UNIVERSITY OF WASHINGTON
LABORATORY OF RADIATION BIOLOGY
FISHERIES CENTER
SEATTLE 5, WASHINGTON

400669

November 9, 1966

FROM 434-91-92 JO13 910 24F 8/10

Mr. Frank Cluff, Chief
Oversead Safety Group
Nevada Operations Office
U.S. Atomic Energy Commission
P. O. Box 1676
Las Vegas, Nevada 89101

Dear Frank:

Dr. Dunham called yesterday to ask that information relative to radioactivity at Bikini Atoll be sent to you for use at a meeting in Honolulu with members of the Trust Territory Government. From our telephone conversation yesterday, I understand that Mr. Bonnet, Manager of the AEC Honolulu Operations Office, will meet with Mr. W. R. Norwood of the Trust Territory on November 16.

The most recent data for Bikini Atoll were obtained by the Laboratory in August, 1964. A detailed report of this survey, much of which is pertinent to discussions regarding the repopulation of Bikini Atoll, was begun by Dr. R. F. Palumbo (deceased) and is now being completed by Dr. A. D. Welander. The complete report will be about 350 pages, three-fourths of which is now ready for reproduction.

Six pieces of information are included in this letter: (1) survey meter readings; (2) gamma-emitting radionuclides in the edible portion of land plants; (3) ^{90}Sr and calcium values for land plants, soils, rats, birds, algae, bottom sediments, invertebrates and fish; (4) a summary of average values for gamma-emitting radionuclides by sample type; (5) gamma-emitting radionuclides in the top inch of soil fines; (6) a copy of a letter of September 21, 1964 from Dr. Held of our Laboratory to Mr. Coleman of the Trust Territory. Items 1-5 were provided by Dr. Welander. The letter by Dr. Held expresses the general attitude of the Laboratory at that time and at present in regard to the re-settlement of Bikini Atoll.

5005198

(1713)

In reviewing the data it should be noted that where average values are given, these are arithmetic means and conservative values. The true mean is less than the arithmetic mean, since the distribution of radiological values is either Poisson or logarithmetic. Also it should be noted that some values are in terms of wet weights and others, dry weights. (For some samples wet weights are difficult to determine reliably). Wet to dry ratios for various types of samples are of the order of 4 to 10. Also, the average value such as given in (4) and the inherent errors associated with lumping things together without consideration for the errors within or between species and within or between areas.

The table of survey meter readings (1) lists maximum and average values at ground levels and at three feet above the ground, and for gamma and beta-gamma combined. The maximum value was 21 mr/hr for beta-gamma at ground level for an area about ten feet in diameter (not a crater) on Rumurikku Island. In my conversation with Dr. Dunham I commented that perhaps levels of radiation in a few small areas might require the establishment of exclusion areas, but upon looking at the other information from this area, this conclusion may not have been justified.

The table of ^{90}Sr values (3) does not list coconut crabs. Only one coconut crab was captured at Bikini in 1964 and the analyses of samples from this specimen were not completed before preparation of the table. The ^{90}Sr and ^{137}Cs values are as follows:

	^{90}Sr	^{137}Cs in pCi/g (dry)
Shell	2200	192
Muscle	(600 est.)	940
Liver		135

The analyses of the muscle sample for ^{90}Sr is in process, but based upon the ratio of ^{90}Sr in shell and muscle of Coenobita, a closely related crab, and in coconut crabs from Rongelap, a value of 600 pCi/g(dry) has been estimated. As you recall, coconut crab was the only food item forbidden to the Rongelapese when they return to their home island.

The values for radionuclides in soils that you asked for are given in Table (5). These are values for the gamma-emitting radionuclides. These samples have not been analyzed for plutonium. Todate, our plutonium analyses have been limited to Johnston Atoll samples.

The result of radiological analyses of Bikini samples and Rongelap samples were compared by inspection. The impression from this subjective comparison is that the levels of radioactivity are closely similar for the two atolls. Certainly the range of values for comparable samples overlap and on the basis of single samples, sometimes Bikini has the highest values, sometimes Rongelap. To refine the comparison much further would require extensive information on specimen, species and area variability.

We trust that this information, which is typical of the data that we have, will be helpful to you. We expect that the Bikini-Eniwetok report mentioned in the second paragraph will be completed next month.

Sincerely yours,

[illegible]:sk
Enc.

Allyn R. Seymour
Associate Director

cc: E.I. Durham
T.M. Dunning

5005192

1715

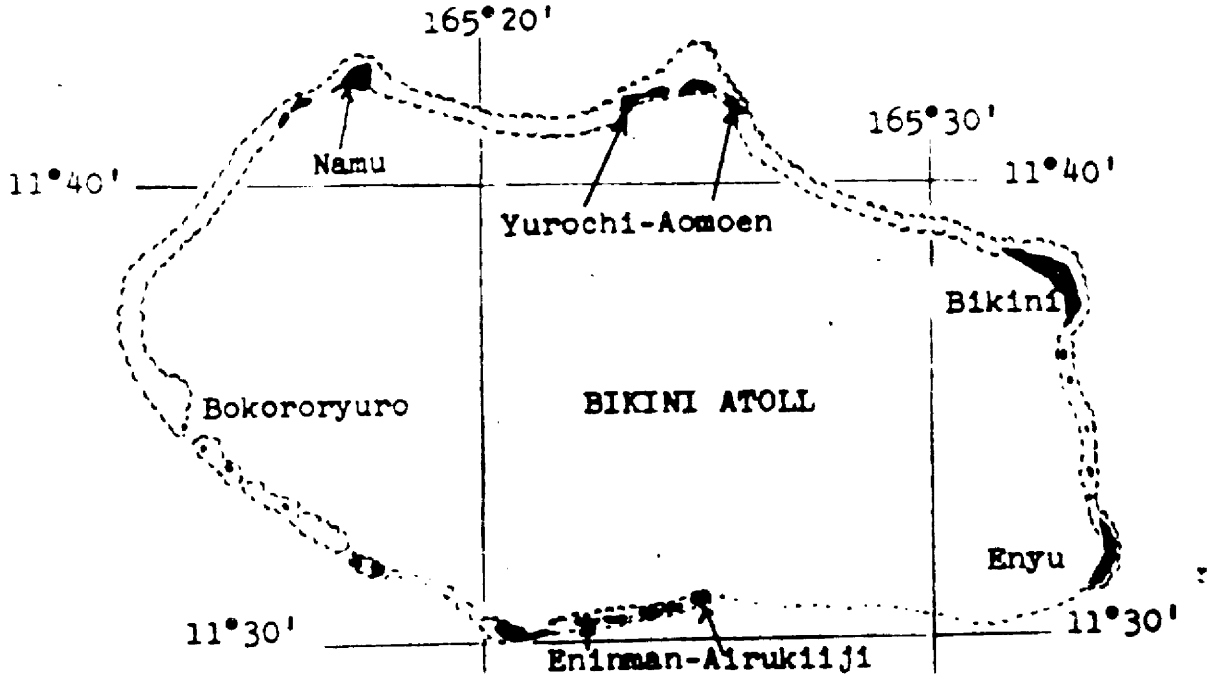

Fig. 1 Map of Bikini Atoll.

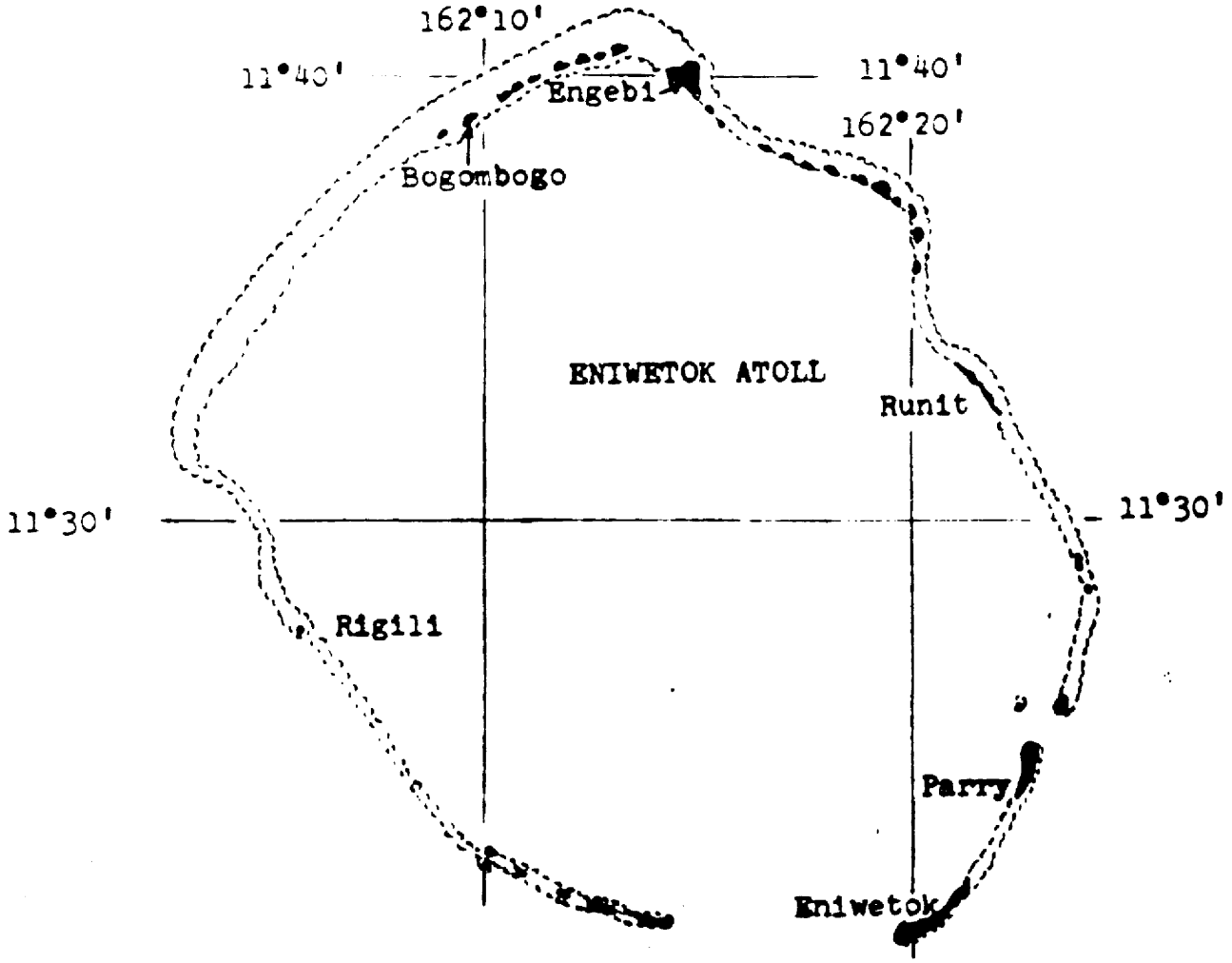

Fig. 2 Map of Eniwetok Atoll.

(1)

(117)

Radiation survey readings August 1964

Eniwetok Atoll	Maximum radiation level* at ground level γ	Maximum radiation level* at ground level β-γ	Average radiation level at ground level γ	Average radiation level at ground level β-γ	Average radiation level at 3' from ground level γ	Average radiation level at 3' from ground level β-γ
Runit I.	0.70	1.0	0.11	0.13	0.10	0.11
Rigili I.	0.02	0.04	0.01	0.03	0.02	0.02
Bogombogo I.	0.20	0.80	0.09	0.23	0.09	0.14
Engebi I.	0.10	0.70	0.05	0.22	0.04	0.08
Average	0.26	0.63	0.06	0.15	0.06	0.08
Bikini Atoll						
Enyu I.	0.02	0.04	0.02	0.03	0.01	0.02
Bikini I.	0.11	0.40	0.05	0.11	0.04	0.08
Aomoen to Yurochi I.	5.0	21.	0.30	1.1	0.16	0.60
Namu I.	0.27	0.65	0.11	0.24	0.09	0.18
Bokororyuro I.	0.15	0.95	0.03	0.50	0.07	0.28
Eninman to Airukiiji I.	2.2	2.9	0.23	0.34	0.15	0.21
Average	1.29	4.32	0.15	0.43	0.08	0.25
Rongelap Atoll						
Kabelle I.	0.09	0.52	0.05	0.22	0.04	0.11

*All readings are taken with a Nuclear Chicago survey meter, Model 2651, and are in mr/hr and are ± 0.01 mr/hr.

Table . Gamma-emitting radionuclides in the edible portions of land plants collected at Bikini and Eniwetok Atolls, August 1964. Values expressed as picocuries per gram of wet weight at time of collection.

Location	Species	Tissue	K^{40}	Mn^{54}	Co^{60}	Ru^{106}	Sb^{125}	Cs^{137}	Ce^{144}
Bikini Atoll									
Airukiiji	Coconut	Meat	2.2	0.10	0	0	0	4.4	0
Bikini	Coconut	Meat	1.1	0	0	0	0	26	0
	Tacca	Corms	1.5	0	0.12	1.8	0	50	0
	Pandanus	Fruits	5.2	0	0	0	0	180	0
Bokororyuro	Morinda	Fruits	2.0	0	0	0	0	19	0
Enyu	Coconut	Meat	2.8	0	0	0	0	6.4	0
	Tacca	Corms	2.3	0	0	0	0	3.1	0
Eniwetok Atoll									
Igurin	Coconut	Meat	2.6	0	0	0	0	0.39	0
Japtan	Coconut	Meat	2.6	0	0	0	0	0.48	0
Rigili	Coconut	Meat	3.3	0	0	0	0	12	0

Table . Strontium-90, strontium units and calcium content in land plants, soils, rats, birds, algae, bottom sediments, invertebrates and fish from Bikini Atoll, August 1964. Values in picocuries per gram of dry weight.

Island and group	Common name, and genus or species	Tissue	Sr^{90} pCi/g	Strontium units	Mg Ca/g
BIKINI I.					
Soil	0-1/2" Pit 11		1800±110*	7100±440	250
	1/2"-1" Pit 11		1300±82	4800±300	270
	5"-6" Pit 11		5.6±0.38	17±1.2	320
	10"-11" Pit 11		0.021±0.077	0.073±0.26	290
	15"-20" Pit 11		0.072±0.050	0.33±0.23	220
	20"-26" Pit 11		0.16±0.055	0.052±0.18	300
	0-1/2" Pit 12		58±3.6	180±11	320
	1/2"-1" Pit 12		60±3.7	180±11	340
	5"-6" Pit 12		18±1.1	48±3.0	370
	10"-12" Pit 12		0.49±0.11	1.5±0.33	320
	15"-20" Pit 12		0.34±0.086	1.1±0.27	320
Land plants					
	Arrow root *Tacca leontopetaloides*	Whole corm	0.34±2.1	6900±430	5.00
	Cocos nucifera	Meat	0.90±0.069	1300±97	0.71

* Counting error

Table , continued

Island and group	Common name, and genus or species	Tissue	Sr^{90} pCi/g	Strontium units	Mg Ca/g
BIKINI I.					
Land plants					
	Fimbristylis atollensis		38±2.4	5000±310	7.6
	Guettarda speciosa	Leaves, basal	301±19	16,000±1000	19
	Guettarda speciosa	Leaves, terminal	230±14	16,000±980	15
	Ipomoea sp.		130±8.0	12,000±760	11
	Messerschmidia argentea	Leaves, basal	245±15	4700±290	52
	Messerschmidia argentea	Leaves, terminal	170±10	4700±290	35
	Pandanas sp.	Fruit	160±10	9300±580	17
	Pandanas sp.	Leaves	120±7.4	7200±450	17
	Pisonia grandis	Leaves	420±26	11,000±700	38
	Scaevola frutescens	Leaves, basal	82±5.1	3500±220	23
	Scaevola frutescens	Leaves, terminal	80±5.0	4200±260	19
Rats	Rattus exulans	Bone	290±19	1500±96	200
	Rattus exulans	Muscle	1.4±0.24	2000±340	0.70
	Rattus rattus	Bone	340±22	1600±100	210
	Rattus rattus	Muscle	1.2±0.20	5100±850	0.23

Table , continued

Island and group	Common name, and genus or species	Tissue	Sr^{90} pCi/g	Strontium units	Mg Ca/g
BIKINI I.					
Birds	Fairy tern *Gygis alba*	Bone	2.6±0.42	100±17	25
	Fairy tern *Gygis alba*	Muscle	0.92±0.17	4400±790	0.21
Invertebrates					
	Clam *Tridacna crocea*	Muscle	0.18±0.12	189±124	0.95
ENYU I.					
Invertebrates					
	Hermit crab *Coenobita*	Muscle	76±7.4	5400±530	14
	Hermit crab *Coenobita*	Shell	630±55	4000±350	160
NAMU I.					
Birds	Ruddy turnstone *Arenaria interpres*	Bone	41±3.7	250±23	160
	Ruddy turnstone *Arenaria interpres*	Muscle	0.12±0.11	360±330	0.33
Invertebrates					
	Hermit crab *Coenobita*	Muscle	80±7.3	7100±650	11
	Hermit crab *Coenobita*	Shell	270±24	1400±120	190

Table , continued

Island and group	Common name, and genus or species	Tissue	Sr^{90} pCi/g	Strontium units	Mg Ca/g
AOMOEN-ROMUK-YUROCHI I.					
Invertebrates	Hermit crab *Coenobita*	Muscle	31±3.2	1700±170	18
	Hermit crab *Coenobita*	Shell	200±17	990±87	200
BOGOMBOGO I.					
Fish	Triggerfish *Rhineacanthus aculeatus*	Muscle	0.34±0.19	110±61	3.2
ENGEBI I.					
Fish	Mullet *Chelon vaigiensis*	Muscle	1.2±0.25	530±110	2.3
Rats	*Rattus rattus*	Bone	280±25	1600±140	180
	Rattus rattus	G.I. tract & content	37±3.3	2300±210	16
	Rattus rattus	Kidney	4.5±0.76	5200±880	0.87
	Rattus rattus	Liver	0.87±0.21	1800±420	0.49
	Rattus rattus	Muscle	1.5±0.17	1700±190	0.88
	Rattus rattus	Skin	2.3±0.32	1600±220	1.5
	Rattus rattus	Testis	0.64±0.41	650±420	0.98

Table , continued

Island and group	Common name, and genus or species	Tissue	Sr^{90} pCi/g	Strontium units	Mg Ca/g
ENGEBI I.					
Birds	Ruddy turnstone *Arenaria interpres*	Gut	18±1.7	4900±470	3.6
	Ruddy turnstone *Arenaria interpres*	Kidney	1.70±0.53	1400±460	1.2
	Ruddy turnstone *Arenaria interpres*	Liver	0.74±0.19	2100±530	0.35

Table . Radionuclide content of various biological and physical systems at Bikini Atoll, August 1964. Values for water are expressed as pCi/liter and values for all others as pCi/gram dry weight.

Type	Mn^{54}	Co^{57}*	Co^{60}	Zn^{65}	Sr^{90}	Ru^{106}	Sb^{125}	Cs^{137}	Ce^{144}	Bi^{207}
Seawater										
Lagoon	0	0	0.73	0	0.42	0	0	12.	-	-
Bravo Crater	0	0.97	5.5	0	67.	0	9.5	97.	-	1.0
Sediments										
Lagoon	1.1	2.4	6.7	-	-	3.5	1.1	0.075	-	0.84
Bravo Crater	26.	92.*	260.	-	-	280.	99.	0	-	180.
Plankton	0	5.0	100.	0	-	4.8	0	0	-	0
Algae	2.5	-	8.8	0	-	6.1	0.34	0.56	47.	0.46
Invertebrates	18	142	781	4.2		2.8	.15	42	6.0	.08
Fish	2.9	1.1	18.	1.2	-	0.038	0	1.2	-	0
Groundwater**	0	-	27	12.	-	68	350	13	0	0
Soils	1.7	-	49.	-	1550	38.	41	170	21.	1.4
Land Plants	17.	-	3.9	-	150.	0.14	0	230	8.2	3.8
Rats	0	-	2.0	-	46.	0	0	260	6.1	0.16
Birds, Sea	1.9	0.058	4.6	1.4	1.8	0	0	0	-	0
Birds, Shore	0.055	0	41.	0	21.	1.6	0.43	370	-	4.9

* Cerium-144 and Europium-155 also contribute to the radioactivity in this column.

** Practically all due to high counts in Namu Island groundwater (near Bravo Crater).

Table . Gamma-emitting radionuclides in the top inch of soil fines from Bikini Atoll, August 1964. Values expressed as picocuries per gram of dry weight at time of collection.

Location	Pit no.	K^{40}	Mn^{54}	Co^{60}	Ru^{106}	Sb^{125}	Cs^{137}	Ce^{144}	Bi^{207}
Aomoen I.	14	0	1.3	7.2	8.0	4.7	3.5	14.	0.29
Bikini I.	11	0	0	85.	0	120.	1300.	0	0
	12	0	0	7.8	4.9	8.9	120.	0	0
Biqiren I.	20	0	0	0.44	0	0	0	0	0.11
Bokororyuro I.	18	0	1.4	30.	42.	51.	40.	94.	0
Eninman I.	19	0	1.2	16.	7.5	0	2.8	19.	0.16
Enyu I.	9	0	0.65	3.8	2.7	2.5	38.	0	1.8
	10	0	0	2.0	0	1.6	44.	0	0
Namu I.	16	0	6.5	120.	100.	76.	100.	120.	3.4
	17	0	0	250.	220.	160.	200.	0	11.
Romurikku I.	13	0	0.67	5.6	5.4	4.6	5.6	0	0.50
Yurochi I.	15	0	8.4	61.	70.	58.	140.	0	0
Average		0	1.7	49.	38.	41.	170.	21.	1.4