ENVIRONMENTAL MONITORING

SEMIANNUAL REPORT

JULY 1, 1968 TO DECEMBER 31, 1968

AND

ANNUAL REPORT

1968

by

J. D. Moore

APPROVED: W. F. Heine

W. F. Heine
Supervisor,
Operational Safety Unit

CONTENTS

TABLES

CONTENTS - TABLES (continued) Page

FIGURES

ABSTRACT

Environmental monitoring at Atomics International is performed by the Operational Safety Unit of the Health, Safety and Radiation Services Department. Soil, vegetation, water, and air are routinely sampled up to a distance of 10 miles from Atomics International property. The environmental radioactivity reported herein is attributed to natural causes and to nuclear weapons testing, rather than to Atomics International operations.

I. SUMMARY

Atomics International, a Division of North American Rockwell Corporation, has been engaged in atomic energy research and development since 1946. The Company designs, develops, and constructs nuclear reactors for central station and compact power plants and for medical, industrial, and scientific applications.

The Company occupies modern facilities in Canoga Park, California, approximately 23 miles northwest of downtown Los Angeles (Figure 1). The 290 acre Nuclear Development Field Laboratory (Figure 2), equipped with extensive facilities for the support of advanced nuclear studies, is located in the Simi Hills of Ventura County approximately 29 miles northwest of downtown Los Angeles. The location of the sites in relation to nearby communities is shown in Figure 3.

The basic concept of radiological hazards control at Atomics International requires adequate containment of radioactive materials, and, through rigid operational controls, minimizes effluent releases and external radiation levels. The environmental monitoring program provides a measure of the effectiveness of the Company's radiological safety procedures and of engineering safeguards incorporated into facility designs.

Environmental sampling stations located within the boundaries of Atomics International's sites are referred to as "on-site" stations. The remaining stations, located within a 10 mile radius of the sites, are referred to as "off-site" stations. The on-site environs of Atomics International's Headquarters and Nuclear Development Field Laboratory (NDFL) facilities are sampled monthly

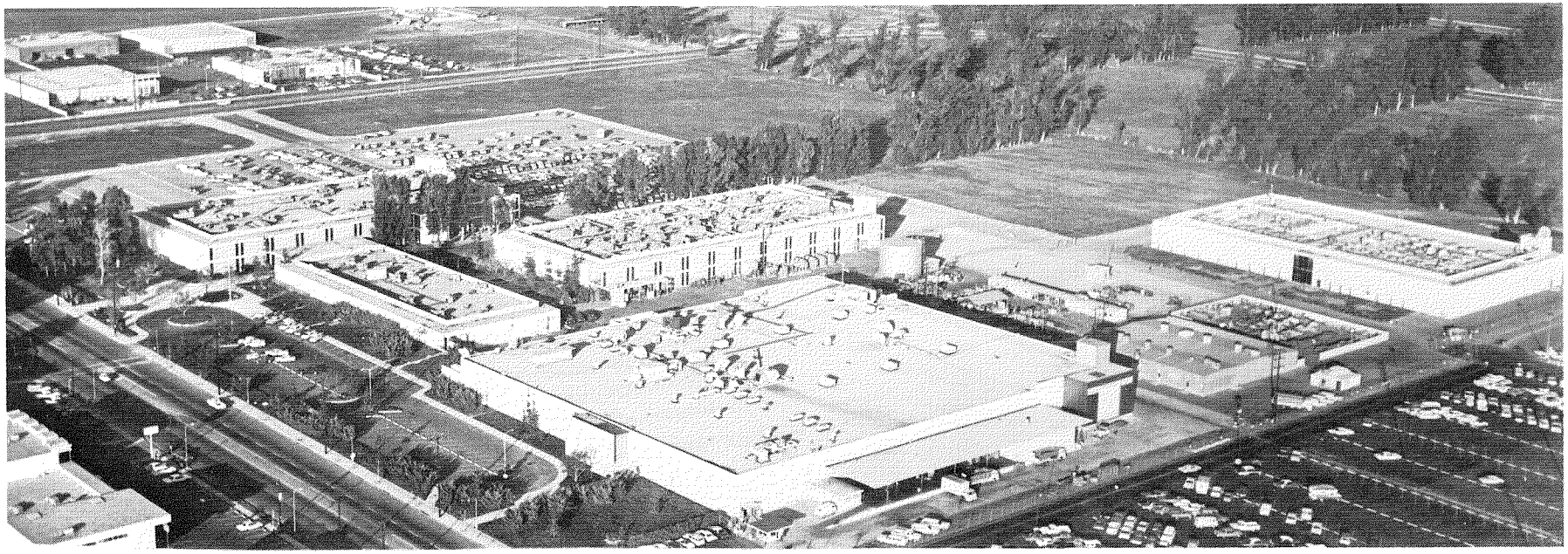

Figure 1. Atomics International Headquarters

Figure 2. Atomics International Nuclear Development Field Laboratory.

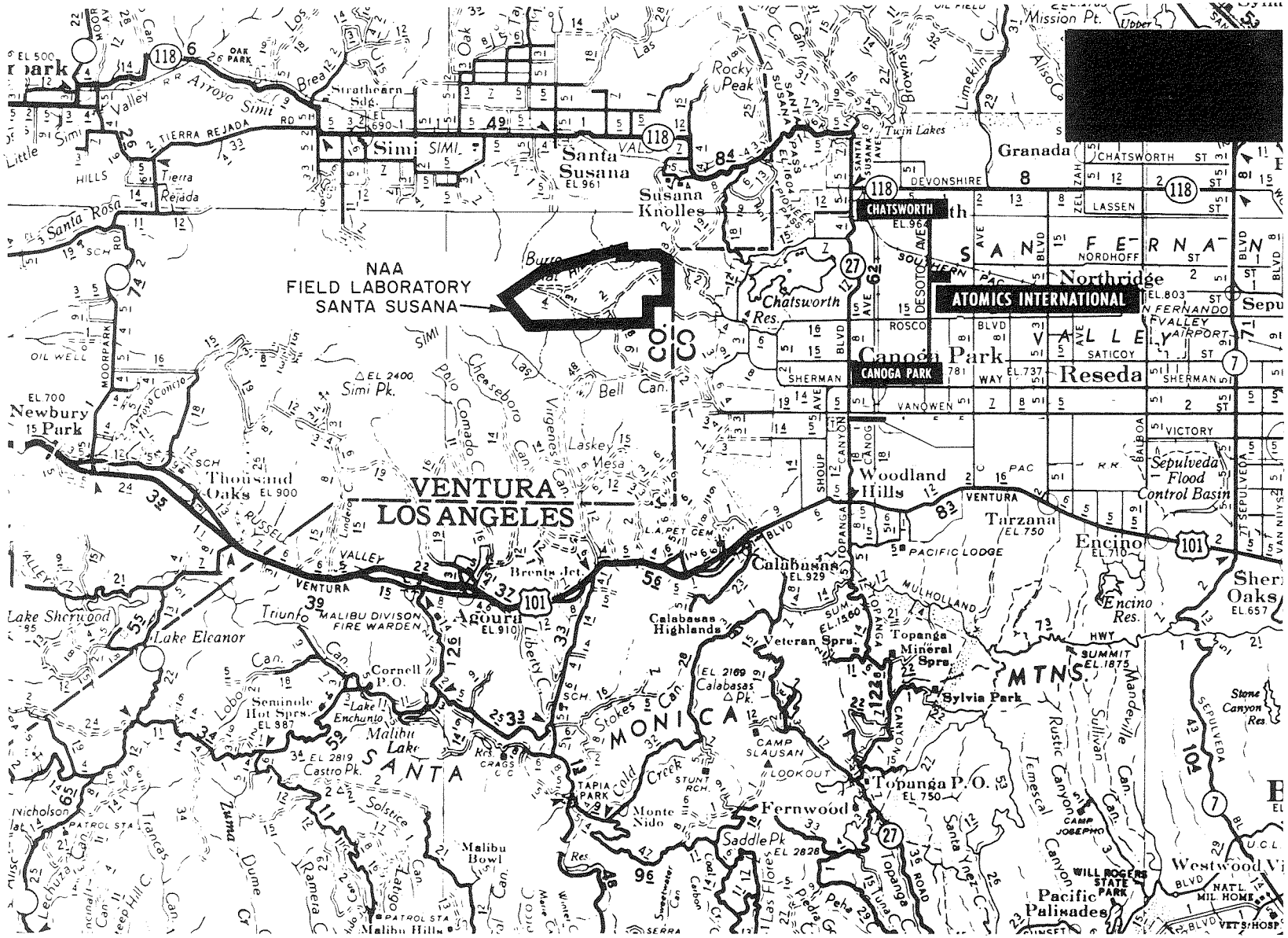

Figure 3. Map of Headquarters and Nuclear Development Field Laboratory Environs.

to determine the concentration of radioactivity in typical surface soil, vegetation, and water samples. The off-site environs are also sampled monthly; however, since January, 1966, analysis of off-site soil and vegetation samples has been performed only quarterly. Also continuous on-site environmental air sampling provides information concerning long-lived airborne particulate radioactivity. This report summarizes environmental monitoring results for the last six months of 1968 and compares the 1968 results with previous years.

A. ENVIRONMENTAL RADIOACTIVITY DATA - 1968

The average radioactivity concentrations in soil and vegetation samples are presented in Tables I and II.

TABLE I

SOIL RADIOACTIVITY DATA - 1968

Area	Activity	First Half - 1968		Last Half - 1968	
		No. Samples	Average pCi/gram	No. Samples	Average pCi/gram
On Site	α	72	0.47	72	0.46
	$\beta\ \gamma$	72	25	72	27
Off Site	α	24	0.50	24	0.47
	$\beta\ \gamma$	24	24	24	26

TABLE II

VEGETATION RADIOACTIVITY DATA - 1968

Area	Activity	First Half - 1968		Last Half - 1968	
		No. Samples	Average pCi/gram-ash	No. Samples	Average pCi/gram-ash
On Site	α	72	0.55	72	0.47
	$\beta\ \gamma$	72	177	72	139
Off Site	α	24	0.55	24	0.46
	$\beta\ \gamma$	24	273	24	138

Process water used at the NDFL is obtained from Ventura County Water District No. 10 and distributed on-site by the same piping system previously used when process water was supplied by on-site wells. Pressure is provided by elevated storage tanks, one 50,000 gallon and one 500,000 gallon tank on-site. While clinically potable, the water is not used for drinking. Bottled potable water is delivered by a vendor and is not analyzed. Water from the pipe system is sampled monthly at two locations. The average process water radioactivity concentration is presented in Table III.

TABLE III

NDFL PROCESS WATER RADIOACTIVITY DATA - 1968

Area	Activity	First Half - 1968		Last Half - 1968	
		No. Samples	Average pCi/Liter	No. Samples	Average pCi/Liter
NDFL	α	12	0.18	12	0.14
	$\beta\ \gamma$	12	4.9	12	5.1

Surface discharged waters from NDFL facilities drain into holding reservoirs on Rocketdyne PFL property. When full, the main reservoir is drained into Bell Creek, a tributary of the Los Angeles River in the San Fernando Valley, Los Angeles County. Pursuant to the requirements of Los Angeles Regional Water Quality Control Board Resolution 66-49 of September 21, 1966, an environmental sampling station has been established in Bell Creek Canyon approximately 3.4 miles downstream from the south North American Rockwell Corporation boundary. Samples,

obtained and analyzed monthly, include stream bed mud, vegetation, and water. Average radioactivity concentrations in Rocketdyne Reservoir and Bell Creek samples are presented in Table IV.

TABLE IV

BELL CREEK AND ROCKETDYNE PFL RESERVOIR

RADIOACTIVITY DATA - 1968

Sample Description	First Half - 1968			Last Half - 1968		
	No. Samples	α	$\beta\gamma$	No Samples	α	$\beta\gamma$
Bell Creek Mud (pCi/gram)	5	0.31	23	6	0.33	25
Bell Creek Vegetation (pCi/gram-ash)	5	0.35	171	6	0.42	169
Bell Creek Water (pCi/Liter)	5	0.07	4.3	3	0.02 to 0.04	5.2
Reservoir Station 6 Water (pCi/Liter)	6	0.26	7.1	5	0.19	9.3
Reservoir Station 12 Water (pCi/Liter)	6	0.58	8.4	6	0.08	7.1

Soil, vegetation, and water are sampled monthly at the Chatsworth Reservoir, which is owned and operated by the Los Angeles City Department of Water and Power. Soil and vegetation radioactivity data for the reservoir are averaged into the off-site data presented in Tables I, II, VII, and VIII. Normally, one water sample is obtained from the lake surface and another obtained from the reservoir water supply inlet located on the north side of the lake. The average radioactivity concentration in reservoir surface and supply water is presented in Table V.

TABLE V

CHATSWORTH RESERVOIR WATER RADIOACTIVITY DATA - 1968

Sample Type	Activity	First Half - 1968		Last Half - 1968	
		No. Samples	Average pCi/Liter	No. Samples	Average pCi/Liter
Lake Surface	α	6	0.42	6	0.22
	$\beta\ \gamma$	6	7.9	6	6.2
Supply Inlet	α	6	0.15	6	0.30
	$\beta\ \gamma$	6	4.5	6	4.9

Environmental air sampling for long-lived particulate radioactivity is performed continuously at both the Headquarters and NDFL sites. Air is drawn through a filter which is analyzed, after a 72-hour decay period, for long-lived radioactivity. The average concentration of long-lived beta-gamma radioactivity is presented in Table VI.

TABLE VI

AIRBORNE RADIOACTIVITY DATA - 1968

Site	Activity	First Half - 1968		Last Half - 1968	
		No. Samples	Average pCi/m^3	No. Samples	Average pCi/m^3
Hqs.	$\beta\ \gamma$	301	0.48	349	0.18
NDFL	$\beta\ \gamma$	1062	0.47	1095	0.17

Table I shows no significant change during the last six months of 1968 in soil radioactivity. Table II shows a moderate decrease in vegetation alpha radioactivity and a considerable decrease in vegetation beta-gamma radioactivity. Table III shows that NDFL process water alpha radioactivity decreased and that beta-gamma radioactivity increased slightly. Table IV shows that

Bell Creek mud radioactivity increased slightly, that Bell Creek vegetation alpha radioactivity increased and that vegetation beta-gamma radioactivity decreased slightly. Table IV also shows that water alpha radioactivity decreased in Bell Creek and reservoir stations 6 and 12 samples, and increased in Bell Creek and Station 6 beta-gamma radioactivity. Station 12 water beta-gamma radioactivity decreased. Table V shows that the Chatsworth Reservoir lake surface water radioactivity decreased and that supply water radioactivity increased during the last half of 1968. Table VI shows a considerable decrease in local airborne beta-gamma radioactivity concentrations during the same period.

B. COMPARISON OF ENVIRONMENTAL RADIOACTIVITY DATA FOR 1968 WITH PREVIOUS YEARS

This section summarizes the environmental monitoring results for the calendar year 1968. Also, annual averages for the years 1959 through 1967 are included with the exception of the Rocketdyne Reservoir, Bell Canyon, and Chatsworth Reservoir. The annual average radioactivity in soil and vegetation is presented in Tables VII and VIII.

TABLE VII

SOIL RADIOACTIVITY DATA - 1959 THROUGH 1968

VII.a. ALPHA RADIOACTIVITY

Year	On Site		Off Site	
	No. Samples	Average pCi/gram	No. Samples	Average pCi/gram
1968	144	0.47	48	0.48
1967	144	0.41 to 0.42	48	0.38 to 0.39
1966	144	0.40 to 0.41	48	0.43 to 0.44
1965	144	0.46	142	0.46 to 0.47
1964	152	0.44 to 0.46	299	0.40 to 0.44
1963	156	0.41 to 0.43	455	0.38 to 0.42
1962	147	0.42 to 0.44	453	0.35 to 0.41
1961	120	0.30 to 0.37	458	0.24 to 0.33
1960	115	0.34 to 0.41	362	0.27 to 0.37
1959	107	0.43	377	0.32

VII.b. BETA-GAMMA RADIOACTIVITY

Year	On Site		Off Site	
	No. Samples	Average pCi/gram	No. Samples	Average pCi/gram
1968	144	26	48	26
1967	144	28	48	24
1966	142	29	48	25
1965	144	36	142	29
1964	146	32	293	26
1963	156	45	455	42
1962	147	48	453	47
1961	120	34	458	23
1960	114	23	360	19
1959	107	15	379	14

TABLE VIII

VEGETATION RADIOACTIVITY DATA - 1959 THROUGH 1968

VIII.a. ALPHA RADIOACTIVITY

Year	On Site		Off Site	
	No. Samples	Average pCi/gram-ash	No. Samples	Average pCi/gram-ash
1968	144	0.51	48	0.51
1967	144	0.61 to 0.62	48	0.38 to 0.39
1966	144	0.37	48	0.37
1965	144	0.55 to 0.56	142	0.61
1964	154	0.49 to 0.50	293	0.50 to 0.51
1963	156	0.43 to 0.44	456	0.36 to 0.37
1962	147	0.44 to 0.45	453	0.42 to 0.44
1961	120	0.32 to 0.35	459	0.26 to 0.29
1960	115	0.31 to 0.35	362	0.21 to 0.25
1959	96	0.29	293	0.18

VIII.b. BETA-GAMMA RADIOACTIVITY

Year	On Site		Off Site	
	No. Samples	Average pCi/gram-ash	No. Samples	Average pCi/gram-ash
1968	144	158	48	205
1967	144	286	48	413
1966	144	169	48	123
1965	144	162	142	138
1964	148	211	299	181
1963	156	465	456	388
1962	147	500	453	406
1961	120	224	459	246
1960	113	137	358	136
1959	107	212	380	168

The annual average radioactivity in NDFL process water is presented Table IX.

TABLE IX

NDFL PROCESS WATER RADIOACTIVITY DATA - 1959 THROUGH 1968

	Alpha		Beta-Gamma	
Year	No. Samples	Average pCi/Liter	No. Samples	Average pCi/Liter
1968	24	0.16	24	5.0
1967	24	0.12 to 0.13	24	6.1
1966	24	0.12 to 0.13	24	4.4 to 4.8
1965	24	0.21 to 0.22	24	5.9 to 6.0
1964	23	0.16 to 0.18	23	5.1 to 5.3
1963	24	0.17 to 0.18	24	6.9 to 7.0
1962	24	0.20 to 0.21	24	12
1961	24	0.06 to 0.09	24	2.2 to 3.6
1960	22	0.06 to 0.09	22	1.0 to 2.7
1959	18	0.08	16	1.6

The annual average radioactivity in the Rocketdyne PFL Reservoir and Bell Creek samples is presented in Table X.

TABLE X

BELL CREEK AND ROCKETDYNE PFL RESERVOIR RADIOACTIVITY DATA

Sample Description	1966			1967			1968		
	No. Samples	α	$\beta\gamma$	No. Samples	α	$\beta\gamma$	No. Samples	α	$\beta\gamma$
Bell Creek Mud (pCi/gram)	3	0.39	25	12	0.40	24	11	0.32	24
Bell Creek Vegetation (pCi/gram-ash)	3	1.12 to 1.14	108	12	0.37 to 0.38	180	11	0.39	170
Bell Creek Water (pCi/Liter)	3	0.60 to 0.90	0 to 2.5	12	0.06 to 0.08	5.7 to 5.9	8	0.04 to 0.06	4.5 to 4.8
Reservoir Station 6 Water (pCi/Liter)	9	0.10 to 0.12	5.8	12	0.19	6.6	11	0.23	8.1
Reservoir Station 12 Water (pCi/Liter)	8	1.0 to 1.1	6.3	10	0.16 to 0.17	7.0	12	0.33	7.7

The annual average radioactivity in Chatsworth Reservoir water is presented in Table XI.

TABLE XI

CHATSWORTH RESERVOIR WATER RADIOACTIVITY DATA

1961 THROUGH 1968

	Lake Surface			Supply Inlet		
Year	No. Samples	Average pCi/Liter α	$\beta\ \gamma$	No. Samples	Average pCi/Liter α	$\beta\ \gamma$
1968	12	0.32	7.0	12	0.23	4.6 to 4.8
1967	12	0.31	8.1	12	0.28	6.0
1966	12	0.32	5.9	12	0.42	5.9
1965	11	0.65	8.7	12	0.61	8.8 to 9.1
1964	18	0.71	10	12	0.49	8.8
1963	37	0.84	18	12	0.57 to 0.58	9.0 to 9.2
1962	41	0.66 to 0.67	19	12	0.50	13
1961	38	0.52	11	10	0.28	7.7 to 8.0

The annual average concentrations of long-lived airborne radioactivity at Headquarters and the NDFL are presented in Table XII.

TABLE XII

AIRBORNE RADIOACTIVITY DATA

1959 THROUGH 1968

$\beta\ \gamma$

	Headquarters		NDFL	
Year	No. Samples	Average pCi/m^3	No. Samples	Average pCi/m^3
1968	650	0.32	2157	0.32
1967	712	0.38 to 0.40	2400	0.40 to 0.41
1966	706	0.17 to 0.18	2205	0.16 to 0.17
1965	483	0.83	1062	0.21
1964	355	2.7	Insufficient Data	
1963	360	6.6	292	4.7
1962	343	7.3	314	5.6
1961	313	4.2	176	3.6
1960	182	0.24	44	0.44
1959	215	2.5	257	0.93

Some of the data presented in the tables are presented as a range within which lies the true average. This is necessary when one or more of the samples contains an "undetectable" amount of radioactivity. In these instances, two values are determined. The lowest assumes that the "undetectable" samples contain no radioactivity; the highest assumes that these samples contain radioactivity equal to the appropriate minimum detection limit specified in Table XIV.

Radioactivity concentrations in most sample types are generally commensurate with the concentrations experienced in 1967, the exception being in vegetation beta-gamma radioactivity which decreased considerably over the 1967 average value. The environmental sample radioactivity concentrations reported and discussed herein are not attributed to Atomics International's operations; rather it is felt to have been produced after September 1, 1961, by several world-wide nuclear detonations.

II. ENVIRONMENTAL MONITORING PROGRAM

A. GENERAL DESCRIPTION

Soil and vegetation sample collection and analysis were initiated in 1952 in the Downey, California area where the Company was initially located. Environmental sampling was subsequently extended to the proposed Sodium Reactor Experiment (SRE) site in the Simi Hills in May of 1954. In addition, sampling was conducted in the Burro Flat area, southwest of SRE, where many nuclear installations are currently in operation. The Downey area survey was

terminated when the Company relocated to Canoga Park. The primary purpose of the environmental monitoring program is to survey environmental radioactivity adequately to ensure that Atomics International operations do not contribute measurably to environmental radioactivity.

A study of past data showed that this purpose could be achieved with a less extensive environmental monitoring program than that which existed until July, 1964. Therefore, beginning with that month, the number of sampling stations was reduced considerably. In addition, since January, 1966, off-site environmental survey samples have been analyzed only quarterly; on-site samples continue to be analyzed monthly. The locations of sampling stations are shown in Figures 4, 5, 6, and 7, and in Table XIII.

TABLE XIII

SAMPLE STATION LOCATIONS

STATION	LOCATION
SV-1	SRE Reactor, NDFL
SV-2	SRE Perimeter Drainage Ditch, NDFL
SV-3	Bldg. 064 Parking Lot, NDFL
SV-4	Bldg. 020, NDFL
SV-5	Bldg. 363, NDFL
SV-6	Rocketdyne Reservoir, PFL
SV-10	Santa Susana Site Access Road
SV-12	KEWB Reactor, NDFL
SV-13	Sodium Cleaning Pad, NDFL
SV-14	Canyon Below Bldg. 022, NDFL

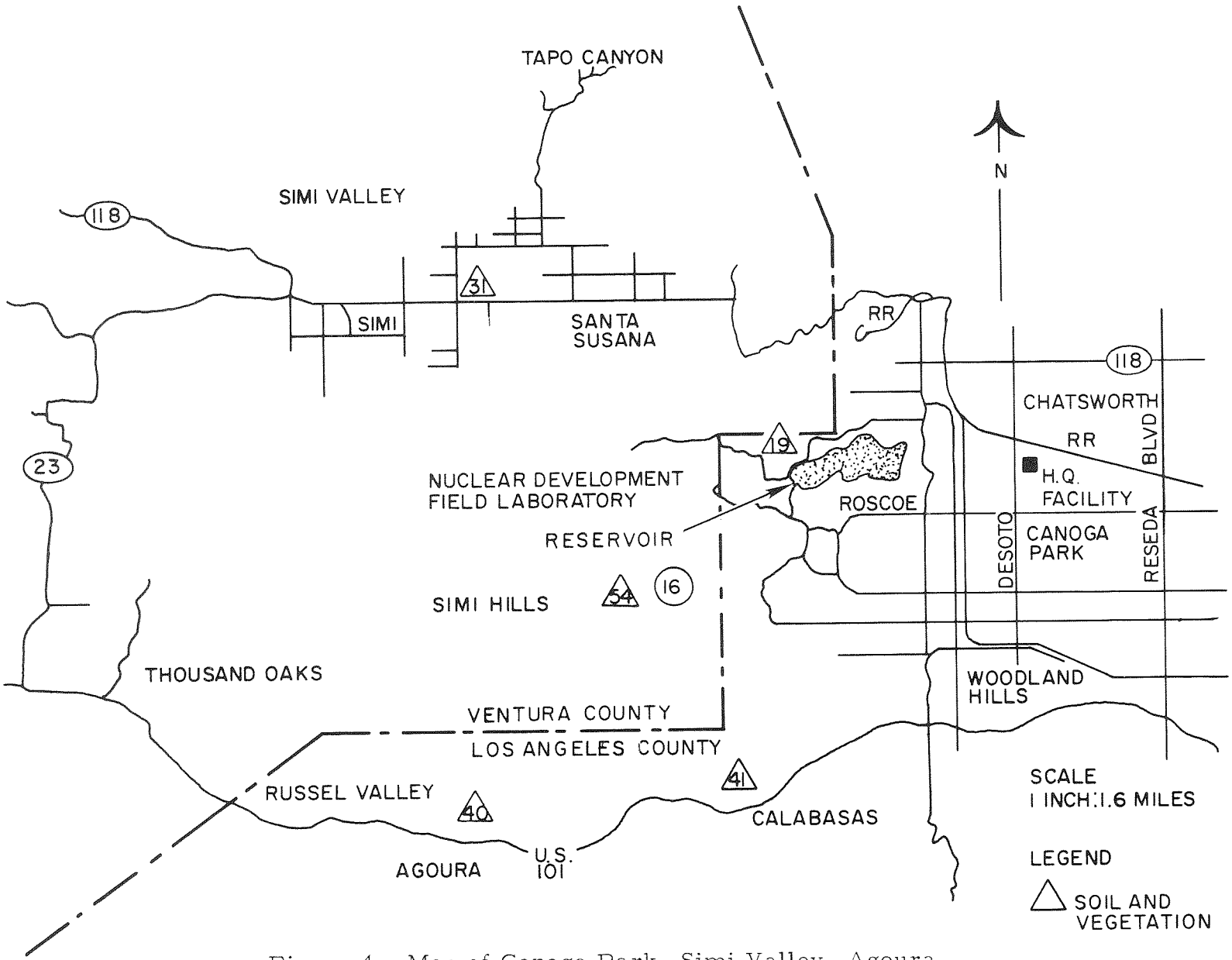

Figure 4. Map of Canoga Park, Simi Valley, Agoura, and Calabasas Sampling Stations

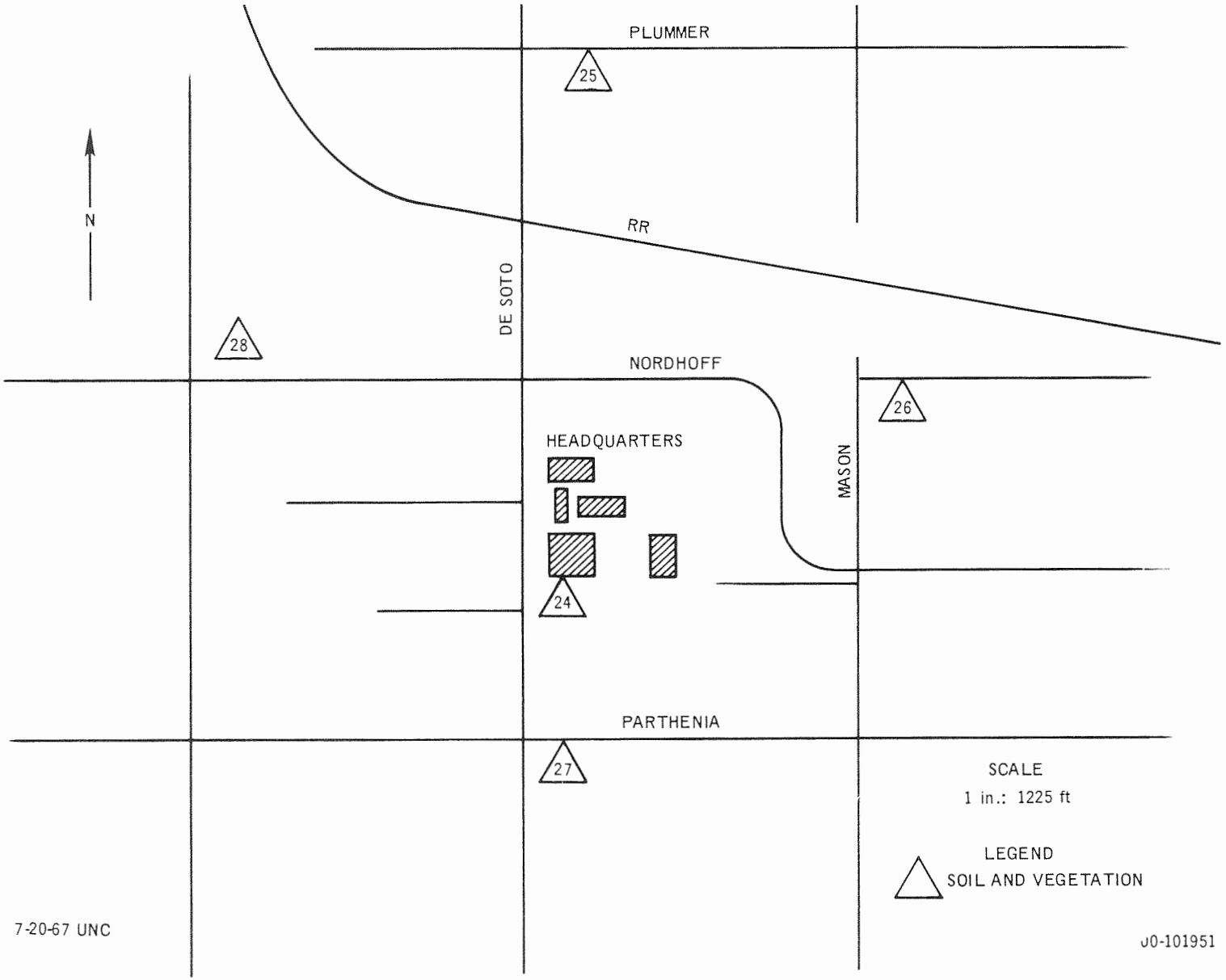

Figure 5. Map of Headquarters Vicinity Sampling Stations

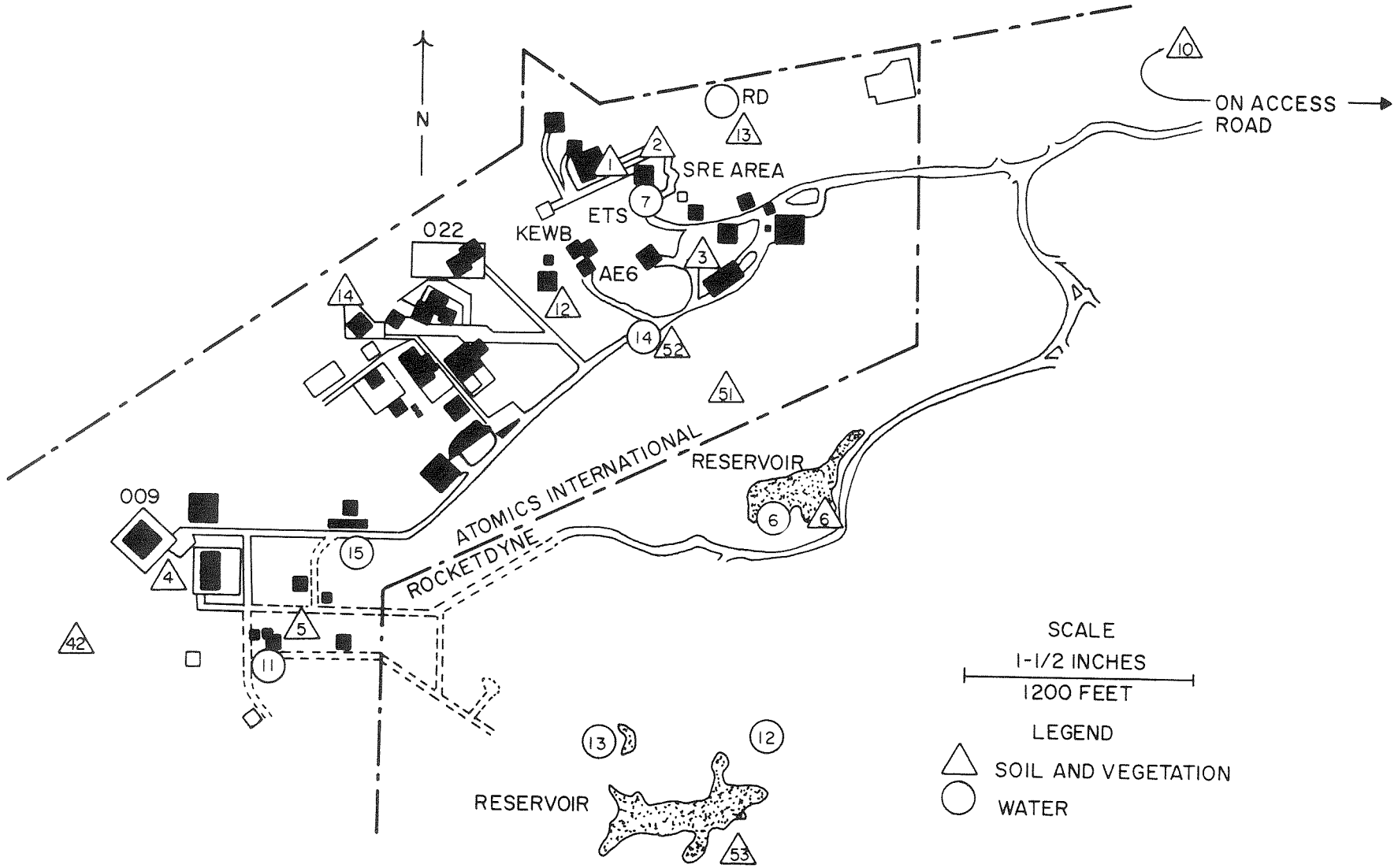

Figure 6. Map of NDFL Sampling Stations

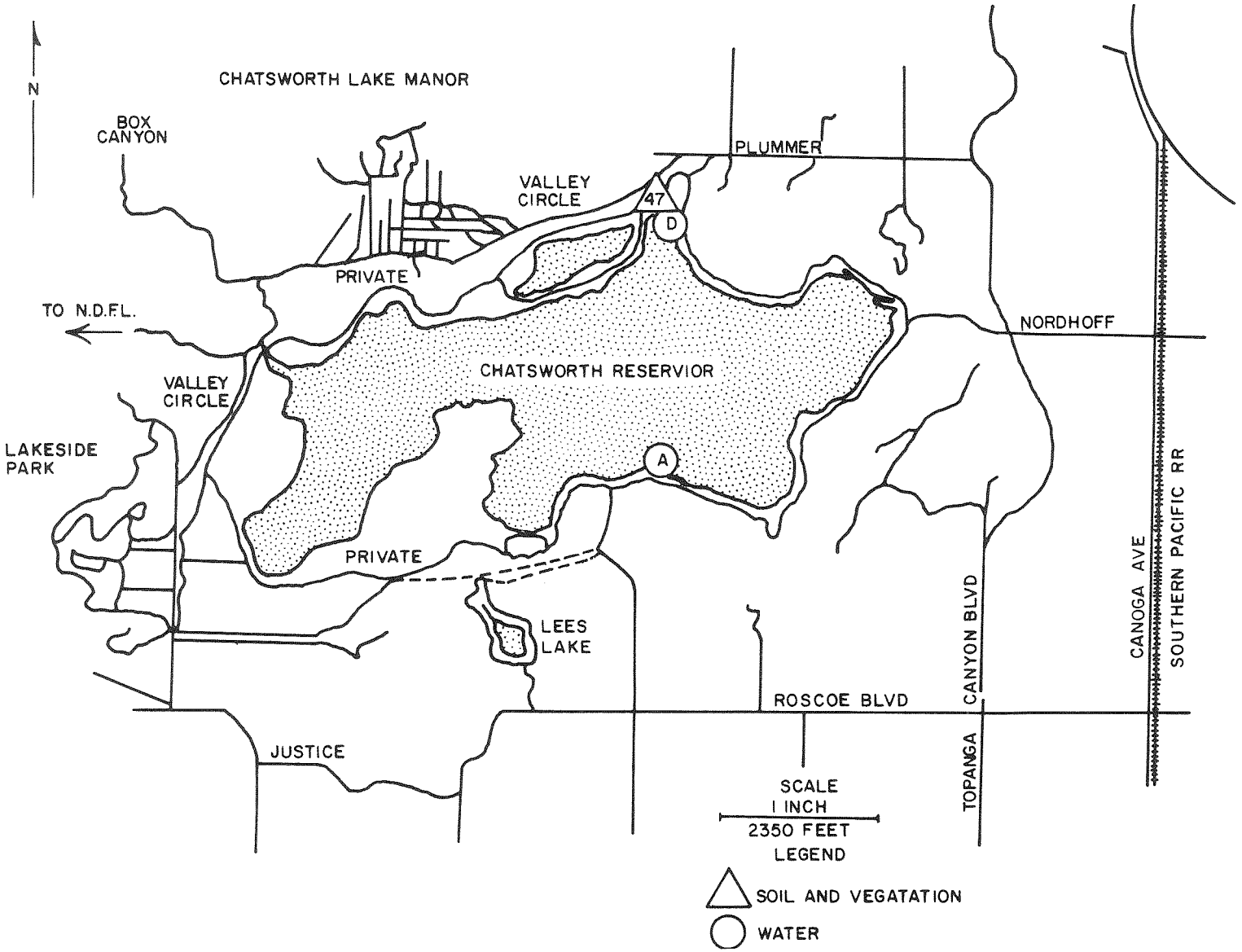

Figure 7. Map of Chatsworth Reservoir Sampling Stations

TABLE XIII (continued)

STATION	LOCATION
SV-19	Santa Susana Site Entrance, Woolsey Canyon
SV-24	Atomics International Headquarters
SV-25	DeSoto Ave. and Plummer St.
SV-26	Nordhoff St. and Mason Ave.
SV-27	DeSoto Ave. and Parthenia St.
SV-28	Canoga Ave. and Nordhoff St.
SV-31	Simi Valley, Los Angeles Avenue and Sycamore Road
SV-40	Agoura
SV-41	Calabasas
SV-42	Non-Radioactive Materials Disposal Area, NDFL
SV-47	Chatsworth Reservoir, North Side
SV-51	Bldg. 029, NDFL
SV-52	Burro Flat Drainage Control Pond, G. St. and 17th St., NDFL
SV-53	Top of Bell Canyon Below Rocketdyne Delta Pond Spillway, PFL
SV-54	Bell Creek
W 6	Rocketdyne Reservoir, PFL
W 7	Process Water from Bldg. 003, NDFL
W 11	Process Water from Bldg. 363, NDFL
W 12	Rocketdyne Reservoir, PFL
W 14	Burro Flat Drainage Control Pond, G. St., and 17th St., NDFL
W 15	Burro Flat Drainage Channel Adjacent to Bldg. 383
W 16	Bell Creek

TABLE XIII (continued)

STATION	LOCATION
W A	Chatsworth Reservoir surface, South Side
W D	Chatsworth Reservoir, Supply Inlet
W RD	SRE Retention Dam, NDFL

B. SAMPLING AND SAMPLE PREPARATION METHODS

SOIL

Surface soil types available for sampling range from decomposed granite to clay and loam. Samples are taken from the top 1/2-inch layer of ground surface. The soil samples are packaged and sealed in plastic containers and returned to the laboratory for analysis.

Sample preparation consists of transferring the soils to pyrex beakers and drying in a muffle furnace at approximately 500°C for eight hours. After cooling, the soil is sieved to obtain uniform particle size. One-gram aliquots of the sieved soil are weighed and transferred to stainless-steel planchets. The soil is wetted in the planchet with acetone, agitated to obtain uniform sample thickness, re-dried, and counted.

VEGETATION

Vegetation samples obtained in the field are of the same plant type wherever possible, generally sunflower or wild tobacco leaves. These types maintain a more active growth rate during the dry season than do most natural vegetation indigenous to the local area.

Vegetation leaves are stripped from plants and sealed in ice cream cartons for transfer to the laboratory for analysis. Plant root systems are not normally analyzed.

Vegetation samples are first washed with tap water to remove foreign matter, and then thoroughly rinsed with distilled water. Washed vegetation is placed in porcelain crucibles and ashed in a muffle furnace at approximately 500°C for eight hours, producing a completely burned ash. Three-hundred milligram aliquots of pulverized ash from each cricible are weighed and transferred to stainless-steel planchets for counting.

WATER

Samples of process water are obtained monthly at the NDFL, from Bell Creek, and from the Chatsworth Reservoir. The water is drawn into one-liter polyethylene bottles and transferred to the laboratory.

Five-hundred ml of water are evaporated to dryness in crystallizing dishes at approximately 90°C. The residue salts are transferred to stainless-steel planchets, wetted with distilled water to produce a uniform sample distribution, re-dried under infra-red lamps, and counted.

AIR

Environmental air sampling is conducted continuously at the Headquarters and NDFL sites with automatic air samplers operating on 24-hour sampling cycles. Airborne particulate radioactivity is collected on HV-70 filter

paper which is automatically changed at the end of each sampling period. The filters are removed from the sampler and counted after the radioactivity has decayed for at least 72 hours. The volume of a typical daily environmental air sample is approximately 20 cubic meters. The minimum detection limit, calculated at 2 σ counter background, is on the order of 0.04 pCi/m^3.

When abnormally high airborne radioactivities are observed, the radioactivity decay data are plotted to determine the presence of short-lived isotopes other than naturally occurring radon, thoron, and daughters. If fall-out is suspected, the decay characteristics are observed. If the radioactivity decays as a function of $t^{-1.2}$, the data curve is extrapolated in order to determine the date of origin. This date is compared with the dates of publicized nuclear detonations to determine if the abnormal airborne radioactivity was caused by such detonations.

A graph of averaged long-lived airborne radioactivity concentrations detected at the Headquarters and NDFL facilities during 1968 is presented in Figure 8. The graph shows the incidence of comparatively high airborne radioactivity concentration peaks during January, diminishing through April, and continuing with relatively low concentrations throughout the reporting period with the exception of a significant transient peak occurring in August followed by another in December, each the result of nuclear detonations.

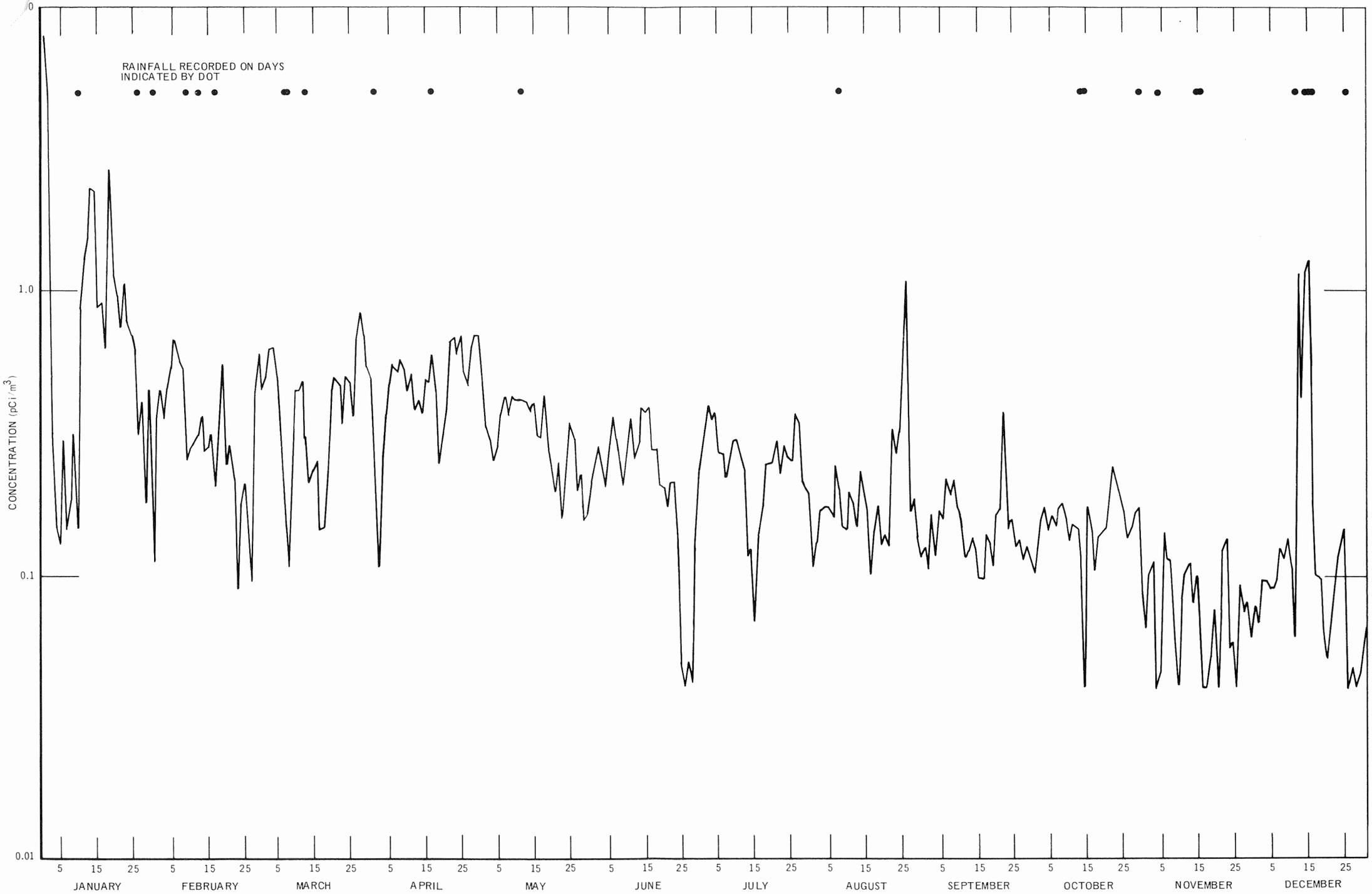

FIGURE 8. LONG-LIVED AIRBORNE RADIOACTIVITY, HEADQUARTERS AND NDFL – 1968

C. COUNTING AND CALIBRATION PROCEDURES

Environmental soil, vegetation, air, and water samples are counted for alpha and beta-gamma radioactivity in automatic proportional counting systems. The sample-detector configuration provides nearly a 2 π geometry. The detector has a thin window and is continually purged with a 90% argon, 10% methane counting gas. A pre-set count mode of operation is used for all samples; however, an overriding pre-set time is also used for alpha counting to prevent the unnecessarily long counting of samples with extremely low activities. The minimum detection limits shown in Table XIV were determined by using typical values for pre-set count, pre-set time, system efficiencies, background count rates (approximately 0.03 cpm α and 12 cpm $\beta\gamma$), and sample size.

TABLE XIV

MINIMUM RADIOACTIVITY DETECTION LIMITS

Sample	Activity	Minimum Detection Limits*
Soil	α	0.19 + 0.038 (pCi/gram)
	$\beta\gamma$	6.9 + 1.1 (pCi/gram)
Vegetation	α	0.064 + 0.076 (pCi/gram-ash)
	$\beta\gamma$	13.8 + 2.1 (pCi/gram-ash)
Water	α	0.038 + 0.046 (pCi/Liter)
	$\beta\gamma$	2.5 + 1.3 (pCi/Liter)

*Standard error

Counting system efficiencies are determined routinely using Ra D + E + F (with and without alpha absorbers) and K^{40}. Potassium - 40, in the form of standard reagent grade KCl, is used to simulate soil and vegetation samples for purposes of

calibration. It has a compound specific activity of approximately 830 dpm per gram KCl and a beta energy of 1.33 mev. Its advantages are purity, long half-life, crystalline form, and low cost. A seeming disadvantage is its beta energy which is somewhat higher than that expected in environmental samples; however, the error introduced by this higher energy has been determined to be insignificant.

In practice, KCl is sieved and divided into aliquots, increasing each in 100-milligram increments from 100 to 1200 milligrams. These aliquots are placed in stainless-steel planchets of the type used for soil and vegetation samples and counted with the proportional counting system. The ratio of sample activity to observed net counting rate for each aliquot is plotted as a function of aliquot weight (see Figure 9). The correction factor (ratio) corresponding to each soil or vegetation sample weight is obtained from this graph. The product of the correction factor and the net sample counting rate yields the sample activity (dpm). This method has been proved usable by applying it to variously sized aliquots of uniformly mixed environmental samples and observing that the resultant specific activities fall within the expected statistical counting error.

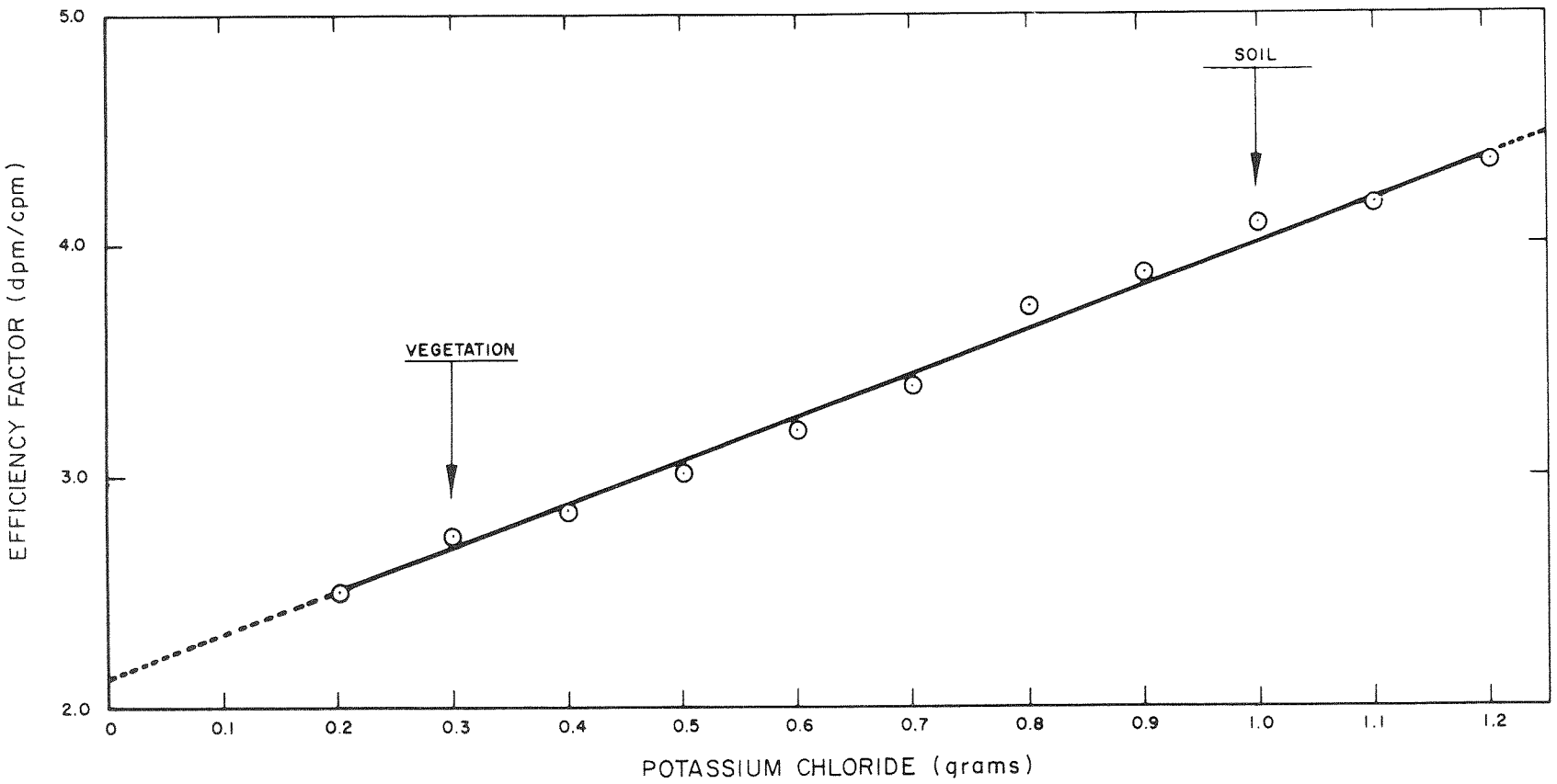

Figure 9. Sample Self-Absorption Correction Graph