PRE-OPERATIONAL ENVIRONMENTAL SURVEY IN THE VICINITY OF INDIAN POINT NUCLEAR POWER PLANT
1959

TEST BUREAU
METER AND TEST DEPARTMENT
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

PRE-OPERATIONAL ENVIRONMENT SURVEY OF RADIOACTIVITY IN THE VICINITY OF INDIAN POINT NUCLEAR POWER PLANT 1959

This report describes the results obtained in the pre-operational environmental survey of 1959 which was a continuation of the survey conducted during 1958. The survey methods and the 1958 results were previously reported.

These measurements are being continued in order to show the level of radioactivity existing before the reactor goes into operation. The results should therefore show any variation in activity that may be expected from natural sources, fallout from bomb tests or other sources, in the vicinity.

Seven sites on the west side of the Hudson River in Orange and Rockland Counties were added in 1959. In addition to air and water, samples of vegetation, soil and a limited number of biological specimens were collected. A total of 680 samples of all media was obtained and checked for radioactivity.

The gross beta activity of the air, water and vegetation samples collected during 1959 show a marked reduction over 1958. Other surveys have also shown this trend and have attributed it to the cessation of nuclear weapons testing.

The results of the survey show the activity in the vicinity of Indian Point to be low and comparable to that existing at other locations in the country. This data will be of much use as a comparison with the data obtained after the reactor goes into operation.

Complete results of the tests, together with a description of the sampling locations, are given in Sections I and II. The radioactivity of individual samples are shown on a monthly basis so that long term trends become more apparent. On these charts the collection date of the individual samples are not given but are shown in approximate sampling order for ease of presentation.

Section III contains two reports of investigations conducted in 1959 in addition to the routine survey. One of these describes tests made to determine the Strontium 90 content in soil samples and the other pertains to measurements of radon in well water.

Results of the environmental survey in this area performed by the New York State Department of Health were published in a report dated November, 1959 and are not shown herein.

Near the end of the year it became apparent that the radioactivity of the environment throughout the survey area was so uniform that samples taken at the plant site would be representative of the entire region and the program was curtailed by eliminating air and water collections at the sampling stations off the Indian Point Plant. The 1960 survey will be conducted on the following sampling schedule:

Continuous air particulate at Indian Point

Fallout collection at Indian Point

Weekly collection of Hudson River water

Weekly collection of drinking water from four sources

Weekly collection of surface water from Indian Point Lake

Monthly collection of well water from Indian Point and Verplanck

Vegetation collection from each sampling station in June, August, and October

Soil collection from each station in July

wfn.rr

A. K. Joecks
Test Engineer

SAMPLING LOCATIONS

The locations chosen to sample air, water, soil and vegetation are shown on the map of the Indian Point area designated as Plate 1. Additional test sites were added for the 1959 survey covering an area west of the Hudson River in both the Rockland and Orange Counties.

The geographical locations circled and numbered on the map are listed in Table I which describes the types of samples collected periodically.

SECTION I

SAMPLING LOCATIONS

TABLE I

SAMPLING LOCATIONS

WESTCHESTER COUNTY

SAMPLING STATION NO.	GEOGRAPHIC LOCATION	SAMPLES COLLECTED
1	Indian Point Plant Site Bleakley Ave., Buchanan	Air, soil, vegetation, fish, Hudson River water, local pond and well water, drinking water.
2	Peekskill Fuel Co. 6th St & Hudson River Verplanck	Air, soil, vegetation, Hudson River water.
3	Flood Gate Dock Kings Ferry Road and Lake Meahagh, Verplanck	Air soil, vegetation, fish, water from Lake Meahagh and Hudson River.
4	Cruger Unit Substation Rt. 9 & Railroad Ave., Crugers Park, Cortlandt	Air, soil, vegetation, water from local pond.
5	Chimney Corner Restaurant Rt. 9 and Furnace Dock Rd., Cortlandt	Air, soil, vegetation, water from Furnace Dock Pond.
6	Valeria Home, Furnace Dock Rd and Furnace Woods Rd., Furnace Woods	Air, soil, vegetation water from Dickerson Pond.
7	Hunterbrook Unit Substation, Old Crompond Rd., & Hunterbrook Rd., Yorktown	Air, soil, vegetation, water from Lake Mohansic.
8	Mohegan Unit Substation Lexington Ave., Mohegan Lake	Air, soil, vegetation, water from Mohegan Lake.
9	Algonquin Gas Metering Station, Crompond Rd., & Croton Ave., Crompond	Air, soil, vegetation.

TABLE I (CONT'D)

SAMPLING LOCATIONS (CONT'D)

WESTCHESTER COUNTY (CONT'D)

SAMPLING STATION NO.	GEOGRAPHIC LOCATION	SAMPLES COLLECTED
10	Citron Upholstery Co., Crompond Rd., and Lafayette Ave.,Cortlandt	Air, soil, vegetation.
11	Peekskill Garage Main St & Hamilton Ave., Peekskill	Air, soil, vegetation, water from Peekskill Reservoir.
12	Peekskill Gas Holder Pemart Ave. & Water St., Peekskill	Air, soil, vegetation, Hudson River water.
13	Esso Gas Co., Roa Hook Rd., & Hudson River, Cortlandt	Air, soil, vegetation, Hudson River water.
14	Camp Smith Rt. 6, Cortlandt	Air, soil, vegetation, water from pond, well and drinking water.
15	National Guard Armory, Washington St.and Welcher Ave., Peekskill	Air, soil, vegetation, water from Loundsbury Pond.
16	Mt. Kisco Gas Holder Suttons Row and Bedford Rd., Mt. Kisco	Air, soil, vegetation.
20	Millwood Substation Quaker St & Millwood Rd., Milwood	Air, soil, vegetation, water from Still Lake.

TABLE I (CONT'D)

SAMPLING LOCATIONS (CONT'D)

WESTCHESTER COUNTY (CONT'D)

SAMPLING STATION NO.	GEOGRAPHIC LOCATION	SAMPLES COLLECTED
21	Ossining Substation Market and Hill St., Ossining	Air, soil, vegetation, Hudson River water and drinking water.
23	Croton Unit Sub-station Rt. 9, Croton-on-Hudson	Air, soil, vegetation, Hudson River water and drinking water.
24	Yorktown Substation, Taconic Pkway and Croton Dam Rd., Cortlandt	Air, soil, vegetation, water from New Croton Reservoir.
	ROCKLAND COUNTY	
30	Rockland Fuel Co., Haverstraw	Air, soil, vegetation, Hudson River water and drinking water.
31	U. S. Gypsum Co., Grassy Point	Air, soil, vegetation, Hudson River water, well and drinking water.
32	Algonquin Metering Station, Rt. 210 Cedar Flats	Air, soil, vegetation, local drinking water.
33	Lovett Generating Station, Rockland and Orange, L. & P. Co., Tompkins Cove	Air, soil, vegetation, Hudson River water.
34	Barney's Tavern Jones Point	Air, soil, vegetation, Hudson River water and drinking water from well.

TABLE I (CONT'D)

SAMPLING LOCATION (CONT'D)

ORANGE COUNTY

SAMPLING STATION NO.	GEOGRAPHIC LOCATION	SAMPLES COLLECTED
35	Anthony Wayne Recreation Park Bear Mountain Park	Air, soil, vegetation, water from Hessian Lake.
36	Perkins Memorial Bear Mountain Park	Air, soil, vegetation, water from Hessian Lake.
	PUTNAM COUNTY	
40	Mom's Restaurant Rt. 9D, Manitou	Air, soil, vegetation, drinking water from well and water from Hudson River
41	Highland Country Club Rt. 9D, Garrison	Air, soil, vegetation, water from pond, Hudson River water, spring water and well drinking water.
42	Tony's Garage Rt. 301 Nelsonville	Air, soil, vegetation, Hudson River water and drinking water.
44	Adams Corner Substation Peekskill Hollow Rd., Adams Corner	Air, soil, vegetation, water from Lake Peekskill and well.

SECTION II

RESULTS OF MEASUREMENTS

NOTE:

1. Counting errors are based on a 95% confidence level.

2. All samples were measured approximately 48 hours after collection.

3. All samples were checked for alpha decay but no measurable activity was noted after the 48-hour hold-up period.

RESULTS OF MEASUREMENTS

Air Particulate

The collection and measurement of air particulate was continued through 1959 in approximately the same manner as in 1958. On Plate 2 is shown the activity of particulate collected in millipore filters at the plant site measured 48 hours and 60 days after collection. The results obtained during 1958 are also shown on this chart to point out the decline in radioactivity since the cessation of weapons testing. Records of wind direction and velocity, at a point 100 feet above grade at the plant site, were obtained and are on file.

A continuous air monitor and wind recorder in the mobile monitor survey unit were in operation at the sampling stations throughout the year. As in 1958, the unit was operated at a station for three or four days and then moved to another location. At the completion of its stay at a station, the filter paper was removed from the air monitor and the activity measured in the laboratory. The results of these measurements are given on Plate 3.

An examination of the continuous air monitor charts showed that in 1959 the number of radioactivity increases due to temperature inversions occurred on 75 nights as compared to 62 nightly increases during the nine months of monitoring in 1958. The report for 1958 attributed these excursions to temperature inversions and it was pointed out that the wind velocity records showed no air movement during these periods.

A similar wind condition existed during 70 of these nights in 1959, but during the other five nights it was observed that a mild breeze was blowing from the Camp Smith area to the station where the monitor was located. The records further show that when the wind direction shifted slightly, the radioactivity decreased to normal. It is felt that the uranium deposits reputed to exist in the Camp Smith region produce the radon which causes this phenomenon.

WATER SAMPLES

Plates 4, 5, 6 and 7 show the results of the gross beta activity obtained from Hudson River water, drinking water and surface waters. The drinking water, which is collected weekly, consists of grab samples taken from reservoirs and taps. Additional water samples were collected randomly and include samples from springs and deep wells.

The surface waters show a drop in activity from that in 1958, which again is probably due to cessation of atomic weapons testing. The Hudson River samples show no significant changes. As is to be expected, the deep well water samples do not show the influence of weapons testing.

SUMMARY OF MEASURED GROSS BETA ACTIVITY

MEDIUM	NO. OF SAMPLES	UNITS	GROSS ACTIVITY MINIMUM	MAXIMUM	AVERAGE
Hudson River	66	Microcuries per Milliliter X 10^{-9}	Less Than 1	180±80	40±15
Drinking Water Weekly Collection	136	Microcuries per Milliliter X 10^{-9}	Less Than 1	90± 5	15± 5
Drinking Water Random Collection	36	Microcuries per Milliliter X 10^{-9}	Less Than 1	40±10	10± 5
Surface Water	103	Microcuries per Milliliter X 10^{-9}	Less Than 1	160±10	30± 5

Special Well Water Samples

As recommended by the New York State Department of Health in the middle of 1959, two additional wells were located from which grab samples were taken for radioactivity measurements.

WATER SAMPLES (CONT'D)

Special Well Water Samples (Cont'd)

One well was located on the Indian Point property while the other one was located in Verplanck. The well in Verplanck is at a lower elevation than the Indian Point well and is therefore more representative of the bottom elevation of the Indian Point reactor vessel. Samples from both wells were also given to the New York State Department of Health for similar measurements. Results are given below:

		GROSS BETA ACTIVITY MICRO-MICROCURIES PER MILLILITER X 10^{-9}		
LOCATION	COLLECTION DATE	SUSPENDED SOLIDS	DISSOLVED SOLIDS	TOTAL ACTIVITY
Verplanck	10-23-59	Less Than 1	20±10	20±10
	11-27-59	Less Than 1	20±10	20±10
Indian Point	11-27-59	Not Filtered		5± 5
	12-29-59	5± 3	5± 5	10± 5
Verplanck	12-29-59	Less Than 1	15± 5	15± 5

12.2

Continuously Collected Hudson River Water Samples

The Westchester County Department of Health arranged for the continuous collection of Hudson River water at the Standards Brands Plant immediately north of Indian Point and at the Sing Sing Prison in Ossining.

Samples of this water are tested by the Westchester County Department of Health and by Consolidated Edison.

Results obtained by the latter are given on the following page.

MEASURED GROSS BETA ACTIVITY OF HUDSON RIVER WATER SAMPLES COLLECTED BY THE NEW YORK STATE DEPARTMENT OF HEALTH IN 1959

MONTH COLLECTED	LOCATION	TOTAL ACTIVITY MICROCURIES PER MILLILITER X 10^{-9}
November	Sing Sing Prison - Ossining	40 ± 30
	Standard Brands-Peekskill	50 ± 30
December	Sing Sing Prison - Ossining	15 ± 30
	Standard Brands-Peekskill	5 ± 10

VEGETATION AND SOIL

Vegetation

Results of the gross beta measurements made on samples of vegetation collected at the various sampling locations are shown on Plate 8. This vegetation consisted of grass and weeds growing in the vicinity of the test locations.

The activity is much less than that in 1958 due in all probability to the fact that no bomb tests were made after the end of 1958.

SUMMARY OF GROSS BETA ACTIVITY MEASURED FROM VEGETATION SAMPLES

NO. OF SAMPLES	UNITS	MINIMUM	MAXIMUM	AVERAGE
94	Micro-Microcuries Per Gram of Fixed Solids	190± 20	1850±50	580±30

Soil

Plate 9 shows the results of the gross beta activity measured from soil samples collected at the various sampling locations.

Soil (Cont'd)

A summary of the results is given below. The average is approximately the same as it was in 1958, although the maximum is lower and the minimum higher than it was in 1958. The naturally occurring activity has a tendency to mask any increase or decrease in activity due to fission products. A report on soil analysis may be found in Section III.

SUMMARY OF GROSS BETA ACTIVITY
MEASURED IN SOIL

NO. OF SAMPLES	UNITS	MINIMUM	MAXIMUM	AVERAGE
34	Micro-Microcuries Per Gram	20±10	70±10	40±10
	Curies/Sq. Mile	3± 2	10± 2	5± 2

Biological Samples

The table below, shows the results of the gross beta measurements made on samples of fish and crabs removed from the Hudson River at Indian Point and frogs removed from the lake at Indian Point. The difficulty involved in their collection accounts for the small number of samples. A periodic system of collection has been established for 1960 by which samples of fish will be secured with the assistance of the New York State Department of Health.

The results show a slight drop in the maximum and average activity from that measured in 1958. The minimum is slightly higher than that measured in 1958.

COLLECTION DATE	TYPE OF SAMPLE	MICRO-MICROCURIES PER GRAM OF FIXED SOLIDS
4-30-59	Shad	160±30
7- 8-59	Crab	140±15
8-11-59	Frog	100±10
8-11-59	Tadpole	100±10
8-27-59	Frog	100±10
9- 1-59	Frog	120±10
9-17-59	Frog	100±20
9-28-59	Frog	100±10
	Minimum	100±10
	Maximum	160±30
	Average	115±15

FALLOUT

An open-pot type of collector was placed at the Indian Point site and monthly collections of atmospheric fallout were obtained.

The collector is actually a polyethylene funnel, 12 inches in diameter, that drains into a collecting bottle. Once a month, the contents of the bottle are removed to the laboratory; the suspended solids are filtered out, and the gross beta activity is counted. The dissolved solids are recovered by boiling the filtrate, and the gross beta activity similarly counted.

The gross beta activity of the total monthly sample is shown on Plate 10 and the activity of each of the parts is given in the following table.

GROSS BETA ACTIVITY OF FALLOUT COLLECTED AT INDIAN POINT

MONTH COLLECTED		MICRO-MICROCURIES PER MONTH	CURIES PER SQUARE MILE PER MONTH X 10^{-3}
January	Suspended Solids	1690± 90	60± 2
	Dissolved Solids	950± 60	35± 2
	Total	2640±110	95± 3
February	Suspended Solids	5260± 60	190± 2
	Dissolved Solids	1880± 20	70± 1
	Total	7140± 65	260± 2
March	Suspended Solids	13900±130	220± 5
	Dissolved Solids	2200± 50	30± 1
	Total	16100±140	250± 5
April	Suspended Solids	20000±140	290± 5
	Dissolved Solids	6280± 70	90± 1
	Total	26280±160	380± 5
May	Suspended Solids	2450± 50	120± 5
	Dissolved Solids	610± 30	90± 5
	Total	3060± 60	210± 5
June	Suspended Solids	2680±110	100± 5
	Dissolved Solids	560± 40	20± 1
	Total	3240±120	120± 5

MONTH COLLECTED		MICRO-MICROCURIES PER MONTH	CURIES PER SQUARE MILE PER MONTH X 10^{-3}
July	Suspended Solids	3260±110	120± 5
	Dissolved Solids	230± 30	10± 1
	Total	3490±110	130± 5
August	Suspended Solids	10970±110	40± 5
	Dissolved Solids	390±110	20± 5
	Total	11360±160	60± 5
September	Suspended Solids	120± 30	5± 1
	Dissolved Solids	50± 25	2± 1
	Total	170± 40	7± 1
October	Suspended Solids	220± 50	10± 2
	Dissolved Solids	-	-
	Total	220± 50	10± 2
November	Suspended Solids	340± 50	10± 2
	Dissolved Solids	210± 40	1± 1
	Total	550± 60	10± 2
December	Suspended Solids	160± 30	5± 1
	Dissolved Solids	25± 25	1± 1
	Total	185± 40	6± 1

SECTION III

Reports:

1. Radioactivity of well and spring water.

2. Measurement of Strontium 90 in soil.

June 18, 1959

Mr. E. R. Thomas, Manager
Meter and Test Department

No. 5950

SHORT-LIVED ACTIVITY OF WELL WATER AND SPRINGS
VICINITY OF INDIAN POINT

Tests were made to determine the short-lived radioactivity of water from several drinking water wells in Putnam and Westchester Counties. Water from some of these wells was checked for gross alpha and beta activities during 1958, but was counted 48 hours after collection to allow the radon daughters decay. The samples reported herein were counted shortly after collection to determine the short-lived activity.

Two liter samples were collected in polyethylene bottles and aliquots filtered through millipore filters. The millipore filter was burned with alcohol in an aluminum planchet and the residue was introduced in a Type PC-3A proportional counter where successive measurements were made for alpha and beta activity. Most of the samples were counted within a few hours after collection. The suspended solids were counted within 10 minutes from the beginning of filtration.

The results of these measurements for 2 samples are plotted on Plate Nos. 1 and 2. The linear portion of the alpha and beta decay curves shows an effective half-life of about 30 minutes. This compares closely with the half-life of radon daughters.

The filtrate was evaporated to dryness with a hot plate in order to measure the activity of dissolved solids. No alpha activity was present after evaporation, and the beta activity ranged between 1×10^{-9} and 5×10^{-9} microcuries per milliliter, very low values for water, but comparable to longer lived gross beta activity of well water found in 1958.

To confirm that the short-life activity is due to radon and radon daughters another test was made in which a water sample was kept in a tightly stoppered bottle from which aliquots were removed at various times up to 12 days. These were filtered and the activity of the suspended solids measured within 10 minutes after removal from the bottle. Since parent and daughters have been together in the bottle at least 3 hours, the approximate time required for radon daughters to build up the rate at which the daughters are being formed equals the rate at which the parent is disintegrating. At this equilibrium condition, if the daughters are separated and counted within a few minutes, then this activity is nearly proportional to the parent activity. By plotting the changing activity exhibited by the suspended solids for period of days, a decay curve can be drawn which corresponds to the radon activity decay. This decay scheme is shown on Plate No.3 indicating an effective half-life of 3 days. This approximates the half-life of radon gas.

Table No. 1 summarizes the short-lived activities measured in well water and springs. The highest activities were found in drinking water from a deep well, 160 feet, in a section of Putnam County where lead was mined at the turn of the century. Low short-lived radioactivity was measured in the Camp Smith reservoir which is well fed, and no alpha and very low beta activities were found in the larger Peekskill and Croton reservoirs.

The decay characteristics of these short-lived activities and the effective half-lives measured, indicate radon and its daughter products are responsible for the high activities found in well water.

attach.
jt.rr

A. K. Joecks
Test Engineer

TABLE NO. I

SUMMARY OF ALPHA AND BETA ACTIVITY OF SUSPENDED SOLIDS IN DRINKING WATER FROM WELLS AND SPRINGS - VICINITY OF INDIAN PT.

SAMPLING LOCATION	SOURCE	DATE AND TIME OF COLLECTION	DATE AND TIME OF INITIAL COUNT	ACTIVITY & COUNTING ERROR MICROCURIES PER MILLI-LITER - X 10^{-9} ALPHA	BETA
Knapp Rd., Hortontown, Putnam, N. Y.	160' Well	10:30 A.M.-5-12-59	11:10 A.M.-5-12-59	4880 ± 140	11500 ± 230
(Property of W. J. Odendahl)	160' Well	5:30 A.M.-5-13-59	9:00 A.M.-5-13-59	4380 ± 130	11200 ± 220
Mom's Rest. Rt. 9-D Manitou, Putnam, N. Y.	17' Well	1:00 P.M.-5- 7-59	4:00 P.M.-5- 7-59	840 ± 20	1700 ± 30
	17' Well	1:16 P.M.-5-12-59	1:26 P.M.-5-12-59	500 ± 30	800 ± 50
	Surface Spring	1:16 P.M.-5-12-59	1:26 P.M. 5-12-59	140 ± 20	250 ± 30
Highland Country Club, Rt. 9-D, Garrison Putnam, N. Y.	10' Well	12 Noon-5-14-59	4:00 P.M.-5-14-59	60 ± 10	180 ± 40
	Spring Fed Tap	12 Noon-5-14-59	4:00 P.M.-5-14-59	70 ± 10	330 ± 40
Camp Smith, Westchester, N. Y.	Well Water Chlorinated	11:00 A.M.-5-28-59	4:00 P.M.-5-28-59	16 ± 4	28 ± 7
	Reservoir after Well	11:00 A.M.-5-28-59	4:00 P.M.-5-28-59	16 ± 4	37 ± 5

Counting errors are for a 95 per cent confidence level

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PLATE NO. 1

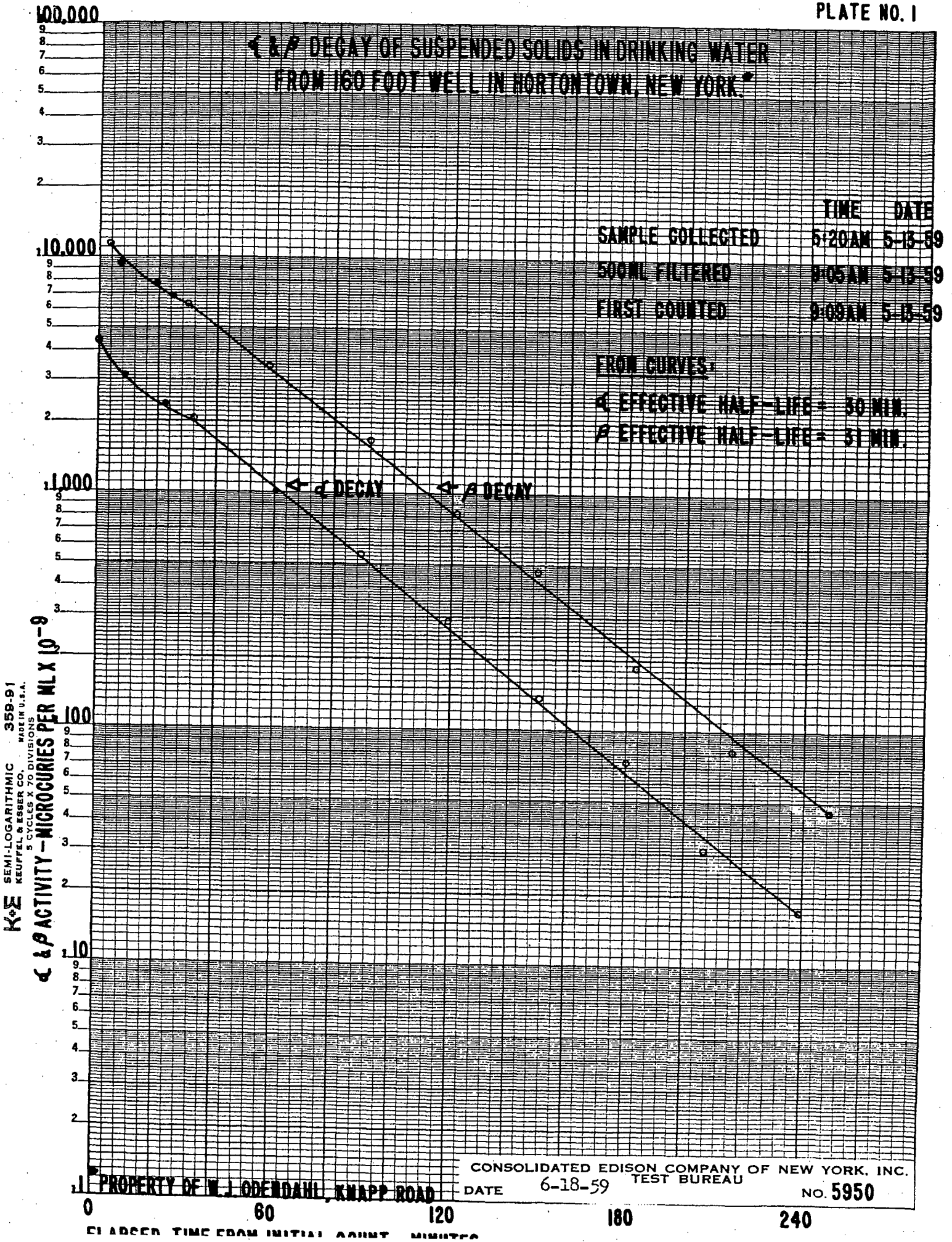

α & β DECAY OF SUSPENDED SOLIDS IN DRINKING WATER FROM 160 FOOT WELL IN HORTONTOWN, NEW YORK.*
TIME DATE
SAMPLE COLLECTED 5:20AM 5-13-59
500ML FILTERED 9:05AM 5-13-59
FIRST COUNTED 9:09AM 5-13-59
FROM CURVES:
α EFFECTIVE HALF-LIFE = 30 MIN.
β EFFECTIVE HALF-LIFE = 31 MIN.
α DECAY
β DECAY
α & β ACTIVITY — MICROCURIES PER ML X 10⁻⁹
100,000
10,000
1,000
100
10
1
0
60
120
180
240
ELAPSED TIME FROM INITIAL COUNT — MINUTES
K&E SEMI-LOGARITHMIC 359-91
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS
*PROPERTY OF W. J. ODENDAHL, KNAPP ROAD
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
TEST BUREAU
DATE 6-18-59
NO. 5950

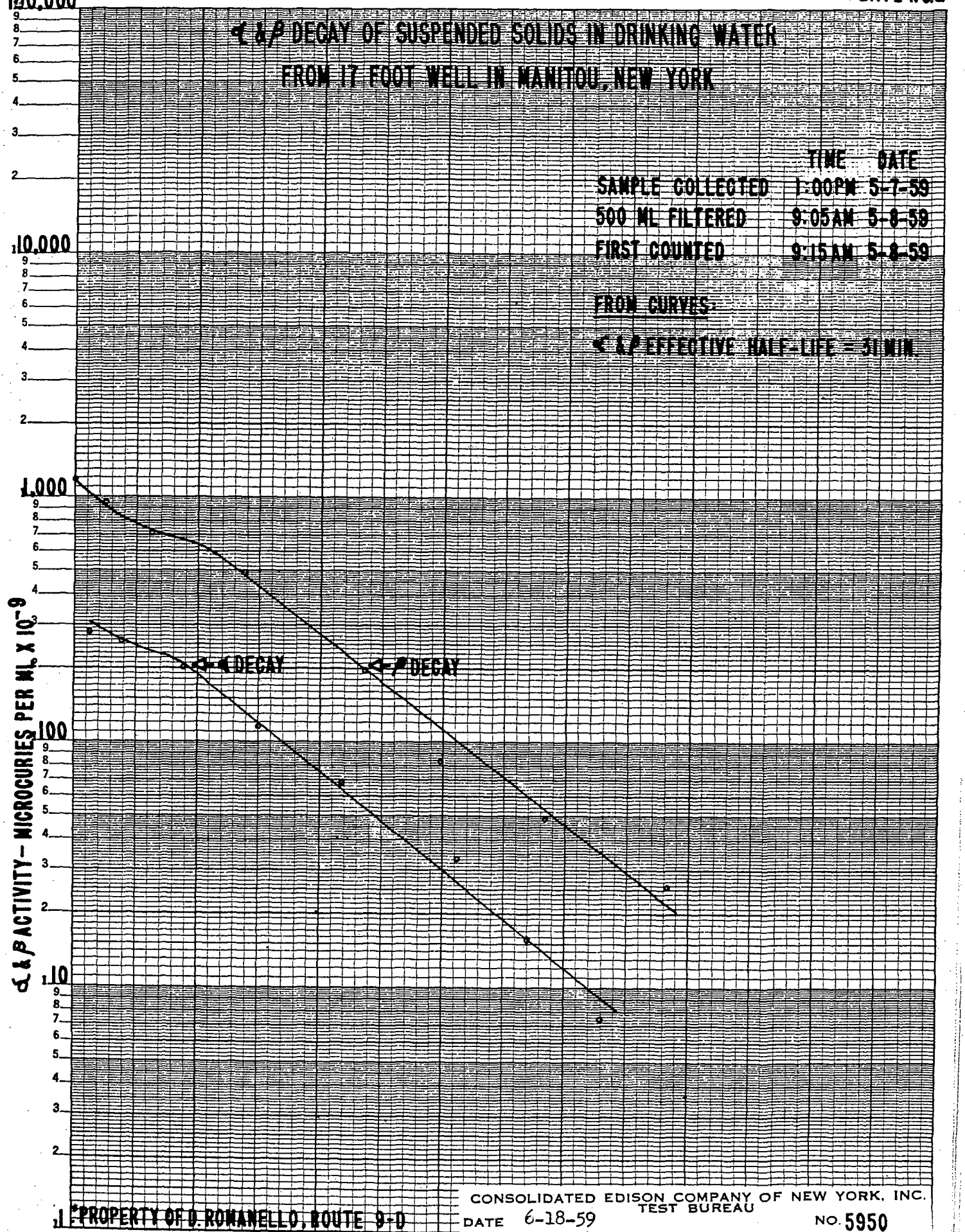
PLATE NO.2

α & β DECAY OF SUSPENDED SOLIDS IN DRINKING WATER FROM 17 FOOT WELL IN MANITOU, NEW YORK

	TIME	DATE
SAMPLE COLLECTED	1:00PM	5-7-59
500 ML FILTERED	9:05AM	5-8-59
FIRST COUNTED	9:15AM	5-8-59

FROM CURVES:

α & β EFFECTIVE HALF-LIFE = 31 MIN.



PROPERTY OF D. ROMANELLO, ROUTE 9-D

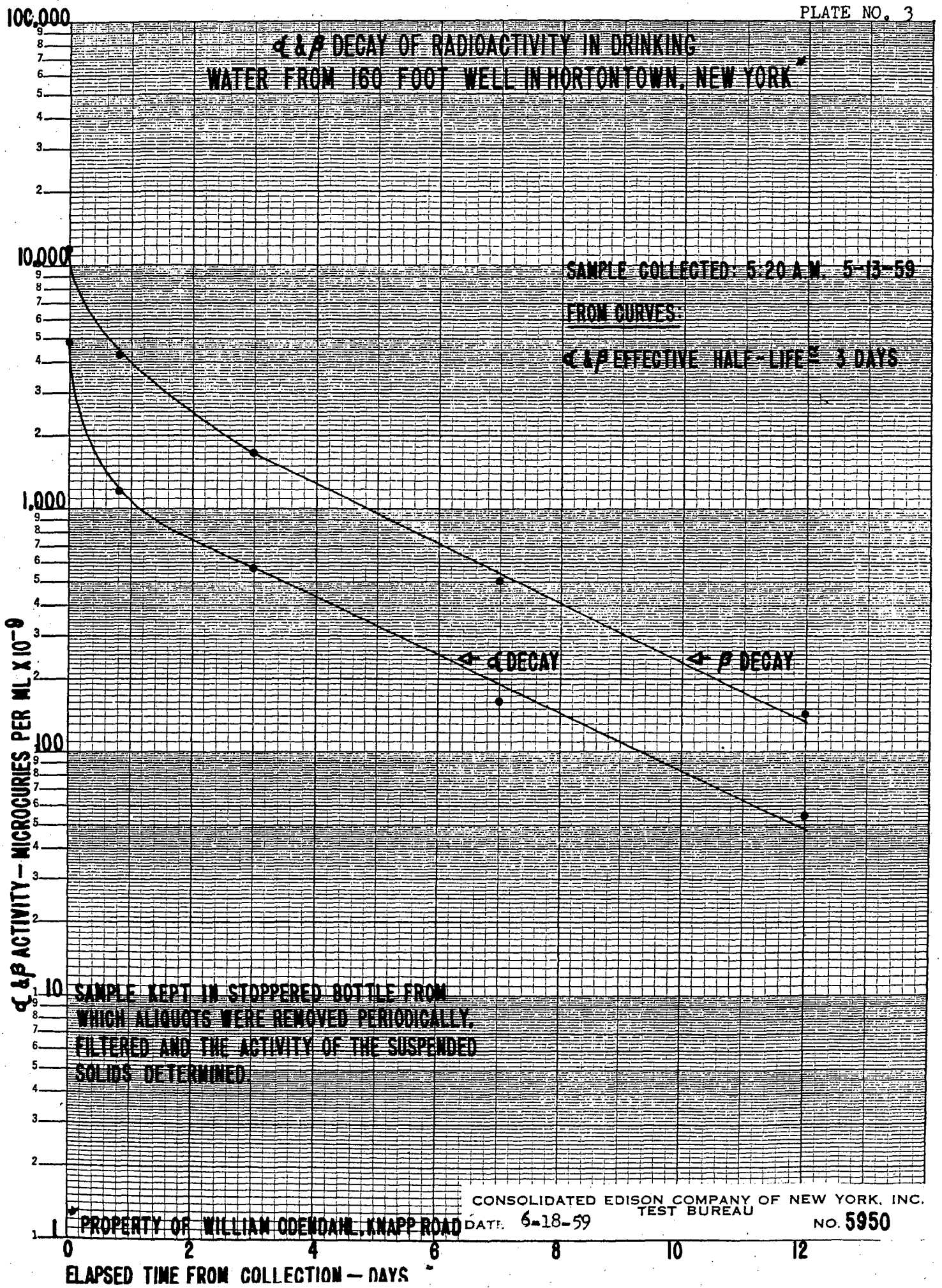
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
TEST BUREAU

DATE 6-18-59

NO. 5950

PLATE NO. 3

α & β DECAY OF RADIOACTIVITY IN DRINKING WATER FROM 160 FOOT WELL IN HORTONTOWN, NEW YORK



CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
TEST BUREAU

DATE 6-18-59

NO. 5950

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

MEMORANDUM

September 16, 1959

Mr. E. R. Thomas, Manager
Meter and Test Department

No. 5950

STRONTIUM 90 IN SOIL

The strontium 90 content in the soil has been determined in conjunction with the pre-operational survey for the Indian Point Nuclear Power Station. Soil samples were collected at the plant site and at a reference site, Dunwoodie Substation, which is far enough away to be beyond the influence of the reactor. Portions of each of these samples were analyzed by the Nuclear Science and Engineering Corp. and by the joint efforts of the Chemical Engineering Bureau and the Test Bureau.

The results obtained are:

	Millicuries per Square Mile	
Sample	NSEC	Con Edison
Indian Point Plant	42.6 ± 1.9	52 ± 5
Dunwoodie Substation	31.1 ± 1.6	52 ± 7

According to Dr. Gerald H. Hamada of the New York office of the AEC, these results compare with their most recent measurements on Westchester County soil which were in the order of 40 to 50 millicuries per square mile.

The report of the NSEC is attached together with a description of their method for the determination of strontium 90 in soil.

The analysis made by Con Edison was in accordance with the HASL-33 report of the AEC except that in the final steps in the preparation for counting, the sample was evaporated on a counting dish rather than filtered and dried in the filter.

A. K. Joecks
Test Engineer

attach.
wfn.baf

Copy to - A. R. Belyea

Nuclear Science and Engineering Corporation

P. O. Box 10901, Pittsburgh 36, Pennsylvania

Homestead 2-4000

NSEC NO. 30-14-5003
L9-21

July 31, 1959

Customer Order No.: M 9-21908

Send report to:	Send invoice to:
Consolidated Edison Co. of New York, Inc. Test Bureau 708 First Avenue New York 17, New York	Consolidated Edison Co. of New York, Inc. Accounts Payable Bureau 4 Irving Place New York 3, New York

INVOICE

2 soil samples assayed for Sr^{90} at $80.00 — $160.00

REPORT

Sample No.	DS1	1S1
Total surface area for 30 plugs (sq. mi.)	2.35×10^{-8}*	2.35×10^{-8}*
Gross dry weight for 30 plugs (g)	3330*	4010*
Sample submitted (g)	1190*	1530*
Sample analysed (g)	205	202
Acid soluble Sr^{90} in sample analysed (dpm)	100 ± 5**	112 ± 5**
mc Sr^{90}/sq. mi.	31.1±1.6	42.6±1.9

* data provided by A. K. Joecks

** errors are in terms of the standard deviation of counting multiplied by appropriate factors to correspond to the units given.

Leonard P. Salter
Section Leader

Encl: "Determination of Acid Soluble Sr-90 in Soil"

DETERMINATION OF ACID SOLUBLE SR^{90} IN SOIL

(1) Sample preparation

The entire soil sample or a representative aliquot of it is dried for several hours at 110°C and weighed. The dried sample is leached with agua regia, diluted with water, and the supernate is decanted. The residue is given a second aqua regia treatment, and after this supernate is decanted, the residue is washed with water.

(2) Radiochemical purification of Sr^{90}

Sr^{85} tracer and strontium carrier are added to the combined supernates and washings. The solution is made basic to phenolpthalein with NH_4OH and an excess of a saturated solution of $(NH_4)_2CO_3$ is added. The supernate is decanted and discarded after centrifugation, and the precipitate is dissolved in the minimum amount of concentrated HNO_3. An equal volume of 90% HNO_3 is added, the sample cooled in an ice bath, and the precipitate centrifuged, washed with concentrated HNO_3 (Note 1) and dissolved in the minimum amount of water.

A few drops of Fe^{+3} carrier are added to this solution which is made basic with CO_2-free NH_4OH. The precipitate is centrifuged and discarded; the supernate is acidified and the $Fe(OH)_3$ scavenging repeated. The time of the second $Fe(OH)_3$ precipitation is taken as zero time for Sr^{90} Y^{90} equilibration. A few drops of barium carrier are added, the solution is adjusted to a pH of 5.5 with HAc and NH_4Ac. and $BaCrO_4$ is precipitated from the hot solution by the slow addition of 1.5 M $Na_2Cr_2O_7$. The precipitate is filtered and discarded. After the filtrate is made basic with NH_4OH. $SrCO_3$ is precipitated by the addition of a saturated solution of $(NH_4)_2CO_3$. The $SrCO_3$

is filtered, dried and the Sr^{85} recovered is counted. The ratio of Sr^{85} activity recovered to that added is used as the strontium chemical yield. The precipitate is quantitatively dissolved in acid and stored.

(3) Y^{90} milk:

After two weeks, to allow for equilibration between Y^{90} and Sr^{90}, yttrium carrier is added to the acid solution of $SrCO_3$ and a double precipitation of $Y(OH)_3$ is made with CO_2-free NH_4OH. The time of the first $Y(OH)_3$ precipitation is taken as the time of the Y^{90} - Sr^{90} separation. The second $Y(OH)_3$ precipitate is dissolved in acid and the yttrium precipitated as the oxalate at a pH of 1. The $Y_2(C_2O_4)_3$ is filtered, washed, and ignited to the oxide which is weighed to determine the yttrium chemical yield. The Y_2O_3 is mounted for counting.

(4) Preparation of the sample for counting:

The weighed carriers are placed on a micarta semi-cylinder (0.75 inch I.D., 2.5 inches long) and mixed with an aqueous solution of agar agar. The mixture is spread over an area of 2 to 5 cm^2 to produce a sample of approximately uniform thickness. After the sample is dried and covered with rubber hydrochloride (0.5 mg/cm^2) it is ready for counting.

(5) Counting:

The sample is counted in one of NSEC's sixteen low level beta counters. These are constructed with cathodes of thin aluminized mylar and operate as gas flow Geiger Muller counters. They are shielded by 8" of steel, an anti-coincidence umbrella of Geiger Muller tubes, and 1" of triple distilled mercury.

The decay of Y^{90} is followed for 8-10 days. The counting rate of Y^{90} at time of separation, R_o, is determined by analysis of the decay curve with extrapolation of the 64 hour half-period to the time of milking. A sufficient number of counts are collected to obtain a gross counting rate with a standard deviation $\leq$ 15% for samples with a gross activity under 1 cpm, $\leq$ 8% between 1 and 5 cpm; and $\leq$ 5% above 5 cpm.

The backgrounds of the counters are about 0.3 cpm; the backgrounds for each counter are checked daily. A sufficient number of counts are obtained to calculate the background counting rate to a standard deviation of $\pm$ 0.04 cpm.

KCl and/or Cs^{137} standards are counted daily to maintain a continual check on counter operation.

(6) Determination of Sr^{90} disintegration rate:

The calculation of the total Sr^{90} disintegration rate is made from the following equation.

$$D = \frac{R_o E}{Y_1 Y_2 (1-e^{-\lambda t})}$$

where

D = total Sr^{90} disintegration rate

R_o = Y^{90} counting rate at time of milk

E = overall counting efficiency correction factor (includes corrections for geometry, absorption, self-absorption, and scattering phenomena).

Y_1 = strontium chemical yield

Y_2 = yttrium chemical yield

λ = Y^{90} decay constant

t = time for Y^{90} growth between $Fe(OH)_3$ scavenging and Y^{90} milk.

Notes:

(1) A complete separation of strontium and calcium is not necessary since the strontium chemical yield is determined by the recovery of Sr^{85} tracer.

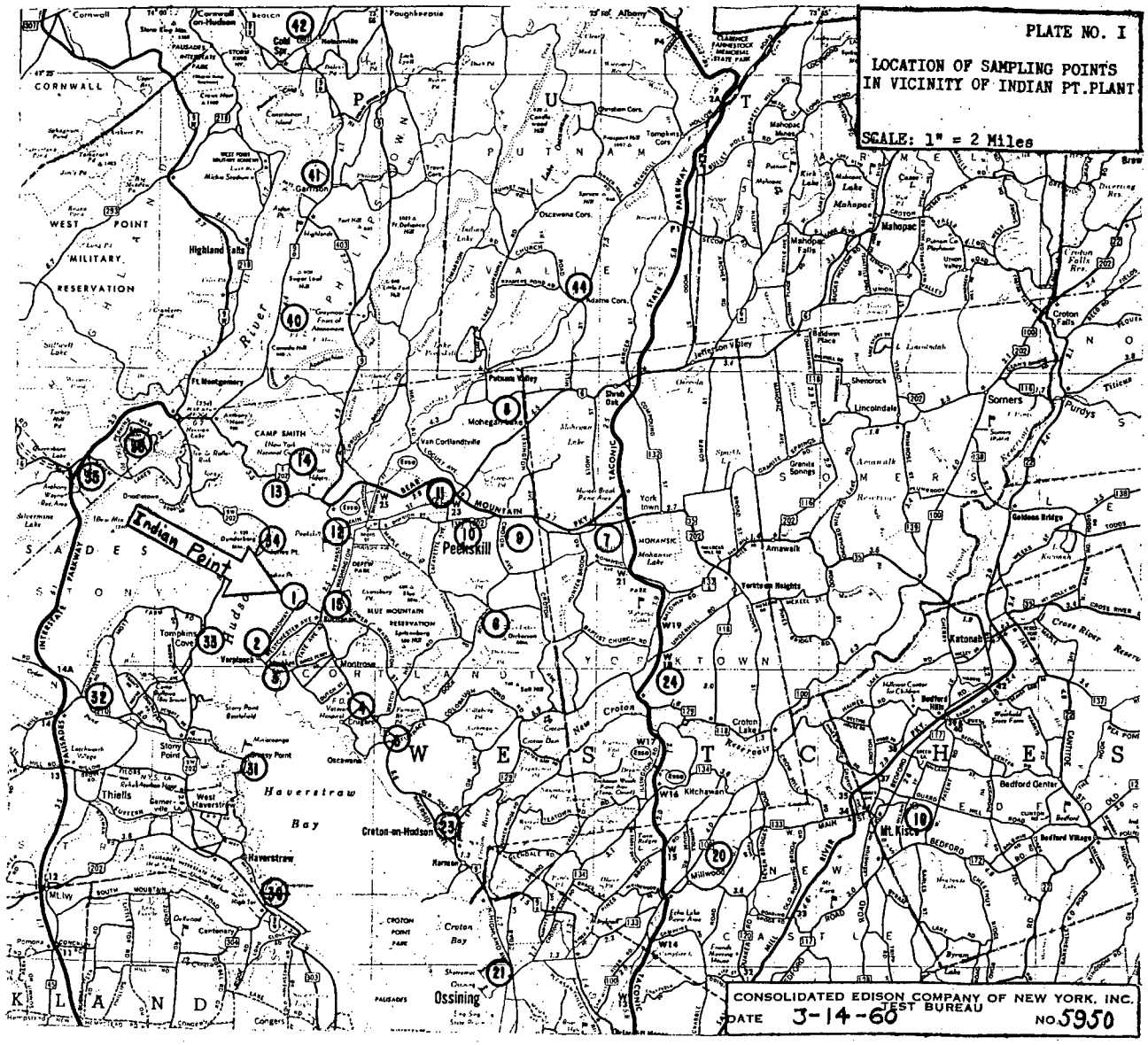


PLATE NO. I
LOCATION OF SAMPLING POINTS
IN VICINITY OF INDIAN PT. PLANT
SCALE: 1" = 2 Miles
Indian Point
Peekskill
Ossining
Croton-on-Hudson
Haverstraw Bay
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
TEST BUREAU
DATE 3-14-60
NO. 5950