ENVIRONMENTAL RADIATION SURVEILLANCE OF THE OYSTER CREEK NUCLEAR GENERATING STATION

NEW JERSEY STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL QUALITY
BUREAU OF RADIATION PROTECTION

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ENVIRONMENTAL RADIATION SURVEILLANCE OF THE OYSTER CREEK NUCLEAR GENERATING STATION

Conducted by the State of New Jersey
For the U.S. Environmental Protection Agency

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I. Introduction

The State has maintained an environmental surveillance program for the Oyster Creek Nuclear Generating Station owned by the Jersey Central Power and Light Company since 1965. Until 1971, major surveillance efforts were directed mainly at providing data relative to Federal effluent standards as set forth in the various Federal regulations concerning nuclear facilities. During 1971 the State initiated a comprehensive environmental study of the plant characterizing the distribution of facility-oriented radionuclides in the various biological and physical components of Barnegat Bay.(1) The 1971 program was deficient in several areas: sampling and analyses of surface air and aqueous samples containing very low concentrations of radionuclides typically discharged from the facility.

Early in 1972, a joint study of the plant was initiated by the Atomic Energy Commission, the U.S. Environmental Protection Agency, the State of New Jersey, and the facility. The study is currently near its completion and should be terminated by the end of 1973.

In April of 1972, the State entered into contract with the U.S. Environmental Protection Agency to provide offsite environmental radiation surveillance data relative to the Oyster Creek facility. Utilizing the additional financial assistance of the contract, scientific equipment was obtained in order to enable the State to evaluate many of the radiological aspects which were not evaluated in 1971.

The information reported in this text is a summarization of the data and the endeavors of the Bureau of Radiation Protection during the past year. Some aspects of the surveillance program shall be continued by the State but at a lower priority.

II. Facility Description

The Oyster Creek Nuclear Generating facility, owned by the Jersey Central Power and Light Company, is located on a 1416 acre site in Lacey and Ocean Townships in Ocean County, New Jersey. The site is approximately nine miles south of Toms River, New Jersey, thirty-five miles north of Atlantic City, New Jersey, and forty-five miles east of Philadelphia, Pennsylvania.

The facility contains a single boiling water reactor currently operating at 1930 megawatts thermal (MWt) and 620 megawatts electrical. The reactor is a single-cycle, forced-circulation boiling water reactor producing steam for direct use in the steam turbine. Fuel elements consist of slightly enriched UO_2 clad in Zircaloy-2 rods. The once-through method of cooling, utilizing water from Barnegat Bay, is provided to remove heat from the condensers. Brackish bay water is taken from Barnegat Bay via the South Branch of Forked River, passed through the condensers at a rate of approximately 460,000 gallons per minute, and discharged into the Bay by access of Oyster Creek. Radioactive liquid wastes from the facility are discharged into the condenser cooling water on a batch basis and eventually flow into Barnegat Bay by route of Oyster Creek. Radioactive gases from the off-gas system on the condensers, and airborne particulates in the ventilation exhausts from the reactor, turbine, and radwaste buildings are exhausted from a 112 meter stack.

III. Surface Air Surveillance

A. Site Location Criteria

In late July, 1972, air sampling equipment was installed at five locations within a 7.5 mile radius of the facility and at a background area 19 miles west of the plant. The site locations for the surface air sampling equipment were predicated on the maximum offsite ground level concentration per emission rate as stated in the facility's Environmental Report to the Atomic Energy Commission (1971). Section 2.6 of the report presents the general meteorological data and the theoretical annual average offsite ground level concentrations in seconds per cubic meter (Sections 2.6.3.1, 2.6.3.2, and 2.6.3.3). Maximum concentration values for each quadrant were selected according to the following grouping of the offsite directions: N (NNW, N, NNE, NE); E (ENE, E, ESE, SE); S (SSE, S, SSW, SW); W (WSW, W, WNW, NW). Each air sampling station was positioned at a site within the quadrant nearest to the distance and direction from the facility in conjunction with the maximum theoretical X/Q concentration. Table 1 lists these theoretical concentrations according to wind direction and distance from the facility. These values are annual averages based upon frequency probabilities of wind direction, wind speed, and stability class. A detailed description of each sampling location has been presented in Table 1A.

Table 1 Annual Average Integrated X/Q Values*

Direction from Stack	Distance (miles)	X/Q Value (second/m^3)
N	7.5	1.20×10^{-9}
NNE	1.5	3.86×10^{-9}
SE	1.5	4.88×10^{-9}
SW	2.5	3.83×10^{-9}
W	1.5	3.81×10^{-9}
W Background	15	1.71×10^{-10}

* Data taken from page 2.6-20 of Environmental Report, submitted by the Oyster Creek Nuclear Generating Station, Jersey Central Power and Light Company to the U.S. Atomic Energy Commission.

Table 1A

CONTINUOUS AIR MONITORING STATIONS

Site #	Direction From Reactor	Location	Distance Meters	Distance Miles
1.	W	Lebanon State Forest, Rt. 72 in open area near Maintenance Shed	30400	19.0
2.	NNE	Forked River Marina, Rt. 9 - on top of Maintenance Shed	2412	1.5
3.	N	Toms River-Highway Dept. Maint. Shed, Rt. 37, West - next to Maint. Shed	12060	7.5
4.	SE	Oyster Creek - Briar Wood Yacht Basin - eastward corner of the dock and property line.	2412	1.5
5.	N	Mr. T. J. Callahan - Lakeside Drive, Forked River. Across from Lacey Playground at Lake Barnegate	4020	2.5
6.	SW	Garden State Parkway (mm 69.0) - Barnegat Toll Plaza, behind office building	4020	2.5
7.	W	Garden State Parkway (mm 71.3) - Oyster Creek Picnic Area, behind lavatory	2000	1.25

B. Sampling Equipment

The basic unit utilized for the continuous sampling of radioactive air particulates was the Staplex high-volume air sampler mounted in a protective housing. The air sample was drawn through a MSA BM-2133 particulate filter (4 inch diameter) in tandem with a MSA charcoal canister (Part No. 46727) at a rate of approximately 25 cubic feet per minute. A seven-day timer was incorporated into the system to disclose any unexpected power failures. In order to check for dust loading of the filter, the flow rate of each sampler was determined at the beginning and end of each sampling period. Generally, no loss of flow rate has been measured for the typical weekly collection interval.

The MSA dust filter BM-2133 has been routinely used for the evaluation of atmospheric fallout by the Radiation Alert Network for over a decade. Studies performed by the U.S. Naval Research Laboratory(2) have indicated that the retention efficiency of this cellulose filter at a air velocity of 295 cm/second (36 cfm) is 98.1±0.1 percent for airborne fission products. At an air velocity of 141 cm/second (~17 cfm), the retention dropped to 88.9±0.1 percent. The flow rate obtained by most of the air samplers in the field has been over 25 cfm, which would correspond to an air velocity of 205 cm/second.

The efficiency of ^{131}I collection of the MSA charcoal canister has not been documented in the literature. The selection of this particular canister was based upon the fact that the canister was used by the Radiation Alert Network in the early 1960's for the measurement of airborne radioiodine from nuclear weapons testing. However, recent studies conducted by the Atomic Energy Commission at the Oyster Creek Reactor have indicated that the majority of ^{131}I discharged from the plant is in the form of methyl iodide (15). Upon learning this fact, several field studies were conducted to estimate the efficiency of collection of the canister for methyl iodide (^{131}I). The first field study was conducted to determine if the radioiodine was penetrating a single canister. Initially, two canisters were placed in series and the radioiodine on each canister was measured after a week of sampling. The results of the first test indicated that the first canister retained about 65 percent of the ^{131}I, assuming no breakthrough (See Table 2). A second similar test revealed an efficiency of 28 ± 22 percent.

Another field test was initiated to determine if the first canister was essentially loading with organics and the observed ^{131}I on the second canister was a result of breakthrough or loading. In this test three canisters were placed in series. If the efficiency of retention of the canister was constant (for the particular air velocity used), then the following formulae apply:

$$\text{Collection Efficiency} = 1 - \frac{\text{Activity on Second Canister}}{\text{Activity on First Canister}}$$

and

$$= 1 - \frac{\text{Activity on Third Canister}}{\text{Activity on Second Canister}}$$

The results of the latest tests show that the ^{131}I efficiency is approximately 60 to 90 percent (See Table 2). However, Earl Wittaker (12) has found that the methyl iodide collection efficiency for this canister type is dependent upon air velocity, humidity, and sampling time or total volume sampled. Consequently, if the methyl iodide was collected at the beginning of the sampling period, perhaps a portion of the organic iodide was subsequently exchanged with other atmospheric pollutants.

Table 2 Field Tests of Radioiodine Efficiency of the MSA Charcoal Canister (Part #46727)

Collection Period	Flow Rate CFM	Total Volume m^3	Canister Position	Concentration (femtocuries/m^3)	Efficiency of Collection (Assuming no breakthrough)
3-16 to 3-21-73		4,800	Top	64±4	67±5 percent
			Bottom	21±3	
3-21 to 3-28-73	24.5	7,000	Top	<2	-
			Bottom	<2	
3-28 to 4-4-73	28.5	8,000	Top	7.9±1.5	28±22 percent
			Bottom	5.7±1.4	
4-4 to 4-11-73	23.0	6,500	Top	41±3	78±6 percent
			Middle	9.0±2.3	62±18 percent
			Bottom	3.4±1.4	
4-11 to 4-17-73	25.0	7,100	Top	10.3±1.3	
			Middle	1.2±1.4	88±14 percent
			Bottom	<2.0	-

C. Surface Air Sample Analysis

Each filter paper and charcoal canister was exchanged after a sampling period of one week (168 hours). The individual filter papers were counted for 10 minutes by a "pancake" Geiger Muller detector at approximately 100 hours after the termination of sampling. The initial procedure was to count the filter at approximately 29 hours post-sampling termination, but this technique was changed upon observation of the decay curve of a typical filter sample. As observed in Figure 1, the rate of beta decay for the first eighty (80) hours after sampling is quite rapid and variations in the time of counting during this early period could lead to discrepancies in the data. The rate of beta decay beyond eighty hours is small and essentially no major correction is required.

The initial rapid decay of beta activity on the filter paper is believed to be due to the decay of naturally-occurring ^{212}Pb, a daughter product of ^{220}Rn. Complete decay of this beta-emitting radionuclide (T 1/2 = 10.6 hours) would be approximately 74.2 hours, which is close to the observed initial flat portion of the decay curve. Upon stripping the longer-lived component from the initial data points of Figure 1 and plotting these residual points on semilog paper, a single short-lived component was revealed. From the slope of the resultant line, the half-life of the short-lived component was estimated to be approximately 10 hours.

The gross beta activity on each filter was standardized to a calibrated ^{90}Sr-Y source utilized for the Radiation Alert Network.

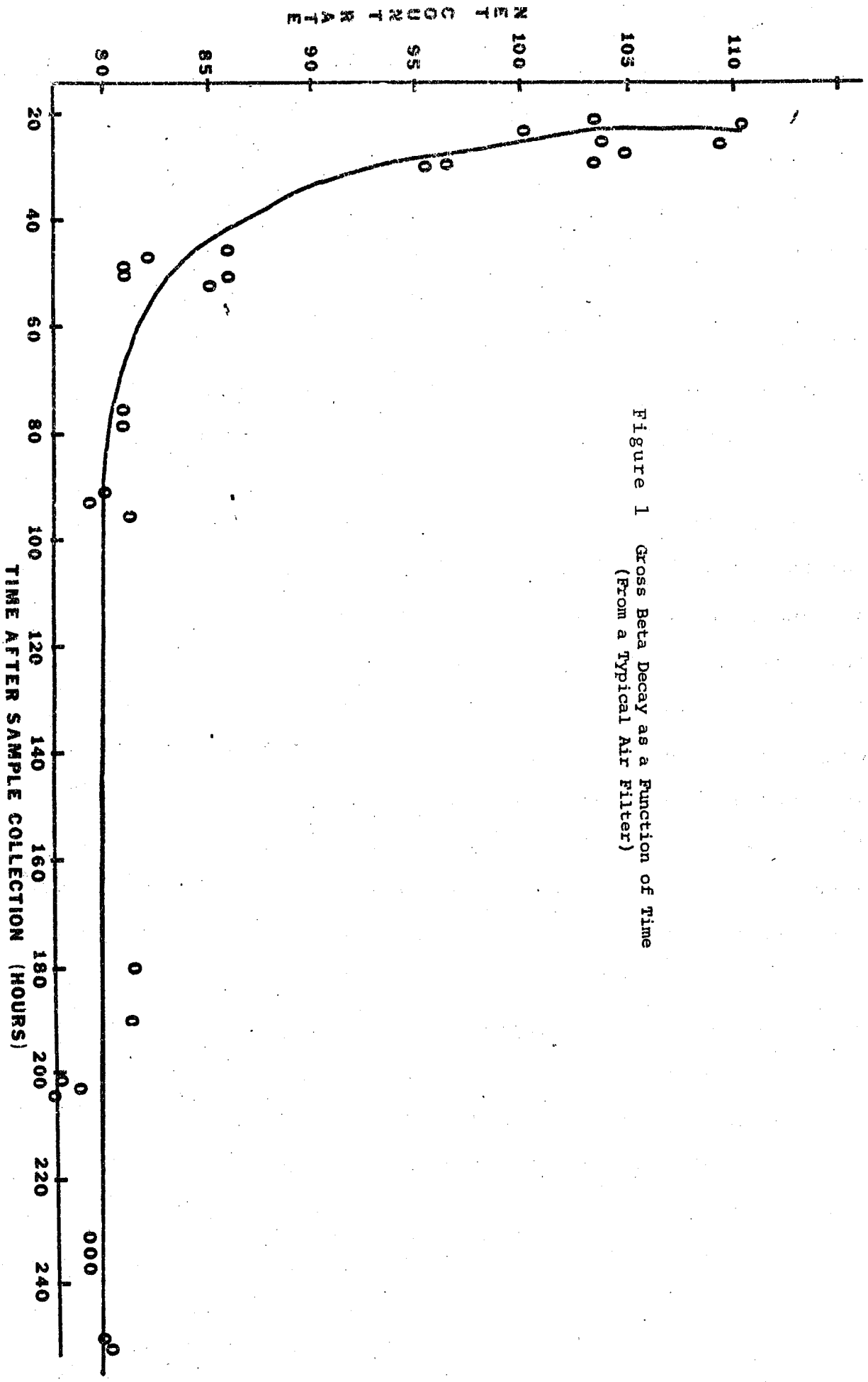

Figure 1 Gross Beta Decay as a Function of Time
(From a Typical Air Filter)

Each charcoal canister was exchanged after a seven-day sampling period and analyzed on either a NaI(Tl) or Ge(Li) gamma-ray detector. The interferring ^{222}Rn (plus daughters) gamma peaks were stripped from the NaI(Tl) spectrum by a weighted-least squares spectra-stripping computer program. Normally, only traces of the radon daughter photopeaks have been observed and the measurements do not appear to be consistent. In all cases, the measured radioiodine concentration was corrected to the mid-point of the sampling period, thus giving a weekly average assuming a constant air concentration for the week.

Following the beta analysis of the filter papers, two weekly samples from the same location were compressed into a 5 cm^3 geometry and analyzed by a Ge(Li) solid state detector having a full-width at half-maximum (FWHM) resolution of 2.9 keV at 1.33 MeV. Each biweekly sample was counted for 40,000 seconds or longer to provide reasonable counting statistics. A total of twelve (12) radionuclides were routinel analyzed and reported. The nuclides of interest were: ^{144}Ce, ^{141}Ce, ^{131}I, ^{7}Be, ^{103}Ru, ^{106}Ru, ^{140}Ba, ^{137}Cs, ^{95}Zr, ^{58}Co, ^{54}Mn, and ^{60}Co. Recent tests of stack particulate samples taken by the facility have shown that of the longer-lived radioactive airborne particulates (excluding ^{131}I) released from Oyster Creek ^{140}Ba, ^{51}Cr, ^{60}Co, and ^{137}Cs have been found in the greatest concentrations. Normally, the stack concentration of ^{140}Ba is at least ten times greater than the other longer-lived radioactive particulates released (see Table 3).

After processing the filter samples for gamma-ray emitting radionuclides, two biweekly composites from the same location were composited and analyzed for radiostrontium (^{89}Sr and ^{90}Sr) for a monthly average.

Table 3 Radionuclide Concentrations of a Typical Stack Sample

Radionuclide	Concentration pCi/liter
^{131}I	4.19±5%
^{133}I	4.75±5%
^{131}I (particulate)	0.026±5%
^{140}Ba	0.029±5%
^{137}Cs	0.0032±5%
^{134}Cs	0.00144±0.00008
^{54}Mn	0.00033±0.00006
^{60}Co	0.00100±0.00013
^{51}Cr	0.00154±0.00064
^{239}Np	0.0159±0.0026

D. Radionuclide Concentrations of Surface Air

The gross beta (^{90}Sr-Y reference) and ^{131}I (charcoal canister for organic vapors) concentrations at each of the six sites appear in Table 4 according to sampling interval. A decreasing trend in the gross beta concentration, probably related to stratospheric fallout, was evident for all stations monitored. No unusual deviations in the gross beta concentration occurred at any particular site even though high concentrations of ^{131}I were measured at several of the sites. However, the collection efficiency of the filter paper was not expected to be high for iodine-131. The greatest gross beta concentration occurred in July, 1972 during the period when stratospheric fallout was elevated in relation to the winter months.

Radioiodine was measured at levels greater than the minimum sensitivity (~2 fCi/m^3) at principally four sites for the nine-month period evaluated: 1.5 miles SE, 2.5 miles SW, 1.5 miles NNE, and 1.25 miles W of the facility. The greatest ^{131}I concentration of 127 $\pm$ 7 femtocuries/m^3 was measured at the 1.5 mile SE site during startup of the plant on January 10, 1973. This measurement was for a five-day sampling period rather than the normal weekly sampling interval. It is unknown whether the release of the ^{131}I occurred in a short burst or averaged over a period of two days. Elevated radioiodine levels of the order of 10 to 60 fCi/m^3 were also noticed at sites 15-26-51-70 (1.5 miles SE) and 15-26-14-70 (1.5 miles NNE) during the two-month period prior to refueling on April 13, 1973.

The data presented in Table 4 has not been corrected for the canister efficiency, since the efficiency studies began during the latter part of the contract period and the results of the tests are not conclusive. Therefore, the data presented in this report are lower than the actual ^{131}I concentration values.

TABLE 4 GROSS BETA AND I^{131} CONCENTRATION (FEMTO CURIE/M^3) OF AIR SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK NUCLEAR POWER GENERATING STATION

Site #	Location #	July 27-Aug. 7	Aug. 7-Aug. 14	Aug. 14-Aug. 21	Aug. 21-Aug. 28	Aug. 28-Sept. 5	Sept. 5-Sept. 12	Sept. 12 Sept. 19	Sept. 19 Sept. 26
1	Gross β 03-81-02-70		64±3	42±2	35±2	38±3	53±3	31±2	14±3
	I^{131} 03-81-02-71		<1.5	<1.8	0.15±.90	0.8±1.2	0.9±1.3	<1.5	<1.7
2	Gross β 15-26-14-70	83±4 (1) 127±7 (2)	52±3	58±4	33±3	49±4	72±4	45±3	24±3
	I^{131} 15-26-14-71	.77±2.70 (1) 1.4±2.3 (2)	1.6±1.8	<2.5	4.8±1.2	0.8±1.9	<2.6	6.4±1.4	<1.9
3	Gross β 15-14-03-70	50±2	57±3	48±3	29±2	33±3	51±4	29±3	13±3
	I^{131} 15-14-03-71	<1.5	<1.5	0.9±1.4	0.52±0.84	0.3±1.2	0.6±1.4	<1.8	<1.9
4	Gross β 15-26-51-70	55±2	64±3	50±4	25±2	37±3	54±4	32±3	18±3
	I^{131} 15-26-51-71	1.1±1.4	1.0±1.6	<2.2	2.5±0.9	2.9±1.5	<2.4	1.6±1.3	<1.8
6	Gross β 15-26-52-70	43±4	53±4	45±3	36±3	45±4	60±4	45±4	21±4
	I^{131} 15-26-52-71	1.9±2.1	0.4±1.3	<2.1	0.6±1.2	3.1±1.8	2.3±2.1	<2.1	3.6±3.4
7	Gross β 15-26-53-70	44±4	67±4	55±4	38±4	43±4	58±5	32±3	17±3
	I^{131} 15-26-53-71	2.0±2.5	0.3±1.5	6.8±1.7	1.1±1.1	4.6±1.1	<4	<1.8	<4.0

NOTES: I^{131} CONCENTRATIONS CORRECTED TO MID TIME OF THE SAMPLING PERIOD. ALL STANDARD DEVIATIONS QUOTED AT THE 95 PERCENT CONFIDENCE LEVEL. GROSS BETA CONCENTRATIONS CORRECTED TO 100 HOURS POST SAMPLING TERMINATION.

(1) SAMPLE COLLECTION PERIOD JULY 26 TO AUGUST 3, 1972.

(2) SAMPLE COLLECTION PERIOD AUGUST 3 TO AUGUST 7, 1972.

TABLE 4 GROSS BETA AND I^{131} CONCENTRATION (FEMTO CURIE/M^3) OF AIR SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK NUCLEAR POWER GENERATING STATION

SITE #	LOCATION #	SEPT. 26-OCT. 3	OCT. 3-OCT. 10	OCT. 10-OCT. 17	OCT. 17-OCT. 24	OCT. 24-OCT. 31	OCT. 31-NOV. 7	NOV. 7-NOV. 14	NOV. 14-NOV. 21	NOV. 21-NOV. 28	NOV. 28-DEC. 5(6)
1 19 MI. W	GROSS β 03-81-02-70	33 ± 4	18 ± 3	31 ± 3	18 ± 3	16 ± 3	28 ± 3	8.6 ± 2.9	18 ± 3	20 ± 3	22 ± 3
	I^{131} 03-81-02-71	<2.2	<2.2	1.5 ± 1.2	<2.6	<3.0	<3.4	<2.0	<2.5	<2.7	<2.0
2 1.5 MI. NNE	GROSS β 15-26-14-70	33 ± 4	26 ± 3	30 ± 3	19 ± 3	18 ± 3	25 ± 3	5.4 ± 2.7	16 ± 3	18 ± 2	14 ± 2
	I^{131} 15-26-14-71	4.5 ± 2.1	<3.2	6.6 ± 1.7	3.2 ± 2.0	1.7 ± 1.7	3.2 ± 1.3	<2.3	1.3 ± 1.5	3.3 ± 1.7	<1.5
3 7.5 MI. N	GROSS β 15-14-03-70	21 ± 3	MOTOR FAILURE	32 ± 3	28 ± 4	17 ± 4	30 ± 4	5.5 ± 3.8	11 ± 3	17 ± 3	13 ± 3
	I^{131} 15-14-03-71	<1.8		<2.6	<3.7	<3.5	<2.1	<2.9	<3.5	<2.7	<2.2
4 1.5 MI. SE	GROSS β 15-26-51-70	23 ± 3	19 ± 2	24 ± 3	20 ± 2	16 ± 4	30 ± 4	9.6 ± 3.6	20 ± 4	23 ± 4	23 ± 4
	I^{131} 15-26-51-71	2.5 ± 1.2	3.7 ± 1.7	6.2 ± 1.7	2.0 ± 1.8	2.9 ± 1.8	3.7 ± 2.9	1.2 ± 1.7	5.0 ± 2.5	5.5 ± 2.1	4.4 ± 2.9
6 2.5 MI. SW	GROSS β 15-26-52-70	22 ± 3	26 ± 3	30 ± 3	29 ± 4	12 ± 3	23 ± 3	5.3 ± 2.9	MOTOR FAILURE	18 ± 3	17 ± 3
	I^{131} 15-26-52-71	1.5 ± 1.5	<2.8	<2.4	<3.1	<2.1	<2.1	1.6 ± 1.7		0.3 ± 1.7	2.5 ± 1.7
7 1.25 MI. W	GROSS β 15-26-53-70	20 ± 3	22 ± 3	28 ± 3	19 ± 3	13 ± 3	10 ± 3	3.5 ± 2.7	9 ± 3	20 ± 3	22 ± 3
	I^{131} 15-26-53-71	4.6 ± 1.6	6.4 ± 1.4*	<2.5	<4.5	<2.5	<2.9	1.5 ± 1.6	0.6 ± 1.6	<2.6	3.0 ± 1.2

NOTES:

*WEIGHTED MEAN.

I^{131} CONCENTRATIONS CORRECTED TO MID TIME OF THE SAMPLING PERIOD. ALL STANDARD DEVIATIONS QUOTED AT THE 95 CONFIDENCE LEVEL. GROSS BETA CONCENTRATIONS CORRECTED TO 100 HOURS POST SAMPLING TERMINATION.

TABLE 4 GROSS BETA AND I^{131} CONCENTRATION (FEMTO CURIE/M^3) OF AIR SAMPLES COLLECTED IN THE VICINITY OF OYSTER CREEK NUCLEAR POWER GENERATING STATION

SITE NO.	LOCATION NO.	DEC. 5-DEC. 12	DEC. 12-DEC. 19	DEC. 19-DEC. 27	DEC. 27-JAN. 2	JAN. 2-JAN. 9	JAN. 9-JAN. 16	JAN. 16-JAN. 23	JAN. 23-JAN. 30	JAN. 30-FEB. 6	FEB. 6-FEB. 13	FEB. 13-FEB. 20	FEB. 20-FEB. 27	FEB. 27-MAR. 6
1 19 MI. W	GROSS BETA 03-81-02-70	14 ± 3	19 ± 3	8 ± 3	20 ± 4	23 ± 4	28 ± 4	26 ± 3	23 ± 5	18 ± 3	20 ± 3	21 ± 3	19 ± 3	18 ± 3
	I^{131} 03-81-02-71	0.62 ± 1.47	<2.4	<3.8	0.5 ± 1.7	<1.0	<2.3	<1.3	<3.5	<2.4	<1.5	<1.5	0.4 ± 1.2	<1.8
2 1.5 MI. NNE	GROSS BETA 15-26-14-70	14 ± 3	17 ± 3	6 ± 2	20 ± 4	26 ± 4	30 ± 4	20 ± 3	14 ± 3	16 ± 3	17 ± 3	18 ± 3	18 ± 3	11 ± 3
	I^{131} 15-26-14-71	0.62 ± 1.07	<1.6	<1.8	<2.9	<4.8	<2.6	0.7 ± 0.9	0.6 ± 1.4	0.6 ± 0.9	<1.9	0.9 ± 2.0	1.0 ± 1.6	0.2 ± 1.0
3 7.5 MI. N	GROSS BETA 15-14-03-70	11 ± 3	17 ± 3	6 ± 2	13 ± 3	15 ± 3	23 ± 4	15 ± 3	11 ± 3	13 ± 3	15 ± 3	17 ± 3	20 ± 3	17 ± 3
	I^{131} 15-14-03-71	<1.7	<2.0	0.12 ± 0.14	<0.65	0.6 ± 1.8	<1.1	<1.4	<3.2	<1.7	<1.9	<1.6	0.4 ± 1.5	<2.6
4 1.5 MI. SE	GROSS BETA 15-26-51-70	18 ± 4	26 ± 4	9 ± 3	25 ± 4	30 ± 4	NOT ANALYZED	16 ± 4	12 ± 2	11 ± 2	14 ± 3	15 ± 3	18 ± 3	14 ± 3
	I^{131} 15-26-51-71	2.1 ± 1.1	5.5 ± 2.4	<1.3	2.7 ± 2.8	<3.1	$(127\pm7)^*$ 75 ± 3	9.2 ± 1.6	3.8 ± 1.5	2.6 ± 1.1	2.3 ± 1.4	14 ± 1	15 ± 3	0.5 ± 1.2
6 2.5 MI. SW	GROSS BETA 15-26-52-70	10 ± 3	18 ± 3	9 ± 3	13 ± 3	22 ± 3	23 ± 3	16 ± 3	11 ± 3	13 ± 3	13 ± 3	16 ± 3	18 ± 3	15 ± 3
	I^{131} 15-26-52-71	<1.7	1.7 ± 1.4	1.7 ± 1.5	<2.8	<4.8	<1.8	<1.7	<1.5	<2.2	<2.0	<2.5	6.0 ± 2.3	1.0 ± 1.1
7 1.25 MI. W	GROSS BETA 15-26-53-70	10 ± 3	18 ± 3	8 ± 3	14 ± 3	18 ± 3	23 ± 3	17 ± 3	14 ± 3	12 ± 3	14 ± 3	15 ± 3	27 ± 4	21 ± 4
	I^{131} 15-26-53-71	<1.9	3.9 ± 1.8	<2.3	<2.7	<3.2		<2.0	1.1 ± 1.9	2.9 ± 1.6	2.7 ± 1.1	<2.1	<3.0	6.0 ± 1.7

NOTES: I^{131} CONCENTRATIONS CORRECTED TO MID TIME OF THE SAMPLING PERIOD. ALL STANDARD DEVIATIONS QUOTED AT THE 95 PERCENT CONFIDENCE LEVEL. GROSS BETA CONCENTRATIONS CORRECTED TO 100 HOURS POST SAMPLING TERMINATION.

* FIVE DAY SAMPLING PERIOD.

Table 4 Gross Beta and I^{131} Concentration (femtocuries/m^3) of Air Samples Collected in the Vicinity of Oyster Creek Nuclear Power Generating Station

Site No.	Location No.	Mar. 6-Mar. 12	Mar. 13-Mar. 20	Mar. 20-Mar. 28	Mar. 28-Apr. 4	Apr. 4-Apr. 11	Apr. 11-Apr. 17	Apr. 17-Apr. 24	Apr. 24-May 1
1 19 mi. W	Gross Beta 03-81-02-70	11±3	10±3	17±2	14±3	11±3	22±3	26±3	13±3
	I^{131} 03-81-02-71	<2.2	<1.6	<1.3	1.8±1.6	<1.5	<1.5	<2	<2
2 1.5 mi. NNE	Gross Beta 15-26-14-70	10±3	8±3	14±2	14±2	17±3	14±2	21±3	8±3
	I^{131} 15-26-14-71	<2.3	<2	1.5±0.8	<1.2	2.2±0.9	61±2	16±1	2±1
3 7.5 mi. N	Gross Beta 15-14-03-70	10±3	10±3	14±3	18±3	19±3	15±3	19±3	11±3
	I^{131} 15-14-03-71	<1	<2.1	1±1	<3	-	<1.5	<2	<2
4 1.5 mi. SE	Gross Beta 15-26-51-70	10±3	16±3	22±4	27±4	15±4	34±5	Motor Failure	12±3
	I^{131} 15-26-52-71	16±2	31±2	1±1	14±3	55±3	18±2		21±9
6 2.5 mi. SW	Gross Beta 15-26-52-70	6±3	10±3	11±2	16±3	13±3	14±3	18±3	11±3
	I^{131} 15-26-52-71	4.6±1.3	<3	3.7±0.8	2.9±1.1	<1.3	<1.7	<2	2±1
7 1.25 mi. W	Gross Beta 15-26-53-70	11±4	10±4	18±3	20±4	19±4	18±3	23±3	8±3
	I^{131} 15-26-53-71	1.8±1.4	5.3±1.7	14±2	17±2	4.9±1.8	<2.4	8±1	4±2

Notes: I^{131} concentrations corrected to mid time of the sampling period. All standard deviations quoted at the 95 percent confidence level. Gross beta cocentrations corrected to 100 hours post sampling termination.

The highest ^{131}I concentration (believed to be methyl iodide) of 127 fCi/m^3 corresponds to 89 percent of the maximum permissible concentration (MPC) based on the food-chain pathway (10^{-10} µCi/cc/700 = 1.43 x 10^{-13} µCi/cc = 1.43 x 10^{+2} fCi/m^3). This same ^{131}I level would be 1/1000 of the MPC air for direct inhalation as per 10CFR20. If the ^{131}I is in the methyl iodide form, only a small portion of the airborne activity would be deposited on local vegetation, thus decreasing the probability of a food-chain reconcentration. Field studies by Atkins, et. al.(3) have shown that the deposition velocity of methyl iodide is 10^{-3} cm/second or 1/1000 of the deposition velocity of I_2.

Since there are no dairy cows within ten miles of the plant, the important exposure pathway for airborne ^{131}I in the immediate vicinity of the plant is from inhalation. Measurements of airborne ^{131}I at the 1.5 mile SE station (15-26-51-70) have indicated weekly concentrations between approximately <2 to 75 fCi/m^3. The estimated weekly average concentration, based on nine months of data, would range between 8.6 fCi/m^3 (assuming the less than values are zero) and 9.1 fCi/m^3 (assuming the less than values are true values). For dose calculation purposes, the weekly concentration can be rounded to 9 fCi/m^3. Assuming a ^{131}I dose to air concentration value of 10 mrem/yr: pCi/m^3 (14,16) for adults and 14 mrem/yr: pCi/m^3 (14) for a child, the thyroid dose due to the inhalation of ^{131}I would be 0.09 mrem/yr for an adult, and 0.13 mrem/yr for a child. The theoretical thyroid dose to a person residing 1.6 miles ESE of the plant has been estimated as 0.059 mrem/yr.(14)

However, radioiodine from the gaseous plume would also be incorporated, in very low concentrations, in milk from dairy cows located 17.5 miles N of the facility. The annual thyroid dose to a child drinking milk from this dairy has been estimated to be between 0.36 mrem[14] and 5.6 mrem.[13] If 80 percent[15] of the ^{131}I released from the facility is methyl iodide, the theoretical dose estimates could be reduced by 80 percent, i.e. 0.072 and 1.1 mrem/yr. The former milk-chain dose estimate approximates the inhalation thyroid dose for a child residing 1.5 miles SE of the facility (0.13 mrem/yr). Under this circumstance, the inhalation dose for the close-in population would be just as important as the thyroid dose resulting from the milk pathway.

Of the five air sampling stations positioned around the facility, the station (15-26-51-70) located 1.5 miles SE of the plant has the greatest annual average theoretical X/Q value. The most probable wind directions at the Oyster Creek plant, based upon an annual average,[13] are from the NW (10.9 percent) and the WNW (12.4 percent). Offsite measurements by this laboratory indicate that the occurrence of airborne facility-produced radionuclides at the SE station has been greater than at the other air stations maintained.

Results of the isotopic gamma-ray analysis of air filters composited biweekly for each collection station appear in Tables 5 through 10. Since the latter part of September, twelve gamma-ray emmitting radionuclides have been routinely evaluated by a Ge(Li) spectrometry system. The origin of the twelve radionuclides can be summarized accordingly: ^{7}Be-naturally-occurring from cosmic-ray interaction with the atmosphere; ^{140}Ba, ^{131}I, ^{60}Co, ^{58}Co, ^{137}Cs, and ^{54}Mn - facility oriented; ^{54}Mn, ^{60}Co, ^{95}Zr, ^{141}Ce, ^{144}Ce, ^{103}Ru, ^{106}Ru, ^{137}Cs, and possible ^{140}Ba and ^{131}I - fallout from nuclear

weapons testing. In the event of any Chinese weapons test, cobalt-60 would be used to relate measured atmospheric concentrations to radioactive airborne particulate emissions from the facility.

The majority of the radionuclides detected in the composited samples can be attributed to fallout. The concentration of ^{141}Ce, ^{144}Ce, ^{103}Ru, ^{106}Ru, ^{95}Zr, and ^{137}Cs has steadily declined since September, 1972. It is anticipated that the surface air content of these radionuclides will begin to increase in late May or early June, indicative of the well documented "spring" maximum for stratospheric fallout.

Detectable quantities of ^{60}Co and ^{54}Mn (slightly over the minimum sensitivity of detection) have been measured principally at the collection station 1.5 miles SE of the plant. The greatest surface air concentration of these radionuclides was measured during the interval January 9 through 14, 1973, which corresponds to the maximum observable ^{131}I concentration (75 fCi/m^3) at this site. At this time, the concentration of ^{60}Co and ^{54}Mn was 2.9 and 1.7 fCi/m^3, respectively, or approximately 10^{-7} of the maximum permissible concentration for these nuclides in air. A somewhat lower ^{60}Co concentration (1.1 fCi/m^3) was measured at Station 15-26-14-70, located 1.5 miles NNE of the plant, during the second and third weeks of April, 1973 (April 11 through April 24, 1973). The weekly average airborne ^{131}I at this site for the same sampling interval ranged between 16 and 61 fCi/m^3. Radiocobalt, in significant quantities (i.e., greater than 3 σ of the counting statistics), was measured occasionally at all collection stations. During the sampling interval February 13

through 27, 1973, ^{60}Co was also detected at the background area of Lebanon State Forest. The concentration was very low, 0.23 ± 0.11 fCi/m^3.

Data reported By Jersey Central Power and Light Company (4) and gamma isotopic measurements of stack filters by this laboratory indicate that ^{140}Ba should be readily detected if ^{60}Co is found on an environmental filter sample. The facility reported stack emission information for the last six months of 1972 which has shown that the ^{140}Ba-La to ^{60}Co ratio varied between 20:1 and 29:1. However, offsite measurements at the five air sampling stations during this period have not disclosed ^{140}Ba above detection limits. Even during the period when the offsite ^{60}Co concentration average 2.9 ± 0.4 fCi/m^3, the ^{140}Ba concentration was less than 1.9 fCi/m^3. Presently, no explanation can be given to resolve the apparent discrepency between the onsite stack data and the offsite environmental measurements.

The radiostrontium content of surface air at each site for the period of September through February has been summarized in Table 11. The ^{89}Sr concentration steadily declined from September to January and leveled off to a concentration of approximately 0.2 fCi/m^3 during January and February. The drop in the ^{90}Sr air content as a function of time was not as drastic as the decline in the ^{89}Sr concentration for the same period. During September, 1972 the measured ^{89}Sr concentration ranged between 2.7 and 4.1 fCi/m^3, which was about four times the ^{90}Sr concentration. By the end of January, the $^{89}Sr/^{90}Sr$ ratio at the background station (17 miles W)

decreased to 0.35:1. The ^{90}Sr air concentration remained essentially constant (~0.4 fCi/m^3) at the majority of the air stations during November through January.

Certain abnormal deviations in the radiostrontium concentration values were noted at sites 15-26-52-70 (2.5 miles SW) and 15-26-53-70 (1.25 miles W) during November, and at site 15-14-03-70 (7.5 miles N) during January. The processed strontium carbonate precipitate for these samples was re-evaluated for possible malfunction of the nuclear instrumentation and the test verified the original values. No explanation can be given for the observed discrepancies.

Under normal plant operation, the total amount of radiostrontium (^{89}Sr and ^{90}Sr) released from the stack has been reported (4) to be about 2×10^{-3} curies per month or 0.0008 µCi/second. Using the annual average X/Q value of 5×10^{-9} second/m^3 for the 1.5 mile SE site (15-26-51-70), the expected annual average ground concentration should approximate 4×10^{-12} µCi/m^3 or 4×10^{-3} fCi/m^3. Even if this radiostrontium concentration was strictly ^{89}Sr, it would be virtually impossible to differentiate facility-produced radiostrontium from current levels of radiostrontium produced by previous weapons testing.

In general, the concentration of radioactive airborne particulates in surface air in the vicinity of the Oyster Creek facility has been very low, being essentially 10^{-4} to 10^{-7} of MPC air. A complete list of the maximum permissible concentrations of the measured radionuclides in air has been presented in Table 12.

Table 5 Radionuclide Concentration of Surface Air at Site # 03-81-02-70 Lebanon State Forest, Rt. 72 (19.0 miles W)

Sampling Interval	Total Volume m^3x1000	Radionuclide Concentration (fCi/ m^3)										
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn
-7 to -14, 1972	10.5	9.5± 0.8	5.1± 0.3	0.5± 2.2	120± 5	11±1	17±2	<7.4	1.6± 0.3	7.6± 0.9	<0.3	0.1± 0.2
-14 to -28, 1972	19.4	5.6± 0.5	2.5± 0.1	0.1± 0.5	84±3	5.4± 0.3	8.0± 1.1	<2.1	0.99± 0.16	3.8± 0.6	0.1± 0.1	0.07± 0.09
-28 to -12, 1972	19.4	6.3± 1.4	2.0± 0.5	2.1± 1.4	120± 10	5.0± 0.8	3.9± 2.0	<3.5	1.2± 0.4	3.8± 1.2	<0.3	<0.4
-12 to -26, 1972	19.0	2.7± 1.5	0.65± 0.40	0.34± 0.82	73± 8	1.9± 0.6	2.9± 2.2	0.2± 2.4	0.76± 0.48	1.7± 1.2	<0.5	<0.6

Notes: Samples analyzed by a Ge(Li) detector. ^{95}Nb concentration is available if desired. Standard deviation is quoted at the 95 percent confidence level. All concentrations have been corrected for buildup and decay of the radionuclides on the filter paper during sampling. Filter paper-MSA-2133.

* Particulate only.

TABLE 5 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE #03-81-02-70

LEBANON STATE FOREST, RT. #72 (19.0 MILES W)

SAMPLING INTERVAL	TOTAL VOLUME M^3 x 1,000	RADIONUCLIDE CONCENTRATION (FCi/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
9-26 TO 10-10-72	19.5	3.07 ± 0.04	0.62 ± 0.12	0.12 ± 0.24	77.6 ± 0.3	1.24 ± 0.14	1.65 ± 0.90	$<0.94 \pm$	0.83 ± 0.14	1.26 ± 0.29	$<0.13 \pm$	0.023 ± 0.085	$<0.4 \pm$
10-10 TO 10-24-72	19.2	3.84 ± 0.92	0.61 ± 0.26	0.72 ± 0.72	108 ± 7	1.09 ± 0.34	3.61 ± 1.59	<2.4	0.75 ± 0.28	1.04 ± 0.58	<0.30	<0.27	0.2 ± 0.1
10-24 TO 11-7-72	17.4	2.42 ± 0.72	0.16 ± 0.19	0.12 ± 0.56	90.4 ± 4.7	0.53 ± 0.24	0.9 ± 1.3	0.2 ± 1.3	0.68 ± 0.21	0.80 ± 0.44	<0.25	<0.24	0.0 ± 0.1
11-7 TO 11-21-72	16.3	1.73 ± 0.87	0.45 ± 0.28	0.8 ± 1.3	60.2 ± 5.5	0.24 ± 0.27	0.4 ± 1.5	1.6 ± 2.3	0.37 ± 0.26	0.04 ± 0.63	<0.33	0.07 ± 0.17	0.2 ± 0.2
11-21 TO 12-6-72	18.3	2.08 ± 0.55	0.12 ± 0.14	0.08 ± 0.47	110 ± 4	0.26 ± 0.17	1.40 ± 1.09	0.74 ± 0.97	0.69 ± 0.17	0.40 ± 0.35	0.09 ± 0.12	<0.18	0.0 ± 0.1

NOTES: THE STANDARD DEVIATION (1.96σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.

LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.

* PARTICULATE ONLY

TABLE 5 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE # 03-81-02-70
LEBANON STATE FOREST, RT. 72 (19 MILES W)

SAMPLING INTERVAL	TOTAL VOLUME $M^3 \times 1{,}000$	RADIONUCLIDE CONCENTRATION (fCi/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
12-6 TO 12-19-72	14.4	1.92 ± 0.63	0.26 ± 0.19	0.34 ± 0.94	94 ± 5	0.16 ± 0.20	0.5 ± 1.3	<3.6	0.72 ± 0.08	0.43 ± 0.40	<0.37	<0.31	0.08 ± 0.16
12-19 TO 1-2-73	16.8	1.64 ± 0.47	<0.27	1.0 ± 1.9	80 ± 4	0.96 ± 0.23	1.11 ± 1.07	<4.8	0.70 ± 0.14	<0.72	<0.20	0.02 ± 0.11	0.03 ± 0.11
1-2 TO 1-16-73	14.7	1.03 ± 0.69	0.24 ± 0.24	<2.7	71.9 ± 4.9	0.12 ± 0.23	0.2 ± 1.4	<3.6	0.50 ± 0.19	0.09 ± 0.46	0.16 ± 0.19	<0.23	0.16 ± 0.20
1-16 TO 1-30-73	15.7	1.65 ± 0.49	0.15 ± 0.16	0.4 ± 0.9	82.3 ± 3.6	0.04 ± 0.16	1.6	<2.1	0.56 ± 0.15	0.38 ± 0.32	<0.20	<0.16	0.09 ± 0.13
1-30 TO 2-13-73	16.0	2.49 ± 0.53	0.1 ± 0.2	<3.1	127 ± 6	0.09 ± 0.19	1.7 ± 1.1	2.0 ± 2.2	0.81 ± 0.16	<0.47	<0.23	<0.19	0.08 ± 0.13
2-13 TO 2-27-73	17.3	2.6 ± 0.5	0.11 ± 0.17	<1.8	140 ± 7	0.11 ± 0.15	1.9 ± 1.0	<2.3	0.91 ± 0.15	0.28 ± 0.31	<0.18	0.04 ± 0.10	0.23 ± 0.11
2-27 TO 3-13-73	15.0	1.82 ± 0.50	0.12 ± 0.20	1.3 ± 2.0	89 ± 4	0.04 ± 0.19	1.2 ± 1.2	0.1 ± 2.3	0.74 ± 0.16	0.10 ± 0.33	0.04 ± 0.15	<0.18	$0.04 - 0.14$
3-13 TO 3-28-73	20.8	2.21 ± 0.43	<2.1	0.57 ± 0.94	103 ± 4	0.21	0.77 ± 0.87	1.2 ± 1.3	1.0 ± 0.1	0.24 ± 0.26	0.04 ± 0.11	0.13 ± 0.09	0.08 ± 0.10

NOTES: THE STANDARD DEVIATION (1.96σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
* Particulate only.

Table 5 Radionuclide Concentration of Surface Air at Site #03-81-02-70
Lebanon State Forest, Rt. 72 (19 miles W)

Radionuclide Concentration (fCi/m^3)

Sampling Interval	Total Volume $m^3 x 1,000$	^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
3-28 to 4-11-73	18.5	2.1± 0.6	<0.4	<8	96±5	<0.4	<2	<6	0.77± 0.19	<0.6	<0.3	0.16± 0.14	<0.3
4-11 to 4-24-73	18.4	2.9± 0.6	0.27± 0.22	<3	146±5	<0.3	2±1	<4	1.6± 0.2	<0.6	<0.2	<0.2	<0.2
4-24 to 5-8-73	19.3	2.2± 0.5	<0.3	<5	103±4	<0.3	2±1	<4	1.2± 0.2	<0.4	<0.2	<0.2	0.1± 0.1
5-8 to 5-22-73	18.9	2.6± 0.4	<0.2	<2	100±3	<0.2	1.4± 0.9	<3	1.0± 0.1	<0.4	<0.2	<0.1	<0.2

Notes: The standard deviation (1.96σ) is for counting statistics only. An additional 10 percent error may be applied due to changes in the counting geometry.
Less than values are predicated on three times the standard deviation of the net counting rate.
* Particulate only.

Table 6 Radionuclide Concentration of Surface Air at Site # 15-26-14-70 Forked River Marina (1.5 mile NNE)

Sampling Interval	Total Volume m^3x1000	Radionuclide Concentration (fCi/ m^3)										
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn
7-28 to 8-3, 1972	7.5	17.8± 1.3	12.0± 0.9	4±10	150± 10	23±2	23±4	<23	3.2± 0.5	15±2	<0.6	0.2± 0.4
8-3 to 8-14, 1972	11.6	10.9± 1.3	6.4± 0.5	<6.3	130± 10	13±1	15±3	5±7	2.3± 0.5	9.0± 1.3	<0.4	<0.4
8-14 to 8-28, 1972	14.5	6.5± 0.6	3.2± 0.2	0.2± 0.6	100± 5	7.1± 0.4	9.3± 1.5	<3	1.4± 0.3	5.4± 0.7	<0.1	<0.15
8-28 to 9-14, 1972	15.8	6.7± 0.9	2.4± 0.3	<1.4	101± 5	4.0± 0.5	5.4± 1.5	<3.1	1.4± 0.3	3.7± 0.7	0.03± 0.17	0.2± 0.2
9-14 to 9-26, 1972	15.1	4.7± 1.0	0.87± 0.28	0.54± 0.63	106± 6	2.1± 0.4	2.9± 1.6	<2.9	1.4± 0.3	1.7± 0.7	<0.34	0.15± 0.21

Notes: Samples analyzed by a Ge(Li) detector. ^{95}Nb concentration is available if desired. Standard deviation is quoted at the 95 percent confidence level. All concentrations have been corrected for buildup and decay of the radionuclides on the filter paper during sampling. Filter paper-MSA-2133.

TABLE 6 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE #15-26-14-70

FORKED RIVER MARINA (1.5 MILES NNE)

SAMPLING INTERVAL	TOTAL VOLUME $M^3 \times 1{,}000$	RADIONUCLIDE CONCENTRATION (FCi/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
9-26 TO 10-10-72	15.5	4.45 ± 0.93	1.02 ± 0.22	0.24 ± 0.64	105 ± 6	1.58 ± 0.32	3.06 ± 0.16	0.1 ± 1.4	0.75 ± 0.26	1.52 ± 0.63	0.17 ± 0.19	0.15 ± 0.18	0.41 ± 0.23
10-10 TO 10-24-72	16.7	3.46 ± 0.86	0.47 ± 0.22	0.82 ± 0.63	111 ± 7	1.21 ± 0.31	1.80 ± 1.47	0.3 ± 1.4	1.22 ± 0.51	0.50 ± 0.57	<0.29	0.07 ± 0.18	0.17 ± 0.21
10-24 TO 11-7-72	17.4	2.30 ± 0.57	0.32 ± 0.16	0.05 ± 0.53	91.8 ± 3.8	0.52 ± 0.19	0.82 ± 1.10	0.72 ± 1.11	0.69 ± 0.19	0.93 ± 0.13	0.17 ± 0.13	0.04 ± 0.12	0.11 ± 0.15
11-7 TO 11-21-72	16.9	1.06 ± 0.64	0.15 ± 0.21	0.34 ± 0.99	54.7 ± 3.9	0.27 ± 0.23	0.2 ± 1.2	0.5 ± 1.9	0.37 ± 0.19	0.45 ± 0.40	0.02 ± 0.16	<0.24	0.00 ± 0.16
11-21 TO 12-5-72	21.8	1.73 ± 0.65	0.26 ± 0.17	0.40 ± 0.51	81.4 ± 4.5	0.25 ± 0.19	0.3 ± 1.1	0.2 ± 1.0	0.66 ± 0.19	0.47 ± 0.37	0.02 ± 0.14	<0.22	0.03 ± 0.16

NOTES: THE STANDARD DEVIATION (1.96σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
* Particulate only.

TABLE 6 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE # 15-26-14-70
FORKED RIVER MARINA (1.5 MILES NNE)

SAMPLING INTERVAL	TOTAL VOLUME M^3 x1,000	RADIONUCLIDE CONCENTRATION (fCi/M^3) ^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
12-5 TO 12-19-72	19.6	1.54 ± 0.70	<0.48	0.4 ± 1.1	94 ± 6	0.147 ± 0.242	1.6 ± 1.2	<3.8	0.51 ± 0.20	0.26 ± 0.42	0.01 ± 0.20	<0.35	0.09 ± 0.16
12-19-72 TO 1-2-73	19.3	1.73 ± 0.43	0.10 ± 0.18	2.5 ± 2.1	59 ± 3	0.04 ± 0.18	1.2 ± 1.0	<5.2	0.44 ± 0.13	0.29 ± 0.31	0.04 ± 0.13	<0.23	0.19 ± 0.12
1-2 TO 1-16-73	14.0	2.49 ± 0.95	0.32 ± 0.32	<3.8	135 ± 8	0.27 ± 0.34	0.9 ± 1.6	<4.9	1.0 ± 0.3	0.14 ± 0.62	<0.39	<0.32	0.29 ± 0.25
1-16 TO 1-30-73	17.4	2.10 ± 0.47	0.05 ± 0.15	0.90 ± 0.72	70.4 ± 3.1	0.12 ± 0.15	0.7 ± 1.0	0.5 ± 1.2	0.52 ± 0.14	0.26 ± 0.29	<0.18	<0.16	0.09 ± 0.14
1-30 TO 2-13-73	17.5	1.83 ± 0.49	<0.29	0.6 ± 2.3	96 ± 4	0.14 ± 0.18	0.8 ± 1.1	2.1 ± 2.2	0.80 ± 0.15	0.49 ± 0.34	<0.22	0.07 ± 0.11	0.10 ± 0.13
2-13 TO 2-27-73	17.9	1.9 ± 0.5	0.20 ± 0.16	<1.7	99 ± 4	0.12 ± 0.17	0.5 ± 1.0	<2.3	0.63 ± 0.15	0.44 ± 0.33	<0.19	0.10 ± 0.12	0.10 ± 0.13
2-27 TO 3-13-73	16.5	1.68 ± 0.41	0.08 ± 0.13	0.82 ± 0.76	87 ± 3	0.03 ± 0.14	0.9 ± 1.0	<1.7	0.77 ± 0.14	<0.43	<0.17	0.09 ± 0.10	0.29 ± 0.12
3-13 TO 3-28-73	21.5	2.07 ± 0.38	0.09 ± 0.11	0.69 ± 0.56	88 ± 3	0.07 ± 0.11	0.90 ± 0.82	<1.3	0.82 ± 0.12	<0.32	0.06 ± 0.09	0.05 ± 0.08	0.14 ± 0.10

NOTES: THE STANDARD DEVIATION (1.96 σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
* Particulate only.

Table 6 Radionuclide Concentration of Surface Air at Site #15-26-14-70 Forked River Marina (1.5 miles NNE)

Radionuclide Concentration (fCi/m^3)

Sampling Interval	Total Volume m^3x1000	^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}C
3-28 to 4-11-73	19.9	1.9± 0.4	0.2± 0.2	<0.1	85±3	<0.2	0.9± 0.9	<3	0.85± 0.13	0.3± 0.3	0.1± 0.1	<0.1	0.2 0.1
4-11 to 4-24-73	20.6	3.4± 0.4	0.17± 0.12	0.8± 0.7	113± 3	<0.2	1.5± 0.9	<2	1.3± 0.2	<0.3	<0.2	0.60± 0.13	1.1 0.2

Notes: The standard deviation (1.96σ) is for counting statistics only. An additional 10 percent error may be applied due to changes in the counting geometry.
Less than values are predicated on three times the standard deviation of the net counting rate.
*Particulate only.

Table 7 Radionuclide Concentration of Surface Air at
Site # 15-14-03-70
Toms River Highway Depot, Rt. 37, Toms River (7.5 miles N)

Sampling Interval	Total Volume m^3x1000	Radionuclide Concentration (fCi/ m^3)										
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn
7-28 to 8-14, 1972	22.8	4.7 ± 1.1	4.2 ± 0.6	2.6 ± 4.2	74 ± 10	8.2 ± 1.1	9.9 ± 2.4	1.4 ± 1.4	1.4 ± 0.4	5.9 ± 1.5	<0.2	<0.4
8-14 to 8-28, 1972	18.5	4.6 ± 0.6	2.0 ± 0.2	0.3 ± 0.5	71 ± 5	4.2 ± 0.4	7.9 ± 1.5	0.8 ± 1.7	0.75 ± 0.24	2.6 ± 0.6	<0.2	0.02 ± 0.1
8-28 to 9-12, 1972	17.8	4.0± 1.6	1.2± 0.5	<1.7	64± 9	3.4± 0.9	3.4± 2.5	<6.2	1.4± 0.5	2.9± 1.2	0.49± 0.43	<0.3
9-12 to 9-26, 1972	17.5	3.2± 0.6	0.78± 0.17	0.08± 0.40	70± 4	1.5± 0.3	2.5± 1.1	<1.8	0.76± 0.18	1.8± 0.4	<0.3	0.06± 0.14

Notes: Samples analyzed by a Ge(Li) detector. ^{95}Nb concentration is available if desired. Standard deviation is quoted at the 95 percent confidence level. All concentrations have been corrected for buildup and decay of the radionuclides on the filter paper during sampling. Filter paper-MSA-2133.

* Particulate only.

TABLE 7 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE #15-14-03-70

TOMS RIVER HIGHWAY, DEPOT, RT. #37, TOMS RIVER (7.5 MILES N)

SAMPLING INTERVAL	TOTAL VOLUME $M^3 \times 1{,}000$	RADIONUCLIDE CONCENTRATION (fCi/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
9-26 TO 10-4-72	10.4	3.47± 0.72	0.74± 0.19	0.88± 0.71	68.6± 3.9	<0.23	0.7± 1.7	<2.3	0.96± 0.21	0.72± 0.46	0.05± 0.20	<0.27	0.5[illegible] 0.1[illegible]
10-10 TO 10-24-72	13.7	4.07± 0.92	0.51± 0.21	0.36± 0.64	124± 6	1.14± 0.33	3.44± 1.62	1.07± 1.45	1.12± 0.26	1.28± 0.60	<0.19	0.30± 0.20	<0.26
10-24 TO 11-9-72	12.7	1.93± 1.03	0.15± 0.29	0.20± 0.86	96± 7	0.78± 0.34	1.15± 1.85	<2.5	0.83± 0.33	1.54± 0.60	0.18± 0.21	0.02± 0.24	<0.3[illegible]
11-9 TO 11-21-72	13.9	1.87± 0.63	0.27± 0.17	0.08± 0.53	56.4± 3.6	0.25± 0.20	0.3± 1.4	0.2± 1.1	0.43± 0.19	<0.60	0.06± 0.18	0.10± 0.16	0.16 0.1[illegible]
11-21 TO 12-5-72	17.3	2.24± 0.44	0.15± 0.13	0.20± 0.44	71.6± 2.9	0.23± 0.14	1.14± 1.00	<1.2	0.55± 0.14	0.54± 0.29	<0.16	0.043± 0.095	0.10 0.12

NOTES: THE STANDARD DEVIATION (1.96σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
* Particulate only.

TABLE 7 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE # 15-14-03-70
TOMS RIVER HIGHWAY DEPOT, RT. 37, TOMS RIVER (7.5 MILES N)

SAMPLING INTERVAL	TOTAL VOLUME M^3x1,000	RADIONUCLIDE CONCENTRATION (FCi/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
12-5 TO 12-19-73	18.1	$2.43^{\pm}_{0.44}$	<0.36	$1.65^{\pm}_{1.34}$	$70.8^{\pm}_{3.0}$	$0.22^{\pm}_{0.16}$	$0.74^{\pm}_{0.98}$	$0.5^{\pm}_{1.7}$	$0.59^{\pm}_{0.13}$	$0.32^{\pm}_{0.30}$	$0.13^{\pm}_{0.12}$	$0.17^{\pm}_{0.11}$	$0.10^{\pm}_{0.11}$
12-19-72 TO 1-2-73	19.2	$1.35^{\pm}_{0.46}$	<0.25	<2.7	$45.9^{\pm}_{2.7}$	$0.10^{\pm}_{0.16}$	$0.54^{\pm}_{0.98}$	$1.5^{\pm}_{1.7}$	$0.26^{\pm}_{0.13}$	$0.14^{\pm}_{0.32}$	<0.2	<0.24	$0.14^{\pm}_{0.13}$
1-2 TO 1-16-73	16.2	$1.87^{\pm}_{0.49}$	$0.12^{\pm}_{0.15}$	$0.55^{\pm}_{0.80}$	$93.7^{\pm}_{3.8}$	$0.11^{\pm}_{0.15}$	<1.6	<2.0	$0.68^{\pm}_{0.15}$	$0.17^{\pm}_{0.29}$	$0.04^{\pm}_{0.11}$	<0.18	<0.16
1-16 TO 1-30-73	17.7	$0.95^{\pm}_{0.48}$	<0.22	$0.49^{\pm}_{0.69}$	$64.1^{\pm}_{3.3}$	$0.06^{\pm}_{0.16}$	$0.3^{\pm}_{1.0}$	$0.5^{\pm}_{1.1}$	$0.56^{\pm}_{0.15}$	$0.10^{\pm}_{0.31}$	$0.13^{\pm}_{0.12}$	$0.06^{\pm}_{0.13}$	$0.11^{\pm}_{0.13}$
1-30 TO 2-13-73	15.4	$1.95^{\pm}_{0.63}$	<0.32	<2.5	$100^{\pm}_{5}$	<0.30	$0.8^{\pm}_{1.2}$	$0.8^{\pm}_{2.2}$	$0.81^{\pm}_{0.19}$	<0.55	<0.25	$0.26^{\pm}_{0.15}$	$0.27^{\pm}_{0.18}$
2-13 TO 2-27-73	15.4	$2.7^{\pm}_{0.5}$	$0.07^{\pm}_{0.15}$	$0.58^{\pm}_{0.85}$	$110^{\pm}_{4}$	<0.22	$0.9^{\pm}_{1.1}$	$0.9^{\pm}_{1.3}$	$0.82^{\pm}_{0.15}$	$0.22^{\pm}_{0.29}$	<0.18	$0.05^{\pm}_{0.11}$	$0.18^{\pm}_{0.12}$
2-27 TO 3-13-73	14.8	$1.42^{\pm}_{0.58}$	$0.15^{\pm}_{0.19}$	<1.6	$75^{\pm}_{4}$	$0.10^{\pm}_{0.19}$	$0.8^{\pm}_{1.3}$	<2.2	$0.70^{\pm}_{0.18}$	<0.60	$0.04^{\pm}_{0.14}$	$0.09^{\pm}_{0.15}$	$0.23^{\pm}_{0.16}$
3-13 TO 3-28-73	16.3	$2.25^{\pm}_{0.50}$	<0.30	$1.0^{\pm}_{1.8}$	$96^{\pm}_{4}$	<0.28	$1.24^{\pm}_{1.09}$	<3.2	$0.84^{\pm}_{0.16}$	$0.15^{\pm}_{0.31}$	$0.30^{\pm}_{0.16}$	$0.12^{\pm}_{0.12}$	<0.19

NOTES: THE STANDARD DEVIATION (1.96 σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
* Particulate only.

Table 7 Radionuclide Concentration of Surface Air at Site #15-14-03-70
Toms River Highway Depot, Rt. 37, Toms River (7.5 miles N)

Radionuclide Concentration (fCi/m^3)

Sampling Interval	Total Volume m^3x1000	^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
3-28 to 4-11-73	15.2	2.4± 0.6	0.43± 0.27	<7	100±5	<0.4	1±1	<6	1.0± 0.2	<0.6	0.4± 0.2	<0.2	0.26± 0.15
4-11 to 4-24-73	17.5	2.5± 0.3	0.1± 0.1	<0.2	115±2	<0.1	1.2± 0.9	<2	1.19± 0.09	0.39± 0.17	<0.1	<0.09	0.15± 0.07

Notes: The standard deviation (1.96σ) is for counting statistics only. An additional 10 percent error may be applied due to changes in the counting geometry.
Less than values are predicated on three times the standard deviation of the net counting rate.
*Particulate only.

Table 8 Radionuclide Concentration of Surface Air at Site # 15-26-51-70
Briarwood Yacht Basin, Oyster Creek, Waretown (1.5 miles SE)

Sampling Interval	Total Volume m^3x1000	Radionuclide Concentration (fCi/ m^3)										
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn
8-14 to 8-28, 1972	17.2	5.5± 1.6	2.6± 0.6	<2	98± 12	6.2± 1.2	7.3± 3.2	<6	1.6± 0.6	5.6± 1.8	0.3± 0.4	0.4± 0.4
8-28 to 9-12, 1972	18.2	4.4± 1.3	1.8± 0.4	<1.2	79± 7	3.1± 0.7	3.5± 2.0	<6.4	1.2± 0.4	3.2± 1.1	<0.3	<0.3
9-12 to 9-26, 1972	17.7	1.7± 1.1	0.52± 0.29	0.14± 0.65	63± 6	1.1± 0.4	1.8± 1.7	0.4± 2.2	1.3± 0.4	0.71± 0.91	0.33± 0.33	<0.5

Notes: Samples analyzed by a Ge(Li) detector. ^{95}Nb concentration is available if desired. Standard deviation is quoted at the 95 percent confidence level. All concentrations have been corrected for buildup and decay of the radionuclides on the filter paper during sampling. Filter paper-MSA-2133.

* Particulate only.

TABLE 8 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE #15-26-51-70

BRIARWOOD YACHT BASIN, OYSTER CREEK, WARETOWN (1.5 MILES SE)

SAMPLING INTERVAL	TOTAL VOLUME M^3 X 1,000	RADIONUCLIDE CONCENTRATION (FCI/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
9-26-72 TO 10-10-72	18.7	2.69± 0.50	0.58± 0.14	0.04± 0.47	71± 3	0.88± 0.19	1.34± 1.02	0.8± 1.1	0.75± 0.17	1.00± 0.34	0.09± 0.14	0.18± 0.13	0.45± 0.16
10-10 TO 10-24-72	18.0	3.44± 0.57	0.50± 0.18	0.58± 0.49	101± 4	0.80± 0.20	2.3± 1.1	<1.8	1.23± 0.20	1.37± 0.39	0.09± 0.12	<0.13	0.81± 0.20
10-24 TO 11-7-72	13.0	3.40± 0.56	0.39± 0.16	0.29± 0.55	107± 4	0.89± 0.19	1.83± 1.31	<1.7	1.42± 0.19	1.10± 0.36	0.11± 0.14	0.14± 0.15	0.58± 0.18
11-7 TO 11-21-72	13.2	2.16± 0.52	0.35± 0.16	0.60± 0.73	82.4± 3.1	0.27± 0.17	0.95± 1.26	0.58± 1.26	0.88± 0.17	0.54± 0.36	<0.21	0.05± 0.13	0.05± 0.15
11-21 TO 12-5-72	12.9	2.73± 0.72	0.08± 0.18	0.46± 0.46	106± 4	0.30± 0.22	2.00± 1.46	1.06± 1.12	0.87± 0.21	0.64± 0.44	0.05± 0.16	0.12± 0.18	0.13± 0.18

NOTES: THE STANDARD DEVIATION (1.96σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
*Particulate only.

TABLE 8 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE # 15-26-51-70
BRIARWOOD YACHT BASIN, OYSTER CREEK, WARETOWN (1.5 MILES SE)

SAMPLING INTERVAL	TOTAL VOLUME M^3x1,000	RADIONUCLIDE CONCENTRATION (fCi/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
12-5 TO 12-19-72	12.5	2.70±0.43	0.18±0.14	0.23±0.84	101±3	0.11±0.15	0.8±1.2	0.1±1.2	0.91±0.13	0.44±0.29	<0.27	0.15±0.11	0.35±0.13
12-5 TO 12-19-72	15.3	1.44±0.61	0.22±0.19	0.44±0.99	69.2±4.0	<0.46	0.8±1.3	1.0±1.7	0.68±0.19	0.43±0.41	<0.24	0.21±0.15	0.44±0.19
12-19-72 TO 1-2-73	13.8	1.89±0.35	0.16±0.10	0.34±0.37	80.4±2.1	0.06±0.11	0.3±1.1	0.67±0.73	0.79±0.11	0.23±0.22	0.08±0.09	0.15±0.09	0.21±0.16
1-2 TO 1-9-73	6.7	3.54±0.80	0.44±0.29	1.4±2.4	175±5	0.15±0.28	<3.4	2.6±3.1	1.47±0.24	<0.83	<0.36	0.29±0.20	0.50±0.23
1-9 TO 1-14-73	4.9	2.54±0.86	0.10±0.20	0.56±0.47	116±4	<0.36	<4.3	<1.9	1.22±0.27	0.18±0.56	0.12±0.24	1.68±0.29	2.87±0.36
1-16 TO 1-30-73	17.0	1.25±0.50	<0.29	<3.2	68.0±3.7	0.05±0.19	<1.6	3.1±2.4	0.65±0.17	0.60±0.36	0.06±0.14	0.19±0.13	0.22±0.14
1-30 TO 2-13-73	20.7	1.73±0.44	<0.20	0.082±0.066	83.8±3.4	0.17±0.13	0.54±0.90	0.4±1.1	0.59±0.14	<0.42	<0.17	<0.10	0.06±0.12
2-13 TO 2-27-73	18.6	1.78±0.50	0.13±0.16	1.2±0.8	96±4	<0.23	1.8±1.0	0.7±1.3	0.80±0.21	0.30±0.32	<0.19	0.19±0.12	0.31±0.16
2-27 TO 3-13-73	19.4	1.82±0.52	0.05±0.16	0.29±0.79	85±4	0.09±0.16	0.7±1.0	0.4±1.3	0.56±0.16	0.15±0.29	0.07±0.13	0.03±0.11	0.09±0.14
3-13 TO 3-28-73	15.6	2.95±0.54	0.22±0.18	1.7±1.3	121±4	<0.26	0.8±1.1	<2.6	1.1±0.2	0.14±0.33	<0.23	0.12±0.12	0.10±0.13

NOTES: THE STANDARD DEVIATION (1.96 σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
* Particulate only.

Table 8 Radionuclide Concentration of Surface Air at Site #15-26-51-70
Briarwood Yacht Basin, Oyster Creek, Waretown (1.5 miles SE)

Radionuclide Concentration (fCi/m^3)

Sampling Interval	Total Volume $m^3 x1000$	^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
3-28 to 4-11-73	12.7	2.8± 0.7	<0.4	5±3	131±6	<0.4	1±1	3±3	1.4± 0.2	<0.6	0.2± 0.2	<0.3	0.47± 0.22
4-11 to 4-24-73	Motor Failure												

Notes: The standard deviation (1.96σ) is for counting statistics only. An additional 10 percent error may be applied due to changes in the counting geometry.
Less than values are predicated on three times the standard deviation of the net counting rate.
*Particulate only.

Table 9 Radionuclide Concentration of Surface Air at
Site # 15-26-52-70
Garden State Parkway Toll Plaza (mm 69.0) (2.5 miles SW)

Sampling Interval	Total Volume m^3x1000	Radionuclide Concentration (fCi/ m^3)										
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn Ot
8-3 to 8-14, 1972	12.8	7.2± 1.9	3.3± 0.8	<10	61± 13	6.5± 1.6	10.9± 3.7	<19	1.3± 0.2	3.8± 1.9	<0.7	0.1± 0.5
8-14 to 8-28, 1972	14.3	4.6± 1.7	2.8± 0.6	<2.4	74± 12	5.8± 1.2	11.1± 3.9	<8.1	1.7± 0.7	5.3± 1.9	<0.4	0.1± 0.3
8-28 to 9-12, 1972	14.4	6.1± 2.1	2.0± 0.7	<3.9	100± 12	4.2± 1.1	5.8± 3.2	<7.2	1.0± 0.6	3.3± 1.6	<0.5	<0.4
9-12 to 9-26, 1972	14.2	4.1± 0.7	1.1± 0.2	0.34± 0.42	97± 4	2.0± 0.3	3.8± 1.3	<1.8	1.2± 0.2	1.9± 0.5	<0.3	0.2± 0.2

Notes: Samples analyzed by a Ge(Li) detector. ^{95}Nb concentration is available if desired. Standard deviation is quoted at the 95 percent confidence level. All concentrations have been corrected for buildup and decay of the radionuclides on the filter paper during sampling. Filter paper-MSA-2133.

* Particulate only.

Table 9 Radionuclide Concentration of Surface Air at Site #15-26-52-70

Garden State Parkway Toll Plaza (mm69.0) (2.5 miles SW)

Sampling Interval	Total Volume m^3x1,000	Radionuclide Concentration (fCi/m^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
9-26 to 10-10-72	15.0	2.98± 0.81	0.58± 0.25	0.11± 0.65	76.8± 5.0	1.1± 0.3	2.0± 1.5	0.8± 1.6	0.72± 0.27	0.99± 0.53	0.03± 0.18	0.02± 0.17	0.06± 0.18
10-10 to 10-24-72	14.9	4.31± 1.19	0.64± 0.28	<1.2	99.4± 7.4	0.87± 0.38	1.8± 1.9	1.6± 1.8	0.64± 0.33	1.39± 0.80	0.10± 0.31	0.28	<0.05
10-24 to 11-7-72	16.9	1.61± 0.53	0.13± 0.15	<0.66	73.0± 3.6	0.44± 0.17	1.0± 1.1	0.2± 1.0	0.66± 0.17	0.05± 0.29	0.07± 0.14	0.10± 0.12	0.22± 0.16
11-7 to 11-14-72	8.3	1.58± 0.90	0.36± 0.28	0.7± 1.3	49.6± 4.3	0.27± 0.33	<3.1	0.24± 0.23	1.03± 0.29	0.44± 0.61	0.16± 0.26	0.29± 0.25	<0.38
11-14 to 11-21-72	Motor Failure												
11-21 to 12-6-72	17.1	1.44± 0.46	0.19± 0.12	0.26± 0.32	73.3± 3.0	0.10± 0.13	0.3± 1.0	0.73± 0.74	0.56± 0.14	0.26± 0.30	0.09± 0.10	<0.16	0.10± 0.13

Notes: The standard deviation (1.96σ) is for counting statistics only. An additional 10 percent error may be applied due to changes in the counting geometry.
Less than values are predicated on three times the standard deviation of the net counting rate.
*Particulate only.

TABLE 9 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE # 15-26-52-70
GARDEN STATE PARKWAY TOLL PLAZA (MM 69.0) (2.5 MILES SW)

SAMPLING INTERVAL	TOTAL VOLUME M^3x1,000	RADIONUCLIDE CONCENTRATION (FCi/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
12-6 TO 12-19-72	15.2	2.11±0.51	0.20±0.18	<3.0	78±4	0.07±0.19	0.5±1.2	<4.2	0.56±0.14	0.25±0.37	<0.20	<0.27	0.09±0.12
12-19 TO 1-2-73	15.7	1.13±0.54	0.10±0.17	0.29±0.77	51.2±3.4	0.25±0.27	0.9±1.1	1.29±1.38	0.42±0.16	0.26±0.33	<0.33	<0.30	0.08±0.1
1-2 TO 1-16-73	15.1	2.37±0.75	<0.39	0.9±1.9	105±6	0.08±0.24	1.4±1.4	<3.6	0.57±0.22	0.55±0.51	<0.30	0.11±0.15	0.22±0.1
1-16 TO 1-30-73	16.9	1.48±0.35	0.07±0.10	<0.51	66.8±2.3	0.04±0.10	0.19±0.92	<1.0	0.64±0.11	0.20±0.22	0.04±0.09	<0.13	0.1±0.0
1-30 TO 2-13-73	17.0	1.28±0.32	0.11±0.12	0.8±1.1	79±2	<0.18	1.1±0.9	0.6±1.4	0.62±0.10	0.14±0.22	<0.14	0.05±0.08	0.1±0.0
2-13 TO 2-27-73	16.3	1.51±0.45	0.6±1.6	1.1±1.3	83±4	<0.24	1.1±1.1	0.8±1.7	0.65±0.14	0.23±0.32	0.07±0.12	<0.17	0.1±0.1
2-27 TO 3-13-73	16.8	1.36±0.40	0.15±0.15	1.2±1.4	67±3	<0.21	<1.5	0.8±1.7	0.74±0.14	0.38±0.28	<0.17	0.13±0.10	0.1±0.1
3-13 TO 3-28-73	20.5	1.55±0.21	0.05±0.07	0.54±0.38	64±1	<0.10	0.73±0.71	<0.83	0.64±0.07	0.23±0.13	0.04±0.06	<0.08	0.05±0.0

NOTES: THE STANDARD DEVIATION (1.96σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
*Particulate only.

Table 9 Radionuclide Concentration of Surface Air at Site #15-26-52-70
Garden State Parkway Toll Plaza (mm 69.0) (2.5 miles SW)

Radionuclide Concentration (fCi/m^3)

Sampling Interval	Total Volume $m^3 \times 1000$	^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
3-28 to 4-11-73	18.3	1.4± 0.6	<0.4	<8	66±7	0.4± 0.3	<2	<7	0.54± 0.18	0.5± 0.5	<0.3	<0.3	<0.3
4-11 to 4-24-73	19.0	2.5± 0.4	<0.2	<3	95±4	<0.2	1.0± 0.9	<3	1.0± 0.1	0.36± 0.29	<0.2	<0.2	<0.2

Notes: The standard deviation (1.96σ) is for counting statistics only. An additional 10 percent error may be applied due to changes in the counting geometry.
Less than values are predicated on three times the standard deviation of the net counting rate.
*Particulate only.

Table 10 Radionuclide Concentration of Surface Air at
Site # 15-26-53-70
Garden State Parkway, Oyster Creek Picnic Area (mm 71.5) (1.25 miles W)

Sampling Interval	Total Volume m^3x1000	Radionuclide Concentration (fCi/ m^3)										
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn
8-2 to 8-14, 1972	13.7	6.6± 0.7	3.7± 0.3	<3	75± 4	7.6± 0.6	6.4± 1.6	2±4	1.3± 0.3	4.6± 0.8	0.04± 0.16	0.1± 0.1
8-14 to 8-28, 1972	14.1	4.9± 1.4	2.2± 0.5	0.4± 1.3	74± 10	6.4± 1.1	6.1± 2.9	<6	1.4± 0.5	3.1± 1.4	<0.4	0.2± 0.3
8-28 to 9-12, 1972	13.7	5.3± 0.8	1.8± 0.2	<0.7	82± 4	3.3± 0.4	3.4± 1.4	<2	1.2± 0.3	3.2± 0.7	<0.2	<0.2
9-12 to 9-26, 1972	15.9	2.3± 1.6	0.41± 0.45	0.4± 1.1	59± 8	1.5± 0.6	<5.1	<6.6	1.0± 0.5	0.5± 1.0	<0.5	<0.5

Notes: Samples analyzed by a Ge(Li) detector. ^{95}Nb concentration is available if desired. Standard deviation is quoted at the 95 percent confidence level. All concentrations have been corrected for buildup and decay of the radionuclides on the filter paper during sampling. Filter paper-MSA-2133.

* Particulate only.

TABLE 10 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE #15-26-53-70

GARDEN STATE PARKWAY, OYSTER CREEK PICNIC AREA (MM 71.5) (1.25 MILES W)

SAMPLING INTERVAL	TOTAL VOLUME $M^3 \times 1{,}000$	RADIONUCLIDE CONCENTRATION (fCi/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
9-26 TO 10-10-72	16.1	2.90 ± 0.52	0.49 ± 0.15	0.28 ± 0.37	66 ± 3	0.72 ± 0.15	1.33 ± 1.10	0.78 ± 0.90	0.76 ± 0.17	1.21 ± 0.33	0.09 ± 0.13	0.03 ± 0.12	0.14 ± 0.14
10-10 TO 10-24-72	16.2	3.61 ± 0.63	0.54 ± 0.15	<0.75	98 ± 4	0.98 ± 0.21	1.34 ± 1.22	0.94 ± 0.94	0.80 ± 0.17	1.10 ± 0.36	<0.20	0.03 ± 0.12	0.20 ± 0.14
10-24 TO 11-7-72	16.7	1.70 ± 0.33	0.18 ± 0.10	<0.54	51 ± 2	0.21 ± 0.11	0.20 ± 0.93	0.28 ± 0.73	0.57 ± 0.10	0.51 ± 0.23	0.16 ± 0.84	0.08 ± 0.08	0.06 ± 0.9
11-7 TO 11-21-72	16.5	1.26 ± 0.84	0.15 ± 0.24	0.18 ± 0.74	51 ± 5	0.29 ± 0.27	1.06 ± 1.49	0.6 ± 1.5	0.25 ± 0.23	1.00 ± 0.54	<0.36	0.16 ± 0.19	0.12 ± 0.2
11-21 TO 12-6-72	17.9	1.44 ± 0.53	0.24 ± 0.14	<0.64	73.3 ± 0.4	0.30 ± 0.17	1.01 ± 1.08	<1.3	0.63 ± 0.16	0.75 ± 0.30	<0.20	<0.20	0.23 ± 0.15

NOTES: THE STANDARD DEVIATION (1.96 σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
* Particulate only.

TABLE 10 RADIONUCLIDE CONCENTRATION OF SURFACE AIR AT SITE # 15-26-53-70
GARDEN STATE PARKWAY, OYSTER CREEK PICNIC AREA (MM 71.5) (1.25 MILES W)

SAMPLING INTERVAL	TOTAL VOLUME M^3x1,000	RADIONUCLIDE CONCENTRATION (fCi/M^3)											
		^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
12-6 TO 12-19-73	14.6	1.51±0.62	0.19±0.22	<3.5	76±4	0.20±0.22	<2.1	1.8±2.2	0.52±0.19	0.41±0.42	<0.38	0.10±0.15	0.09±0.16
12-19 TO 1-2-73	16.0	1.17±0.47	0.08±0.18	0.4±1.4	46±3	<0.29	<2.5	0.6±2.0	0.53±0.15	0.22±0.36	0.07±0.15	<0.28	<0.20
1-2 TO 1-16-73	17.6	1.87±0.50	0.18±0.15	0.92±0.77	96±4	0.13±0.15	0.66±1.03	<1.9	0.64±0.15	0.31±0.30	<0.19	0.10±0.11	0.06±0.13
1-16 TO 1-30-73	17.4	1.30±0.55	0.06±0.19	1.0±1.5	60.4±3.8	0.26±0.21	0.7±1.1	1.7±2.1	0.96±0.19	0.15±0.39	0.08±0.14	0.06±0.13	0.07±0.18
1-30 TO 2-13-73	16.9	1.78±0.48	<0.23	0.2±0.8	78±4	0.06±0.15	0.8±1.0	<1.9	0.70±0.16	<0.49	<0.19	<0.19	<0.19
2-13 TO 2-27-73	13.9	2.55±0.50	0.16±0.19	0.8±1.8	115±6	0.14±0.19	1.0±1.2	2.5±2.1	0.80±0.16	0.28±0.34	0.07±0.13	0.04±0.12	0.07±0.13
2-27 TO 3-13-73	12.7	1.18±0.64	0.11±0.23	0.4±1.6	88±5	0.13±0.22	1.1±1.5	1.5±2.1	0.92±0.20	<0.64	0.09±0.19	<0.25	0.20±0.19
3-13 TO 3-28-73	14.5	2.52±0.38	0.27±0.14	1.0±1.2	105±3	0.20±0.13	0.5±1.1	0.5±1.5	1.06±0.13	0.09±0.25	<0.16	0.04±0.09	0.14±0.19

NOTES: THE STANDARD DEVIATION (1.96σ) IS FOR COUNTING STATISTICS ONLY. AN ADDITIONAL 10 PERCENT ERROR MAY BE APPLIED DUE TO CHANGES IN THE COUNTING GEOMETRY.
LESS THAN VALUES ARE PREDICATED ON THREE TIMES THE STANDARD DEVIATION OF THE NET COUNTING RATE.
*Particulate only.

Table 10 Radionuclide Concentration of Surface Air at
Site #15-26-53-70
Garden State Parkway, Oyster Creek Picnic Area (mm 71.5) (1.25 miles W)

Radionuclide Concentration (fCi/m^3)

Sampling Interval	Total Volume m^3x1000	^{144}Ce	^{141}Ce	^{131}I*	^{7}Be	^{103}Ru	^{106}Ru	^{140}Ba	^{137}Cs	^{95}Zr	^{58}Co	^{54}Mn	^{60}Co
3-28 to 4-11-73	13.3	2.4± 0.8	<0.4	4±3	104±6	<0.4	1±1	<5	1.0± 0.2	<0.8	<0.3	<0.3	<0.3
4-11 to 4-24-73	15.3	2.6± 0.6	<0.3	<4	124±5	<0.3	1.5± 1.2	<4	1.3± 0.2	<6	0.2± 0.2	0.40± 0.24	0.67± 0.16

Notes: The standard deviation (1.96σ) is for counting statistics only. An additional 10 percent error may be applied due to changes in the counting geometry.
Less than values are predicated on three times the standard deviation of the net counting rate.
*Particulate only.

Table 11 Radiostrontium Concentration in Surface Air in the Vicinity of the Oyster Creek NPGS
(femtocuries/cubic meter)

Site No.	Location No.		July 28 to Aug. 14, 1972	Aug. 28 to Sept. 26, 1972	Sept. 26 to Oct. 24, 1972	Oct. 24 to Nov. 21, 1972
1 19 mi. W	03-81-02-70	^{90}Sr		0.69±0.04	0.55±0.03	0.37±0.03
		^{89}Sr		3.17±0.13	1.44±0.09	0.59±0.04
2 1.5 mi. N	15-26-14-70	^{90}Sr		0.87±0.05	0.60±0.04	0.39±0.03
		^{89}Sr		4.09±0.15	1.57±0.09	0.62±0.05
3 7.5 mi. N	15-14-03-70	^{90}Sr		0.59±0.04	0.62±0.05	0.41±0.04
		^{89}Sr		2.70±0.12	1.11±0.12 *1	0.62±0.06
4 1.5 mi. SE	15-26-51-70	^{90}Sr	1.18±0.07	0.68±0.04	0.52±0.03	0.39±0.04
		^{89}Sr	9.45±0.35	3.00±0.14	1.25±0.08	0.74±0.05
6 2.5 mi. SW	15-26-52-70	^{90}Sr		0.71±0.04	0.56±0.03	0.35±0.03
		^{89}Sr		3.14±0.14	1.46±0.08	0.51±0.06 *2
7 1.25 mi. W	15-26-53-70	^{90}Sr		0.65±0.04	0.50±0.04	0.21±0.03
		^{89}Sr		2.78±0.15	1.24±0.09	0.37±0.05

Notes: All concentrations were corrected to the mid-point of the collection interval.

*1 Missing sample during the interval Oct. 4 through Oct. 10, 1972.

*2 Collection interval - Oct. 24 through Nov. 14, 1972.

Table 11 Radiostrontium Concentration in Surface Air in the Vicinity of the Oyster Creek NPGS
(femtocuries/cubic meter)

Site No.	Location No.		Nov. 21 to Dec. 19, 1972	Dec. 19 to Jan. 16, 1973	Jan. 16 to Feb. 13, 1973	Feb. 13 to Feb. 27, 1973
1 19 mi. W	03-81-02-70	^{90}Sr	0.44±0.03	0.41±0.03	0.52±0.03	0.61±0.04
		^{89}Sr	0.39±0.05	0.17±0.10	0.18±0.09	0.18±0.10
2 1.5 mi. NNE	15-26-14-70	^{90}Sr	0.37±0.02	0.35±0.03	0.33±0.03	0.50±0.04
		^{89}Sr	0.39±0.04	0.14±0.08	0.16±0.07	0.27±0.10
3 7.5 mi. N	15-14-03-70	^{90}Sr	0.32±0.05	0.29±0.02	0.06±0.03	0.56±0.05
		^{89}Sr	0.35±0.05	0.13±0.07	1.19±0.07	0.01±0.11
4 1.5 mi. SE	15-26-51-70	^{90}Sr	0.55±0.03	0.39±0.04	0.34±0.02	0.54±0.04
		^{89}Sr	0.39±0.06	0.28±0.13	0.18±0.05	0.29±0.09
6 2.5 mi. SW	15-26-52-70	^{90}Sr	0.34±0.02	0.29±0.02	0.35±0.02	0.44±0.05
		^{89}Sr	0.0019±0.0004	0.22±0.08	0.19±0.05	0.26±0.10
7 1.25 mi. W	15-26-53-70	^{90}Sr	0.35±0.03	0.27±0.02	0.32±0.03	0.56±0.05
		^{89}Sr	0.0021±0.0005	0.18±0.07	0.18±0.07	0.09±0.12

Notes: All concentrations were corrected to the mid-point of the collection interval.

Table 11 Radiostrontium Concentration in Surface Air in the Vicinity of the Oyster Creek NPGS (femtocuries/cubic meter)

Site No.	Location No.		Feb. 27 to March 28, 1973	March 28 to April 24, 1973
1 19 mi. W	03-81-02-70	^{90}Sr	0.65±0.04	0.88±0.03
		^{89}Sr	0.13±0.12	0.09±0.13
2 1.5 mi. NNE	15-26-14-70	^{90}Sr	0.59±0.03	0.72±0.01
		^{89}Sr	0.15±0.08	<0.12
3 7.5 mi. N	15-14-03-70	^{90}Sr	0.59±0.04	0.83±0.04
		^{89}Sr	<0.17	<0.23
4 1.5 mi. SE	15-26-51-70	^{90}Sr	0.68±0.04	1.06±0.19*
		^{89}Sr	0.41±0.12	0.46±0.24*
6 2.5 mi. SE	15-26-52-70	^{90}Sr	0.44±0.03	0.60±0.01
		^{89}Sr	0.33±0.11	<0.16
7 1.25 mi. W	15-26-53-70	^{90}Sr	0.64±0.05	0.84±0.04
		^{89}Sr	0.30±0.14	0.14±0.14

Notes: *The error includes an estimated 13 percent error in the sample volume.
All concentrations were corrected to the mid-point of the collection interval.

Table 12
Non-Occupational Maximum Permissible Concentration in Air (Soluble Form)

Radionuclide	Non-Occupational Maximum Permissible* Concentration (Air) fCi/m^3
^{54}Mn	1×10^7
^{58}Co	3×10^7
^{60}Co	1×10^7
^{89}Sr	3×10^5
^{90}Sr	4×10^4
^{95}Zr	4×10^6
^{103}Ru	2×10^7
^{106}Ru	3×10^6
^{131}I	1×10^5
^{133}I	4×10^5
^{134}Cs	1×10^6
^{137}Cs	2×10^6
^{140}Ba	4×10^6
^{141}Ce	2×10^7
^{144}Ce	3×10^5
^{239}Np	3×10^7

* Title 10 CFR Part 20

IV. Aquatic Environment Surveillance

A. Surface Water Surveillance

In the early portion of the surveillance program, three water collection stations were selected to be routinely sampled every month. The sites included: one station on Oyster Creek at the bridge serving U.S. Highway Route 9 (Location No. 15-26-20-06), one station on the South Branch of the Forked River (intake canal) at the Route 9 bridge (Location No. 15-26-26-06), and one station at a background reference area in Great Bay (Location No. 01-64-01-06). During late July, the station on Oyster Creek was changed to the Sands Point Marina in order to accommodate apparatus for continuous water collection.

The continuous water sampling equipment consisted of a low-flow rate Masterflex pump (33 ml/minute) equipped to provide a sampling interval of one hour every five hours during a total collection period of one week. The water was sampled from Oyster Creek at a depth of four feet and flowed through forty feet of 1/4" I.D. vacuum tubing into a thirteen gallon polyethylene receiving carboy. Prior to sampling, 300 mls of concentrated nitric acid was placed into the carboy to prevent radionuclide losses to the surface of the carboy. A flow rate measurement was taken at each weekly exchange to determine if a change in flow rate had occurred during the sampling period.

During the first few collection periods, a breakdown of the tygon tubing in the pump head had been evident. The problem was remedied by substituting high-grade silicone tubing for the tygon tubing. Further difficulties in the continuous water sampling equipment were encountered during the winter months when the sampling line would freeze at low temperatures. The frequency

of the sample line freeze-up decreased somewhat when a new timing cycle of 6 seconds of sample collection per minute was applied. The new sampling cycle began on January 16, 1973.

Continuous water sampling of the condenser intake water was initiated on January 4, 1973 in order to evaluate the recirculation of radioactivity from Oyster Creek into Forked River. The condenser intake station was designated as Site No. 15-26-12-06 and replaced the collection station on the South Branch of the Forked River (No. 15-26-26-06). The water collection interval for this sampler was syncronized with the sampler at Sands Point Marina.

Each weekly composited sample was analyzed for sixteen radionuclides by various radiochemical techniques. Tritium was measured by analyzing 2 mls of sample distillate by means of a liquid scintillation counting system having a minimum sensitivity of approximately 1,000 pCi/liter. The radionuclides ^{141}Ce, ^{144}Ce, ^{103}Ru, ^{106}Ru, ^{51}Cr, ^{58}Co, ^{60}Co, ^{54}Mn, ^{65}Zn, and ^{59}Fe were evaluated by means of a ferric hydroxide precipitation technique described in the first quarterly progress report. The technique has been found to be essentially quantitative for all of the stated nuclides except ^{54}Mn, ^{58}Co, and ^{60}Co. The recovery for these two elements in the dissolved form, as determined by tracer studies, was 24 and 54 percent for Mn and Co, respectively. However, measurements by Kahn, et. al.[5] have shown that 86 percent of the ^{60}Co and 82 percent of the ^{54}Mn discharged from the facility was associated with suspended material. Since each sample is entirely filtered through a Whatman No. 542 slow filter, any suspended material scavanged by the $Fe(OH)_3$ precipitates would be incorporated in the analysis. Therefore, most of the ^{54}Mn, ^{58}Co, and ^{60}Co would have been recovered (>90 percent).

Fourteen liters of the $Fe(OH)_3$ filtrate was analyzed for dissolved radiocesium (^{134}Cs and ^{137}Cs) by means of selective adsorption onto ammonium-12 - molybdophosphate (AMP) crystals followed by gamma-ray spectrometry analysis. The minimum sensitivity of this technique was about 0.1 pCi/liter for ^{137}Cs.

An additional ten liters of the $Fe(OH)_3$ filtrate was processed for dissolved radiostrontium by a recently modified carbonate technique. The naturally-occurring stable strontium content of each brackish sample was evaluated by determining the chloride content and applying the factor: 0.41 mg of Sr per liter/1.0 PPT Cl^- . The strontium recovery of the technique was predicated on the total recovery of both the natural and carrier strontium.

The results of the monthly grab samples of the discharge canal taken at the Route 9 bridge during the spring and summer months appear in Table 13. In this period, several samples were collected while the facility was discharging a sample waste tank. Of the nuclides measured, only ^{60}Co, ^{54}Mn, ^{59}Fe, and ^{51}Cr were measured in significant concentrations. The maximum ^{60}Co concentration was about 1 pCi/liter, whereas ^{51}Cr was 1.5 pCi/liter on one occasion. Numerical data for the dissolved radiocesium was not available for this time because the radiochemical process was developed somewhat later. The tritium and radiostrontium content at the time of discharge were not discernible from background. Zirconium-95, ^{103}Ru, and ^{141}Ce, related to the Chinese atmospheric weapons testing in January and March, were detected in both Barnegat and Great Bay in the month of April. These short-lived radionuclides persisted, in concentrations less than 0.4 pCi/1, at both areas through June, 1972.

Table 14 is a summary of the specific analyses performed on the weekly composited discharge canal samples collected at the Sands Point Marina. An increase in the weekly average ^{137}Cs and ^{134}Cs (dissolved) concentration levels was evident in August, 1972 and continued into October. The maximum offsite radiocesium concentrations occurred during August 21 through August 28, 1972 (^{134}Cs - 26.4 pCi/1; ^{137}Cs - 48.2 pCi/1), but were less than 0.3 percent of the maximum permissible concentration as per the Code of Federal Regulations. The actual sampling period was shorter than a week because the tygon tubing in the pump head deteriorated during the last few days. Concomitant with the elevated radiocesium levels in August and September were increases in the weekly average ^{60}Co and ^{54}Mn concentrations. The time interval of the maximum concentration of these nuclides did not correspond with the interval for the maximum radiocesium, but occurred during September 12 through 19, 1972 (^{60}Co - 14.4 pCi/1; ^{54}Mn - 4.4 pCi/1). Detectable amounts of ^{51}Cr, ^{58}Co, and ^{59}Fe were measured only sporadically during the eight months of continuous sampling. However, the concentration of these radionuclides in the radwaste is normally lower than that of ^{60}Co, ^{54}Mn, and radiocesium. In addition, due to the lower gamma branching ratios of these isotopes, the minimum sensitivity of detection is somewhat greater than that of ^{60}Co or ^{54}Mn. For example, the ^{51}Cr and ^{54}Mn concentrations in the November monthly radwaste composite were 21 and 11 pCi/ml, respectively. Applying a dilution factor of 203,000 would result in an average monthly discharge canal concentration 0.1 pCi/1 ^{51}Cr and 0.055 pCi/1 ^{54}Mn. As shown in Table 14, detectable amounts of ^{54}Mn were measured in the discharge canal, but the ^{51}Cr content was less than the minimum sensitivity of ~0.3 pCi/liter for most of the period.

The ^{60}Co and ^{54}Mn aqueous levels in Oyster Creek would be a combination of 1. discharges from the facility, 2. recirculation of the same, and 3. radioactive particulates from sediment resuspension. The ^{60}Co to ^{54}Mn ratio in the weekly water samples in January ranged between 1.1 to 2, which corresponds very closely to the nuclide ratio (1.9:1) in the undiluted radwaste for January. The ratio of these two nuclides in sediment sampled next to the water sampling equipment was 4.9 in January and varied between 4.1 and 5.3 (See Table 20) during November through April. Consequently, most of the radioactivity measured in the water samples would be related to facility discharges rather than sediment resuspension.

Under most circumstances, the detection of facility-produced radiostrontium is limited by the low concentrations of ^{89}Sr and ^{90}Sr in the waste releases and the applied dilution. Typically, the ^{89}Sr to ^{90}Sr ratio in the radwaste is of the order of 10 to 30 and very rarely does the ^{89}Sr concentration exceed 10 pCi/ml (See Table 17). At a minimum dilution of 50,000,* the expected maximum monthly average Oyster Creek concentration would be ~0.2 pCi ^{89}Sr/liter. The strontium-89 concentrations in August were somewhat greater than the expected maximum value. For all other sampling periods, except once in February, the ^{89}Sr concentration was below 0.5 pCi/liters. The ^{90}Sr concentration in Oyster Creek approximated values measured in Great Bay, ~0.3 to 0.4 pCi/liter (dissolved). Elevated radiostrontium levels were noted during the first week of February, 1973 in both Oyster Creek and the condenser intake water. No increases in the other typical facility-produced radionuclides were observed in the sample.

*Normally, the radwaste tank is discharged at approximately 26 gpm into a condenser cooling water flow of 460,000 gpm. During August through December, 1972, the dilution varied between 58,000 and 202,000.

For the first four months of 1973 attempts have been made to measure the recirculation of radionuclides from Oyster Creek into the Forked River. Dye studies performed by Carpenter in 1963[9] showed that the aqueous plume from Oyster Creek would proceed toward Forked River at periods of both Ebb and Flood tides. The first indication of recirculation was presented in 1972 when data substantiated ^{60}Co and ^{54}Mn in sediment taken from all branches of the Forked River[1]. For one reason or another, measurements taken to date have not been able to isolate a value. Two problems have been common: 1. the concentration of most of the radionuclide has been too low for accurate measurements, and 2. sample period biasing due to sample line freeze-up during the winter months. It is anticipated that ^{134}Cs will give a good indication of the recirculation of dissolved radionuclides and ^{60}Co will represent dissolved plus suspended material recirculation. Tritium would be the ideal nuclide for the recirculation measurement but its low offsite concentration and the minimum sensitivity of detection precludes its use. It is hoped that subsequent measurements will elucidate the recirculation value. Table 15 summarizes the data accumulated for the condenser intake sampler since the beginning of the year.

The monthly variation in the radionuclides of Great Bay has been presented in Table 16. During the spring and early summer, ^{95}Zr-Nb, ^{103}Ru and ^{144}Ce, in concentrations less than 1 pCi/liter, were measured at this site. The shorter-lived nuclides were most likely related to earlier atmospheric weapons tests conducted by the Chinese during January and March, 1972. For the ten-month period investigated, the dissolved ^{137}Cs concentration ranged from 0.19 (February, 1973) to 0.48 pCi/liter (March, 1973). The average of the ten measurements was 0.32 ± 0.09 pCi/liter (dissolved). The

dissolved strontium-90 concentration approximated the ^{137}Cs levels. Based on ten observations, the average ^{90}Sr content was 0.27±0.15 pCi/liter (dissolved only). Strontium-89 was detected during two months, August (0.14±0.08 pCi/liter) and November, 1972 (0.09±0.05 pCi/liter). In general, the corrosion products ^{51}Cr, ^{54}Mn, ^{58}Co, ^{59}Fe, ^{60}Co, and ^{65}Zn have been found to be in concentrations below the minimum of sensitivity of detection.

In summary, aqueous discharges from the facility have resulted in offsite stream concentrations below 1 pCi/liter for most radionuclides. Occasionally, the concentration of certain radionuclides may be elevated by a factor of 100 above typical values. Both ^{90}Sr and ^{137}Cs from previous stratospheric fallout constitute a major portion of the measured offsite concentration of these nuclides.

TABLE 13. RADIONUCLIDE CONCENTRATIONS OF OYSTER CREEK AT U.S. HIGHWAY ROUTE 9 (LOCATION #15-26-20-06)

COLLECTION DATE	RH#	RADIONUCLIDE CONCENTRATION (pCi/LITER)														
		^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
4-6-72	16068	<1.5	0.4±0.3*	-	0.28±0.39	<0.14	0.07±0.07	<0.35	0.07±0.08	<0.23	<0.06	0.13±0.09	<0.6	-	-	<0.2	0.16±0.28
4-7-72@	16073	<1.5	0.3±0.2	<1000	<0.3	0.39±0.06	<0.07	<0.3	1.01±0.05	0.08±0.09	0.045±0.020	0.19±0.06	<0.4	-		0.066±0.040	0.16±0.11
			0.34±0.16*														
4-10-72	16076	<1.5	<0.3	<1000	<0.3	0.064±0.051	<0.07	<0.12	0.051±0.044	0.02±0.08	0.086±0.021	0.12±0.05	<0.4	-	-	0.037±0.047	0.16±0.28
4-12-72@	16084	<0.5	0.46±0.12	-	1.49±0.25	0.096±0.039	<0.07	<0.12	0.10±0.03	0.05±0.05	0.22±0.02	0.19±0.05	<0.25	-		0.16±0.05	0.26±0.15
		0.1±0.3*	0.4±0.2*														
4-18-72	16146	-	-	<1000	<0.9	0.11±0.17	<0.22	<0.4	<0.25	0.17±0.30	0.13±0.09	0.36±0.18	<1.1	-	-	0.24±0.18	<0.82
5-4-72	16196	-	-	<1000	-	-	-	-	-	-	-	-	-	-	-	-	-
5-11-72	16224	-	-	<1000	<0.4	0.17±0.06	<0.09	<0.2	0.22±0.05	<0.2	0.15±0.02	0.35±0.09	<0.6	-	-	0.14±0.06	0.16±0.26
5-16-72	16238	0.4±0.2*	0.26±0.16*	-	<0.26	<0.09	0.03±0.04	<0.11	0.057±0.046	0.04±0.08	0.061±0.022	0.14±0.06	0.22±0.24	-	0.37±0.10*	0.04±0.06	0.20±0.19
5-16-72@	16239	0.3±0.2*	0.38±0.17*	<1000	0.26±0.20	0.59±0.08	0.03±0.09	0.27±0.12	0.98±0.07	<0.20	0.050±0.026	0.116±0.068	0.17±0.31	-	0.46±0.10*	0.130±0.058	<0.36
6-5-72	16276	<0.48	0.67±0.12	<1000	<0.3	0.036±0.057	<0.09	<0.13	0.055±0.055	0.040±0.091	0.072±0.025	0.137±0.063	0.12±0.30	-	0.33±0.09*	0.086±0.060	0.12±0.25

NOTES: *DISSOLVED FRACTION. ALL OTHER CONCENTRATIONS ARE STATED AS TOTAL (SUSPENDED PLUS DISSOLVED) EXCEPT FOR ^{60}Co, ^{58}Co, AND ^{54}Mn. THE CHEMICAL RECOVERY FOR THESE ELEMENTS IS 54% FOR DISSOLVED Co AND 24% FOR Mn. ^{95}Zr IS ASSUMED TO BE IN EQUILIBRIUM WITH ^{95}Nb.
@ SAMPLE TAKEN WHILE THE FACILITY WAS DISCHARGING.

TABLE 13a VARIATION IN THE RADIONUCLIDE CONCENTRATION OF THE SOUTH BRANCH OF FORKED RIVER AT U.S. HIGHWAY ROUTE 9 (INTAKE CANAL-LOCATION # 15-26-26-06)

RADIONUCLIDE CONCENTRATION (pCi/LITER)

COLLECTION DATE	RH#	^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
3-30-72	16044	-	-	<1000	<0.4	0.04±0.08	0.04±0.06	<0.2	0.03±0.06	<0.2	0.012±0.024	0.12±0.07	<0.6	-		<0.08	0.27±0.19
4-12-72 A	16086	0.9±1.7	0.2±1.0	-	<0.4	0.11±0.05	<0.07	<0.12	0.058±0.043	0.05±0.08	0.20±0.02	0.16±0.05	<0.4	-		0.15±0.04	0.25±0.14
5-4-72	16197	0.15±*0.36	0.36±*0.25	-	<0.3	<0.1	0.052±0.057	<0.1	0.062±0.043	<0.12	0.36±0.02	0.17±0.05	<0.4	-		0.086±0.059	0.34±0.26
6-5-72	16278	0.42±0.33	0.32±0.26	<1000	<0.4	0.078±0.084	<0.2	<0.2	0.057±0.073	<0.2	0.087±0.033	0.142±0.095	0.13±0.43	-	0.36±*0.12	0.078±0.062	<0.5
7-12-72	16410	0.48±0.32	0.34±0.23	1500±900	<0.34	0.034±0.069	0.10±0.10	<0.15	0.12±0.06	<0.15	0.034±0.026	0.05±0.08	0.16±0.20	0.11±*0.13	0.74±*0.12	0.023±0.050	0.20±0.20
8-9-72	16500	0.27±0.20	0.11±0.16	<1200	<0.22	0.11±0.05	<0.09	<0.11	0.14±0.05	<0.12	0.021±0.019	0.026±0.052	0.40±0.43	1.6±*0.2	2.5±*0.2	<0.06	0.17±0.17
9-18-72	16670	0.10±*0.40	0.20±*0.30	<950	<0.34	0.36±0.08	0.01±0.10	<0.17	0.91±0.07	0.10±0.13	0.02±0.02	0.05±0.07	<0.8	1.6±*0.2	2.5±*0.2	0.04±0.05	<0.25
11-14-72	16927	0.13±*0.10	0.40±*0.08	<1000	<0.33	0.055±0.064	<0.12	<0.15	0.19±0.06	0.16±0.11	0.17±0.02	0.23±0.07	<0.92	0.19±*0.13	0.64±*0.11	<0.07	0.20±0.16
12-7-72	17027	0.02±*0.09	0.36±*0.08	-	<0.29	0.065±0.059	0.019±0.075	<0.13	0.20±0.05	0.097±0.093	0.025±0.021	0.13±0.06	<0.80	0.11±*0.13	0.47±*0.10	0.016±0.040	0.03±0.16

NOTES: *DISSOLVED FRACTION ONLY. ALL OTHER CONCENTRATIONS ARE STATED AS TOTAL (SUSPENDED PLUS DISSOLVED) EXCEPT FOR ^{60}Co, ^{58}Co, AND ^{54}Mn. THE CHEMICAL RECOVERY FOR THESE ELEMENTS IN THE DISSOLVED FORM IS Mn-24%, Co-54%. ^{95}Zr IS ASSUMED TO BE IN EQUILIBRIUM WITH ^{95}Nb. STANDARD DEVIATION IS QUOTED AT THE 95 PERCENT CONFIDENCE LEVEL. A - SAMPLE TAKEN WHILE FACILITY WAS DISCHARGING.

TABLE 14 WEEKLY VARIATION IN THE RADIONUCLIDE CONCENTRATION OF OYSTER CREEK AT SANDS POINT MARINA (DISCHARGE CANAL)
LOCATION # 15-26-20-06

RADIONUCLIDE CONCENTRATION (pCi/LITER)

COLLECTION DATE	RH#	^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
7-27 TO 8-2-72	16492@	0.2±* 0.3	0.4±* 0.3	<1200	0.39± 0.25	0.69± 0.09	0.29± 0.11	<0.3	4.0± 0.1	<0.28	0.024± 0.026	0.22± 0.08	<0.15	14.6± 1.1	21.5±* 1.6	0.01± 0.06	0.27± 0.21
8-2 TO 8-9-72	16501	0.88±* 0.22	0.41±* 0.15	<1200	0.26± 0.41	0.29± 0.13	0.24± 0.16	<0.3	1.1± 0.1	0.12± 0.21	0.022± 0.043	0.15± 0.14	<1.8	5.0±* 0.4	7.2±* 0.4	0.026± 0.083	0.02± 0.27
8-11 TO 8-18-72	16544@	0.33±* 0.17	0.22±* 0.14	<1100	1.8± 3.4	5.1± 1.4	2.6± 1.7	1.8± 1.6	10.6± 1.0	1.0± 1.9	0.22± 0.34	0.73± 0.98	<1.2	3.8±* 0.2	5.6±* 0.2	1.3± 0.6	<4.5
8-21 TO 8-28-72	16594@	0.45±* 0.12	0.30±* 0.08	<1100	<0.6	1.7± 0.2	0.44± 0.28	<0.39	6.0± 0.2	0.3± 0.3	<0.5	0.12± 0.11	<1.4	26.4±* 3.7	48.2±* 5.7	0.04± 0.06	0.10± 0.25
8-28 TO 9-4-72	16620	0.30± 0.08	0.19± 0.06	<1100	0.16± 0.19	0.46± 0.08	0.12± 0.09	<0.15	1.29± 0.06	0.06± 0.12	0.012± 0.022	0.12± 0.06	<0.79	8.6±* 0.7	13.±* 1.0	0.025± 0.039	<0.22
9-4 TO 9-12-72	16649	<0.8*	0.4±* 0.2	<1000	<0.3	0.06± 0.06	0.04± 0.07	<0.13	0.21± 0.05	0.05± 0.09	<0.03	0.06± 0.06	<0.7	2.5±* 0.2	4.0±* 0.3	0.01± 0.04	<0.2
9-12 TO 9-19-72	16671	0.2±* 0.2	0.30±* 0.15	<950	1.5± 0.7	4.4± 0.4	0.26± 0.52	0.72± 0.57	14.4± 0.3	<0.8	<0.08	<0.25	<2.5	1.81±* 0.21	2.89±* 0.21	<0.2	<0.8
9-19 TO 9-26-72	16706	0.27±* 0.33	0.28±* 0.11	<1200	0.43± 0.45	1.14± 0.16	0.11± 0.20	<0.36	3.74± 0.14	0.25± 0.24	<0.08	0.18± 0.13	<1.5	2.65±* 0.17	4.27±* 0.17	0.10± 0.09	<0.45
9-26 TO 10-3-72	16754	0.26± 0.22	0.21± 0.17	<1200	0.13± 0.30	0.53± 0.11	0.07± 0.13	<2.5	1.6± 0.1	0.14± 0.18	<0.06	0.10± 0.10	<1.2	4.93±* 0.28	7.37±* 0.26	0.08± 0.08	<0.42
10-3 TO 10-10-72	16780	0.3± 1.1	0.24± 0.74	<1100	0.22± 0.19	0.20± 0.06	0.02± 0.08	<0.13	0.57± 0.05	0.03± 0.09	0.015± 0.020	0.082± 0.057	<0.63	1.72±* 0.20	2.92±* 0.24	0.032± 0.040	0.12± 0.14

NOTES:

@ BIASED SAMPLE. * DISSOLVED FRACTION ONLY. ALL OTHER CONCENTRATIONS ARE STATED AS TOTAL (SUSPENDED PLUS DISSOLVED) EXCEPT FOR 60-Co, 58-Co, AND 54-Mn. THE CHEMICAL RECOVERY FOR THESE ELEMENTS IN THE DISSOLVED FORM IS Mn-24%, Co-54%. 95-Zr IS ASSUMED TO BE IN EQUILIBRIUM WITH 95-Nb. THE STANDARD DEVIATION IS QUOTED AT THE 95 PERCENT CONFIDENCE LEVEL.

TABLE 14 WEEKLY VARIATION IN THE RADIONUCLIDE CONCENTRATION OF OYSTER CREEK AT SANDS POINT MARINA (DISCHARGE CANAL) (CONTINUED)
LOCATION # 15-26-20-06

RADIONUCLIDE CONCENTRATION (pCi/LITER)

COLLECTION DATE	RH#	^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
10-10 TO 10-18-72	16810	0.03 ± 0.31	0.33 ± 0.21	<1200	<0.3	0.085 ± 0.053	0.03 ± 0.07	<0.13	0.21 ± 0.05	0.06 ± 0.09	0.016 ± 0.020	0.077 ± 0.060	<0.67	0.75 ± 0.16 *	1.31 ± 0.14 *	<0.06	0.05 ± 0.13
		<0.5*	0.41 ± 0.09 *														
10-18 TO 10-24-72	16840	0.02 ± 0.23	0.30 ± 0.19	<1100	<0.26	0.035 ± 0.049	0.022 ± 0.062	<0.11	0.100 ± 0.045	0.073 ± 0.079	<0.03	0.054 ± 0.057	<0.6	0.67 ± 0.15 *	1.08 ± 0.13 *	0.018 ± 0.037	<0.20
10-24 TO 10-31-72	16870	0.20 ± 0.25 *	0.37 ± 0.07 *	-	<0.33	0.095 ± 0.061	0.028 ± 0.078	<0.14	0.234 ± 0.055	0.02 ± 0.10	0.037 ± 0.022	0.077 ± 0.066	<0.76	0.36 ± 0.19 *	1.15 ± 0.28 *	0.012 ± 0.044	0.09 ± 0.16
		0.04 ± 0.10	0.24 ± 0.19														
10-31 TO 11-7-72	16890	<0.34*	0.23 ± 0.08 *<1100		<0.24	0.076 ± 0.041	<0.075	<0.10	0.14 ± 0.04	0.076 ± 0.073	0.012 ± 0.018	0.111 ± 0.047	<0.53	0.40 ± 0.15 *	0.81 ± 0.12 *	0.043 ± 0.042	0.03 ± 0.16
														0.40 ± 0.15 *	0.81 ± 0.12 *		
11-7 TO 11-14-72	16929	<0.31	0.34 ± 0.08	<1200	<0.30	0.020 ± 0.055	0.05 ± 0.07	<0.13	0.123 ± 0.050	0.083 ± 0.088	0.005 ± 0.021	0.060 ± 0.062	<0.70	0.28 ± 0.14 *	0.74 ± 0.12 *	<0.062	0.02 ± 0.13
		<0.12*	0.38 ± 0.03 *														
11-14 TO 11-21-72	16986@			<1100										0.38 ± 0.18	0.46 ± 0.12		
11-21 TO 11-28-72		SAMPLE LINE FREEZE-UP															
11-28 TO 12-5-72	17022	<0.2*	0.38 ± 0.03 *<1200		<0.29	0.057 ± 0.044	<0.086	<0.12	0.093 ± 0.042	<0.11	0.014 ± 0.020	0.037 ± 0.053	0.03 ± 0.35	0.16 ± 0.13 *	0.45 ± 0.10 *	0.016 ± 0.047	<0.22

TABLE 14 WEEKLY VARIATION IN THE RADIONUCLIDE CONCENTRATION OF OYSTER CREEK AT SANDS POINT MARINA (DISCHARGE CANAL) (CONTINUED)
LOCATION # 15-26-20-06

RADIONUCLIDE CONCENTRATION (pCi/LITER)

COLLECTION DATE	RH#	^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
12-5 TO 12-12-72	17054	0.3±* 1.7	0.5±* 1.0	<1200	<0.30	0.072± 0.053	<0.10	<0.13	0.187± 0.048	0.090± 0.087	0.020± 0.020	0.18± 0.06	<0.75	0.16±* 0.12	0.46±* 0.09	0.029± 0.041	0.08± 0.15
12-20 TO 12-27-72	17108	<0.2*	0.41±* 0.04	<980										0.03±* 0.16	0.36±* 0.10		
12-28-72 1-2-73	17149	0.3±* 0.7	0.20±* 0.40	<980										0.52±* 0.15	0.56±* 0.11		
1-2 TO 1-4-73	17161	0.14±* 0.26	0.42±* 0.02	<1200	<0.80	0.21± 0.16	<0.30	<0.36	0.43± 0.15	<0.39	0.021± 0.063	<0.27	<2.0	1.18±* 0.27	0.98±* 0.10	0.05± 0.11	0.30± 0.43
1-4 TO 1-11-73	17200@	0.03±* 0.16	0.36±* 0.11	<1100	0.68± 0.37	0.51± 0.13	<0.25	<0.27	0.84± 0.10	<0.27	0.034± 0.039	0.21± 0.11	<1.3	0.20±* 0.18	0.50±* 0.14	0.02± 0.08	0.36± 0.29
1-11 TO 1-16-73	17234@	<1.6*	0.14±* 0.20	-	<0.53	0.21± 0.11	<0.19	0.06± 0.17	0.30± 0.09	<0.26	0.024± 0.039	<0.18	0.23± 0.80	0.08±* 0.16	0.13±* 0.11	<0.11	0.18± 0.25
1-23-73	17273	0.17±* 0.11	0.31±* 0.08	<1100	<0.30	0.17± 0.07	<0.12	<0.15	0.32± 0.06	0.06± 0.11	0.011± 0.024	0.18± 0.07	<0.83	0.56±* 0.13	0.91±* 0.12	<0.09	0.49± 0.20
1-23 TO 1-30-73	17298	0.07±* 0.11	0.25±* 0.07	500± 700	<0.26	0.098± 0.045	<0.09	0.01± 0.07	0.11± 0.04	0.05± 0.07	0.014± 0.019	0.099± 0.053	<0.58	0.14±* 0.13	0.36±* 0.10	<0.07	<0.23
1-30 TO 2-5-73	17325	<0.5*	0.25±* 0.05	<1000	0.10± 0.18	0.31± 0.07	<0.14	0.098± 0.086	0.44± 0.05	<0.13	0.015± 0.020	0.068± 0.055	<0.62	0.16±* 0.13	0.28±* 0.09	0.021± 0.038	0.11± 0.13
2-6 TO 2-13-73	17354@	31.7±* 1.1	3.8±* 0.5	<1100	0.15± 0.30	0.40± 0.12	0.02± 0.15	<0.23	0.81± 0.08	0.20± 0.15	0.035± 0.035	0.26± 0.09	<1.1	0.25±* 0.19	0.42±* 0.18	<0.1	0.38± 0.22

TABLE 14 WEEKLY VARIATION IN THE RADIONUCLIDE CONCENTRATION OF OYSTER CREEK AT SANDS POINT MARINA (DISCHARGE CANAL) (CONTINUED)
LOCATION # 15-26-20-06

RADIONUCLIDE CONCENTRATION (pCi/LITER)

COLLECTION DATE	RH#	^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
2-13 TO 2-20-73	17381@	0.07±* 0.21	0.27±* 0.11	<1100	<0.61	0.04± 0.08	<0.18	<0.23	0.10± 0.08	0.06± 0.13	0.03± 0.04	0.08± 0.12	<1.1	0.33±* 0.18	0.61±* 0.14	0.02± 0.08	0.10± 0.21
2-20 TO 2-17-73	(17582) 17419	<0.6*	0.33±* 0.07	<1100	<0.55	0.02± 0.05	<0.12	0.04± 0.12	0.089± 0.052	<0.15	0.035	0.03± 0.09	<0.75	0.22±* 0.11	0.20±* 0.09	<0.12	<0.31
2-27 TO 3-6-73	17448	0.07±* 0.21	0.31±* 0.12	<1100	<0.24	0.026± 0.042	<0.08	<0.10	0.047± 0.047	0.02± 0.07	<0.03	<0.07	0.15± 0.35	0.07±* 0.13	0.26±* 0.10	<0.06	0.09± 0.16
3-6 TO 3-13-73	17489	<0.20*	0.32±* 0.03		<0.25	0.052± 0.042	<0.079	0.04± 0.07	0.046± 0.041	<0.11	0.007± 0.019	0.060± 0.050	<0.57	0.07±* 0.12	0.22±* 0.09	<0.07	0.15± 0.15
3-13 TO 3-21-73	17530	<0.4*	0.30±* 0.05	<1100	0.13± 0.23	0.046± 0.054	0.016± 0.072	<0.14	0.090± 0.049	0.124± 0.088	0.012± 0.021	0.13± 0.07	<0.74	<0.20*	0.31±* 0.10	0.049± 0.045	0.06± 0.16
3-28 TO 4-4-73	17625	0.08±* 0.10	0.31±* 0.05	<1100	<0.31	<0.074	0.030± 0.065	<0.14	0.057± 0.049	0.087± 0.088	0.006± 0.019	0.077± 0.060	<0.66	<0.2*	0.30±* 0.10	0.020± 0.041	<0.21
4-4 TO 4-17-73	17695	<0.3*	0.29±* 0.08	<1300										0.13±* 0.12	0.34±* 0.09		
4-18 TO 4-24-73	17734	<0.4*	0.35±* 0.05	<1100										0.13±* 0.12	0.32±* 0.09		

TABLE 15 WEEKLY VARIATION IN THE RADIONUCLIDE CONCENTRATION OF THE INTAKE CANAL (CONDENSER INTAKE)
LOCATION # 15-26-12-06

RADIONUCLIDE CONCENTRATION (pCi/LITER)

COLLECTION DATE	RH#	^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
1-4 TO 1-11-73	17201@	0.09±0.29*	0.35±0.19*		<0.49	0.071±0.081	<0.16	<0.20	0.076±0.080	0.15±0.14	0.014±0.037	0.10±0.10	<1.2	0.16±0.14*	0.20±0.11*	<0.13	0.29±0.32
1-11 TO 1-16-73	17235@	<0.27*	0.37±0.04*		<0.48	0.079±0.070	<0.14	<0.19	0.062±0.072	0.14±0.13	0.025±0.032	<0.13	<0.90	0.11±0.17*	0.41±0.13*	<0.12	0.08±0.23
1-16 TO 1-24-73	17274@	0.05±0.10*	0.26±0.06*	<1100	<0.33	0.071±0.058	<0.12	<0.15	0.068±0.053	0.069±0.096	0.01±0.02	0.095±0.072	<0.83	0.19±0.14*	0.29±0.10*	0.043±0.045*	<0.24
1-24 TO 1-31-73	17297	<0.15*	0.30±0.03*		<0.27	0.046±0.044	<0.086	<0.11	0.098±0.044	0.094±0.078	<0.029	0.17±0.05	<0.6	0.07±0.12*	0.29±0.10*	<0.07	<0.24
1-31 TO 2-7-73	17328	0.02±0.24*	0.34±0.09*	<1000	<0.19	0.028±0.035	<0.065	<0.086	0.065±0.036	<0.09	0.01±0.02	0.071±0.043	<0.5	0.04±0.09*	0.16±0.07*	0.01±0.03	<0.18
2-7 TO 2-13-73	17353@	21.7±1.0	3.1±0.5	400±700	<0.43	0.11±0.07	<0.13	<0.18	0.27±0.07	0.10±0.13	0.027±0.031	0.16±0.08	<0.9	0.09±0.17*	0.32±0.13*	<0.11	0.13±0.23
2-13 TO 2-20-73	17382@			<1100	<0.70	<0.14	<0.19	<0.25	0.04±0.08	<0.23	0.01±0.04	<0.19	0.1±0.8	0.10±0.17	0.35±0.13	<0.13	0.22±0.24
2-20 TO 2-27-73	17418			<1100	<0.30	0.056±0.044	<0.085	0.03±0.08	0.03±0.04	0.01±0.08	0.007±0.019	0.071±0.055	<0.57	0.11±0.11*	0.27±0.09*	<0.08	0.09±0.16
3-6 TO 3-13-73	17490@	<0.4*	0.34±0.07*		<0.31	0.076±0.057	<0.11	<0.14	0.087±0.053	0.02±0.09	0.007±0.022	0.073±0.067	<0.80	0.09±0.12*	0.26±0.09*	<0.07	0.08±0.16
3-13 TO 3-21-73	17531			<1100	<0.40	0.12±0.06	<0.12	<0.16	0.11±0.06	0.11±0.10	0.010±0.026	0.13±0.07	<0.79	<0.20*	0.21±0.09*	<0.10	0.21±0.20
3-21 TO 3-28-73	17574	<0.2*	0.33±0.03*	<1100	<0.42	0.040±0.057	<0.12	<0.16	0.10±0.05	0.10±0.09	<0.034	0.20±0.08	<0.81	0.08±0.12*	0.28±0.09*	0.030±0.052	<0.20

NOTES: @ BIASED SAMPLE. *DISSOLVED FRACTION ONLY. ALL OTHER CONCENTRATIONS ARE STATED AS TOTAL (SUSPENDED PLUS DISSOLVED) EXCEPT FOR 60-Co, 58-Co, AND 54-Mn. THE CHEMICAL RECOVERY FOR THESE ELEMENTS IN THE DISSOLVED FORM IS Mn-24%, Co-54%. 95-Zr IS ASSUMED TO BE IN EQUILIBRIUM WITH 95-Nb. STANDARD DEVIATION IS QUOTED AT THE 95 PERCENT CONFIDENCE LEVEL.

TABLE 15 WEEKLY VARIATION IN THE RADIONUCLIDE CONCENTRATION OF THE INTAKE CANAL (CONDENSER INTAKE) (CONTINUED)
LOCATION # 15-26-12-06

RADIONUCLIDE CONCENTRATION (pCi/LITER)

COLLECTION DATE	RH#	^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
3-28 TO 4-4-73	17626			<1200										<0.18*	0.29±* 0.09		
4-4 TO 4-11-73	17668	<0.23*	0.33±* 0.08											0.11±* 0.09	1.13±* 0.29		
4-17 TO 4-24-73	17735	<0.3*	0.34±* 0.04											0.16±* 0.13	1.13±* 0.41		

TABLE 16 TEMPORAL VARIATIONS IN THE RADIONUCLIDE CONCENTRATION OF GREAT BAY (LOCATION # 01-64-01-06)

RADIONUCLIDE CONCENTRATION (pCi/LITER)

COLLECTION DATE	RH#	^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
4-17-72	16098	0.1±0.2*	0.38±0.14*	<860	0.26±0.60	<0.3	<0.23	<0.52	<0.24	<0.5	0.21±0.09	0.36±0.18	<1.1	-	-	0.09±0.18	0.79±0.52
5-2-72	16187	0.1±0.3*	0.6±0.2*	-	<0.31	<0.12	0.14±0.07	<0.16	<0.15	<0.18	0.065±0.029	<0.12	0.77±0.44	-	-	<0.11	0.54±0.30
6-26-72	16333	0.15±0.48	0.26±0.33	<1200	<0.25	<0.09	<0.07	<0.12	<0.08	<0.13	0.047±0.022	0.094±0.048	0.07±0.16	-	-	0.026±0.048	0.16±0.17
7-10-72	16395	0.12±0.29	0.58±0.44	680±840	<0.16	<0.06	<0.06	<0.10	<0.06	<0.10	0.018±0.018*	0.081±0.045	0.08±0.14	-	0.28±0.09*	0.013±0.037	0.08±0.14
8-9-72	16502	0.14±0.08*	0.12±0.06*	<1200	<0.26	0.03±0.06	<0.11	<0.12	0.054±0.056	0.095±0.098	0.016±0.021	0.059±0.066	<0.88	<0.17*	0.29±0.09*	<0.06	0.09±0.14
9-18-72	16669	<0.4*	0.39±0.08*	<940	<0.6	<0.15	<0.18	<0.25	<0.14	<0.25	0.016±0.038	<0.16	0.27±0.84	0.11±0.16*	0.38±0.11*	<0.15	<0.46
10-31-72	16869	0.11±0.18*	0.23±0.13*		<0.18	0.026±0.036	<0.067	<0.08	0.018±0.033	0.038±0.058	0.012±0.014	0.024±0.039	<0.45	0.14±0.12*	0.41±0.09*	0.021±0.026	0.06±0.11
11-14-72	16928	0.17±0.19	0.14±0.19	<930	<0.33	0.01±0.06	0.02±0.07	<0.15	0.025±0.023	0.02±0.11	0.038±0.023	0.50±0.08	<1.0	0.06±0.14*	0.34±0.10*	0.04±0.06	<0.39
		0.09±0.05*	0.09±0.04*														
12-7-72	17026	0.00±0.08*	0.26±0.03*	500±700	<0.22	<0.064	0.024±0.051	0.04±0.06	<0.06	0.016±0.073	0.016±0.019	<0.07	0.24±0.35	0.06±0.12*	0.25±0.09*	<0.06	0.05±0.14
2-1-73	17296	<0.12*	0.18±0.02*	<1900	<0.42	0.03±0.07	<0.13	<0.18	0.02±0.07	0.20±0.12	0.016±0.025	0.15±0.07	<0.97	0.02±0.20*	0.32±0.14*	0.02±0.07	<0.40

NOTES: *DISSOLVED FRACTION ONLY. **SUSPENDED FRACTION ONLY. ALL OTHER CONCENTRATIONS ARE STATED AS TOTAL (SUSPENDED PLUS DISSOLVED) EXCEPT FOR 60-Co, 58-Co AND 54-Mn. THE CHEMICAL RECOVERY FOR THESE ELEMENTS IN THE DISSOLVED FORM IS Mn-24%, Co-54%. 95-Zr IS ASSUMED TO BE IN EQUILIBRIUM WITH 95-Nb. STANDARD DEVIATION IS QUOTED AT THE 95 PERCENT CONFIDENCE LEVEL.

TABLE 16 TEMPORAL VARIATIONS IN THE RADIONUCLIDE CONCENTRATION OF GREAT BAY (LOCATION # 01-64-01-06) (CONTINUED)

RADIONUCLIDE CONCENTRATION (pCi/LITER)

COLLECTION DATE	RH#	^{89}Sr	^{90}Sr	^{3}H	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce
2-28-73	17420	$<0.15^{*}$	$0.19\pm0.03^{*}$	<1000	<0.25	0.02 ± 0.05	0.01 ± 0.06	0.04 ± 0.07	0.02 ± 0.05	<0.12	0.011 ± 0.020	0.031 ± 0.053	<0.63	$0.02\pm0.12^{*}$	$0.19\pm0.09^{*}$	0.018 ± 0.037	<0.23
3-29-73	17576	$<1\pm3^{*}$	$<1.5^{*}$	<1100	<0.26	0.044 ± 0.051	<0.10	<0.12	0.036 ± 0.046	0.05 ± 0.08	0.011 ± 0.020	0.071 ± 0.056	<0.66	$0.12\pm0.14^{*}$	$0.48\pm0.11^{*}$	<0.58	0.13 ± 0.14
4-27-73	17747	$<0.2^{*}$	$0.22\pm0.02^{*}$	<1200	<0.3	<0.7	<0.1	<0.2	0.05 ± 0.05	<0.13	<0.03	0.12 ± 0.06	<0.7	$<0.2^{*}$	$0.22\pm0.09^{*}$	<0.07	<0.2

Table 17

Monthly Average Radionuclide Concentration of Undiluted Rad Waste (Oyster Creek NPGS)

Month	Radionuclide Concentration (pCi/ml)*								
	^{51}Cr	^{54}Mn	^{58}Co	^{60}Co	^{131}I	^{134}Cs	^{137}Cs	^{89}Sr	^{90}Sr
Aug., 1972	-	18.7±1.0	8.6±1.4	135±2	-	563±3	899±4	7.87±0.06	0.97±0
Sept., 1972	-	2.9±0.1	1.7±0.2	12.9±0.3	-	57.6±0.4	93.4±0.5	2.60±0.04	0.055± 0.016
Oct., 1972	8.1±5.1	5.1±0.4	1.3±0.4	20.2±0.8	16.7±4.1	41.9±0.8	68.8±1.1	1.11±0.02	0.051± 0.020
Nov., 1972	20.9±4.6	11.5±0.7	1.2±0.5	50.0±1.3	7.5±2.6	25.2±0.7	42.0±1.0	0.14±0.01	0.021± 0.007
Dec., 1972	19.1±1.5	2.6±1.9	0.38±0.22	8.7±0.4	5.7±0.7	1.6±0.2	3.1±0.2	0.32±0.01	0.016± 0.007
Jan., 1973	15.8±3.1	7.43±0.32	1.69±0.29	14.4±0.5	97.9±4.3	21.5±0.4	33.4±0.6	3.05±0.05	0.21± 0.02
Feb., 1973	16.2±3.7	12.7±0.6	1.32±0.46	29.1±1.4	8.63±1.69	23.1±1.2	31.9±1.6	0.85±0.03	0.067± 0.012
Mar., 1973	13.5±0.8	0.89±0.05	0.22±0.05	2.59±0.08	11.6±2.2	1.55±0.04	2.14±0.05	0.39±0.02	0.030± 0.007
Apr., 1973	14.1±1.2	3.04±0.15	0.52±0.13	9.64±0.28	43.6±0.8	6.12±0.17	7.07±0.19	1.25±0.03	0.071± 0.015

Notes: * Concentrations corrected to the 15th of each month. The standard deviations are quoted at the 95 percent confidence level.

B. Radioactivity Content of Bottom Sediment

Bottom sediment specimens were collected in Oyster Creek (discharge canal below the property line of the facility), Forked River (intake canal) and in Barnegat Bay near Cedar Creek. Beginning in November, 1972, a sediment sample was collected monthly at the continuous water sampling station maintained at Sands Point marina on the discharge canal in an attempt to relate sediment radioactivity to the water data.

Samples were taken in the main channels of the two streams using an Ekman dredge. Prior experiments(1) have shown that the majority of the sediment-associated radioactivity was confined to the main stream and not along the shoreline. Each sediment sample was uniformly mixed, dried at a low temperature on a hot plate, and analyzed on a gamma-ray spectrometry system.

On May 18, 1972, core samples were taken at two locations in the discharge canal in order to evaluate the vertical profile of the radioactivity in the sediment. Each core sample consisted of several 1.25 inch diameter slices of the bottom sediment with subsequent sectioning by length with the top layer serving as a reference point. The core samples were frozen and then cut into three sections with a saw: Top 2 inches, 2 to 4 inches, greater than 4 inches. Each section was then prepared and analyzed in accordance with the procedure used for the Ekman samples.

The radioactivity content of sediments from Oyster Creek (discharge canal), Forked River, Barnegat Bay, and Great Bay has been summarized in Tables 18 through 22. A description of the collection locations is presented as Table 23. The two radionuclides found in the greatest concentrations, which can be related to the aqueous discharges of the plant, were ^{60}Co and ^{54}Mn. This finding supports previous investigations,(1) although ^{58}Co in sediment (and benthic algae) was found more extensively in 1971. The area of the discharge canal having the maximum ^{60}Co concentration was at the water sampling station maintained off Sands Point Marina (See Table 20). This station was at the first commerical marina on Oyster Creek below the Route 9 bridge just as the stream widens. The monthly grab samples were taken approximately forty feet from the southern shoreline at the end of a boat dock. Most samples from this area contained high quantities of ^{40}K, normally indicative of a high organic content. Studies conducted of the area in 1971(1) and in 1972(5) have shown that highly organic sediments contain larger amounts of fallout and facility-produced radionuclides than sandy sediments.

The higher quantities of ^{60}Co and ^{54}Mn were somewhat confined to the widened area of Oyster Creek utilized by the boat marinas (See Figure 2). Two core samples taken in this area point out that the vertical distribution of the radiocobalt and ^{54}Mn was limited to the upper most two-inch layer (Table 22). Similar studies by Kahn, et.al.(5) have shown the same general vertical profiles of facility-produced radionuclides. It is speculated that a great deal of the ^{60}Co and ^{54}Mn sediment activity is related to sedimentation or settling of suspended particulate activity. Radiochemical analysis of the water at the Route 9

bridge during known discharges[5] indicated that 86 percent of the ^{60}Co and 82 percent of the ^{54}Mn was associated with suspended material. Most of the radioactivity on the suspended material of the brackish water could be filtered by a 8.0 micron porosity filter.

Apparently a major fraction of the radiocesium discharged from the facility remains in solution rather than becoming associated with suspended material or incorporated in sediment. Very little ^{134}Cs or ^{137}Cs has been observed in sediment. In addition, of the long-lived radionuclides discharged from the facility, ^{134}Cs and ^{137}Cs have been found to be two nuclides in the greatest concentration (See Table 17); the ^{137}Cs concentration is normally greater than the ^{60}Co concentration.

Facility produced radioactivity was not confined to the sediment of the discharge canal. Studies published in 1972[1] reported a widespread distribution of ^{60}Co and ^{54}Mn in Forked River, Barnegat Bay, and, to a lesser degree, in Manahawkin Bay. Recirculation of radioactivity into Forked River by water movement is evident by the presence of ^{60}Co and ^{54}Mn in sediments of this stream. During April, 1972, concentrations greater than 3 pCi/gram-dry of ^{60}Co were measured along the South Branch of Forked River. Radioactivity intrusion into the North Branch of the stream was also apparent during this period, confirming previous measurements in 1971.[1] Recirculation of radioactivity into the discharge canal has also been verified by analyses of water specimens taken at the condenser water intake during the beginning of 1973 (See Section VA).

Background sediment from Great Bay contained trace quantities of ^{60}Co, ^{134}Cs, and some fallout ^{137}Cs. The quantitative measurements have been summarized in Table 21.

For a more detailed radioactivity profile of Barnegat Bay, Oyster Creek, and Forked River, refer to references (1) and (5).

FIGURE 2 MAP OF THE OYSTER CREEK AREA DENOTING SEDIMENT AND WATER SAMPLING SITES

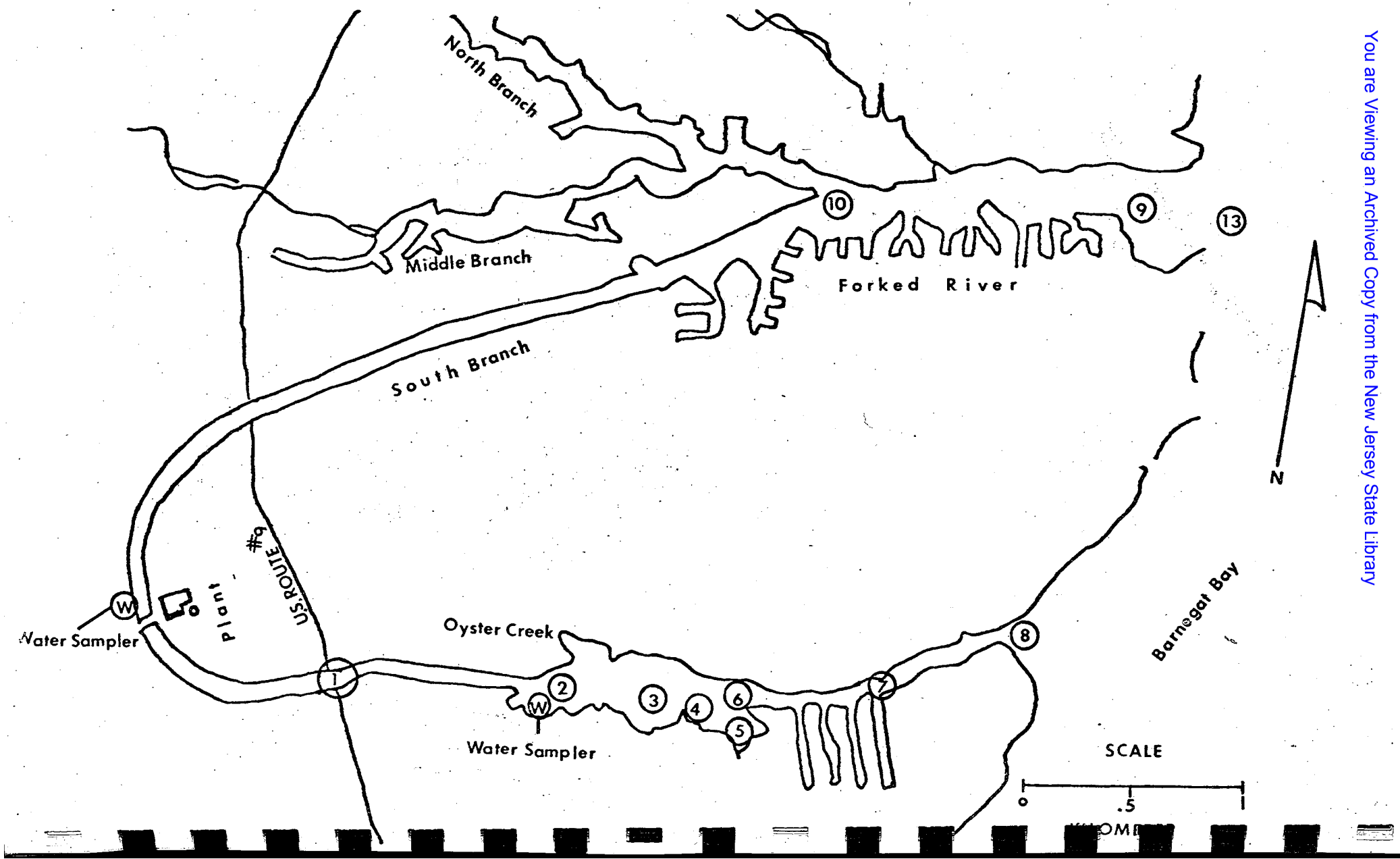

TABLE 18 RADIONUCLIDE CONCENTRATION OF BOTTOM SEDIMENT FROM OYSTER CREEK (DISCHARGE CANAL)

LOCATION #	DISTANCE DOWNSTREAM OF RT. 9 BRIDGE (FEET)	COLLECTION DATE	CONCENTRATION (pCi/GRAM-DRY) ^{144}Ce	^{141}Ce	^{51}Cr	^{103}Ru	^{106}Ru	^{137}Cs	^{134}Cs	^{95}Zr-Nb	^{58}Co	^{54}Mn	^{65}Zn	^{60}Co	^{40}K
15-26-22-26 (MAP #8)	8200	4-18-72	0.86± 0.42	-	<1.1	0.07± 0.15	<0.85	0.70± 0.08	<0.14	0.014± 0.034	0.22± 0.21	1.2± 0.2	0.28± 0.26	1.2± 0.1	1.4± 0.8
15-26-23-26 (MAP #7)	6850	4-18-72	0.56± 0.29	-	0.56± 0.42	0.04± 0.08	<0.5	0.34± 0.05	0.01± 0.06	0.021± 0.019	0.11± 0.12	0.44± 0.09	0.13± 0.15	4.8± 0.1	1.3± 0.6
15-26-33-26 (MAP #6)	~ 5200	4-18-72	0.96± 0.36	-	<0.80	0.19± 0.11	<0.56	0.38± 0.05	0.06± 0.06	0.027± 0.023	<0.18	0.40± 0.08	0.15± 0.13	2.4± 0.1	9.7± 0.6
15-26-33-26 (MAP #6)	~ 5200	7-11-72	0.58± 0.32	<0.12	<0.41	<0.14	<0.54	0.16± 0.04	-	0.08± 0.02	0.04± 0.09	0.28± 0.07	0.06± 0.15	1.2± 0.1	8.7± 0.5
15-26-35-26 (MAP #5)	~ 5000	7-11-72	0.97± 0.55	0.08± 0.16	<1.2	0.18± 0.17	0.37± 0.72	0.74± 0.10	-	0.24± 0.04	0.26± 0.24	1.5± 0.2	0.29± 0.45	12.0± 0.2	12± 1
15-26-48-26 (MAP #4)	~ 4800	4-18-72	2.0± 0.6	-	<1.3	0.34± 0.20	<1.0	0.74± 0.09	0.18± 0.11	0.059± 0.042	<0.34	1.5± 0.2	0.64± 0.28	12.1± 0.1	12.2± 0.8
15-26-08-26 MIDDLE OF CHANNEL (MAP #3)	4000	4-18-72	0.46± 0.26	-	0.28± 0.49	0.11± 0.09	<0.46	0.16± 0.04	0.044± 0.052	0.035± 0.019	0.10± 0.11	0.26± 0.08	0.03± 0.12	2.1± 0.1	8.9± 0.5
MIDDLE OF CHANNEL		7-11-72	0.85± 0.31	0.12± 0.08	<0.6	0.28± 0.09	0.09± 0.39	0.43± 0.05	-	0.24± 0.02	0.30± 0.12	1.1± 0.1	0.06± 0.20	4.8± 0.1	10.5± 0.5
SOUTH SIDE OF CHANNEL	4000	4-18-72	2.2± 0.4	-	0.08± 0.59	0.20± 0.12	0.58± 0.42	0.66± 0.06	0.059± 0.068	0.30± 0.03	0.03± 0.15	1.0± 0.1	0.16± 0.17	7.2± 0.1	12.9± 0.6
NORTH SIDE OF CHANNEL	4000	4-18-72	3.2± 0.7	-	<1.3	0.52± 0.20	0.21± 0.75	0.80± 0.09	0.31± 0.11	0.12± 0.04	0.04± 0.24	2.6± 0.2	0.37± 0.27	10.2± 0.1	15.3± 0.9

TABLE 18 RADIONUCLIDE CONCENTRATION OF BOTTOM SEDIMENT FROM OYSTER CREEK (DISCHARGE CANAL) (CONTINUED)

LOCATION #	DISTANCE DOWNSTREAM OF RT. 9 BRIDGE (FEET)	COLLECTION DATE	CONCENTRATION (pCi/GRAM-DRY) ^{144}Ce	^{141}Ce	^{51}Cr	^{103}Ru	^{106}Ru	^{137}Cs	^{134}Cs	^{95}Zr-Nb	^{58}Co	^{54}Mn	^{65}Zn	^{60}Co	^{40}K
15-26-34-26 (MAP #2)	~2200	4-18-72	0.67± 0.32	-	<0.6	0.075± 0.095	<0.54	0.24± 0.04	0.021± 0.056	0.034± 0.020	0.10± 0.11	0.28± 0.08	0.15± 0.13	3.3± 0.1	4.7± 0.4
15-26-20-26 (MAP #1)	0	4-18-72	0.41± 0.17	-	0.27± 0.26	0.093± 0.052	<0.18	0.060± 0.020	<0.05	0.049± 0.011	0.032± 0.057	0.063± 0.040	0.021± 0.058	0.33± 0.03	1.0± 0.2
15-26-20-26 (MAP #1)	0	7-11-72	0.42± 0.15	0.03± 0.04	<0.35	0.070± 0.040	<0.36	0.070± 0.020	-	0.040± 0.010	0.030± 0.045	0.080± 0.040	<0.12	0.45± 0.03	1.0± 0.2

TABLE 19 RADIONUCLIDE CONCENTRATION OF BOTTOM SEDIMENT FROM FORKED RIVER (INTAKE STREAM)

LOCATION #	DISTANCE UPSTREAM FROM BARNEGAT BAY (FEET)	COLLECTION DATE	CONCENTRATION (pCi/GRAM-DRY) ^{144}Ce	^{141}Ce	^{51}Cr	^{103}Ru	^{106}Ru	^{137}Cs	^{134}Cs	^{95}Zr-Nb	^{58}Co	^{54}Mn	^{65}Zn	^{60}Co	^{40}K
15-26-09-26 (MAP #9)	230 S.B.	7-11-72	2.3±0.5	<0.09	-	0.33±0.10	0.09±0.13	0.39±0.05	-	0.25±0.02	<0.09	0.34±0.09	<0.28	1.6±0.1	14.1±0.7
15-26-25-26 (MAP #10)	4,000 S.B. AND N.B.	4-18-72	1.2±0.4	-	<0.66	0.26±0.10	<0.64	0.37±0.05	<0.11	0.046±0.022	<0.18	0.22±0.09	0.09±0.14	2.2±0.1	14.5±0.7
15-26-07-26 (MAP #11)	7,000 S.B.	4-18-72	1.7±0.4	-	0.20±0.56	0.08±0.12	0.66±0.42	0.44±0.06	0.025±0.069	0.058±0.024	0.09±0.14	0.36±0.10	<0.25	3.4±0.1	14.6±0.7
15-26-26-26 (MAP #12)	11,500 S.B.	4-18-72	1.2±0.3	-	0.68±0.57	0.16±0.11	0.14±0.35	0.33±0.05	0.025±0.060	0.032±0.020	0.10±0.12	0.16±0.08	0.12±0.13	2.1±0.1	6.6±0.5
15-26-27-26	6,900 N.B.	4-18-72	2.3±0.5	-	<1.1	0.22±0.15	0.37±0.53	0.71±0.07	0.16±0.09	0.045±0.030	<0.24	0.46±0.11	0.15±0.18	3.2±0.1	13.6±0.8
15-26-44-26	RT. 9 N.B. BRIDGE	4-18-72	0.58±0.26	-	<0.40	0.04±0.06	0.17±0.20	0.24±0.03	<0.04	0.014±0.012	0.032±0.062	0.027±0.046	0.01±0.07	0.39±0.03	1.7±0.3
15-26-40-26 (MAP #13)	CONFLUENCE INTO BARNEGAT BAY	4-18-72	2.7±0.5	-	<0.9	0.61±0.14	0.09±0.49	0.46±0.06	0.088±0.073	0.12±0.03	<0.2	0.63±0.10	0.15±0.14	1.7±0.1	12.3±0.7

NOTES: S.B. - SOUTH BRANCH, N.B. - NORTH BRANCH

Table 20 Radioactivity of Sediment at the Water Sampling Station on the Discharge Canal

Radionuclide	Concentration (pCi/gram-dry)				
	11-21-72	1-16-73	2-8-73	3-13-73	4-3-73
^{144}Ce	2.0±0.3	1.5±0.6	1.4±0.7	1.8±0.2	2.2±0.5
^{141}Ce	0.15±0.07	0.07±0.19	0.16±0.18	0.11±0.06	<0.21
^{51}Cr	0.79±0.73	<3	0.6±1.9	0.81±0.65	<0.22
^{131}I	0.09±0.17	0.40±0.63	<0.6	0.07±0.16	-
^{125}Sb	-	<0.9	-	0.52±0.21	0.35±0.42
^{7}Be	-	0.8±2.2	-	2.2±0.8	2.5±1.7
^{103}Ru	0.04±0.11	0.24±0.27	<0.4	0.13±0.09	<0.31
^{106}Ru	1.6±1.0	1.3±0.24	-	0.82±0.87	-
^{140}Ba	0.49±0.60	-	0.9±1.4	<0.82	<2.2
^{134}Cs	2.0±0.5	1.6±0.3	2.5±0.3	1.9±0.1	1.5±0.3
^{137}Cs	3.9±0.2	4.2±0.4	5.7±0.4	4.1±0.2	3.9±0.3
^{95}Zr	0.37±0.28	0.62±0.74	<1.1	<0.38	<0.79
^{95}Nb	-	0.14±0.39	0.42±0.38	<0.20	0.14±0.29
^{58}Co	0.52±0.15	0.24±0.37	0.26±0.40	0.23±0.13	0.14±0.28
^{54}Mn	7.2±0.2	5.6±0.5	10.0±0.6	6.1±0.2	6.2±0.4
^{59}Fe	-	<1.3	0.2±0.9	0.22±0.32	<1.0
^{65}Zn	0.37±0.35	2.4±0.8	3.1±0.9	0.82±0.31	2.1±0.6
^{60}Co	29.6±0.4	27.2±1.0	45.2±1.2	28.8±0.4	33.0±0.8
^{40}K	13±1	15±1	-	15±1	-

Table 21

Radionuclide Concentration of Bottom Sediment from Great Bay (Background Area) and Barnegat Bay

Concentration (pCi/gram-dry)

Location	Collection Date	^{144}Ce	^{51}Cr	^{103}Ru	^{106}Ru	^{137}Cs	^{134}Cs	^{95}Zr-Nb	^{58}Co	^{54}Mn	^{65}Zn	^{60}Co	^{40}K
01640126	4-17-72	1.0± 0.4	0.63± 0.50	0.08± 0.10	0.19± 0.40	0.47± 0.06	0.086± 0.073	0.03± 0.02	<0.17	<0.12	<0.16	0.059± 0.048	1.7± 0.1
Background at Great Bay	7-10-72	1.1± 0.4	<0.52	<0.16	<0.70	0.31± 0.05	-	0.03± 0.02	<0.12	<0.10	<0.19	<0.06	1.6± 1.0
Barnegat Bay													
15261126 Cedar Creek	7-11-72	<0.42	0.30± 0.35	<0.14	<0.54	0.07± 0.03	-	0.02± 0.01	<0.10	<0.08	<0.14	<0.07	8.6± 0.4

TABLE 22 VERTICAL PROFILE OF RADIOACTIVITY IN SEDIMENTS OF THE DISCHARGE CANAL (CORE SAMPLES TAKEN ON MAY 18, 1972)

RADIONUCLIDE CONCENTRATIONS (pCi/GRAM-DRY)

LOCATION	DISTRIBUTION DEPTH	^{144}Ce	^{141}Ce	^{51}Cr	^{103}Ru	^{106}Ru	^{137}Cs	^{95}Zr-Nb	^{58}Co	^{54}Mn	^{60}Co	^{65}Zn	^{40}K
15-26-22-26	TOP 2"	1.3 ± 0.7	<0.60	<3.6	0.15 ± 0.38	<1.3	0.67 ± 0.12	0.10 ± 0.07	0.29 ± 0.37	0.95 ± 0.23	8.6 ± 0.2	0.38 ± 0.54	20 ± 1
	2" TO 4"	0.87 ± 0.87	<0.55	<2.7	0.33 ± 0.30	<1.1	0.47 ± 0.08	0.03 ± 0.05	<0.35	0.30 ± 0.14	2.1 ± 0.1	<0.44	17 ± 1
	4"	0.96 ± 0.58	<0.50	<2.4	0.09 ± 0.25	<0.9	0.25 ± 0.07	<0.05	<0.29	0.16 ± 0.12	1.3 ± 0.1	<0.40	18 ± 1
15-26-24-26	TOP 2"	0.61 ± 0.49	<0.42	<2.5	<0.39	0.58 ± 0.61	0.39 ± 0.08	0.20 0.05	<0.33	0.35 ± 0.14	1.6 ± 0.1	<0.41	20 ± 1
	2" TO 4"	1.1 ± 0.9	<0.8	<0.36	0.50 ± 0.39	<0.14	0.26 ± 0.10	<0.06	<0.41	0.06 ± 0.17	0.17 ± 0.09	<0.49	23 ± 1

Table 23

Bottom Sediment Collection Stations in the Vicinity of the Oyster Creek Nuclear Generating Station

Map #	Location#	Description
1	15-26-40-26	Forked River, Flashing Red Marker #12 at the mouth of Forked River (Mid-Channel).
2	15-26-25-26	Forked River at Intersection of North and South Branch. 1300 yards up from Barnegat Bay.
3	15-26-27-26	Forked River, North Branch just off Captain's Inn, about 2300 yards up from Barnegat Bay.
4	15-26-44-26	Forked River, North Branch of Forked River about 20 ft. east of U.S. Rt.#9.
5	15-26-07-26	Forked River at Forked River Estates Road.
6	15-26-26-26	Forked River, South Branch at U.S. Rt.#9 Bridge about 4000 yards up stream from Barnegat Bay.
7	15-26-20-26	Oyster Creek Rt. #9.
8	15-26-34-26	Oyster Creek, between Rue's Boat Yard (and--P.T. Harbor Mid-Channel) just before the Creek widens.
9	15-26-08-26	Oyster Creek at Rue's Boat Yard.
10	15-26-48-26	Oyster Creek, just off the Oyster Creek Marina (Mid-Channel).
11	15-26-33-26	Oyster Creek, just east of the Oyster Creek Marina where the Creek narrows (Mid-Channel).
12	15-26-23-26	Oyster Creek, 600 yards up from Barnegat Bay.
13	15-26-22-26	Oyster Creek, 50 to 70 yards up from Barnegat Bay.
Not on Map	01-64-01-26	Great Bay (Background Reference 23 miles south of Oyster Creek).

Table 23 (Continued)

Map #	Location#	Description
Not Presented	15-26-11-26	Barnegat Bay at Cedar Creek entrance into the Bay. Near red light marker #64.
Not Presented	15-26-24-26	Oyster Creek, approximately 1,000 yards up from Barnegat Bay near the 4th inlet lagoon (from Bay).
Not Presented	15-26-35-26	Oyster Creek just southeast of the Oyster Creek Marina.
Not Presented	15-26-09-26	Confluence of Forked River and Barnegat Bay. Approximately 230 feet up Forked River from the Bay.

C. Shellfish and Fin Fish Collection and Analysis

Samples of Mercenaria mercenaria (hard clams) were collected from five areas in Barnegat Bay on June 14, 1972 and March 21, 1973. A general description of the sampling sites appears in Table 27. Approximately three dozen clams of various sizes were taken from each Bay area and processed for isotopic gamma and radiostrontium content. Each specimen was shucked and the edible meat and fluid were separated and analyzed independently.

The results of isotopic gamma analyses on the clam samples are given in Table 24. Of the radionuclides evaluated, ^{60}Co and ^{58}Co were the only facility-produced isotopes found in detectable quantities. On a per unit weight basis, radiocobalt was more prevalent in the fluid than in the edible meat. During both sampling periods, clams from the Cedar Creek area contained more ^{60}Co (210 to 270 pCi/kg-fluid) than clams from the other areas. Somewhat lower radiocobalt values were found in clams at the Oyster Creek inlet into the Bay. Non-detectable amounts of ^{54}Mn were measured in clams sampled in 1972 and 1973, although this nuclide was prevalent in clams sampled in 1971. The ^{90}Sr content of clam meat and fluid was very low, being less than 6 pCi/kg-fresh for both the June, 1972 and March, 1973 samples. Detectable quantities of ^{89}Sr (~ 4-5 pCi/kg) were found in both the fluid and meat fractions of shellfish from the Cedar Creek area (1972). The ^{90}Sr content of background clams from Great Bay collected in July, 1972 was approximately 3 pCi/kg-meat. No corrosion products were detected in these background clams (See Table 29).

In general, the incorporation of facility-discharged radionuclides into clams has been less than that of benthic algae and sediment. The maximum ^{60}Co clam concentration measured was 270 pCi/kg, which is less than 0.05 percent of the recommended maximum permissible concentration as per federal guides.(11)

Specimens of winter flounder (Pseudopleuronectes americanus), white perch (Roccus americanus), eel (Anguilla rostrata), blue crab (Collinectes sapides), and Atlantic Silversides (Menidia menidia) were collected from Barnegat Bay on several occasions in 1972. Similar fin fish were sampled from a background area in Great Bay in July, 1972. Normally, the quantity of fish caught via a trawl was insufficient to permit filleting for separate isotopic gamma-ray analysis of the meat and radiostrontium analysis of the bone. Therefore, the fish was cut into sections and analyzed in toto. The small silversides, a primary consumer of approximately 1 1/2 inches in length, were collected by means of a seine at each area and composited for analysis.

Winter flounder collected in April, 1972 at Waretown and Cedar Creek were found to contain ^{60}Co in concentrations between 40 and 70 pCi/kg-whole (See Table 28). Radiocobalt was also detected in silversides which were resident of the Oyster Creek inlet area. Silversides collected from several other regions of the western portion of the Bay were devoid of any detectable quantities of the common corrosion products (^{60}Co, ^{54}Mn, ^{58}Co, and ^{51}Cr). Cesium-137, in varying concentrations, was present in most of the fish specimens processed from Barnegat Bay. Silversides collected from Silver Bay in August, 1972 were found to contain ^{137}Cs (91 pCi/kg-whole).

Radiostrontium was prevalent in most of the fish of Barnegat Bay, ^{89}Sr being an order of magnitude greater than ^{90}Sr. The data presented are biased from the standpoint that both meat and bone were analyzed together. Consequently, the strontium results can only be interpreted for isotopic ratios and not for concentrations. The fact that ^{89}Sr was detected in most of the specimens of Barnegat Bay and not in specimens of Great Bay indicates that this isotope is readily absorbed and its presence is probably related to facility discharges.

The results of the analyses performed on fish from Great Bay are presented in Table 29. The concentration of ^{137}Cs in the various fin fish was below the minimum sensitivity of detection 46 to 78 pCi/kg-whole). Very little ^{90}Sr and no ^{89}Sr were detected in the five different types of fish (whole) analyzed. Clam shells from this area contained no ^{89}Sr and 27 pCi/kg of ^{90}Sr.

Table 24
RADIONUCLIDE CONCENTRATION IN SHELLFISH FROM BARNEGAT BAY

LOCATION#	DESCRIPTION	COLLECTION DATE	TYPE	RADIONUCLIDE CONCENTRATION (pCi/kg-fresh)*									
				^{54}Mn	^{58}Co	^{60}Co	^{65}Zn	^{95}Zr	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{40}K
15-26-10-80	AREA OF NAVIGATION BUOY #5 AT MOUTH OF OYSTER CREEK	JUNE 14, 1972	MEAT	<140	110±110	220±56	<180	30±23	<180	450±470	<90	22±55	2000±600
		"	FLUID	<60	76±47	210±25	<80	<30	<110	<560	<40	<32	490±220
15-42-02-80	800 YARDS EAST OF WARETOWN FISHING STATION	JUNE 14, 1972	MEAT	<54	59±45	90±23	<90	<20	<110	<710	<40	<40	1900±270
		"	FLUID	<78	120±67	200±35	<110	<30	<110	310±300	<54	15±33	900±350
15-68-03-80	300 YARDS WEST OF GULF POINT	JUNE 14, 1972	MEAT	<51	62±45	110±21	<90	<20	<110	<710	<40	<40	1400±240
		"	FLUID	<55	57±48	160±24	43±52	<20	<110	<710	<40	<40	<470
15-02-01-80	BARNEGAT LIGHT INLET AREA	JUNE 14, 1972	MEAT	<55	<80	62±23	<79	<20	<110	<610	<40	<50	1200±280
		"	FLUID	<50	<80	150±30	<100	<20	<110	<610	8±33	<50	530±310
15-26-11-80	CEDAR CREEK AREA	JUNE 14, 1972	MEAT	<66	<80	67±27	21±64	<20	<110	<610	<40	<50	1600±340
		"	FLUID	20±90	<120	270±56	<130	11±25	<200	270±530	13±62	26±58	1200±590

* NOTES: THE STANDARD DEVIATION IS STATED AT THE 95 PERCENT CONFIDENCE LEVEL. LESS THAN MINIMUM SENSITIVITY VALUES ARE BASED UPON THREE TIMES THE STANDARD DEVIATION OF THE BACKGROUND COUNT. NO OTHER GAMMA-RAY PHOTOPEAKS WERE OBSERVED IN THE GAMMA-RAY SPECTRUM OTHER THAN FOR THE QUOTED RADIONUCLIDES.

TABLE 24 (CONTINUED)

RADIONUCLIDE CONCENTRATION IN SHELLFISH FROM BARNEGAT BAY

LOCATION #	DESCRIPTION	COLLECTION DATE	TYPE	RADIONUCLIDE CONCENTRATION (pCi/kg-fresh)*									
				^{54}Mn	^{58}Co	^{60}Co	^{65}Zn	^{95}Zr-Nb	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{40}K
15-26-10-80	AREA OF NAVIGATION BUOY #5 AT MOUTH OF OYSTER CREEK	3-21-73	MEAT	<56	<70	86±25	<110	<31	<84	<430	<34	23±24	1400± 300
			FLUID	30±39	<76	160±30	72±87	18±22	20±63	<450	<36	11±24	420± 250
15-42-02-80	800 YARDS EAST OF WARETOWN FISHING STATION	3-21-73	MEAT	<42	<54	74±18	<81	<24	69±45	<430	30±18	22±18	2000± 200
			FLUID	<42	<52	150±20	<78	<22	60±36	<430	<29	26±15	610± 170
15-68-03-80	300 YARDS WEST OF GULF POINT	3-21-73	MEAT	<43	20±37	76±19	<84	<24	22±53	<430	11±20	<28	1900± 200
			FLUID										
15-02-01-80	BARNEGAT LIGHT INLET AREA	3-21-73	MEAT	31±33	<61	90±25	<98	13±17	<73	<430	12±20	20±20	1700± 200
			FLUID	<45	28±38	160±20	<90	<25	58±53	<430	<29	16±19	470± 200
15-26-11-80	CEDAR CREEK AREA	3-21-73	MEAT	<68	<92	120±30	80±91	11±27	<110	<550	30±30	44±30	2000± 300
			FLUID	<48	<64	210±20	42±100	<28	41±55	<430	17±20	22±20	540± 220

*NOTES: THE STANDARD DEVIATION IS STATED AT THE 95 PERCENT CONFIDENCE LEVEL. LESS THAN MINIMUM SENSITIVITY VALUES ARE BASED UPON THREE TIMES THE STANDARD DEVIATION OF THE BACKGROUND COUNT. NO OTHER GAMMA-RAY PHOTOPEAKS WERE OBSERVED IN THE GAMMA-RAY SPECTRUM OTHER THAN FOR THE QUOTED RADIONUCLIDES.

Table 25 Radiostrontium Content of Shellfish Collected in Barnegat Bay during June, 1972

Concentration (pCi/kg-fresh)

Location #	Description	RH#	Sample Type	Collection Date	^{89}Sr	^{90}Sr
15-26-10-80	Area of Navigation Buoy #5 at mouth of Oyster Creek	16311	Fluid	June 14, 1972	<9	4.0±2.9
15-26-03-80	"	16420	Fluid	July 12, 1972	<2	0.89±0.74
	"	16420	Meat		<1.2 <1.3	2.3±2.0 1.0±2.4
15-68-03-80	300 yards West of Gulf Point	16312	Meat	June 14, 1972	<10	5.0±1.4
		16312	Fluid	June 14, 1972	<8	3.6±2.6
15-02-01-80	Barnegat Light Inlet Area	16313	Fluid	June 14, 1972	<9	4.8±1.2
		16313	Meat		<11	1.9±1.8
15-42-02-80	800 yards East of Waretown Fishing Station	16314	Fluid	June 14, 1972	<11	4.6±3.3
		16314	Meat		<1	<1.3
15-26-11-80	Cedar Creek Area	16315	Meat	June 14, 1972	4±2	<1.7
		16315	Fluid		5.2±3.4	1.9±1.6

Table 26 Radiostrontium Content of Shellfish Collected in Barnegat Bay During March, 1973

Location #	Description	RH#	Sample Type	Collection Date	Concentration (pCi/kg-fresh) ^{89}Sr	^{90}Sr
15-26-10-80	Area of Navigation Buoy #5 at mouth of Oyster Creek	17523	Fluid	March 21, 1973	<6	3.6±0.8
			Meat		<11	4±2
15-68-03-80	300 yards West of Gulf Point	17525	Fluid	March 21, 1973	<8	<2
			Meat		<12	2.0±1.2
15-02-01-80	Barnegat Light Inlet Area	17524	Fluid	March 21, 1973	<8	<3
			Meat		<10	2.4±0.9
15-42-02-80	800 yards East of Waretown Fishing Station	17526	Fluid	March 21, 1973	<7	1.3±0.8
			Meat		<8	1.5±0.8
15-26-11-80	Cedar Creek Area	17527	Fluid	March 21, 1973	<7	0.7±0.7
			Meat		<11	5±3

Table 26 Radiostrontium Content of Shellfish Collected in Barnegat Bay During March, 1973

Location #	Description	RH#	Sample Type	Collection Date	Concentration (pCi/kg-fresh) ^{89}Sr	^{90}Sr
15-26-10-80	Area of Navigation Buoy #5 at mouth of Oyster Creek	17523	Fluid	March 21, 1973	<6	3.6±0.8
			Meat		<11	4±2
15-68-03-80	300 yards West of Gulf Point	17525	Fluid	March 21, 1973	<8	<2
			Meat		<12	2.0±1.2
15-02-01-80	Barnegat Light Inlet Area	17524	Fluid	March 21, 1973	<8	<3
			Meat		<10	2.4±0.9
15-42-02-80	800 yards East of Waretown Fishing Station	17526	Fluid	March 21, 1973	<7	1.3±0.8
			Meat		<8	1.5±0.8
15-26-11-80	Cedar Creek Area	17527	Fluid	March 21, 1973	<7	0.7±0.7
			Meat		<11	5±3

Table 26 Radiostrontium Content of Shellfish Collected in Barnegat Bay During March, 1973

Location #	Description	RH#	Sample Type	Collection Date	Concentration (pCi/kg-fresh) ^{89}Sr	^{90}Sr
15-26-10-80	Area of Navigation Buoy #5 at mouth of Oyster Creek	17523	Fluid	March 21, 1973	<6	3.6±0.8
			Meat		<11	4±2
15-68-03-80	300 yards West of Gulf Point	17525	Fluid	March 21, 1973	<8	<2
			Meat		<12	2.0±1.2
15-02-01-80	Barnegat Light Inlet Area	17524	Fluid	March 21, 1973	<8	<3
			Meat		<10	2.4±0.9
15-42-02-80	800 yards East of Waretown Fishing Station	17526	Fluid	March 21, 1973	<7	1.3±0.8
			Meat		<8	1.5±0.8
15-26-11-80	Cedar Creek Area	17527	Fluid	March 21, 1973	<7	0.7±0.7
			Meat		<11	5±3

Table 27

Shellfish Collection Stations in Barnegat Bay

Map #	Location #	Description
1	15-26-10-80	Just east of the mouth of Oyster Creek (~0.25 mi. east from the mouth of Oyster Creek).
2	15-68-03-80	300 yards NE of Gulf Point (~4.5 mi. south from the mouth of Oyster Creek).
3	15-02-01-80	Barnegat Light Inlet Area (~5.0 mi. east south east from the mouth of Oyster Creek).
4	15-42-02-80	800 yards east of Waretown (~2.0 mi. south from the mouth of Oyster Creek).
5	15-26-11-80	Cedar Creek Area (~4.0 mi. north north east from the mouth of Oyster Creek).

Table 28 Radioactivity Content of Fin Fish and Crabs of Barnegat Bay

Specie	Location	Collection Date	Radionuclide Concentration (pCi/kg-fresh) ^{51}Cr	^{54}Mn	^{58}Co	^{60}Co	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{89}Sr	^{90}Sr
Winter Flounder	15-14-02-80 Silver Bay	4-28-72	<200	<50	<100	<70	<110	<700	<40	<40	<8	3±5
Silver-Side (Whole)		7-19-72	-	<70	<240	<60	<1000	<780	<72	45±30	-	-
Silver-Side (Whole)		8-22-72	<3900	<81	<180	<60	<350	<750	91±44	<60	-	-
Winter Flounder (Whole)		11-29-72	<2400	<57	92±83	<60	<230	<540	<45	41±22	30±11	3.0±1.8
Silver-Side (Whole)	15-56-01-80 Seaside Park	9-15-72	-	<72	<160	<60	<380	<720	<75	70±30	-	-
Winter Flounder (Whole)		11-28-72	1000±1700	23±47	<140	<60	50±190	<570	<45	<50	22±11	2.5±1.8
White Perch (Whole)		11-28-72	<250	<74	<150	<60	140±180	<580	30±31	85±31	83±16	5.9±2.7
Flounder (Whole)	15-42-02-80 Waretown	4-18-72	<200	<50	<100	40±20	<110	<700	<40	<40	<15	2.8±1.2
Eel (Whole)		4-18-72	<200	<50	<100	25±20	<110	<700	<40	35±20	5.5±4.6	<0.9

Table 28 Radioactivity Content of Fin Fish and Crabs of Barnegat Bay (Continued)

Specie	Location	Collection Date	Radionuclide Concentration (pCi/kg-fresh) ^{51}Cr	^{54}Mn	^{58}Co	^{60}Co	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{89}Sr	^{90}Sr
Winter Flounder (Whole)	15-26-11-80 Cedar Creek	4-19-72	<200	<50	100± 100	70±40	<110	<700	<40	<40	<20	<23
Flounder (Whole)		11-27-72	500± 1300	<55	<110	<60	100± 150	<540	<45	<50	91±16	2.1± 2.5
Silver-Side (Whole)	15-26-10-80 Oyster Creek Inlet	4-19-72	<200	<50	<100	22±7	<110	<700	<40	<40	-	-
Blue Crab (Meat)		7-12-72	<710	<140	<160	33±61	<190	200± 600	-	67±64	<1.6	1.7± 2.6
Winter Flounder (Whole)	15-12-01-80 Metedeconk River	11-30-72	-	<67	<30	<60	<280	250± 340	<45	20±25	<0.2	4.2± 1.0
Winter Flounder (Whole)	15-44-01-80 Toms River	11-28-72	<2600	<57	82± 82	<60	<240	240± 310	<42	35±22	23±11	3.5± 1.7

Table 29 Radioactivity Levels in Background Fish of Great Bay

Specie	RH#	Collection Date	Radionuclide Concentration (pCi/kg-fresh) ^{51}Cr	^{54}Mn	^{58}Co	^{60}Co	^{103}Ru	^{106}Ru	^{137}Cs	^{89}Sr	^{90}Sr
Killi (whole)	16390B-3	7-10-72	<480	<63	<87	<49	<130	<460	<46	<2.2	3.8±2.5
Flounder (meat)	16390B-2	7-10-72	<390	<68	<71	<65	<100	<430	<47	<27	<3.9
Lung (whole)	16390A-3	7-10-72	<600	<120	<150	<80	<270	<950	<78	<4.5	2.4±1.9
Shrimp (whole)	16390A-2	7-10-72	<240	<55	<75	<60	<140	290± 260	<50	<30	6.3±1.4
Silver Side (whole)	16390C	7-10-72	<1200	<180	<200	<120	<320	800± 760	60± 80	<19	1.0±2.6
Black Fish (whole)	16390B	7-10-72	<430	<80	<85	<60	<140	<540	<50	<1.8	10.0±2.2
Stripped Killi (whole)	16390A	7-10-72	<350	<60	<75	<65	<100	<430	<56	<13	2.5±1.3
Crab Meat	16393	7-10-72	<1700	<210	<430	<180	<690	<2900	<190	<30	<9.0
Clam Fluid	16404	7-11-72	<350	<56	<70	<79	<100	<430	<42	<3	1.3±1.0
Clam Meat	16404	7-11-72	<350	<55	<70	<70	70±40	<430	<40	<1.1	3.0±2.1
Clam Meat	16433	7-12-72	<350	<55	<40	<65	<100	<430	23±19	<19	<4.2

D. Radioactivity Content of Benthic Algae and Aquatic Plants of Barnegat Bay

Since aquatic algae and plants concentrate many elements to levels 10^2 to 10^3 of that in sea water,(6) these biological specimens provide a means of estimating the water concentration of certain radionuclides and a means of determining the general patterns of the radioactive aqueous plume in a water system. A more extensive study of the radioactivity distribution in Barnegat Bay by means of benthic algae sampling has been previously presented.(1)

On five separate occasions in 1972, benthic algae specimens were collected from four locations in Barnegat Bay near the Oyster Creek area. The specimens collected included: Gracilaria, Ulva lactuca, Codium fragile, Fucus, Enteromorpha, and the aquatic plant Zostera marina. On April 18, 1972, several Asterias forbesi, the common sea starfish, were also taken from Barnegat Bay near Waretown.

Samples were obtained by means of a trawl towed behind a boat. After a sampling pass, each specimen was separated on the boat and returned to the laboratory for processing. Laboratory preparation and analysis involved wet-weight determination, drying at a low temperature, ashing at 550°C, and counting on a 4"x4" well NaI(Tl) gamma-ray spectrometry system. The gamma-ray spectra were resolved using a weighted-least squares computer program. The wet-weight radionuclide concentration was determined by applying the measured ash/wet weight ratio to the results of the gamma-ray analysis of the ashed specimen.

Gamma-ray spectral analysis of the specimens indicates that ^{60}Co and ^{54}Mn were the principal facility-produced radionuclides incorporated in algae sampled during 1972 (See Table 30). No

significant quantities of ^{51}Cr have been detected in algae even though this nuclide has been released in moderate concentrations on occasion and should be incorporated in marine plants (6). The short half life (27.8 days) of ^{51}Cr may limit any substantial buildup of the nuclide in the Bay. The fact that nondetectable quantities of ^{51}Cr have been measured in bottom sediment supports this proposal.

Benthic algae near the Oyster Creek inlet into the Bay appears to contain higher concentrations of ^{60}Co and ^{54}Mn than algae from the other areas sampled. Similar concentrations of ^{60}Co and ^{54}Mn were observed in the same algae species from the Waretown and Cedar Creek areas. Of the three algae species analyzed from the Oyster Creek inlet in July, 1972, Gracilaria had the greatest radionuclide content (~395 pCi ^{60}Co/kg-fresh*), followed by Ulva lactuca (~255 pCi ^{60}Co/kg-fresh*), and Codium fragile (~115 pCi ^{60}Co/kg-fresh*). Samples in the Oyster Creek area in July showed that the aquatic plant Zostera marina incorporated as much ^{54}Mn and ^{60}Co as did Gracilaria. The preferential sorption capacity of certain algae has been previously documented by our laboratory (1) and the U.S. Environmental Protection Agency (5).

There was a significant increase in the ^{60}Co and ^{54}Mn concentrations of Gracilaria and Ulva lactuca at the Oyster Creek inlet station during November, 1972, as compared to July, 1972. This observed increase may be related to facility releases in August which contained higher than normal levels of radioactivity (by at least a factor of 3 to 16 for ^{60}Co).

* Average values for July, 1972.

Studies conducted by this laboratory have shown that in 1971 ^{54}Mn was found in greater concentration than ^{60}Co and, in addition, detectable quantities of ^{58}Co (200 to 300 pCi/kg-fresh in the Oyster Creek area) were observed at nearly every station sampled. Data accumulated in 1972 do not support the 1971 findings. However, analyses of the monthly composited samples of aqueous discharges during the latter half of 1972 revealed that the ^{60}Co to ^{54}Mn concentration ratio ranged between 3.3 to 7.2:1. The ^{60}Co to ^{58}Co ratio during August through December, 1972 ranged between 7.6 to 4.2:1. The observed differences between the 1971 and 1972 data may be a result of changes in the constituents of the radwaste discharged for the two years.

Fucus, Ulva lactuca and Gracilaria sampled from the background area of Great Bay contained no significant (detectable) quantities of ^{51}Cr, ^{58}Co, ^{54}Mn, ^{60}Co, ^{65}Zn, or ^{59}Fe. Trace amounts of ^{103}Ru and ^{95}Zr-Nb, related to stratospheric fallout, were detected in all specimens from this area. Table 31 summarizes the results of analyses performed on the background specimens.

TABLE 30 RADIOACTIVITY CONTENT OF CERTAIN BENTHIC FLORA FROM BARNEGAT BAY

ALGAE OR PLANT TYPE	COLLECTION DATE	LOCATION	RADIONUCLIDE CONCENTRATION (pCi/kg-wet)								
			^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{103}Ru	^{106}Ru	^{95}Zr	^{65}Zn
GRACILARIA	7-11-72	OYSTER CREEK INLET 15-26-10-85	<180	280±50	10±40	<100	500±40	130±40	<310	60±15	109±70
GRACILARIA	7-12-72		65±59	160±20	<22	<46	270±20	51±18	<120	37±7	9±29
GRACILARIA	11-1-72		<330	390±80	60±100	<180	1260±70	72±70	<890	22±25	150±140
ZOSTERA MARINA	7-12-72		<180	160±30	12±28	<90	390±30	97±36	<210	40±13	30±60
CODIUM FRAGILE	7-12-72		14±32	57±32	<12	<24	120±10	21±9	<61	35±4	9±16
CODIUM FRAGILE	11-1-72		<72	37±16	<29	14±23	82±13	-	-	5±4	<39
ULVA LACTUCA	7-12-72		40±90	130±30	<34	<65	170±20	60±30	<170	31±10	-
ULVA LACTUCA	11-1-72		<200	310±60	30±70	<120	800±50	-	-	18±17	60±90
ULVA LACTUCA	7-13-72	CEDAR CREEK INLET 15-26-11-85	<190	220±50	<60	<100	270±40	76±47	<320	49±16	20±60
CODIUM FRAGILE	4-19-72		60±70	120±20	<30	-	180±20	<60	<200	56±12	<40
CODIUM FRAGILE	7-12-72		<70	85±17	<20	<35	120±10	22±15	<100	18±5	6±23

NOTES: NIOBIUM-95 IS ASSUMED TO BE IN EQUILIBRIUM WITH ^{95}Zr.

TABLE 30 RADIOACTIVITY CONTENT OF CERTAIN BENTHIC FLORA FROM BARNEGAT BAY (CONTINUED)

ALGAE OR PLANT TYPE	COLLECTION DATE	LOCATION	RADIONUCLIDE CONCENTRATION (pCi/kg-wet)								
			^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{103}Ru	^{106}Ru	^{95}Zr	^{65}Zn
GRACILARIA	7-12-72		40±80	280±30	<40	<75	420±30	68±26	<180	48±10	45±46
ZOSTERA MARINA (STOCK & ROOT)	9-29-72		<150	68±35	28±44	<78	320±30	<53	<410	-	<85
CODIUM FRAGILE	4-18-72	WARETOWN AREA 15-42-02-85	<80	41±14	<20	<40	84±12	<40	<140	15±3	<40
CODIUM FRAGILE	7-11-72		20±30	73±11	<13	<25	110±10	38±10	<71	-	-
ULVA LACTUCA	4-18-72		<40	40±20	<30	20±30	36±16	-	-	36±8	<45
ULVA LACTUCA	7-12-72		<230	200±50	<65	<110	240±40	100±50	<350	36±16	73±73
GRACILARIA	7-11-72		<240	210±50	<60	<135	370±40	50±50	<360	55±16	<120
ASTERIOS FORBESI (STARFISH)	4-18-72		-	<170	<150	-	<150	-	-	<110	<210
ZOSTERA MARINA (STOCK & ROOT)	9-29-72	SANDY POINT BEACH 15-26-19-85	<120	210±40	31±44	<100	1020±40	17±31	<370	-	<120

TABLE 31 RADIOACTIVITY CONTENT OF CERTAIN BENTHIC FLORA FROM GREAT BAY

ALGAE OR PLANT TYPE	COLLECTION DATE	LOCATION	RADIONUCLIDE CONCENTRATION								
			^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{103}Ru	^{106}Ru	^{95}Zr	^{65}Zn
FUCUS	5-2-72	01-64-01-85 PCI/KG-WET	<320	<42	<70	<105	<42	80 ± 50	<200	210 ± 20	<110
ULVA LACTUCA	7-10-72	PCI/G-ASH	<7	1.1 ± 1.4	<1.8	<3.2	<2	1.5 ± 1.4	<9.9	1.2 ± 0.6	<3.3
GRACILARIA	7-10-72	PCI/G-ASH	<4.6	<0.9	<12	<2.3	<1.4	1.4 ± 1.0	<6.6	0.93 ± 0.42	1.1 ± 1.5
FUCUS	7-10-72	PCI/G-ASH	1.4 ± 1.5	0.5 ± 0.4	<0.6	<1.0	<0.6	0.82 ± 0.48	<3.3	0.61 ± 0.19	<1.2

V. Radiation and Radionuclides in the Terrestrial Environment

A. External Radiation Surveillance

Individual packets containing thermoluminescent dosimeters were placed at twelve surveillance sites during the first of June, 1972, and were exchanged on a quarterly basis. The monitoring sites were predicated on maximum predicted population dose estimates (man-rem) for each quadrant encompassing the facility. The theoretical estimates of the population dose as a function of distance from the plant were obtained from the Environmental Report submitted to the Atomic Energy Commission by the utility. A description of the site locations has been summarized in Table 32.

Each dosimeter packet incorporates two LiF and two $CaSO_4$:Dy dosimeters calibrated in reference to the gamma radiations from cobalt-60. Each packet was stapled to a utility pole in the area approximately eight feet above ground level to prevent vandalism. The dosimeter packets and dosimetric interpretation of the radiation doses has been provided by Teledyne Isotopes of Westwood, New Jersey.

The quarterly external radiation dose measurements at each site have been summarized in Table 33 according to collection period. The dose results for the first two quarterly periods evaluated appear to be high in relationship to measurements obtained by Beck, et. al.[7] in the vicinity of the Oyster Creek plant. After consulting with personnel from Teledyne, it was learned that certain problems involving the processing of TLD's for low-level exposures were evident. Initially, there were problems associated with the reduction of the inherent luminescence of the LiF material and the immediate annealing of the material prior to placement in the field. The basic problems appear to have been solved, since the results obtained for the third quarterly exposure period (December 13, 1972 through March 20, 1973) correspond to the expected external radiation exposure range.

At this particular time, the contribution of the plume radiations to the quarterly radiation dose measurements at each site can not be evaluated. The total radiation exposure of the TLDs is comprised of the integrated doses from natural terrestrial background, terrestrial fallout, cosmic radiations, and the noble gas plume radiations. In order to evaluate the former "background" radiations, the thermoluminescent dosimeters must be exposed at each site at periods when the facility is shut down for refueling. Due to plant operations, it shall be perhaps another full year before the natural background radiation dose can be measured.

Nevertheless, the external radiation dose measured at all sites from December, 1972 through June, 1973 indicates that the total (background plus all other sources) radiation dose to an offsite resident would be approximately 60 to 70 mrem/year. The radiation dose contributed by the gaseous plume is therefore well below the permissible whole body dose of 500 mrem/year above background to an individual in an unrestricted area.

Table 32

DIRECT RADIATION MONITORING STATIONS

	Direction From Reactor	Location	Distance Meters	Distance Miles
1.	W	Lebanon State Forest, Rt. 72, Maint. Shed - telephone pole next to air sampler unit.	30400	19.0
2.	S	Beach Haven Crest, Long Beach Island - telephone pole on Bay Ave. & New Jersey Ave., next to Long Beach Water Co. pump station (water tower is a silo type).	24120	15.0
3.	SSW	Margate City (5 miles south of Atlantic City), Margate City Municipal Court Bldg., Washington St. & Ventnor Ave. - telephone pole in front of court entrance.	56280	35.0
4.	SSW	Parkerstown-Rt. 9 (West Creek) Parkerstown Vol. Fire Co. - pole in front of firehouse on Rt. #9.	24120	15.0
5.	S	Barnegat-½ mile E. on Bay Street (Rt. 534 & Water Street)	5628	3.5
6.	SE	Waretown (Rt. 532 going to shore), Wm. Cottrell & Son Fish Market - service post on building - follow road out to the shore (dock).	2412	1.5
7.	NNE	Forked River Marina, Rt. 9 - telephone pole on east side of open shed (near dirt road).	2412	1.5
8.	N	Toms River-Highway Dept. Maint. Shed, Rt. 37, West - telephone pole next to air sampler unit.	12060	7.5
9.	NNE	Lanoka Harbor, Rt. 9, Lanoka Harbor Vol. Fire Co. Parking Yard, telephone pole for lights.	2412	1.5
10.	Ne	State Game Farm - Forked River - 1st pole on left side of road, past entrance gate house (next to sing).	2412	1.5
11.	N	Lakeside Dirve, Forked River - Mr. Calahan - pole in front of house	4020	2.5
12.	ENE	South Winds Yacht Basin, Lacey Road, Forked River - follow road past Captain's Inn Restaurant - onto dirt road - pole is next to launching ramp (R.R. track).	2412	1.5

Table 33 Exernal Radiation Dose Rates near the Oyster Creek Nuclear Generating Station

Site #	Location	Dose Per Exposure Period (mrem)							
		June 5 thru Sept. 13, 1972		Sept. 13 thru Dec. 13, 1972		Dec. 13, 1972 thru Mar. 20, 1973		Mar. 20 thru June 20, 1973	
		LiF	$CaSO_4$:Dy	LiF	$CaSO_4$:Dy	LiF	$CaSO_4$:Dy	LiF	$CaSO_4$:Dy
1	Lebanon State Forest	38.8	23.2	28.7	34.6	13.1	17.4	17.4	18.0
2	Beach Haven Crest, Long Beach Island	lost	lost	13.7	27.4	13.5	14.0	16.2	14.2
3	Margate City	37.6	24.6	26.3	40.2	15.9	14.5	20.6	18.1
4	Parkerstown - Rt. 9	36.0	26.1	18.3	31.2	10.5	14.4	17.2	16.2
5	Barnegat	35.6	20.9	24.0	29.0	13.5	15.3	14.3	15.4
6	Waretown	39.9	27.5	27.0	36.4	14.3	18.8	22.1	20.2
7	Forked River Marina	34.9	24.8	29.0	30.5	15.8	15.1	18.3	16.1
8	Toms River- Highway Dept. Maintenance Shed	44.4	29.1	33.3	41.2	15.1	18.9	22.5	20.8
9	Lanoka Harbor, Rt. 9	38.3	22.9	28.7	29.2	14.7	13.0	14.6	15.2
10	State Game Farm, Forked River	37.6	23.6	36.7	32.5	10.7	14.7	18.4	17.3
11	Lakeside Dr., Forked River	42.8	26.3	26.3	36.8	10.3	15.2	lost	
12	South Winds Yacht Basin, Lacey Rd., Forked River	39.4	23.6	30.0	31.0	20.4	14.3	16.2	14.9

B. Potable Ground Water Supplies

Four potable water supplies in the Forked River-Waretown area were sampled in order to provide information relative to possible intrusions of low-level wastes discharged into Oyster Creek. Three of the wells sampled represent ground water from locations which are North, South, and East of the facility having major population centers. Water from a well maintained by the Oyster Creek facility was also supplied to our laboratory for analysis. A description of the sampling locations has been presented in Table 34.

Each sample obtained was routinely analyzed for gross alpha and beta content, tritium, and strontium-89 and 90. If there was evidence of an elevated gross alpha concentration, a total radium analysis would have been conducted on the remaining sample aliquot.

The results of the radiochemical analyses appear in Table 34 according to collection date and sample location. Since each sample contained a gross beta concentration below 30 pCi/1, a gamma isotopic analysis was not performed. The well samples appear to be devoid of radiostrontium (^{89}Sr and ^{90}Sr) but some wells were noted to have detectable quantities of radium (assumed to be ^{226}Ra). All ground water supplies met with potable water standards for radioactivity as per federal regulations.(8)

Barring any direct spills of radioactive waste onto the ground or a rupture of a waste storage tank, intrusions of the low-level radioactive wastes of Oyster Creek into the ground water system would be accompanied by brackish water. The exception to the case would be tritium. Brackish water intrusions would increase the gross beta content of the well waters (due to the

naturally-occurring ^{40}K in the water) as well as increase the total solid contents of an evaporated sample. In such a situation, an analysis of the chloride content of the well water would indicate any seepage of brackish water. Of the wells tested by this laboratory, no abnormal salt residue had been observed.

Table 34 Radioactivity Content of Selected Ground Water Supplies in the Forked River Area

Location #	Collection Date	Site Description	Radionuclide Concentration (pCi/liter) ^{3}H	Gross α	Gross β	^{89}Sr	^{90}Sr	Total Radium*
15-26-14-04	5-4-72	Forked River State Marina U.S. Rt. 9, Forked River, N.J.	<1200	7.1±0.8	8.0±0.6	<0.4	<0.2	1.6±0.1
	12-22-72		<1000	13.4±0.8	8.5±0.6	<0.6	<0.2	1.1±0.2
	3-9-73		<1100	5.9±3.0	6.0±0.3			1.8±0.2
	4-27-73		<1100			<3	0.3±0.3	1.6±0.2
15-26-08-04	5-4-72	Rue's Boat Yard, Forked River, N.J.	<1000	<1.5	3.2±0.4	<0.3	<0.2	-
	1-2-73		<950	6.9±0.9	4.8±0.6	<0.5	<0.2	0.95±0.14
	3-9-73		<1100	4.5±0.8 4.2±0.8	5.7±0.6 5.9±0.6			1.4±0.1
	5-8-73		<1200	7.8±1.0	7.3±0.9	<0.7	<0.4	1.2±0.2
15-42-09-04	5-4-72	Mid-Jersey Water & Sewerage Co., Waretown, N.J.	<1000	1.4±0.4	3.1±0.3	<0.6	<0.3	-
	1-2-73		<1100	3.1±0.9	4.1±0.8	<0.5	<0.2	0.32±0.09
	3-9-73			1.0±0.4	3.6±0.5			
15-26-12-04	5-4-72	Well of Oyster Creek Nuclear Generating Station, Forked River, N.J.	<1000	0.5±0.2	4.1±0.4	0.3±0.3	<0.2	-
	12-22-72		<1000	0.41±0.24	3.3±0.3	0.1±0.3	<0.4	0.19±0.08
	3-9-73			0.6±0.4 0.3±0.3	4.0±0.4 4.0±0.4			
	4-27-73		<1200	0.3±0.3 0.7±0.4	3.4±0.7 3.9±0.7	<0.9	<0.2	

* Assumed to be ^{226}Ra.

Notes: Gross beta and alpha analysis predicated on ^{137}Cs and ^{230}Th standardization, respectively.

C. Agricultural Produce Analysis

In the immediate ten mile area encompassing the Oyster Creek nuclear facility, there is very little agricultural activity. However, there are several roadside stands near the facility which sell vegetables grown in backyard gardens. From a surveillance standpoint, the air → soil → vegetable pathways are the only food chains which could give rise to the incorporation of facility-produced radioactivity in the vegetables. Based upon air surveillance measurements, the total amount of radioactivity available for food (vegetable) incorporation would be very small. The major portion of the surface air radioactivity has been related to stratospheric fallout rather than related to the facility.

The facility-related radionuclides which have been detected at several air sampling sites include: ^{131}I, ^{60}Co, and ^{54}Mn. Barium and lanthanum-140 may also be prevalent in air but in concentrations less than 3 fCi/m^3 (3×10^{-15} $\mu Ci/cc$). The relatively short half-lives of ^{131}I, ^{140}Ba, and ^{140}La would limit the buildup of these nuclides in plants.

Various vegetables from four roadside stands were collected during the peak harvesting period in July, 1972. The vegetables sampled and analyzed included: cucumbers, squash, peppers, tomatoes, and radishes. Each specimen was diced and then pulverized in an automatic blender to a uniform mixture. Approximately 400 grams (wet) of an aliquot sample was analyzed for gamma-ray emitting radionuclides by a 4" x 4" NaI(Tl) spectrometry system. Following the isotopic gamma analyses, 200 grams of the various vegetable types was analyzed for radiostrontium. Each aliquot was wet-ashed with HNO_3 and H_2O_2, followed by routine radiostrontium chemical processing.

The results of the radiochemical analyses have been summarized in Tables 35 and 36. With the exception of ^{140}Ba, no facility-produced radionuclides were found in significant concentrations as per isotopic gamma analysis. Barium-140 was measured in concentrations less than 70 pCi/kg-fresh in tomatoes, yellow squash, and red radishes from two areas. The stated ^{140}Ba concentrations approached the minimum sensitivity of detection for the geometry utilized.

The ^{89}Sr and ^{90}Sr content measurements have been summarized in Table 36 according to collection location. The ^{90}Sr concentration ranged between 1.3 and 50 pCi/kg-fresh in the vegetables sampled. Yellow peppers from a roadside stand one mile north of the facility contained 50 pCi ^{90}Sr/kg-fresh. The average ^{90}Sr concentration of all vegetables was 12±14 pCi/kg-fresh, which is similar to the documented ^{90}Sr content of fresh vegetables (12.2 pCi/kg) sold in New York City in 1968.(10) The ^{89}Sr content of the same Oyster Creek vicinity vegetables was below detectable quantities.

Vegetables grown in the background area near Salem, New Jersey (Table 38) contained somewhat lower concentrations of ^{90}Sr than did the vegetables from the Forked River area (range <1.4 to 15 pCi/kg-fresh). Detectable amounts of ^{89}Sr (~10 pCi/kg-fresh) were measured in tomatoes grown near Salem during August, 1972. Isotopic gamma-ray analysis of the background vegetables revealed non-detectable amounts of the more prevalent gamma-ray emitting radionuclides (Table 37).

TABLE 35 RADIOCHEMICAL ANALYSIS OF FOOD-PRODUCTS GROWN IN THE VICINITY OF OYSTER CREEK NPGS

#	LOCATION	SAMPLE TYPE	RH#	COLLECTION DATE	RADIONUCLIDE CONCENTRATION (pCi/kg-fresh) ^{54}Mn	^{58}Co	^{60}Co	^{103}Ru	^{106}Ru	^{131}I	^{134}Cs	^{137}Cs	^{140}Ba
	GALLOS FARM STAND* ROUTE 9, SOUTH OF THE FACILITY												
	15-26-50-87	CUCUMBER	16460	7-25-72	<50	<50	<55	<140	<360	<40	-	<50	<20
	15-26-50-87	SQUASH	16461	7-25-72	<55	<75	<60	<140	<540	<50	-	<50	<60
	15-26-50-87	PEPPERS	16459	7-25-72	<50	<50	<55	<140	<360	20±20	-	<50	<23
	15-26-50-87	TOMATOE	16458	7-25-72	<55	<75	<60	<140	<540	20±40	-	<50	45±29
	RUSSNICK, COMPASS RD., SANDS POINT, N.J. 2 MILES E												
	15-26-69-87	PEPPERS	16463	7-25-72	<55	<70	<65	<100	<430	<42	-	<40	<46
	15-26-69-87	TOMATOE	16462	7-25-72	<55	<75	<60	<140	<540	<50	-	<50	<60
	EISSING ROAD STAND ROUTE 9, FORKED RIVER, N.J. 1 MILE N												
	15-26-49-87	TOMATOE	16455-1	7-25-72	<55	<70	<65	<100	<430	<35	-	<40	<30
	15-26-49-87	YELLOW SQUASH	16457	7-25-72	<55	<75	<60	<140	<540	<50	-	<50	60±30
	15-26-49-87	GREEN SQUASH	16456	7-25-72	<55	<75	<60	<140	<540	<52	-	<50	<60
	HENDRICKS ROAD STAND ROUTE 9, FORKED RIVER, N.J., 1 MILE N												
	15-26-32-87	YELLOW PEPPER	16467D	7-28-72	<55	<70	<65	<100	<430	<35	-	22±20	<40

* ITEMS GROWN IN THE AREA OF WELLS MILLS AND BROOKVILLE, N.J. (7 MILES SW)

Table 36 Radiochemical Analysis of Food Products Grown in the Vicinity of Oyster Creek NPGS

Location	Sample Type	RH#	Collection Date	Radionuclide Concentration (pCi/kg-fresh) ^{89}Sr	^{90}Sr
Gallos Farm Stand*					
Route 9, South of the facility					
15-26-50-87	Cucumber	16460	7-25-72	<15	13.5±2.9
15-26-50-87	Squash	16461	7-25-72	<31	6.7±1.4
15-26-50-87	Peppers	16459	7-25-72	<23	17.7±1.1
15-26-50-87	Tomatoes	16458	7-25-72	<11	5.4±2.3
Russnick, Compass Rd., Sands Point, N.J. 2 miles E					
15-26-69-87	Peppers	16463	7-25-72	<18	5.7±2.2
15-26-69-87	Tomatoes	16462	7-25-72	<12	1.3±0.5
Eissing Road Stand Route 9, Forked River, N.J. 1 mile N					
15-26-49-87	Tomatoes	16455-1	7-25-72	<12	9.1±0.9
15-26-49-87	Yellow Squash	16457	7-25-72	<15	6.5±2.4
15-26-49-87	Green Squash	16456	7-25-72	4.4±7.6 <11	5.1±1.9
Hendricks Road Stand Route 9, Forked River, N.J. 1 mile N					
15-26-32-87	Yellow Pepper	16467	7-28-72	<30	49.7±1.3

* Items grown in the area of Wells Mills and Brookville, N.J. (7 miles SW)

Table 36 Radiochemical Analysis of Food Products Grown in the Vicinity of Oyster Creek NPGS (Continued)

Location	Sample Type	RH#	Collection Date	Radionuclide Concentration (pCi/kg-fresh) ^{89}Sr	^{90}Sr
Hendricks Road Stand Route 9, Forked River, N.J. 1 mile N					
15-26-32-87	Green Pepper	16467	7-28-72	<20	5.8±0.9
15-26-32-87	Cucumbers	16467E	7-28-72	<28	18.5±4.2
15-26-32-87	Red Radish	16467	7-28-72	<12	10.3±2.5
15-26-32-87	Tomatoes	16467C	7-28-72	<20	4.8±1.0

TABLE 37 RADIOCHEMICAL ANALYSIS OF BACKGROUND FOOD-PRODUCTS FROM THE SALEM, N.J. AREA

LOCATION	SAMPLE TYPE	RH#	COLLECTION DATE	RADIONUCLIDE CONCENTRATION (pCi/kg-fresh) ^{54}Mn	^{58}Co	^{60}Co	^{103}Ru	^{106}Ru	^{131}I	^{134}Cs	^{137}Cs	^{140}Ba
HINCHMAN FARM POPLAR ST., HANCOCKS BRIDGE												
17-20-11-87	CUCUMBER	16504D	8-10-72	-	-	-	<150	<720	<72	-	<60	<70
17-20-11-87	PEPPERS	16504C	8-10-72	-	-	-	<150	<720	<110	-	<60	<84
17-20-11-87	TOMATOES	16504B	8-10-72	-	-	-	<150	<720	<110	-	<60	<75
TURNER, STOW CREEK LANDING												
06-65-02-87	PEPPERS	16505	8-10-72	-	-	-	<150	<720	50±80	-	<60	<70
F. GOULD, STOW CREEK LANDING R.D. #3, SALEM, N.J.												
06-65-02-87	TOMATOE	16506A	8-10-72	-	-	-	<150	<720	<80	-	<60	<70
GRISCOM, MOORES CORNER, SALEM, N.J.												
17-15-05-87	TOMATOE	16507B	8-10-72	-	-	-	<110	<500	<50	-	<45	<40
17-15-05-87	CORN	16507A	8-10-72	-	-	-	<150	<720	<70	-	<60	<140
CHARLES TABLE VEGETABLE STAND HANCOCKS BRIDGE, R.D. #2, SALEM												
17-20-12-87	POTATOE	16508	8-10-72	-	-	-	<140	<540	<70	-	<50	<60

Table 38 Radiochemical Analysis of Background Food-Products from the Salem, N.J. Area

Location	Sample Type	RH#	Collection Date	Radionuclide Concentration (pCi/kg-fresh) ^{89}Sr	^{90}Sr
Hinchman Farm Poplar St., Hancocks Bridge					
17-20-11-87	Cucumber	16504D	8-10-72	<0.9	<1.4
17-20-11-87	Peppers	16504C	8-10-72	5.2±5.9	2.4±2.2
17-20-11-87	Tomatoes	16504B	8-10-72	<0.9	3.8±1.1
17-20-11-87	Corn	16504A	8-10-72	<0.9	7.4±1.3
Turner, Stow Creek Landing					
06-65-02-87	Peppers	16505	8-10-72	<0.9	3.8±1.2
F. Gould, Stow Creek Landing R.D. #3, Salem, N.J.					
06-65-02-87	Tomatoes	16506A	8-10-72	12.0±4.5	3.8±1.3
Griscom, Moores Corner, Salem, N.J.					
17-15-05-87	Tomatoes	16507B	8-10-72	8.3±3.7	5.5±1.3
17-15-05-87	Corn	16507A	8-10-72	<10.5	3.6±1.0
Charles Table Vegetable Stand Hancocks Bridge, R.D.#2, Salem, N.J.					
17-20-12-87	Potatoes	16508	8-10-72	<2.1	15.3±2.0

VI. Summary

A detailed environmental surveillance program of the Oyster Creek Nuclear Generating Station was implemented during 1972 and 1973. The program consisted of radiological measurements of airborne particulates and radioiodine, aqueous discharges, potable water supplies, locally-grown food produce, benthic algae and sediment from Barnegat Bay and Oyster Creek, shellfish and fin fish from Barnegat Bay, and the external radiation at twelve locations.

Stack emissions of ^{131}I, ^{60}Co, and ^{54}Mn from the facility have been detected at principally four locations during the nine months investigated. The offsite air concentration of ^{131}I was at least an order of magnitude greater than the other facility related radionuclides evaluated. The nine-month average ^{131}I concentration at 1.5 miles SE of the facility was approximately 9×10^{-15} uCi/cc. The adult inhalation dose from radioiodine to a resident at this location has been estimated to be 0.1 mrem/year. Since 80 percent of the airborne ^{131}I discharged from the facility is of the methyl iodide form, the radioiodine inhalation dose to residents in the immediate vicinity of the facility is equally as important as the radioiodine dose resulting from the consumption of milk from the nearest dairy farm.

The airborne concentrations of the other radionuclides evaluated, ^{141}Ce, ^{144}Ce, ^{103}Ru, ^{106}Ru, ^{95}Zr, ^{137}Cs, ^{89}Sr, ^{140}Ba, and ^{90}Sr, were of the order of 10^{-15} to 10^{-14} uCi/cc, which is approximately 10^{-14} to 10^{-7} of the maximum permissible

concentration as per federal guidelines. The temporal variation in the concentration of these radionuclides was related to the systematic trend of previous nuclear weapons testing fallout.

Under normal plant operations, aqueous discharges from the facility have resulted in weekly average offsite stream concentrations below 1 pCi/liter for most radionuclides (excluding ^{3}H). Cobalt -60, ^{54}Mn, ^{134}Cs, and ^{137}Cs have been the main artificially-produced radionuclides detected in Oyster Creek, but occasionally ^{51}Cr, ^{58}Co, and ^{59}Fe have also been measured. During the months of August and September, 1972, the facility experienced certain difficulties in processing the radwaste, and,as a consequence,higher than normal offsite radioactivity levels were observed. The ^{137}Cs, ^{134}Cs, and ^{60}Co concentrations in Oyster Creek within this time period peaked at 48, 26, and 14 pCi/liter, respectively. Due to the low radiostrontium content of the radwaste discharged, the detection of ^{89}Sr and ^{90}Sr in Oyster Creek above background levels (^{90}Sr ~ 0.3 pCi/liter) was rarely observed. In addition, the lower limit of tritium detection (~1000 pCi/liter) has prevented the evaluation of the increase in the tritium levels due to plant operations. In general, measured offsite concentrations of facility-produced radionuclides have been approximately 10^{-4} to 10^{-5} of the maximum permissible concentrations as per federal guidelines.

The environmental impact of the aqueous discharges from

the plant has been a substantial sorption of ^{60}Co and ^{54}Mn in sediments of Oyster Creek, Barnegat Bay, and Forked River and the incorporation of ^{60}Co and ^{54}Mn in benthic algae and shellfish of Barnegat Bay. Isotopic gamma measurements of Oyster Creek sediment taken near the water sampling equipment revealed ^{60}Co and ^{54}Mn concentrations as great as 45 and 10 pCi/gram-dry, respectively. Assuming a 1 pCi/liter average water concentration, the sediment uptake of these radionuclides would be approximately 20,000 to 40,000 times the water level. Of course, the sorption has been a cumulative process for the past three years. Core samples taken from Oyster Creek indicate that the vertical distribution of the radioactivity was limited to the top two inches of the sediment.

Recirculation of radioactivity from Oyster Creek into Forked River by water movement was evident by the presence of ^{60}Co and ^{54}Mn in the sediment of this stream.

Certain benthic algae species and aquatic plants of Barnegat Bay have incorporated ^{60}Co and ^{54}Mn to levels 400 to 1200 times the typical aqueous levels found in Oyster Creek. Of the five algae species evaluated, Gracilaria appears to have a greater affinity for cobalt and manganese than do the other specimens. The aquatic plant Zostera marina (eel grass) was also found to concentrate ^{60}Co and ^{54}Mn to the same levels as Gracilaria. The ^{60}Co concentration in Gracilaria near the Oyster Creek inlet into the Bay ranged between 270 and 1260 pCi/kg-wet in July and November, 1972. Benthic algae from

three other areas of the Barnegat Bay contained less artificially-produced radioactivity. However, the data presented in this report and a previous report have shown that most of Barnegat Bay has been influenced by the aqueous discharges from the facility.

Shellfish (Mercenaria mercenaria) collected from five different areas of Barnegat Bay were found to have incorporated only cobalt-60 in significant amounts. Bay clams sampled on two occasions, once in June 1972 and once in March 1973, had a ^{60}Co concentration ranging between 62 and 220 pCi/kg-meat. The fluid portion of the shucked clams contained statistically greater amounts of radiocobalt than did the edible meat fraction. Using an average ^{60}Co concentration of 140 pCi/kg-meat, the annual dose to an individual consuming 18.2 kilograms per year of shellfish meat would be ~0.1 mrem to the gastrointestinal tract.

During 1972 and early 1973, shellfish from the Cedar Creek area were found to have concentrated more ^{60}Co than did shellfish from the other areas of the Bay. The ^{90}Sr content of the edible meat portions of the Bay clams was 5 pCi/ kg or less.

Of the three finfish varieties sampled from Barnegat Bay in 1972, only winter flounder and silversides contained facility-produced radioactivity. The ^{60}Co concentration of winter flounder collected in April, 1972, near Waretown and Cedar Creek ranged between 40 to 70 pCi/kg-whole. Silversides, which were resident of the Oyster Creek inlet area,were also found to contain ^{60}Co (~ 20 pCi/kg-whole). Individuals consuming winter flounder having a ^{60}Co concentration of 70 pCi/kg would

receive a radiation dose to the gastrointestinal tract of 0.003 mrem for every kilogram of meat ingested. This radiation dose is very small in comparison to the radiation dose due to other radionuclides in the typical diet and to natural background.

Quarterly analysis of four potable ground water supplies in the immediate vicinity of the facility have shown that radioactive effluents from Oyster Creek had not permeated the local aquifers. Most samples analyzed contained non-detectable amounts of ^{3}H (<~ 1100 pCi/liter), ^{89}Sr (<~ 0.8 pCi/liter), and ^{90}Sr (<~ 0.3 pCi/liter). Radium, in concentrations between 0.2 and 1.8 pCi/liter, was present in all water supplies monitored. All ground water supplies evaluated were found to meet potable water radioactivity standards as per federal regulations.

With the exception of ^{140}Ba, locally grown vegetables sampled from four roadside stands in July, 1973 were devoid of any detectable quantities of facility-produced radionuclides. Barium - 140 was measured in concentrations less than 70 pCi/kg-fresh in tomatoes, yellow squash, and red radishes. However, the measured ^{140}Ba concentration approached the minimum sensitivity of detection for this radioisotope. The average ^{90}Sr concentration of all vegetables sampled was 12 $\pm$ 14 pCi/kg-fresh. The ^{89}Sr content of the five vegetable types was below detectable quantities.

Thermoluminescent dosimeters were utilized to measure the external radiation at twelve surveillance points encompassing the facility. The quarterly exposure results, as reported by the vendor providing the dosimeter interpretations, have been provided

within the text. Due to certain technical difficulties encountered in processing the TLDs , no interpretation of the data for the first year was attempted. Further investigations of the experimental accuracy of the dosimeters in the field are currently being performed.

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