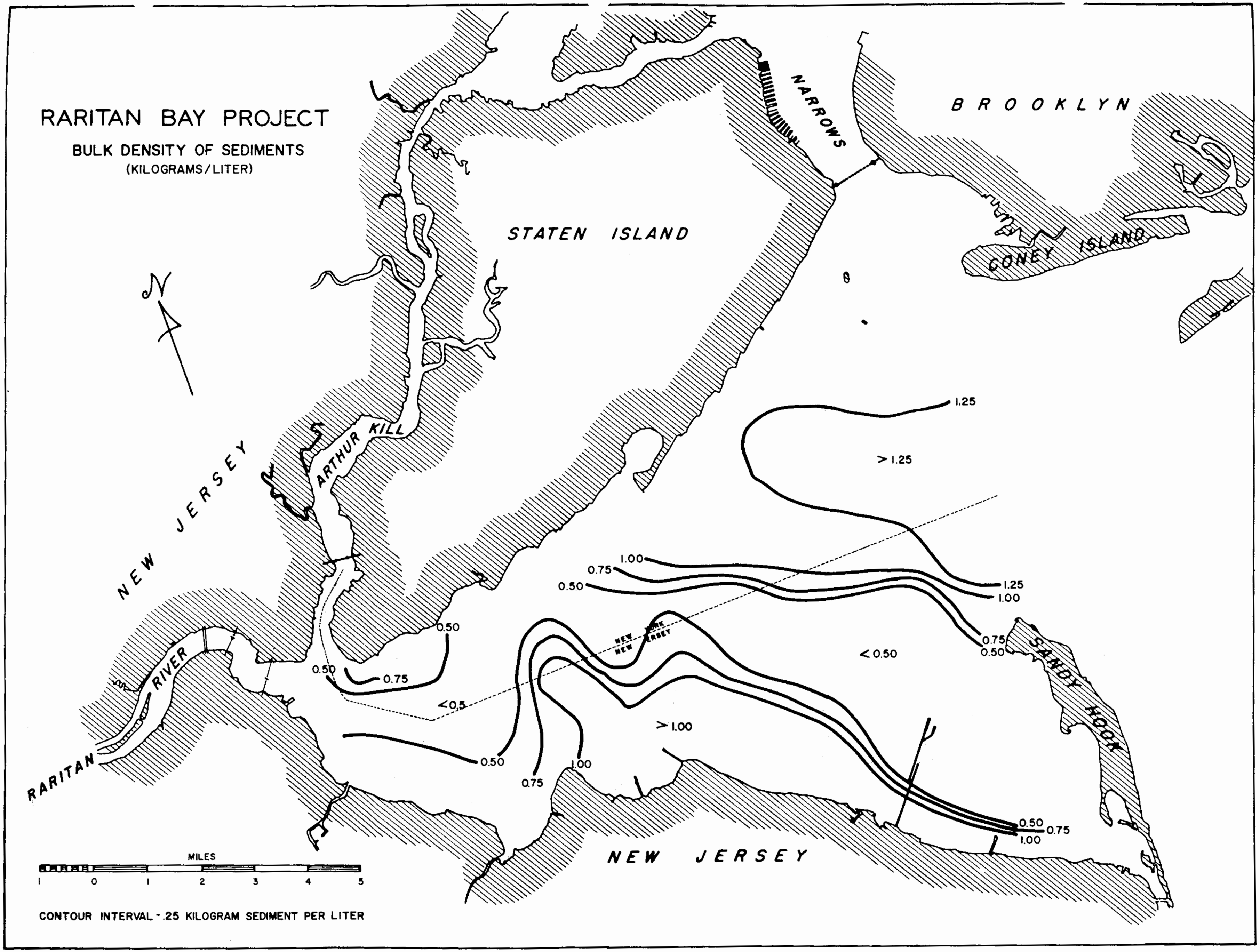
RARITAN BAY PROJECT
BULK DENSITY OF SEDIMENTS
(KILOGRAMS/LITER)
STATEN ISLAND
NARROWS
BROOKLYN
CONEY ISLAND
ARTHUR KILL
NEW JERSEY
RARITAN RIVER
SANDY HOOK
NEW JERSEY
1.25
> 1.25
1.00
0.75
0.50
1.25
1.00
0.75
0.50
< 0.50
0.50
0.50
0.75
<0.5
> 1.00
0.50
0.75
1.00
0.50
0.75
1.00
MILES
1 0 1 2 3 4 5
CONTOUR INTERVAL - .25 KILOGRAM SEDIMENT PER LITER

FIGURE 16

WATER CONTENT

Analyses of 28 representative samples show that sediment water content usually is either greater than 50 percent or less than 30 percent of the total weight. Intermediate values are found at only two stations. Water content values have been plotted in Figure 17. A contour has been constructed in Figure 17 for water content of 50 percent of total weight. Stations where water content is less than 35 percent are 4, 6, 7, 10, 20, 28, 45, 47, 51 and 53. Water content is greater than 50 percent at Stations 14, 15, 23, 24, 27, 29, 30, 54, 55, 56, 58, 60, 62 and 63. Intermediate values are found at Stations 2 and 59. The coarser sediments, i.e., the sands, contain less water than the fine-grained silt sediments, as is normally the case with sedimentary rocks.

Organic Carbon Content: The organic carbon content is shown in Figure 18. In Raritan Bay sediments, the organic carbon content was between 0.1 and 6.2 percent by weight, averaging slightly less than 1 percent. Organic content, in general, is inversely proportioned to grain size and is relatively constant for a particular sediment body. In the Lower Bay and Keansburg sands the organic content is 0.2 and 0.4 percent respectively. The percentage of organic carbon in the Sandy Hook Bay muds varied from 0.6 to 2.0 percent, while that of the West Raritan Bay muds was quite high and variable, with values from 0.3 to 6.2 percent.

Organic Debris: The weight of organic debris in the sand size fractions is plotted in Figure 19. The organic debris in Raritan Bay was found to consist largely of amphipod tubes and wood fragments. The lowest amount of organic debris was found in the West Raritan Bay muds, which also showed the highest organic content. Hence, the organic content in the West Raritan Bay muds must be due to particles of silt-clay size.

Carbonate Content: Carbonate content of the bay sediments, in the form of shells and shell fragments, is plotted in Figure 20. The percentage carbonate content of the sediments varies from less than 0.1 percent to 40.2 percent, and was highest at Stations 26, 44, 47, 55, 56 and 59. Shell content was generally lower in Sandy Hook Bay and in the shoals northwest of Sandy Hook. Most of the samples with high weights contained large oyster shells. Production of these shells appeared to be in the areas north of Keyport. In general the higher shell contents appear to be related to sands, while the mud areas showed the lowest production.

Carbonate in clastic sediments may originate by chemical precipitation from the overlying water or by production of animal skeletons. Since the shells in Raritan Bay show evidence of solution, a condition occurring when the water is undersaturated, there is probably little chemical precipitation. Solution of shells was evidenced by the following: (1) Articulated shells showed loss of material in certain shell layers; (2) Remains of mussel (Mytelus) shells were often found with periostracum intact but little carbonate clinging to the periostracum; and (3) Live Nassarius obsoleuts often carry shells which show material lost along the sutures. While boring organisms could account for some of these factors, no remains of such organisms were found. Since additionally no detrital carbonate derived from limestone was found, shell production must be the source of carbonates in Raritan Bay.

Mineral Content: The major light mineral constituents counted were quartz, feldspar and rock fragments. Most of the sands examined contained between 10 and 25 percent feldspar and rock fragments with the latter predominating. Hence, the sands can be classified as lithic sands or protoquartzites[5]. Some samples contained more than 25 percent feldspar and rock fragments and can be called subgraywackes(5). Sediments of this sand composition, and with over 15 percent fine grained material were found in

144m the western part of the Keansburg Sands. When lithified, these would develop into the rock type known as graywacke. These sands are found only in the areas where there is a transition between the sands and muds. Since lithic fragments of chemically unstable components are found in the bay sediment, the physical breakdown of source rocks must be occurring faster than chemical decomposition.

Sediment Bodies Summary: On the basis of the above studies, the sediment bodies in Raritan Bay have been divided into four groups: the Keansburg and the Lower Bay sands, and the Sandy Hook Bay and the West Raritan Bay muds.

SEDIMENT DISTRIBUTION

The origin and distribution of three types of clastic particles were evaluated to provide data on water movement. The types were the mineral muscovite, the empty shell of a small clam, and detrital coal. For each of these types, it was assumed that the grain size distribution at each source was essentially the same when multiple sources are indicated and that during distribution of sediment particles throughout the bay, the larger particles are deposited closest to the source and progressively smaller particles are deposited at progressively increasing distances from the source.

Muscovite Distribution: The colorless mica, muscovite, was selected for study because it is easily identified and is relatively light in weight and easily moved by water. Figures 21, 22 and 23 show the distribution of muscovite retained on the #20, #40, and #100 screen respectively. The areas where the muscovite is introduced to the bay are defined by the distribution of material retained by the #20 sieve. These areas are north and west of Sandy Hook, and near Laurence Harbor. The #40 screen size muscovite appears through much of New York Lower Bay, except in the zone south and southeast of Great Kills Harbor. In Raritan Bay, it appears in a tongue extending southwest from Great Kills Harbor and through much of the southwestern part of Raritan Bay.

Muscovite caught in the #100 screen appears through nearly all the bay area, except for the sands north of the Keansburg area.

While muscovite can form in the marine environment, particles so formed rarely show signs of abrasion. The particles found in Raritan Bay showed signs of abrasion, so probably were transported into the bay. The muscovite appears to be introduced from the ocean east of the bay, and from an area where a suitable rock, the Raritan Formation, crops out. It is spread progressively through much of the

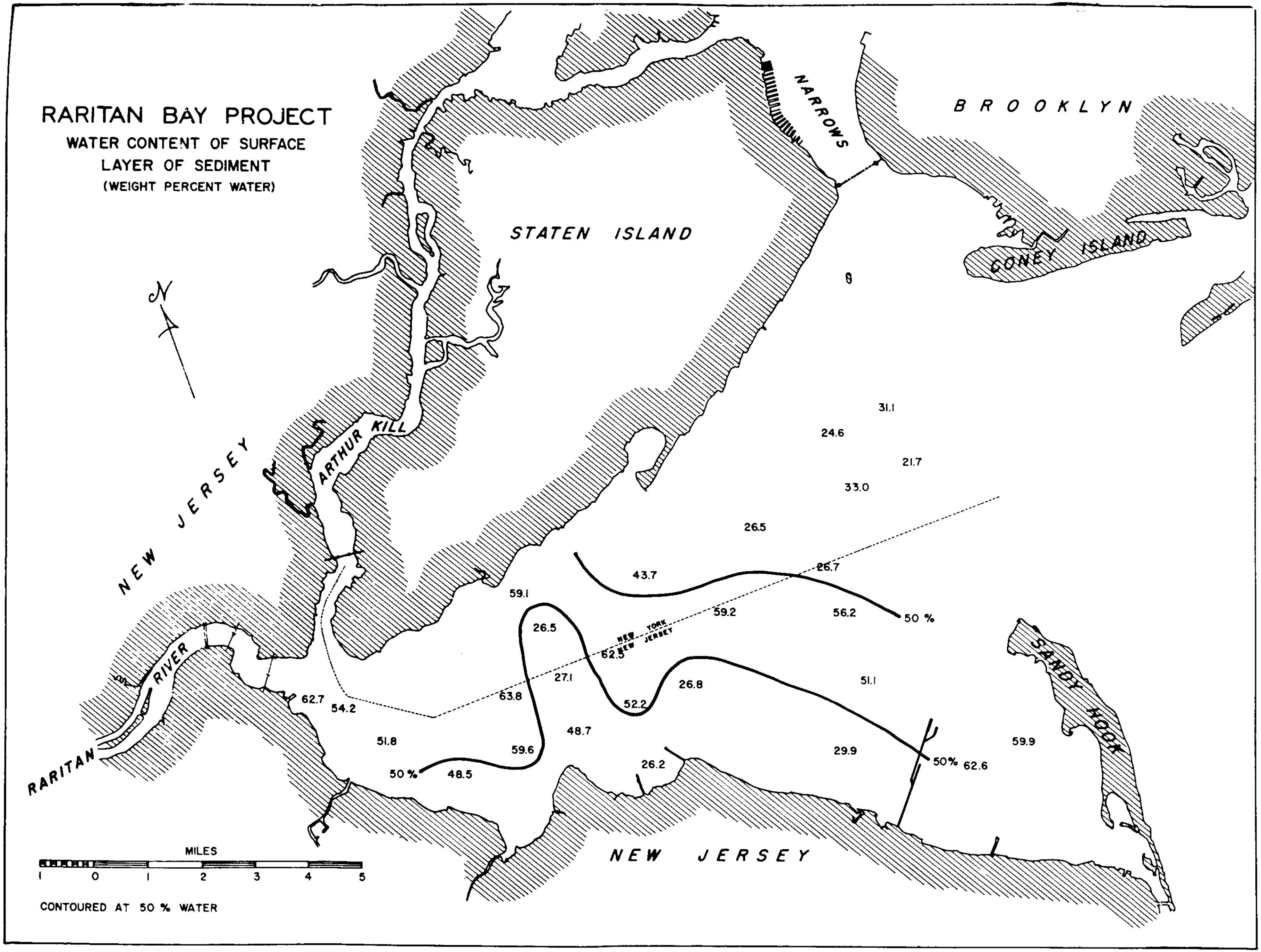

FIGURE 17

GPO 956-592

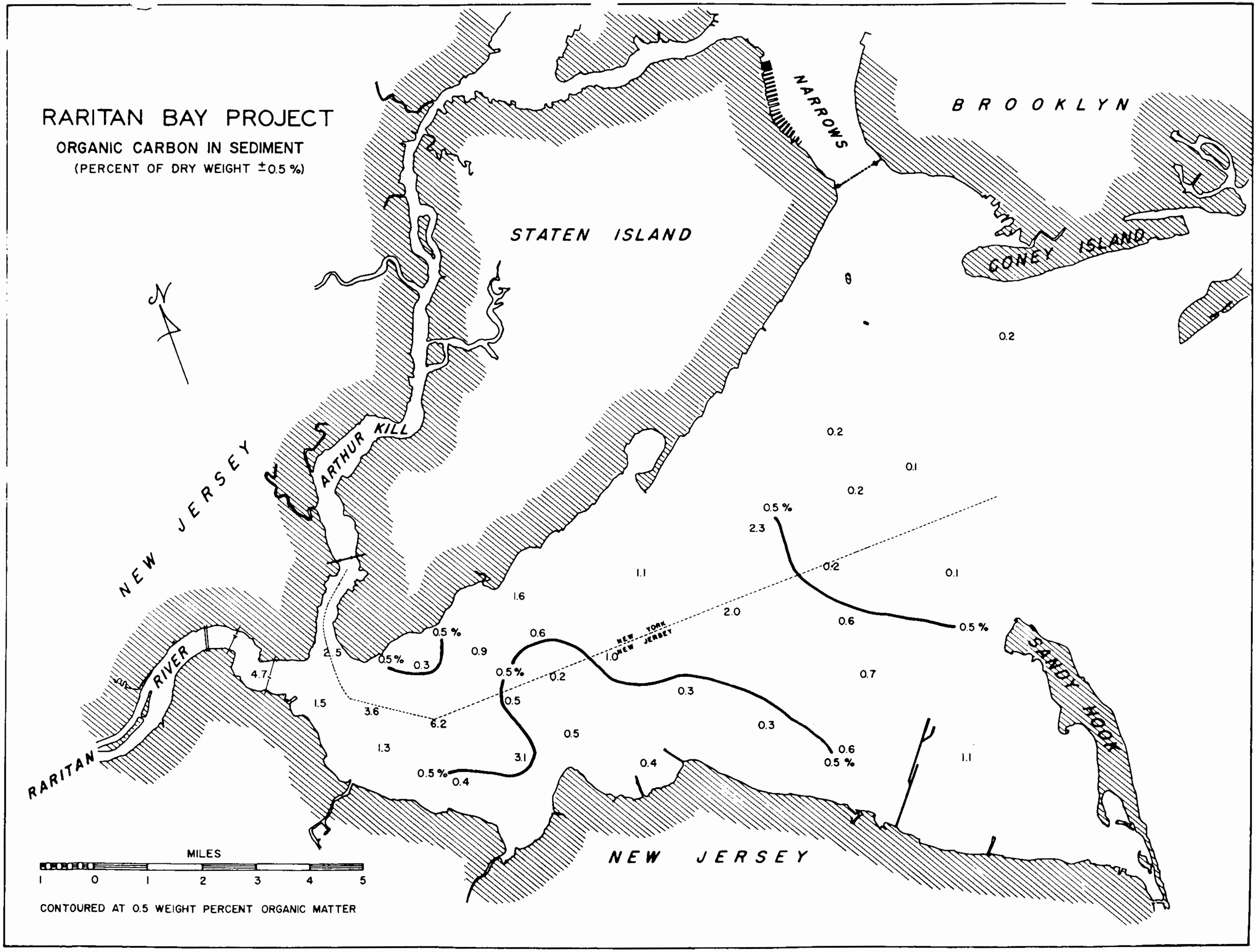

FIGURE 18

GPO 956-592

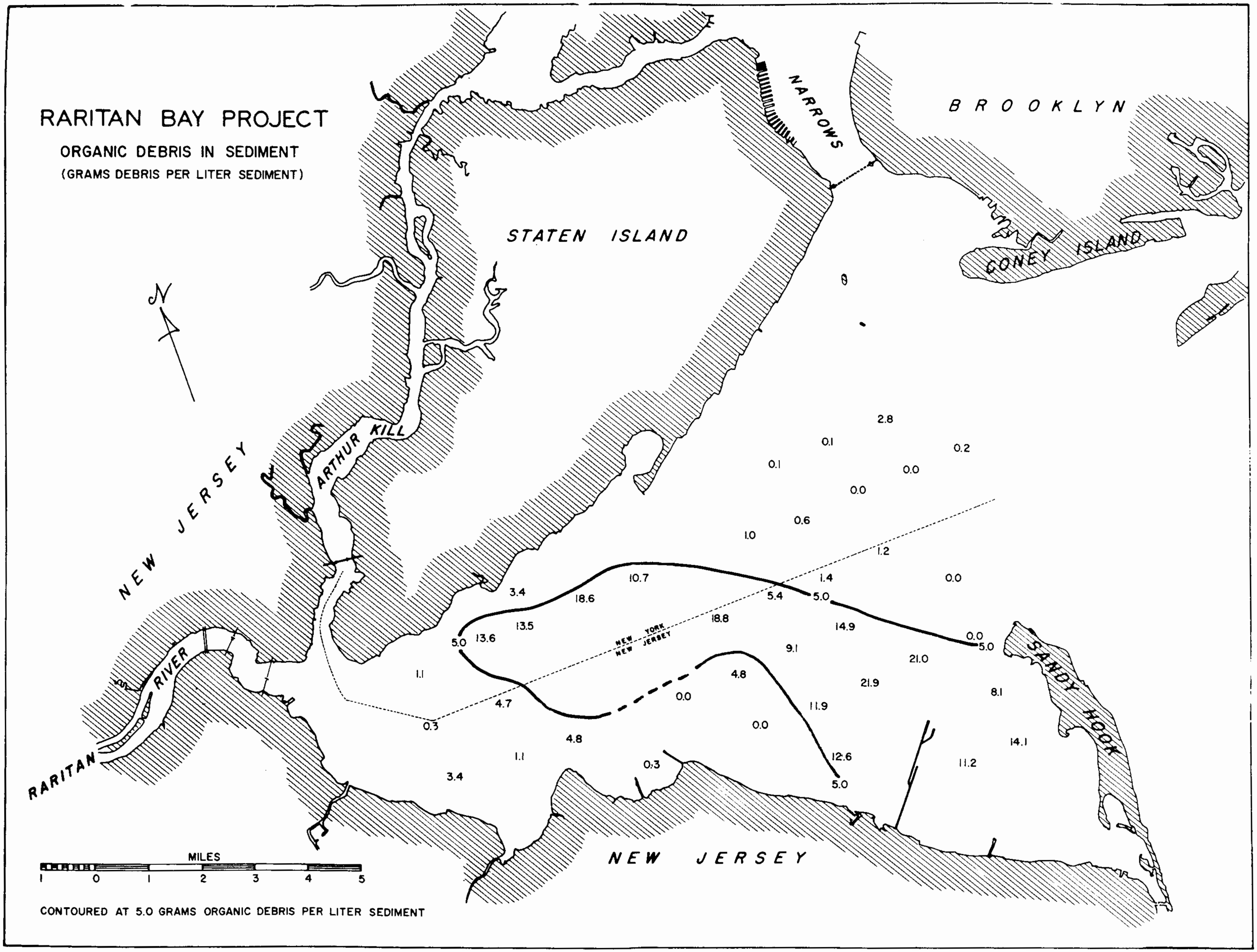

FIGURE 19

GPO 956-592

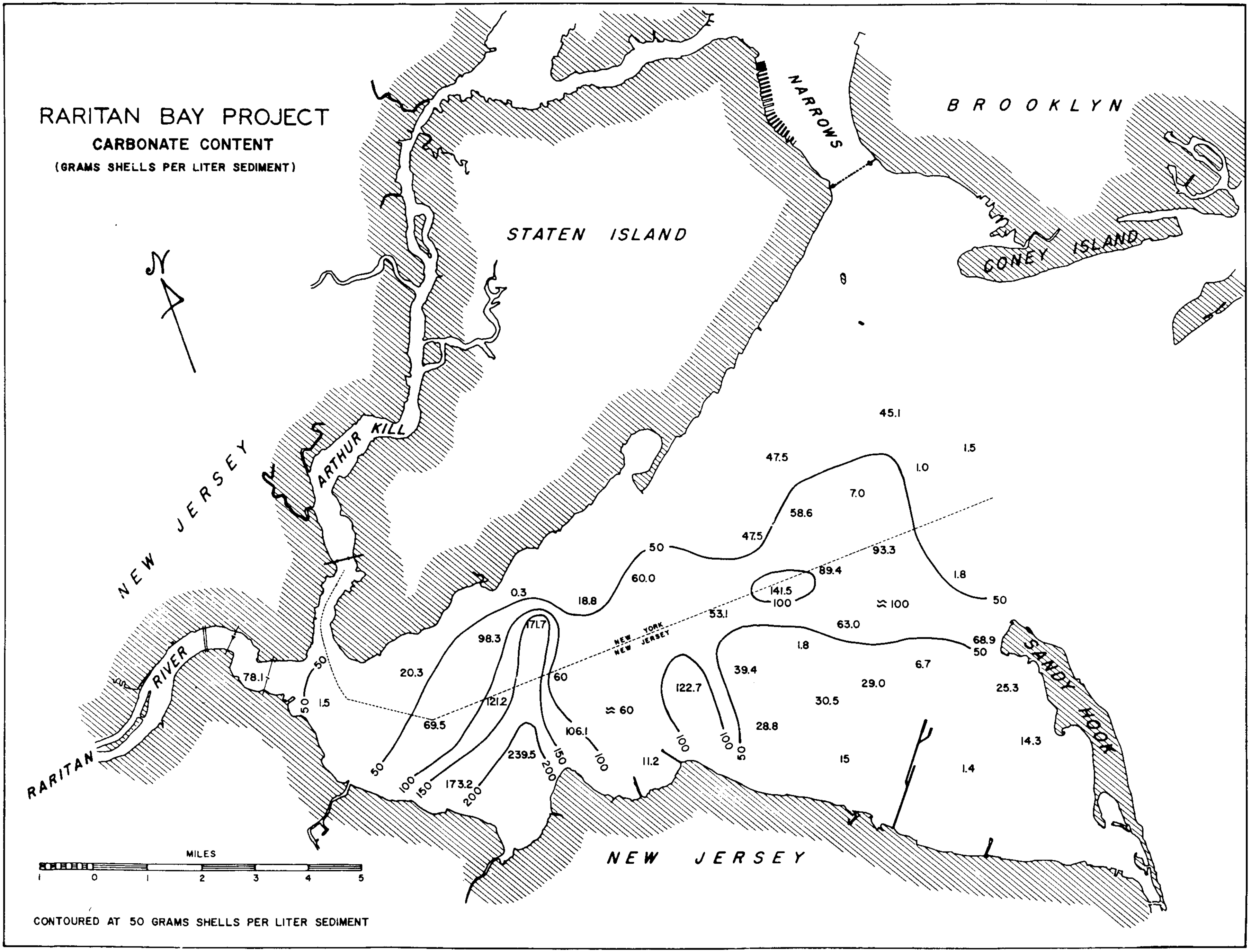

FIGURE 20

GPO 956-592

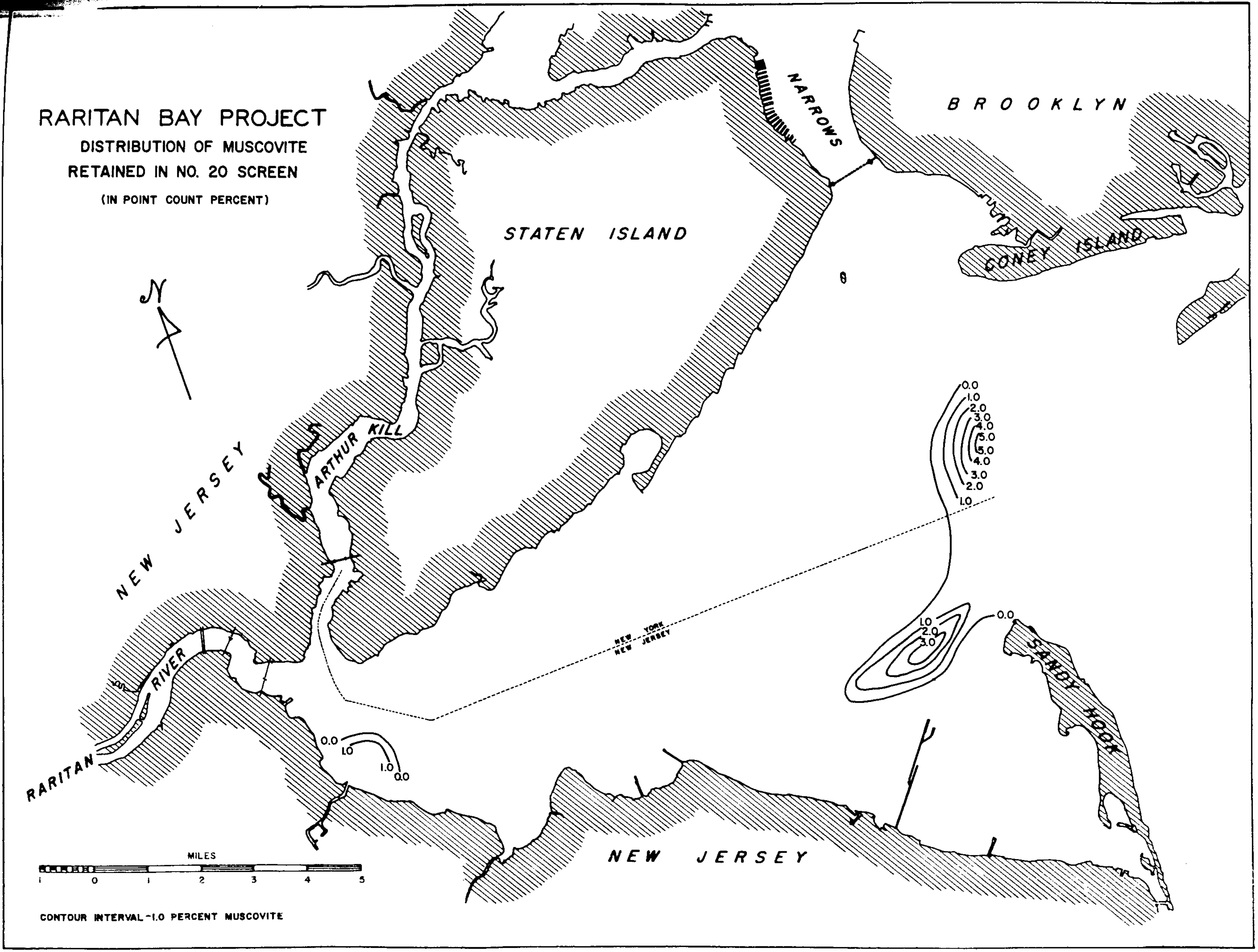

FIGURE 21

GPO 956-592

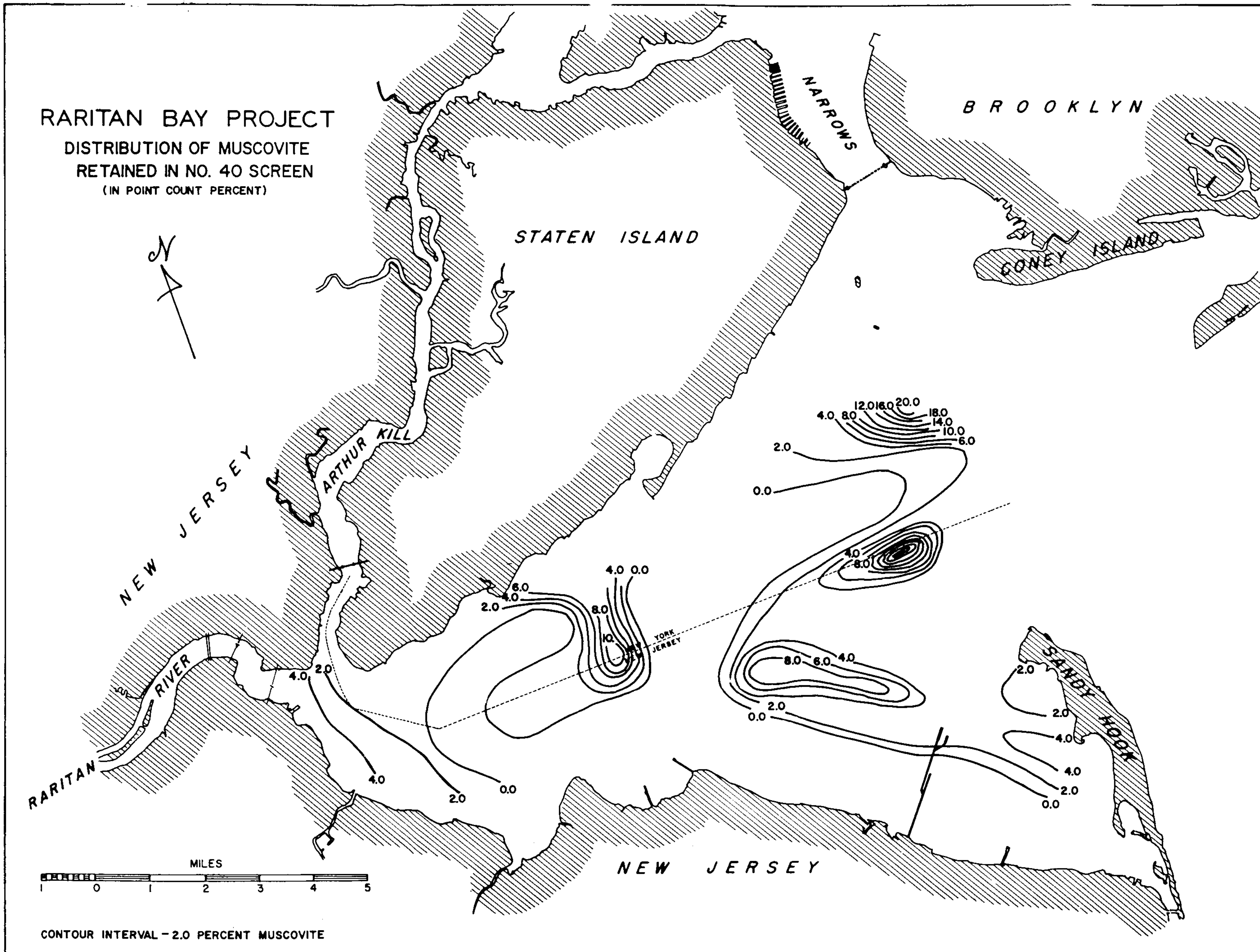
RARITAN BAY PROJECT
DISTRIBUTION OF MUSCOVITE
RETAINED IN NO. 40 SCREEN
(IN POINT COUNT PERCENT)
N
STATEN ISLAND
BROOKLYN
NARROWS
CONEY ISLAND
ARTHUR KILL
NEW JERSEY
RARITAN RIVER
SANDY HOOK
NEW YORK
NEW JERSEY
MILES
1 0 1 2 3 4 5
CONTOUR INTERVAL – 2.0 PERCENT MUSCOVITE
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0

FIGURE 22

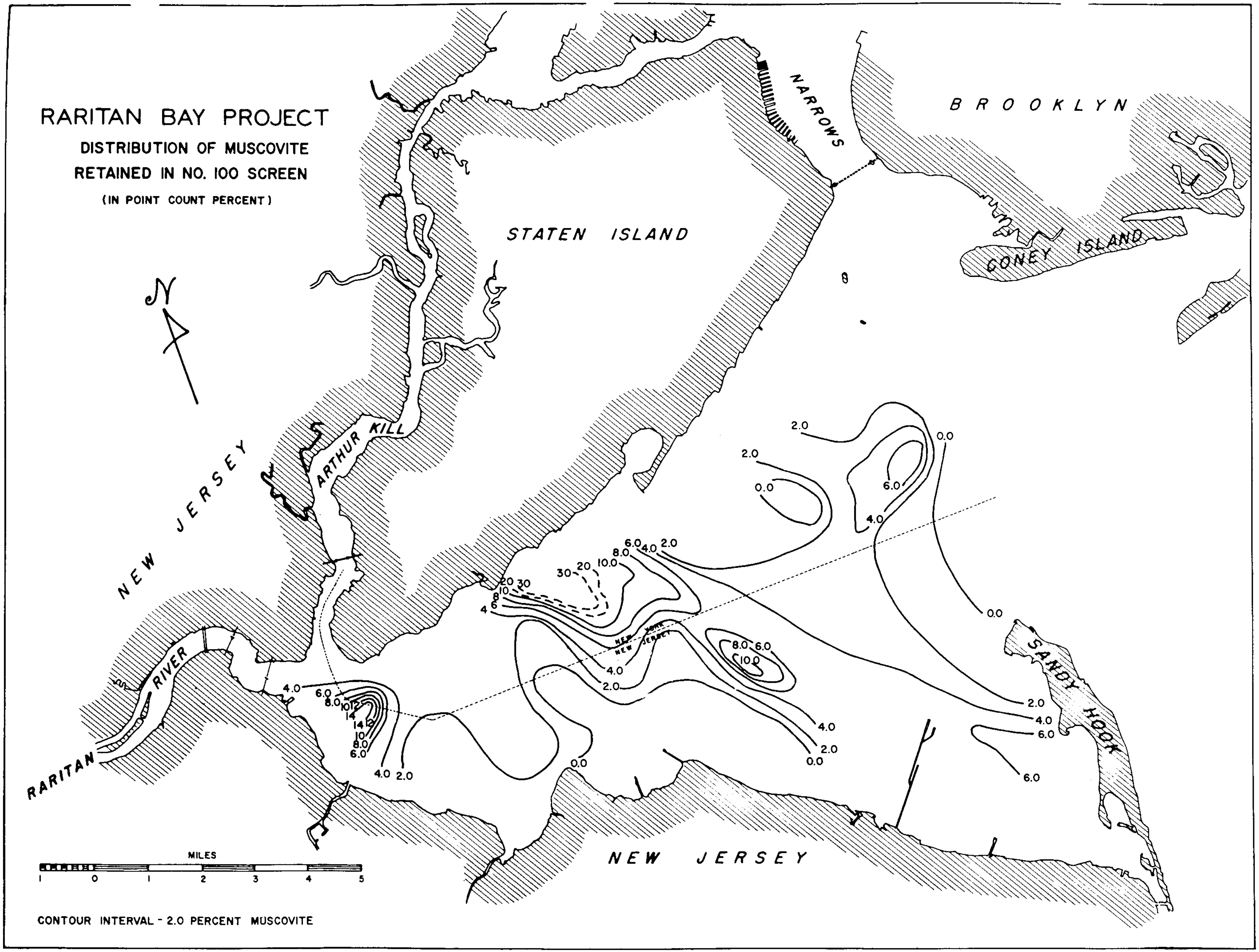

FIGURE 23

GPO 956-592

bay, with net movement toward the area southeast of Seguine Point.

Mollusk Shell Distribution: Final transport and distribution of authigenic sediment particles (particles produced within the area of sedimentation) was determined by studying the distribution of shells of a particular mollusk. These shells can be considered as authigenic particles if it can be shown that the shells are largely produced within the confines of the bay. The small estuarine clam *Mulinia lateralis* was chosen because it is relatively common and its shells are sufficiently small to be moved about by forces of sediment distribution.

As shown by the distribution of the live clam in Figure 24, these shells are largely produced in three areas, north of Port Monmouth, N. J., north of Keyport, and southwest of Seguine Point. Figure 25 shows that the shells are deposited (1) near the production areas; (2) in the fine grained sediment north of the Port Monmouth-Keansburg area; and (3) in a tongue extending north of Keyport. The shells appear to have been transported north from the Keyport area, and west from the Port Monmouth area.

Detrital Coal Distribution: Detrital coal, including cinders, is a clastic element exclusively introduced by man in the Raritan Bay area, since there are no outcrops of coal in the bay or on tributary streams. Coal can be introduced into the bay from coal-using industries along the bay and its tributaries, and from ships bringing coal to these industries.

Figures 26, 27, 28 and 29 show the distribution of coal retained on #5, #20, #40 and #100 screens respectively. These figures show that coal is introduced into Raritan Bay from four areas, around Perth Amboy, above Keyport, near Port Monmouth, and east of Old Orchard Shoal lighthouse. Ultimate movement is toward the area northwest of Keyport, southwest of Great Kills and the Old Orchard Shoal lighthouse. As previously noted, this assumes that grain size distributions for the difference sources are essentially identical.

Sediment Movement and Distribution: The results of the above studies of sediment distribution indicate permanent effects of water movement within the Raritan Bay system. Based upon the patterns of muscovite, clam shells and detrital coal distributions, it would appear that sediments, although introduced into the bay at various places, are all moved toward the roughly quadrilateral area between Seguine Point, Great Kills, Keyport and Keansburg. While river water moves through the entire estuary, its transport influence is felt primarily in the western portion of the bay, while the influence of the ocean predominates in the eastern portion.

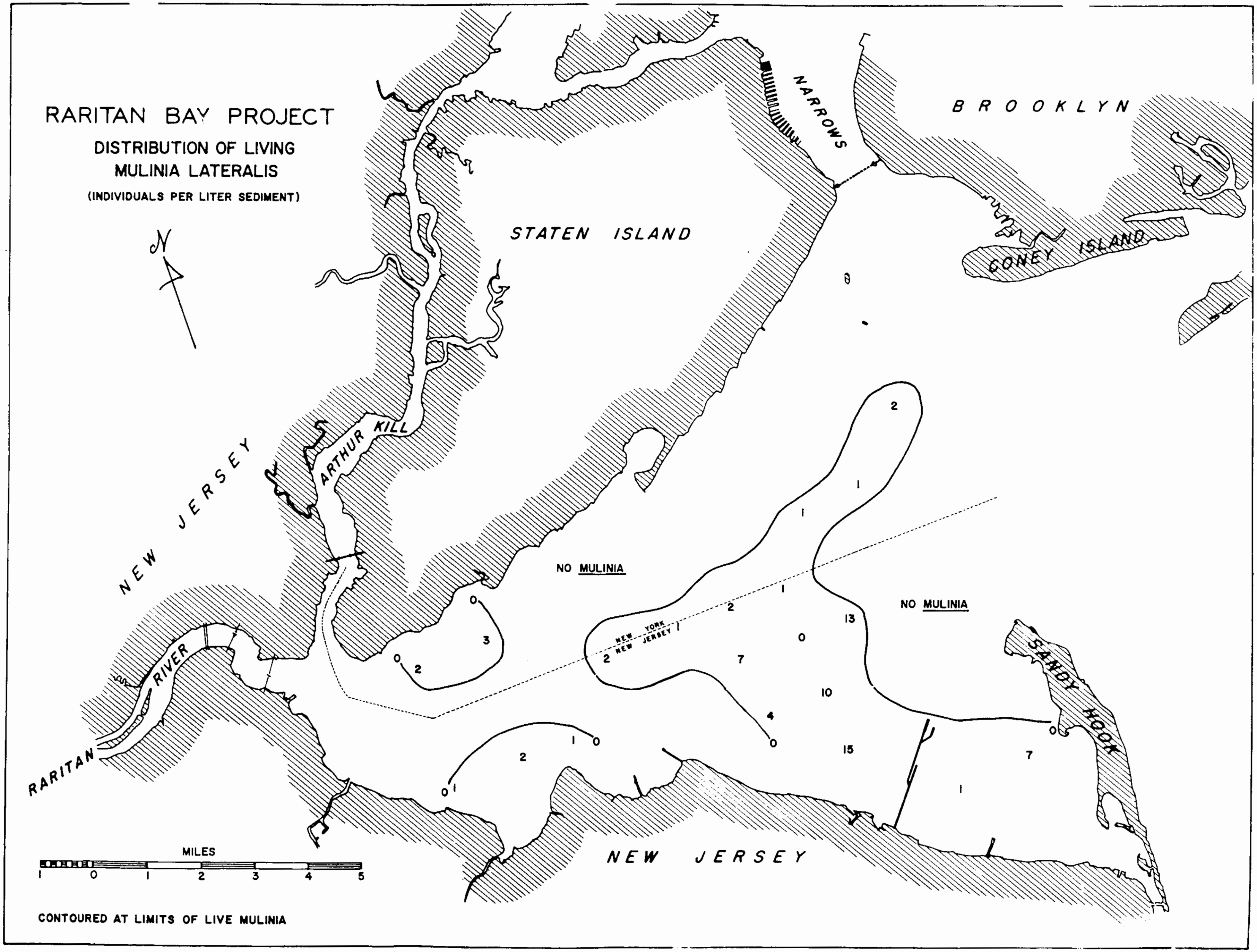
RARITAN BAY PROJECT
DISTRIBUTION OF LIVING
MULINIA LATERALIS
(INDIVIDUALS PER LITER SEDIMENT)
N
STATEN ISLAND
NARROWS
BROOKLYN
CONEY ISLAND
NEW JERSEY
ARTHUR KILL
RARITAN RIVER
NO MULINIA
NO MULINIA
NEW YORK
NEW JERSEY
SANDY HOOK
NEW JERSEY
MILES
1 0 1 2 3 4 5
CONTOURED AT LIMITS OF LIVE MULINIA

FIGURE 24

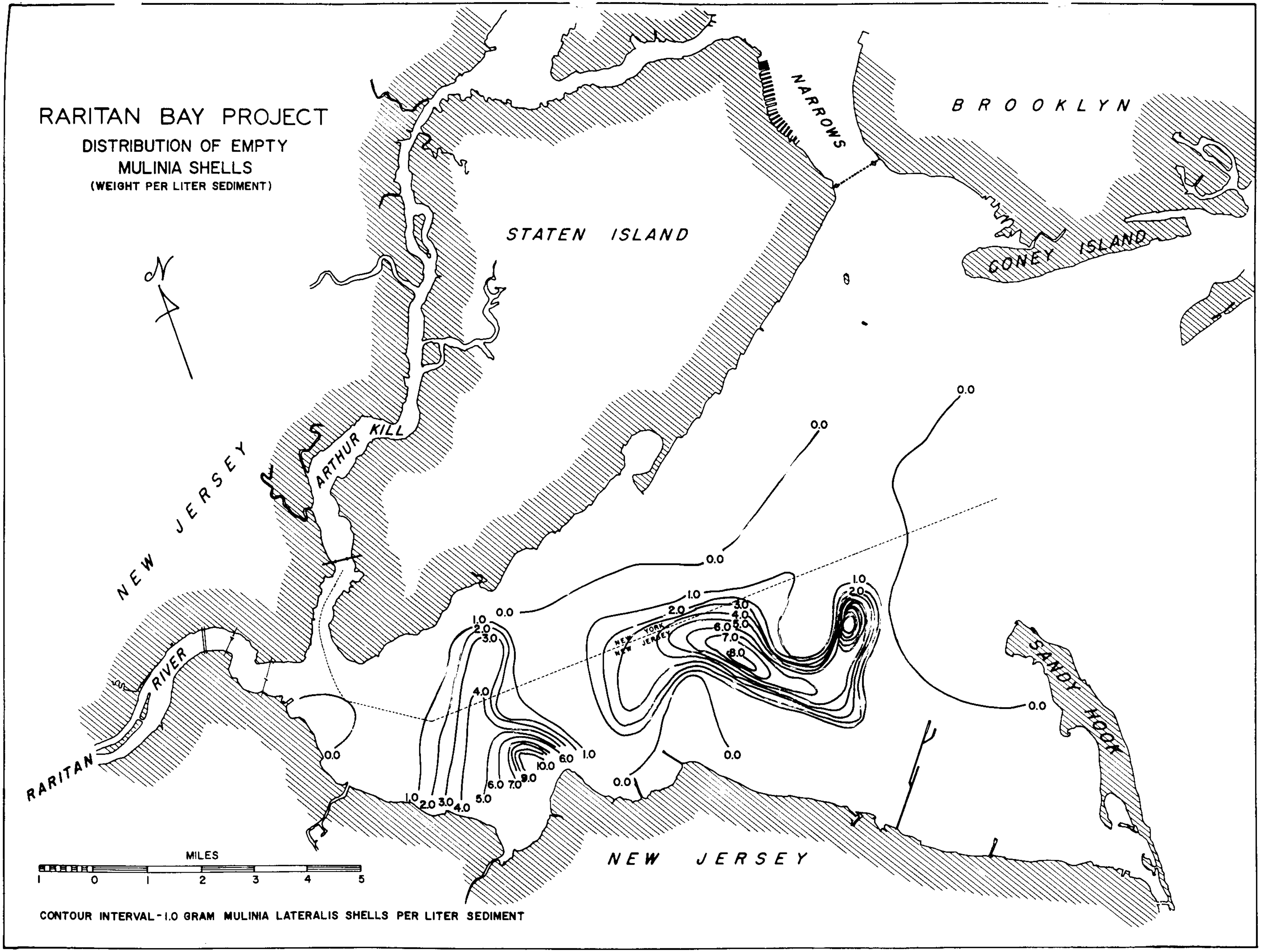

FIGURE 25

GPO 956-592

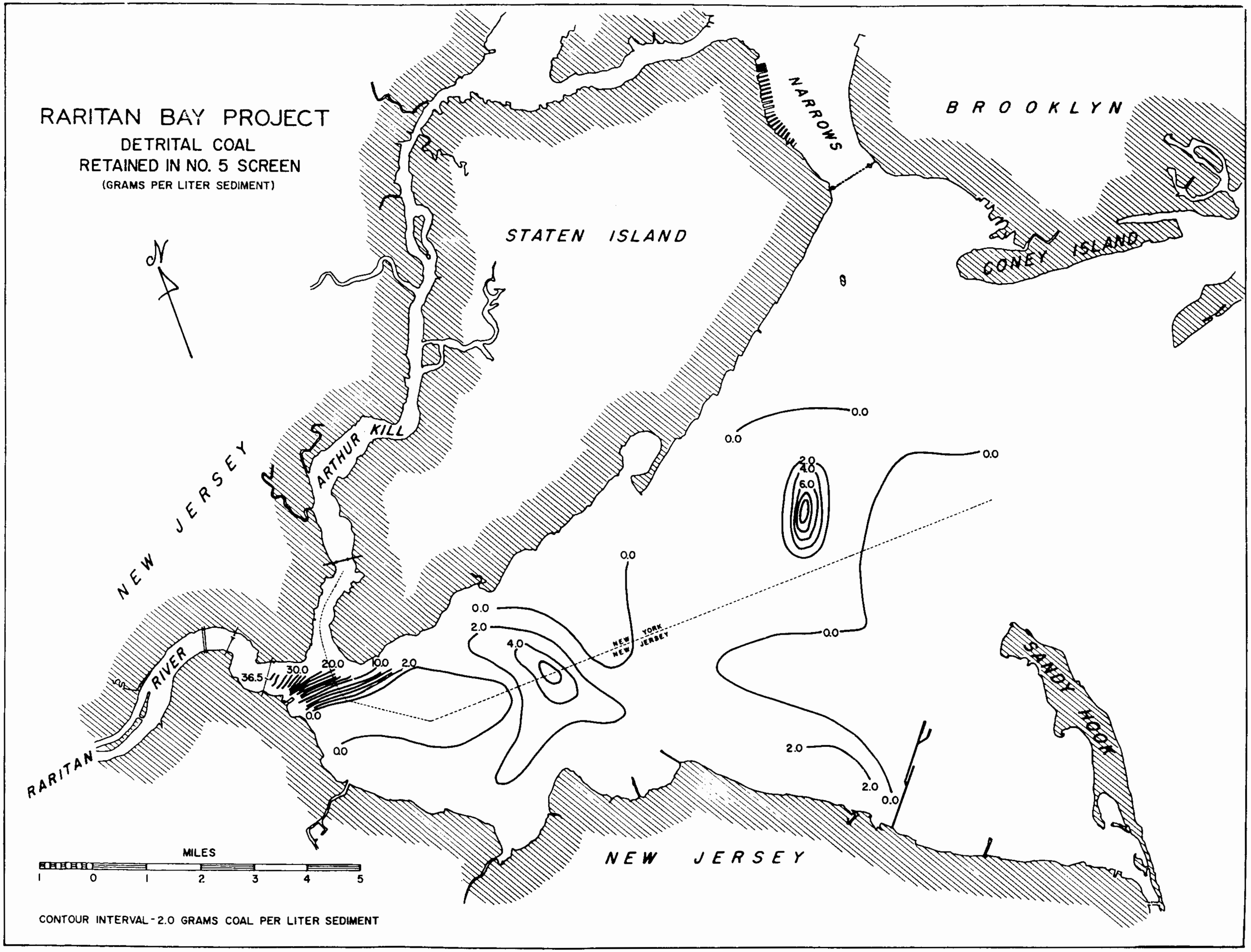

FIGURE 26

GPO 956-592

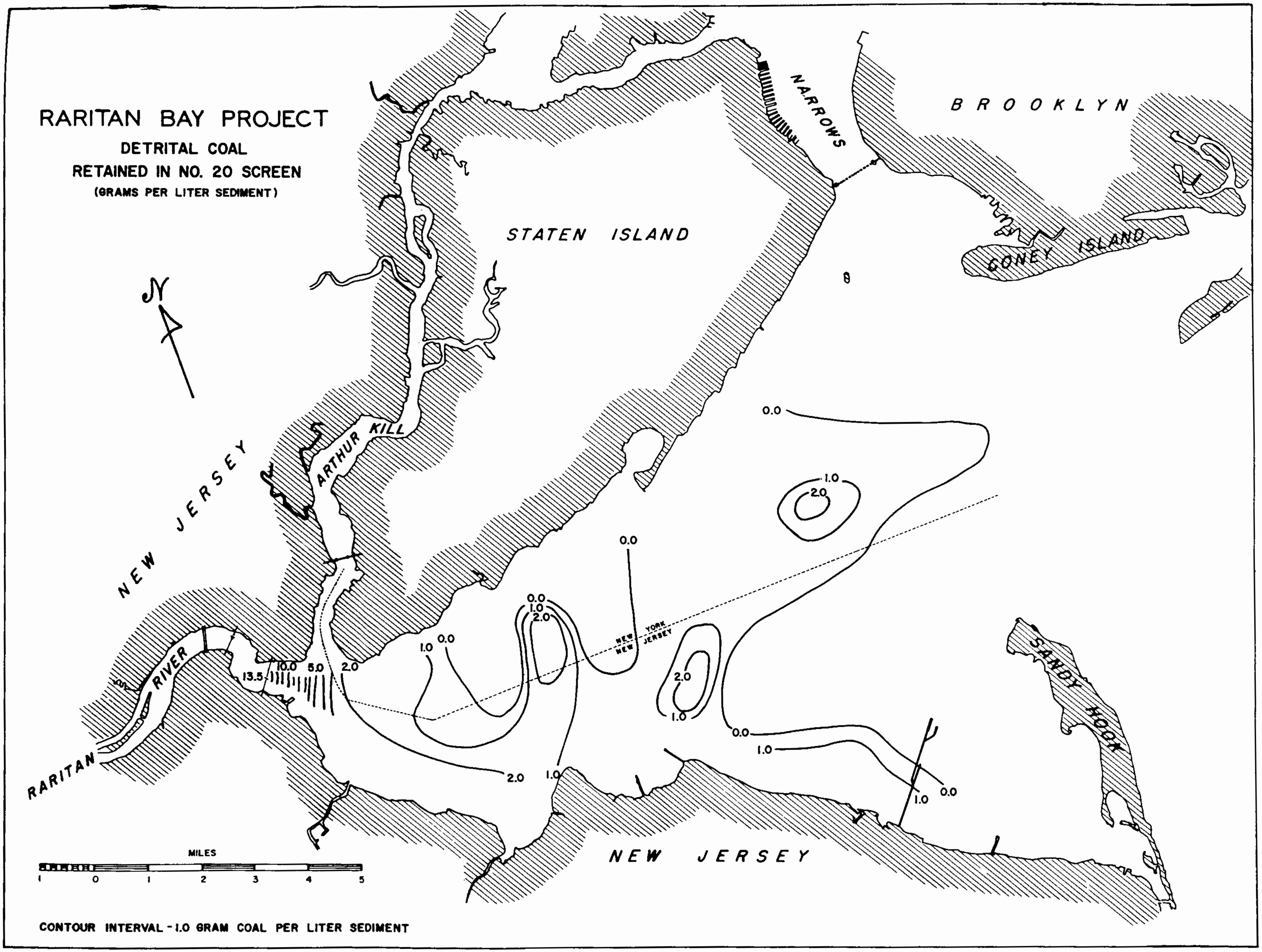

FIGURE 27

GPO 956-592

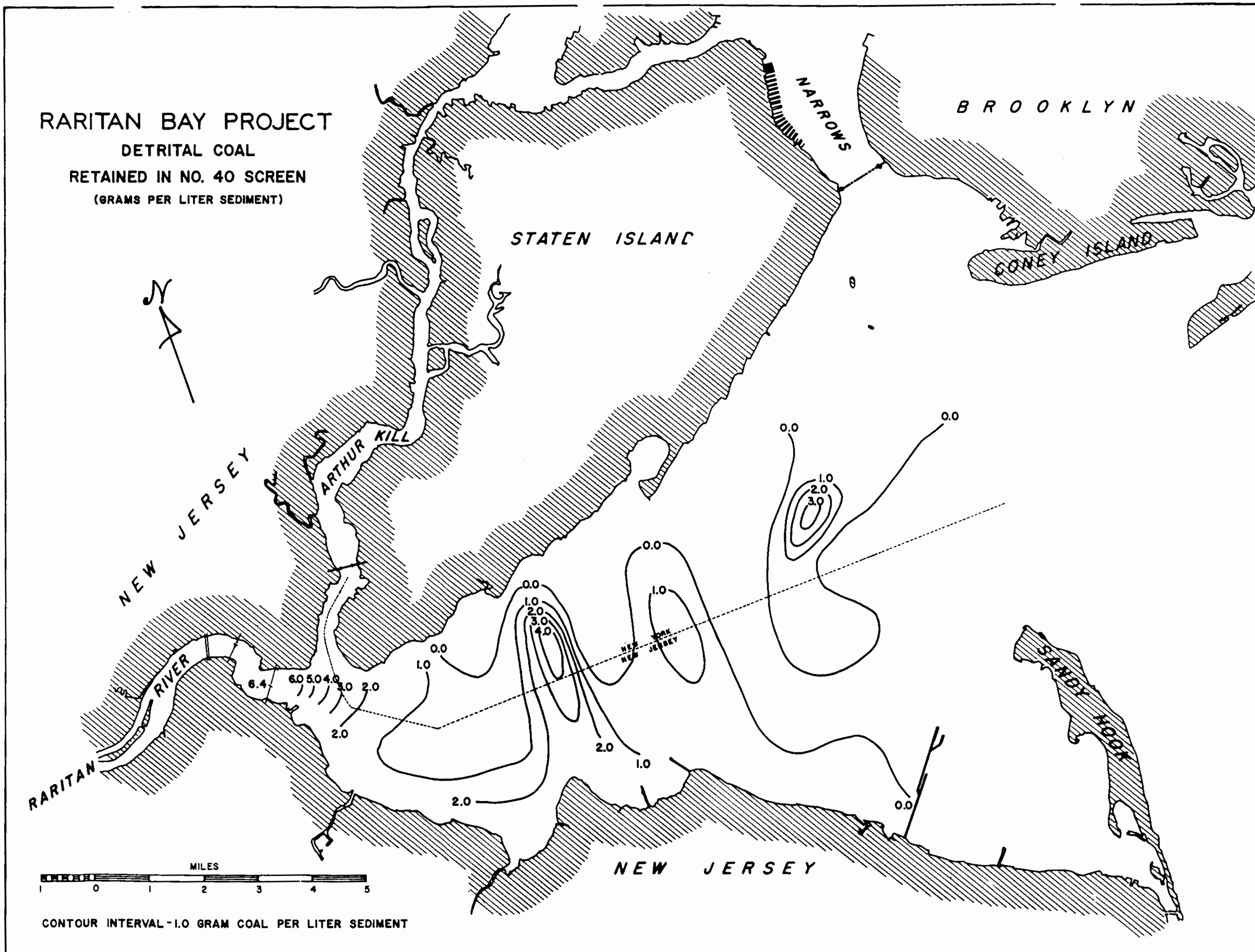

FIGURE 28

GPO 956-592

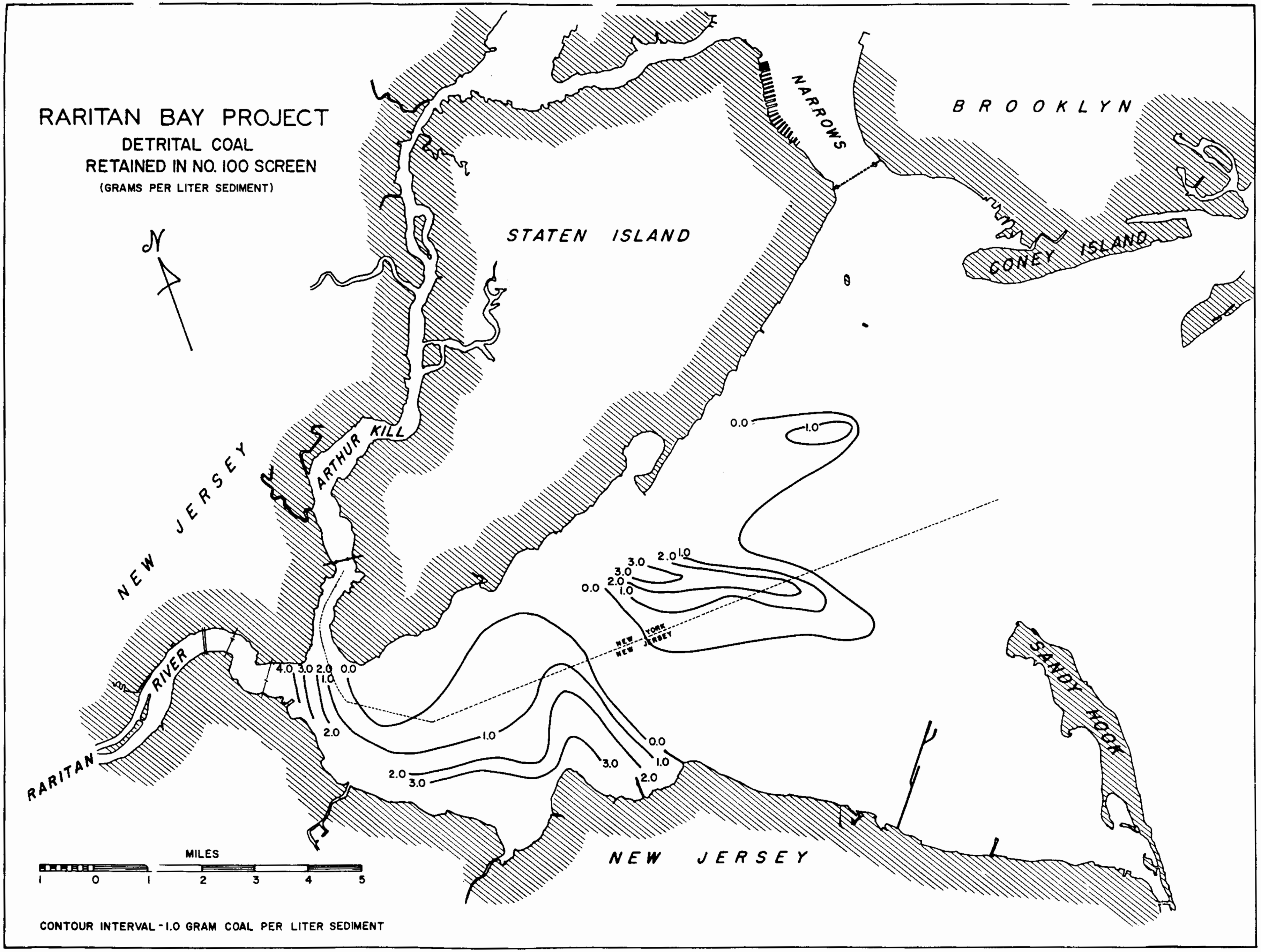

FIGURE 29

GPO 956-592

The net effective movement from these two forces is thus toward the area described above.

FINDINGS AND CONCLUSIONS

FINDINGS

Major findings of the study of Raritan Bay geology are as follows:

1. The shorelines of the Raritan estuary are relatively straight, with linear continuity between sea cliffs and wide sandy beaches. The bay shoreline also contains some tidal marshes on the New Jersey Coast.

2. High chlorinity water occupies the northern portion of the estuary; lower chlorinity water is found in the southern portion. The main water masses show much inter-fingering with one another.

3. Wind appears to affect the position of the water masses. With a west wind the main tongue of high chlorinity water moves close to the Staten Island shore, while an east wind moves the main tongue of high chlorinity water toward the central position of the bay.

4. The floor of the estuary is made up of four major sediment bodies. Sands with an average size of 300

to 400 microns are found north of the New Jersey shore and in Lower New York Bay. The sands are well sorted and have low organic and water content. Silts, or muds, with median diameters of 20 to 80 microns are found in the western part of Raritan Bay and in Sandy Hook Bay. The silts are poorly sorted and have high organic and water content.

5. Most of the sands can be classified as lithic or subgraywackes.

6. The sands generally are denser than the muds. Bulk densities of the sands are usually over 1.0 kg/l, compared to general values of less than 0.5 kg/l for the muds.

7. Carbonate content ranges from 0.1 percent to 42 percent of total sediment by weight. The highest quantities of carbonate per unit volume of sediment are found in a narrow zone parallel to the long axis of the estuary. Carbonate is produced by shell-bearing organisms rather than by chemical composition.

8. Organic content ranges from 0.1 percent to 6 percent by weight. All values greater than 2.0 percent occur in the West Raritan Bay muds.

9. Organic debris, consisting generally of amphipod tubes and wood fragments, varies in the estuary, but is generally highest in Sandy Hook Bay.

10. A study of the disposal of muscovite particles, shells of a small clam, and detrital coal showed that while

these materials were introduced into the estuary at varying locations, increasingly smaller particles were found progressively closer to the area bounded by Seguine Point, Great Kills, Keansburg and Keyport.

11. Detrital coal found in the bay sediment is concentrated near industrial sources, particularly the Perth Amboy area.

CONCLUSIONS

Major conclusions drawn from this study are as follows:

1. The shoreline of the Raritan estuary has reached early maturity in the geomorphic cycle of shoreline development.

2. Movement of high chlorinity water is centered in the northerly portion of the bay while fresher water moves through the southern portion.

3. The bay floor is made up of four major sediment bodies, referred to as the Lower Bay and Keansburg sands, and the Sandy Hook Bay and West Raritan Bay muds.

4. The high organic carbon content found in West Raritan Bay is due to small particles of organic matter, probably the result of an excess of organic matter introduced through pollution.

Paul DeFalco

5. Sediment particles originating at various locations in the bay are moved progressively toward the area bounded by Seguine Point, Great Kills, Keyport and Keansburg.

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Paul DeFalco

APPENDIX G

CHEMICAL ANALYSES OF SHELLFISH - RARITAN BAY

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE

BUREAU OF DISEASE PREVENTION AND ENVIRONMENTAL CONTROL

National Center for Urban and Industrial Health

Water Supply and Sea Resources Program

NORTHEAST RESEARCH CENTER

Narragansett, Rhode Island 02882

A Report on the

Analytical Chemical Data on Shellfish from Raritan Bay

From the Chemistry Section, NERC

July 1965

Paul DeFalco

Introduction

The cooperative role of the Northeast Research Center in the Raritan Bay Project has been based upon a two-fold interest in the quality of the environmental water as related to biological and chemical contaminants, and the distribution of the shellfish resource. Of special interest has been the effect of these contaminants on shellfish including reclamation of this food source.

This study has consisted of two phases. Phase I was a resource study concerned with shellfish density (1) while Phase II has involved the investigation of quality characteristics of the overlying water, silt, and clam meats.

The chemical data described herein represents a contribution to the quality study of the Raritan Bay Project (2, 3, 4). More specifically, Raritan Bay shellfish have been analyzed at NERC for selected trace metals, pesticides, as well as certain other pertinent organic materials.

A description of our methods and procedures, including a discussion of the data obtained, follows.

Materials and Methods

Approximately seventy samples were selected from some four hundred collected during 1963 and 1964 from five areas within the Raritan Bay. These samples, representing twenty stations within these areas, were chosen on the basis of shellfish concentrations and the prevailing currents, as being most indicative of the quality information that we are seeking. The areas and stations along with the shellfish densities and currents are illustrated in the map of Raritan Bay shown in Figure I. Figure II summarizes the total wet weight of the whole-sample homogenate according to area, station and date of collection.

The shucked and frozen samples, as received from the Raritan Bay Project, were thawed and drained via standard NERC procedures in an open Buchner funnel. The samples were weighed and homogenized in a Waring blender and portions of the material were removed for analysis. The remainder was placed in plastic bags inside of pint containers and refrozen for additional sampling, if necessary. Portions of the material removed were lyophilized for phenols and mineral oil determinations. The rest of the homogenate removed was used in the wet state for both metals and pesticide analysis.

Analysis of Mineral Oils

NERC modifications of the chromotographic method of H. D. Silverberg (5) was used for the determination of mineral oils.

I. Preparation:

A. Reagents

1) Chromatographic column: - 3x30 CM with stopcock at the constricted end.

2) Alumina (absorbent): - 80-200 mesh Fisher No. A. 540.

3) Petroleum Ether: ACS Grade.

4) Carbon Tetrachloride.

B. Sample Preparation

Lyophilize or oven-dry sample on a non-absorbent surface until crisp and brittle. Grind and mix well, store in air-tight container. Record the dry weight.

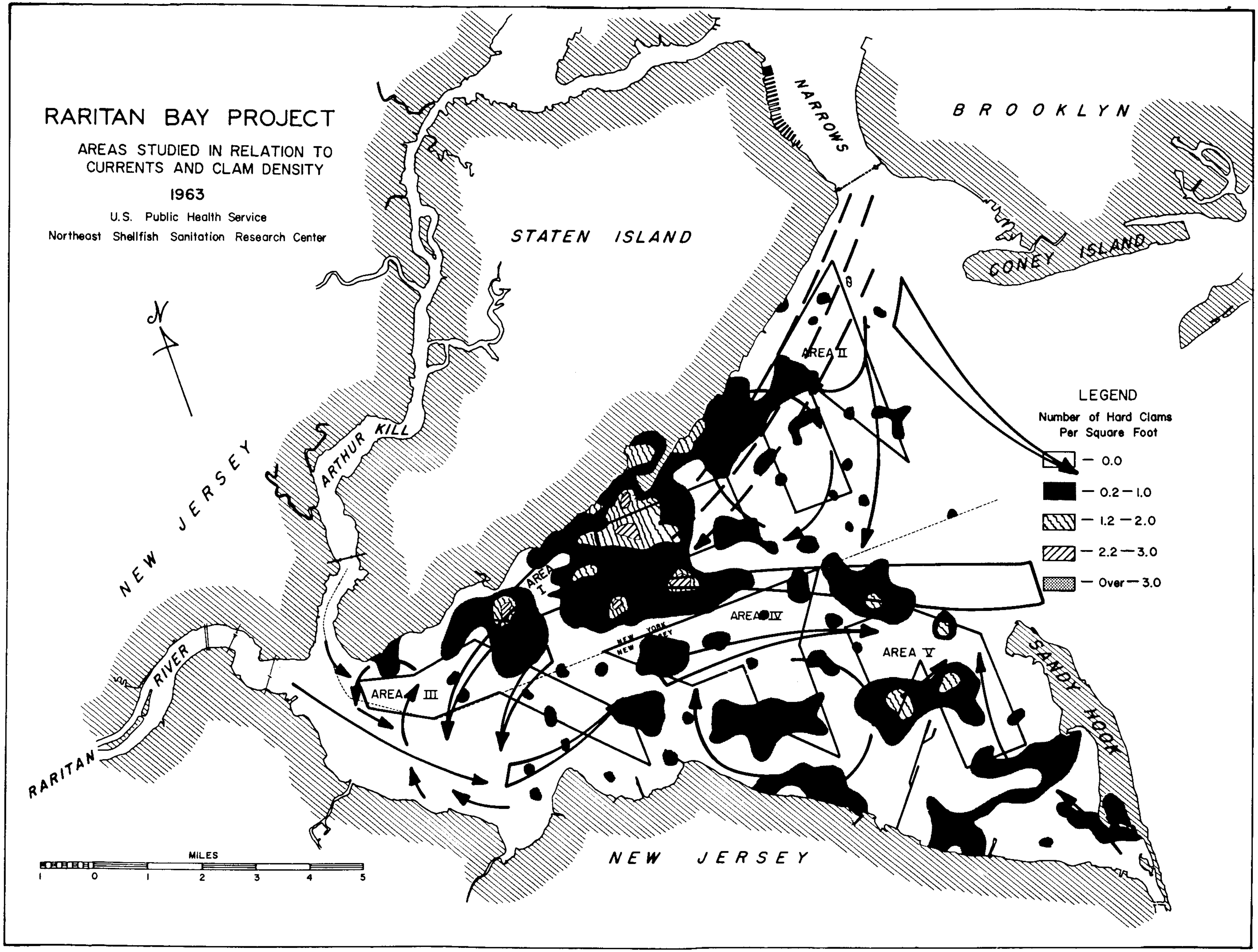

RARITAN BAY PROJECT
AREAS STUDIED IN RELATION TO CURRENTS AND CLAM DENSITY
1963
U.S. Public Health Service
Northeast Shellfish Sanitation Research Center
N
STATEN ISLAND
NARROWS
BROOKLYN
CONEY ISLAND
ARTHUR KILL
NEW JERSEY
RARITAN RIVER
AREA I
AREA II
AREA III
AREA IV
AREA V
NEW YORK
NEW JERSEY
SANDY HOOK
NEW JERSEY
LEGEND
Number of Hard Clams Per Square Foot
— 0.0
— 0.2 — 1.0
— 1.2 — 2.0
— 2.2 — 3.0
— Over — 3.0
MILES
1 0 1 2 3 4 5

FIGURE I

FIGURE II

Summary of Samples by Area and Station

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
I	1	8/7/63	125
	1	11/5/63	476
	1	11/10/63	444
	1	12/10/63	389
	1	1/27/64	406
	1	3/24/64	427
	1	5/25/64	390
	2	8/12/63	800
	2	11/5/63	494
	2	11/19/63	456
	2	12/10/63	432
	2	1/27/64	392
	2	3/24/64	405
	2	5/25/64	414
	3	8/21/63	459
	3	8/21/63	442
	3	11/5/63	478
	3	11/19/63	490
	3	12/11/63	421
	3	1/27/64	390
	3	3/24/64	405
	3	5/25/64	307

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
I	4	8/12/63	404
	4	11/5/63	499
	4	11/19/63	483
	4	1/20/64	426
	4	3/16/64	449
	4	3/31/64	471
	30	8/7/63	349
	30	11/6/63	418
	30	11/19/63	408
	30	12/10/63	499
	30	2/6/64	406
	30	3/30/64	153
	30	5/26/64	221
	31	8/7/63	375
	31	11/6/63	415
	31	11/19/63	468
	31	12/10/63	447
	31	3/30/64	389
	31	5/25/64	326
	41	8/21/63	462
	41	8/21/63	496

FIGURE II (Cont'd.)

Summary of Samples by Area and Station

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams	Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
I	41	11/5/63	492	II	5	8/26/63	155
	41	11/19/63	397		5	8/28/63	362
	41	12/11/63	420		5	11/5/63	483
	41	1/20/64	408		5	11/12/63	497
	41	3/16/64	437		5	12/2/63	274
	41	3/31/64	237		5	12/9/63	386
					5	1/20/64	404
	42	8/19/63	594		5	3/16/64	223
	42	11/5/63	460		5	3/31/64	411
	42	11/19/63	441		5	5/26/64	193
	42	12/11/63	425				
	42	1/27/64	376		6	11/4/63	470
	42	3/24/64	423		6	11/12/63	423
					6	12/2/63	413
	43	8/7/63	165		6	1/20/64	399
	43	11/5/63	505		6	3/23/64	463
	43	11/19/63	434		6	5/26/64	231
	43	12/10/63	384				
	43	1/17/64	431		7	8/28/63	480
	43	3/24/64	409		7	11/4/63	512
	43	5/25/64	402		7	11/12/63	465
					7	12/2/63	383
	44	10/7/63	203		7	1/20/64	374
	44	11/6/63	416		7	3/23/64	365
	44	11/19/63	432		7	5/26/64	301
	44	12/10/63	391				
	44	2/5/64	416		10	11/4/63	486
	44	3/30/64	414		10	11/12/63	465
	44	5/25/64	406		10	12/2/63	383

822

FIGURE II (Cont'd.)

Summary of Samples by Area and Station

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
II	10	5/26/64	301
	20	10/21/63	541
	20	11/4/63	501
	20	11/12/63	473
	20	12/2/63	104
	20	1/20/64	392
	20	3/23/64	410
	20	5/26/64	418
	21	8/12/63	415
	21	8/21/63	478
	21	11/5/63	378
	21	11/12/63	510
	21	12/2/63	384
	21	1/20/64	430
	21	3/24/64	416
	36	8/28/63	605
	36	11/4/63	506
	36	11/12/63	467
	36	12/2/63	443
	36	1/20/63	423
	36	3/31/63	407
	36	5/26/63	369
	37	11/4/63	470
	37	11/12/63	478

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
II	37	12/2/63	389
	37	3/16/64	323
	37	3/31/64	413
	37	5/26/64	416
	39	8/28/63	498
	39	11/4/63	477
	39	11/12/63	444
	39	12/2/63	427
	39	1/20/64	385
	39	3/16/64	431
	39	3/31/64	392
	40	11/5/63	391
	40	11/12/63	478
	40	12/2/63	438
	40	1/20/64	395
III	32	8/7/63	250
	32	11/6/63	481
	32	11/20/63	453
	32	12/4/63	360
	33	11/20/63	373
	33	12/6/63	347
	33	12/11/63	424
	33	2/6/64	406

FIGURE II (Cont'd.)

Summary of Samples by Area and Station

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
III	33	3/30/64	304
	33	5/25/64	289
	45	8/7/63	253
	45	11/20/63	412
	45	11/30/63	481
	45	12/9/63	447
	45	3/30/64	229
	46	8/7/63	170
	46	10/31/63	418
	46	11/20/63	436
	46	12/9/63	439
	46	1/27/64	396
	46	6/2/64	401
	53	8/28/63	71
	53	10/31/63	449
	53	11/20/63	492
	53	2/5/64	443
	53	3/30/64	401
	53	6/2/64	351
	54	10/29/63	457
	54	11/20/63	414
	54	12/9/63	434
	54	2/5/64	403

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
III	54	3/30/64	418
	54	6/2/64	377
	56	8/7/63	285
	56	10/31/63	467
	56	11/20/63	412
	56	12/9/63	368
	56	2/6/64	399
	56	3/30/64	335
	57	8/7/63	204
	57	11/6/63	356
	57	11/9/63	413
	57	11/13/63	419
	57	11/20/63	417
	57	2/6/64	369
	57	3/30/64	368
	57	5/25/64	305
	58	10/31/63	147
	58	11/20/63	377
	58	12/9/63	374
	58	2/6/64	424
	58	3/30/64	196
	61	11/6/63	421
	61	11/20/63	412
	61	12/9/63	396
	61	2/6/64	421
	61	3/30/64	281
	61	5/25/64	171

FIGURE II (Cont'd.)

Summary of Samples by Area and Station

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
IV	22	8/21/63	426
	22	8/21/63	494
	22	10/28/63	504
	22	11/18/63	458
	22	12/4/63	434
	22	1/20/64	390
	22	3/16/64	382
	22	6/1/64	187
	22	6/2/64	402
	25	10/28/63	474
	25	11/18/63	453
	25	12/4/63	424
	25	12/11/63	452
	25	6/1/64	320
	26	8/19/63	132
	26	10/28/63	489
	26	11/18/63	446
	26	12/4/63	455
	26	12/11/63	424
	26	1/27/64	397
	26	3/24/64	434
	26	6/1/64	413
	27	8/21/63	367
	27	8/21/63	800

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
IV	27	10/28/63	486
	27	11/18/63	463
	27	12/4/63	417
	27	1/27/64	429
	27	3/30/64	396
	28	8/12/63	605
	28	10/28/63	498
	28	11/18/63	468
	28	12/4/63	420
	28	1/27/64	396
	28	3/30/64	451
	28	6/1/64	349
	29	8/7/63	209
	29	10/31/63	474
	29	11/18/63	487
	29	12/4/63	425
	29	1/27/64	396
	29	3/30/64	399
	47	8/12/63	800
	47	10/28/63	478
	47	11/18/63	470
	47	12/4/63	453
	47	1/27/64	420
	47	3/7/64	384

FIGURE II (Cont'd.)

Summary of Samples by Area and Station

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
IV	48	8/26/63	397
	48	10/28/63	514
	48	11/18/63	475
	48	12/4/63	451
	48	1/27/64	370
	48	3/24/64	370
	48	6/2/64	400
	49	8/26/63	800
	49	8/26/63	800
	49	10/28/63	498
	49	11/18/63	469
	49	3/23/64	424
	49	6/1/64	380
	51	10/28/63	504
	51	11/18/63	510
	51	12/4/63	479
	51	1/22/64	458
	51	3/23/64	424
	51	6/1/64	354
	52	10/28/63	489
	52	11/18/63	441
	52	12/4/63	435
	52	1/27/64	417
	52	3/24/64	403

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
V	13	10/29/63	415
	13	11/13/63	347
	13	1/22/64	213
	13	3/23/63	434
	13	6/1/64	412
	14	8/26/63	333
	14	10/29/63	491
	14	11/13/63	434
	14	12/3/63	437
	14	1/22/64	416
	14	3/23/64	409
	14	6/1/64	409
	15	8/26/63	136
	15	10/29/63	428
	15	11/13/64	493
	15	12/3/63	411
	15	1/22/64	413
	15	3/23/64	404
	15	6/1/64	312
	16	8/28/63	125
	16	10/29/63	455
	16	11/13/63	475
	16	12/3/63	410
	16	1/22/64	395
	16	3/23/64	387
	16	6/1/64	307

FIGURE II (Cont'd.)

Summary of Samples by Area and Station

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
V	17	8/26/63	621
	17	10/29/63	484
	17	11/13/63	456
	17	12/3/63	459
	17	1/22/64	384
	17	3/23/64	455
	17	6/1/64	357
	18	10/29/63	477
	18	11/13/63	452
	18	12/3/63	422
	18	1/22/64	388
	18	3/23/64	401
	18	6/1/64	427
	23	8/21/63	430
	23	10/29/63	488
	23	11/13/63	497
	23	11/13/63	429
	23	12/3/63	444
	23	1/22/64	397
	23	1/22/64	399
	23	3/23/64	372
	23	6/1/63	352
	24	8/26/63	473
	24	10/29/63	471

Area #	Station #	Date	Total Wet Weight of Homogenized Sample in Grams
V	24	12/3/63	431
	24	1/22/64	412
	24	3/23/64	412
	24	6/1/64	414
	50	10/29/63	483
	50	12/3/63	436
	50	3/23/63	410

Miscellaneous Station

Station #	Date	Total Wet Weight of Homogenized Sample in Grams
19	8/21/63	475
	8/21/63	677
11	8/28/63	620
73	12/3/63	426
	2/22/64	400
	6/1/64	397

II. Analytical Procedure:

One hundred grams of drained, homogenized clam tissue is lyophilized for 15 hours. The sample is ground to a powder and extracted as in the original procedure.

A 100 gram wet-weight equivalent of the lyophilized sample is weighed into a 800 ml. beaker. Extract once with 300 ml. and repeat with 200 ml. of hot $CHCL_3$. Heat with stirring on a steam bath to effect extraction. Filter each portion through fluted filter paper into a 600 ml. beaker. Evaporate extracts to a small volume on a steam bath with the use of air. Transfer to a small tared beaker. Evaporate solvent and dry oil to constant weight at 100°C.

Preparation of column. Pack pledget of glass wool in the constricted end of a glass column. A constant weighed amount of dry alumina is placed in the column. The column is packed by using an electric vibrator for 4 minutes during filling to insure uniform and consistent results. The surface of the alumina is covered with a disc made from any rapid flow filter paper, making it slightly smaller than the inside of the column. Wash with 50 5 ml. portions of petroleum ether. Shut off the flow just before the last washing settles in the alumina.

Separation of Unsaponifiables. The weighed and extracted oil from the original sample is dissolved in petroleum ether in a small beaker. This is carefully placed on the alumina column. The stopcock is opened and the eluate is collected at a rate not to exceed 5 ml/minute. The stopcock is closed when ether-oil mixture reaches the surface of the alumina. The beaker is rinsed with 2-3 mls. of petroleum ether, pouring each rinse on the column so that the sides are washed down. Again the stopcock is opened and the ether is allowed to settle to the alumina surface. The column is filled with petroleum ether and 100 mls. of eluate is collected at the rate of 5 ml/minute. The petroleum ether is concentrated to a small volume and transferred quantitatively to a tared beaker. Evaporate to dryness at 100°C and calculate the percent of unsaponifiables. The results are given as mgms per 100 grams of tissue homogenate.

The residual oil is transferred to NaCl plates and the IR spectrum is run. This is compared with a standard USP mineral oil. If volume is too small, it is transferred with the aid of CS_2. Peaks should be present at 3.4, 6.82 and 7.25.

Analysis of Total Phenols

Total phenols were determined by the method of

Swain and Hillis [6] with certain NERC modifications.

I. Preparation:

A. Reagents

1) Folin-Denis Reagent: To 750 ml. of H_2O add 100 g. Sodium Tungstate, 20 g. phosphomolybdic acid and 50 ml. phosphoric acid. Reflux 2 hours, cool, dilute to 1 liter.

B. Extraction

Lyophilize 15 gram sample of drained homogenized clam tissue for 16 hours. The 15 gram wet-weight equivalent of material is extracted with five 50 ml. portions of methanol. The extract is filtered through #1 Whatman paper into a 250 ml. volumetric flask and made up to volume.

II. Analytical Procedure:

Twenty ml. of distilled water is introduced into a 25 ml. volumetric flask. To this 0.5 ml. of the methanol extract is added and mixed well. Add 1.25 ml. of Folin-Denis reagent and mix thoroughly. Exactly three minutes later 2.5 ml. of 1.5M sodium carbonate solution is added and mixed. The solution is diluted to volume, and mixed and set in a 30°C constant temperature bath for 50 minutes. After 50 minutes it is read on a DU spectrophotometer in a 1 cm cell at 725 mu. Results are read from a standard curve and calculated as mgms per 100 grams of original tissue homogenate.

Pesticide Analysis

Gas liquid chromatographic techniques were used for the analysis of Lindane, Aldrin, and Dieldrin in shellfish for this study, with NERC modifications of techniques developed by Mills (7, 8). The sample is stripped, saponified, extracted, and clean-up via either column chromatography (Florisil, etc.) or solvent partitioning (acetonitrile, etc.).

Procedure:

Ten grams of shellfish tissue homogenate is extracted with hexane and saponified with 20 ml. of alcoholic KOH on a steam bath for 15-20 minutes. The material is cooled and extracted quantitatively with 10 ml. of hexane. This extract is dried with anhydrous sodium sulfate and cleaned up if necessary via solvent partition with acetonitrile or on a Florisil column. The final hexane extract is sealed in glass ampoules and held for analysis on a Perkin-Elmer Gas Chromatograph Model #800 with electron capture detector using Chromosorb W and silicone gum rubber. The unknowns were quantitated with pesticide analytical standards. The results are calculated on the basis of ppm of the original tissue homogenate.

Metals

The metals in this study were determined by a method developed at NERC making use of atomic absorption spectrophotometry (9). The metals zinc, chromium, nickel, lead and copper were determined by wet-ashing 5 gram samples of shellfish homogenate in 125 ml. Erlenmeyer flasks using 1.1 mixture of concentrated nitric and perchloric acids with heat, such that the reaction temperature of the mixture never exceeded 100°C. The resultant mixture was diluted to 100 ml. with conductivity water and read on a Perkin-Elmer Atomic Absorption Spectrophotometer, Model #303. The readouts for each unknown were quantitated by means of a similarly prepared metal standard. The results are reported as mgms per kilo of the original tissue homogenate.

Results and Discussion

In order to properly assess the analytical data from this study, it was deemed necessary to develop a normal comparative pattern which could be used to evaluate the experimental results. Comparable data in the literature for these particular contaminants in shellfish are either non-existent, or out-dated methods-wise. It was therefore decided to collect a representative group of "normal" shellfish samples from chemically and biologically clean areas and to analyze for those compounds and metals under study. The resulting data served as our baseline values and were used as "normal" levels in evaluating the Raritan Bay analyses. These values are shown in Table I.

TABLE I

NERC Base Line Values

Trace Metals Mg./Kilo tissue	Phenols Mg./100 gms tissue	Mineral Oils Mg./100 gms tiss.	Pesticides PPM	
Cu 0 - 5 mg.	35.2	0 - 4	Aldrin	0
Zn 40-60 mg.			Dieldrin	0
Pb 0-.3 mg			Lindane	0
Cr 0-.2 mg.				
Ni 0-.2 mg				

The complete experimental data of this study are summarized in Figure III and more specifically are illustrated throughout this report in the various accompanying plates.

Results and Discussion

Phenols

The phenol data are summarized in Plates I and II. The average station values within the areas studied, arranged according to seasons of collection, are illustrated in the map on Plate I. There appear to be no significant differences between the warm and cold weather samples within the period studied. The values range from 38.0 to 100 mg./100 grams of tissue. The station and area averages are shown in Plate 2. Area I contained the greatest number of analyzed stations (eight), due to the fact that this area was considered to be one of the three highly indicative of possible contaminant accumulation. The station levels within this area range from 53.6 to 76.0 mg./100 grams of tissue, with an Area I average of 63.7. Area II contained two stations giving an average value of 55.5. Areas III through V contributed the highest values. with averages of 73.3, 65.5 and 72.0 respectively. All five areas within the bay resulted in an overall value of

66.0 mg./100 grams wet tissue. In comparing these results with our baseline value of 35.2, we find an 88 percent increase in the overall phenol values when compared with the normal, for those areas studied.

The levels in those sections of the bay studied are almost double our normal phenol value and perhaps represent a certain degree of pollution in these particular areas.

FIGURE III

Summary of Analytical Chemical Data on Raritan Bay

Area #	Station #	Collection Date	Trace Metals (Mgms/Kilo) Cu	Zn	Pb	Cr	Ni
I	2	8-12-63	6.4	43.0	3.0	0.0	1.8
	2	11-5-63	10.2	47.0	1.6	0.0	3.8
	2	3-24-63	7.0	55.0	3.6	0.8	3.1
	4	11-5-63	8.0	51.0	5.4	0.4	2.1
	4	8-12-63	7.4	47.0	2.2	0.0	1.8
	4	3-31-64	7.4	60.0	3.0	1.4	1.4
	4	8-13-64	9.4	84.5	3.5	0.0	1.0
	30	8-7-63	7.2	66.0	3.5	0.7	1.8
	30	11-6-63	8.0	52.0	1.6	0.4	5.0
	31	8-7-63	7.6	50.0	7.3	0.6	6.0
	31	11-6-63	8.8	53.0	3.0	0.8	3.1
	31	3-30-64	8.4	55.0	3.6	0.8	2.1
	31	8-19-64	8.4	42.0	3.6	0.0	4.2
	41	8-13-64	8.2	78.0	6.6	0.0	2.6
	41	8-21-63	9.4	52.0	6.6	0.0	4.5
	41	11-5-63	9.4	63.0	5.8	0.0	3.6
	41	3-16-64	7.2	52.0	5.8	0.0	4.0
	42	8-19-63	7.2	64.0	6.0	0.0	3.1
	42	11-5-63	6.4	38.0	6.0	0.0	3.9
	42	3-24-64	6.2	50.0	6.6	0.7	3.1
	42	8-18-64	7.6	71.0	4.9	0.0	4.5
	43	11-5-63	6.8	32.0	3.5	0.0	4.0
	43	3-24-64	3.6	39.0	6.0	0.0	3.1
	43	8-19-64	7.0	43.0	3.6	0.0	2.8
	44	11-6-63	6.6	44.0	6.4	2.0	4.0
	44	3-30-64	7.4	52.0	5.0	1.5	4.0
	44	8-19-64	7.0	54.0	3.5	2.0	3.0
II	7	8-28-63	5.4	69.6	5.5	0.0	3.0
	7	11-4-63	10.4	87.6	3.3	2.8	3.0
	7	3-23-63	6.6	88.4	4.7	0.0	3.2
	7	8-13-64	8.4	118.6	4.3	0.0	1.8
	40	11-5-63	68.1	2.0	0.0	1.8	
	40	3-31-64	6.6	27.0	2.2	0.9	4.3
	40	8-13-64	6.2	72.0	2.3	1.3	0.0

FIGURE III (Cont'd.)

Summary of Analytical Chemical Data on Raritan Bay

Area #	Station #	Collection Date	Pesticides (PPM) Aldrin	Dieldrin	Lindane	Phenols (Mgms/100 Gms)	Mineral Oil (Mgms/100 Gms)
I	2	8-12-63	-	-	-	67.0	7.82
	2	11-5-63	<.01	-	-	71.0	
	2	3-24-64	-	-	-	47.0	
	4	11-5-63	-	-	-	65.0	0.3
	4	8-12-63	-	<.01	<.01	70.0	
	4	3-31-64	-	-	-	41.5	
	4	8-13-64	-	-	-	48.0	4.08
	30	8-7-63	-	-	-	49.0	
	30	11-6-63	-	<.01	-	68.0	
	31	8-7-63	-	-	-	100.5	
	31	11-6-63	-	<.01	-	50.0	
	31	3-30-64	<.01	-	<.01	40.5	
	31	8-19-64	-	-	-	50.0	
	41	8-13-64	<.01	<.01	-	81.5	
	41	8-21-63	<.01	<.01	-	60.0	0.75
	41	11-5-63	-	<.01	<.01	83.5	0.24
	41	3-16-64	<.01	-	-	79.0	
	42	8-19-63	-	<.01	-	70.0	4.17
	42	11-5-63	-	<.01	-	73.0	1.91
	42	3-24-64	-	-	-	68.5	
	42	8-18-64	<.01	-	-	75.0	
	43	11-5-63	<.01	-	-	56.5	0.72
	43	3-24-64	-	<.01	-	72.5	3.46
	43	8-19-64	-	-	-	75.0	
	44	11-6-63	-	-	-	62.5	4.45
	44	3-30-64	<.01	-	-	52.0	
	44	8-19-64	-	-	-	53.5	
II	7	8-28-63	-	-	-	55.5	0.1
	7	11-4-63	-	-	-	66.5	
	7	3-23-64	-	-	-	43.0	1.7
	7	8-13-64	-	-	-	44.0	
	40	11-5-63	-	0.01	-	39.0	0.2
	40	3-31-64	-	-	-	65.5	
	40	8-13-64	-	-	-	75.0	

FIGURE III (Cont'd.)

Summary of Analytical Chemical Data on Raritan Bay

Area #	Station #	Collection Date	Trace Metals (Mgms/Kilo) Cu	Zn	Pb	Cr	Ni
III	46	10-31-63	9.4	64.0	3.5	1.4	4.5
	46	8-18-64	6.3	36.6	2.8	0.0	2.9
	56	10-31-63	7.3	53.0	4.4	0.0	2.7
	56	3-30-64	6.5	35.0	4.2	0.0	2.0
	56	8-19-64	6.8	53.0	3.3	0.0	2.4
	57	11-6-63	4.2	66.0	4.2	0.0	3.0
	57	3-30-64	4.6	74.0	4.6	0.0	4.2
	57	8-19-64	7.7	47.0	3.4	0.0	4.0
	61	11-6-63	9.8	76.6	5.0	0.0	4.2
	61	8-19-64	8.1	77.2	6.1	0.0	1.9
	61	3-30-64	7.7	90.6	2.7	0.0	1.7
IV	22	8-21-63	7.2	70.3	2.4	0.0	2.4
	22	10-28-63	5.9	43.1	3.3	0.0	2.0
	22	8-21-63	8.5	67.3	2.5	0.0	2.0
	22	3-16-64	6.6	59.1	2.7	0.0	2.6
	22	8-18-64	7.0	44.0	0.5	0.0	2.0
	28	8-12-63	3.9	48.2	0.7	0.0	2.8
	28	3-30-64	7.0	47.4	2.2	0.0	2.3
	28	10-28-63	6.8	45.3	1.9	0.0	2.7
	48	8-26-63	7.2	73.2	3.3	0.0	2.9
	48	10-28-63	7.3	49.7	1.6	0.0	2.1
	48	3-24-64	6.4	50.2	2.3	0.0	1.3
	48	8-18-64	8.3	73.2	2.3	2.1	2.6
	52	10-28-63	9.2	83.0	0.0	0.0	3.9
	52	3-24-64	7.4	77.0	3.1	0.0	2.6
	52	8-8-64	8.2	79.0	3.1	0.0	0.0
V	24	8-26-63	4.5	44.4	4.5	0.0	2.5
	24	10-29-63	7.2	77.0	0.3	0.0	3.2
	24	3-23-64	6.0	56.0	2.4	0.0	0.0
	24	8-17-64	10.0	55.0	4.2	0.0	1.8
	50	10-29-63	5.6	54.0	1.0	0.0	2.3
	50	3-23-64	5.0	34.0	1.0	0.0	1.6
	50	8-17-64	5.3	46.0	0.5	0.0	1.0

FIGURE III (Cont'd.)

Summary of Analytical Chemical Data on Raritan Bay

Area #	Station #	Collection Date	Pesticides (PPM) Aldrin	Dieldrin	Lindane	Phenols (Mgms/100 Gms)	Mineral Oil (Mgms/100 Gms)
III	46	10-31-63	-	-	-	61.0	2.3
	46	3-30-64	-	0.05	-	58.0	
	46	8-18-64	-	-	-	78.0	
	56	10-31-63	-	-	-	68.0	
	56	3-30-64	-	-	-	77.0	
	56	8-19-64	-	-	-	85.5	
	57	11-6-63	-	-	-	66.6	1.19
	57	3-30-64	-	-	-	89.0	
	57	8-19-64	-	-	-	64.0	
	61	11-6-63	-	-	-	88.0	8.32
	61	8-19-64	-	-	-	78.5	
	61	3-30-64	-	-	-	65.0	
IV	22	8-21-63(1)	-	-	0.01	92.0	
	22	10-28-63	-	-	0.02	97.0	1.1
	22	8-21-63(2)	-	-	-	70.0	
	22	3-16-64	-	-	-	53.0	0.5
	22	8-18-64	-	0.02	-	52.5	
	28	8-12-63	< .01	-	-	56.6	
	28	3-30-64	-	-	0.04	54.0	
	28	10-28-63	-	-	-	53.5	
	48	8-26-63	-	-	-	66.0	1.7
	48	10-28-63	-	-	-	64.5	
	48	3-24-64	-	-	-	92.0	
	48	8-18-64	-	-	< .01	65.5	
	52	10-28-63	-	0.01	-	74.0	0.7
	52	3-24-64	-	-	-	54.5	
	52	8-18-64	-	0.01	-	38.0	
V	24	8-26-63	< .01	-	-	79.0	3.5
	24	10-29-63	-	-	-	78.0	
	24	3-23-64	-	-	-	75.0	0.9
	24	8-17-64	-	-	0.04	75.5	
	50	10-29-63	-	-	-	72.5	0.1
	50	3-23-64	< .01	-	-	62.5	
	50	8-17-64	-	-	-	61.5	

Mineral Oils

Inasmuch as the method used for the detection of mineral oils requires a considerable amount of sample material, we were necessarily limited as to the number of samples and stations that could be studied within a given area. As a result, in order to obtain sufficient analytical material, it was found necessary to combine samples within certain stations. The results of the mineral oil analyses are shown in Plate 3. The average of all areas was approximately 2 mg./100 grams wet tissue. The greatest concentration was found in Area III with an average of 3.6 and a range of 1.19 to 8.32 mg./100 grams. Area I with the greater number of stations analyzed resulted in a value of 2.8 and a range of .3 to 7.82 mg./100 grams. The average value of Area V is 1.5 with a range of .1 to 3.5 mg./100 grams. The remaining areas (II and IV) gave the lowest values of .67 (range .1 to 1.7) and 1.1 (range .5 to 1.7) respectively. In comparison with the normal range (0 to 4 mg./100 grams) we find that four stations in Area I (40% of total) and one station in Area III (33% of total) exceed this figure. All stations within Areas II, IV and V fail to exceed the normal level for mineral oil content. However, in Areas I (60%), III (66%) and V(33%), we find the median of the normal range exceeded by the percentages indicated within the parentheses. These results may indicate a degree of pollution as concerns mineral oils.

Trace Metals

Chromium

The data for chromium is illustrated in Plates 4 and 5. Here the data are somewhat inconclusive in reference to possible abnormal levels for chromium (Plate 5). In addition, there is no evidence of any significant seasonal variations. (Plate 4). Only two areas (I and II) indicate a questionable elevated chromium level, when compared with the normal range of 0. to .2 mg/100 grams of tissue. Area I and II show average station values of 0.4 and 0.7 mg./100 grams respectively. The possibility of chromium contamination is rather improbable, although 75 percent (six of eight of the stations in Area I show values significantly greater than our normal range. All stations (two of two) in Area II resulted in values somewhat higher than normal. It would appear, however, that chromium is not a significant source of contamination in the areas considered and determined through the analysis of shellfish tissue.

Copper

Plates 6 and 7 summarize the data for copper. Plate 6 again indicates that there are no seasonal variations in copper levels. Plate 7 summarizes the area results for copper. All stations exceed the normal baseline range as determined for copper. The area average for copper is 7 mg./100 grams of tissue with a range of 6.2 to 7.6. The survey values are significantly greater by about 50 percent over the highest levels in our baseline range (Table I). They exceed by 40 percent the average figures for copper in hard clams, as determined by a recently completed NERC trace metal study of the eastern Atlantic Coast. Although the bay copper levels may tend to indicate a degree of pollution, they do not indicate that excessive amounts are present, when compared to certain coastal areas where copper is known to be a definite contaminant.

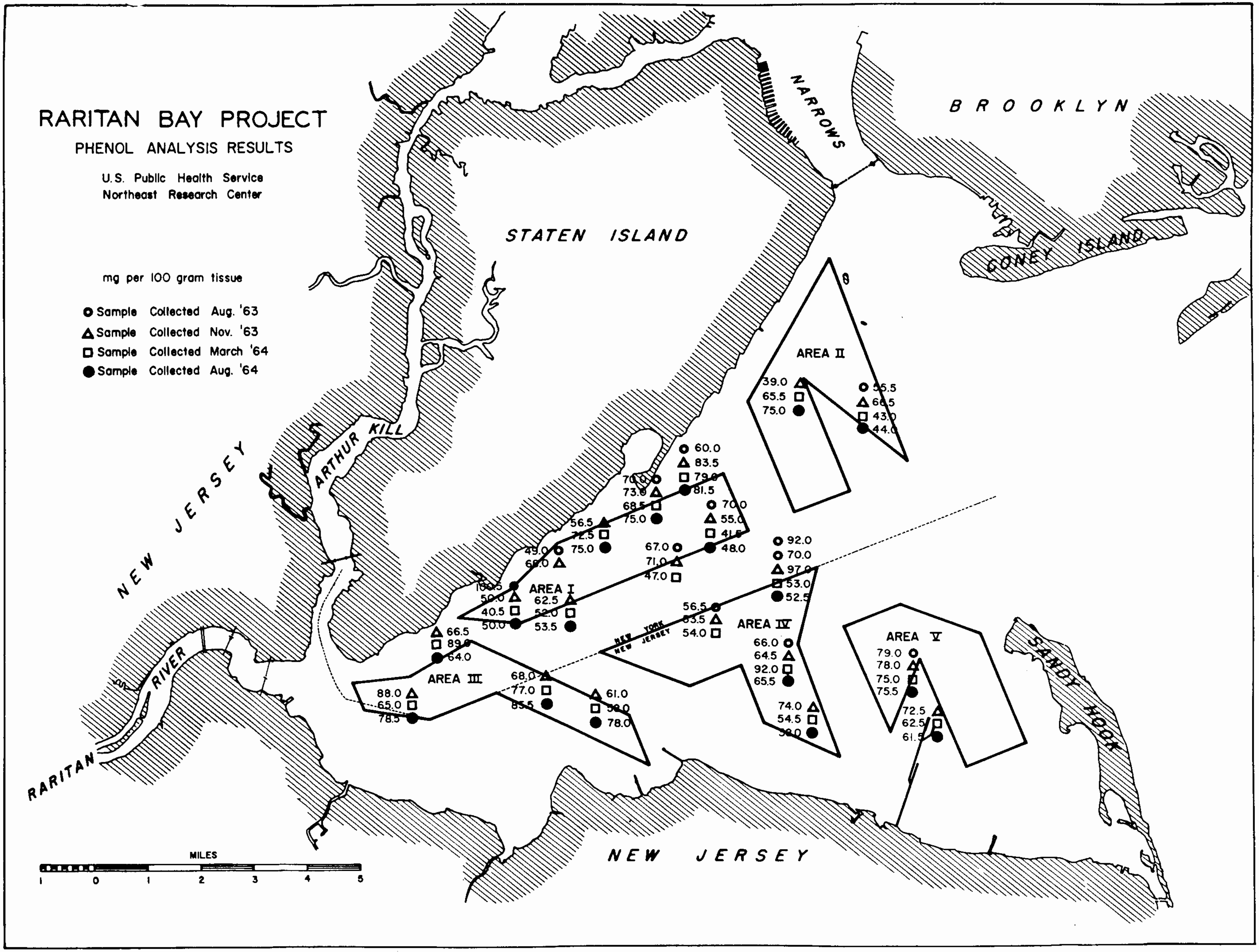

RARITAN BAY PROJECT
PHENOL ANALYSIS RESULTS
U.S. Public Health Service
Northeast Research Center
mg per 100 gram tissue
Sample Collected Aug. '63
Sample Collected Nov. '63
Sample Collected March '64
Sample Collected Aug. '64
STATEN ISLAND
BROOKLYN
NARROWS
CONEY ISLAND
ARTHUR KILL
NEW JERSEY
RARITAN RIVER
SANDY HOOK
AREA I
AREA II
AREA III
AREA IV
AREA V
NEW YORK
NEW JERSEY
MILES
1 0 1 2 3 4 5

PLATE I

PHENOL

MG / 100 GRAM TISSUE

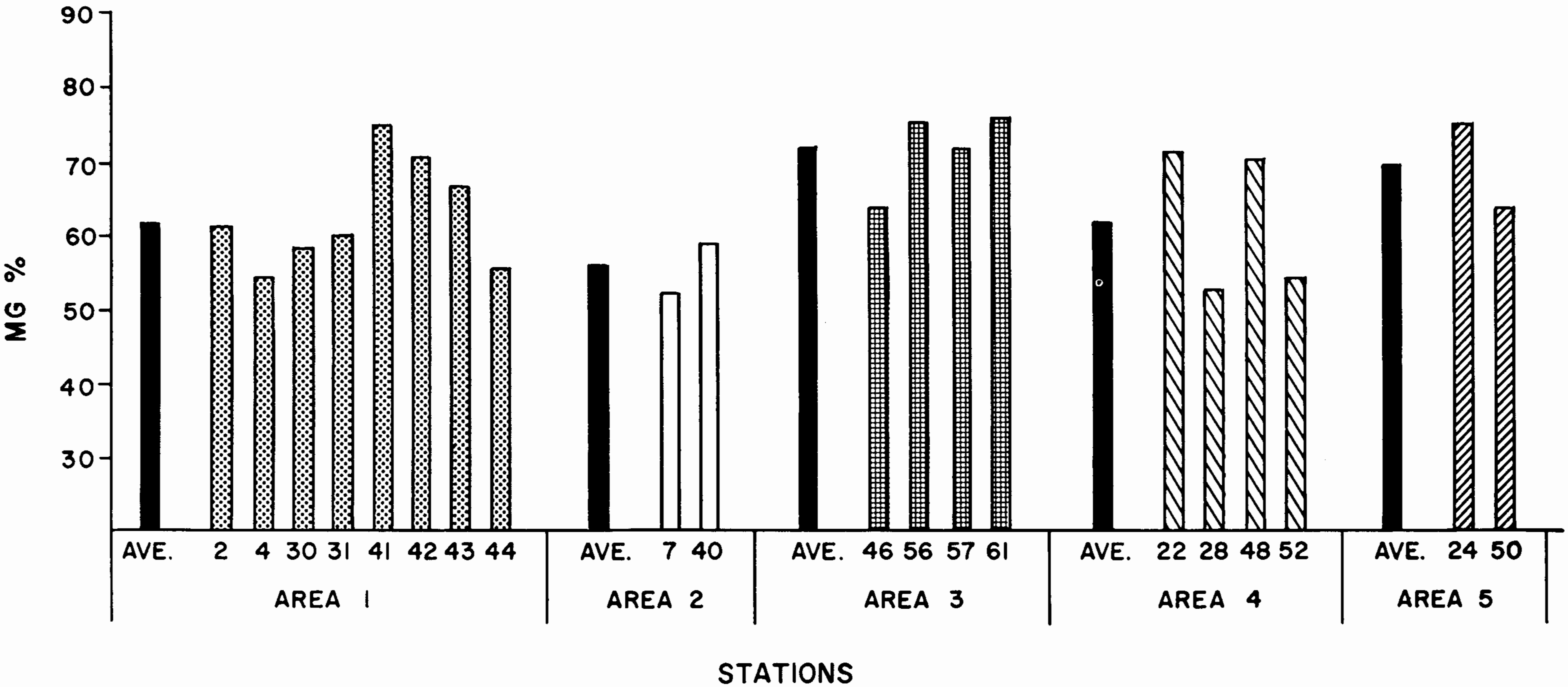


PLATE 2

MINERAL OIL

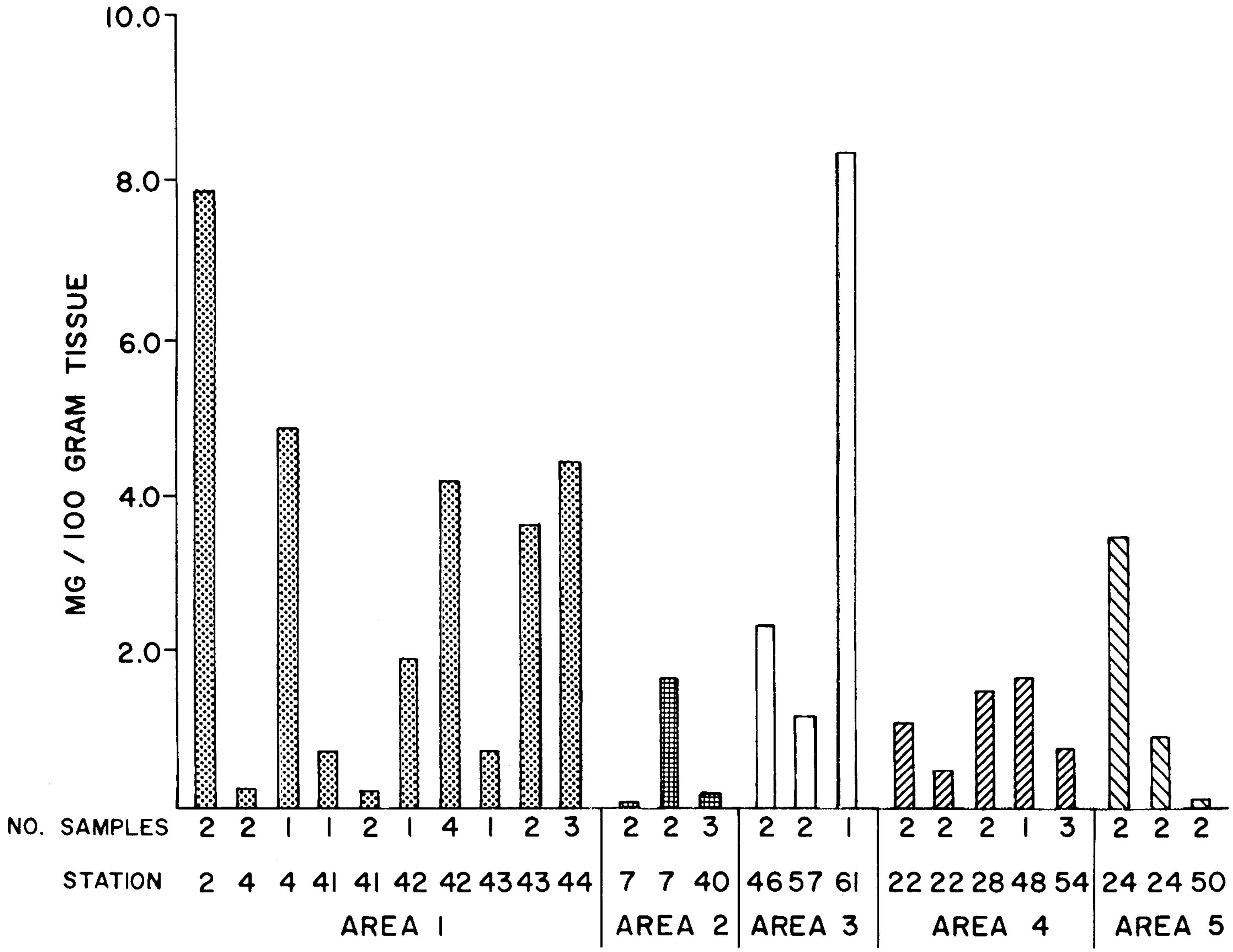
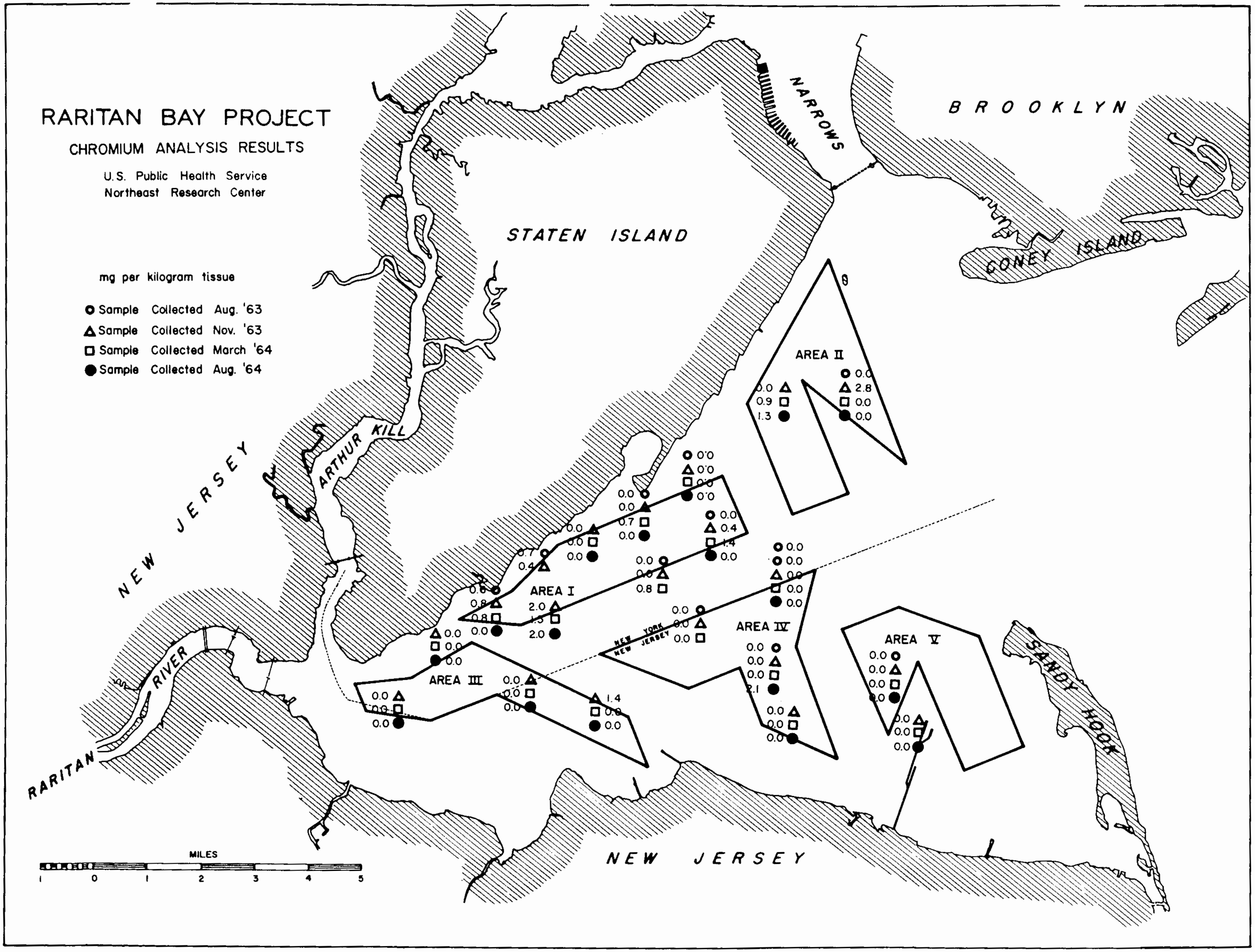


PLATE 3



GPO 956-592

PLATE 4

CHROMIUM

MG / KILOGRAM TISSUE

O - NO CHROMIUM DETECTED

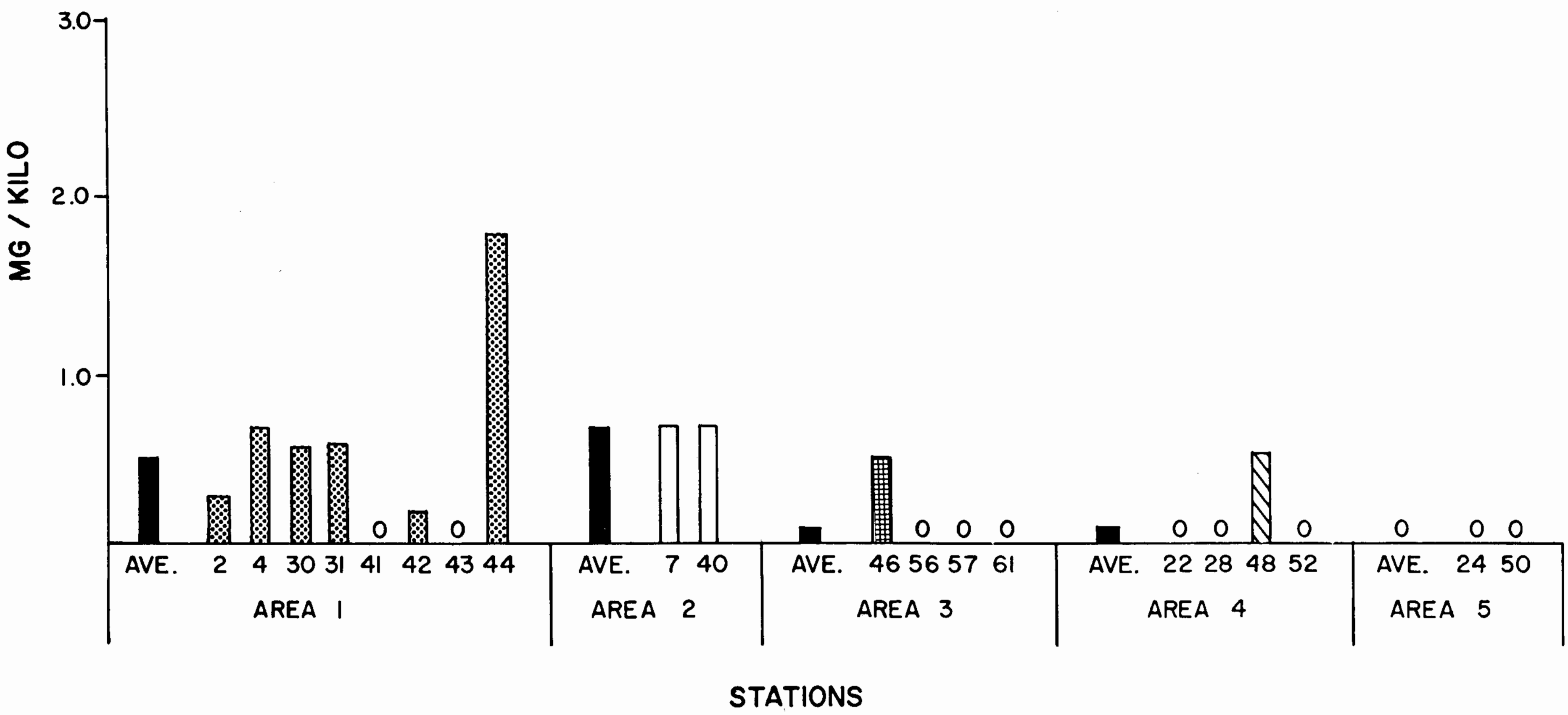
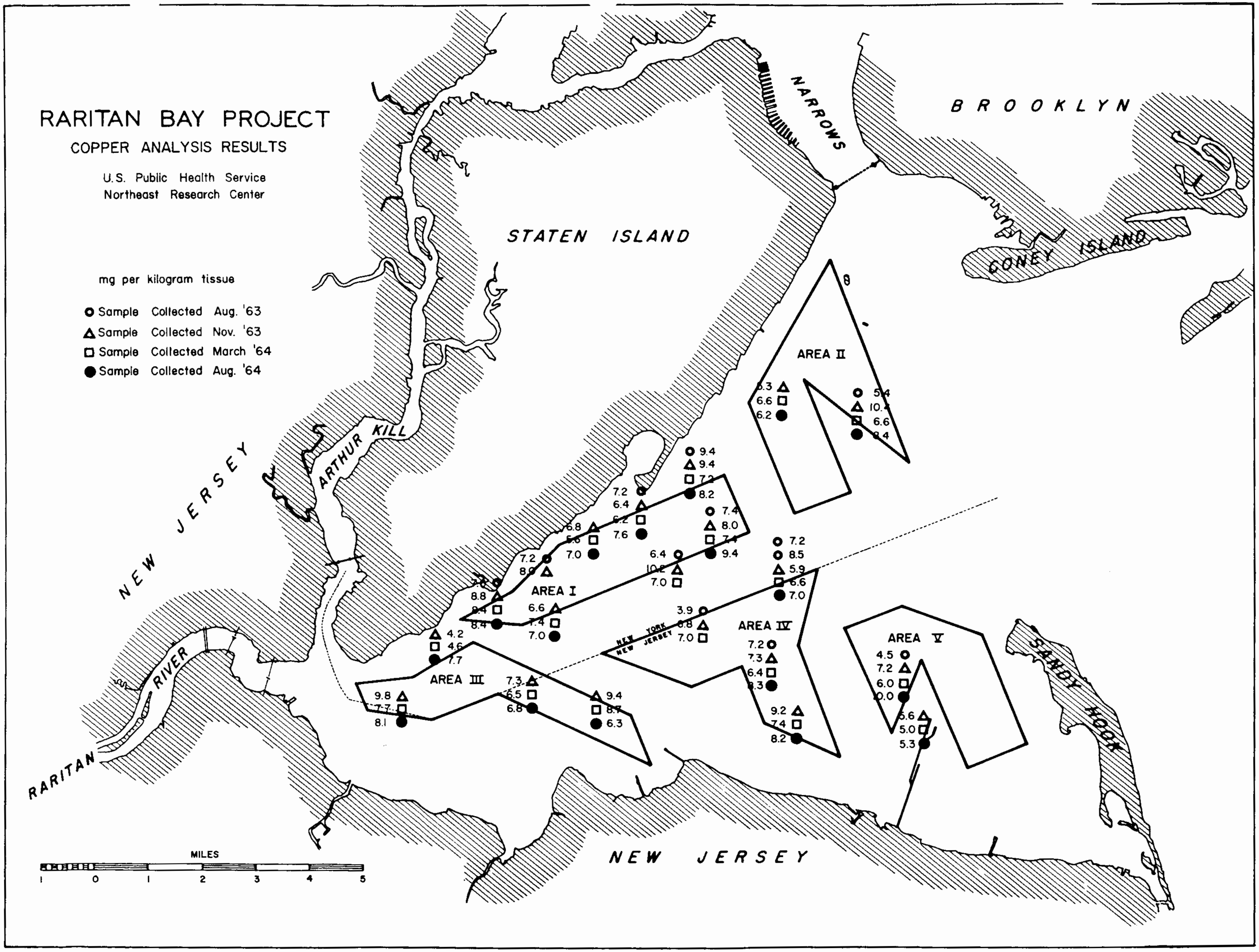


PLATE 5

GPO 956-592



GPO 956-592

PLATE 6

COPPER

MG / KILOGRAM TISSUE

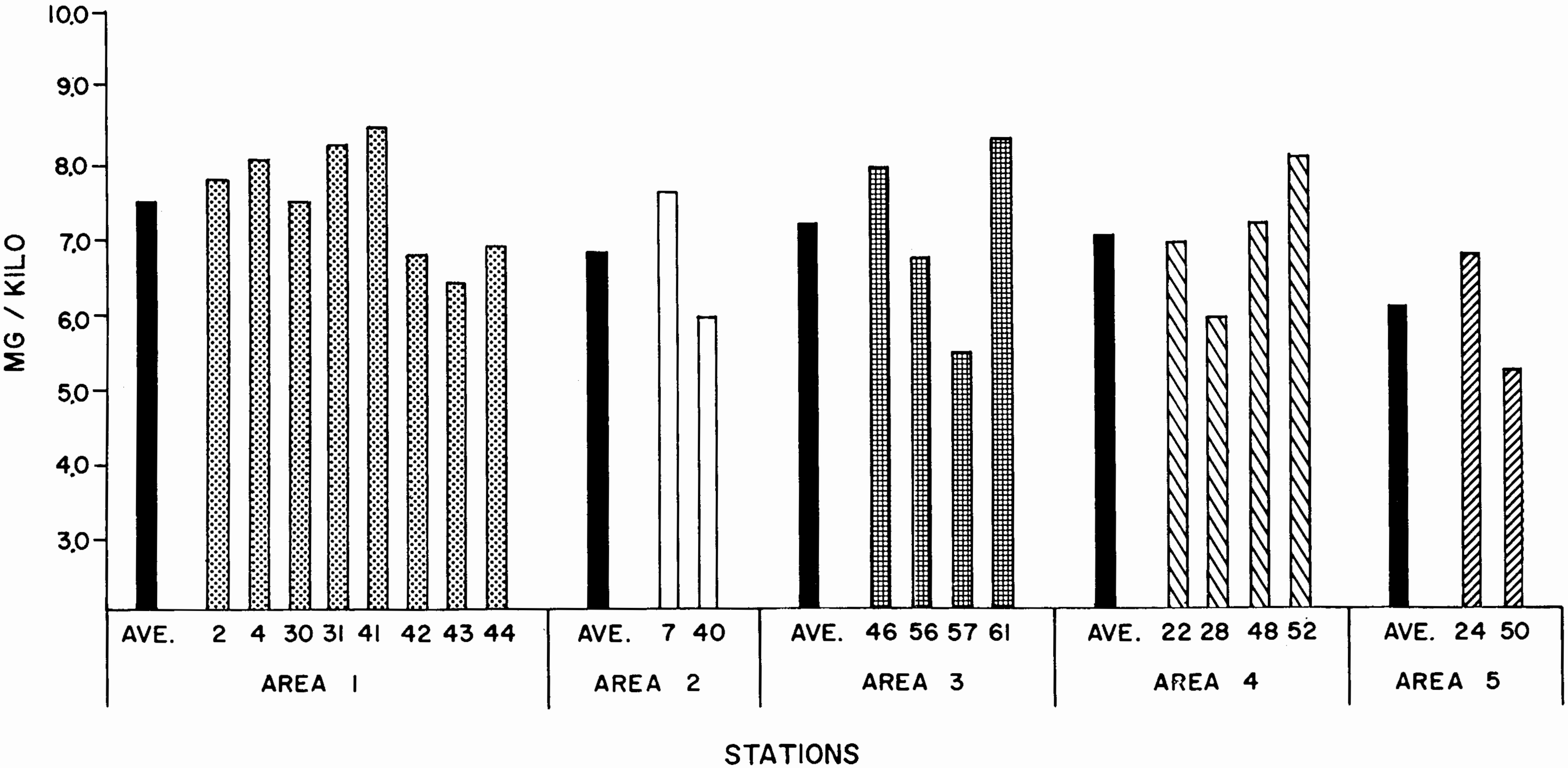


PLATE 7

99m

Paul DeFalco

Lead

Lead values, detected in those sections of the bay studied, proved to be substantially elevated when compared to our normal levels for this particular metal. Plates 8 and 9 summarize the analytical results for lead. In Plate 8 we were unable to observe any cold versus warm weather sample difference. Plate 9 indicates that all stations have lead values exceeding the normal limits by approximately ten times. The area average for lead is 3.2 mg./kilo tissue. The station values range from .8 to 6.2 mg. This is a tenfold elevation when compared to the normal range of 0 to .3 mg. It appears that lead might be considered a pollutant source as regards the area studied. We find that Area V appears here as elsewhere to be the section of least pollution.

Nickel

The results for nickel appear to be about the same as for lead. Every station gave values which were elevated tenfold over normal. The overall average is 2.6 mg./kilo, while the results range from 1.8 to 3.2 mg. The data for nickel are summarized in Plates 10 and 11. Consistent with all our other data, the seasonal levels shown in

Plate 10 again indicate that no warm and cold weather relations appear to exist as regards shellfish tissue for those contaminants studied. Here again, although elevated, we find lower station values for nickel in Area V.

Zinc

Zinc data are illustrated in Plates 12 and 13. As has been the case throughout this study, we have been unable to detect any significant variations between warm and cold weather sampling. This pattern holds for the zinc levels as well and is shown in Plate 12. The station averages indicate values in the upper range of normal, but no significant elevations were noted. Plate 13 indicates that Area averages range from 50.8 to 75.9 mg./kilo tissue. The overall area average is approximately 61 mg., which is at the uppermost limits of our normal range of values (40-60 mg./kilo) shown in Table I. Therefore, it appears that zinc levels as found in shellfish tissue do not appear to be a significant contaminant within the bay areas studied.

Pesticides

In the cooperative experimental design of this study, it was decided that the three pesticides proposed to be studied would probably be most indicative for this particular area as regards such a group of organic contaminants. The compounds selected were Aldrin, Dieldrin and Lindane, which are exceptionally persistent in the environment in which released, because of their chemical structure (chlorinated hydrocarbons). The pesticide data are illustrated in Plate 14. All Area I stations were positive for at least one of the three pesticides studied, although no station gave values greater than .01 ppm. All samples in this area were positive for all of the eight stations analyzed. Twenty of a total of twenty-seven samples were positive for one of the three pesticides surveyed. Ten samples out of thirty resulted in values of .02 to .05 ppm for these same three pesticides in Areas II through V. The remaining positive samples in these four areas were of levels of less than .01 ppm. Out of a total of 68 samples 33 proved to be positive for one of these particular compounds. It appears that these materials are finding their way into the bay areas studied and are being picked up with probable concentration by shellfish within this environment.

Summary

1. Sixty-nine representative shellfish samples

out of some four hundred collected were studied to ascertain the possible presence of certain trace metals, and organic materials (phenols, mineral oils, and pesticides), which had been agreed upon as possibly being indicative of contaminant sources within the areas of the Raritan Bay being studied.

2. These sixty-nine samples from twenty stations within the five areas were selected on the basis of shellfish source and currents.

3. The phenol values within the areas studied appear to be significantly elevated when compared with the normal values.

4. The results of mineral oils analyses may possibly indicate some degree of pollution.

5. The copper levels, although somewhat elevated compared with the normal baseline values, do not appear to indicate any gross contamination.

6. Lead appears to be a possible contaminant source in all areas studied. The values are approximately tenfold higher than normal.

7. The nickel levels run almost parallel with lead as a contaminant source, inasmuch as values for this particular metal were also found to be at least ten times those of the normal baseline results.

8. Zinc, with values falling within the upper level of the normal range, does not appear elevated and probably does not represent a contaminant source for shellfish in these areas.

9. Chromium results in general are not indicative of a contaminant source role for this particular metal within any of the five areas studied. Levels were found to be within the normal range with the exception of Areas I and II. In these particular areas, the levels did not approach values to lend any credence to chromium being a possible pollutant.

10. The fact that at least one of the three pesticides under study was detected in every area, does indicate the possibility that these materials may be contributing to pollution within the areas studied.

11. Analytical results within Area V indicate that there probably is less contamination here than in the remaining sections surveyed.

12. All other sections vary as to the degree of contamination, while Areas I and II indicate pollution of greater significance for those materials studied.

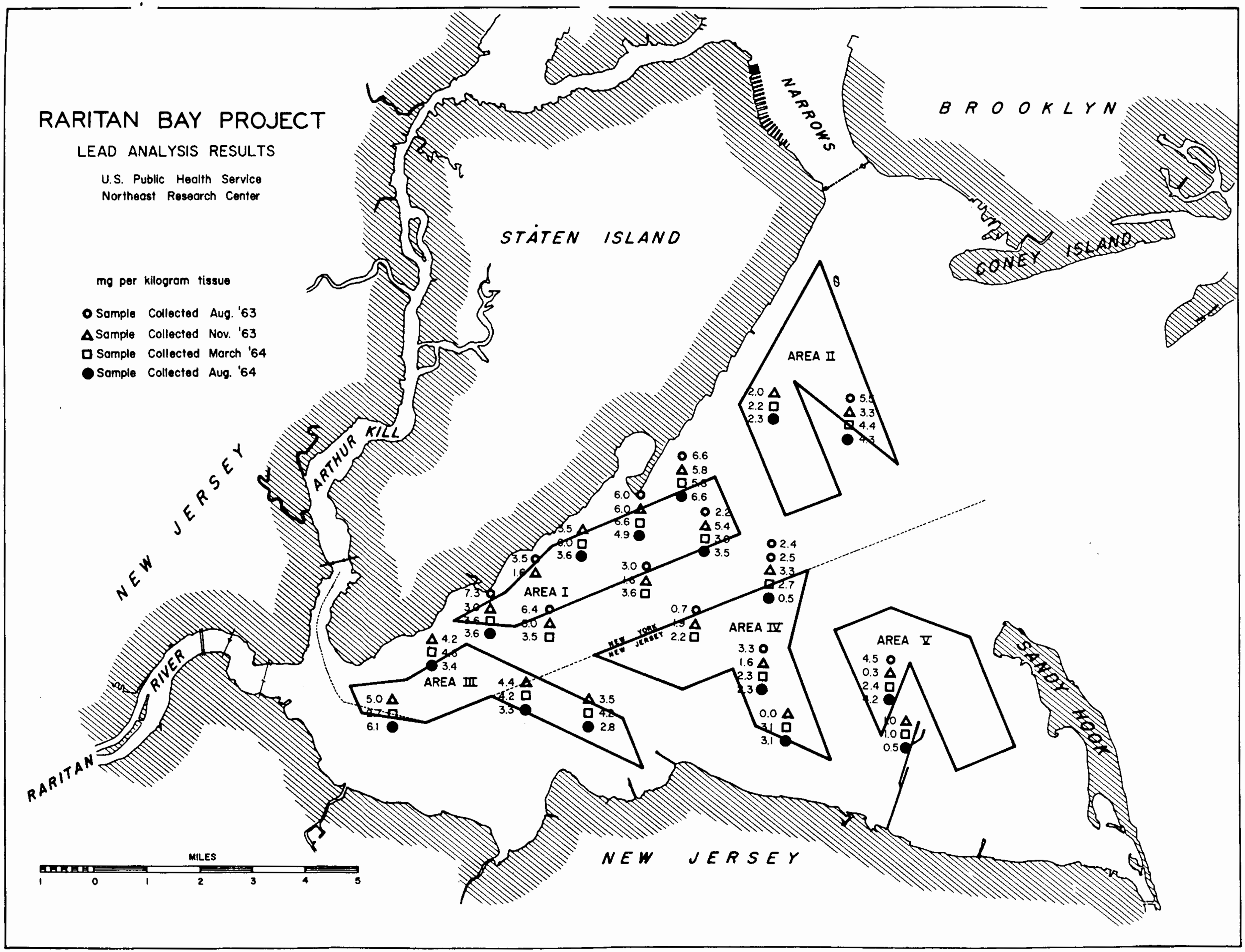

RARITAN BAY PROJECT
LEAD ANALYSIS RESULTS
U.S. Public Health Service
Northeast Research Center
mg per kilogram tissue
Sample Collected Aug. '63
Sample Collected Nov. '63
Sample Collected March '64
Sample Collected Aug. '64
STATEN ISLAND
NARROWS
BROOKLYN
CONEY ISLAND
ARTHUR KILL
NEW JERSEY
RARITAN RIVER
AREA I
AREA II
AREA III
AREA IV
AREA V
NEW YORK
NEW JERSEY
SANDY HOOK
NEW JERSEY
MILES
1 0 1 2 3 4 5

PLATE 8

LEAD

MG / KILOGRAM TISSUE

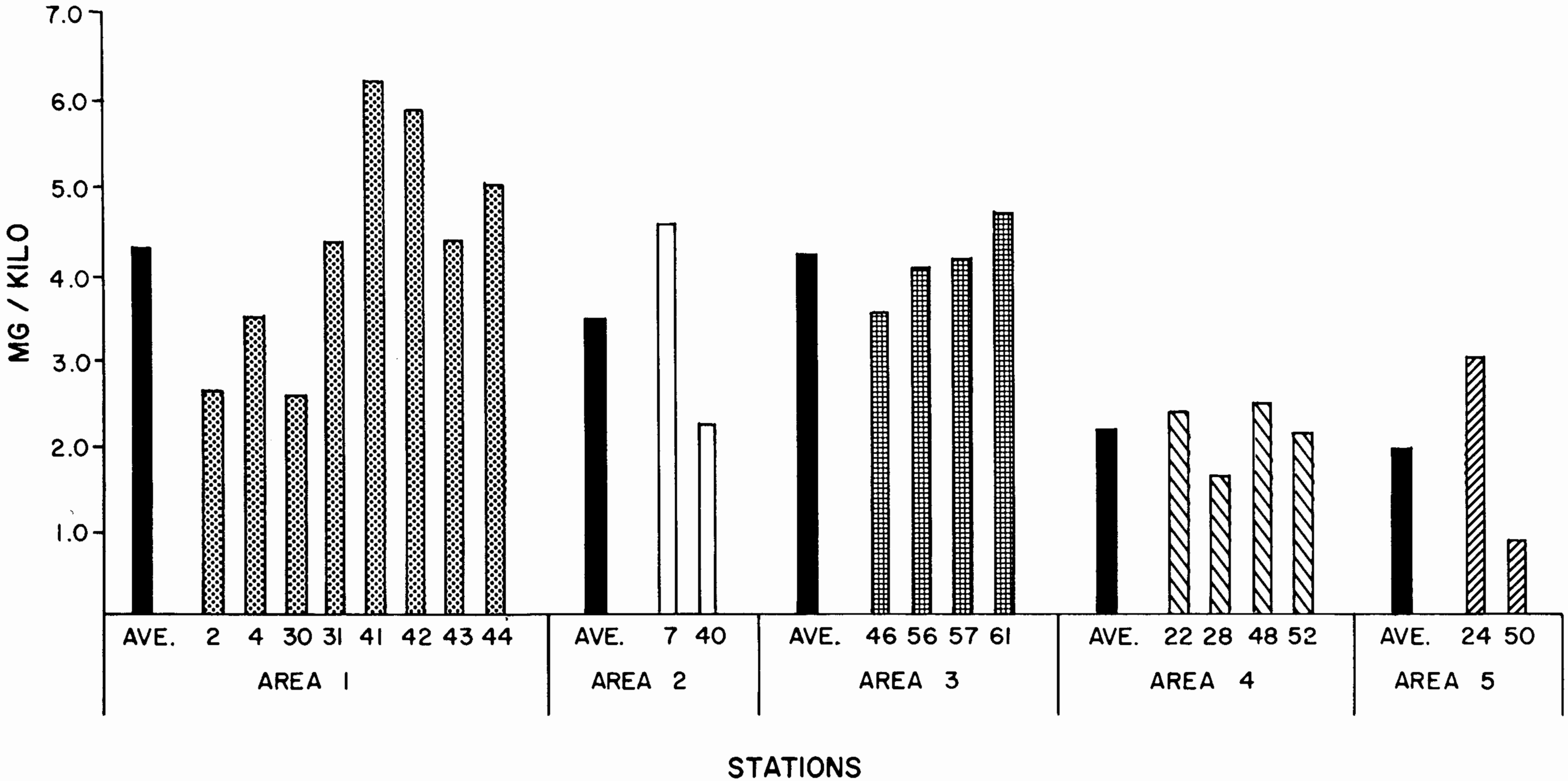


PLATE 9

GPO 956-592

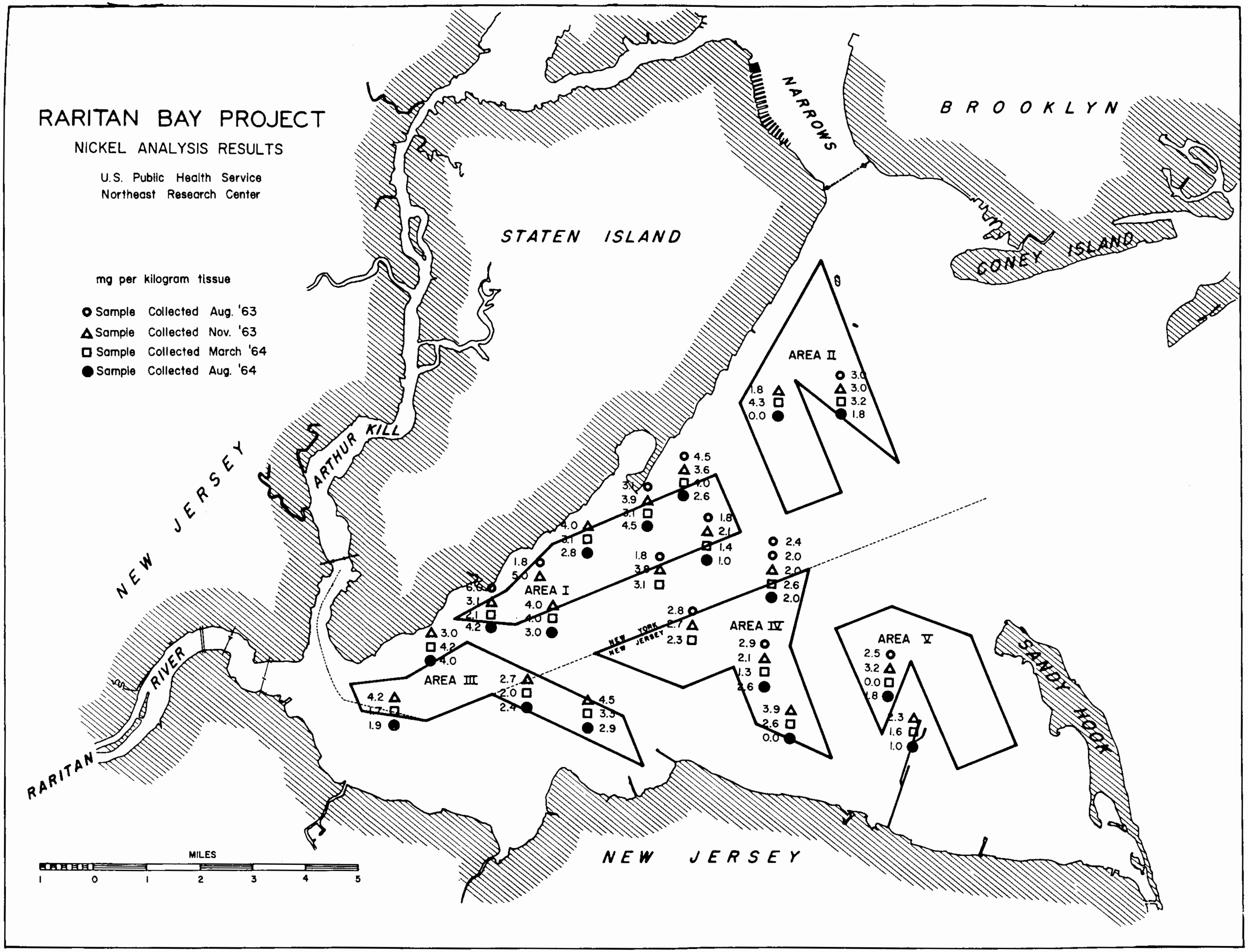

RARITAN BAY PROJECT
NICKEL ANALYSIS RESULTS
U.S. Public Health Service
Northeast Research Center
mg per kilogram tissue
Sample Collected Aug. '63
Sample Collected Nov. '63
Sample Collected March '64
Sample Collected Aug. '64
STATEN ISLAND
BROOKLYN
NARROWS
CONEY ISLAND
ARTHUR KILL
NEW JERSEY
RARITAN RIVER
AREA I
AREA II
AREA III
AREA IV
AREA V
SANDY HOOK
NEW YORK
NEW JERSEY
MILES
1 0 1 2 3 4 5

PLATE 10

NICKEL

MG / KILOGRAM TISSUE

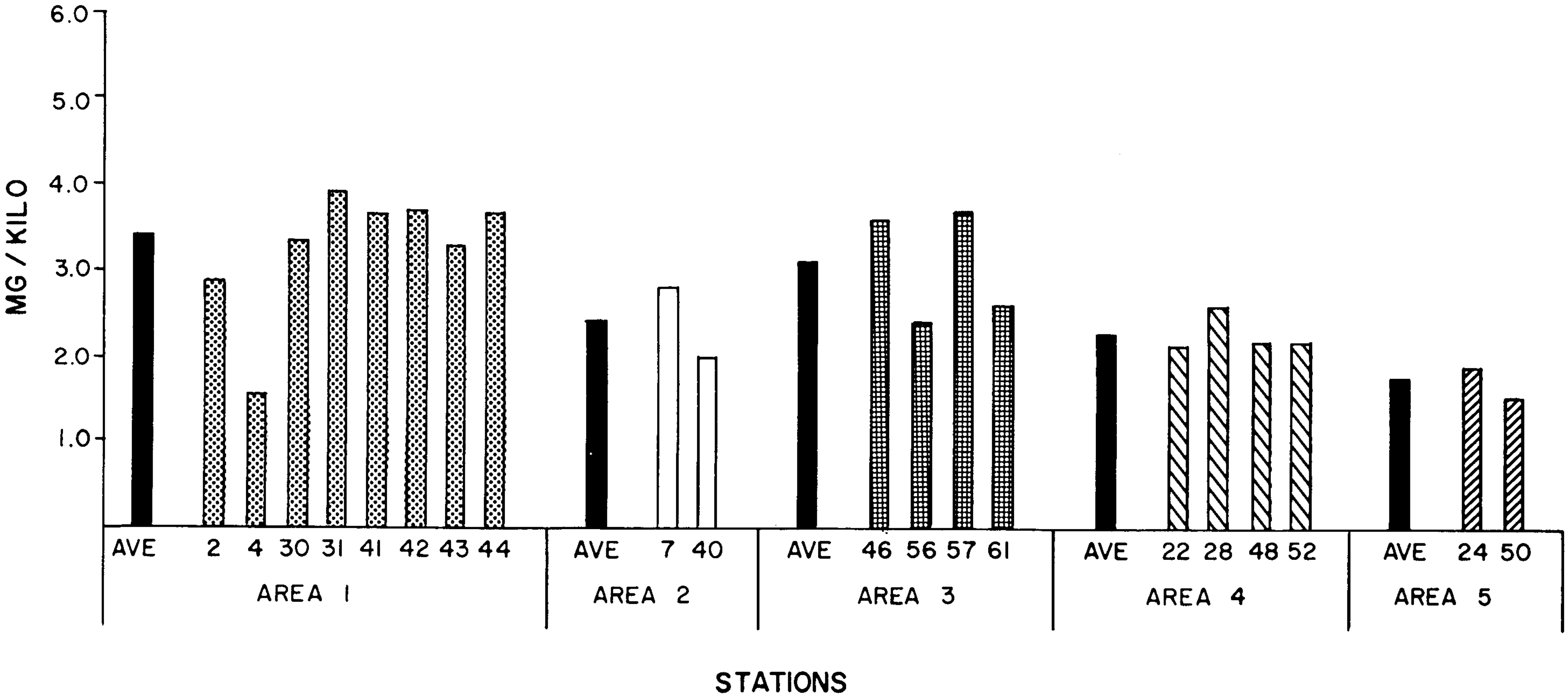
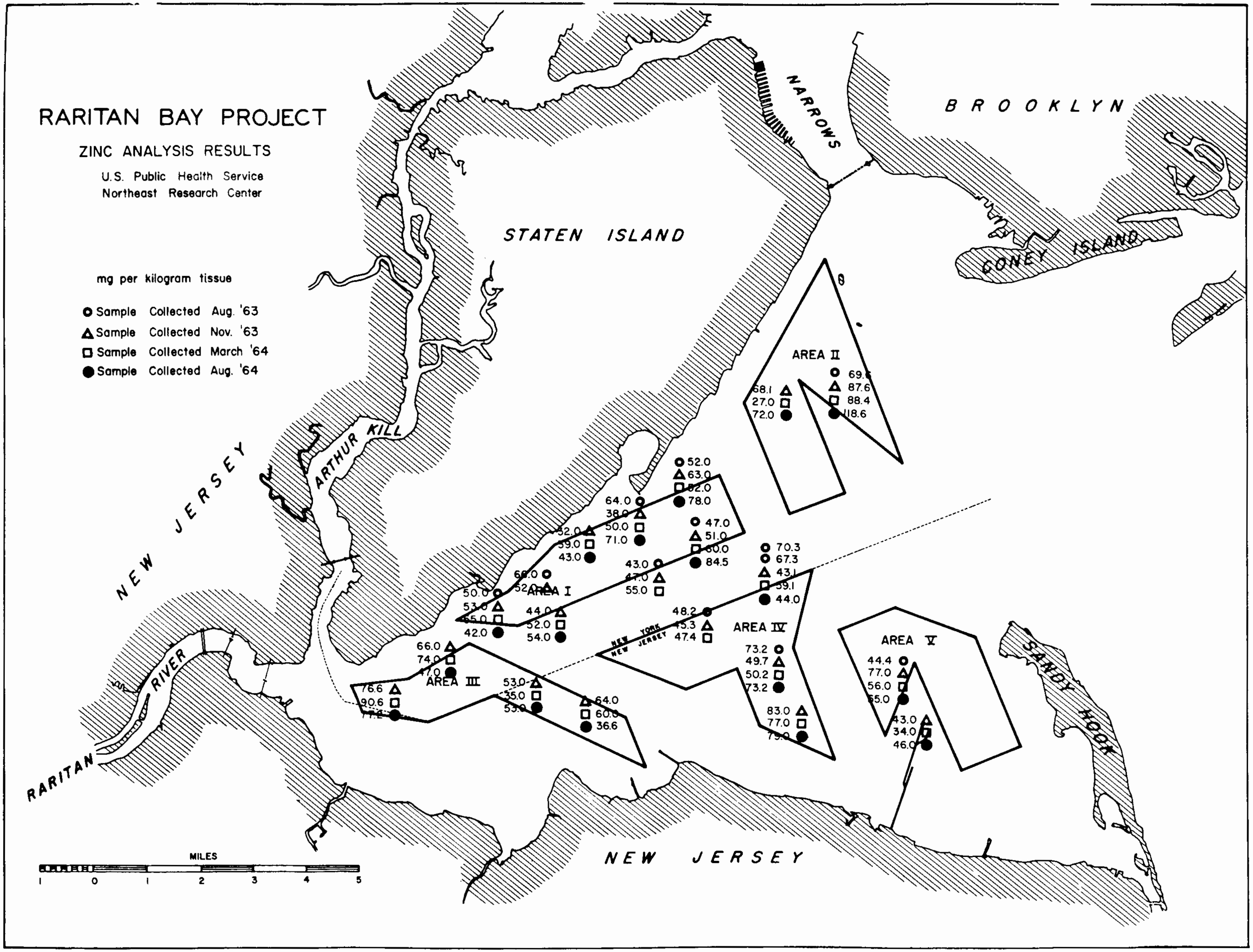


PLATE II

GPO 956-592


RARITAN BAY PROJECT
ZINC ANALYSIS RESULTS
U.S. Public Health Service
Northeast Research Center
mg per kilogram tissue
Sample Collected Aug. '63
Sample Collected Nov. '63
Sample Collected March '64
Sample Collected Aug. '64
STATEN ISLAND
NARROWS
BROOKLYN
CONEY ISLAND
ARTHUR KILL
NEW JERSEY
RARITAN RIVER
SANDY HOOK
NEW JERSEY
NEW YORK
NEW JERSEY
AREA I
AREA II
AREA III
AREA IV
AREA V
69.6
87.6
88.4
118.6
68.1
27.0
72.0
52.0
63.0
52.0
78.0
64.0
38.0
50.0
71.0
47.0
51.0
60.0
84.5
52.0
59.0
43.0
43.0
47.0
55.0
66.0
52.0
50.0
53.0
55.0
42.0
44.0
52.0
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70.3
67.3
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48.2
45.3
47.4
73.2
49.7
50.2
73.2
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76.6
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53.0
35.0
53.0
64.0
60.0
36.6
44.4
77.0
56.0
55.0
43.0
34.0
46.0
MILES
1 0 1 2 3 4 5

PLATE 12

ZINC

MG / KILOGRAM TISSUE

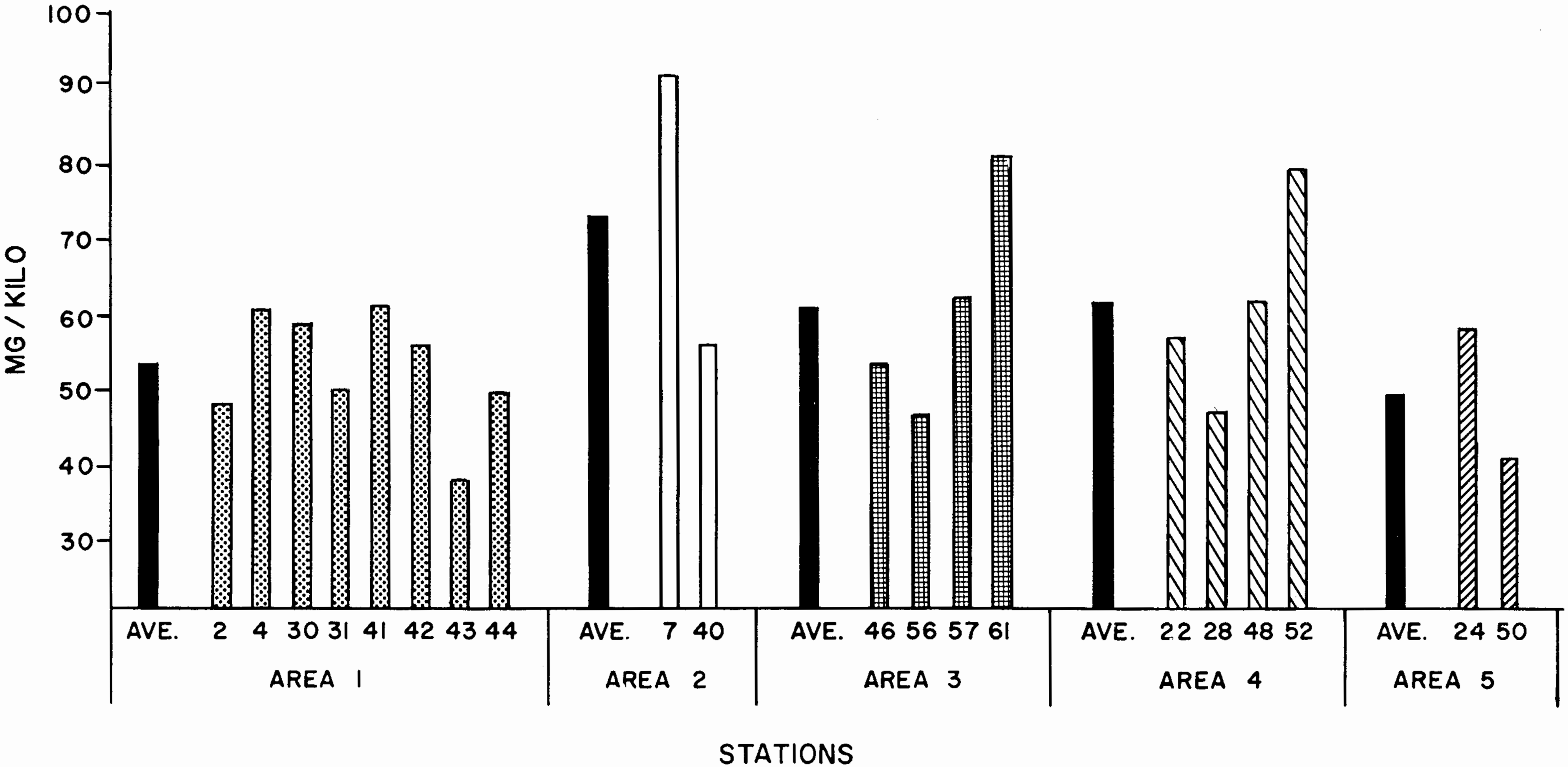
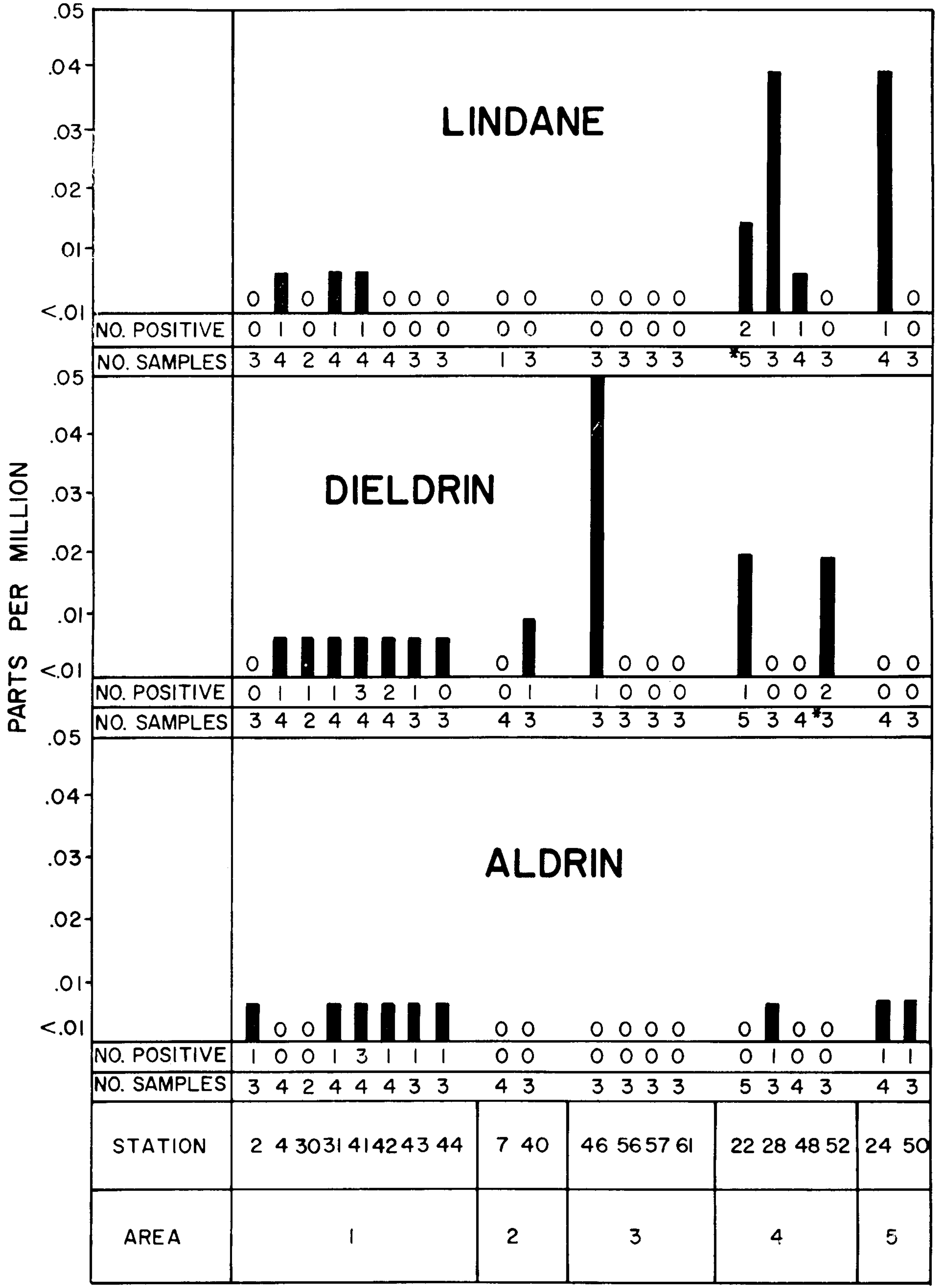


PLATE 13



O - NO PESTICIDES DETECTED

* - AVERAGE OF 2 RESULTS

PLATE 14

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Paul DeFalco

MR. DE FALCO: That, gentlemen, is the complete report of the Project.

fols. Vol. III of report

MR. STEIN: Thank you.

Are there any comments or questions from the conferees?

Mr. Glenn?

MR. GLENN: No.

MR. STEIN: Dr. Kandle?

DR. KANDLE: No.

MR. STEIN: Mr. Hennigan?

MR. HENNIGAN: No.

MR. STEIN: Mr. Klashman?

MR. KLASHMAN: I have none.

MR. STEIN: I would like to say, at least speaking for myself, that I think the report you gentlemen have completed is one of the most comprehensive, thorough and direct that I have seen in my years in this business. As most of you know, that has been a considerable number of years.

As a matter of fact, this might explain some of the activities you will see later. Most of the people we have on the panel, in dealing with this, are old colleagues who have known each other for the better part of a quarter of a century, and have worked together for a long time.

With this report that we have heard, we have a clear statement of the problem and, as I sense, without questions on the details from the conferees we will be prepared to move forward.

At this point I would like to, as I always like to do, give you the best prognosis that I can make of the conference. After a recess for lunch, we will hear from the other Federal agencies. Then New Jersey and its invitees will make presentations; the Interstate Sanitation Commission will come next; and New York will follow that.

If we have any of the congressional delegations, they will be here tomorrow morning. We will make an announcement on that later.

Checking with the local experts, the New York situation being what it is, I understand the most rapid time we can adjourn for a reasonable lunch hour is an hour and a half, and so we will stand recessed until one-thirty.

Thank you.

(Whereupon, at twelve o'clock noon a luncheon recess was taken.)

AFTERNOON SESSION

(1:30 p.m.)

MR. STEIN: May we reconvene?

Mr. Klashman?

MR. KLASHMAN: I would like now to call on the Federal agencies who have indicated they wish to make statements.

The first will be Mr. Mark Abelson, who is my colleague in Boston. He is the Regional Coordinator for the United States Department of the Interior in Boston, representing this region.

STATEMENT OF MARK ABELSON, REGIONAL COORDINATOR, UNITED STATES DEPARTMENT OF THE INTERIOR, BOSTON, MASSACHUSETTS

MR. ABELSON: Chairman Stein, Conferees, Ladies and Gentlemen:

I am Mark Abelson, Regional Coordinator for the Northeast Region, United States Department of the Interior.

The Department of the Interior is the Nation's primary agency charged with the responsibility for a wide variety of programs for the management, conservation and development of the natural resources benefiting every section of the Nation. For this reason Interior can best be described as the "Department of Natural Resources."

The Department is made up of some two dozen bureaus and offices, whose functions and responsibilities cover the entire range of natural and human resources. In the Northeast, coordination of these functions and responsibilities is accomplished through my office in Boston.

In carrying out our vital responsibilities for sound management of natural resources, the Department encourages efficient resources use; works to assure that a sound resource base is provided to meet the needs of our expanding economy and our natural security; promotes an equitable distribution of benefits from nationally owned resources; and seeks to prevent wasteful exploitation of resources.

The Department has a definite interest in all waters of the country and in the entire pollution problem.

Water, and its associated opportunities and problems, ignores State, regional and international boundaries. It is necessary that these interrelationships of water be so recognized, and that the efforts of all concerned plan for the best use of this valuable resource.

The focus of Interior's efforts is directed to the maintenance of adequate water supplies and adequate water quality, for whatever uses man may wish to make of this resource. The Department's approach emphasizes the coordination and interrelation between uses and the effect of these uses on management and the quality of the total water supply system. We hope we can keep the country as an affluent, not as an effluent, society.

Maintenance of water quality involves not only the quality levels for human consumption, but also quality levels for consumption by other animal and plant life, for development of other natural resources, and for industrial processes. These quality considerations are interrelated. They can be understood and controlled best from the point of view of water as a resource, rather than of a particular quality need.

Interior Bureaus, in addition to the Water Pollution Control Administration, carry on water quality studies related to the physical, chemical and biological adequacy of our water resources. These studies and the associated research are chiefly those in which the skills and required knowledge are based on geology, chemistry, hydrology, engineering and other physical science aspects of water management. Interior's water quality research extends beyond water supply to the study of environments adequate for the propagation, production and control of both fish and wildlife resources, and for water-based recreation.

In conclusion, I would like to say that we urge that steps be taken to eliminate from Raritan Bay and adjacent interstate waters those domestic and industrial pollutants which detract from the full public enjoyment of the aquatic resources of these areas.

Mr. Richard Griffith, who is at present the Regional Director of the Bureau of Sport Fisheries and Wildlife, will present a statement on the interests of that and the sister Bureau of the Department -- the Bureau of Commercial Fisheries.

Thank you.

MR. STEIN: Thank you.

Are there any comments or questions?

(No response.)

MR. STEIN: If not, thank you very much.

MR. KLASHMAN: Mr. Griffith is the Northeastern Regional Director of the Bureau of Sports Fisheries and Wildlife, another colleague from the Department of the Interior, also located in Boston.

STATEMENT OF RICHARD E. GRIFFITH, NORTH-EASTERN REGIONAL DIRECTOR OF BUREAU OF SPORTS FISHERIES AND WILDLIFE, DEPARTMENT OF THE INTERIOR, BOSTON, MASSACHUSETTS

MR. GRIFFITH: Chairman Stein, Conferees, Ladies and Gentlemen:

I am Richard Griffith, Northeastern Regional Director, Bureau of Sports Fisheries and Wildlife, Boston.

In 1964 the U. S. Fish and Wildlife Service prepared a report on the fish and wildlife resources of the Raritan, Lower New York, and Sandy Hook Bays. I would like to call your attention to some of the highlights of that report at this time, even though the report itself will be made a part of the record of this hearing.

The Service is vitally interested in reducing pollution in Raritan Bay and we feel that major benefits would result if the quality of these waters were at the level necessary to support a safe shellfishery.

The commercial shellfish resources presently consist of hard clams, soft clams, and blue crabs. The history of the shellfish resources in the Raritan Bay area indicates that the harvest reached a peak in the late

1800's and maintained that level until about 1945, when it began a gradual decline. Oyster production was once a major activity in this area. At present, due to destruction of seed beds, increased salinity due to channel dredging, and increased pollution load, the oyster has disappeared.

Of the shellfish, hard clams are the most important commercial species. About 50 percent of the Project area is commercial hard clam habitat. Due to present pollution conditions, only a portion of Sandy Hook Bay is open to commercial clamming. The commercial fishery for hard clams in the Raritan Bay area is one of steadily decreased harvests as pollution increased. In recent years, the limited area open to clamming in Sandy Hook Bay provides an annual harvest of about $40,000.

It is estimated that there is a total population amounting to 3,444,000 bushels in the New York section and 1,393,000 bushels in New Jersey. Under optimum water quality conditions for this resource, the potential harvest would be about 550,000 bushels annually, with a value of about $3,850,000.

At one time, soft clams were taken commercially along the New Jersey coast from Conaskonk Point to the northern tip of Sandy Hook. In New York the production area included the entire south shore of Staten Island.

The history of the soft clam follows that of the hard clam in that deteriorating habitat conditions resulted in a decline of the fishery. The latest commercial harvest data reveal that in 1948 about 175,000 bushels of soft clams valued at over $600,000 were taken. At the present time, there is no significant commercial harvest. Under optimum conditions the soft clam beds can produce a sustained average annual yield of 300 bushels per acre of habitat. It is estimated that about 40,000 acres are soft clam habitat of commercial quality. This indicates a potential commercial value of about $18,000,000 annually. It should be noted that to realize this potential, the soft clam product would have to meet the Federal and State requirements of quality.

The commercial crab fishery is largely a winter dredge fishery. During spring, summer and fall, the crab population spreads out to the shallow waters. During the period November to March the crabs concentrate in the deeper waters and hibernate in the muddy bottom. At this time they are taken by dredge boats. The commercial blue crab fishery is subject to violent fluctuations throughout its range. While there is no specific data for blue crab harvests in the early days of the fishery in the project area, data covering adjacent areas indicate that the blue crab harvests are continuing these fluctuations.

The commercial finfishery exhibits the same history in the Raritan Bay area as the commercial shellfishery. Peak catches, with an estimated value of $2,000,000, were reported around the turn of the century and, on the average, have declined to the present time. The present commercial finfish harvest is estimated to be about $200,000. This includes those fish actually taken in the project area and those caught outside the project area, but which are dependent on the inshore bays for part of their life cycle. Under optimum conditions of water quality and assuming that such things as overfishing and physical destruction of habitat will not occur, it is estimated that the potential commercial finfishery would approximate $400,000 in annual value.

In addition to the major benefits to commercial finfishing and shellfishing that would result from optimum water quality conditions, a very substantial increase in the value of the area for marine sport fishing and recreational shellfishing would result.

The Raritan Bay is important to waterfowl as a resting and feeding area during migration periods. Improvement in water quality conditions would improve waterfowl habitat by increasing the food supply in the form of small fish and shellfish.

About 1,000 acres of salt marsh border the bay and are extremely important for fish and wildlife. Except for the wetlands in Cheesequake State Park, this acreage is under constant threat of development. Present hunting use of the waterfowl resource is limited. It is estimated that about 1,000 man-days, worth approximately $3,000, constitute the present waterfowl hunting value.

In summary, the Raritan Bay area was once a leading producer of commercial finfish and shellfish. Human activity in the interests of residential and industrial development, navigation, beach erosion control, hurricane protection, and mosquito control have destroyed or altered adversely a considerable reach of the shoreline and the adjacent bay waters. The effects of these activities cannot be overcome to the point of fully restoring conditions favorable to finfish and shellfish. There is, however, a problem which can be corrected and that is pollution. The increase in the pollution load in the waters of this area has had very damaging effects on the finfish and shellfish populations.

In the interest of meeting future needs for food supplies and recreational opportunities, the United

States Fish and Wildlife Service urges that steps be taken to cure the unfavorable conditions which now prevail in Raritan Bay and adjacent interstate waters.

Thank you.

MR. STEIN: Thank you, Mr. Griffith, for a very excellent statement.

Are there any comments or questions?

(No response.)

MR. STEIN: Let me ask you one question.

You say the oysters disappeared completely and clams only account for 50 percent of the harvest. What accounts for the rest?

MR. GRIFFITH: The clams account for 50 percent of the fishery resource harvest in this area.

MR. STEIN: That includes finfish?

MR. GRIFFITH: The remainder constitutes the finfish, both commercially important species and those which are important as game species.

MR. STEIN: What do you estimate that you can increase your clams to?

MR. GRIFFITH: I quoted a figure of an annual potential yield of about $3,850,000.

MR. STEIN: How much of an increase is that over the existing yield?

MR. GRIFFITH: The existing yield at the present time, based upon information available, is valued at about $40,000, so this represents an almost fantastic increase.

MR. STEIN: Let me ask another question: Do you think we can ever restore the oysters in this area?

MR. GRIFFITH: There are two experts on that question in the audience, and I am sure Mrs. Wallace or Mr. Wallace will comment on this later.

DR. KANDLE: All it needs is that the people disappear.

MR. STEIN: Let's hear from Mrs. Wallace. She may be able to tell you, Doctor, how we can have both people and oysters. It is possible. We had a walrus and the carpenter. (Laughter.)

This seems to me rather significant. In any area where you have, even at these depleted conditions, 50 percent of the value of the fishery in shellfish as compared to finfish--and you have heard the almost astronomical increase projected by Mr. Griffith and we will hear about the oysters later--this is, as far as I can see, a rather significant fact.

MR. GRIFFITH: With your permission, I would

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like to make an additional comment.

MR. STEIN: Yes.

MR. GRIFFITH: This relates to the offshore fisheries, commercially as well as recreationally.

It is estimated that the recreational fishery for the mid-Atlantic coast has an annual value of about $25 million. This figure represents the annual expenditures of the many people for the equipment and services to pursue their sport.

This $25 million sport fishery, not to mention the commercial fishery, is dependent in very large part on a series of small estuary areas, a series of bays, such as Raritan Bay, to provide the nursery grounds for the fishes themselves, as well as some of the organisms upon which they are dependent.

I cannot overemphasize the extreme importance of every area along the metropolitan coast, such as Raritan Bay. It is my sincere hope that in the interest of the total fishery resource represented in this area, that there is progressive action towards producing a solution to the problem.

MR. STEIN: Thank you.

Are there any further comments or questions?

(No response.)

MR. STEIN: If not, thank you very much.

Mr. Klashman?

MR. KLASHMAN: The next Federal representative I wish to call is Mr. Ralph Van Derwerker, United States Public Health Service, Department of Health, Education, and Welfare.

MR. STEIN: You know Mr. Van Derwerker and I worked together so long ago, I'm not sure that the Raritan wasn't clean that far back.

(Laughter.)

STATEMENT OF RALPH VAN DERWERKER, REGIONAL REPRESENTATIVE OF THE NATIONAL CENTER FOR URBAN AND INDUSTRIAL HEALTH AND REGIONAL PROGRAM CHIEF OF THE WATER SUPPLY AND SEA RESOURCES PROGRAM OF THE PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

MR. VAN DERWERKER: Chairman Stein, Conferees, Ladies and Gentlemen:

My name is Ralph Van Derwerker. I am Regional Representative of the National Center for Urban and Industrial Health and the Regional Program Chief of the Water Supply and Sea Resources Program of the Public Health Service, Department of Health, Education, and Welfare.

I would like to compliment Mr. DeFalco and his staff for the really excellent report and job they have done on a truly difficult task.

My statement of interest in the Third Session of the Conference on Pollution of Raritan Bay and Adjacent Interstate Waters is on the health aspects of water pollution control and is made under the auspices of the Interdepartmental Agreement between the Department of Health, Education, and Welfare and the Department of the Interior dated September 2, 1966. Our interest in the health aspects of water pollution at this conference relate principally to our responsibilities under the National Shellfish Sanitation Program and the use of Raritan Bay waters for water contact recreation.

The National Shellfish Sanitation Program was established in 1925 to provide for the protection and certification of safe shellfish through effective sanitary control of the shellfish industry. It is a voluntary cooperative effort comprising the Public Health Service, the several participating States and the shellfish industry itself.

The fundamental components of this National Program are contained in the Manual of Recommended Practices for the Sanitary Control of the Shellfish Industry, Part I, II and III. Copies of these parts are submitted here for the record.

I have copies of these, if the conferees need them for the record.

MR. STEIN: Do you want them included in the record?

MR. VAN DERWERKER: If you desire them.

MR. STEIN: Let's make them an appendix to the record.

MR. VAN DERWERKER: Fine.

MR. STEIN: Thank you.

MR. VAN DERWERKER: The goals of the National Shellfish Sanitation Program, as stated in Part I of the National Shellfish Sanitation Program Manual of Operations (see Appendix) are:

1. "the continued safe use of this natural resource and
2. "active encouragement of water quality programs which will preserve all possible coastal areas for this beneficial use."

As a result of these goals and the administrative responsibilities of the Public Health Service in the National Shellfish Sanitation Program, we are directly interested in the pollution profiles of Raritan Bay and Adjacent Interstate Waters and the proposals both as to the use of these waters and the means for safeguarding any such use for shellfishery purposes.

18m I would first like to speak to the relationship of the second goal enumerated above, namely, "active encouragement of water quality programs which will preserve all possible coastal areas for this beneficial use." For this purpose it will be necessary to make reference to the transcripts of the record for the First and Second Sessions and the Summary Report for the Third Session.

In the First Session it was found that in accordance with the Federal Water Pollution Control Act (Public Law 660) pollution of interstate waters which endangers the health or welfare of persons in a State other than the one in which the discharges originate did exist and that this was cause for considering abatement under the procedures described by law. Among the material presented by the Public Health Service in support of this finding was the reported "substantial number of cases of infectious hepatitis" traced to clams taken from Raritan Bay. Among the material presented by the Public Health Service in support of damage to the welfare of the area was the loss to the economy from the closing of shellfish areas only a few months prior to the First Session.

The conclusions of the Second Session reported that the cooperative studies undertaken by the Public Health Service had demonstrated that pollution interfered with the legitimate use of Raritan Bay and that such conditions "still remain a health hazard at bathing beaches, preclude the operation of a safe shellfish industry and interfered with other recreational uses, including fishing, and boating..."

For the conference record, I would like at this point to submit reports covering two aspects of the Raritan Bay Study prepared by the Public Health Service's Northeast Marine Health Sciences Laboratory, Narragansett, Rhode Island, formerly known as the Northeast Shellfish Sanitation Research Center. The two reports are titled, "Analytical Chemical Data on Shellfish from Raritan Bay, New Jersey" and "Shellfish Resources of Raritan Bay, New Jersey," which furnish an estimate of the value of this resource.

Because of the direct relationship of the initiation of this conference and related study to the National Shellfish Sanitation Program, and the possibility of benefits to this program in keeping with the second goal of the National Shellfish Sanitation Program, it is necessary to express regrets that shellfishing is not listed in the "conclusions" of the Summary Report for the Third Session as a planned benefit to be covered by a related abatement program, but only as a possible additional undetermined or unspecified by-product. The exact statement is:

"Additional major benefits would accrue if "the quality of these waters were at the level necessary to support a safe shellfishery."

No information was presented that would indicate if any such benefit would accrue as the result of the proposed abatement schedule.

When I arrived here this morning, I was given a revision of Table X, "Water Quality Requirements," which corrects some of this comment, in that the provision for sanitary quality in the shellfish sanitation manual be described by this revision as a criteria of water requirement for a coliform bacteria.

In connection with this revision, I would like to comment again on it. Under other parameters it refers to parameters in Table IX, and I would suggest adding all other provisions in the National Shellfish Sanitation Program Manual, because there are chemical, radioactive and pesticide requirements in the manual that are not mentioned in Table IX and should be applied to this commercial shellfish area.

It is necessary to point out that associated with the water quality, for a safe shellfish area, are the safeguards associated with the continuity of such quality for all times that shellfishing is permitted. This apparent demotion of shellfishing to a lower consideration as a benefit to be derived from a designed abatement program is of particular surprise to the National Shellfish Sanitation Program since we understand that within the stated enforcement measures enumerated in the latest Water Pollution Control Act, 33 USC 466 et seq, is the following:

> "The Secretary shall also call such a conference whenever, on the basis of reports, surveys, or studies he has reason to believe that any pollution referred to in subsection (a) and endangering the health or welfare of persons in a State other than that in which the discharge or discharges originate is occurring; or he finds that substantial economic injury results from the inability to market shellfish or shellfish products in interstate commerce because of pollution referred to in subsection (a)..."

No information was presented in the "Summary Report" covering the considerations given to the re-establishment of the shellfish industry and the basis for not including an abatement program for at least a partial recovery of the shellfishery. We would urge that this session of the conference give every consideration to this possibility, together with the associate procedures for developing the abatement program needed for any specified protection for the area associated and in keeping with the health requirements as specified in the National Shellfish Sanitation Program Manual of Operations. In addition it is suggested that such considerations should be made a part of the final conclusions of the conference.

If in the future, as a part of this conference, an abatement program is to be designed to reclaim the use of a portion of the shellfish areas in Raritan Bay for market shellfish or if it is anticipated that such reclamation of areas be a by-product of other abatement actions and programs, it is recommended that the plan and the supporting information be presented to the applicable units of the National Shellfish Sanitation Program both State and Federal for an adequate review and comment before entering upon such a program. This will reduce the possibility of situations where a proposed abatement action does not achieve the desired result due to inadequate understanding of the critical health considerations applicable for the safe use of raw food resource. It should be noted that a complete review has not been possible with the data and in the time made available as the "Summary Report" was received on May 26, 1967. We would suggest that if shellfishing is to be contemplated as a legitimate use of a portion of the Raritan Bay that abatement proposals and the supporting study information be presented to the National Shellfish Sanitation Program for review and that in keeping with the volume of supportive data neede and complexity of the situation that appropriate time be given for such a review.

In regards to the first goal of the National Shellfish Sanitation Program, namely, "the continued safe use of this natural resource," I would like to call your attention to the fact that presently the governing area classification needs are covered in the National Shellfish Sanitation Program Manuals of Operation and would apply to interstate shellfish shipments. These include chemical, bacteriological, radiological and pesticidal criteria for ensuring the safety of the shellfish from these growing areas. Special reference is made to items #3 and #4 of Section C of Part I of the applicable Manual of Operations.

The recreational use of the waters in Raritan Bay is also an important consideration since the report indicates 90% of the present estimated annual value of water use of the Bay is associated with recreation. On the health aspects of water pollution in the use of Raritan Bay waters for water contact recreation, the Public Health Service is currently developing water quality standards for applying to recreational waters. We know it is potentially dangerous to have recreational contact with waters containing unchlorinated sewage effluent as in Raritan Bay and obviously the higher the coliform count, the greater the possibility that a public health hazard exists.

Waters used for swimming and bathing should conform to three general conditions: (a) they should be esthetically enjoyable, i.e., free from obnoxious floating or suspended substances, objectionable color, and foul odors; (b) they should contain no substances that are toxic upon ingestion or irritating to the skin; and (c) they should be reasonably free from pathogenic organisms. Specific bacteriological standards for recreational waters, however, have not been promulgated by the Public Health Service as they have for approved shellfish growing waters which must have a median coliform MPN of less than 70 per 100 ml. In general though a limit of 1,000 to 2,400 coliform organisms per 100 ml as an indicator of pathogenic organisms is considered acceptable for approved beach waters by the American Public Health Association Joint Committee on Swimming Pools and Bathing Places, as discussed in their 10th edition of "Recommended Practice for Design, Equipment and Operation of Swimming Pools and other Public Bathing Places." This water quality level is considered by the Public Health Service and most State health departments to be the best guide currently available on the subject and we have no evidence to indicate a health hazard exists when it is met. However, we feel that where water contact recreation is permitted in an area, secondary treatment including disinfection of sewage discharging to the area should be required.

In most instances, therefore, any recreational water quality standards would be met in Raritan Bay if the quality of the Bay waters were at a level for an approved area classification for shellfish growing waters, as presented in the National Shellfish Sanitation Program Manual of Operations.

Conclusion

1. The use of Raritan Bay as a shellfish growing area and the loss of such area for market shellfish following a reported outbreak of infectious hepatitis traced to shellfish from Raritan Bay was a prime cause for the initiation of the Conference on Pollution of Raritan Bay and Adjacent Interstate Waters in accordance with the Federal Water Pollution Control Act (Public Law 660).

2. The "Conclusions" of the Summary Report for the Third Session of this conference apparently do not include the restoration of any portion of the shellfishery lost in 1961 just prior to the calling of the First Session of the conference.

3. In keeping with the two goals of the National Shellfish Sanitation Program concerned with the continued safe use of this natural resource and the active encouragement of water quality programs which will preserve all possible coastal areas for this beneficial use, it is recommended for consideration by this Third Session that a proposed abatement program related to restoration of a portion of Raritan Bay for market shellfishing be developed by the Raritan Bay Project together with supportive technical and study findings and this abatement program along with supportive material be presented to the National Shellfish Sanitation Program for review and comments prior to arriving at a Conference decision for or against the use of the area for such market shellfish purposes.

4. We are in agreement with the report statement that "Additional major benefits would accrue if the quality of these waters were at the level necessary to support a safe shellfishery." We therefore urge the effective implementation of an abatement program designed to restore maximal usage of Raritan Bay waters for the direct market harvesting of shellfish. Such a program would by virtue of the utilization of the stringent shellfish standards also reclaim a maximum of area acceptable to water contact recreation including fishing.

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R. Van Derwerker

MR. STEIN: Thank you, Mr. Van Derwerker.

Do you have available those manuals for submission to the reporter?

MR. VAN DERWERKER: Yes.

MR. STEIN: Would you hold yourself available for questions?

Mr. Glenn?

MR. GLENN: I would like to ask Mr. Van Derwerker a couple of questions.

One is that I am sure that the Federal Water Pollution Control Administration, as well as ourselves, would love to open the shellfish beds in Raritan Bay again. They have proposed secondary treatment with year-round chlorination, which again I am in favor of. However, we still have combined sewers in the area that we do not have a solution to.

Every time it rains in the future, after all this work has been completed which has been proposed, over 750 million gallons a day of raw waste will be discharged out of the combined sewers into these shellfish waters that used to be open.

Now, the question I would like to ask is this: What do you propose for an abatement program in addition to what has been proposed, so that these shellfish waters could be opened for shellfish again?

MR. VAN DERWERKER: I would propose a full consideration and awareness of the water quality standards in the shellfish manual. I agree with that portion of the report which indicated that it is impossible at this time to evaluate the effects of the combined stormwaters on the conditions in the bay; and certainly, after your abatement program on industrial and municipal wastes is well along, that should be measured.

Actually, we cannot predict at any time what the conditions will be five or ten years hence in an area of this sort because, while we are cleaning up one situation, another situation is likely to develop.

MR. GLENN: Do you think you should open the shellfish beds as long as there are going to be combined sewers spilling out every time it rains?

MR. VAN DERWERKER: I don't think it is a question of that. I think shellfish beds can be opened when bacteriological surveillance indicates that they are approved. So far, from the indications we have the chemical, pesticidal and radiological, are within the criteria being proposed. It is only in the bacteriological area that the approved area criteria are exceeded at some time during the year.

MR. GLENN: I don't think you have answered my question. As long as there are going to be 750 million gallons of raw waste discharged every time it rains that will reach these shellfish beds within a tidal cycle, would you recommend these beds be opened for shellfish?

MR. VAN DERWERKER: That would be subject to a survey at the time. We can't predict. We cannot recommend now.

MR. GLENN: But you said in your statement: "We therefore urge the effective implementation of an abatement program designed to restore maximal usage of Raritan Bay waters."

I am asking you for this abatement program you are proposing. So far I have heard nothing other than to wait until this other work that has been proposed is done.

Now, I would agree if we did all this other work and there is some way we could correct the combined sewers, that the shellfish beds should be opened, but I do not have any confidence that they will ever be opened unless we can find a solution to the combined sewers.

I know that there are many Federal research grants being given now trying to find a solution to combined sewers, but I do not like to see a statement made like this, indicating that if the States and the interstate agency did their job, these shellfish beds would be open. I have so far not heard anything you have said in addition to what has

4ma been proposed that would bring about these conditions.

MR. VAN DERWERKER: I think that if the abatement program as proposed here were adopted, that the open area could be increased. I don't think all the shellfish area in the bay could, because of the problem that you raised.

MR. GLENN: How much --

MR. VAN DERWERKER: I think of the area out near the Narrows.

MR. GLENN: I don't have any further questions.

MR. STEIN: Are there any other questions or comments?

(No response.)

MR. STEIN: Let me see if I can understand this. As I understand the purport of the Federal Report and your comments, which were very pertinent, one of the key questions we have is the opening of the shellfish beds.

In the New York metropolitan area, you really want to have two rough indicators of abatement of pollution. One is whether you can swim safely in all the beaches; and the other is whether we can have shellfish harvesting and marketing with the approval of the Public Health Service. If you can match these two, you will have clean waters in New York.

The question is how to get this, and there have been certain proposals made here. Obviously, we have the stormwater problem and many other problems.

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R. Van Derwerker

As I understand this, the Federal Report proposes a relatively ambitious program of 90 percent removal and year-round chlorination. This is about as high a degree of treatment as is generally demanded in any but very specialized places in the country.

Once this is done, the probability is that we will be able to find many more of the beaches safe -- hopefully, most of them, and maybe all of them. The more critical and delicate area is to be able to open many more of the closed areas to shellfish harvesting and marketing. The question here is if we have any proposal at this time to feed into the program to do more.

As I understand the proposal here, once we have accomplished this program and examined the effects of this on the beaches and on the shellfish harvesting areas, the question will be, in the light of the effects then, what we have to do further.

I think what Mr. Glenn was pointing out is if there is anything to suggest in the program at this time other than what is suggested by the Federal Report that could give us a further leg up on the program.

I fully agree with you that the prime objective should be to open the shellfish areas. I do not think that the statement was made that an additional objective should be the opening of the shellfish areas, because they did not want the areas open.

The question was -- and I think this was likely related to what Mr. Glenn stated -- that he did not want to hold out the false hope, or the investigators did not want to hold out the false hope that with the program they were recommending at this time we would have water quality conditions that would permit the unlimited opening of shellfish areas.

Unless I do not understand the facts, I think this is the case.

MR. GLENN: That is right.

MR. STEIN: Now, here we get down to two points: Either we adopt the program recommended by the study group, or some modification of it, with a reevaluation of opening the shellfish areas at the time, or we have at the present time some other device that we can put in or recommend for the consideration of the conferees which would permit the opening of the shellfish areas, and more shellfish areas.

With that approach, I would like to have your comment. Do we have that? And, if we have it, I would like to give it to the conferees, because no one likes to eat oysters and clams more than I do, and I don't like the high prices we are paying now.

MR. VAN DERWERKER: This gets me into another personal forecast with regard to the shellfish industry. That is, it won't be many years before all shellfish to be eaten raw will have to go through a depuration process. As a matter of fact, the shellfish in Raritan Bay that are used now is with this type of treatment.

MR. STEIN: It is, in fact, being used now, isn't it?

MR. VAN DERWERKER: No, it is not on Raritan Bay.

There are two projects under consideration and study to be developed, which will permit the utilization of this resource even under present conditions in a good deal of Raritan Bay.

MR. STEIN: Let me go off the record here for a minute.

(Discussion off the record.)

MR. STEIN: All right.

MR. VAN DERWERKER: I agree that this matter of stormwater is an additional problem.

MR. STEIN: But what else could you suggest, Mr. Van Derwerker?

Again, I ask you this just as a question of a respected individual in the business. What else do you suggest that we could propose and crank into the program now which would provide additional protection for the shellfish, or a reason to believe that we can open up additional shellfish areas other than that proposed in the Federal Report?

If we have any of these, I certainly will press them with the conferees.

MR. VAN DERWERKER: One thought that I would offer in connection with this is to discharge any effluents that are possible out to the sea instead of in the bay.

MR. STEIN: You mean, have long outfall lines?

MR. VAN DERWERKER: Yes. There is under consideration now a large plant in one of the counties there that is proposing to discharge into the bay and would be relatively close to the remaining open area of the bay. Instead of discharging it there, I would think consideration be given to spending a little more money and taking it outside the bay area.

This has been recommended in New Jersey for South Jersey as a means of eliminating the problem in the estuarine bays. I think it is applicable to this location in some situations, though probably not all.

However, any diversion of waste from the bay is certainly going to be helpful to the overall water quality picture in the bay.

MR. STEIN: Thank you.

Are there any other comments or questions?

(No response.)

MR. STEIN: If not, thank you very much, Mr. Van Derwerker.

MR. VAN DERWERKER: You are welcome.

MR. STEIN: Mr. Klashman?

MR. KLASHMAN: Thank you very much, Mr. Van Derwerker.

Next we will hear from Mr. Pagano of the Corps of Engineers.

STATEMENT OF FRANK PAGANO, NEW YORK DISTRICT OFFICE, CORPS OF ENGINEERS, NEW YORK, NEW YORK

MR. PAGANO: Chairman Stein, Conferees, Ladies and Gentlemen:

My name is Frank Pagano and I represent the Corps of Engineers, New York District Office, which is located at 111 East 16th Street, New York City. Colonel R. T. Botson, the District Engineer, regrets that he cannot be here today.

The Corps of Engineers, through a long list of

Rivers and Harbors and Flood Control Acts, is authorized to plan, design and construct water resource projects in the interest of river basin development, flood control, river and harbor improvements for navigation, major drainage, water supply, beach erosion control and hurricane flood protection. Other functions in the interest of hydro-electric power, water quality control, recreation, fish and wildlife enhancement may be included in such projects where warranted.

The Corps is also responsible for preparation of flood plain information reports which are developed and furnished to local communities for use in planning judicious use of the flood plains. This authority has recently been extended to include a management service to local officials in which guidance, advice, and technical support may be provided as requested.

In addition to the foregoing, the Corps is also authorized to participate in disaster relief in connection with natural major disasters when determined to be such and to perform emergency operations involving flood fighting, rescue operations and emergency repairs when required.

The New York District includes for civil works, the watersheds of the Hudson River and Lake Champlain and the many waterways draining into New York Harbor and the Atlantic Ocean as far south as Manasquan Inlet, New Jersey, and as far east as Montauk Point, Long Island, New York.

The basic interest of the Corps of Engineers in pollution of navigable waters stems from its responsibility in the development of water resources of all rivers, bays and harbors within its boundaries. The most general law with respect to pollution, enforced by the Corps of Engineers, is Section 13 of the River and Harbor Act of 3 March 1899. This law in essence states that it is unlawful to throw, discharge or deposit any refuse matter of any kind or description whatsoever other than that flowing from streets and sewers and passing therefrom in a liquid state, whereby navigation shall or may be impeded. You will note from the last phrase, that pollution in its broadest interpretation is not unlawful under the statute but only the deposit of refuse material which is injurious to navigation. Under this statute this distinction limits the role of the Corps of Engineers in the prevention of pollution.

However, the Corps of Engineers plays a significant part in pollution abatement in comprehensive natural resource studies that involve navigation, flood control, beach erosion, and hurricane protection. In this light it is effected through close coordination and participation of local, State and Federal agencies in these studies.

Pursuant to the foregoing, several studies are being conducted by the New York District Office in the Raritan area. The first is a multiple purpose study in the interest of water supply, recreation, flood control and other allied purposes, and covers the entire Raritan River Basin. In connection with this study, consideration is being given to the feasibility of a tide dam near Crab Island, which is in the lower estuary about 5 miles above the mouth of the stream, with a view toward strengthening the existing groundwater aquifers for water supply purposes since they have been intruded by salt water, provision of a fresh water lake upstream of the barrier for outdoor recreational purposes and construction of improvements to protect adjacent communities against flooding either by fluvial flow or hurricane conditions. This study also gives consideration to water resource improvements in other areas of the basin. Coordination is being effected with the Federal Water Pollution Control Administration to assure the compatibility of any recommended improvement with water quality interests; in fact, in this particular instance, the Federal Water Pollution Control Administrati

3ma is actually participating in the study, which is scheduled for completion in fiscal year 1968.

Several years ago a report was completed by our office titled "Raritan and Sandy Hook Bays, New Jersey." This study, also coordinated in 1962 with the United States Public Health Service, Division of Water Supply and Pollution Control, has resulted in authorization of projects by the Congress which include:

a. A combined shore and hurricane protection project at Madison Township;

b. A shore protection project at Matawan Township and the Borough of Union Beach; and

c. A hurricane protection project at Keansburg and East Keansburg.

The work consists principally of placing beach fill on each of four reaches, constructing three groins at Keansburg and constructing levees at Madison Township, Keansburg and East Keansburg. The Madison project has been constructed, and the work at Keansburg and East Keansburg will be initiated after formal receipt of lands, easements and rights-of-way from the State of New Jersey. It is noted that in connection with assurances of local cooperation, local interests are required to include an item which assures our office that water pollution will be controlled to the extent necessary to safeguard the health of bathers. Another study in the interest of hurricane protection for those remaining areas of Raritan and Sandy Hook Bays which were not included in the recommendation for projects previously mentioned, is underway, and is scheduled for completion in fiscal year 1968.

In addition to the foregoing, a completely separate study is nearing completion by our office to determine the feasibility of deepening and widening channels in the Raritan River and Washington Canal for navigation purposes and to determine the reasons for the occurrence of shoaling in these streams. This report is nearing completion and present indications are that navigation improvements appear uneconomically justified.

In connection with our New York-New Jersey Channels Study -- consideration is being given to straightening of the existing project channel in Raritan Bay from Raritan Bay East reach at mile 10.0 west to the bend at Ward Point mile 17.7. This would eliminate a 60 degree bend at Sequine Point and reduce travel time by about 0.40 hours per tanker trip or 0.80 hours per round trip. However, based on navigation considerations alone, the cost of such a proposal may not fully justify the expenditure. Therefore, consideration must be given to any pollution abatement benefits that would accrue as a result of this channel relocation. The Federal Water Pollution Control Administration will be requested to evaluate the magnitude of this benefit so that it can be integrated into our study prior to completion.

Lastly, advanced engineering and design is underway in connection with construction of a navigation inlet through Sandy Hook Peninsula. The design, which is scheduled for completion by the end of calendar year 1968, is also being developed in close coordination with the Federal Water Pollution Control Administration to assure compatibility with water quality interests.

The foregoing represents a summary of our present civil works activities in the Raritan Bay area. We will continue to cooperate with all local, State and Federal agencies to control pollution in streams to the extent of allowable authority and to ask for their cooperation on stream pollution matters in basin-wide studies for the conservation and development of water resources. The Corps fully supports the effort of the Federal Water Pollution Control Administration in this endeavor to restore Raritan Bay and adjacent waters to a high quality water resource.

Thank you.

MR. STEIN: Thank you, Mr. Pagano.

Are there any questions or comments?

(No response.)

MR. STEIN: The Corps is one of our sister agencies in water resource development, and we work very, very closely with them on these programs.

Mr. Klashman?

MR. KLASHMAN: Thank you very much, Mr. Pagano.

Is Mr. Kachic, Assistant Regional Hydrologist of the United States Weather Bureau, here?

(No response.)

MR. KLASHMAN: If not, are there any other Federal agencies who wish to make a statement?

(No response.)

MR. KLASHMAN: That completes the presentation for the Federal Government.

MR. STEIN: For the rest of this afternoon, we will have presentations from New Jersey and then from the Interstate Sanitation Commission.

At this time, let's recess for ten minutes.

(Whereupon a recess was had.)

MR. STEIN: May we reconvene?

We have one more statement that the Federal people are going to ask for. This will be from a long-time

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professional in the field, Mrs. David H. Wallace of the Oyster Institute of America, really known as Elizabeth M. Wallace, except I call her "Libby."

Would you come up, please?

STATEMENT OF MRS. ELIZABETH M. WALLACE, DIRECTOR, OYSTER INSTITUTE, SAYVILLE, NEW YORK

MRS. WALLACE: Chairman Stein, Conferees, Ladies and Gentlemen:

You may consider me an extension to the recess, because this is not a prepared statement. It is just an opportunity -- and I'm not in the business of representing the molluscan industry to clam up at an opportunity like this -- so I thank you all for the privilege of being able to come up and represent the people who belong to the Association, which is one of the oldest in existence, the Oyster Institute of North America.

Now, that is a bit confusing, because you think that I represent only the oyster people, but, in reality, I represent three species of oysters and the people that work with them.

Clams seem to succeed oysters when the going gets tough, so our people in the oyster business become people in the clam business. Many of them are in both simultaneously, so I represent the molluscan industry.

We asked for the Government's help of the Public Health Service back in 1925, having first gotten ourselves organized in 1904.

I am enormously impressed as a citizen with the work that has been done on this Raritan Bay Project. I told Mr. DeFalco so, and I thank him as a citizen, because I think it is this kind of information we must have if we are going to get a substantial improvement in the situation. We absolutely must know with what we are dealing. If we comply at the 90 percent level being set by the Project, we will find such an improvement in the waters that we will be able to meet the standards as set by the Public Health Service.

Now, I intend to live so long that in the shellfish industry, good news is good news, instead of the reverse of bad news being good news.

You can be sure that the shellfish-associated diseases are here. I intend to live so long that all of you will know that oysters and clams make more people well by far than any that might by chance make them ill. The disease relating to this is purely circumstantial -- everybody will admit to that -- and I would like you to consider, please, that it is also circumstantial evidence that those of us who enjoy and eat shellfish are so hale and hearty, as witness Chairman Stein (Laughter).

I was asked earlier about oysters in Raritan Bay. We have members walking around who are considerably younger than I who remember the harvesting and farming of oysters in Princess Bay, where they had their leases. Why are oysters there no longer? Because they could not be used even if they were there. The pollution has made it economically infeasible to farm these areas.

However, if we comply with the recommendations of the Raritan Project, that again will become quite attractive. I hope my husband, David Wallace, who is in charge of the District of New York, will have the privilege of issuing leases again in this area for the husbandrymanship that it takes to raise the oysters.

The minute it becomes even remotely feasible to make a profit, you can be sure the oystermen will be in there in order to plant, grow, husband this resource, and bring the oyster back.

Right now we have uncounted millions of bushels of clams that are available to be used if we can get around to using them, if we can bring the necessary expertise to bear to reduce the pollution loads so that these waters are returned to the standards by which we can harvest them.

Naturally, I am speaking for the industry, but I think our truest justification comes not from the money value that Mr. McNamara made so popular. I do think that it is quite unrealistic and it is on its way out. If I may put a price tag, if that would make anybody feel better, we could say that an oyster industry of $1 million is quite feasible in this area, provided, of course, this resource could be used.

However, so much more is involved in this. It is the enhancement of an environment to be enjoyed by millions of people. This is for the benefit of all our citizens and, if you will permit me to go further and say, for all of those who will follow us. Surely, we owe them this as their rightful heritage.

Thank you.

MR. STEIN: Thank you, Mrs. Wallace.

Are there any comments or questions?

(No response.)

MR. STEIN: You wouldn't believe this, but Libby is a scientist. You know, this is the reason why we have so few pretty women scientists. When they find one, they make her an executive of a trade association.

Thank you very much.

Are there any further comments or questions?

(No response.)

MR. STEIN: If not, we will call on New Jersey. Dr. Kandle?

STATEMENT OF ROSCOE P. KANDLE, M.D., CONFEREE AND COMMISSIONER, NEW JERSEY STATE DEPARTMENT OF HEALTH, TRENTON, NEW JERSEY

DR. KANDLE: Good afternoon, friends.

I am Roscoe P. Kandle, Commissioner of the New Jersey State Department of Health, which is the responsible agency in our State for water pollution control. In this capacity I am representing the State of New Jersey as one of the conference participants in this Third Session of the Interstate Conference on Pollution of the Raritan Bay and Adjacent Interstate Waters.

We are pleased to participate in this conference and hope that its deliberations and conclusions will constructively aid our cooperative effort to eliminate pollution of the Raritan estuary system. While we are pleased to participate, I would like to comment for the record on the notice given of this conference and on its timeliness.

On May 23 I received telegram notification of of the conference which was to begin on June 13. This notice was to the day the minimum required by the Federal statute under which such conferences are authorized. The reports of the Project study upon which the conference will be based were delivered to us on May 29, 1967. This schedule hardly permitted careful examination of the results of the thorough study made of the Raritan by the Federal Water Pollution Control Administration and preparation of a suitable commentary on our part. Furthermore, the conference itself has been scheduled in the midst of our final preparation of water quality standards, stream classifications, plans for their implementation, and of the State water pollution program plan, all of which are to be submitted before the end of this month to the same agency which has called the conference.

Maybe this job we do doesn't mean anything to you, but it means a lot to New Jersey, because it is whether or not we get the "Federal dough," so this is a matter of very considerable importance. We were loath to interrupt our efforts.

Given these considerations and the fact that more than four years have been permitted to elapse since the Second Session of the Conference, we recommended on May 31 that the session be postponed until July. We were notified yesterday afternoon by telegram that this request was denied.

8mb R. P. Kandle

Obviously, we considered the silence in the interim to be a constructive denial.

In future cases we would recommend to the Federal Water Pollution Control Administration to give the States at least 30 days' notice of an impending conference, including delivery of the Project study reports.

Pollution control was a major, if not the major, consideration of our State administration in the current legislative session. Both the legislative message and the fiscal message of Governor Richard J. Hughes cite the pollution control needs in New Jersey.

A package of legislative bills was introduced which would provide a statutory strengthening of our pollution control efforts, both as to air and water. The Joint Committee on Air and Water Pollution and Public Health of the legislature held a series of public hearings throughout the State to assess public opinion on these important issues and as to the specific legislative proposals themselves. The six basic bills were adopted and will be signed into law by Governor Hughes on Thursday of this week. In the statement which follows by Mr. Sullivan, a brief description will be given of the import of this new legislation as it regards water pollution control.

Governor Hughes' fiscal recommendations were likewise adopted. The funds available for our Water Pollution Control Program for the fiscal year beginning 1 July will be more than twice the appropriation for this purpose in the current year.

To provide maximum administrative strength to our Department's pollution control programs I have accomplished a Department reorganization of these functions. Effective February 16, 1967, by administrative order, I established a new Division of Clean Air and Water. The new agency comprises the Air Pollution Control Program, the Solid Waste Disposal Program and the Water Pollution Control Program. These three were merged in a single unit of government because of their obvious common denominator. It is my belief that the establishment of this Division will help us to move ahead more forcefully and with more perspective in the important work we need to do to improve the quality of our environment.

On the same day the new Division was established, we appointed and were lucky to recruit as its Director Richard J. Sullivan. You will hear from him shortly.

I would like to comment, Murray, about a couple of points in the report. There is one sentence in the Summary Report to which I think particular attention ought to be given. It is on Page 4 and it is No. 6 in the Summary volume. It says, and I quote:

"Priority for construction grants be established so affected communities may obtain funds to meet the requirements outlined above."

There is no information about where these funds are to come from. The facts are that most, almost all of the funds for water pollution abatement and control, have come from local government through bonds, and from industry. The local people are the ones who actually achieve pollution abatement and control, and who put up their money and build sewerage systems and treatment plants. It is not the Federal or the State government which actually cleans up the water.

Federal funds have subsidized construction in New Jersey to the extent, in the past and currently, of about 4 to 6 percent of the total annual construction costs. The annual average construction costs have been about 60 to 75 million dollars, plus those which have been expended by industry and which I do not have very accurate data on.

There is one thing that is bothering me, Murray. I may say, as an aside, that in some ways the subsidy programs have held things up, because people postpone with the idea that they are going to get more Federal money, and this has plagued us, as it has plagued you, I am sure.

Starting July 1st, there will be also State funds for the subsidy of construction. At present, these funds will be at about the same level as the current Federal money. There is the possibility of their being raised to larger amounts, should Federal money be available.

As you may have seen in today's New York Times, another group indicated that there was a need for $2-1/2 billion, and that seems modest to me in view of the New York excellent activity.

However, New Jersey has made, over the past three years, both outright grants for stream or regional or multi-municipal feasibility studies, and has provided interest-free loan funds for engineering designs of stream value or regional or interim municipal sewerage systems.

Obviously, if you do not have very much money, as we have not had in the way of subsidy money, you have to have a priority system, and so we have always had one and always used it.

The construction schedules which are recommended by the Department of the Interior, however, do not appear to utilize a priority system, except that the emphasis is on the total Raritan. That is understandable in the context of this conference.

However, just a short time ago, we had the one on the Hudson River, and we were faced with exactly the same situation, where the priority ought to be on the Hudson.

Well, we also have the Delaware River, and we also have a couple of rivers inside of our State which are not so hot, so we might think of some other priorities.

All I am pointing out is that this is quite a contest, to see where the priorities ought to go.

Certainly, both the Federal and State funds are totally inadequate now with regard to subsidy for the construction at these enormous costs which will be necessary, and which we certainly will achieve. I have no doubt that we will achieve the kind of treatment that we ought to have, but it sure is going to cost us.

The last recommendation is 10c of the Summary Report, and that puzzles me. That is the one that deals with the possibility of an interceptor that would pick up stuff from the Arthur Kill.

I just have to talk to Paul about it, and I apologize, Paul, that I have not brought it up before, but I don't know what you do with the effluent.

Does somebody intend that that go into the Raritan River too, or the Raritan Bay?

This whole issue bothers me considerably, Murray, and I think it is a point that we have really not gotten into as much as we should, that there is a re-use of water, and whether or not we can afford to dump all this stuff into the ocean or some place like that, and not re-use it more effectively. This is concerning us in New Jersey since we have had this drought situation.

I don't know the answer to this, but I am concerned that that recommendation stands rather baldly.

For example, we have used the ocean for discharge of sewage from above Beach Haven for a great many years, and we have studied this. This is our third year of research on the use of the ocean as a method of disposal, and we know that we can use it safely, and we must use it more, because the bays are absolutely filled up. We can't put any more sewage into the bays, including the Raritan, so this matter of the disposal and conservation and re-use of these waters seems to be an area which we have not covered very well.

I would like for the record to assure the audience and Murray if he will come and visit with us in the summer, that the bathing and contact water areas of Raritan Bay which are open for such purposes, are safe, and they do meet our standards, which are even higher than the ones which are suggested within the range of the conference, so I am not really bothered about that at the moment. They have always been protected by chlorinated water, so any information to the contrary is incorrect.

We expect to participate in this conference constructively, and we welcome the opportunity to work with our friends, Murray and Lester Klashman and Paul and the rest.

Now Mr. Richard J. Sullivan, Director of the Division of Clean Air and Water, will continue with the technical statement of the conference.

MR. STEIN: Let's see if we have any comments or questions. Are there any?

(No response.)

MR. STEIN: You know, Doctor, I agree with almost all that you said, particularly your statement about the re-use of water. That certainly makes sense. I do not have any disagreement with that.

Dr. Kandle has worked with pollution problems through the years long and hard, and his words are worth noting.

However, there are a few other points there, the first being this notion that subsidies have held things up.

We have heard this argument ever since the beginning of the Federal grant program, and it is always an appealing argument. I like it because intellectually and theoretically it makes sense.

However, there is one problem with this: Whenever our construction grant people come up with the figures, they show every time we have more millions, there is more construction. There is a direct correlation between the amount of Federal and State money and the amount of construction.

So, despite what we may think theoretically about the Federal Government or the State government putting up money, you may expect these fellows to prove the point to my satisfaction, but all I can do is add, and they add, and then we have more construction.

The third point I wish to make is that I agree with Dr. Kandle that if we come there in the summer, the beaches which are open are safe. That is no doubt true.

I grew up around this area, just across the river on the bay in Brooklyn. I don't think the kids have changed a bit since I grew up. When I went to a beach -- and if pressed I will give you its name -- I saw those kids swimming within a hundred feet of a sewage outfall. I know you did not declare it safe, but there the kids were. My guess is that they are no different today than when I used to be there, because I used to do the same thing.

The fourth and last point I have to make is this -- and this always kind of intrigues me because, Dr. Kandle, I am always a student of poetic predetermination in government -- I share your sympathy with the short notice of

21 days, but this 21 days was adopted by the Congress at the suggestion of Dr. Daniel Bergsma, Dr. Kandle's predecessor in office as Health Commissioner of New Jersey (Laughter).

DR. KANDLE: I don't want to argue, Murray. I agree with you that the larger Federal subsidies will, No. 1, beget larger State moneys for construction, and will beget a good deal of construction money.

I just mean that this is like in all other things, it is a two-edged sword.

MR. STEIN: Right. I don't think there is any disagreement.

Are there any further comments or questions?

(No response.)

MR. STEIN: If not, will you continue with the presentation, Dr. Kandle?

DR. KANDLE: Mr. Richard J. Sullivan.

STATEMENT OF RICHARD J. SULLIVAN, DIRECTOR, DIVISION OF CLEAN AIR AND WATER, NEW JERSEY STATE DEPARTMENT OF HEALTH, TRENTON, NEW JERSEY

MR. SULLIVAN: Mr. Chairman, Conferees, Ladies and Gentlemen:

I am Richard J. Sullivan, Director of the Division of Clean Air and Water of the New Jersey State Department of Health. The remarks which follow supplement those of Commissioner Roscoe P. Kandle and are a part of the total statement made on behalf of the New Jersey State Department of Health.

The temper of New Jersey -- of the State administration, of the Legislature, the press, and the public -- is one of impatience toward pollution control, both air and water. I personally share this impatience.

When I was appointed Director of the Division of Clean Air and Water in February of this year I was given a clear, certain mandate by Dr. Kandle and by Governor Hughes to enforce fully all of the Department's pollution control statutes and regulations. This I intend to do.

Dr. Kandle has given me a free hand to issue corrective orders where the facts require and to initiate court prosecution when necessary to achieve timely compliance.

In the last six weeks I have issued water pollution abatement orders against 76 municipalities, authorities, large industries and private utilities, some of them in the Raritan area. A similar number of orders is likely to be issued in the next 60 days, mostly against pollution sources in the southern Delaware Basin and on the Atlantic Coastal Plain. Orders do not make the water clean; but we cannot enforce them if we do not first issue them. If reasonable steps toward compliance with these orders are not taken in accordance with the time schedule contained in them we will invoke the sanctions provided by statute.

The Division now has the full-time service of three competent and dedicated Deputy Attorneys General to handle prosecutions in air and water pollution cases. Several current court cases of interest to this conference will be referred to later.

The New Jersey Legislature has shown its willingness to support effective water pollution control. Since the last session of this conference, Session No. 2, New Jersey has enacted statutes which provide State grants for the study of the feasibility of regional collection and treatment systems; loans to defray the engineering costs of system design; and authority of our Department to disapprove any waste treatment facility not a part of a rational regional system. On Thursday of this week two new statutes affecting water pollution control will be signed into law. One provides that equipment and facilities whose primary purpose is water pollution control shall be exempt from real and personal property taxes as is already the case in air pollution control facilities. The other statute will add to the available supply of professional staff in this field, offering fully funded undergraduate and graduate scholarships; the law will also create a representative Clean Water Council to serve as our advisory committee. Most significantly, the new law will put New Jersey in the construction grant business in a program compatible with the Federal grant system and providing funds to match this year's Federal allocation. We will appropriate from $2.8 to $7 million depending on the outcome of the current Congressional debate on this subject. More on this later.

In addition, the State is strengthening its program by providing additional funds beginning 1 July next. We will have the money to add 24 people to our water pollution control staff. We hope to be able to recruit in a field where the unemployment rate is very low. I might say one of our recruitment problems is the existing aspect of personnel in New Jersey who are all on the staff of the Federal Government. (Laughter.)

Further, we have ambitious plans to collect on a continuous basis the water quality data we require to measure control needs and progress. Our Division now has on the line the best air quality monitoring system in the country. By August, three field laboratories and four monitoring stations will continuously be telemetering air measurement data to our central office receiving station and computer. By the following August this network will comprise 22 stations. One of the products of this system will be the frequency distribution for a number of air quality parameters of integrated half-hour samples on a continuous basis. Absent this kind of statistically significant data for water, no one can really appraise the quality and the changes in quality of water even for the much studied Raritan. I mention the air monitoring system because it was designed and has the capacity to receive and process, without modification, water quality data on the same basis. It is our intention to select appropriate sites in consultation with our Federal friends and others, where the proper sensing elements can be placed to telemeter the data for the appropriate water quality parameters as well.

As a part of the total enforcement activity, water quality standards have been defined and established, streams have been classified, and degree-of-treatment regulations promulgated for every drainage basin, except one. The exception is the Little Wallkill, up in North Jersey, where the water runs uphill to New York State. We haven't withheld for that reason, however, but to assure compatibility with the New Jersey program for the controlled development of the impact area of the Tocks Island national park. The Wallkill public hearing will be held next Monday.

Our water quality standards, stream classifications, treatment regulations, and plans of implementation for all drainage basins and, as well, our program plan, will be submitted to the U. S. Department of the Interior before the end of this month.

All of the elements of the program mentioned above are important. But the main one, however, is money.

Our professional staff has estimated that it will cost approximately $500 million to construct at this moment in time the treatment facilities needed in New Jersey to comply with our current regulations. This figure does not take into account the impact of growth, nor does it provide for the cost of collection facilities in unsewered communities. If the latter two elements are incorporated, the estimate becomes $760 million.

If the $500 million figure is used and if we postulate that this money could be spent by 1971 in keeping with the objectives of the Federal statute, we find this would considerably more than double the current rate of expenditure. If all the funds promised under the Federal Water Pollution Control Act are, in fact, provided they will amount to 22% of our needs in this period. If the current proposed cutback to 40% of this amount were to prevail throughout the four-year period, total Federal assistance under this law will amount to less than 9% of our funding requirements, which is hardly overwhelming support for this area.

The decision of the Federal administration to cut back this year is distressing and we hope it will be changed. If the full amount of these funds is available and increasing amounts become available through the matching grants of other Federal agencies we will be able to make significantly more progress in the massive treatment facility construction program that faces us.

With regard to the technology of water pollution control as opposed to administrative matters, I am a ninety-day wonder with all of the limitations that phrase implies. I have consulted at length, however, with our competent and well-informed professional staff as to the water pollution problem in the Raritan and particularly with regard to the Federal report on these waters, which is the subject of this conference.

The previous session of this conference concluded that the State and Interstate water pollution control agencies had effective water pollution abatement programs within the conference area. New Jersey has continued this program since the conclusion of the second session. More significant progress toward the resolution of these pollution problems in the project area can be reported than in the previous years despite the continued rapid growth that is taking place.

The uses of these waters have been well established in the previous esssions of this conference and there is no need to dwell on this subject except merely to say that these uses have intensified because of the tremendous growth in the area.

An interdepartmental committee of representatives of various divisions within the Departments of Health and Conservation and Economic Development recommended classification of the Raritan River and Raritan Bay in accordance with the provisions of the water quality criteria that I mentioned earlier. These waters were selected for the first trial in the classification procedure. A public hearing was held in Trenton on December 8, 1964, at which time these classification regulations

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were discussed by the public and interested persons. The hearing was conducted in conformity with the laws of New Jersey.

Effective April 15, 1965, our State Department of Health promulgated regulations entitled "Classification of the Surface Waters of the Raritan River Basin Including the Raritan Bay." The classes established for the water of the basin varied from Class FW-2 for the upstream reaches of the river, which are used for public potable water supply, to the tidal reaches of the river and bay, which were classified as TW-1.

The definition of TW-1 waters is as follows:

"Tidal surface waters suitable for all recreational purposes, as a source of public potable water supply where permitted and, where shellfishing is permitted, to be suitable for such purposes."

To avoid confusion regarding this definition, as it applies to the Raritan tidal waters, it was given special treatment as follows:

"These waters are not a source of public potable water supply and therefore standards of quality and criteria referring exclusively to water supplies are not applicable. The standards of quality and bacterial criteria for shellfish growing areas are applicable only in areas where shellfish harvesting is permitted by the Department."

"These waters shall be maintained in a condition suitable for all recreational purposes."

Implementation Plan

Implementation of this classification program is a very simple and direct procedure.

The first step in the Raritan Valley was the enactment of rules and regulations establishing minimum degrees of treatment for domestic and industrial wastes. These regulations carry an effective date of February 1, 1966, and require as a minimum 80 percent reduction in BOD for domestic wastes separately or in combination with industrial wastes at all times including any four-hour period of a day when the strength of the waste may be expected to exceed average conditions. These regulations also require a minimum of 80 percent BOD reduction at all times for industrial wastes and such further reduction in BOD as may be necessary in order to maintain the water quality as specified in our criteria.

Employing the regulations establishing classifications, the regulations governing minimum degrees of treatment and the procedures established by law, orders were issued against the known major violators in the Valley. These orders took the form of long standing and they contained no timetable for compliance. They carried an effective date generally of approximately 100 days after the date of issue. All of these orders recently have been supplanted by "Amended Orders," establishing timetables for appropriate action, including terminal dates for the completion of the required construction.

There is attached to these papers -- and I will make them part of the record -- a tabulation listing the names of the principal offenders against whom orders incorporating timetables have been issued.

MR. STEIN: Do you have that paper with you?

MR. SULLIVAN: That is attached.

MR. STEIN: That will be entered in the record, without objection, as if read.

MR. SULLIVAN: Very good.

The listing is here to make it clear as to what timetable I am referring to. The events, in sequence, are to report on design, preliminary plans, final plans, awarding of contracts, and the completion of construction.

As I said earlier, it is our intention, if reasonable steps toward meeting any of these dates are not taken, to invoke the sanctions provided in our control statute.

From time to time, additional orders will be issued against pollution sources in the upper reaches of the Raritan as the facts are developed. The tabulation shows the timetable to be applied throughout the "interstate" waters of the Raritan River Basin. This list includes every municipal waste treatment plant which presently discharges into the Raritan Bay, with the exception of the new secondary treatment plant serving the Cliffwood Beach area of Matawan Township.

Abatement Program - Arthur Kill

Effective May 16, 1965, the waters of the Arthur Kill were classified as TW-3 subsequent to a public hearing. The definition of TW-3 waters is as follows:

> "Tidal surface waters used primarily for navigation, not recreation. These waters, although not expected to be used for fishing, shall provide for fish survival. These waters shall not be an odor nuisance and shall not cause damage to pleasure craft traversing them."

The treatment requirement established for these waters was specified in a report of the Interstate Sanitation Commission in 1962. The requirement of 80 percent BOD reduction for all wastes entering the Arthur Kill was established after a detailed analysis of the Arthur Kill during the critical time period and at the point of critical dissolved oxygen deficit. The recommendation of the Interstate Sanitation Commission was endorsed by the New Jersey Department of Health and incorporated in our orders.

Orders were issued against municipalities, sewerage authorities and industries requiring abatement of pollutional discharge into the kill. These orders, as well, were recently supplanted by amended orders establishing timetables, as was the case of Raritan Bay, for appropriate action, including terminal dates for the completion of indicated construction.

Likewise, I would like to enter into the record a tabulation listing the names of the recipients of these amended orders. This tabulation shows the dates of important stages of development in each case.

MR. STEIN: Without objection, that will be entered into the record, as if read.

In addition, the following sources of pollution have been or shortly will be removed from the Arthur Kill:

(a) Citgo (formerly Cities Service Oil Company) was placed under order by the Department on August 26, 1965. This firm ceased manufacturing operations on November 1, 1967.

(b) The Reichhold Chemicals, Inc., operates two manufacturing plants in the study area; one in Elizabeth and

New Jersey State Department of Health
Raritan River Basin
Performance Schedule Under Current Orders

	Report on Design	Preliminary Plans	Final Plans	Award Contracts	Complete Construction	Remarks
Atlantic Highlands	10/1/67	4/1/68	3/1/69	6/1/69	10/30/70	See note 3.
Highlands	"	"	"	"	"	" " "
Keansburg	"	"	"	"	"	" " "
Keyport	"	"	"	"	"	" " "
Madison Township	"	"	"	"	"	See note 4.
Matawan Borough	"	"	"	"	"	See note 3.
Matawan Township Authority (2 plants)	"	"	"	"	"	" " "
Middlesex County Sewerage Authority			4/31/68	10/30/68	10/30/70	
Perth Amboy	10/1/67	4/1/68	3/1/69	6/1/69	10/30/70	See note 1.
Sayreville	"	"	"	"	"	" " "
South Amboy	"	"	"	"	"	" " "
Woodbridge (Keasbey)	"	"	"	"	"	" " "
American Cyanamid (Bound Brook)					1/1/70	See note 2.

1. Or agree to tie into Middlesex County Sewerage System on or before 10/1/67.

2. Other significant dates refer to equipment testing and installations.

3. Work performance schedule shall be in conformity with the master engineering plan for sewerage services in the County of Monmouth approved by the N. J. State Department of Health.

New Jersey State Department of Health
Arthur Kill Basin
Performance Schedule Under Current Orders

	Report on Design	Preliminary Plans	Final Plans	Award Contracts	Complete Construction	Remarks
Perth Amboy	10/1/67	4/1/68	3/1/69	6/1/69	10/30/70	See Footnote 1
Borough of Carteret		11/1/67	2/1/68	4/1/68	4/1/69	Borough of Carteret under court order
Woodbridge Township Sewaren Section	10/1/67	4/1/68	3/1/69	6/1/69	10/30/70	See footnote 1
Rahway Valley Sewage Authority		7/31/67	3/31/68	8/31/68	10/30/69	
Elizabeth Joint Meeting	10/1/67	4/1/68	3/1/69	6/1/69	10/30/70	
Linden-Roselle Sewage Authority			4/30/68	7/15/68	12/31/69	
Hess Oil and Chemical Corporation			7/1/67	12/1/67	6/1/68	
American Cyanamid Company					11/30/67	
DuPont			7/1/67	10/1/67	5/1/68	
Humble Oil and Refining Co.	10/1/70	2/1/68	6/1/68	7/1/68	12/30/69	
General Aniline and Film Corporation	6/30/68	10/30/68	4/30/69	10/30/69	10/30/70	

1. Or agree to tie into Middlesex County Sewerage System on or before 10/1/67.

the other in Carteret. In October 1965, the Elizabeth plant completed a connection into the municipal sewer system. The Carteret plant is presently negotiating for a connection into the Borough sewer system.

(c) The Sinclair-Koppers Company, located in Port Reading, is also negotiating at this time to make a connection into the municipal sewer system.

As a result of efforts of the Department and the Middlesex County Sewerage Authority, the Hatco Chemical Division of W. R. Grace & Co., located in Fords (Woodbridge Township) became a participant in the Middlesex County Sewerage Authority system on November 21, 1966. This resulted in the removal of a substantial pollution source from the Raritan River.

In addition, the Department issued orders against the Catalin Corporation, December 29, 1966, also located in Fords. Although this corporation is a participant in the Middlesex County Sewerage Authority, laxity on the part of the company resulted in a small portion of their wastes escaping into a marsh area, and thence to the Raritan River. Recent inspections have revealed that corrective measures have been completed.

Additional improvements completed in this area since the second session of this conference are noted as follows:

(a) A new secondary waste treatment facility has been constructed by the Matawan Township Municipal Utilities Authority to serve the Cliffwood Beach area along the Raritan Bay shore. These facilities were placed in operation in January of last year.

(b) The duPont Photo Products Division located in Parlin has reached an agreement with the Borough of Sayreville to discharge 150,000 gallons per day of highly concentrated wastes into the municipal sewer system for treatment at Middlesex County Sewerage Authority facilities.

(c) The Johns-Manville Products Corporation, located in Manville, has recently completed improvements to its industrial waste treatment facilities. These include segregation of the highly contaminated paper mill wastes and diversion to a mechanically aerated lagoon. This system has been in operation for a year.

Staff members of the Water Pollution Control Administration have made investigations of the industries in the Project study area. It is interesting to note that in many cases following conferences with these industries their reports commended these industries for their pollution abatement efforts.

R. J. Sullivan

General Comments

The Project study under consideration here has assigned to the Raritan River a daily BOD load of approximately 72,000 lbs. The report lists for Hatco Chemical Division a discharge of approximately 37,000 lbs per day of BOD into the Raritan River. This represents more than 50 percent of the total loading ascribed to the river. In fact, this material is no longer discharged into the river, as noted in comments above concerning this company. Furthermore, our information shows the average daily BOD loading at the present to be approximately 22,000 lbs. The discrepancy between our information and that contained in the Project report is 50,000 lbs. per day, about 10 percent of the loading of the entire Project study area.

Five cases in the area of interest recently have been brought to the courts for prosecution under our control statutes, as follows:

(1) Trans-Liquids, Inc., located in South Brunswick Township, charged with pollution of Farrington Lake (Lawrence Brook), a tributary of the Raritan River.

(2) The Borough of Carteret, charged with discharging inadequately treated waste into the Arthur Kill.

(3) Republic Wire, located in Woodbridge

Township, charged with pollution of Woodbridge Creek, a tributary of the Arthur Kill.

(4) Heyden Chemical Division of Tenneco Plastics, Inc., located in Fords (Woodbridge Township), charged with pollution of the Raritan River.

(5) Philip Carey Manufacturing Company, located in Perth Amboy, charged also with pollution of the Raritan River.

In each of these cases, actions have resulted in the issuance of a court injunction in each case.

Another indication of New Jersey's efforts to control pollution in this area is the "Master Sewerage Plan for the County of Monmouth," which was approved by our Department on March 15, 1966. This plan outlines in great detail a realistic regional approach to providing sewerage services for the entire County of Monmouth.

In the current report before this session, today's session, there have been presented a number of recommendations. The most significant of these recommendations is that favoring a minimum of 90 percent removal of BOD and suspended solids. It does not appear from the information contained in the report that this standard was scientifically determined giving full consideration to the size, location and use of the receiving waters. This standard appears to be arbitrary and without scientific or technical justification. As was pointed out earlier in this statement, New Jersey has established a minimum degree of treatment of 80 percent BOD removal. This requirement was established after a detailed mathematical analysis by the Interstate Sanitation Commission, and was further substantiated by a consultant expert in the field of water quality analysis. New Jersey's requirement of 80 percent BOD removal has been general knowledge to the Project study staff since the requirement was established.

The consulting firm of Quirk, Lawler and Matusky of New York City on the 10th of March, 1966, was engaged by the New Jersey State Department of Health to make a mathematical analysis of the effects of waste discharges entering the Arthur Kill-Raritan Bay-Raritan River estuary system.

The following data were used in this analysis for the Arthur Kill, which has the highest pollution level of the waters of the estuary system:

(a) Temperature-81°F. (Highest daily average temperature recorded in the data collected by the Interstate Sanitation Commission over a period of years.)

(b) Average Dissolved Oxygen - 4.0 mg/l (the value recommended in the Project study report.)

5mb

(c) Daily BOD loading - 500,000 pounds (the value reported in the Project study report for the entire area).

(d) A 25 percent reserve capacity for future development.

Even though these extreme parameters were used in this analysis, it was shown that an overall reduction in BOD loading of 61 percent is required to meet these conditions.

Assuming that all of the BOD originated from New Jersey and that New York was entitled to 50 percent of the assimilation capacity, it would then be required that the New Jersey loading be reduced by 80 percent, or the standard we now have in effect.

Therefore, under the worst conceivable conditions a reduction of 80 percent in the BOD loading would satisfy the specified requirements during extreme conditions, with a large margin of safety, since 25 percent reserve capacity has been allowed for in the analysis. An additional safety factor is built in this analysis because there are only insignificant sources of pollution now originating in the Staten Island area. This area may never build up to a point of requiring its allowed 50 percent of the capacity of the waterway.

It is our opinion that if the recommended 90 percent BOD removal is established in the Project study area such a requirement would set back the entire pollution abatement program for several years. All of the working programs and time schedules have been established based on New Jersey requirements.

I would like to emphasize this point. I have no psychological attachment to the standard of 80 percent. Four months ago I never heard of it.

My only concern here would be, as administrator of this program, that we do not, in an attempt to achieve a higher degree of clean water, have further delay. Because of the fact that the industries and municipal systems here themselves treat a great deal of industrial waste, a lot of the research and development was indeed geared to comply with the standards of our order, based on 80 percent. This work by our staff would be nullified by a new standard at this date, making it possible for a new time schedule and the changing of our orders.

Whatever we do now, I can't see any change now that would put off to, say 1972, that which can be established by 1970, especially since there is no scientific justification for the standard that is already in force.

There is only one significant source in New Jersey of raw sewage being discharged into the Project study area. This originates from two sections of the City of Elizabeth. The City of Elizabeth has recently advertised for bids and authorized an expenditure of almost one million dollars for the construction of interceptor sewers to serve these areas.

New Jersey's water quality criteria specify a dissolved oxygen requirement of not less than 50 percent

R. J. Sullivan

saturation for TW-1 waters (Raritan Bay and tidal portion of the Raritan River and its tributaries) and not less than 30 percent saturation for TW-3 waters (Arthur Kill). To meet these requirements the average dissolved oxygen saturation will be much higher than these absolute minimum values, especially in the tidal waters of the Project area.

Therefore, it is our opinion that our oxygen standard saturation is at least comparable to that of the Project report.

In my own judgment there is a remarkable improvement in the prospect of a successful attack against the destruction of our waterways by pollution. We look forward to continued cooperation with our neighboring States, the Interstate Sanitation Commission, and the Department of the Interior in protecting the public interest in this important area.

Thank you.

MR. STEIN: Thank you, Mr. Sullivan.

Are there any comments or questions?

(No response.)

MR. STEIN: Mr. Sullivan, I would like to congratulate you on a very clear and comprehensive statement.

I can understand it very well, although I did not really have the benefit of reading it 21 days in advance, or even now, when you gave a copy to the reporter. I understand Mr. DeFalco had that 20 minutes ago, and you started speaking 19 minutes ago, but I think your statement speaks for itself. It is really clear, and I had no trouble understanding it.

I think you pointed out, though, the major discrepancies that might be discussed by the conferees in executive session, and that is the clear issue of the difference between the 80 and 90 percent. I don't think there is any doubt about that.

I have one more point on a tactical statement. I am not arguing with the 80 or 90, because that is a matter of view. I think the facts are straight.

However, there is one statement that is repeated over and over again, a sober, factual statement, and that is, "If we get the money promised under the Federal Act."

Gentlemen, as many of you well know, no money was promised under the Federal Act.

Under the Federal system, as in most State systems, we have an authorization and an appropriation. An authorization is not a binding promise. It is not a promissory note. At most, it is a hunting license.

We may have differences of view in judgment on what you say. I don't have any differences on your facts or your computations, although our scientific people may have, but this is the kind of thing that we have heard over and over again, and that creates a load of confusion.

If we had in the Federal Government all the money appropriated for which there were authorizations, the national debt wouldn't even begin to come close. The authorizations vastly exceed that.

In other words, you have to remember, as we have to remember, that in the States until the State legislature or the Congress appropriate the actual cash, we do not have it. There is no holding a legislative body, State or Federal, to any kind of promise.

MR. SULLIVAN: I will change from "promise" to "authorize."

MR. STEIN: Thank you (Laughter).

Are there any other comments or questions?

(No response.)

MR. STEIN: If not, thank you very much.

Dr. Kandle?

DR. KANDLE: We would like to hear from the Middlesex County Sewerage Authority. Mr. Mat Adams will speak

STATEMENT OF H. MAT ADAMS, CHAIRMAN, MIDDLESEX COUNTY SEWERAGE AUTHORITY, SAYREVILLE, NEW JERSEY

H. M. Adams

MR. ADAMS: Chairman Stein, Distinguished Conferees, Ladies and Gentlemen:

My name is Mat Adams. I am Chairman of the Middlesex County Sewerage Authority.

The Middlesex County Sewerage Authority, serving the lower basin of the Raritan River and its tributaries which comprises Middlesex County, portions of Somerset and Union Counties, their municpalities, joint meetings and separate industrial firms, is pleased to participate in the Third Session of this conference called by the United States Secretary of the Interior. We wish to commend those who have assembled the voluminous data contained in the various reports for the conferees and to again state our appreciation for the opportunity of participating in the fact-finding efforts carried out over the past few years by the fine personnel of the Federal Government.

Represented at this conference are officials of the Federal Government, the two States concerned -- New York and New Jersey -- the Interstate Commission, regional groups such as ours and the representatives of municipalities and industries of the region. It is our fervent hope that in this fight against water pollution a real and dynamic partnership may come to exist between the levels of government involved so that time, energy, talent and money may be best employed to eliminate the presence of pollution in our waters.

We have welcomed this conference as we have the two previously held. We have consistently called for higher standards of pollution control and vigorous and uniform enforcement thereof.

We wish to record our approval of the progress made in New Jersey in administrative and legislative matters concerning water pollution under Governor Hughes' leadership. The splendid work of the representatives of the Federal Water Pollution Control Agency with Dr. Kandle, New Jersey Commissioner of Health, has borne fruit and has brought forth an up-dating in the approach to a better solution of problems in this area, demonstrating once again the benefits that may be derived from a Federal-State partnership.

It has been this Authority's policy, our interpretation of our duty, to pursue ways and means to do a more effective pollution control job and to anticipate the future, even without regulatory order or suggestion. After thorough investigation by our engineers as to the methods of secondary treatment best applicable to our wastes containing a heavy percentage of industrial wastes, we placed in operation two pilot treatment plants for experimental purposes in November 1965. The results of these studies definitely indicate that the wastes of this Authority are treatable by microbiological methods. Therefore, we have commissioned engineers to draw up preliminary design for this secondary process together with a study and preliminary design of expansion of our trunk line collecting system to meet the explosive growth of our basin. The Authority has funded more than half a million dollars for these engineering purposes.

Reflecting a concept strongly advocated by the State Department of Health, we have opened the door to those municipalities and separate industries in the lower valley and bay area and the upper river who have not joined our Authority as participants to study with us ways and means of joining with us in one vast regional approach for central treatment and disposal of wastes. In those instances wherein definitive studies have been made both the efficiency and the economics appear to markedly favor the centralized regional approach.

We have been concerned with a recent public discussion of perhaps locating a major metropolitan jetport at the Solberg site in Hunterdon-Somerset Counties in the heart of the State reservoir system of the Raritan watershed. Spruce Run Reservoir is now operating and Round Valley Reservoir is now filling up, and both are designed to release water into the branches of the Raritan for down-river potable draws. Round Valley and the open streams would one day carry

8mc Tocks Island water from the Delaware, and New Jersey has requested 300 million gallons daily. Other reservoirs planned are all within a few miles of the jetport site itself, which would virtually border both branches of the Raritan. We soon discovered that we had the makings of a major pollution catastrophy.

In brief, the sources of pollution were from three groupings that could all directly result from the jet-port, and the calculations of pollution loadings when projected on the limited flows of the streams were quite shocking. The sources were:

1) Residual pollution after sewage, industrial wastes and stormwater from the jetport had been treated and discharged into the streams;

2) unburned hydrocarbons and other exhaust gases from the jets from taxiing, landing, take-off and hold patterns of planes in the area of the jetport, including the influx of thousands of automobiles and emergency dumping of jet fuel;

3) the pollution created from new industries and a new spread city as "camp followers" of the jetport.

The Governor of New Jersey has removed this site from consideration, at least for the time being. We believe that the pollution menace of this potable watershed will remove it forever. Also the impact of locating the jetport in this watershed would be immense on the water use of the basin affecting plans downstream, including the Army Corps of Engineers' studies of the Crab Island Dam and intrusion into the bay's waters of pollution, including some very difficult-to-treat chemicals from the jetport and that area.

We are proceeding with our planning and development with the assumption that a gross error such as this will not be made at some future time. We cannot compensate for it in our planning and attain the satisfactory water use results unless we change the concept and reduce both the quantity and quality of the water.

On July 3, 1967, just several weeks away, we commence construction of a 67 million gallon daily pumping station gravity sewer and force main on the northern side of the Raritan, enabling us to serve an expanded industrial and municipal requirement in the Edison-Heyden area, as well as others who may seek our service in that general region.

In all of these efforts anticipating the future, our boldness in committing our own funds and our desire to accomplish our mission in the finest manner, we would be remiss if we did not take full cognizance of what is happening around us and what others may do or not do which would virtually torpedo what we will do. In short, the Raritan Bay is the "low man on the totem pole" in the greater New York waters. If ever the rule of relativity was applicable, it is so in these waters.

Although we are encouraged with a number of things that are happening in the States of New Jersey and New York, we still wish to register our concern about the general situation. The hundreds of millions of gallons of raw sewage and the added jolts of partially treated industrial wastes that enter the Hudson River far upstream at Troy, Rensselaer, Albany and other places along the Hudson are of concern to the resident of Plainfield, New Brunswick and Bound Brook, as well as to the industrialist in Middlesex Borough and Sayreville. For this pollution from the Hudson, from New York City, from Newark Bay, from Northern New Jersey sources, from the Arthur Kill or the Kill Van Kull enters Raritan Bay. Today it joins with local sources in hitting the bay, and the contribution from other than the bay's shores is in itself enormous.

Therefore we are concerned with the rules, the timetables, the standards and the stream criteria and the uniform enforcement of these requirements, when violated. We think we have a right to expect uniformity. Certainly the record of achievement and agreement among the States of the Delaware River Basin, wherein New York State and New

Jersey and the Federal Government play such a vital role should indicate the concerted agreement possible in these interstate waters of the greater New York metropolitan area.

I would like to say at this time that certainly we in New Jersey salute Governor Rockefeller for his courageous and very able program of the bond issue for $1 billion to get the ball rolling in New York State for a fast water clean-up. He certainly has set the tone and the spirit and the pace for the other States to follow. He has given all the States, I am sure, great encouragement in this field.

As to the recommended timetable for completing municipal treatment plants to meet new standards, the Middlesex County Sewerage Authority, operating under orders from the New Jersey State Department of Health, wishes to advse as follows:

1. The Federal suggestion is that treatment plant design must be completed by not later than December 1, 1967. The State of New Jersey order calls for such work to be completed by April 30, 1968. This date was predicated on completion of the work of our two pilot plants, which were completed on April 30, 1967, and a preliminary design contract has been duly entered into calling for completion of the preliminary work by November 1, 1967, and anticipating final design by April 30, 1968.

2. Initiate construction no later than June 1, 1968, as suggested by the Federal people. This must be compared to the New Jersey order date calling for same by September 30, 1968.

3. The Federal suggestion calls for June 1, 1970, to be the completion date and the State order calls for October 30, 1970.

We have accepted the New Jersey order in good faith and have acted contractually thereon. We have committed more than half a million dollars of our funds for the implementation of this timetable program.

Our position at this conference is to support this order. Therefore, Dr. Kandle, we support your position in regard to this matter.

This Authority, as well as other agencies and people interested in this vast problem of pollution control, is concerned with the aspects of financing the projects which call for the outlay of tremendous sums of money. In our case the secondary treatment plant could reach $30 million. It was in recognition of this problem nationally that there evolved a sincere desire to divide the costs of these projects between the Federal Government, the States and the local or regional government concerned. This is a matter of law. This Authority was a part of a national movement that supported this philosophy and subscribed to and publicly advocated a "crash program" for an all-out effort to finance and build these required water treatment facilities at the earliest date. And this position was taken long before meaningful legislation to accomplish this was introduced in the Congress.

The Congress acted with the Clean Waters Restoration Act of 1966, which was passed unanimously by both Houses and supported by both political parties. The Federal Government authorized a water treatment program which would escalate from year to year with $450 million in grants in 1968, $700 million in 1969, $1 billion in 1970 and $1.25 billion in 1971.

Also stipulated was that maximum grants of upwards to 55 percent of construction costs would be to those projects in States where the State would grant 25 percent of construction costs if they were regional and conformed to a comprehensive plan.

Governor Hughes advocated and New Jersey, for the first time in its history, has responded with a 25 percent grant appropriation. However, the disturbing element is that the Federal Government as reflected by the President's Budget asks that the 1968 authorization be cut from $450 million to $203 million, moved, we are sure, by problems pertaining to our military commitments.

We have asked our representatives in Congress to restore the authorized amount in the appropriation bill. We feel that in this initial year, with timetables for performance obviously predicated on the fulfillment of the authorized funds, the almost 60 percent cut would throw programs out of gear and have a sorry psychological dampening of enthusiasm to meet responsibilities as planned.

We are hopeful that Congress will respond to public demand and restore these funds. If not, we foresee problems.

We have submitted this to you, Commissioner Roscoe Kandle, in your capacity as the New Jersey Conferee in this conference, and we trust it will be made a part of the record.

In your capacity as Commissioner of Health for New Jersey, this Authority wishes to express its appreciation for your many kindnesses and fine efforts in our common endeavors in the Raritan, as well as for your leadership in this field.

Thank you very much.

MR. STEIN: Thank you, Mr. Adams.

Would you wait for any comments or questions?

I have just one comment. By the way, I think this is an excellent and very perceptive statement, but, among other things, you mentioned the interrelationship of the Hudson and the Raritan Bay. You go as far upstream as Troy, Rensselaer, Albany, Plainfield and other places, and I could not agree with you more. Then you say, "We think we have a right to expect uniformity." I agree with you.

Now, the problem here, as it is with every city, is that Troy, Rensselaer, Plainfield, New Brunswick, Bound Brook, and so forth and so on, also think they have a right to expect uniformity together with you.

The question you raise and that must be faced here is that you are dealing with the entire Hudson River. I think the time schedule is what we should talk about. By secondary treatment we mean 90 percent. If we come up with secondary treatment; if they are thinking in terms of uniformity and you are talking in terms of uniformity -- this is the problem that you are just going to have to face.

I just want to focus the issue. This is quite important, I think, for both States and the Federal Government. I don't want to minimize this.

Again, I say that you have stated the problem as clearly as I have seen it stated. But from the other point of view, those other cities are asking for uniformity too.

Are there any other comments or questions?

(No response.)

MR. STEIN: If not, thank you very much.

Dr. Kandle?

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DR. KANDLE: May I inquire? I have the names of some people from New Jersey who indicated that they might want to speak, and I am sorry that I have not been able to identify them. The list is as follows:

Mr. Robert Smalley.

I do not have the name of the Morgan Bayview Manor Improvement Association.

Mr. Meseroll.

MR. KARMATZ: Mr. Meseroll will be here tomorrow.

DR. KANDLE: We will have another speaker, Murray, if I could ask your indulgence. With the people tomorrow then we will complete our presentation.

MR. STEIN: Do you have any more today?

DR. KANDLE: No, sir.

MR. STEIN: All right. That concludes New Jersey.

As I understand our commitments, Mr. Glenn, we have this room engaged until five o'clock. Do you think we can find a convenient breaking point, or I will be glad to incur the wrath of the management if you want to go over that time. I just wanted to indicate that to you.

MR. GLENN: We should be through by four-thirty.

MR. STEIN: All right. Thank you very much.

MR. KARMATZ: My name is Karmatz and I am from New Brunswick, New Jersey. There will be two men here tomorrow. Mr. Meseroll will be one.

MR. STEIN: Either see Dr. Kandle or myself, and we assure you that anyone who feels they have anything relevant to say will be given an opportunity to present the statement.

Mr. Glenn?

MR. GLENN: The Interstate Sanitation Commission would like to call on our Chairman, Dr. Natale Colosi, to present the statement.

STATEMENT OF DR. NATALE COLOSI, CHAIRMAN, INTERSTATE SANITATION COMMISSION, NEW YORK, NEW YORK

DR. COLOSI: Mr. Chairman, Distinguished Conferees, Ladies and Gentlemen:

My name is Natale Colosi. I am Professor of Bacteriology and Public Health at Wagner College, and also Dean of New York Polyclinic Medical School and Hospital. However, I speak here today in my capacity as Chairman of the Interstate Sanitation Commission.

The Interstate Sanitation Commission and the State and local water pollution control agencies of New York and New Jersey have continued to engage in an active and effective program in the New York metropolitan area waters.

N. Colosi

We would like to bring the status of pollution abatement up to date since the Second Session on the Pollution of the Interstate Waters of the Raritan Bay and Adjacent Interstate Waters was held on May 9, 1963.

The waters of Raritan Bay are affected by any pollution in entrant waters from the Arthur Kill, Raritan River, through the Narrows and from any direct discharges locally.

Some wastes are transported by the Arthur Kill directly into the Raritan Bay, but the majority of the wastes discharged into the Arthur Kill pass through the northerly end out through the Kill Van Kull and eventually through the Narrows into the Raritan Bay. As stated at the second conference, the Commission in November 1962 determined the assimilative capacity of the tidal waterway and made it possible to set new treatment requirements for the Arthur Kill. The State of New Jersey and New York City followed this up with orders to municipal and industrial plants requiring 80 percent removal of BOD or its equivalent.

Several of the smaller industries found it more economical to connect to municipal systems rather than provide secondary treatment on their individual wastes. One of the larger industrial plants has chosen to barge their wastes 110 miles to sea. Their barge is under construction and this operation should begin in September of this year. Three of the five municipal plants located in New Jersey along the Arthur Kill constructed and operated pilot plants and these studies are nearly completed.

The State of New Jersey followed up the original orders with amended orders which contained detailed timetables. The Rahway Valley Sewerage Authority is scheduled to complete construction by October 30, 1969, the Linden-Roselle Sewerage Authority by December 31, 1969, the Elizabeth Joint Meeting and the Woodbridge Treatment Plants by October 30, 1970, and the Carteret Sewage Treatment Plant has been turned over to the Attorney General of New Jersey for the necessary legal action to obtain compliance.

The industries on the Arthur Kill which are required to have 80 percent BOD reduction or equivalent, have also received timetables requiring completion by specific times, some as early as this year, but none later than October 30, 1970. Elizabeth is receiving bids on the two projects which will remove raw wastes from the Bayway and Singer area. These projects will be completed this year. On the New York State side of the Arthur Kill, it was determined that the Willowbrook State School, instead of going into secondary treatment, would put in a pumping station and pump to the Port Richmond Treatment Plant on the Kill Van Kull. This diversion has now been completed. The two industrial waste discharges will be intercepted into the New York City sewer system. The West Branch Interceptor of the Port Richmond Plant which will intercept one of these industrial plants, is scheduled to be completed in the summer of 1968 and the Tottenville Plant will intercept the other.

In addition to wastes from the Arthur Kill eventually passing through the Narrows, there are other sources in the Upper Harbor area which were subject to the Hudson River Conference, which also discharge out through the Narrows and affect Raritan Bay. In 1965, the States agreed with the Commission that more than primary treatment should be required and it would be left to the States as to what degree of secondary treatment is necessary. At the Hudson River Conference the States and this Commission again agreed to this policy of secondary treatment. Construction continues on the Newton Creek Pollution Control Project and is nearing completion. This plant will provide treatment for approximately 300 million gallons per day of raw wastes and will remove approximately 150 million gallons per day for treatment immediately and the remainder will be intercepted for treatment in 1968, when the pumping station on Manhattan is completed. This project has been under construction for several years and the total cost is approximately $165,000,000.

It will make a substantial improvement in the quality of the water passing through the Narrows and thereby will benefit the bathing beaches of the Raritan-Lower Bay area.

The States and the Commission agreed in 1965 that chlorination would be required for plants in the Upper Harbor area by the summer of 1967. This is timed with the completion of the Newtown Creek Plant. This chlorination requirement will make a tremendous improvement in the bacteriological quality of the beaches in the Staten Island and Coney Island area. The North River Treatment Project, which will remove the remainder of raw wastes from Manhattan for treatment, has been designed and some of the interceptors are under construction. The treatment plants in the Upper Harbor, Lower Hudson and Kill Van Kull areas have been issued orders by the State of New Jersey with detailed timetables. The larger plants affected by these orders are Passaic Valley, Bayonne, Jersey City and Hoboken, and the construction of secondary treatment plants to remove not less than 80 percent BOD is to be completed not later than October 30, 1970. New York City has designed plans not only for secondary treatment, but also greater capacity for the Port Richmond Plant. This is scheduled to be completed during 1969.

In the immediate Raritan Bay area, New Jersey has issued orders on all plants requiring secondary treatment not later than October 1970. The Middlesex County Sewerage Authority in preparation for this additional treatment has been operating a pilot plant to obtain design criteria. The Tottenville Plant is under design and the plant for secondary treatment completed by the summer of 1969. New York City is planning an extension of the Oakwood Beach interceptor by the summer of 1969. Between this interceptor and the sewer system for Tottenville, all industries along the south shore of Staten Island will be intercepted for treatment.

Thus it may be seen that very substantial progress is being made in the conference area and in the waters adjacent thereto. As the conferees agreed at the close of the second session of the conference, "The States of New Jersey and New York and the Interstate Sanitation Commission have active and effective programs for the control and abatement of pollution of the waters of Raritan Bay and adjacent waters as evidenced by:..." This was followed by a recital of the activities of the two States and the Commission up to the time of the second session. This is not to say that the waters under consideration are in a condition even approaching the quality that could prevail if the area were less heavily populated and industrialized. On the other hand, the fact of this intense population and industrial concentration must not be used to condone a lesser water quality than reasonably can be produced, and that is desirable for the health and welfare of the people of the metropolitan area.

In view of the ongoing programs already recognized by the conference, the problem is how best to sustain control and abatement activities which have been under way for a number of years. In the Raritan Bay area we do not write on a clean slate. Fortunately, all of the municipal discharges and many of the industrial discharges are already receiving a significant measure of treatment or are programmed as per administrative and court orders already issued and containing timetables for the installation of facilities. Nothing should be permitted to place obstacles in the way of compliance with these orders and timetables.

The fact that standards for effluents and receiving waters have been increasing in the past few years introduces a complicating element. Several years ago we would have viewed the achievement of primary treatment of all wastes as a proud accomplishment. Anything more was thought by the knowledgeable part of the public and the technicians to be an extra measure of virtue, above and beyond the call of necessity. It is only within the last five years that secondary treatment has been determined to be the general rule for the area. This is not to say that it should remain so for an indefinite length of time or for the future. But no one interested in improving the quality of Raritan Bay waters now or in the immediate future can ignore the fact that plants recently completed, others already under construction, and still others which have already entered the design and financing stages, rely on the proposition that secondary treatment will meet regulatory requirements now and for a reasonable time into the future. Moreover, secondary treatment is not generally understood to mean an immutable set of numbers. Account must be taken of the fact that virtually all secondary treatment facilities recently built and under way have been designed to an 80 percent removal figure, and that this has most assuredly been regarded as well within the confines of secondary treatment. Indeed, this 80 percent figure frequently means something more than that, because the standards in effect for most of the Raritan Bay area propose "never less than 80 percent."

The report issued by the Federal Water Pollution Control Administration just prior to this third session of the conference suggests that a flat 90 percent removal of BOD be required. It also suggests agreement on a timetable for all dischargers of waste in the area that would have universal completion of treatment works designs by the end of this year, commencement of all construction no later than mid-1968, and all treatment works in operation and meeting the 90 percent removal requirement by 1970. This completion date is realistic only if reliance is placed on the knowledge that most or all of the major projects necessary to meet the standard have already been initiated and that some actual work has been done. Indeed, so far as those who will comply with the outstanding orders by 1970 are concerned, this is the case. But their compliance will be the standard as it is now and as it was when they made their commitments, and not with an until now unknown 90 percent removal figure.

Consequently, this proposal based on an administrative decision creates a dilemma that all the conferees should avoid. Either a number of new plants will be in immediate violation of requirements, through no fault of their municipal and industrial owners, or design and construction work already in progress must be discarded, with consequent waste of money and time, and the time when actual improvement of water quality in the area can be expected must be pushed back a number of years.

If the standards being suggested were so clearly superior in practical effect on the waters of Raritan Bay and its environs to the versions of secondary treatment hitherto thought acceptable, present insistence on the new requirement might be justified, even though involving substantial delay in the attainment of any improvement in water quality. But, as already pointed out, the actual difference between what has been hitherto understood and what the Federal Water Pollution Control Administration now suggests, is quite small. The practical effect becomes yet smaller when one realizes that none of the water concerned is potable and that its uses are limited by its salt character. Moreover, it must be recognized that such difference as may exist will be periodically obliterated by mammoth discharges from combined sewers.

It should be clearly understood that the Interstate Sanitation Commission has no objection to a 90 percent removal requirement as such. If secondary treatment were not yet a fact on any significant part of the waters under consideration, and if there were not substantial construction already in preparation or under way to produce more such treatment, we would be pleased to consider the 90 percent proposal. On the other hand, the existence of the circumstances just discussed leads us to point out further that the report of the Federal Water Pollution Control Administration which proposes 90 percent removal contains no explanation of the figure and does not even attempt to show why it is the best one to meet the actual conditions and needs of the area. Accordingly, we suggest a firm requirement for secondary treatment. It is also useful to point out in the conference conclusions, as the Federal Water Pollution Control

Administration report does, that even more treatment probably will be required in the future, as population densities and pressures on water use increase, and to indicate that all future site selections should be so arranged that these additional degrees of treatment may be added.

One more point should be made. All sessions of this conference have dwelled more or less forcefully on the previous shellfish industry in Raritan Bay and on the closing of the beds because the water quality in the area is not good enough to make shellfish culture safe. Unfortunately, the Federal Water Pollution Control Administration report does not state unequivocally that shellfish require the very best water quality and that, under the conditions prevailing in the greater New York metropolitan area, even 90 percent BOD, plus year-round disinfection of effluents, will not raise the quality of Raritan Bay water to a point where there can be a safe shellfishery. Achievement of this goal, in addition to many other steps that might be necessary, would certainly require the elimination of the combined sewers in the area, at a cost of many billions of dollars.

Accordingly, we urge that proposed "Conclusion 12" be amended to read:

"12. Additional major benefits would accrue if the quality of these waters were at the level necessary to support a safe shellfishery, but this could be accomplished only at a cost running to many billions of dollars."

The Interstate Sanitation Commission is pleased to see the change that has come over attitudes toward water pollution control in this area and throughout the Nation. It is now almost universally recognized, as it was not only several years ago, that we do need to make major improvements in water quality, and that substantially increased treatment requirements must be one of the means to the necessary end. However, we do not want to see our progress measured only by paper requirements of a kind that, however impressive sounding, will produce significant delay in the actual clean-up. We need to encourage early compliance, and we do not want enforcement agencies faced with numerous foredoomed violators who can plead the changes in requirements as an excuse to win endless extensions of their timetables in the courts.

Thank you very much.

MR. STEIN: Thank you, Dr. Colosi.

Are there any comments or questions?

(No response.)

MR. STEIN: If not, thank you very much for a very complete, forthright statement.

DR. COLOSI: Thank you.

MR. STEIN: Are there any other statements on behalf of the Interstate Sanitation Commission?

MR. GLENN: That is all the statements we have.

MR. STEIN: Does anyone else have anything today?

(No response.)

MR. STEIN: Tomorrow we may well have some congressional visitors, if the situation in Washington permits. Then we will hear from New York, and, hopefully, we will be able to get into executive session. I don't know how long New York is going to take. We will see how far we can go towards concluding the conference. We will also hear from the people in New Jersey, if they appear, to make their presentations.

I suspect if we do get a visit from Washington, it may very well prove the most entertaining and instructive and dramatic portion of the conference. If that occurs, it will be at 9:00 a.m. tomorrow morning.

The conference will stand in recess. We will reconvene at 9:00 a.m. tomorrow morning.

(Whereupon, at 4:35 p.m., the conference was adjourned until Wednesday, June 14, 1967, at 9:00 o'clock a.m.)