PRNC-3
Health Physics

ENVIRONMENTAL SURVEY PROCEDURES MANUAL

By J. A.Ferrer Monge

Puerto Rico Nuclear Center
Operated By
University of Puerto Rico
For
U.S. Atomic Energy Commission
Mayagüez, P.R.
JULY 1,1960

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(HEALTH PHYSICS)

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INTRODUCTION

This manual has been prepared for the purpose of establishing standard procedures to be followed by the Puerto Rico Nuclear Center Health Physics Section, for use in training personnel and trainees in the Health Physics programs and to supply technical information to all persons interested in the field of environmental surveillance.

AREA OF STUDY

The area to be surveyed is located between latitute 18°00 to 18°25' (North) and longitude 66°57'30" to 67°17'30" (West) with an area of approximately 352 square miles. This is mostly mountainous region being an extension of the Cordillera Central and includes several water sheds, the main ones being the Culebrinas, Grande de Añasco, Yague, Río Cañas, Guanajibo and Rosario Rivers. The lowlands are located in Cabo Rojo, Lajas, Mayaguez, Añasco and Aguadilla.

Figure 1 presents a map of the island of Puerto Rico indicating the area of study, the cities and towns within that area as well as other large towns (15,000 or more inhabitants) outside the area.

Figure 2 presents a map of the area of study and is based on the U.S. Geological Survey topographical maps and includes a plan of the city of Mayaguez indicating the site of the PRNC and permanent stations where special samples will be collected.

To facilitate the identification of the samples the whole area has been divided into quadrangles. Each one represents 6.4 square miles (2.45 x 2.45). With PRNC as center, a number of circles with radii of 2.5, 5.0, 7.5, 10.0 and 12.5 miles respectively has been drawn to relate activity measured to distance if this were necessary.

ACTIVITY TO BE MEASURED

The radiological survey involves the measurements of gross alpha and beta-gamma activity.

IDENTIFICATION OF SAMPLES

Table 1 presents the code to be used in the identification of samples. Samples will have an identification number as follows: RS-I-A-35(E1)W or RS-I-J-35W where:

RS	-	Radiological Survey Program
I	-	first Radiological Survey to be carried out
A	-	area in the map where the sample was collected
35	-	sample number independently of the area where it was collected
(E1)	-	indicates that the sample was collected in a permanent station
W	-	indicates water sample. (A - air, B - sediment, M - milk, S - soil, V - vegetation, W - water)

PROCEDURES

I- Collection and Identification of Samples

A. Soil

Four soil samples (from stations E1, E3, E4 and E6) will be collected per month. Additional samples will be collected if needed. The soil shall be sampled to a depth of 6" using a 4" diameter hand auger. The sample will be divided into 2 portions. The 2" top soil will be placed in a plyethelene plastic bag including a tag with the following information:

1. Radiological Survey
2. Sample No.
3. Date

This number shall correspond with that in Form 631. The remaining 4" of soil will be placed in another bag including Form 631. Next, Form 631a Field Data Sheet, shall be completed. In the laboratory the plastic bags will be sealed enclosing the small one within the larger. The sample is now ready for storage.

B. Water

1. Drinking Water

One sample will be collected every two weeks from station (E1) at the mouth of the Yaguez River and one per month at station (E2), five miles up stream of the Yaguez River. One sample will be collected weekly at station (E3), Quebrada de Oro, and one per month at station (E4), a dam and (E5), an artesian well. A weekly sample will be collected from statinn (E6), at PRNC.

Additional samples will be collected whenever necessary from permanent stations or elsewhere.

All water samples shall be collected in duplicate using polyethelene one liter bottles properly identified (Form No. 631). Complete form 631a.

(a) Surface Water

Bottles will be filled either by immersion in water or using another container to transfer the liquid to the bottles.

(b) Underground Water

Same as 1(a)

2. Rain Water

One sample will be collected each week from the pluviometer installed in the vicinity of PRNC, station (E7) and one per month from the one at the city airport, station (E8). All the water accumulated in the pluviometers during the week will be collected.

The bottles will be sealed, the samples identified and forms 631 and 631a completed.

C. Air

Each week one air sample will be taken from 2 stations (E3) and (E6) and one sample four times per year from three other stations. Samples are to be collected in Whatman filter paper No. 41, approximately 4" in diameter using a High-Volume air sampler during 24 hours.

After removing the filter paper from the sampler it shall be enclosed in an envelope with the following information:

Location	:	area or station where the sample was collected
Date	:	indicate the time at which collection started and the time at which sampling was finished.
cfm	:	indicate the ft^3/min. at the begining and end of sampling as indicated by the instrument. (See Manual of Instrument Used in H.P. - Portable Air Sampler).
Signature	:	signature of the person who took the sample.

D. Milk

Two one liter samples will be collected per semester. Samples shall be collected in polyethelene bottles sealed and identified.

Form 631 and 631a shall be completed.

E. Vegetation

One sample per quarter will be collected from e stations (E1), (E3) and (E6). Each sample shall consist of approximately 500 grams and it will be enclosed in a cardboard box or plastic bag properly identified.

Fill Forms 631 and 631a.

F. Sediment

One sample shall be collected per semester from three stations (E1), (E3) and (E4). The wet weight of each sample shall be no less than 20 grams. Sample will be collected in polyethelene bottles from the middle of the stream or at a point 4 to 6 feet from the shore. The bottles will be sealed and properly identified.

Complete Forms 631 and 631a.

SAMPLE COLLECTION PERMIT

Whenever samples are to be collected in private property, the collector shall fill Form 631b.

I ______________________________ certify

that the following listed samples are in storage,

have been physically inspected, sealed and in good

conditions on this ________day of __________ 19 ___.

____
Signature of storekeeper

____
Signature of Witness

SAMPLE PREPARATION

A. **Soil**

1. Samples low in O.M. content are dried in an oven at 103°C.
2. Sample is pulverized and sieved in a No. 60 sieve (250 microns).
3. Approximately 200 mg. of the sample are spread uniformly in a 2" diameter, 1/8" deep, weighed stainless steel planchet. If necessary water may be added to form a thin paste, then dried under an infrared lamp.
4. Determine sample weight.
   Samples high in O.M. content are dried at 103°C and then ashed at 600°C.
   From here on follow the same procedure outlined above.

B. **Water**

Insoluble Solids*

1. Filter 1 liter** of water using Whatman filter paper No. 42 (ashless) approximately 5.5 cm in diameter, previously weighed, in a 1500 ml beaker.
2. Dry the filter paper containing the insoluble solids in an oven at 103°C. and weight it.
3. Transfer to a planchet (same type as used for soil samples).
4. Saturate paper with ethyl alcohol and burn using a Meeker burner.
   Ten to twenty seconds is usually enough.

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* Water samples with low turbidity (i.c. clear will not be filtered)
** In case of rain water this may be less than 1 liter.

Soluble Solids

1. Evaporate the filtrate in the beaker to a volume of about 10 ml. and transfer quantitatively to a previously weighed planchet containing several drops of 2N nitric acid. Wash beaker with 2N nitric and transfer to planchet.
2. Dry in an oven at 103°C or under an infrared lamp.
3. Determine weight of soluble solids.

C. Air

Air samples do not require any preparation. The filter paper is removed from the air sampler and counted directly (See Air-Counting & Accuracy).

D. Sediment

1. Decant and remove excess water.
2. Transfer to a weighed planchet an amount of sediment such that when dry it is approximately 200 mg.
3. Evaporate to dryness.
4. Determine weight of sediment.

E. Milk

1. Shake sample well. Pour 20 cc in a 100 ml. beaker.
2. Add approximately 5 ml. of concentrated HNO_3 (s. gr. 1.42). Wait 1 hour or longer until serum separates completely from the solid portion.
3. Carefully place the beaker in a hot plate and evaporate slowly almost to dryness (80°- 95°C).
4. Remove the beaker from the hot plate and add 10 ml. concentrated HNO_3. Wait until the solids are dissolved.
5. Evaporate to dryness. Cool for 5 minutes.
6. Repeat a second and third digestion adding each time 5 ml. of HNO_3 and evaporating to dryness.
7. Add 1 ml. concentrated HNO_3 and 2 to 5 drops of a 30% solution of H_2O_2.
8. Remove acidity by adding carefully distilled water down the sides of the beaker and evaporating to dryness. Repeat this step twice.
9. Add about 10 ml. of distilled water and transfer carefully to a previously weighed planchet.
10. Evaporate to dryness and count.

activity of a sample by direct counting unless the emitter is known, reference standards are used to counteract this difficulty.

A. Alpha Standards

1. Soil and Sediment

   a. Pulverize a quantity of quartz and pass through a No. 60 sieve.
   b. Add to a known weight of quartz a known amount of uranyl nitrate in solution.
   c. Mix thoroughly and evaporate to dryness.
   d. Transfer 50, 100, 150, 200, 300, 500, 750, 1000 mgs. approximate of the mixture of quartz and Uranyl Nitrate to previously weighed planchets and count.
   e. Find the efficiency of the instrument by dividing the counting rate of the sample by the desintegration rate obtained by the amount of Uranyl Nitrate present.
   f. Plot a curve of per cent efficiency versus weight of sample. (Graph 1).

2. Water

   a. Evaporate enough water to obtain weights of 25, 50, 75, 100 mgs. of soluble solids.
   b. Transfer these solids to previously weighed planchets.
   c. Add a volume of uranyl nitrate solution having an activity of approximately 1000 desintegrations per minute to each sample.
   d. Dry under an infrared lamp and weigh the planchet to find the weight of the samples.
   e. Count the sample and find the efficiency of the instrument in each case by dividing the counting rate obtained by the desintegration rate of the sample.
   f. Plot a graph of percent efficiency of the instrument versus weight of sample (Graph 2).

B. Beta Standards

1. Soil

   a. Pulverize the KCl in a mortar and pass it through a No. 60 sieve.
   b. Transfer 50, 100, 150, 200, 300, 400, 500, 750 and 1000 mgs. of KCl to previously weighed planchets
   c. Find the counting rate for each sample.
   d. Determine the efficiency of the instrument by dividing the counting rate by the desintegration rate of the K^{40} isotope present in each sample of KCl.
   e. Plot a graph or percent efficiency versus weight of sample (Graph 3).

2. Water

   a. Prepare a saturated solution of KCl.

b. To previously weighed planchets add different amounts of the solution so as to have 5, 15, 25, 40, 60, 80, and 100 mgs. range of KCl.
c. Add ethyl alcohol to each planchet, and evaporate.
d. Determine the counting rates of the samples and calculate the efficiency of the instrument by dividing the counting rate by the activity of the KCl due to the K40 isotope.
e. Plot a curve of percent efficiency of the instrument versus weight of sample (Graph 4).

For air samples the portable air sampler is assumed to have a collecting efficiency of 1 (100%) and the filter paper an absorption efficiency of .7 for alphas (.3 or 30% is lost) and 1.0 for betas (no loss).

COUNTING AND INTERPRETATION

I. Soil, Vegetation, Milk, Sediment and Water

A. Accuracy

Samples shall be counted for a period of time not less than 55 minutes.

Thirty minutes counts for background shall be taken at least twice a day.

The counting rate of samples will be reported with a 0.9 statistical error. This error (E) is calculated from:

$$E = K \left(\frac{N_s}{t_s} + \frac{N_b}{t_b} \right)^{1/2}$$

where K = 1.65
N_s = counting rate of sample (background included)
N_b = counting rate of background
t_s = time in minutes the sample was counted
t_b = time in minutes the background was counted
the net counting rate, N, will be given as
$N = (N_s - N_b) \pm E$

Example:

A soil sample is counted for 55 minutes and the total count obtained was 6916. The background obtained for 30 minutes was 2550 counts. What is the net counting rate of the sample?

$$N_s = \frac{6916}{55} = 126 \text{ c/m}$$

$$N_b = \frac{2550}{30} = 85 \text{ c/m}$$

$$t_s = 55 \text{ min.}$$

$$t_b = 30 \text{ min.}$$

The 0.9 statistical error is

$$E = K \left(\frac{N_s}{t_s} + \frac{N_b}{t_b} \right)^{1/2}$$

$$= 1.65 \left(\frac{126}{55} + \frac{85}{30} \right)^{1/2} = 1.65 \, (2.29 + 2.83)^{1/2}$$

$$= 1.65 \, (5.12)^{1/2} = 1.65 \, (2.26)$$

$$E = 3.7 \text{ c/m}$$

The net counting rate of the samples is therefore:

$$N = N_s - N_b \pm E = (126 - 85) \pm 3.7$$

$$N = 41 \pm 3.7 \text{ c/m}$$

Whenever greater accuracy is desired the sample and background can be counted for a longer period of time thus making the 0.9 error smaller. This is true specially in cases where the counting rate of sample (N_s) is very close to background's (N_b).

In such cases it is desirable to distribute the counting periods of sample and background in such a way as to reduce the error to a minimum. This can be done applying the formula

$$\frac{t_s}{t_b} = \left(\frac{N_s}{N_b} \right)^{1/2}$$

Since N_m and N_f have been previously determined (in the first run) the ratio between the counting time of the sample and the counting time of the background ($\frac{t_s}{t_b}$) can be obtained.

II. Air

A. Counting and Accuracy

1. Count the sample until a minimum of 500 total counts is obtained or for 55 minutes, whichever is shorter*. This gives approximately 7% error at the 90% C.L.
2. For immediate alpha or beta activity, count sample as soon as removed from sampler.
3. For alpha activity due to long-lived radioisotopes take one count (C_1) at least four hours after collecting the sample.
4. Take a second count (C_2) at least 20 hours after taking first count.
5. For beta activity due to long-lived radioisotopes take one count (C_1) after removing the filter from the sampler.
6. Take a second count (C_2) at least twenty hours after the first count.
7. Between first and second counting return filter paper to its appropriate envelope.
8. Determine activity due to alpha and/or beta as instructed in Form PRNC-HPS(RS) 632a.
9. Save all samples until final calculations and reports have been made.

REPORT OF RESULTS

The final result of sample analyses shall be reported in microcuries per cc or gm. whichever the case may be.

An individual report shall be made of each sample using the following forms:

Form PRNC-HPS(RS)632 - Data Sheet - Soil, Vegetation, Milk, Sediment and water.

Form PRNC-HPS(RS)632a - Data Sheet - Air

A monthly report shall be made of the samples analyzed using Form (RS) 632b. Use one sheet for each type of sample (e.g. all soil samples in one sheet, all water samples in another sheet, etc.).

* The activity of the sample will determine the counting time.

CALCULATIONS

Some calculations and examples are given under Counting and Interpretation. As reference other calcula tions are presented herein.

I. Activity in Air Samples

The general equation to use is:

(1)

$$uc/cc = \frac{\text{net c/m}}{f_e \times A} \times \frac{1}{R \times T \times f_f \times K}$$

f_e = efficiency of counter. This value is obtained from the efficiency curves of the corresponding standards.

A = absorption of activity by the filter paper.

A = 0.7 for alphas (assume 30% activity is absorbed).

A = 1.0 for betas (assume no absorption)

R = air flow cc/minute.

T = sampling time interval in minutes.

f_f = filter paper efficiency for collecting particles in the air. Assume f_f = 1.

K = a constant to convert d/m/cc to uc/cc; $K = 2.22 \times 10^6$ d/m-uc

Substituting in equation (1) for alphas

(2)

$$uc/cc = \frac{\text{net c/m}}{0.2^* \times 0.7 \times R \times T \times 1 \times 2.22 \times 10^6}$$

which can be simplified to

(3)

$$uc/cc = \frac{\text{net c/m } 5.4 \times 10^{-6}}{RT}$$

This is the equation in Form 632a for air samples.

For betas the equation is similar, but f_e is assumed to be 0.5 and A = 1, thus

* See Graph 1.

(4) $$uc/cc = \frac{\text{net c/m} \times 0.9 \times 10^{-6}}{RT}$$

This equation also appears in Form 632a. To determine activity in air due to long-lived radioisotopes the general equation to use is:

(5) $$C_{LL} = \frac{C_2 - C_1 e^{-.0655(t_2 - t_1)}}{1 - e^{-.0655(t_2 - t_1)}} \text{ c/m}$$

C_{LL} = counts-minute due to long-lived radioisotopes

C_1 = counts/minute 4 hours or more after collecting the sample

C_2 = counts/minute 24 hours after C_1

$e^{-.0655(t_2 - t_1)}$ = correction factor due to desintegration rate of Thoron

$(t_2 - t_1)$ = time lapse between C_1 and C_2 (in hours).

If $(t_2 - t_1)$ is kept constant, for example 20 hours, equation (5) can be substituted by:

(6) $$C_{LL} = \frac{C_2 - C_1 (.27)}{0.73} = 1.4 (C_2 - .27 C_1) \text{ c/m}$$

Once C_{LL} counts/minute corrected has been determined for α and β activity this value is substituted in equations (3) and (4) to calculate the alpha and beta activity in the sample so that:

(7) $$uc/cc \text{ alpha} = \frac{C_{LL} \times 5.4 \times 10^{-6}}{RT}$$

(8) $$uc/cc \text{ beta} = \frac{C_{LL} \times 0.9 \times 10^{-6}}{RT}$$

II. Activity in Soil, Water, Milk, Vegetation and Sediment Samples

A. Alpha Activity of the samples will be expressed in uc relative to natural uranium.

The activity in natural Uranium is due to its isotopes 238, 235 and 234 and it is determined as follows:

$$A_{Total} = \sum_{i=1}^{3} \lambda_i N_i$$

where $\lambda_i N_i$ is the activity of each one of the isotopes

The activity due to U^{238}

$$\lambda = \frac{.693}{T\ 1/2} = 4.88 \times 10^{-18}\ sec^{-1}$$

where T 1/2 is the half-life of U^{238} or 4.49×10^{9} years

N = number of U^{238} atoms per gm of Uranyl Nitrate

$$= \frac{.993}{502} \times 6.025 \times 10^{23} = 1.19 \times 10^{21}$$

where: 0.993 is the abundance of the 238 isotope

6.025×10^{23} is Avogadro's number

502 is the mass number of Uranyl Nitrate

$$A = \lambda N = 4.88 \times 10^{-18} \times 1.19 \times 10^{21}$$

$$= 5810 \text{ d/sec/g of Uranyl Nitrate}$$

The activity of U^{235}

$$\lambda = \frac{.693}{T\ 1/2} = 3.08 \times 10^{-17}\ sec^{-1}$$

where $T\ 1/2 = 7.13 \times 10^{8}$ years

$$N = \frac{.00715 \times 6.02 \times 10^{23}}{502} = 8.60 \times 10^{18}$$ atoms of U^{235} per gram of Uranyl Nitrate

where 0.00715 is the abundance of U^{235} isotope

$$A = \lambda N = (3.08 \times 10^{-17})(8.60 \times 10^{18}) = 260 \text{ d/s/gm.}$$

The activity of U^{234} isotope is the same as the activity of the U^{238} because they are in secular equilibrium. The total activity per gram of Uranyl Nitrate is therefore

$$A_{Total} = 5810 + 5810 + 260$$

$$= 11900 \text{ d/sec}$$

B. Beta activity of the samples will be expressed in uc relative to K^{40}.

The activity in KCl due to K^{40} is determined as follows:

a- Percent of K^{40} in natural K = .0119%

b- Half-life of K^{40} (T 1/2) = 1.3×10^9 years

Therefore:

$$\lambda = \frac{.693}{T\ 1/2} = \frac{.693}{1.3 \times 10^9 \times 365 \times 24 \times 60}$$

$$= 1.01 \times 10^{-15} \text{ min.}^{-1}$$

c- Molecular weight of KCl = 74.557

d- N = number of K^{40} atoms/g of KCl

$$N = \frac{.000119}{74.557} \times 6.02 \times 10^{23}$$

$$N = 9.6 \times 10^{17}\ K^{40} \text{ atoms}$$

e- A = activity of K^{40} in d/m

$$A = \lambda N = 1.01 \times 10^{-15} \times 9.6 \times 10^{17}$$

$$A = 970 \text{ d/m/g of KCl}$$

The basic equation to convert activity of sample in d/m to uc/cc or uc/g is:

(9)
$$\text{uc/cc or g} = \frac{\text{net c/m}}{f_e \times A_m \times K}$$

f_e = efficiency factor

A_m = sample weight in cc or g

K = constant to convert d/m to uc $K = 2.22 \times 10^6$

APPENDICES

MAP OF THE ISLAND OF PUERTO RICO

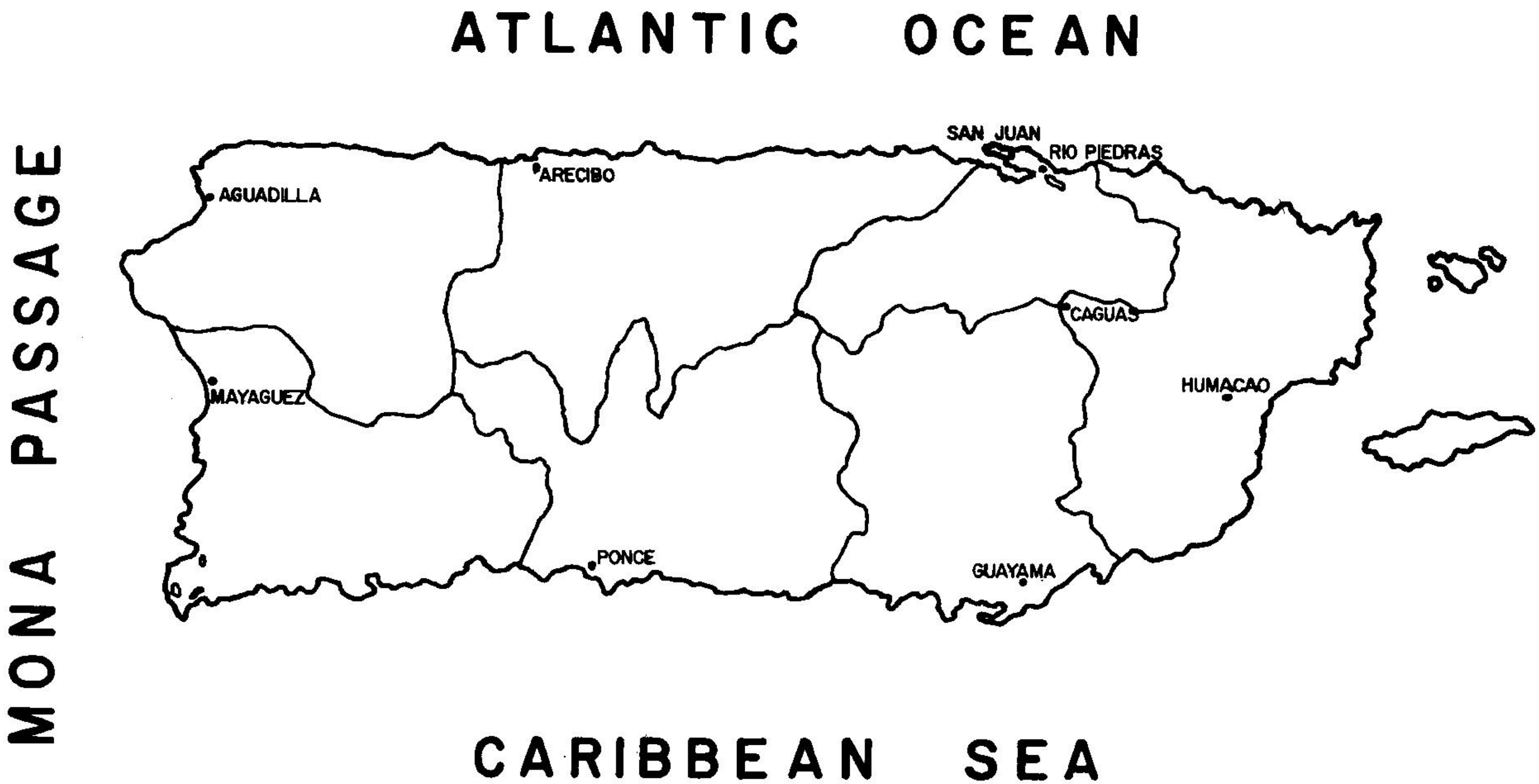

FIG.-1

TABLE 1

Areas	LATITUDE From	LATITUDE To	LONGITUDE From	LONGITUDE To
A	18° 10'	18° 12' 30"	67° 10'	67° 12' 30"
B	10'	12' 30"	07' 30"	10'
C	10'	12' 30"	05'	07' 30"
D	10'	12' 30"	02' 30"	05'
E	10'	12' 30"	67° 00'	02' 30"
F	10"	12' 30"	66° 57' 30"	67° 00'
G	07' 30"	10'	67° 10'	67° 12' 30"
H	07' 30"	10'	07' 30"	10'
I	07' 30"	10'	05'	07' 30"
J	07' 30"	10'	02' 30"	05'
K	07' 30"	10'	67° 00'	02' 30"
L	07' 30"	10'	66° 57' 30"	67° 00'
M	05'	07'	67° 10'	12' 30"
N	05' 30"	07' 30"	07' 30"	10'
O	05'	07' 30"	05'	07' 30"
P	05'	07' 30"	02' 30"	05'
Q	05'	07' 30"	00'	02' 30"
R	05'	07' 30"	66° 57' 30"	67° 00'
S	02' 30"	05'	67° 10'	12' 30"
T	02' 30"	05'	07' 30"	10'
U	02' 30"	05'	05'	07' 30"
V	02' 30"	05'	02' 30"	05'
W	02' 30"	05'	00'	02' 30"
X	02' 30"	05'	66° 57' 30"	67° 00'
Y	18° 00' 30"	02' 30"	67° 10'	67° 12' 30"
Z	00'	02' 30"	07' 30"	10'

Areas	LATITUDE From			LATITUDE To		LONGITUDE From			LONGITUDE To		
AA		00'		02'	30"		05'			07'	30"
BB		00'		02'	30"		02'	30"		05'	
CC		00'		02'	30"	67°	00'			02'	30"
DD		00'		02'	30"	66°	57'	30"	67°	00'	
EE	18°	12'	30"	15'		67°	10'			12'	30"
FF		12'	30"	15'			07'	30"		10'	
GG		12'	30"	15'			05'			07'	30"
HH		12'	30"	15'			02'	30"		05'	
II		12'	30"	15'			00'			02'	30"
JJ		12'	30"	15'		66°	57'	30"	67°	00'	
KK		15'		17'	30"	67°	10'			12'	30"
LL		15'		17'	30"		07'	30"		10'	
MM		15'		17'	30"		05'			07'	30"
NN		15'		17'	30"		02'	30"		05'	
OO		15'		17'	30"		00'			02'	30"
PP		15'		17'	30"	66°	57'	30"		00'	
QQ		17'	30"	20'		67°	12'	30"		15'	
RR		17'	30"	20'			10'			12'	30"
SS		17'	30"	20'			07'	30"		10'	
TT		17'	30"	20'			05'			07'	30"
UU		17'	30"	20'			02'	30"		05'	
VV		17'	30"	20'			00'			02'	30"
WW		17'	30"	20'		66°	57'	30"		00'	
XX		20'		22'	30"	67°	15'			17'	30"
YY		20'		22'	30"		12'	30"		15'	
ZZ		20'		22'	30"		10'			12'	30"

Areas	LATITUDE From	LATITUDE To	LONGITUDE From	LONGITUDE To
AAA	20'	22' 30"	07' 30"	10'
BBB	20'	22' 30"	05'	07' 30"
CCC	20'	22' 30"	02' 30"	05'
DDD	20'	22' 30"	00'	02' 30"
EEE	20'	22' 30"	66° 57' 30"	00'
FFF	22' 30"	25'	12' 30"	15'
GGG	18° 22' 30"	18° 25'	67° 10'	67° 12' 30"
HHH	22' 30"	25'	07' 30"	10'
III	22' 30"	25'	05'	07' 30"
JJJ	22' 30"	25'	02' 30"	05'
KKK	22' 30"	25'	67° 00'	02' 30"
LLL	22' 30"	25'	66° 57' 30"	00'

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PUERTO RICO NUCLEAR CENTER ENVIRONMENTAL SURVEY

SAMPLE IDENTIFICATION

Sample No.________ Book No.______ Page No.________ Ref. Map ________________

Sample Location- Latitude___ ___ ____ Longitude ___ ____ ____.

The undersigned certifies that this sample was taken in accordance with the sampling specifications of the approved survey date,____________________

on this ______________day of _______________, 19____.

____
Client

____
Signature of Collector

Form PRNC- HPS (RS) 631

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PUERTO RICO NUCLEAR CENTER ENVIRONMENTAL SURVEY

SAMPLE IDENTIFICATION

Sample No.________ Book No.________ Page _______ Ref. Map.________________

Sample Location-Latitude- ________' ___" Longitude ____° ______' _______"

The undersigned certifies that this sample was taken in accordance with the sampling specifications of the approved survey date, ____________________

on this ______________ day of _______________, 19____.

____
Client

____
Signature of Collector

Form PRNC- HPS (RS) 631

PUERTO RICO NUCLEAR CENTER

OPERATED BY THE UNIVERSITY OF PUERTO RICO

FOR THE UNITED STATES ATOMIC ENERGY COMMISSION

PUERTO RICO NUCLEAR CENTER ENVIRONMENTAL SURVEY

FIELD DATA SHEET

Area Designation ______ Data Sheet No. ______ Weather Data

Book No. ______________ Book Page _________ Temperature_____ Wind_______

Client ______________________ Humidity_______ Date_______

Precipitation ____________

Sample No.	Date	Time	Type	Latitude	Longitude	Remarks

To be completed on the field.

I, ___________________ certify that I have collected, marked and sealed the above samples in accordance with methods and procedures in the P.R.N.C. Radiological Survey sampling specifications dated __________________________.

To be completed at the Laboratory

I, ___________________ certify that the data on this sheet corresponds to that on the sample turned over to me by _____ __________ on this _________________day of ______________, 19____ and that I have inspected the samples and found them to be in good conditions, sealed and legally labelled.

__________________________ __________________________

Signature of Witness Signature of Storekeeper

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REMOVAL OF SAMPLE FROM STORAGE

I, ______________________________ certify that I have received Sample No. ________________ from ________ on this ______ day of ____________, 19____ in order to __________ ______________________________________. (Purpose of Removal).

____
Signature of Recipient

____
Signature of Storekeeper

____
Signature of Witness

FORM PRNC-HPS(RS)631c

SAMPLE DATA SHEET

TYPE: ________

Sample no. ______________________ Date and Time of Coll: ______________________

Area: ______________________ Sample Volume or Weight: ______________________

Survey Remarks: ______________________ Laboratory Remarks: ______________________

Date Sample Prepared: ______________________

ALPHA

Aliquot: ______________________ ml. or gm.

Date	Time	Instrument	Reg.	Lights	Total Counts	Counting Time	c/m	B.G. (c/m)	net c/m

Eff. Factor: ______________________

$$\frac{\text{net c/m}}{F \times A \times 2.22 \times 10^{6}} = \underline{\qquad\qquad} \mu c/\text{ml. or gm.}$$

BETA-GAMMA

Aliquot: ______________________ ml. or gm.

Date	Time	Instrument	Reg.	Lights	Total Counts	Counting Time	c/m	B.G. (c/m)	net c/m	
									$\alpha + \beta\gamma$	net $\beta-\gamma$

Eff. Factor: ______________________

$$\frac{\text{net c/m}}{F \times A \times 2.22 \times 10^{6}} = \underline{\qquad\qquad} \mu c/\text{ml. or gm.}$$

Special Analyses: ______________________

____
Signature

Form PRNC - HPS(RS) 632

PRNC ~~SAMPLES ANALYSIS~~ MONTHLY REPORT

Type of Sample: ______________ Collected by: ______________

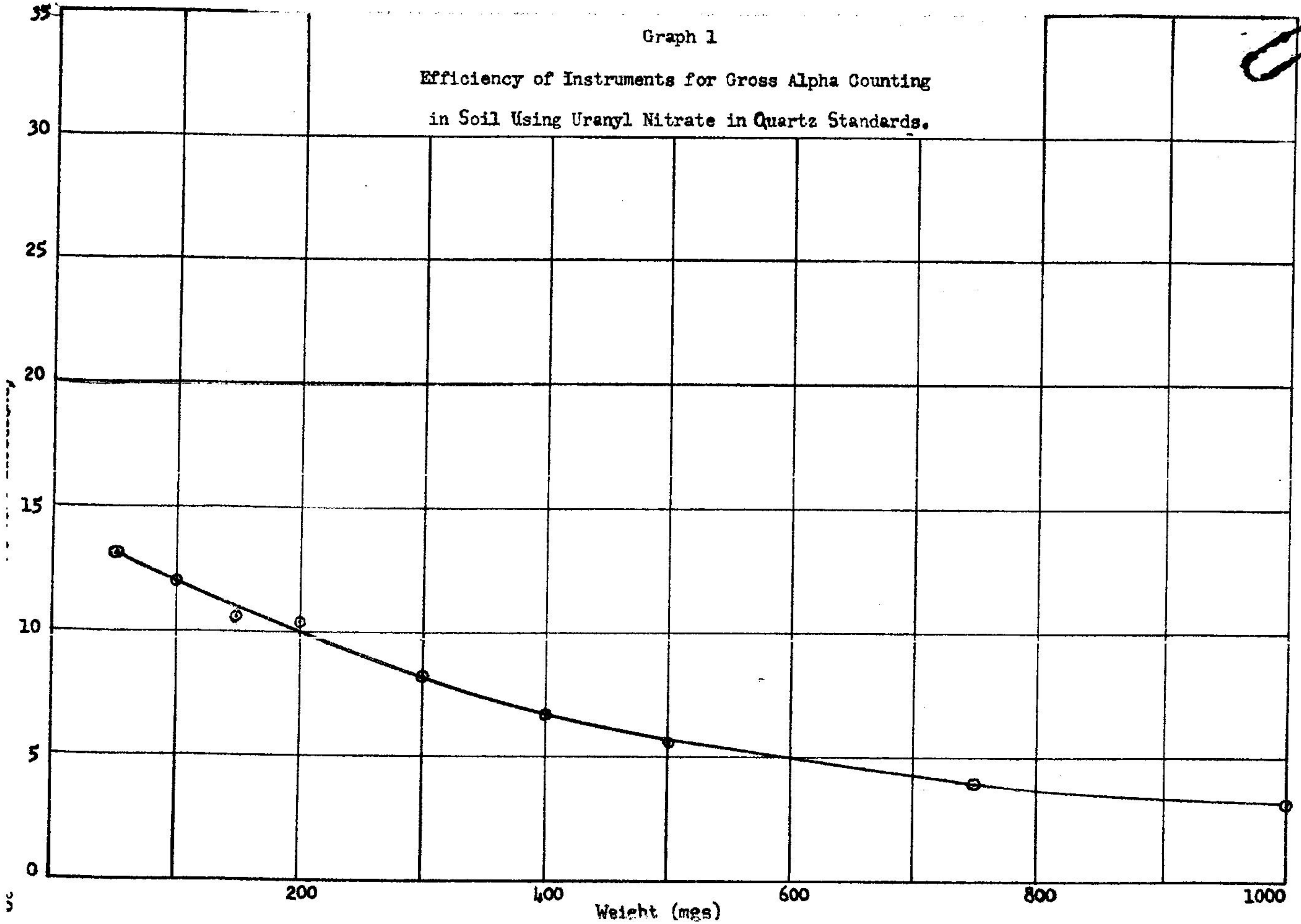
Analyzed by: ______________ Instrument Used: ______________ Date of Report: ______________

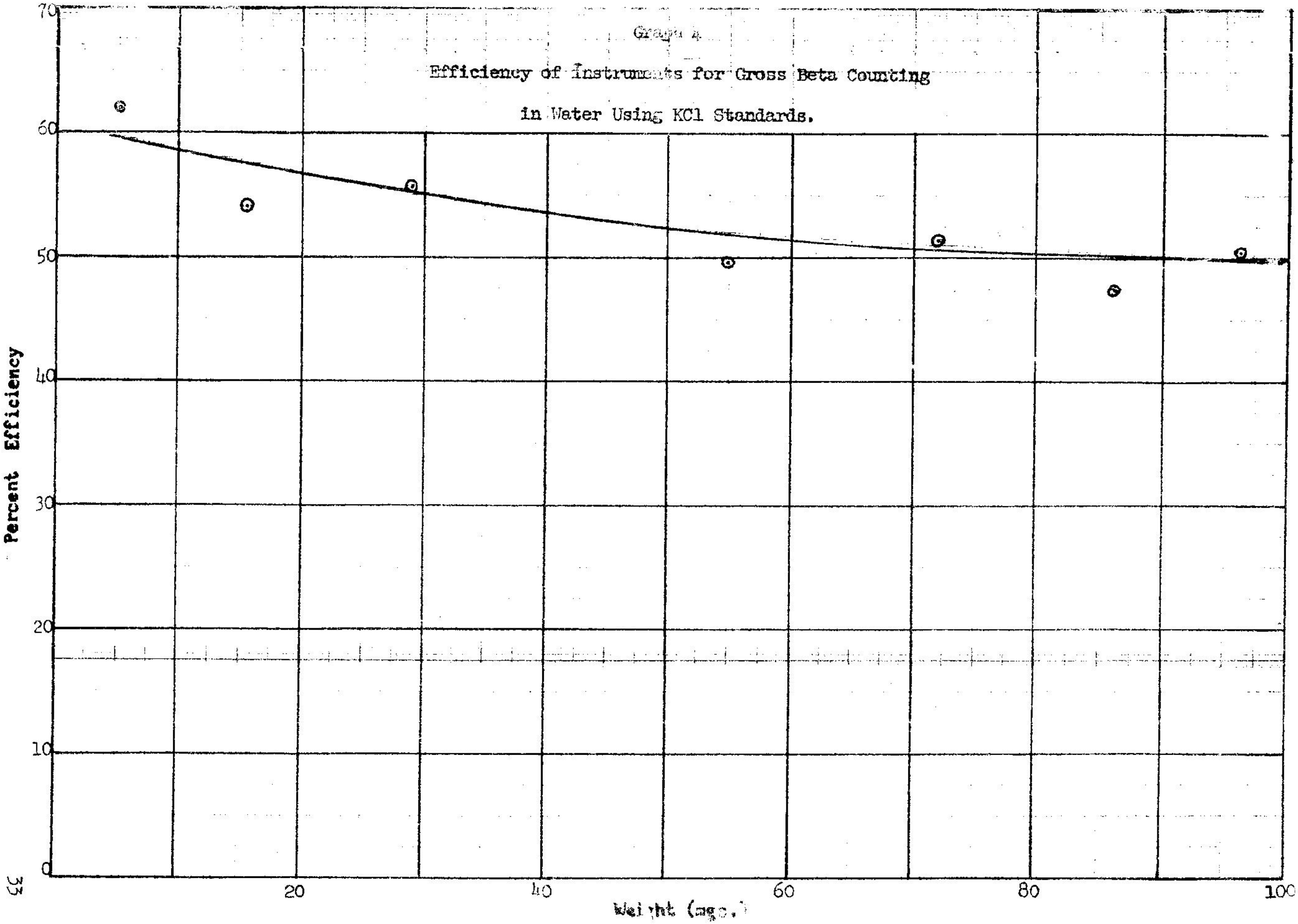
Sample No.	Date	Time	Identification	Quantity	Total Count	Counting Time	c/m	BG c/m	Analysis	Activity Microcuries/cc or g

Form PRNC-HPS (RS) 632 b

Graph 1

Efficiency of Instruments for Gross Alpha Counting in Soil Using Uranyl Nitrate in Quartz Standards.




Graph 4
Efficiency of Instruments for Gross Beta Counting
in Water Using KCl Standards.
Percent Efficiency
0
10
20
30
40
50
60
70
Weight (mgs.)
20
40
60
80
100