

ENVIRONMENTAL MONITORING
SEMIANNUAL REPORT
JULY 1, 1966 TO DECEMBER 31, 1966
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by
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ABSTRACT

Environmental monitoring at Atomics International is performed by the Radiation 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.

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I. SUMMARY

Atomics International, a Division of North American Aviation, Incorporated, 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 to determine the concentration of radioactivity in typical surface soil, vegetation, and water samples. The off-site environs are also sampled monthly;

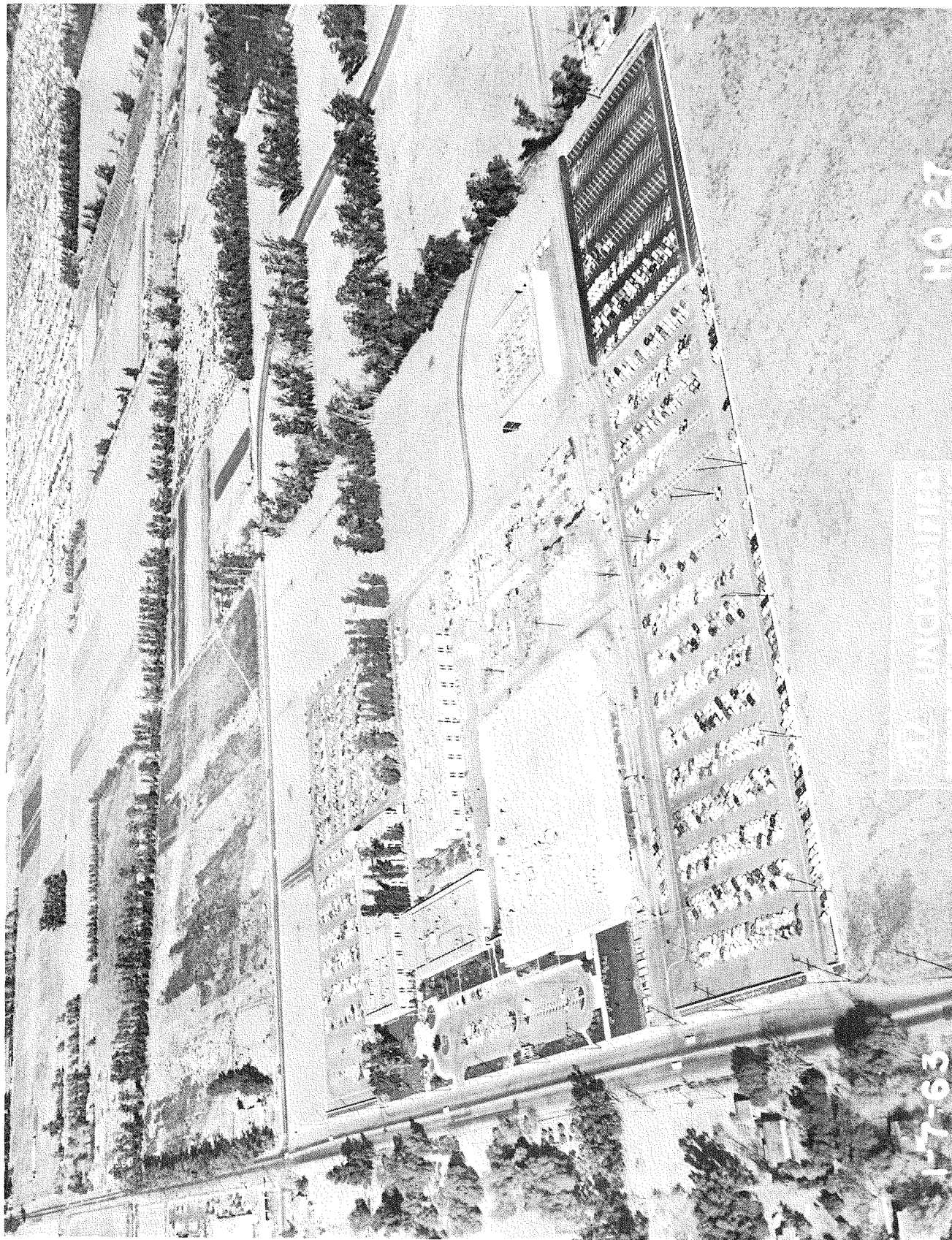


Figure 1. Atomics International World Headquarters



Figure 2. Atomics International Nuclear Development Field Laboratory

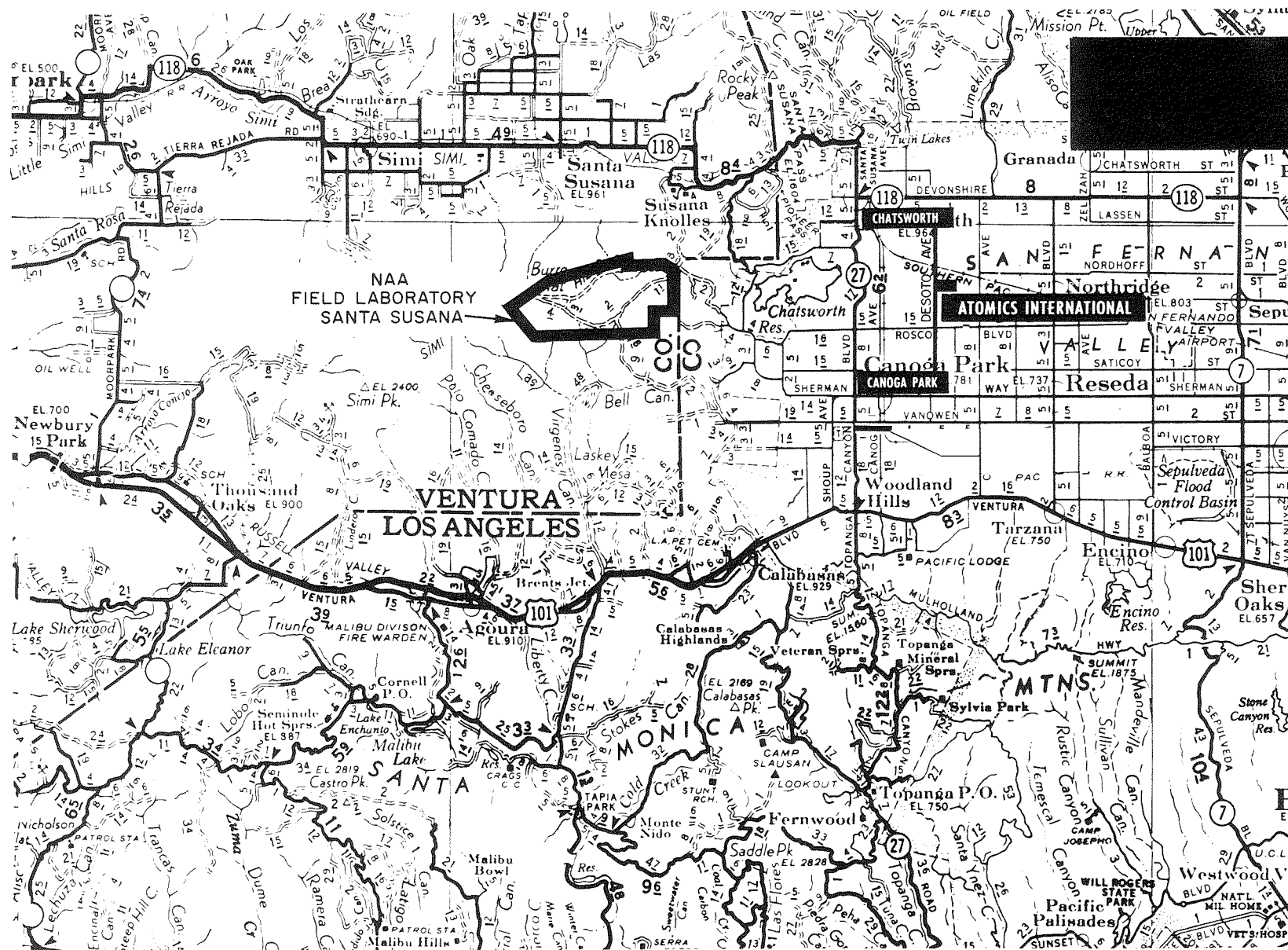


Figure 3. Map of Headquarters and Nuclear Development Field Laboratory Environs

however, since January, 1966, analysis of off-site soil and vegetation samples have been performed only quarterly. Also, continuous on-site environmental air monitoring provides information concerning long-lived airborne particulate radioactivity. This report summarizes environmental monitoring results for the last six months of 1966 and compares the data for 1966 with previous years.

A. ENVIRONMENTAL RADIOACTIVITY DATA - 1966

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

TABLE I
SOIL RADIOACTIVITY DATA - 1966

Area	Activity	First Half - 1966		Last Half - 1966	
		No. Samples	Average $\mu\text{uc}/\text{gram}$	No. Samples	Average $\mu\text{uc}/\text{gram}$
On Site	α	72	0.38 to 0.39	72	0.42 to 0.43
	$\beta\text{-}\gamma$	72	31	70	28
Off Site	α	24	0.44 to 0.45	24	0.42 to 0.44
	$\beta\text{-}\gamma$	24	25	24	24

TABLE II
VEGETATION RADIOACTIVITY DATA - 1966

Area	Activity	First Half - 1966		Last Half - 1966	
		No. Samples	Average $\mu\text{uc}/\text{gram}$	No. Samples	Average $\mu\text{uc}/\text{gram}$
On Site	α	72	0.39 to 0.40	72	0.34 to 0.35
	$\beta\text{-}\gamma$	72	176	72	162
Off Site	α	24	0.38 to 0.39	24	0.35
	$\beta\text{-}\gamma$	24	130	24	117

Process water used at the NDFL is obtained from wells and stored in two 50,000 gallon capacity tanks. Bottled potable water is

delivered to the site by a vendor and is not analyzed. Well water is sampled monthly from the supply line at two locations. The average well water radioactivity concentration is presented in Table III.

TABLE III
WELL WATER RADIOACTIVITY DATA - 1966

Location	Activity	First Half - 1966		Last Half - 1966	
		No. Samples	Average $\mu\text{uc/liter}$	No. Samples	Average $\mu\text{uc/liter}$
NDFL	α	12	0.11	12	0.14 to 0.15
	$\beta-\gamma$	12	5.9	12	2.8 to 3.6

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 NAA Boundary. Samples, obtained and analyzed monthly, include stream bed mud, vegetation, and water. Average radioactivity concentrations in the reservoir and Bell Creek samples are presented in Table IV.

TABLE IV

BELL CREEK AND ROCKETDYNE PFL RESERVOIR
RADIOACTIVITY DATA - 1966

Sample Description	First Half - 1966			Last Half - 1966		
	No. Samples	α	β - γ	No. Samples	α	β - γ
Bell Creek Mud (μ uc/gram)	--	--	--	3	0.39	25
Bell Creek Vegetation (μ uc/gram/ash)	--	--	--	3	1.12 to 1.14	108
Bell Creek Water (μ uc/liter)	--	--	--	3	0.60 to 0.90	0 to 2.5
Reservoir Station 6 (μ uc/liter)	4	0.16	6.5	5	0.05 to 0.08	5.3
Reservoir Station 12 (μ uc/liter)	2	0.09 to 0.11	5.5	6	1.3 to 1.4	6.6

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 lake surface and supply water is presented in Table V.

TABLE V
CHATSWORTH RESERVOIR WATER RADIOACTIVITY DATA - 1966

Sample Type	Activity	First Half - 1966		Last Half - 1966	
		No. Samples	Average $\mu\text{uc/liter}$	No. Samples	Average $\mu\text{uc/liter}$
Lake Surface	α	6	0.35	6	0.29
	$\beta\text{-}\gamma$	6	6.6	6	5.2
Supply Inlet	α	6	0.47	6	0.35
	$\beta\text{-}\gamma$	6	6.9	6	4.8

Environmental air monitoring 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 radioactivity is presented in Table VI.

TABLE VI
AIRBORNE RADIOACTIVITY DATA - 1966

Site	Activity	First Half - 1966		Last Half - 1966	
		No. Samples	Average $\mu\text{uc/M}^3$	No. Samples	Average $\mu\text{uc/M}^3$
Hqs.	$\beta\text{-}\gamma$	360	0.14	346	0.20 to 0.21
NDFL	$\beta\text{-}\gamma$	1178	0.16	1027	0.17 to 0.18

Tables I and II show no change during the last six months of 1966 in soil alpha radioactivity, a slight decrease in soil beta-gamma radioactivity, and moderate decreases in vegetation alpha and beta-gamma radioactivity. Table III shows a slight increase in well water alpha radioactivity and a decrease in beta-gamma radioactivity during the last six months of the year. Table IV shows a decrease in reservoir station 6 water alpha and beta-gamma radioactivity and increases in reservoir station 12 water alpha and beta-gamma radioactivity during the same period. Initial environmental sampling in Bell Creek Canyon was performed on September 30, 1966; therefore no comparative data are available for inclusion in this report. Table V shows that alpha and beta-gamma radioactivity in Chatsworth Reservoir lake surface and supply water decreased during the last six-month period. Chatsworth Reservoir water originates primarily as run-off from the Sierra Mountains at a considerable distance from the local area, and, since both NDFL well water and Chatsworth Reservoir water radioactivities are similar, the radioactivity in well water is not attributed to Atomics International's operations.

Table VI shows moderate increases in airborne radioactivity during the last six months of 1966. This increase is attributed to atmospheric nuclear weapons tests conducted by China during the year.

B. COMPARISON OF ENVIRONMENTAL RADIOACTIVITY DATA FOR 1966 WITH PREVIOUS YEARS

This section summarizes the environmental monitoring results for the calendar year 1966. Also, the annual averages for the years 1957 through 1965 are included for comparison. The averaged annual radioactivity in soil and vegetation is presented in Tables VII and VIII.

TABLE VII
SOIL RADIOACTIVITY DATA - 1957 THROUGH 1966
VII. a. ALPHA RADIOACTIVITY

Year	On Site		Off Site	
	No. Samples	Average $\mu\text{uc}/\text{gram}$	No. Samples	Average $\mu\text{uc}/\text{gram}$
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
1958	80	0.27	309	0.26
1957	64	0.32	318	0.35

VII. b. BETA-GAMMA RADIOACTIVITY

Year	On Site		Off Site	
	No. Samples	Average $\mu\text{uc}/\text{gram}$	No. Samples	Average $\mu\text{uc}/\text{gram}$
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
1958	84	21	318	10
1957	72	11	354	10

TABLE VIII
VEGETATION RADIOACTIVITY DATA - 1957 THROUGH 1966
VIII. a. ALPHA RADIOACTIVITY

Year	On Site		Off Site	
	No. Samples	Average $\mu\text{uc}/\text{gram}/\text{ash}$	No. Samples	Average $\mu\text{uc}/\text{gram}/\text{ash}$
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
1958	65	0.57	250	0.39
1957	58	1.1	304	0.89

VIII. b. BETA-GAMMA RADIOACTIVITY

Year	On Site		Off Site	
	No. Samples	Average $\mu\text{uc}/\text{gram}/\text{ash}$	No. Samples	Average $\mu\text{uc}/\text{gram}/\text{ash}$
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
1958	84	683	318	356
1957	70	208	351	200

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

TABLE IX
WELL WATER RADIOACTIVITY DATA - 1957 THROUGH 1966

Year	Alpha		Beta - Gamma	
	No. Samples	Average $\mu\text{mc/liter}$	No. Samples	Average $\mu\text{mc/liter}$
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
1958	13	0.16	18	4.7
1957	--	--	17	13

The annual average radioactivity in Chatsworth Reservoir Water is presented in Table X.

TABLE X
CHATSWORTH RESERVOIR WATER RADIOACTIVITY DATA -
1961 THROUGH 1966

Year	Lake Surface			Supply Inlet		
	No. Samples	Average $\mu\text{mc/liter}$		No. Samples	Average $\mu\text{mc/liter}$	
		α	$\beta-\gamma$		α	$\beta-\gamma$
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 gross annual average excludes January and February, since the reservoir water sampling stations indicated in Table XII were established in March, 1961.

The annual average concentration of long-lived airborne radioactivity at Headquarters and the NDFL is presented in Table XI.

TABLE XI
AIRBORNE RADIOACTIVITY DATA - 1957 THROUGH 1966
 β - γ

Year	Headquarters		NDFL	
	No. Samples	Average $\mu\text{uc}/\text{M}^3$	No. Samples	Average $\mu\text{uc}/\text{M}^3$
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
1958	366	4.9	164	2.7
1957	63	1.6	141	2.7

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 contain 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 XIII.

Tables VII through XI show moderate decreases in alpha and beta-gamma radioactivity in all sample types except for on-site vegetation which increased slightly. As indicated in the discussions of data for the last half of 1966, the radioactivity detected during 1966 is 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, as indicated in the data tables of this report. In addition, beginning in January, 1966, off-site environmental survey samples have been analyzed quarterly; on-site samples will continue to be analyzed monthly. The locations of sampling stations are shown in Figures 4, 5, 6, and 7, and in Table XII.

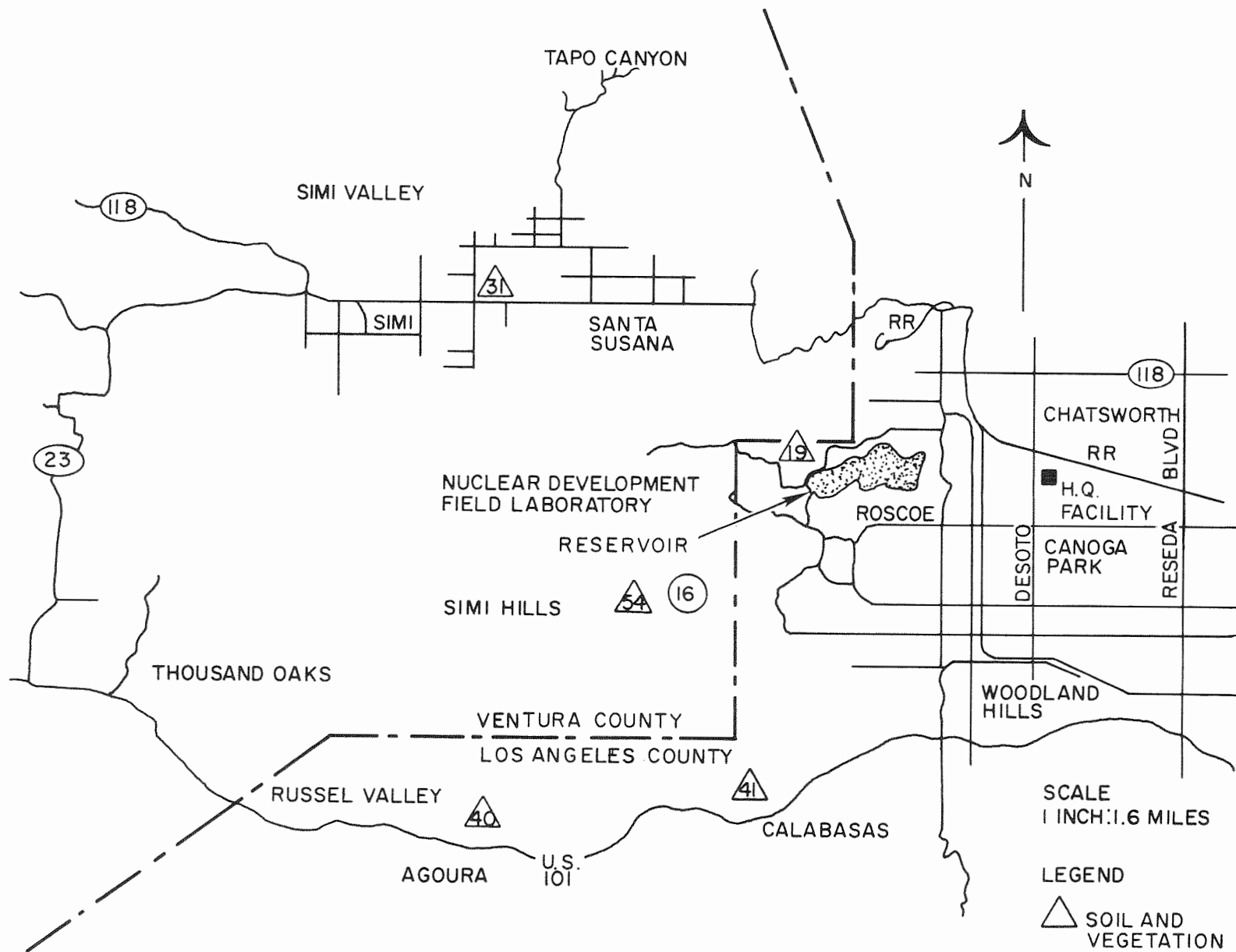


Figure 4. Map of Canoga Park, Simi Valley, Agoura, and Calabasas Sampling Stations

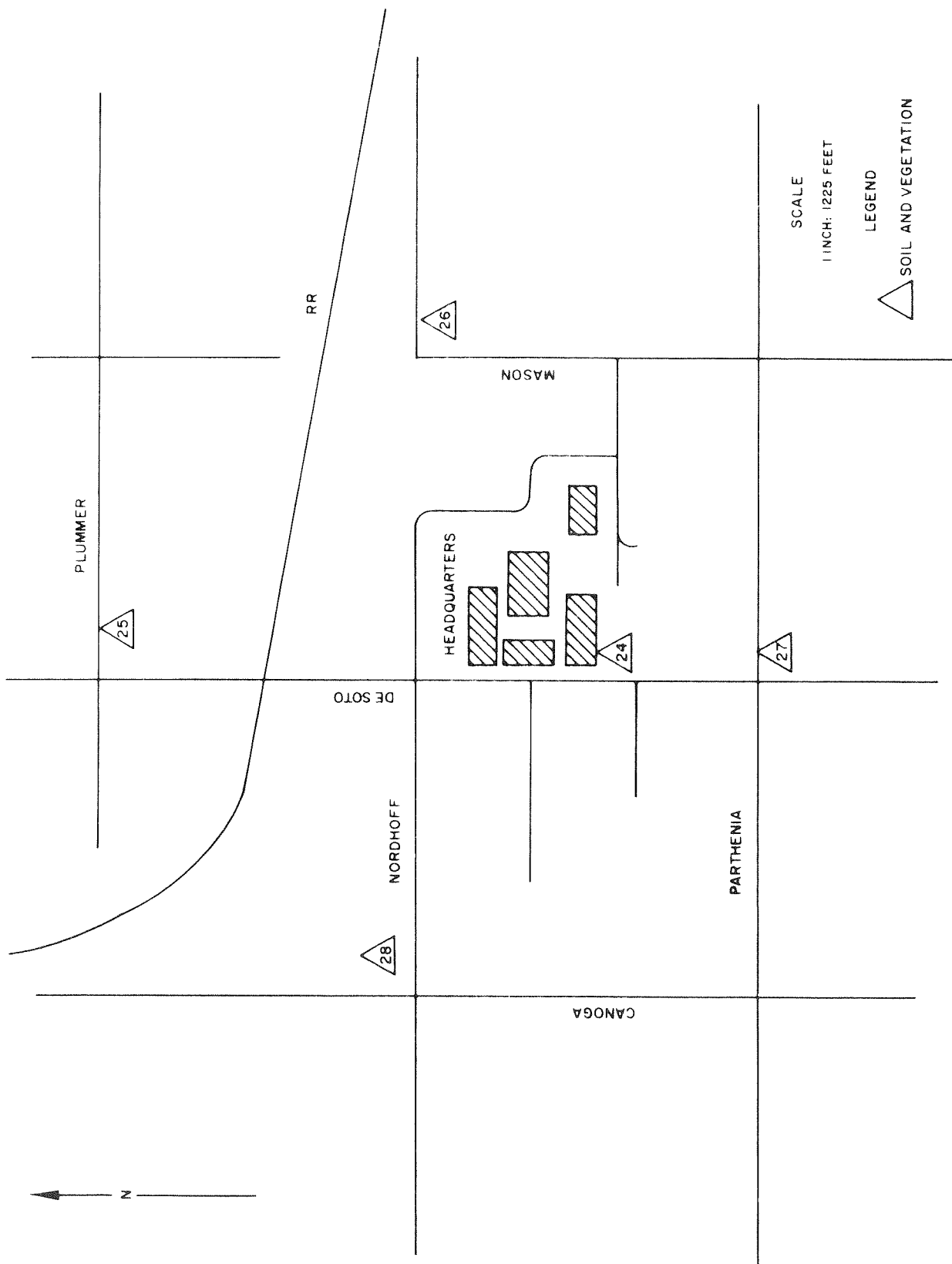


Figure 5. Map of Headquarters Vicinity Sampling Stations

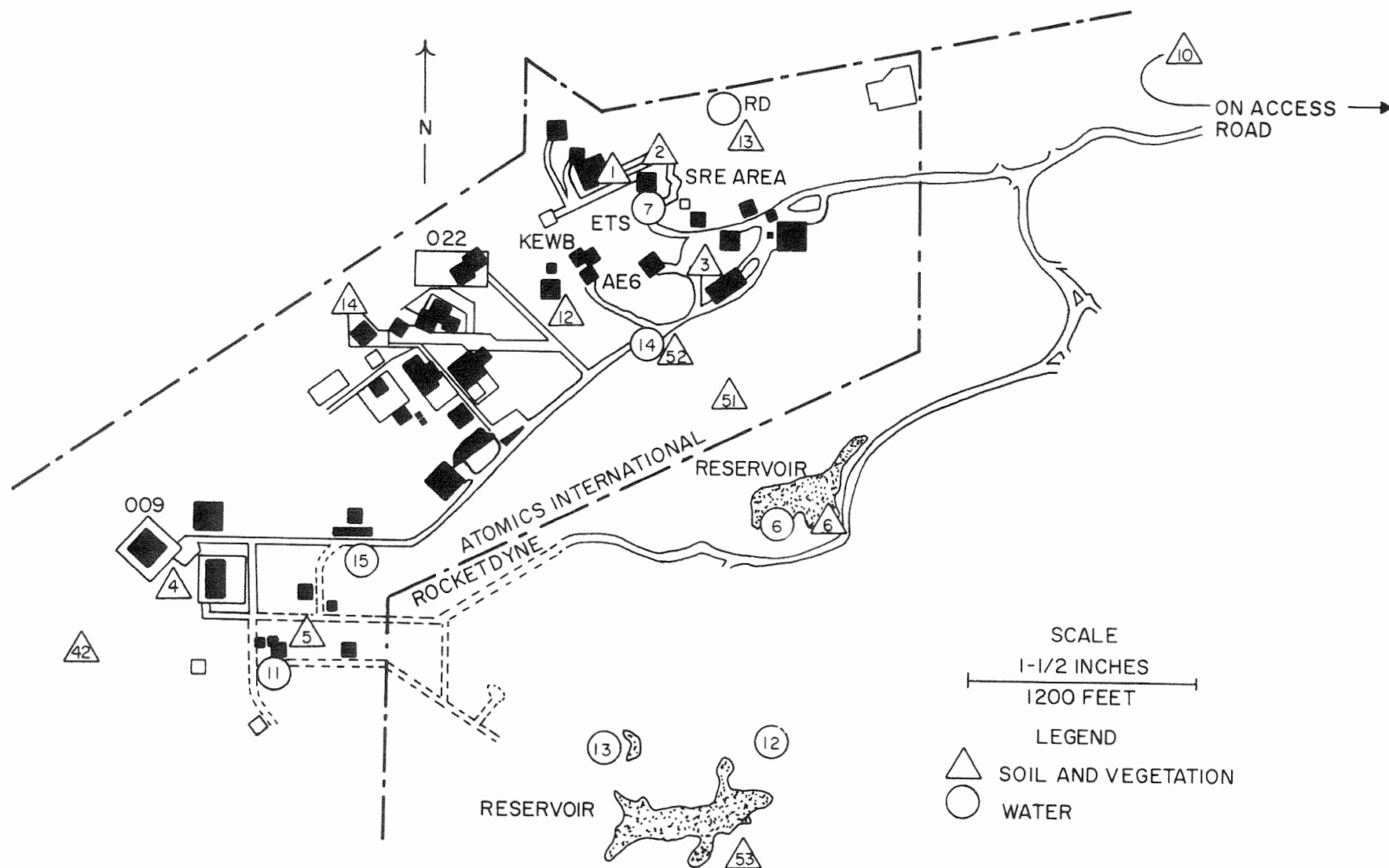


Figure 6. Map of NDFL Sampling Stations

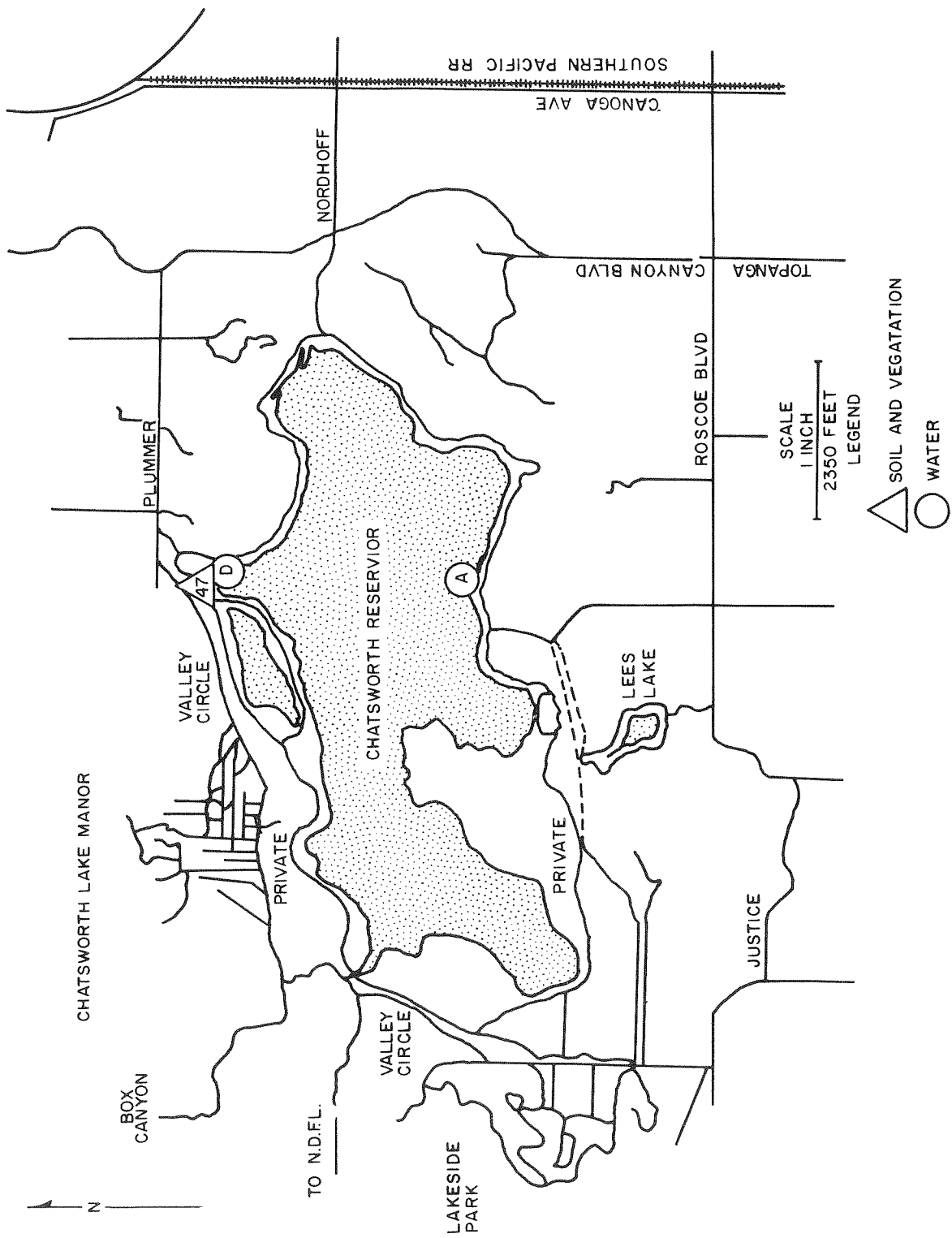


Figure 7. Map of Chatsworth Reservoir Sampling Stations

TABLE XII
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, 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
SV-19	Santa Susana Site Entrance
SV-24	Headquarters
SV-25	DeSoto Avenue and Plummer Street
SV-26	Nordhoff Street and Mason Avenue
SV-27	DeSoto Avenue and Parthenia Street
SV-28	Canoga Avenue and Nordhoff Street
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	Adjacent to 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 R.D.	SRE Retention Dam, NDFL
W 6	Rocketdyne Retention Reservoir, PFL

STATION

LOCATION

W 7	Well Water From E. T. B., NDFL
W 11	Well Water From Bldg. 363, NDFL
W 12	Rocketdyne Retention Reservoir, PFL
W 13	Rocketdyne Retention Reservoir, PFL
W 14	Burro Flat Drainage Control Pond, G. Street and 17th Street, NDFL
W 15	Burro Flat Drainage Channel Adjacent to Bldg. 383. (Collects drainage from Bldg. 009, 020, and 100 areas)
W 16	Bell Creek
W A	Chatsworth Reservoir, South Side
W D	Chatsworth Reservoir, Supply Inlet

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 crucible are weighed and transferred to stainless-steel planchets for counting.

WATER

Samples of well 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 2σ counter background, is on the order of $0.04 \mu\text{c}/\text{m}^3$.

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 1966 is presented in Figure 8. The graph shows relatively low airborne radioactivity concentrations during the first three months of the reporting period, followed by an increase in the incidence of transient peaks accompanied by a slightly higher baseline radioactivity concentration level. These peaks diminished until November 6, when fall-out from a nuclear weapons detonation of October 13-14, 1966, intruded into the local area. This date corresponds with a publicized nuclear detonation by China.

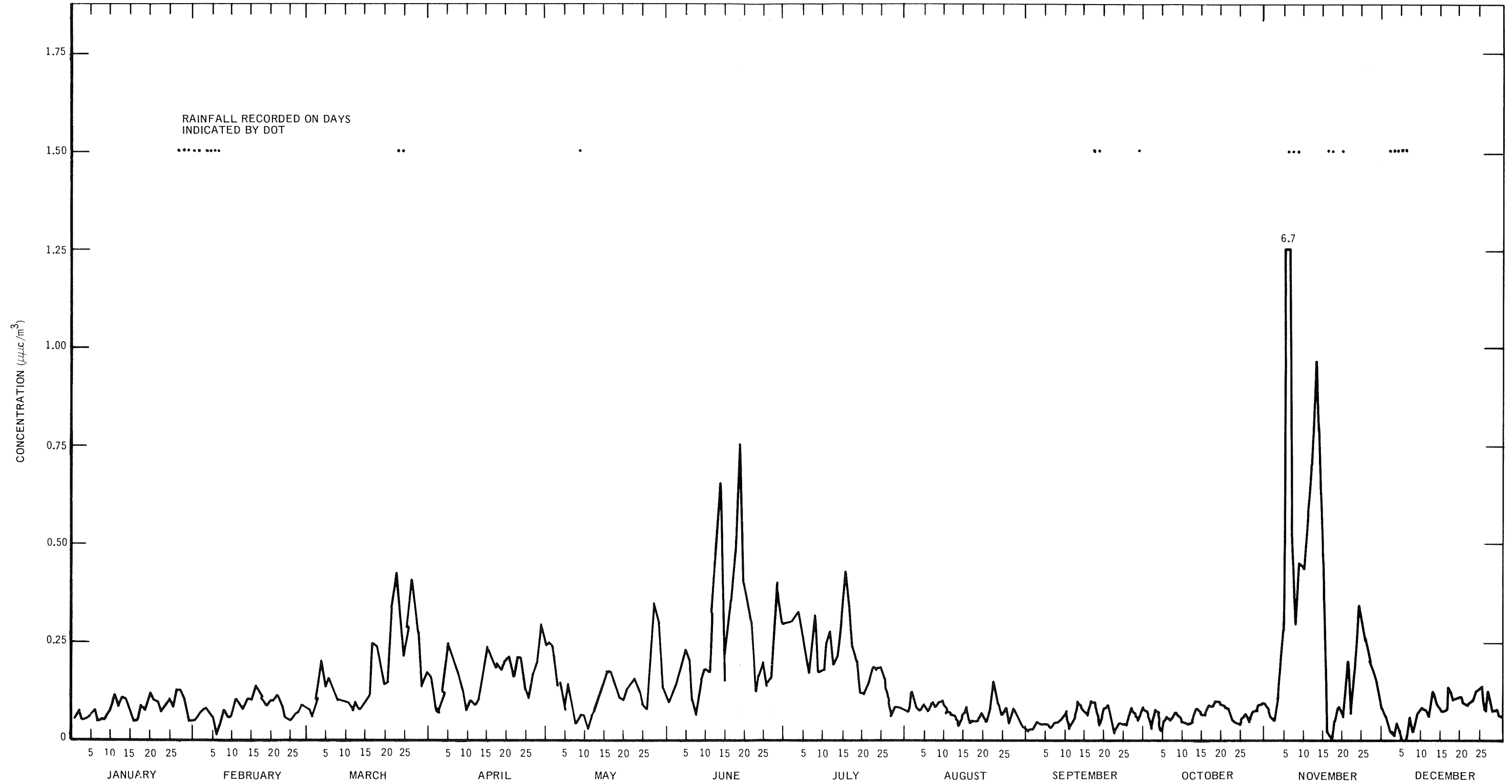


Figure 8. Long-Lived Airborne Particulate Radioactivity
Atoms International Headquarters and NDFL - 1966

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 2π 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 XIII 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 β - γ , and sample size.

TABLE XIII
MINIMUM DETECTION LIMITS

Sample	Activity	Minimum Detection Limits*
Soil	α	0.19 ± 0.038 ($\mu\text{uc}/\text{gram}$)
	β - γ	6.9 ± 1.1 ($\mu\text{uc}/\text{gram}$)
Vegetation	α	0.064 ± 0.076 ($\mu\text{uc}/\text{gram ash}$)
	β - γ	13.8 ± 2.1 ($\mu\text{uc}/\text{gram ash}$)
Water	α	0.038 ± 0.046 ($\mu\text{nc}/\text{liter}$)
	β - γ	2.5 ± 1.3 ($\mu\text{nc}/\text{liter}$)

*Standard error

Counting system efficiencies are determined routinely using Ra D+E+F (with and without alpha absorbers) and K^{40} . K^{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 advantage 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.

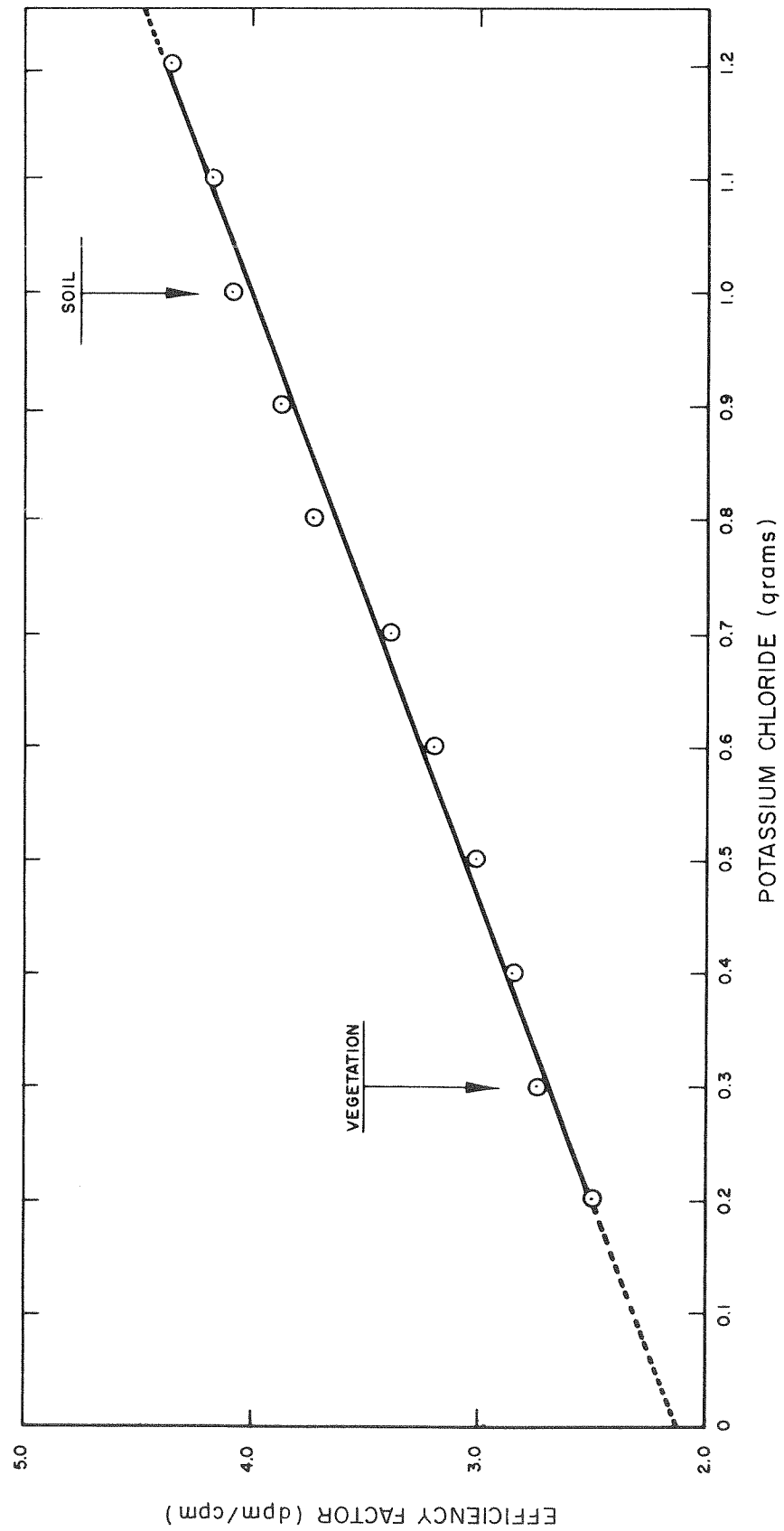


Figure 9. Self-Absorption Correction Graph