38E

RI/RD86-140

1041

ROCKETDYNE DIVISION
ENVIRONMENTAL MONITORING
AND
FACILITY EFFLUENT
ANNUAL REPORT
DE SOTO AND
SANTA SUSANA FIELD LABORATORIES SITES
1985

Rockwell International

Rocketdyne Division
6633 Canoga Avenue
Canoga Park, CA, U.S.A. 91303

RI/RD86-140

ROCKETDYNE DIVISION ENVIRONMENTAL MONITORING AND FACILITY EFFLUENT ANNUAL REPORT DE SOTO AND SANTA SUSANA FIELD LABORATORIES SITES 1985

By
J. D. Moore

APPROVED:

R. J. TUTTLE
Manager
Radiation and
Nuclear Safety

Rockwell International
Rocketdyne Division
6633 Canoga Avenue
Canoga Park, California 91303

ISSUED: APRIL 1986

CONTENTS

		Page
I.	Introduction	1
II.	Summary and Evaluation of Environmental Monitoring Results	11
III.	Environmental Monitoring Results	15
	A. Radioactive Materials--1985	15
	B. Nonradioactive Materials--1985	27
IV.	Environmental Monitoring Program	29
	A. Description	29
	B. Sampling and Sample Preparation	29
	1. Soil	29
	2. Vegetation	37
	3. Water	38
	4. Ambient Air	38
	C. Counting and Calibration	40
	D. Nonradioactive Materials	42
V.	Effluent Monitoring Program	45
	A. Treatment and Handling	45
	B. Facility Descriptions	47
	1. De Soto Site	47
	2. Santa Susana Field Laboratories Site	47
	C. Estimation of General Population Dose Attributable to Nuclear Operations--1985	48
Appendices		
A.	Comparison of Environmental Radioactivity Data for 1985 With Previous Years	57
B.	Environmental Monitoring Program Quality Control	65
C.	California Regional Water Quality Control Board Criteria for Discharging Nonradioactive Constituents from Rocketdyne Division, SSFL	67
D.	References	69
E.	External Distribution	71
F.	Alternative Units for Radiological Data	73

TABLES

		Page
1.	Soil Plutonium Radioactivity Data--1985	16
2.	Soil Radioactivity Data--1985	18
3.	Vegetation Radioactivity Data--1985	18
4.	Supply Water Radioactivity Data--1985	20
5.	Bell Creek and Retention Pond Radioactivity Data--1985	22
6.	Ambient Air Radioactivity Data--1985	24
7.	De Soto and SSFL Sites--Ambient Radiation Dosimetry Data--1985	25
8.	De Soto and SSFL--State of California Ambient Radiation Dosimetry Data--1985	27
9.	Nonradioactive Constituents in Wastewater Discharged to Unrestricted Areas--1985	28
10.	Sampling Location Description	33
11.	Minimum Radioactivity Detection Levels (MDLs)	41
12.	Atmospheric Emissions to Unrestricted Areas--1985	46
13.	Maximum Downwind Plume Centerline Concentrations of Atmospheric Emissions--1985	53
14.	Exposure to the Public in the Vicinity of Rocketdyne Facilities--1985	54
15.	Population Dose Estimates for Atmospheric Emissions from SSFL Facilities--1985	56

FIGURES

1.	Rocketdyne Division--De Soto Site	3
2.	Rocketdyne Division--Santa Susana Field Laboratories Site	4
3.	Map of Santa Susana Field Laboratories Site Facilities	5
4.	Map of General Los Angeles Area	7
5.	Map of Canoga Park, Simi Valley, Agoura, and Calabasas Sampling Stations	30
6.	Map of De Soto Site and Vicinity Sampling Stations	31
7.	Map of Santa Susana Field Laboratories Site Sampling Stations	32

FIGURES

		Page
8.	Weekly, Montnly, and Annual Averaged Long-Lived Airborne Radioactivity at the De Soto and Santa Susana Field Laboratories sites--1985	39
9.	Santa Susana Field Laboratories Site-Centered Demography to 8 km Distance	50
10.	Santa Susana Field Laboratories Site-Centered Demography to 16 km Distance	51
11.	Santa Susana Field Laboratories Site-Centered Demography to 80 km Distance	52

I. INTRODUCTION

In a Rockwell International Corporation organizational realignment, effective on 1 October 1984, the Energy Systems Group was merged with Rocketdyne Division and is no longer a separate organization. Annual reports will hereafter reflect this change.

Environmental and facility effluent radioactivity monitoring at the Rocketdyne Division of Rockwell International (California operations) is performed by the Radiation and Nuclear Safety Group of the Health, Safety, and Environment Department. Soil, vegetation, and surface water are routinely sampled to a distance of 10 miles from Division sites. Ground water from site supply water wells and other test wells is periodically sampled to measure radioactivity in these waters. Continuous ambient air sampling and direct radiation monitoring by thermoluminescent dosimetry are performed at several on-site and off-site locations for measuring airborne radioactivity concentrations and site ambient radiation levels. Radioactivity in emissions discharged to the atmosphere from nuclear facilities is continuously sampled and monitored to ensure that amounts released to unrestricted areas are below appropriate limits and to identify processes that may require additional engineering safeguards to minimize radioactivity in such discharges. In addition, selected nonradioactive chemical constituent concentrations in surface water discharged to unrestricted areas are determined.

The environmental radioactivity reported herein is attributed to natural sources and to residual fallout of radioactive material from past atmospheric testing of nuclear devices.

Work in nuclear energy research and development in what has become the Rocketdyne Division of Rockwell International Corporation began in 1946. Rocketdyne is currently working on the design, development, fabrication, and testing of components and systems for central station power plants, on the

decladding of irradiated nuclear fuel, and on the decontamination and disposition (D&D) of facilities program in addition to a broad spectrum of conventional programs in rocket propulsion, utilization of space, and national defense.

The administrative and scientific research facilities associated with these efforts are located at several major facilities in Canoga Park, California, including the De Soto site, (Figure 1), approximately 23 miles northwest of downtown Los Angeles and in the Simi Hills. The De Soto site is typical of the San Fernando Valley floor, at an altitude of 875 ft above sea level. Several nuclear research programs, licensed by the State of California, are conducted here. These include Building 104 analytical chemistry and applied nuclear research laboratories and the Gamma Irradiation Facility containing approximately 35 kCi of ^{60}Co.

The 290-acre Santa Susana Field Laboratories (SSFL) site (Figure 2) is located in the Simi Hills of Ventura County, approximately 30 miles northwest of downtown Los Angeles. The SSFL site, situated in rugged terrain typical of mountain areas of recent geological age, is underlain by a sandstone bedrock unit called the upper cretaceous Chatsworth formation. The site may be described as an irregular plateau sprinkled with outcroppings above the more level patches and with peripheral eroded ravines. Elevations of the site vary from 1650 to 2250 ft above sea level. The surface mantle consists of unconsolidated gravel, sand, silt, and clay. Both Department of Energy (DOE) and Rockwell International owned facilities, shown in Figure 3, share the Area IV portion of this site. The SSFL site also contains facilities in which nuclear operations licensed by the U.S. Nuclear Regulatory Commission and the State are conducted. The licensed facilities include (1) the Rockwell International Hot Laboratory (RIHL) (Building 020), (2) the Nuclear Materials Development Facility (NMDF) (Building 055), (3) a former neutron radiography facility containing the defueled L-85 nuclear examination and research reactor (Building 093), (4) several X-ray and radioisotope industrial radiography inspection facilities, and (5) a nuclear instrument calibration laboratory.

Figure 1. Rocketdyne Division – De Soto Site

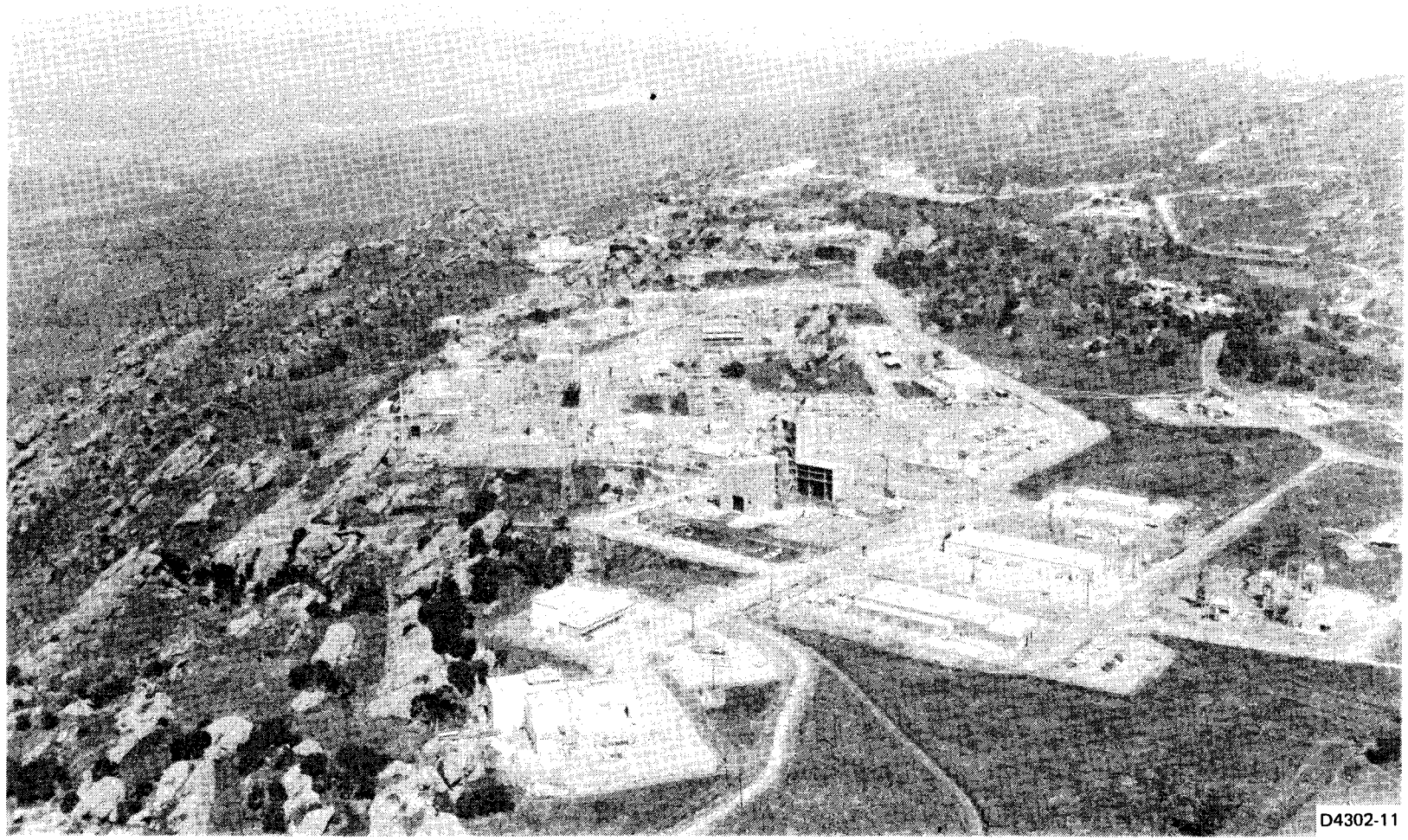

Figure 2. Rocketdyne Division— Santa Susana Field Laboratories Site

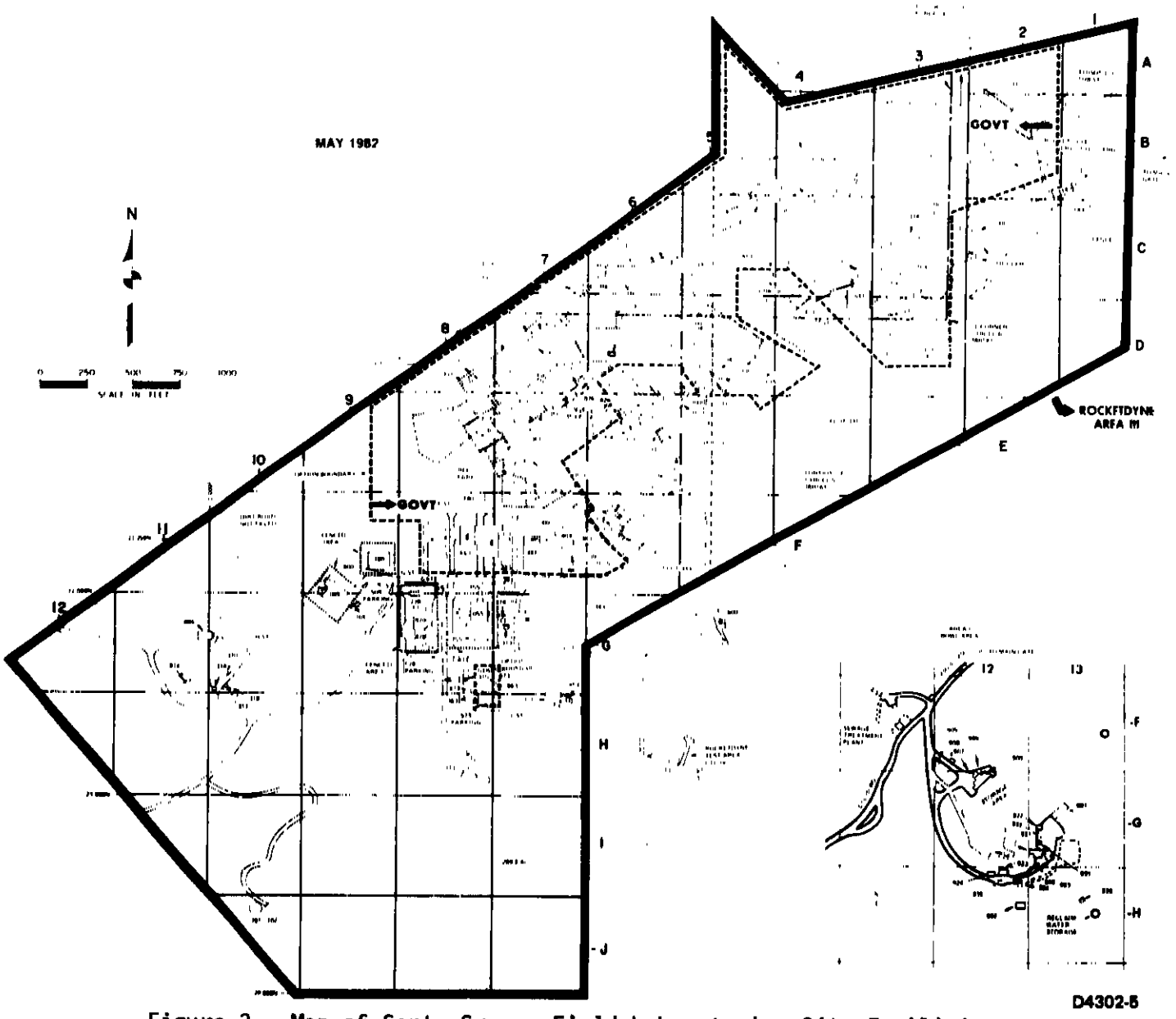

Figure 3. Map of Santa Susana Field Laboratories Site Facilities

The location of these sites in relation to nearby communities is shown in Figure 4. Much of the land surrounding the De Soto site is used for light industry and other commercial uses and for residential apartments and single-family dwellings. Most of the land surrounding the SSFL site is barren, with some minor cattle grazing on the southern portion and some orchard farming at the eastern boundary. At greater distances, residences and some light industries become prevalent. Within 30 km of the SSFL site, there is no significant agricultural land use and, except for the Pacific Ocean about 20 km south, there is no significant body of water reserved for recreational use. There are four major reservoirs within 50 km of the site, which provide domestic water to the greater Los Angeles area. The nearest of these is more than 16 km distant.

Included within the SSFL site is an 82-acre government-optioned area where DOE contract activities are conducted, primarily by the nonnuclear Energy Technology Engineering Center (ETEC). The major operational nuclear installation within the DOE-optioned area is the Radioactive Material Disposal Facility (RMDF). This facility is used for storage of irradiated fuel and for packaging radioactive wastes generated as a result of the D&D program and fuel decladding operations. Several deactivated nuclear reactor and support facilities, all within the optioned area, are affected by the D&D program.

Licensed programs conducted during 1985 included (1) the operation of the RIHL for nuclear reactor fuel decladding and reactor system component examination and the fabrication of sealed radiation sources and (2) the dismantling of the previously defueled L-85 nuclear examination and research reactor.

The basic policy for the control of radiological and chemical hazards requires that, through engineering controls, adequate containment of such materials be provided and that, through rigid operational controls, facility effluent releases and external radiation levels be reduced to a minimum. The environmental monitoring program provides a measure of the effectiveness of

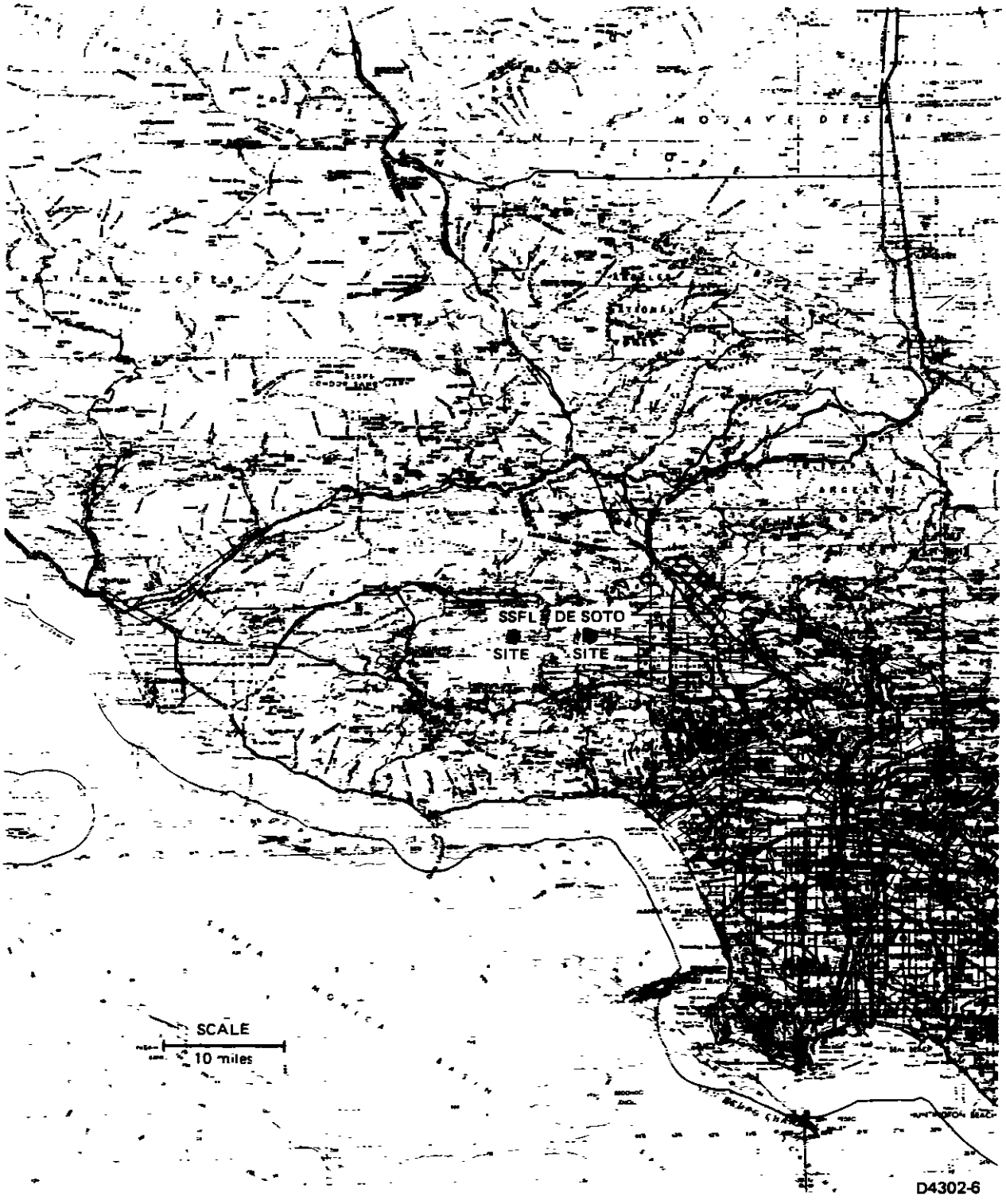

Figure 4. Map of General Los Angeles Area

safety procedures and of the engineering safeguards incorporated into facility designs. Specific radionuclides in facility effluent or environmental samples are not routinely identified because of the extremely low radioactivity levels normally detected, but they would be identified by analytical or radiochemistry techniques if significantly increased radioactivity levels were observed. Relatively few different radionuclides are involved in these operations.

Occasional gamma-spectral analyses of bulk samples such as soil, water, and air confirm that the major radionuclides present are those of the naturally occurring thorium and uranium decay chains, plus other natural radionuclides such as the primordial ^{40}K, and ^{7}Be, produced by cosmic ray interactions in the atmosphere.

In addition to environmental monitoring, work area air and atmospheric emissions are continuously monitored or sampled, as appropriate. This provides a direct measure of the effectiveness of engineering controls and allows remedial action to be taken before a significant release of hazardous material can occur.

Environmental sampling stations located within the boundaries of the De Soto and SSFL sites are referred to as "on-site" stations; those located outside these boundaries, or relatively distant from any nuclear facilities, are referred to as "off-site" stations. The De Soto and SSFL sites are sampled monthly to determine the concentration of radioactivity in typical surface soil, native vegetation, and water. Soil is sampled on-site (SSFL) and off-site semiannually for plutonium analysis. Similar off-site environmental samples, except for plutonium analysis, are obtained quarterly. Continuous ambient air sampling provides information concerning long-lived airborne particulate radioactivity. On-site ambient radiation monitoring using thermoluminescent dosimetry (TLD) measures environmental radiation levels at the De Soto and SSFL sites and also at several off-site locations.

Nonradioactive wastes discharged to unrestricted areas are limited to liquids released to sanitary sewage systems and to surface water drainage systems. No intentional releases of any liquid pollutants are made to unrestricted areas. Sanitary sewage from all DOE and Rocketdyne facilities at the SSFL site is treated at an on-site sewage plant. The plant outfall drains into retention pond R-2A, located toward the southern portion of SSFL. The surface water drainage system of SSFL, which is composed of catch ponds and open drainage ditches, also drains to retention pond R-2A. Water from the pond may be reclaimed as industrial process water or released, as necessary, off-site into Bell Creek, a tributary of the Los Angeles River. The pond is periodically sampled for radioactivity and sampled at discharge for both radioactive and nonradioactive pollutants as required by the discharge permit issued to Rocketdyne Division by the California Regional Water Quality Control Board.

This report summarizes environmental monitoring results for 1985, which are presented in Section III. The sampling and analytical methods used in the environmental monitoring program for radioactive materials are described in Section IV. A comparison of 1985 radioactivity results with the results from previous years appears in Appendix A, with a summary of the Environmental Monitoring Program Quality Control in Appendix B. Appendix C shows regulatory limits on nonradioactive pollutants in water released from the site. References are listed in Appendix D. The external distribution of this report is shown in Appendix E, and a table of alternative units for radiological data is shown in Appendix F. The gross alpha and beta radioactivity is reported as results of the monitoring program. Estimates of radionuclide components in effluents provide the basis for dose commitment calculations.

II. SUMMARY AND EVALUATION OF ENVIRONMENTAL MONTORING RESULTS

All radioactivity levels observed in environmental samples for 1985 show close agreement with radioactivity levels measured during recent years and reported in the previous issues of this report. Local environmental radioactivity levels, which result from both natural and man-made radionuclides and showed the presence of fallout from past atmospheric testing of nuclear devices, have decreased to generally constant levels during the past several years. These levels are now due mainly to the primordial radionuclides. The local effects of foreign atmospheric nuclear tests, which had been readily observable in daily ambient airborne radioactivity levels, were not evident in 1985. The long-term effect of airborne radioactivity on surface sample radioactivity levels also has not been discernable in recent years. The continuing relative constancy in environmental radioactivity levels is primarily due to the dominance of naturally occurring radionuclides in the environment.

The results of this environmental monitoring indicate that there are no significant sources of unnatural radioactive material in the vicinity of the Rocketdyne sites. Additionally, identical results obtained for on-site and off-site samples furtner indicate that there is no contribution to general environmental radioactivity attributable to nuclear operations at Rocketdyne. Potentially significant exposure pathways to the general public resulting from Rocketdyne nuclear operations are limited to the atmospheric discharge of radioactive materials for which the only exposure pathways to people result from whole body external exposure and from inhalation exposure to released materials, and to direct radiation exposure of individuals and the general public beyond the site boundary. No discharge of liquid radioactive wastes is made to the environment. All such materials are processed for disposal at regulated disposal sites.

The maximum individual annual exposures estimated for persons at the site boundary and also at the residence nearest the SSFL site are small when compared with natural radiation and with all applicable guidelines. The estimates of exposure due to inhalation at the boundary and the nearest residence

were derived from the AIRDOS-EPA calculated concentrations at those locations and incorporated the dose conversion factors appropriate for radionuclides in process at each nuclear facility. This inhalation exposure estimate is the sum of contributions calculated for the measured releases from each facility. The external radiation exposure estimates at the maximum exposed boundary location and at the nearest residence are based on results for site ambient radiation dosimeters and also for several facility workplace radiation dosimeters. The unattenuated external annual exposure due to operations conducted at the RMDF is estimated to be 80 mrem at the nearest boundary-line location and less than 0.1 mrem for the nearest residence for operations conducted at the RMDF. The boundary-line exposure is conservative in that the rugged terrain at the site boundary nearest the RMDF precludes anything more than the occasional and temporary presence of any person at that location. These values were determined by calculating the unattenuated exposure expected at the boundary and nearest residence on the basis of the highest annual result for area dosimeters in place around the facility. For the nearest residence, radiation attenuation due to air absorption and also to the intervening rock formations will lower direct radiation to practically nonexistent levels with only natural background radiation inherent to the residence location being present. Boundary-line direct radiation exposures for the State of California and U.S. NRC-licensed operations at other Rocketdyne nuclear facilities were very much below 10 mrem for the year. The topography of the SSFL site surrounding the nuclear facilities and out to the site boundary is extremely irregular. Hills and rock outcroppings shield the off-site areas, significantly reducing off-site exposures from on-site sources.

Similarly for the De Soto site, internal dose estimates at the boundary and at the nearest residence are not significantly different from zero. Estimates of the external radiation exposure at the De Soto boundary (4 ± 10 mrem) and at the nearest residence (0.01 ± 0.01 mrem) are based on the difference between the single highest on-site TLD measurement and the average of off-site measurements. The difference is more likely the result of random variability in the measurements than from actual radiation exposure.

Supply water at the SSFL site is monitored at two locations. This water consists of ground water from deep wells on the site blended with potable water from the Ventura County Water District 17. In addition, shallow ground water is periodically sampled at a standpipe adjacent to the basement level of a deactivated systems for nuclear auxiliary power (SNAP) reactor test facility (Building 059). These samples are evaluated to detect the transfer of activation product radioactivity from the underground reactor test vault containment and into the surrounding soil. None nas been detected. Therefore, these analyses serve as a measure of radioactivity naturally present in the ground water.

Quality assurance measures incorporated into the environmental monitoring program include participation in DOE-sponsored programs such as the Environmental Dosimeter Intercomparison Program and the DOE Environmental Measurements Laboratory Quality Assessment Program (EML-QAP). Participation in two EML-QAP sample analysis sets (QAP XXIII and XXIV) was done in 1985. Analysis of the results indicates that accuracy in measuring radioactivity in the sample media provided for the intercomparison improved; however, additional work is required to develop counting standards that are more representative of the types of samples and analyses addressed in the quality assessment program. In addition to participation in these programs, laboratory analyses of split and replicate samples are routinely used to evaluate the reproducibility of sample radioactivity measurements of water and soil gross radioactivity. Control charts of counting system radiation response are maintained. These data are periodically evaluated to determine the correla- tion between sample sets and trends in background.

III. ENVIRONMENTAL MONITORING RESULTS

A. RADIOACTIVE MATERIALS--1985

The average radioactivity concentrations in local soil, vegetation, surface water, and ambient air for 1985 are presented in Tables 1 through 6. The data shown for gross alpha activity in samples that are generally thick compared with the range of the alpha particles represent a marked change in the manner of calculating and reporting them, compared with prior reports. This change reflects the gradual redirection of the monitoring program from monitoring to measurement. Previously, alpha count rate data had been converted to alpha activity concentrations by using an efficiency factor for a thin electroplated source, and the results were monitored for changes from prior values. This resulted in artificially low numerical values for the alpha activity in several sample media. Starting with the 1984 report, the alpha activity concentrations for these media are reported based on an efficiency factor derived from a sample with distributed alpha activity that is thick relative to the alpha particle range. For monitoring purposes, this has no effect. However, the values reported more closely represent the actual alpha activity existing in the environment. In calculating the average concentration values, all values, including negative values, are included. This method of noncensored data averaging, recommended by DOE Order 5484.1, affords a better estimate of the central value and dispersion of the data. All limits of error reported in the tables are for one standard deviation (1 sigma). Usually, these show the dispersion of the measured values about the mean. These two changes in data interpretation result in noticeable differences in the data shown in the historical comparisons. It must be recognized that these differences do not reflect changes in environmental radioactivity but are merely consequences of the evolution of the monitoring program.

The presentation of data in the tables includes the annually averaged data for each sample type and the maximum radioactivity level detected for a single sample from the annual set, which is reported because of its significance in indicating the occurrence of a major episode or an area-wide incident

of radioactive material deposition. None of the maximum observed values, which (as the tables show) occurred randomly during the year, shows a great increase over the average values beyond inherent variability. The ambient air sampling data show no greatly increasing or decreasing trends for most of the year and can be described as generally constant, with some increase in local airborne radioactivity levels occurring during the second and fourth quarters.

To achieve much higher detection sensitivity for plutonium than gross alpha measurements can provide, soil samples are collected and sent to an independent testing laboratory for specific analysis for plutonium. In this analysis, the individual soil samples are leached with acid, and the leachate is treated chemically to separate and concentrate any plutonium present in the sample. In this way, minute quantities of plutonium, such as that distributed globally by testing of nuclear weapons, can be detected and quantitatively measured by alpha spectroscopy. The results are shown in Table 1. Alpha spectroscopy permits identifying of $^{239}Pu + ^{240}Pu$, predominantly from weapons tests, and ^{238}Pu, from the destructive reentry of a Transit satellite over the Indian Ocean in April 1964.

TABLE 1

SOIL PLUTONIUM RADIOACTIVITY DATA--1985

Sample Location	26 June 1985 Survey Results		4 December 1985 Survey Results	
	^{238}Pu (pCi/g)	$^{239}Pu + ^{240}Pu$ (pCi/g)	^{238}Pu (pCi/g)	$^{239}Pu + ^{240}Pu$ (pCi/g)
S-56	0.0001 ± 0.0002	0.0009 ± 0.0003	0.0005 ± 0.0004	0.0051 ± 0.0006
S-57	0 ± 0.0001	0.0038 ± 0.0004	0.0003 ± 0.0003	0.0028 ± 0.0005
S-58	0.0001 ± 0.0001	0.0020 ± 0.0004	0 ± 0.0001	0.0048 ± 0.0006
S-59	0.0001 ± 0.0001	0.0025 ± 0.0004	0.0001 ± 0.0001	0.0017 ± 0.0004
S-60	0.0001 ± 0.0001	0.0019 ± 0.0004	0 ± 0.0002	0.0008 ± 0.0004
S-61[a]	0 ± 0.0001	0.0005 ± 0.0002	0 ± 0.0001	0.0003 ± 0.0002

[a]Off-site location

For comparison with the plutonium present as a result of fallout from nuclear weapons tests and failure at launch of a radioisotope-powered satellite, published data from soil tests in nearby Burbank, California, in 1970-71 show a plutonium concentration of approximately 2×10^{-9} µCi/g for ^{239}Pu + ^{240}Pu and approximately 0.06×10^{-9} µCi/g for ^{238}Pu. The data in Table 1 show no significant increases in on-site soil plutonium relative to the Burbank values.

Table 1 shows no significant variation in soil plutonium concentrations for the 1985 sample sets. The results of the gross radioactivity measurements in soil (Table 2) and in vegetation (Table 3) show no significant difference between on-site and off-site samples.

The detected gross radioactivity in soil and vegetation is due to various naturally occurring radionuclides present in the environment and to radioactive fallout of dispersed nuclear weapons materials and fission product radioactivity produced by past atmospheric tests of nuclear weapons. No atmospheric nuclear weapons tests were announced during 1985. Naturally occurring radionuclides include ^{7}Be, ^{40}K, ^{87}Rb, ^{147}Sm, and the uranium and thorium series (including radon and daughters). The radionuclide composition of local area surface soil has been determined to be predominantly ^{40}K, natural thorium, and natural uranium, both in secular equilibrium with daughter nuclides, with less than 1% fission-produced radionuclides, principally ^{137}Cs. Radioactivity in aged fallout consists primarily of the fission produced ^{90}Sr-^{90}Y, ^{137}Cs, and ^{147}Pm, and also ^{234}U and ^{239}Pu. Gamma spectrometric analysis of composited ambient air samples collected during 1985 detected only the cosmogenic radionuclide ^{7}Be, plus additional natural radionuclides of terrestrial origin, the natural uranium and thorium series, and ^{40}K. Relative amounts of these radionuclides were approximately 65% ^{40}K, 34% ^{7}Be, and the remainder due to the natural uranium series and natural thorium series. The value for ^{7}Be is representative for the mixture only at the time of measurement since the physical half-life is extremely short compared with those of the other radionuclides detected.

TABLE 2

SOIL RADIOACTIVITY DATA--1985

Area	Activity	Number of Samples	Gross Radioactivity (pCi/g)	
			Annual Average Value and Dispersion	Maximum Observed Value[a] and Month Observed
On-site (monthly)	Alpha	144	25.2 ± 7.3	48.36 (April)
	Beta	144	24.2 ± 1.9	32.7 (September)
Off-site (quarterly)	Alpha	48	26.3 ± 7.8	46.00 (July)
	Beta	48	23.9 ± 3.3	30.2 (April)

[a]Maximum value observed for single sample.

TABLE 3

VEGETATION RADIOACTIVITY DATA--1985

Area	Activity	Number of Samples	Gross Radioactivity (pCi/g)			Percent of Samples With Activity ≥MDL[b]
			Dry Weight	Ash		
			Annual Average Value and Dispersion	Annual Average Value and Dispersion	Maximum Value[a] and Month Observed	
On-site (monthly)	Alpha	144	0.49 ± 0.58	3.76 ± 4.44	22.0 (December)	100
	Beta	144	18.5 ± 9.0	134.8 ± 53.4	268.9 (October)	0
Off-site (quarterly)	Alpha	48	1.05 ± 1.73	4.68 ± 6.25	25.3 (January)	100
	Beta	48	26.2 ± 13.7	132.8 ± 49.2	242.4 (January)	0

[a]Maximum value observed for single sample.
[b]Minimum detection level: 2.27 pCi/g alpha; 0.36 pCi/g beta (ash).

Supply water is sampled monthly at De Soto and at two widely separated SSFL site locations. The average supply water radioactivity concentration for each site is presented in Table 4. Supply water used at the De Soto site is supplied by the Los Angeles Department of Water and Power. Supply water used at the SSFL site is obtained partly from the Ventura County Water District No. 17, which also supplies nearby communities, and from local well water and is distributed on the site by the same piping system previously used when all facility supply water was obtained from on-site wells. Two on-site water wells (wells 5 and 13) were operated during 1985 to reduce the consumption of the Ventura County water. The well water proportion in the blend averaged about 51% for the year, for a total well water consumption of about 2.8×10^5 m^3 (7.4×10^7 gal). Pressure for the water system is provided by elevated storage tanks.

A shallow standpipe, connected to a French drain at foundation level, placed during construction of a modification to a now deactivated SNAP reactor test facility, is being used for sampling of ground water adjacent to the underground reactor test vault. The well is periodically sampled for the purpose of detecting any transfer of activation product radioactivity from the containment to the soil bed. Radioactivity in samples taken during 1985 averaged 3.7×10^{-8} μCi/ml beta with no alpha activity detected. Gamma spectrometric analysis, with a minimum detection limit for ^{60}Co of about 5×10^{-7} μCi/ml, has not identified any specific unnatural radionuclides in the water; thus, this activity is attributed to dissolved radioelements of natural origin in the soil bed.

A recent hydrogeologic study at SSFL describes two ground water systems at the site: a shallow, unconfined system of alluvial surface mantle on the Burro Flats area and along the major drainage channels, and a deeper ground water system in the fractured Chatsworth sandstone. Alluvium along the major surface drainage systems may store and transmit ground water to the underlying Chatsworth Formation through fractures. Water levels in the alluvium respond to recharge resulting from surface flows and may vary considerably between wet and dry periods. The alluvium, composed of a heterogeneous mixture of gravel,

TABLE 4

SUPPLY WATER RADIOACTIVITY DATA--1985

Area	Activity	Number of Samples	Gross Radioactivity (10^{-9} µCi/ml)	
			Average Value and Dispersion	Maximum Value[a] and Month Observed
De Soto (monthly)	Alpha	12	2.76 ± 1.82	5.73 (November)
	Beta	12	3.17 ± 0.78	4.60 (March)
SSFL (monthly)	Alpha	24	2.45 ± 2.61	8.63 (December)
	Beta	24	2.80 ± 0.51	3.95 (October)

[a]Maximum value observed for single sample.

sand, silt, and clay, has an estimated hydraulic conductivity ranging from 0.1 to 1000 gal/day/ft^2.

The Chatsworth Formation is composed of well-consolidated, massively bedded sandstones with interbedded layers of siltstone and claystone. The layer may be as thick as 6,000 ft at the SSFL site. The direction of ground water flow in the formation is probably radially off-site toward the surrounding lowlands and is probably controlled by fracture zones.

The hydrogeologic environment at the SSFL site is a dynamic system. Ground water is recharged at the site, moves through the aquifers, and discharges to the surface or to other aquifers down-gradient of the site. The ground water system is recharged by precipitation and by unlined ponds and drainage channels. Because of the meager rainfall in the area and the relatively large variability in annual precipitation, ground water recharge may vary greatly from year to year. Specific pathways of possible contaminant

transport are difficult to predict on the basis of on-site well data. The most likely pathways are along fracture zones that trend off-site.

As discussed earlier, surface waters discharged from SSFL facilities and the sewage plant outfall drain southward into Rocketdyne retention pond R-2A. When full, the pond may be 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 21 September 1966, a sampling station for evaluating environmental radioactivity in Bell Canyon was established in 1966. It is located approximately 2.5 miles downstream from the southern Rockwell International Corporation boundary. Samples, obtained and analyzed monthly, include stream bed mud, vegetation, and water. Average radioactivity concentrations in Retention Pond R-2A and Bell Creek samples are presented in Table 5.

Comparison of the radioactivity concentrations in water from the ponds and from Bell Creek with that of the supply water shows no significant differences in either alpha or beta activity. Similar comparisons between on-site and off-site soil and vegetation samples and those of Bell Creek show no significant differences.

The SSFL site surface water and the ambient air radioactivity concentration guide values selected for each site are the most restrictive limits for those radionuclides currently in use at Rocketdyne facilities and should not be taken to indicate the identification of these radionuclides in the samples. Radioactivity concentration guide values are those concentration limits adopted by DOE, Nuclear Regulatory Commission (NRC), and the State of California as maximum permissible concentrations (MPCs) for unrestricted areas. The MPC values are dependent on the radionuclide and its behavior as a soluble or an insoluble material. For comparison with results of environmental and effluent monitoring, the single lowest MPC value for the various radionuclides present is selected rather than a derived MPC for the mixture. Accordingly, for SSFL site surface water, the guide values of 5×10^{-6} uCi/ml alpha activity corresponding to ^{239}Pu and 3×10^{-7} uCi/ml beta activity corresponding

TABLE 5

BELL CREEK AND RETENTION POND RADIOACTIVITY DATA--1985

Area (monthly)	Activity	Number of Samples	Gross Radioactivity Concentrations		
			Annual Average Value and Dispersion	Maximum Value[a] and Month Observed	Percent of Samples With Activity ≤MDL[b]
Bell Creek mud no. 54 (pCi/g)	Alpha	12	21.9 ± 6.5	31.9 (January)	0
	Beta	12	22.7 ± 1.1	24.7 (November)	0
Pond R-2A mud no. 55 (pCi/g)	Alpha	12	31.4 ± 6.0	43.7 (May)	0
	Beta	12	24.0 ± 1.1	25.3 (December)	0
Bell Creek vegetation no. 54 (pCi/g-ash)	Alpha	12	1.34 ± 1.25	2.82 (January)	100
	Beta	12	137.1 ± 28.6	178.8 (August)	0
Bell Creek vegetation no. 54 (pCi/g dry weight)	Alpha	12	0.23 ± 0.20	0.49 (September)	100
	Beta	12	22.4 ± 6.1	32.94 (September)	0
Bell Creek water no. 16 (10^{-9} µCi/ml)	Alpha	12	1.38 ± 7.09	19.68 (December)	100
	Beta	12	2.49 ± 0.75	3.79 (December)	0
Pond water no. 6 (10^{-9} µCi/ml)	Alpha	12	2.06 ± 4.44	13.65 (October)	100
	Beta	12	3.53 ± 0.96	4.92 (November)	0
SSFL pond R-2A water no. 12 (10^{-9} µCi/ml)	Alpha	12	3.07 ± 1.94	6.61 (April)	100
	Beta	12	3.49 ± 0.76	5.56 (October)	0

[a]Maximum value observed for single sample.
[b]Minimum detection level: Approximately 6.40 x 10^{-9} µCi/ml alpha; 0.64 x 10^{-9} µCi/ml beta for water: approximately 2.3 µCi/g alpha; 0.23 µCi/g for soil: approximately 2.3 pCi/g alpha; 0.36 µCi/gm for vegetation ash.

to ^{90}Sr are appropriate. These values are established in 10 CFR 20, California Administrative Code Title 17, and DOE Order 5480.1A.

Ambient air sampling for long-lived particulate alpha and beta radioactivity is performed continuously by automatic sequential samplers located at the De Soto and SSFL sites. Air is drawn through Type A glass fiber filter media, which are analyzed for retained long-lived radioactivity after a minimum 120-h decay period that eliminates naturally occurring short-lived particulate radioactivity (most radon daughters). The average concentrations of ambient air alpha and beta radioactivity for 1985 are presented for the various sampler locations in Table 6.

The guide value of 6×10^{-14} µCi/ml for SSFL site ambient air alpha activity is due to work with unencapsulated plutonium. The value of 3×10^{-11} µCi/ml for beta activity is due to the presence of ^{90}Sr in fission products in irradiated nuclear fuel at the SSFL site. The guide value of 3×10^{-12} µCi/ml for De Soto ambient air alpha activity is due to work with unencapsulated uranium (including depleted uranium). The guide value of 3×10^{-10} µCi/ml is for ^{60}Co, for which the ambient air beta activity guide is appropriate since it is the most restrictive limit for any beta-emitting radionuclide in use at the De Soto site. Guide value percentages are not presented for soil or vegetation data since none have been established.

Monitoring of ambient radiation is performed with TLDs. Each dosimeter set uses two calcium fluoride (CaF_2:Mn) low background, bulb-type chip dosimeters. The dosimeter sets are placed at locations on or near the perimeters of the De Soto and SSFL sites. Each dosimeter, sealed in a light-proof energy compensation shield, is installed in a sealed plastic container mounted about 1 m above ground at each location. The dosimeters are exchanged and evaluated quarterly. During the year, 18 on-site TLD monitoring locations were used. Five additional dosimeter sets, placed at locations up to 10 miles from the sites, are similarly evaluated to determine the local area off-site ambient radiation level, which averaged 11 µrem/h for 1985. The quarterly and

TABLE 6

AMBIENT AIR RADIOACTIVITY DATA--1985

Area (monthly)	Activity	Number of Samples	Gross Radioactivity Concentrations—Femtocuries per cm^3 (10^{-15} µCi/ml)			
			Annual Average Value and Dispersion	Maximum Value[a] and Month Observed	Percent of Guide[b]	Percent of Samples With Activity <MDL[c]
De Soto on-site (2 locations)	Alpha	544	2.7 ± 2.2	38.0 (01/07)	0.09	89
	Beta		40.0 ± 14.0	180.0 (05/10)	0.01	2
SSFL on-site (5 locations)	Alpha	1725	2.0 ± 1.6	44.0 (07/04)	3.3	93
	Beta		40.0 ± 13.0	170.0 (07/05)	0.01	2
SSFL sewage treatment plant	Alpha	360	2.3 ± 1.9	25.0 (01/29)	3.8	89
SSFL control center	Alpha	365	1.6 ± 1.4	13.0 (07/04)	2.7	93
	Beta		38.0 ± 12.0	160.0 (07/15)	0.1	3
All locations	Alpha	2994	2.1 ± 1.8	44.0 (07/04)	0.07	92
	Beta		40.8 ± 15.2	240.0 (05/07)	0.01	2

[a]Maximum value observed for single sample.
[b]Guide: 3×10^{-12} µCi/ml alpha, 3×10^{-10} µCi/ml beta; 10 CFR 20 Appendix B. SSFL site: 6×10^{-14} µCi/ml alpha, 3×10^{-11} µCi/ml beta; 10 CFR 20 Appendix B, CAC 17, DOE Order 5480.1A.
[c]MDL = 6.4×10^{-15} µCi/ml alpha; 1.3×10^{-14} µCi/ml beta.

annual radiation exposures and the equivalent absolute and altitude-adjusted annual exposures, and exposure rates determined for each dosimeter location are presented in Tables 7 and 8.

Table 7 shows that radiation exposures and equivalent annual exposure rates monitored on-site are nearly identical to levels monitored at five widely separated off-site locations. These data reflect natural background radiation from cosmic radiation, radionuclides in the soil, radon and thoron in the atmosphere, and radioactive fallout from atmospheric nuclear device tests. Locally, the natural background radiation level as measured by these

TABLE 7

DE SOTO AND SSFL SITES--AMBIENT RADIATION
DOSIMETRY DATA--1985

TLD Location		Quarterly Exposure (mrem)				Annual Exposure (mrem)	Equivalent Exposure at 1000 ft ASL	
		Q-1	Q-2	Q-3	Q-4		(mrem)	(μrem/h)
De Soto	DS-1	22	31	26	28	107	109	12
	DS-2	20	24	30	26	100	102	12
	DS-3	20	29	26	26	101	103	12
	DS-4	23	31	25	a	105	107	12
	DS-5	21	28	22	25	96	98	11
	DS-6	24	32	24	a	107	109	12
	DS-7	20	26	21	24	91	93	11
	DS-8	21	28	20	24	93	95	11
Mean value		21	29	24	26	100	102	12
SSFL	SS-1	23	35	26	a	112	100	11
	SS-2	20	35	30	32	117	105	12
	SS-3	24	35	30	32	121	109	12
	SS-4	a	33	31	32	128	115	13
	SS-5	24	34	29	30	117	104	12
	SS-6	26	37	30	32	125	114	13
	SS-7	19	36	26	29	110	98	11
	SS-8	b	38	29	32	132	120	14
	SS-9	b	40	34	40	152	140	16
	SS-10	b	34	28	30	123	112	13
Mean value		23	36	29	32	124	112	13
Off-site	OS-1	22	32	29	29	112	114	13
	OS-2	21	27	23	26	97	95	11
	OS-3	20	34	24	26	104	106	12
	OS-4	22	30	24	27	103	101	12
	OS-5	23	32	25	30	110	111	13
Mean value		22	31	25	28	105	105	12

[a]Missing dosimeter; annual exposure estimated from data for three quarters.
[b]Dosimeter location established at the beginning of the second quarter. Annual exposure estimated from data for three quarters.

dosimeters is about 100 mrem/year. The small variability observed in tne data is attributed to differences in elevation and geologic conditions at the various dosimeter locations. The altitude range for the dosimeter locations is from about 875 ft ASL (above sea level) at the De Soto site to a maximum of about 1900 ft ASL for one of the SSFL dosimeters. When normalized to a specific altitude by adjusting the measured value by an altitude adjustment factor equal to 15 mrem/1000 ft elevation difference, derived radiation exposures for all locations are essentially identical. The 1985 averaged exposure values adjusted to 1000 ft ASL are 102 $\pm$ 6 mrem for the De Soto site, 112 $\pm$ 12 mrem for the SSFL site, and 105 $\pm$ 8 mrem for the off-site control dosimeters.

During the 4-year period of 1977 through 1980, a steady increase was observed in the TLD readings for all locations. Although the increases were variable from year to year and between locations, averaged over 4 years, the increases were in the range of 14 to 17 mrem/year. The values for 1985 show a slight increase from the previous year's results when adjusted to a common altitude.

Supplementary measurements of ambient radiation levels with high-pressure ion chamber (HPIC) monitors are made at two locations at the SSFL site. The HPIC values for 1985 were equivalent to annual exposures of 111 mrem for the Building 207 monitor and 120 mrem for the Building 363 monitor. These values are in good agreement with results for nearby TLD locations for the year.

For independent monitoring of radiation levels in this area, the Radiologic Health Section of the State of California Department of Health Services provides packages containing lithium fluoride (LiF) chip dosimeters for placement with the packets used for the bulb dosimeters. The State dosimeters are returned to the Radiologic Health Section in Sacramento for evaluation. Data for tnese TLDs, placed at eight Rocketdyne dosimeter locations, both on-site and off-site, are presented in Table 8 for 1985. Considering the total independence of these measurements and the use of different thermoluminescent materials, tne agreement is reasonably good; however, the State results are somewhat lower for each location jointly monitored.

TABLE 8

DE SOTO AND SSFL SITES--STATE OF CALIFORNIA
AMBIENT RADIATION DOSIMETRY DATA--1985

TLD Location		Quarterly Exposure (mrem)				Annual Exposure (mrem)	Equivalent Exposure at 1000 ft ASL	
		Q-1	Q-2	Q-3	Q-4		(mrem)	(μrem/h)
De Soto	DS-2	23	12	17	19	71	73	8
	DS-6	24	20	21	a	87[b]	89	10
	DS-8	a	16	20	19	73[b]	75	9
Mean value		24	16	19	19	78	79	9
SSFL	SS-3	27	20	24	22	93	81	9
	SS-6	27	24	21	30	102	91	10
	SS-7	21	21	24	a	88[b]	76	9
Mean value		25	22	23	26	96	83	9
Off-site	OS-1	22	20	21	26	89	91	10
	OS-5	26	19	18	26	89	90	10
Mean value		24	20	20	26	89	91	10

[a]Missing dosimeter; annual exposure estimated from data for the three quarters.
[b]Annualized value.

B. NONRADIOACTIVE MATERIALS--1985

Processed wastewater and most collected surface runoff discharged from the SSFL site flows to Rocketdyne retention pond R-2A. Water samples from the pond are analyzed for various constituents, as required by the Regional Water Quality Control Board, for each discharge to Bell Canyon. Such discharges are normally done only as a result of excessive rainfall runoff; however, during 1985, only four off-site discharges occurred due to a dry year. The results of analyses for each discharge for 1985 are presented in Table 9.

TABLE 9

NONRADIOACTIVE CONSTITUENTS IN WASTEWATER DISCHARGED TO UNRESTRICTED AREAS--1985
(Analysis Results for Wastewater Discharged from Pond R-2A to
Bell Creek on Date Indicated - Sample Station W-12)

	January 29[a]		March 7[a]		March 28[a]		November 25[a]	
	Result	of Guide	Result	of Guide	Result	of Guide	Result	of Guide
Total dissolved solids (mg/l)	340	35.8	480	50.5	380	40.0	224	23.6
Chloride (mg/l)	40	26.7	52	34.7	40	26.7	21	14.0
Sulfate (mg/l)	110	36.7	124	41.3	108	36.0	52	17.3
Suspended solids (mg/l)	24	-	17	-	20	-	39.4	-
Settleable solids (mg/l)	0.1	-	<0.1	-	<0.1	-	<0.1	-
BOD_5 (mg/l)	7	23.3	3	30.0	4	13.3	4.3	14.3
Oil and grease (mg/l)	1.6	10.7	<5	<33.3	<5	<33.3	2.6	17.3
Turbidity (TU)	14	-	4	-	11	-	51	-
Fluoride (mg/l)	0.4	40.0	0.4	40.0	0.5	50.0	0.1	10.0
Boron (mg/l)	0.3	30.0	0.3	30.0	0.2	20.0	0.2	20.0
Residual chlorine (mg/l)	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0
Fecal coliform (MPN/100 ml)	<2	<8.7	<2	<8.7	<2	<8.7	<2	<8.7
Surfactants (MBAS)	0.03	6.0	0.08	16.0	0.03	6.0	0.04	26.7
pH	8.6		8.3		8.4		7.8	
Rainfall (cm)	1.4		0.9		2.8		6.5	
Estimated rainfall runoff (m^3)	47,250		28,350		86,940		151,200	
Release volume (m^3)	23,247		15,974		7,401		13,986	

[a]Rainfall-related discharge

0003Y/slw

IV. ENVIRONMENTAL MONITORING PROGRAM

A. DESCRIPTION

A program of soil and vegetation sample collection and analysis for radioactivity was begun in 1952 in the Downey, California area where the nuclear research and development work of the predecessor company to Rocketdyne was initially located. Environmental sampling was subsequently extended to the then proposed Sodium Reactor Experiment (SRE) site in the Simi Hills in May 1954. In addition, sampling was begun in the Burro Flats area, southwest of SRE, where other nuclear installations were planned and are currently in operation. The Downey area survey was terminated when nuclear activities were relocated to Canoga Park in 1955. The primary purpose of the environmental monitoring program is to adequately survey environmental radioactivity to ensure that Rocketdyne nuclear operations do not contribute significantly to environmental radioactivity. The locations of sampling stations are shown in Figures 5 through 7 and listed in Table 10.

B. SAMPLING AND SAMPLE PREPARATION

1. Soil

Soil is analyzed for radioactivity to monitor for any significant increase in radioactive deposition by fallout from airborne radioactivity. Since soil is naturally radioactive and has been contaminated by atmospheric testing of nuclear weapons, a general background level of radioactivity exists. The data are monitored for increases beyond the natural variability of this background. For most radionuclides, gross alpha and beta radioactivity measurements are adequate for this purpose. Chemically specific analyses are performed for plutonium to provide improved sensitivity.

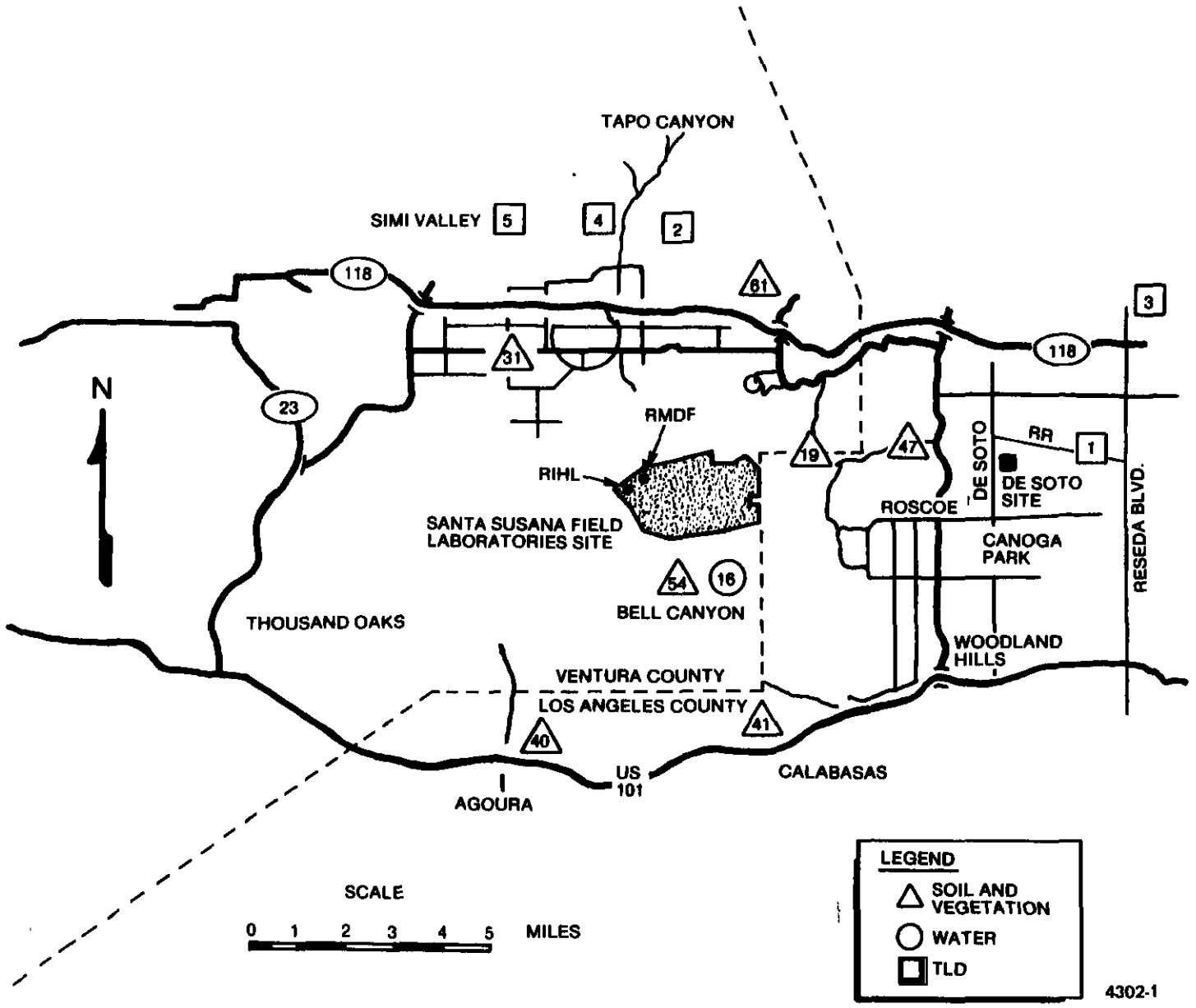

Figure 5. Map of Canoga Park, Simi Valley, Agoura, and Calabassas Sampling Stations

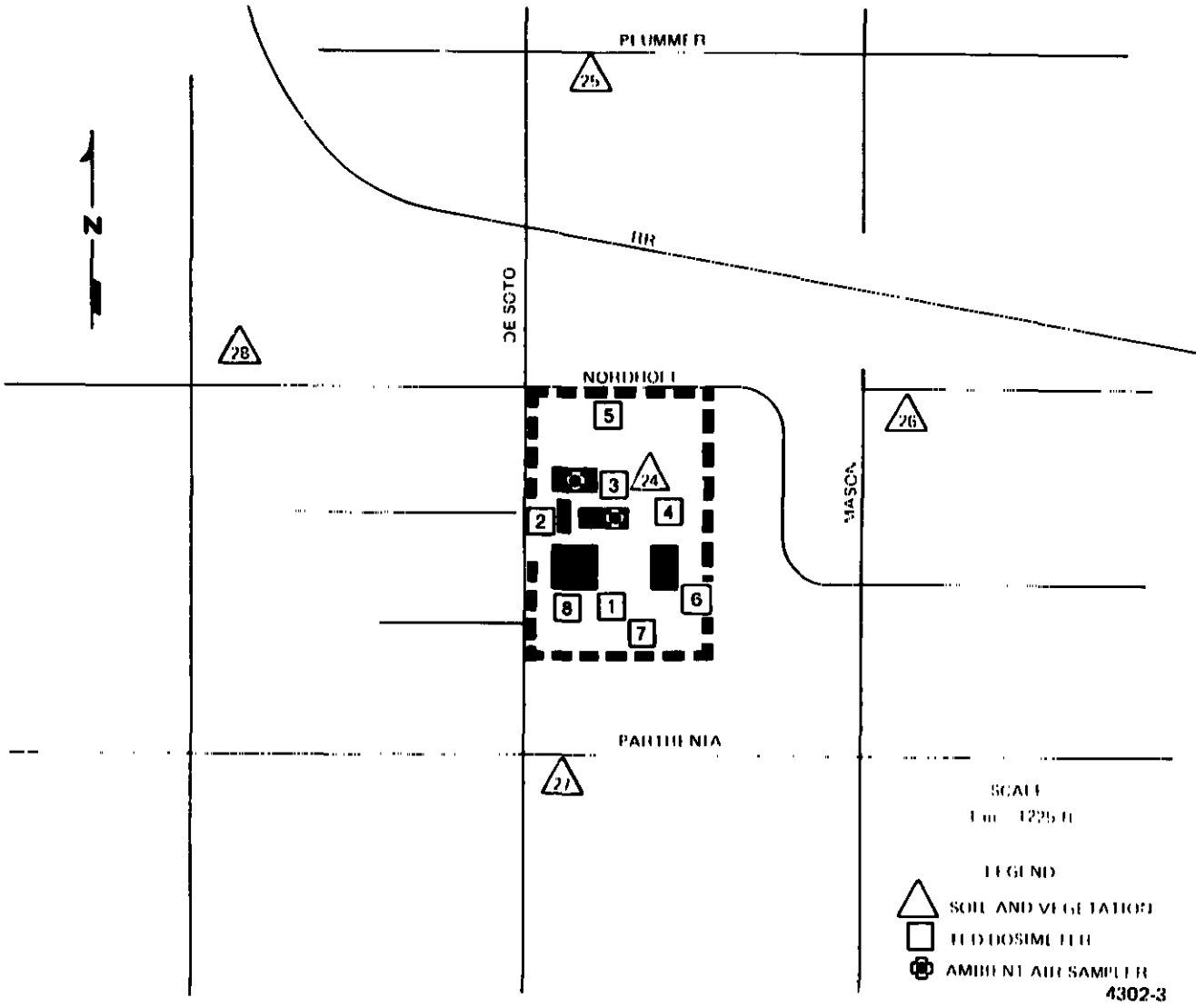

Figure 6. Map of De Soto Site and Vicinity Sampling Stations

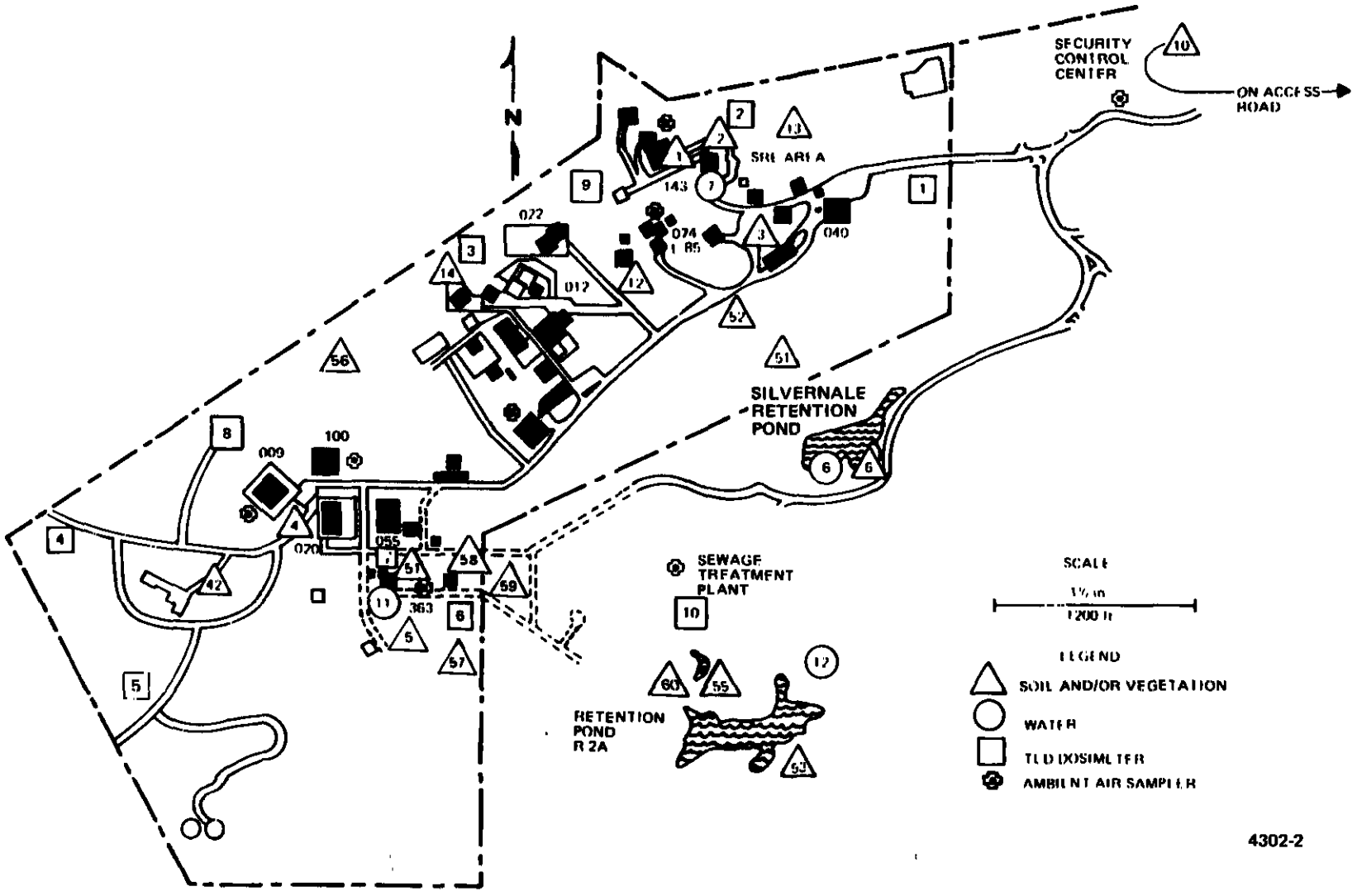

Figure 7. Map of Santa Susana Field Laboratories Site Sampling Stations

TABLE 10

SAMPLING LOCATION DESCRIPTION
(Sheet 1 of 4)

Station	Location	Frequency of Sampling[a]
SV-1	SSFL Site, Building 143, southeast side	(M)
SV-2	SSFL Site, Building 143, at perimeter drainage system	(M)
SV-3	SSFL Site, Building 064, north parking lot area	(M)
SV-4	SSFL Site, Building 020, at west fence	(M)
SV-5	SSFL Site, Building 363, east parking lot area	(M)
SV-6	SSFL Site Interim Retention Pond, south side	(Q)
SV-10	SSFL Site Access Road, at upper mobile home park entrance	(Q)
SV-12	SSFL Site, Building 093, at reactor building driveway	(M)
SV-13	SSFL Site, between SRE Water Retention Pond and former sodium cleaning facility	(M)
SV-14	SSFL Site, Building 028, upper parking lot area	(M)
SV-19	SSFL Site Entrance, Woolsey Canyon	(Q)
SV-24	De Soto Site, Building 104, east side	(M)
SV-25	De Soto Avenue and Plummer Street, southeast corner	(Q)
SV-26	Mason Avenue and Nordhoff Street, southeast corner	(Q)
SV-27	De Soto Avenue and Parthenia Street, northeast corner	(Q)
SV-28	Canoga Avenue and Nordhoff Street, northwest corner	(Q)
SV-31	Simi Valley, Alamo Avenue and Sycamore Road, southeast corner	(Q)
SV-40	Agoura - Kanan Road and Ventura Freeway at Frontage Road	(Q)
SV-41	Calabasas - Parkway Calabasas and Ventura Freeway at Frontage Road	(Q)
SV-42	SSFL Site, Building 886, at old sodium disposal facility gate	(M)
SV-47	Chatsworth Reservoir Site North Boundary at north gate	(M)
SV-51	SSFL Site, Building 029, at driveway	(M)

TABLE 10

SAMPLING LOCATION DESCRIPTION
(Sheet 2 of 4)

Station	Location	Frequency of Sampling[a]
SV-52	SSFL Site, Burro Flats Drainage Control Sump, G Street and 17th Street	(M)
SV-53	SSFL Site Pond R-2A	(Q)
SV-54	Bell Creek at Ventura County Line	(M)
SV-55	SSFL Site, Pond R-2A (Pond Bottom Mud), north side	(M)
SV-56	SSFL Site, F Street and 24th Street	(S)
S-57	SSFL Site, J Street, south of Building 055 exhaust stack	(S)
S-58	SSFL Site, Building 353, south of road	(S)
S-59	SSFL Site, Test Area CTL 4, entrance, east side	(S)
S-60	SSFL Site, Pond R-2A, northwest side	(S)
S-61	Simi Valley, east end of Alamo Avenue	(S)
W-6	SSFL Site Interim Retention Pond, south side	(M)
W-7	SSFL Site Supply Water, Building 003, washroom faucet	(M)
W-11	SSFL Site Domestic Water, Building 363, washroom faucet	(M)
W-12	SSFL Site, Pond R-2A, north side	(M)
W-16	Bell Creek at Ventura-Los Angeles County Line	(M)
A-1	De Soto Site, Building 102 roof	(D)
A-2	De Soto Site, Building 104 roof	(D)
A-3	SSFL Site, Building 100, east side	(D)
A-4	SSFL Site, Building 011, west side	(D)
A-5	SSFL Site, Building 600, Sewage Treatment Plant, north side	(D)
A-6	SSFL Site, Building 207, Security Control Center, north side	(D)
A-7	SSFL Site, Building 074, south side	(D)
A-8	SSFL Site, Building 163, Box Shop at east side	(D)
A-9	SSFL Site, Building 363, west side	(D)
A-10	SSFL Site, Building 100, east side - 7-day sampler	(168 h)

TABLE 10

SAMPLING LOCATION DESCRIPTION
(Sheet 3 of 4)

Station	Location	Frequency of Sampling[a]
On-Site--De Soto - Ambient Radiation Dosimeter Locations (TLD)		
DS-1	De Soto Site, south of Building 102	(Q)
DS-2	De Soto Site, west boundary inside water supply enclosure (State of California TLD Location Number 2)	(Q)
DS-3	De Soto Site, Guard Post 1, Building 102	(Q)
DS-4	De Soto Site, northeast corner of storage yard fence	(Q)
DS-5	De Soto Site, north boundary at parking lot entry	(Q)
DS-6	De Soto Site, east boundary, southeast corner of fence (State of California TLD Location Number 1)	(Q)
DS-7	De Soto Site, south boundary in parking lot telephone pole stay	(Q)
DS-8	De Soto Site Guard Post 4, southwest corner of Building 101 (State of California TLD Location Number 7)	(Q)
On-Site--SSFL (TLD)		
SS-1	SSFL Site, Building 114 on telephone pole	(Q)
SS-2	SSFL Site, SRE Retention Pond on pump motor control panel	(Q)
SS-3	SSFL Site, Electric Substation 719 on boundary fence (State of California TLD Location Number 3)	(Q)
SS-4	SSFL Site, west boundary on H Street	(Q)
SS-5	SSFL Site, southwest boundary at property line gate	(Q)
SS-6	SSFL Site, Building 854 (State of California TLD Location Number 4)	(Q)
SS-7	SSFL Site, Building 363, north side on HPIC monitor (State of California TLD Location Number 8)	(Q)
SS-8	SSFL Site, Sodium Disposal Facility north boundary	(Q)
SS-9	SSFL Site, Radioactive Materials Disposal Facility, northeast boundary	(Q)
SS-10	SSFL Site, Building 600, Sewage Treatment Plant	(Q)

TABLE 10

SAMPLING LOCATION DESCRIPTION
(Sheet 4 of 4)

Station	Location	Frequency of Sampling[a]
Off-Site (TLD)		
OS-1	Off-site, Northridge, approximately Oakdale Avenue and Lassen Street (State of California TLD Location Number 5)	(Q)
OS-2	Off-site, Simi Valley, approximately Tapo Canyon and Walnut Streets	(Q)
OS-3	Off-site, San Fernando Valley, Northridge, approximately Plummer Street and Vanalden Avenue	(Q)
OS-4	Off-site, Simi Valley, approximately Tapo Canyon and Walnut Streets	(Q)
OS-5	Off-site, Simi Valley, approximately Erringer Road and Highway 118 (State of California TLD Location Number 6)	(Q)
HPI-1	High-Pressure Ion Chambers (HPIC) Ambient Radiation Monitor at Building 207, north side	(C)
HPI-2	HPIC Ambient Radiation Monitor at Building 363, north side	(C)

[a]Code	Description
SV	Soil and vegetation sample station
S	Soil sample station
W	Water sample station
A	Air sampler station
TLD	Thermoluminescent dosimeter
D	Daily sample
M	Monthly sample
Q	Quarterly sample
S	Semiannual sample
C	Continuous

Surface soil types available for sampling range from decomposed granite to clay and loam. Samples are taken from the upper 1 cm of undisturbed ground surface for gross radioactivity analysis and to a depth of 5 cm for plutonium analysis. The soil samples are packaged in plastic containers and returned to the laboratory for analysis.

Sample preparation of soil for gross radioactivity determination consists of transferring the soils to Pyrex beakers and drying them in a muffle furnace at about 500°C for 8 h. After cooling, the soil is sieved to obtain uniform particle size. Two-gram aliquots of the sieved soil are weighed into copper planchets. The soil is wetted in the planchet with alcohol, evenly distributed to obtain uniform sample thickness, dried, and counted for alpha and beta radiation.

Soil plutonium analysis is performed using a chemically specific method by a certified independent testing laboratory according to the guidelines specified in the U.S. NRC Regulatory Guide 4.5 titled "Measurements of Radionuclides in the Environment--Sampling and Analysis of Plutonium in Soil."

2. Vegetation

The analysis of vegetation, performed as an adjunct to the soil analysis, is done to determine the uptake of radioactivity by plants. These plants do not contribute to the human food chain, and there is no significant agriculture or grazing in the immediate neighborhood of either site.

Vegetation samples obtained in the field are of the same perennial plant types, wherever possible; these are usually sunflower or wild tobacco. Vegetation leaves are stripped from plants and placed in waxed cardboard containers for transfer to the laboratory for analysis. Ordinarily, plant root systems are not analyzed.

Since the analysis is done to determine uptake only, and not fallout deposition, vegetation is first washed with tap water to remove soil, dust, and other foreign matter and then thoroughly rinsed with distilled water.

Washed vegetation is vacuum-dried in tared beakers at 100°C for 24 h for dry weight determination, then ashed in a muffle furnace at about 500°C for 8 h, producing a completely burned ash. One-gram aliquots of pulverized ash from each beaker are weighed into copper planchets. The vegetation ash is wetted in the planchet with alcohol, evenly distributed to obtain uniform sample thickness, dried, and counted for alpha and beta radiation. The dry/ash weight ratio is used for determining the equivalent dry weight gross radioactivity concentration value. The moisture content of the vegetation is about 80% of the total plant weight.

3. Water

Surface and supply water samples are obtained monthly at the De Soto and SSFL sites and from Bell Creek. The water is drawn into 1-liter polyethylene bottles and transferred to the laboratory.

Five-hundred-milliliter volumes of water are evaporated to dryness in crystallizing dishes at about 90°C. The residual salts are redissolved into distilled water, transferred to planchets, dried under heat lamps, and counted for alpha and beta radiation.

4. Ambient Air

Air sampling is performed continuously at the De Soto and SSFL sites with continuous air samplers operating on 24-h sampling cycles. Airborne particulate radioactivity is collected on Type A glass fiber filter media, which are automatically changed daily at the end of each sampling period (midnight). The samples are counted for alpha and beta radiation following a minimum 120-h decay period. The volume of a typical daily ambient air sample is about 25 m^3.

Figure 8 is a graph of the weekly averaged long-lived alpha and beta ambient air radioactivity concentrations for the De Soto and SSFL sites during 1985. The daily data were mathematically smoothed in a moving weekly average

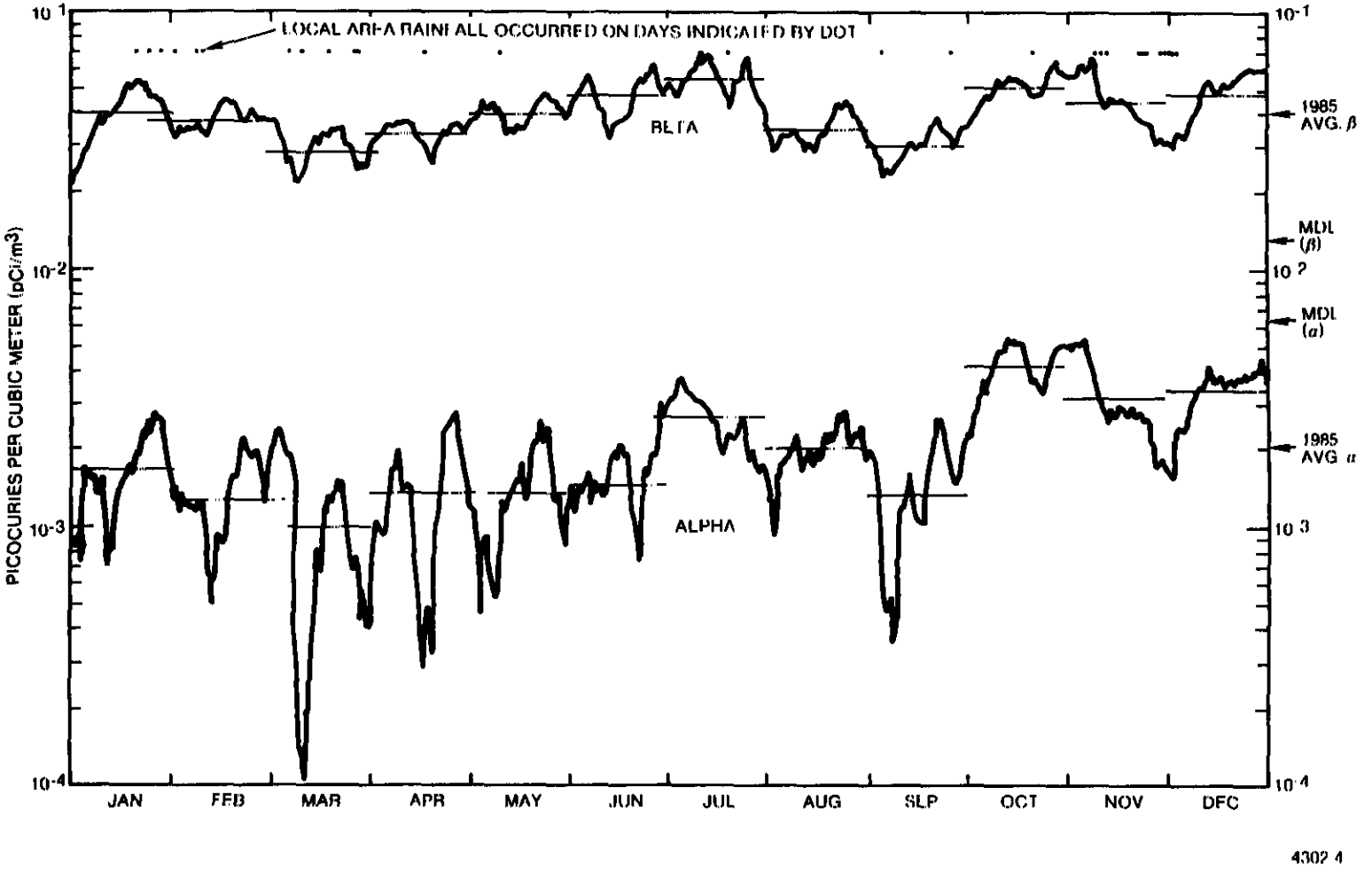

Figure 8. Weekly, Monthly, and Annual Averaged Long-Lived Airborne Radioactivity at the De Soto and Santa Susana Field Laboratories Sites--1985

of daily data for the year. The average alpha and beta radioactivity concentrations for each month are indicated by horizontal bars. The graph shows small decreasing trends in airborne radioactivity during the first and third quarters, with a small increase in the summer and again late in the year; however, overall levels were generally constant for the year. Several transient peak concentration levels were observed within the general trend. This activity is attributed to naturally occurring airborne radioactive materials and, to a minor degree, to residual aged fallout from past foreign atmospheric tests of nuclear devices. Nuclides identified in air samples collected during 1985 include ^{7}Be, and ^{40}K, plus several of the naturally occurring radionuclides from the uranium and thorium series. While the data for airborne alpha activity are nearly all below the minimum detection level for a single sample, averaging values from 9 daily air samples over 7 consecutive days and over calendar months reveals the long-term behavior of this activity, which for 1985 shows relatively constant levels with the exception of depressed airborne alpha radioactivity coincident with periods of rainfall.

C. COUNTING AND CALIBRATION

Environmental soil, vegetation, water, and ambient air samples are counted for alpha and beta radiation with a low-background gas flow proportional counting system. The system is capable of simultaneously counting both alpha and beta radiation. The sample-detector configuration provides a nearly 2π geometry. The thin-window detector is continually purged with methane counting gas. A preset time mode of operation is used for all samples. The minimum detection levels shown in Table 11 are those for a single sample determined by using typical values for counting time, system efficiencies for detecting alpha and beta radiation, background count rates (approximately 0.05 cpm alpha and 1.0 cpm beta), and sample size. For the table, the minimum statistically significant amount of radioactivity, irrespective of sample configuration, is taken as that amount equal in count rate to three times the standard deviation of the system background count rate. The minimum detection level (MDL) is that value that would be statistically expected to be exceeded by random variation in background in only 0.135% of the measurements.

TABLE 11

MINIMUM RADIOACTIVITY DETECTION LEVELS (MDLs)

Sample	Activity	Minimum Detection Level
Soil	Alpha	$(2.3 \pm 1.4)\ 10^{-6}$ µCi/g
	Beta	$(2.3 \pm 1.2)\ 10^{-7}$ µCi/g
Vegetation	Alpha	$(2.3 \pm 1.3)\ 10^{-6}$ µCi/g ash
	Beta	$(3.6 \pm 1.8)\ 10^{-7}$ µCi/g ash
Water	Alpha	$(6.4 \pm 3.9)\ 10^{-9}$ µCi/ml
	Beta	$(6.4 \pm 3.2)\ 10^{-10}$ µCi/ml
Air	Alpha	$(6.4 \pm 3.8)\ 10^{-15}$ µCi/ml
	Beta	$(1.3 \pm 0.6)\ 10^{-14}$ µCi/ml

Counting system efficiencies are determined routinely with Ra-D+E+F (with alpha absorber), ^{36}Cl, ^{230}Th, ^{235}U, and ^{239}Pu standard sources and with ^{40}K, in the form of standard reagent-grade KCl, which is used to simulate soil and vegetation samples, and with soil containing known amounts of fully enriched uranium.

Self-absorption standards for beta counting are made by dividing sieved KCl into samples that increase in mass by 200-mg increments, from 100 to 3000 mg. The samples are placed in planchets of the type used for environmental samples and are counted. The ratio of sample activity to the observed net count rate for each sample is plotted as a function of sample mass and a smooth curve is drawn through these points. The correction factor (ratio) corresponding to the mass of environmental samples is then obtained from the graph. The product of the correction factor and the net sample count rate yields the sample activity (dpm). This method has been proven usable by applying it to various-sized aliquots of uniformly mixed environmental samples and observing that the resultant specific activities fell within the expected statistical counting error, showing the absence of any systematic bias.

Since the observed radioactivity in environmental samples is primarily the result of natural sources and weapons testing and is at such low concentrations, no identification of constituent radionuclides is done for each sample; however, collected samples are composited for gamma spectrometry of accumulated sample materials. The detection of significant levels of radioactivity would lead to an investigation of the radioactive material involved, the sources, and the possible causes.

D. NONRADIOACTIVE MATERIALS

The Rocketdyne Division of Rockwell International Corporation has filed a Report of Waste Discharge with the California Regional Water Quality Control Board and has been granted a National Pollutant Discharge Elimination System permit to discharge wastewater, pursuant to Section 402 of the Federal Water Pollution Control Act. The permit, NPDES No. CA0001309, which became effective 27 September 1976, was renewed with minor changes effective 17 September 1984. This permit covers discharge of overflow and storm runoff from water reclamation retention ponds into Bell Creek. Discharge generally occurs only during and immediately after periods of heavy rainfall or during extended periods of rocket engine testing that release large amounts of cooling water to the ponds.

Only one of the retention ponds receives influent from the nuclear operating areas of the SSFL site. It is identified as retention pond R-2A, Water Sample Station W-12 in Table 10.

The influent includes sewage treatment plant outfall and surface runoff water. Grab-type water samples taken at the retention pond prior to a discharge are analyzed by a California State certified analytical testing laboratory for nonradioactive chemical constitutents and for radioactivity. The specific constituents analyzed for, and their respective limitations in discharged wastewater, are presented in Appendix C. Wastewater originating from facilities located throughout the SSFL site is collected at the retention pond.

The point of origin of small amounts of most nonradioactive constituents normally found in wastewater is difficult to determine; however, in the event of excessive amounts of any of these materials in wastewater, the origin could be determined from the knowledge of facility operations involving their use. Four off-site discharges of wastewater from pond R-2A occurred during 1985.

In addition to the wastewater discharge limitations, atmospheric pollutant discharge limitations were imposed by the Ventura County Air Pollution Control District (APCD) Permit 0271 on two natural-gas/oil-fired sodium heaters operated by ETEC. The limitations are 0.12 tons/year for reactive organic compounds, 79.63 tons/year for oxides of nitrogen, 1.87 tons/year for particulates, 0.11 tons/year for oxide of sulfur, and 3.2 tons/year for carbon dioxide. Based on fuel consumption records for this facility during 1985, there was essentially no discharge to the atmosphere in comparison with the discharge limits. During 1985, the APCD permit was renegotiated with Ventura County resulting in the more restrictive pollutant discharge limitations described above as compared to 1984.

V. EFFLUENT MONITORING PROGRAM

Effluents that may contain radioactive material are generated at the Rocketdyne Division facilities as the result of operations performed under contract to DOE, under NRC Special Nuclear Materials License SNM-21, and under the State of California Radioactive Material License 0015-70. The specific facilities are identified as Buildings 020, 021-022, and 055 at the Santa Susana site, SSFL, and Building 104 (previously identified as 004) at the De Soto Facility.

A. TREATMENT AND HANDLING

Waste streams released to unrestricted areas are always limited to atmospheric emissions. No contaminated liquids are discharged to unrestricted areas.

The level of radioactivity contained in all atmospheric emissions is reduced to the lowest value by passing the emissions through certified, high-efficiency particulate air (HEPA) filters. These emissions are sampled for particulate radioactive materials by means of continuously operating stack exhaust samplers at the points of release. In addition, stack monitors installed at Buildings 020, 021-022, and 055 provide automatic alarm capability in the event of the release of gaseous or particulate activity from Building 020 and particulate activity from Buildings 021-022 and 055. The HEPA filters used for filtering atmospheric emissions are at least 99.97% efficient for particles 0.3 μm in diameter. Particle filtration efficiency increases for particles above and below this size.

The average concentration and total radioactivity in atmospheric emissions to unrestricted areas are shown in Table 12. The effectiveness of the air cleaning systems is evident from the fact that in most cases the atmospheric emissions are less radioactive than is ambient air. The total shows that no significant quantities of radioactivity were released in 1985.

TABLE 12

ATMOSPHERIC EMISSIONS TO UNRESTRICTED AREAS--1985

	Approximate Emissions Volume (m^3)	Activity Monitored	Approximate Minimum Detection Level (10^{-15} µCi/ml)	Annual Average Concentration (10^{-15} µCi/ml)	Sampling Period Maximum Observed Concentration (10^{-15} µCi/ml)	Total Radio-activity Released (Ci)	Percent of Guide[a]	Percent of Samples with Activity <MDL
104 De Soto	1.3×10^8	Alpha	0.21	1.10	4.50	1.5×10^{-7}	0.04	7
		Beta	0.72	3.42	7.34	4.5×10^{-7}	0.001	20
020 SSFL	2.5×10^8	Alpha	0.09	1.77	102.80	4.5×10^{-7}	2.95	7
		Beta	0.30	354.22	22410.00	9.0×10^{-5}	1.18	0
021-022 SSFL	2.3×10^8	Alpha	0.09	0.17	1.80	3.9×10^{-8}	0.28	71
		Beta	0.30	39.13	673.28	9.0×10^{-6}	0.13	0
055 SSFL	2.2×10^8	Alpha	0.29	0.24	1.34	5.3×10^{-8}	0.40	73
		Beta	0.96	6.51	25.56	1.5×10^{-6}	0.22	4
Total	8.3×10^8				Total	1.0×10^{-4}		
Annual average ambient air radio-activity concen-centration[b] - 1985		Alpha	2.0		Ambient equivalent[c]	3.1×10^{-5}		
		Beta	35.0					

[a]Assuming all radioactivity detected is from Rocketdyne nuclear operations.
Guide: De Soto site: 3×10^{-12} µCi/ml alpha, 3×10^{-10} µCi/ml beta; 10 CFR 20 Appendix B.
SSFL site: 6×10^{-14} µCi/ml alpha, 3×10^{-11} µCi/ml beta, 3×10^{-12} µCi/ml beta (055 only); 10 CFR 20 Appendix B, CAC-17, and DOE Order 5480.1 Chapter XI.

[b]Averaged result for 7-day (200 m^3) SSFL continuous air sampler.

[c]Natural radioactivity contained in equivalent volume of air discharged through exhaust systems after filtration.

Note: All release points are at the stack exit.

0003Y/bjb

B. FACILITY DESCRIPTIONS

1. De Soto Site

a. Building 104--California State Licensed Activities

Operations at Building 104 that may generate radioactive effluents consist of research studies in applied physics and physical chemistry. Only atmospheric emissions are released from the building to uncontrolled areas. Major quantities of radionuclides present in encapsulated form are limited to ^{60}Co. Small amounts of irradiated metallurgical samples and depleted uranium are used for research purposes.

2. Santa Susana Field Laboratories Site

a. Building 020--NRC and California State Licensed Activities

Operations at Building 020 that may generate radioactive effluents consist of hot cell examination and decladding of irradiated nuclear fuels and examination of reactor components. Only atmospheric emissions are released from the building to uncontrolled areas. The discharge may contain particulate material, as well as radioactive gases, depending on the operations being performed and the history of the irradiated fuel or other material. No radioactive liquid waste is released from the facility. Radioactive material handled in unencapsulated form in this facility includes the following radionuclides: Th, U, Pu, as constituents in the various fuel materials; and ^{137}Cs, ^{90}Sr, ^{85}Kr, and ^{147}Pm as mixed fission products.

b. Buildings 021 and 022--DOE Contract Activities

Operations at Buildings 021 and 022 that may generate radioactive effluents consist of the processing, packaging, and temporary storage of liquid and dry radioactive waste material for disposal. Only atmospheric emissions are

released from the building to uncontrolled areas. No radioactive liquid waste is released from the facility. Nuclear fuel material handled in encapsulated or unencapsulated form contains uranium and plutonium plus ^{137}Cs, ^{90}Sr, ^{85}Kr, and ^{147}Pm as mixed fission products.

c. Building 055--NRC and California State Licensed Activities

Operations at Building 055 that may generate radioactive effluents consist of decommissioning and decontamination of the facility and equipment pending release for unrestricted use. Only atmospheric emissions are released from the facility to uncontrolled areas. No radioactive liquid waste is released from the facility.

The various fuel materials that have been used at the facility (depleted and enriched uranium and plutonium) contained the following radionuclides: U plus ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Am. No irradiated fuel materials have been processed at the facility.

C. ESTIMATION OF GENERAL POPULATION DOSE ATTRIBUTABLE TO NUCLEAR OPERATIONS--1985

The Los Angeles basin is a semiarid region whose climate is controlled primarily by the semipermanent Pacific high-pressure cell that extends from Hawaii to the southern California coast. The seasonal changes in the position of this cell greatly influence the weather conditions in this area. During the summer months, the high-pressure cell is displaced to the north. This results in mostly clear skies with little precipitation. During the winter, the cell moves sufficiently southward to allow some Pacific lows with their associated frontal systems to move into the area. This produces light to moderate precipitation with northerly and northwesterly winds.

The release of airborne material at the De Soto site for summer season weather conditions would generally be under a subsidence inversion into an

atmosphere that is typical of slight neutral to lapse conditions. Nocturnal cooling inversions, although present, are relatively shallow in extent. During the summer, a subsidence inversion is present almost every day. The base and top of this inversion usually lie below the elevation of the SSFL site. Thus, any atmospheric release from the SSFL site under this condition would result in Pasquill Type D lofting diffusion conditions above the inversion and considerable atmospheric dispersion, prior to any diffusion through the inversion into the Simi or San Fernando Valleys. In the winter season, the Pacific high-pressure cell shifts to the south and the subsidence inversion is usually absent. The surface airflow is then dominated by frontal activity moving easterly through the area, resulting in high-pressure systems in the great basin region. Frontal passages through the area during winter are generally accompanied by rainfall. Diffusion characteristics are highly variable depending on the location of the front. Generally, a light to moderate southwesterly wind precedes these frontal passages, introducing a strong onshore flow of marine air and producing lapse rates that are slightly unstable. Wind speeds increase as the frontal systems approach, enhancing diffusion. The diffusion characteristics of the frontal passage are lapse conditions with light to moderate northerly winds. Locally, average wind speeds for the various stability categories range from 0 to about 4.4 m/s with the greatest frequency occurring for winds from the north to northwest sectors. Local population distribution estimates projected for 1986, based on the 1980 federal census and on direct observation of nearby residences, for areas surrounding the SSFL site and out to 80 km for 16 sectors are shown in Figures 9 through 11.

The downwind concentration of radioactive material emissions to the atmosphere during 1985 from each of the three major Rocketdyne nuclear facilities has been calculated with the AIRDOS-EPA computer code using site-specific input data including local area windspeed, directional frequency, and stability plus facility-specific data such as stack heights and exhaust air velocity.

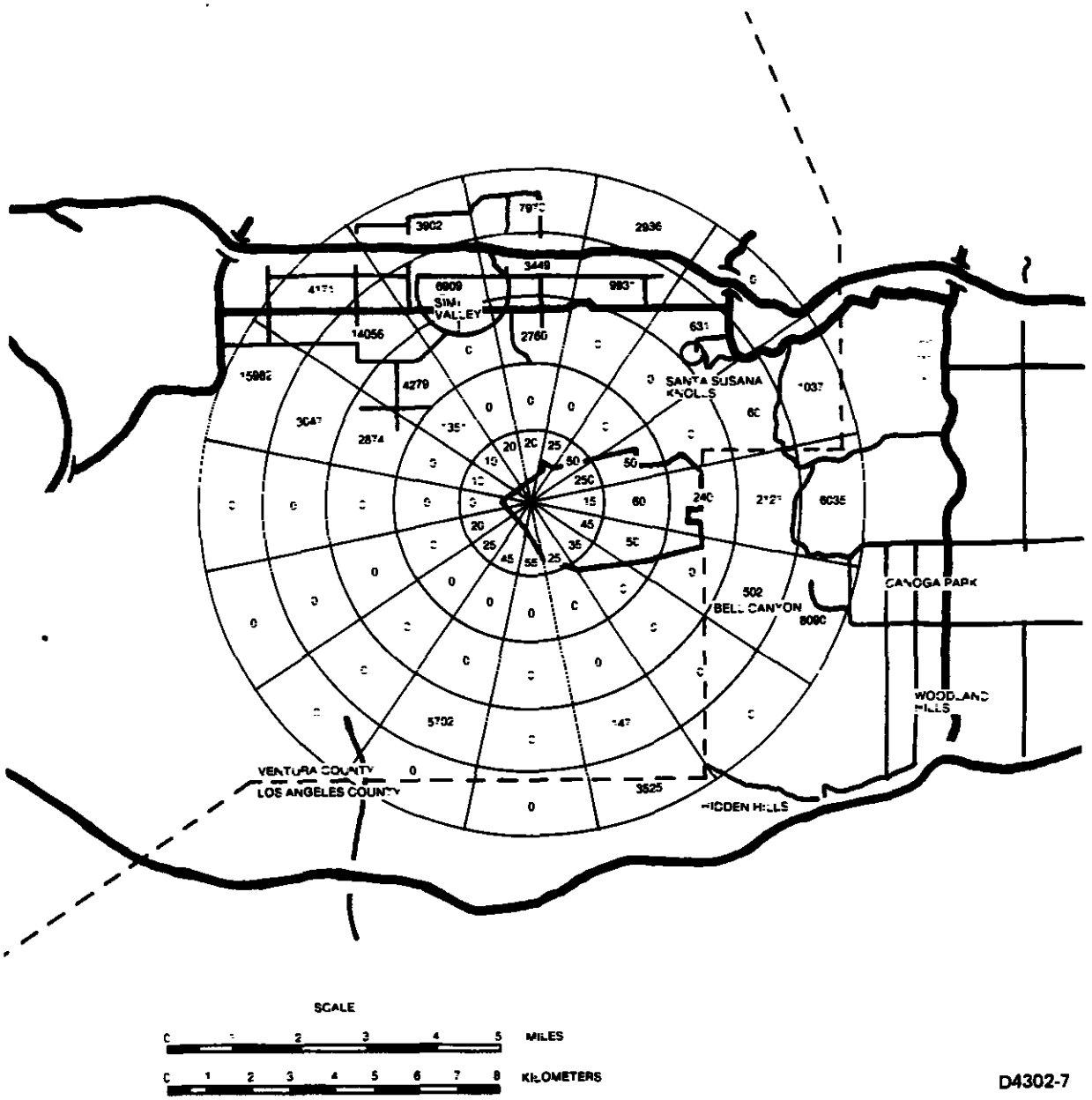

Figure 9. Santa Susana Field Laboratories Site Centered Demography to 8 km Distance

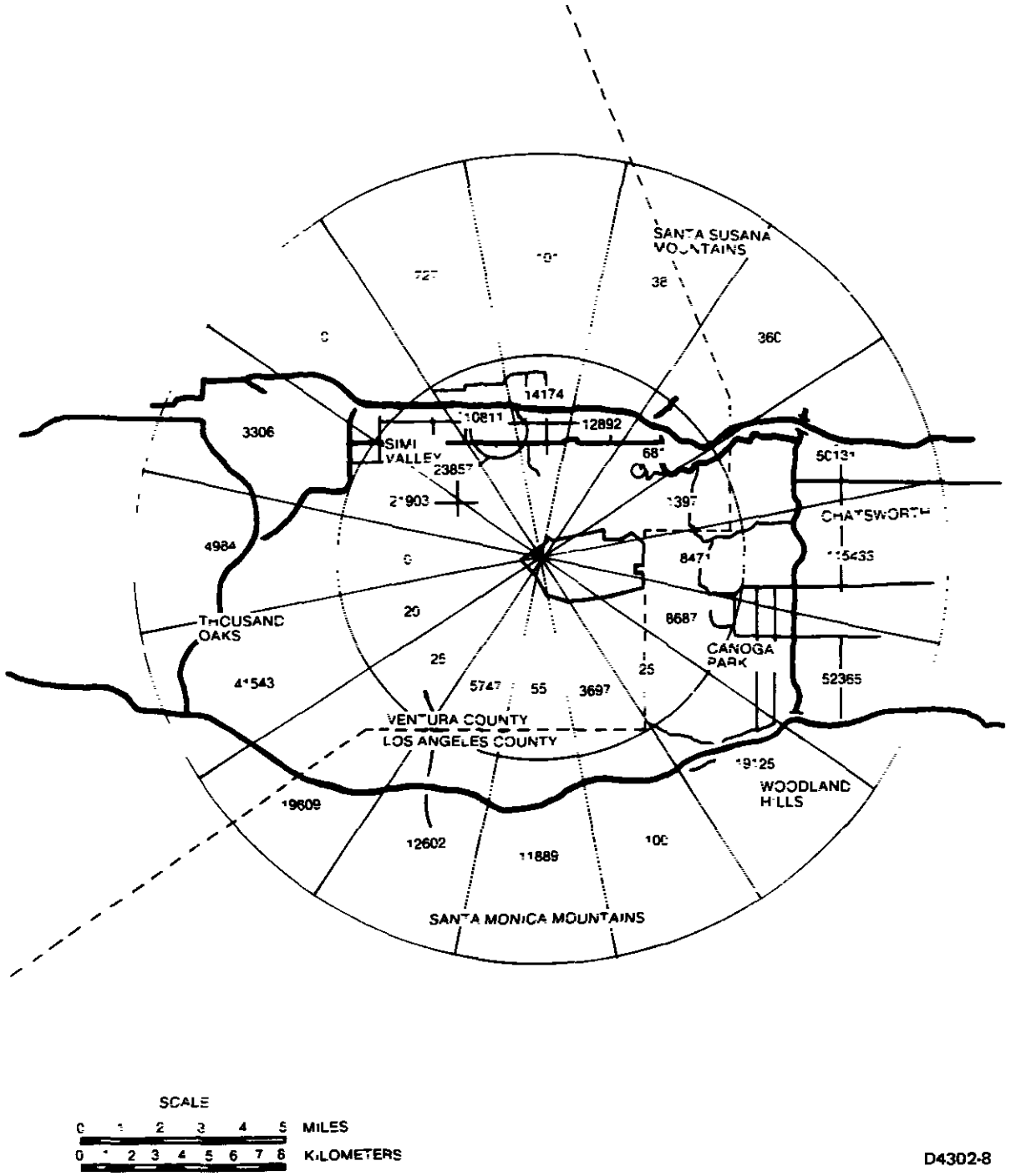

Figure 10. Santa Susana Field Laboratories Site Centered Demography to 16 km Distance

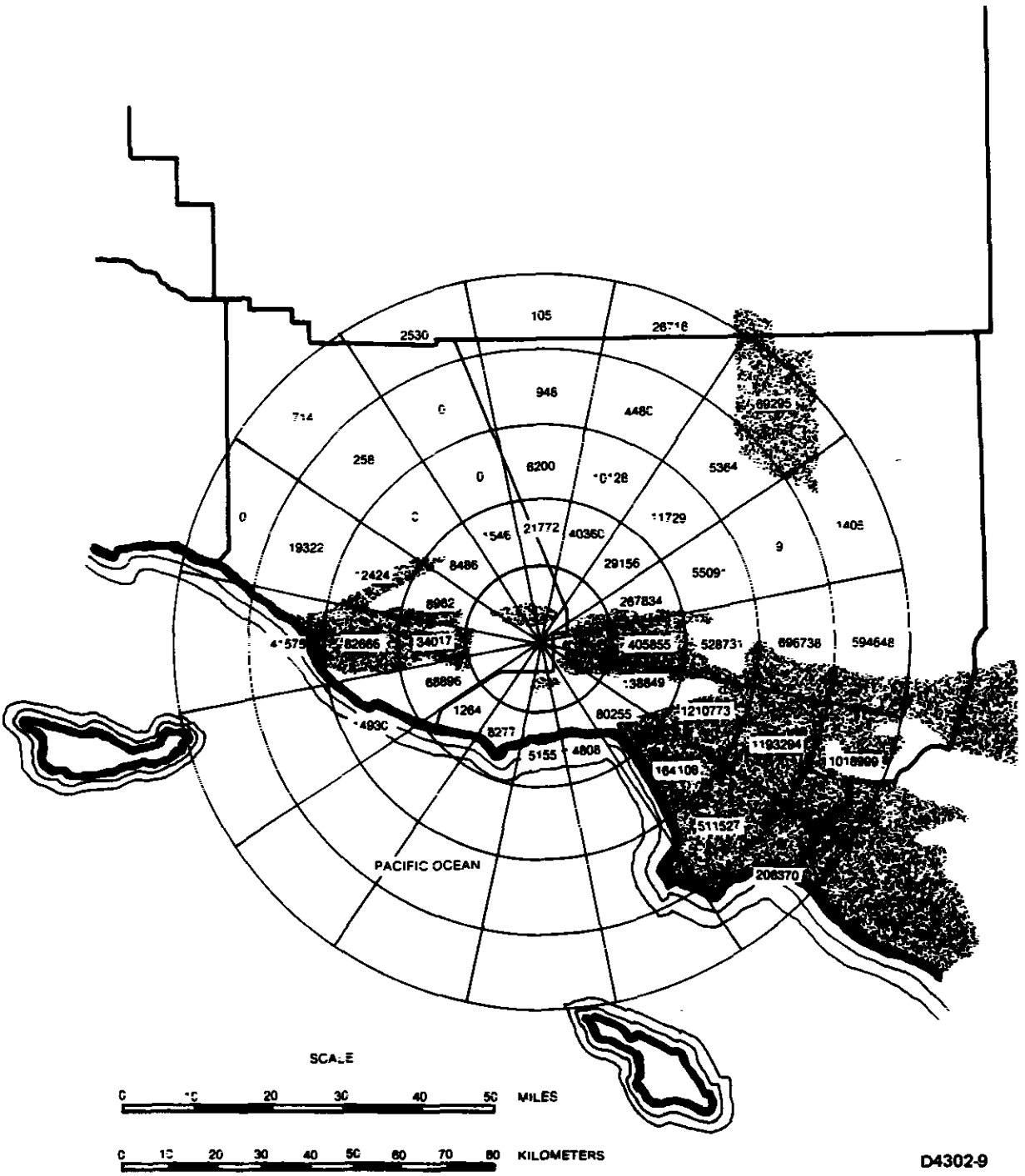

Figure 11. Santa Susana Field Laboratories Site Centered Demography to 80 km Distance (heavily populated areas are shown by shading)

To determine the maximum possible radioactivity concentrations at the site boundary location nearest to each release point and at the nearest residence, a mean wind speed of 2.2 m/s for each stability class was assumed and used to evaluate the plume centerline (maximum) concentrations toward the sector in which those locations lie. The 80-km concentration was calculated for the greatest wind frequency, which is toward a northerly direction. The concentration estimates are shown in Table 13, and both internal and external radiation dose estimates are shown in Table 14. The internal dose calculations in Table 14 assume a constant unsheltered exposure, adjusted for wind direction frequency, throughout the year and therefore considerably overestimate the actual annual-averaged doses at the nearest boundary and nearest residence. The external dose calculations assume that differences in TLD readings represent true differences in local exposure. These differences are extrapolated to the boundary and nearest residence using an inverse square distance relation from an assumed source of radiation.

TABLE 13

MAXIMUM DOWNWIND PLUME CENTERLINE CONCENTRATIONS OF ATMOSPHERIC EMISSIONS--1985

Facility	Release Rate (Ci/year)	Distance (m) to		Downwind Concentation (10^{-15} μCi/ml)[a]		
		Boundary	Residence	Boundary	Residence	80 km
B/104	6.0×10^{-7}	200 W	315 SW	0.0021	0.002	0.000013
B/020	9.0×10^{-5}	305 NW	1900 SE	0.13	0.066	0.0022
B/022	9.0×10^{-6}	350 NW	2300 SE	0.005	0.0037	0.0002
B/055	1.6×10^{-6}	400 NW	1830 SE	0.00016	0.000052	0.0000013

[a]Assume $\bar{u}$ = 2.2 m/s average wind speed, wind direction averaged for full year.

TABLE 14

EXPOSURE TO THE PUBLIC IN THE VICINITY OF ROCKETDYNE FACILITIES--1985 (rem)

Air Pathway Organ	De Soto Building 104		SSFL-T/020 (RIHL)		SSFL-T/021-022 (RMDF)		SSFL-T/055 (NMDF)	
	Boundary	Residence	Boundary	Residence	Boundary	Residence	Boundary	Residence
Gonads	3.5×10^{-12}	1.1×10^{-12}	0	0	0	0	0	0
Breast	2.2×10^{-12}	6.8×10^{-13}	0	0	0	0	0	0
Red bone marrow	1.8×10^{-12}	5.4×10^{-13}	2.9×10^{-8}	1.0×10^{-8}	1.0×10^{-9}	5.3×10^{-10}	3.9×10^{-9}	8.7×10^{-10}
Lungs	3.9×10^{-8}	1.2×10^{-8}	6.8×10^{-8}	2.3×10^{-8}	2.0×10^{-9}	1.1×10^{-9}	1.7×10^{-8}	3.7×10^{-9}
Thyroid	0	0	0	0	0	0	0	0
Bone surfaces	0	0	5.7×10^{-8}	2.0×10^{-8}	1.9×10^{-9}	9.8×10^{-10}	1.2×10^{-8}	2.7×10^{-9}
Liver	1.9×10^{-12}	5.7×10^{-13}	2.3×10^{-8}	7.9×10^{-9}	7.5×10^{-10}	3.8×10^{-10}	5.7×10^{-9}	1.3×10^{-9}
Kidney	0	0	0	0	0	0	0	0
Spleen	0	0	0	0	0	0	0	0
Thymus	0	0	0	0	0	0	0	0
Adrenals	0	0	0	0	0	0	0	0
Pancreas	0	0	0	0	0	0	0	0
Stomach	0	0	0	0	0	0	0	0
Small intestine	0	0	0	0	0	0	0	0
ULI + LLI	0	0	0	0	0	0	0	0
Remainder	0	0	0	0	0	0	0	0
50-yr committed whole body dose equivalent	3.9×10^{-8}	1.2×10^{-8}	1.8×10^{-7}	6.1×10^{-8}	5.7×10^{-9}	3.0×10^{-9}	3.9×10^{-8}	8.6×10^{-9}
Other pathways	0	0	0	0	0	0	0	0
External direct whole body - rem	4×10^{-3}	1×10^{-5}	4×10^{-3}	1×10^{-4}	8×10^{-2}	1×10^{-4}	0	0
Total exposure - rem	4×10^{-3}	1×10^{-5}	4×10^{-3}	1×10^{-4}	8×10^{-2}	1×10^{-4}	3.9×10^{-8}	8.6×10^{-9}
SI equivalent-SV	4×10^{-5}	1×10^{-7}	4×10^{-5}	1×10^{-6}	8×10^{-4}	1×10^{-6}	3.9×10^{-10}	8.6×10^{-11}

0003Y/emh

The general population person-rem dose estimates are calculated from the demographic distribution and the sector total inhalation intake (person-pCi/year) generated by AIRDOS-EPA, which uses release rate, wind speed, wind direction and frequency, inversion, lapse, and effective stack height parameters as input data. Population dose estimates centered on the SSFL site are presented in Table 15. Inhalation is the only significant exposure pathway likely to exist, with the lung the critical organ for Pu, and bone for Sr. The doses reported for SSFL site emissions are summed for all release points and nuclides.

The estimated off-site doses are extremely low compared to the maximum permissible exposures recommended for the general population in the vicinity of DOE facilities. The effective dose equivalent for any member of the public, for all pathways, shall not exceed 500 mrem/year for occasional exposures, and 100 mrem/year for prolonged periods of exposure. For the air patnway only, the limits are 25 mrem/year for whole body dose, and 75 mrem/year for any organ. The maximum estimated internal and external exposures to an individual for 1985 at the De Soto and SSFL site boundaries and also at the nearest residence are shown in Table 14. Estimated internal radiation doses due to atmospheric emission of radioactive materials from De Soto and the SSFL nuclear facilities are several orders of magnitude below the radiation standards and are far below doses due to internal exposure to natural radioactivity in air.

The external exposures, above background, are based on the greatest exposure adjusted to a constant altitude (1000 ft ASL) measured by a single dosimeter compared with average adjusted off-site measurements. The mean adjusted value for five off-site dosimeters was 105 mrem with a maximum observed value of 114 mrem. Boundary dose estimates assume 100% occupancy, whereas tne actual presence of persons at the boundary is rare or nonexistent. Review of the data indicates that these derived values, except for the RMDF, are not statistically different from zero, as shown by the uncertainties being near the reported value, but result from assumptions in the analysis.

TABLE 15

POPULATION DOSE ESTIMATES FOR ATMOSPHERIC EMISSIONS
FROM SSFL FACILITIES--1985

22.5° Sector	Dose to Receptor Population Segment (person-rem)						
	0-8 km	8-16 km	16-32 km	32-48 km	48-64 km	64-80 km	Total
N	4.6×10^{-4}	1.1×10^{-6}	1.0×10^{-4}	1.8×10^{-5}	2.0×10^{-6}	1.7×10^{-7}	5.8×10^{-4}
NNW	2.8×10^{-4}	4.8×10^{-6}	4.5×10^{-6}	0	0	2.5×10^{-6}	2.9×10^{-4}
NW	5.7×10^{-4}	0	2.7×10^{-5}	0	3.7×10^{-7}	8.0×10^{-7}	6.0×10^{-4}
WNW	8.2×10^{-4}	4.8×10^{-5}	6.0×10^{-5}	5.3×10^{-5}	6.0×10^{-5}	0	1.0×10^{-3}
W	0	4.4×10^{-5}	1.4×10^{-4}	2.2×10^{-4}	8.0×10^{-5}	0	4.8×10^{-4}
WSW	9.5×10^{-7}	1.9×10^{-4}	1.5×10^{-4}	2.1×10^{-5}	3.9×10^{-6}	0	3.7×10^{-4}
SW	7.8×10^{-7}	6.9×10^{-5}	2.1×10^{-6}	0	0	0	7.2×10^{-5}
SSW	6.4×10^{-5}	4.9×10^{-5}	1.5×10^{-5}	0	0	0	1.3×10^{-4}
S	4.6×10^{-6}	9.8×10^{-5}	2.0×10^{-5}	0	0	0	1.2×10^{-4}
SSE	8.0×10^{-5}	9.6×10^{-7}	2.2×10^{-5}	0	0	0	1.0×10^{-4}
SE	2.3×10^{-6}	1.7×10^{-4}	3.4×10^{-4}	4.5×10^{-4}	1.0×10^{-3}	3.2×10^{-4}	2.3×10^{-3}
ESE	1.4×10^{-4}	3.7×10^{-4}	4.6×10^{-4}	2.6×10^{-3}	1.8×10^{-3}	1.2×10^{-3}	6.3×10^{-3}
E	1.0×10^{-4}	5.6×10^{-4}	9.1×10^{-4}	7.6×10^{-4}	7.3×10^{-4}	4.9×10^{-4}	3.6×10^{-3}
ENE	1.8×10^{-5}	1.6×10^{-4}	4.0×10^{-4}	5.2×10^{-5}	6.2×10^{-9}	7.6×10^{-7}	6.3×10^{-4}
NE	1.1×10^{-5}	1.6×10^{-6}	5.9×10^{-5}	1.5×10^{-5}	5.1×10^{-6}	5.1×10^{-5}	1.4×10^{-4}
NNE	2.4×10^{-4}	2.4×10^{-7}	1.2×10^{-4}	1.8×10^{-5}	5.8×10^{-6}	2.7×10^{-5}	4.1×10^{-4}
Total	2.8×10^{-3}	1.8×10^{-3}	2.8×10^{-3}	3.9×10^{-3}	3.7×10^{-3}	2.1×10^{-3}	0.017

Average individual dose = 2.1×10^{-9} rem for the 80-km radius area total population.

APPENDIX A

COMPARISON OF ENVIRONMENTAL RADIOACTIVITY DATA FOR 1985 WITH PREVIOUS YEARS

This section compares environmental monitoring results for the calendar year 1985 with previous annual data.

The data presented in Tables A-1 through A-5 summarize past annual average radioactivity concentrations. These data show the effects of both the short-lived and long-lived radioactive fallout from nuclear weapons tests superimposed on the natural radioactivity inherent in the various sample types.

Over the considerable period of time that the environmental program has been in operation, evolutionary changes have been made in order to provide more effective data. In some cases, this is readily apparent in the data. For example, in Table A-1, a small but abrupt increase in the alpha activity reported for soil occurs in 1971. This increase, which is observed in both the on-site and the off-site samples, resulted from use of an improved counting system with a thinner sample configuration. The thinner sample increases the sensitivity of the detector to alpha-emitting radionuclides in the sample, thus producing a higher measured specific sample activity.

Similarly, prior to 1971, gross activity in ambient air was measured, including both alpha and beta activity. In 1971, measurements were begun that allowed separate identification of these two types of radiation.

In 1984, recalibration of the alpha counting method for thick samples was achieved, resulting in determination of the absolute alpha activity in these samples rather than the relative values previously used for monitoring purposes. Comparison of the values for 1985 as determined by the relative method with those for prior years shows no significant difference.

The ambient radiation monitoring results show a continuing long-term variation that had been apparant in previous years but is unrelated to operations on-site. Independent measurements and intercomparisons support the values measured by the bulb-type dosimeters. With the exception of apparent changes resulting from improvements in analytical methods and interpretation of the data, the soil, vegetation, water, and air radioactivity results are notably constant over the past 20 years. In particular, environmental radioactivity data for the De Soto site show no reduction in the measured levels below those that had been observed during the fuel fabrication operations that were discontinued in 1982 confirming that those levels represent natural radioactivity.

For all types of samples, the data indicate that there is no concentrated local source of unnatural radioactivity in the environment. Also, the similarity between on-site and off-site results further indicates that Rocketdyne operations contribute essentially nothing to general environmental radioactivity.

TABLE A-1

SOIL RADIOACTIVITY DATA--1966 THROUGH 1985

Year	On-site Average (pCi/g)			Off-site Average (pCi/g)		
	Number of Samples	Alpha	Beta	Number of Samples	Alpha	Beta
1985[a]	144	25.2	24	48	26.3	24
1984[a]	144	25.8	24	48	26.2	23
1983	144	0.61	24	48	0.59	23
1982	144	0.69	25	48	0.68	23
1981	144	0.69	25	48	0.64	23
1980	144	0.60	24	48	0.58	23
1979	144	0.64	25	48	0.50	23
1978	144	0.63	24	48	0.51	24
1977	144	0.56	24	48	0.53	23
1976	144	0.56	25	48	0.56	24
1975	144	0.60	25	48	0.58	24
1974	144	0.60	25	48	0.54	24
1973	144	0.57	25	48	0.51	24
1972	144	0.56	25	48	0.57	24
1971	144	0.55	25	48	0.53	23
1970	144	0.47	27	48	0.48	25
1969	144	0.42	27	48	0.42	25
1968	144	0.47	26	48	0.48	26
1967	144	0.42	28	48	0.39	24
1966	144	0.41	29	48	0.44	25

[a]The change in alpha activity after 1983 is the result of an improved calibration method that provides a true measure of alpha activity in thick samples rather than the relative values used previously. This is discussed in detail in Part III, Section A. Values for 1985 using the prior method would be 0.63 for the on-site average and 0.66 for the off-site average.

0003Y/bjb

TABLE A-2

VEGETATION RADIOACTIVITY DATA--1966 THROUGH 1985

Year	On-site Average (pCi/g-ash)			Off-site Average (pCi/g-ash)		
	Number of Samples	Alpha	Beta	Number of Samples	Alpha	Beta
1985[a]	144	3.8	135	48	4.7	133
1984[a]	144	4.0	136	48	5.9	136
1983	144	0.18	149	48	0.24	143
1982	144	0.16	140	48	0.17	130
1981	144	0.20	137	48	0.21	129
1980	144	0.25	160	48	0.19	142
1979	144	0.24	139	48	0.23	134
1978	144	0.24	166	48	0.24	143
1977	144	0.22	162	48	0.21	142
1976	144	0.19	170	48	0.22	147
1975	144	0.21	155	48	0.21	141
1974	144	0.20	152	48	0.27	141
1973	144	0.24	155	48	0.24	142
1972	144	0.23	145	48	0.36	125
1971	144	0.24	165	48	0.31	132
1970	144	0.33	159	48	0.30	142
1969	144	0.40	165	48	0.36	144
1968	144	0.51	158	48	0.51	205
1967	144	0.62	286	48	0.39	413
1966	144	0.37	169	48	0.37	123

[a]The change in alpha activity after 1983 is the result of an improved calibration method that provides a true measure of alpha activity in thick samples rather than the relative values used previously. This is discussed in detail in Part III, Section A. Values for 1985 using the prior method would be 0.19 for the on-site average and 0.23 for the off-site average.

0003Y/bjb

TABLE A-3

SSFL SITE SUPPLY WATER RADIOACTIVITY DATA--
1966 THROUGH 1985

Year	Number of Samples	Average Alpha (10^{-9} µCi/ml)	Average Beta (10^{-9} µCi/ml)
1985[a]	24	2.05	2.8
1984[a]	24	3.53	2.9
1983	24	0.12	3.0
1982	24	0.14	3.0
1981	24	0.24	2.8
1980	24	0.22	2.4
1979	24	0.23	2.8
1978	24	0.26	3.0
1977	24	0.25	2.5
1976	24	0.25	2.0
1975	24	0.24	2.3
1974	24	0.24	2.7
1973	24	0.26	3.4
1972	24	0.22	3.7
1971	24	0.28	4.9
1970	24	0.18	5.3
1969	24	0.11	5.0
1968	24	0.16	5.0
1967	24	0.13	6.1
1966	24	0.13	4.6

[a]The change in alpha activity after 1983 is the result of an improved calibration method that provides a true measure of alpha activity in thick samples rather than the relative values used previously. This is discussed in detail in Part III, Section A. The value for 1985 using the prior method would be 0.09.

0003Y/sjv

TABLE A-4

BELL CREEK AND ROCKETDYNE DIVISION RETENTION POND RADIOACTIVITY DATA--1966 THROUGH 1985

Year	Samples														
	Bell Creek Mud 54			Bell Creek Vegetation 54			Bell Creek Water 16			Interim Retention Pond Water 6			Final Retention Pond R-2A Water 12		
	Number of Samples	Average (pCi/g)		Number of Samples	Average (pCi/g-ash)		Number of Samples	Average (10^{-9} µCi/ml)		Number of Samples	Average (10^{-9} µCi/ml)		Number of Samples	Average (10^{-9} µCi/ml)	
		Alpha	Beta		Alpha	Beta		Alpha	Beta		Alpha	Beta		Alpha	Beta
1985[a]	12	21.9	23	12	1.34	137	12	1.38	2.5	12	2.06	3.5	12	3.07	3.5
1984[a]	12	20.8	24	12	1.70	138	12	4.15	2.9	12	2.07	4.6	12	0.15	4.2
1983	12	0.54	23	12	0.12	136	12	0.08	3.3	12	0.12	3.6	12	0.13	4.4
1982	12	0.64	25	12	0.08	160	12	0.03	3.3	12	0.17	3.9	12	0.11	3.9
1981	12	0.58	24	12	<0.13	103	12	<0.23	3.8	12	<0.23	4.3	12	<0.25	5.2
1980	12	0.51	23	12	<0.18	150	12	<0.22	2.9	12	<0.22	2.9	12	<0.22	3.9
1979	12	0.46	23	12	<0.26	136	12	<0.23	3.2	12	<0.25	3.1	12	<0.23	4.5
1978	12	0.42	23	12	<0.26	156	12	<0.24	2.5	12	<0.25	4.3	12	<0.25	4.6
1977	12	0.29	22	12	<0.19	155	12	<0.24	1.8	12	<0.24	4.3	12	<0.25	5.2
1976	12	0.38	23	12	<0.17	164	12	<0.25	2.2	12	<0.24	4.3	12	<0.28	4.4
1975	12	0.29	22	12	<0.19	123	12	<0.22	2.4	12	<0.24	4.2	12	<0.31	4.5
1974	12	0.32	22	12	<0.16	142	12	<0.21	2.5	12	<0.22	4.2	12	<0.21	4.5
1973	12	0.34	24	12	<0.17	147	12	<0.21	2.7	12	<0.23	4.5	12	<0.37	5.6
1972	12	0.32	22	12	0.12	139	12	0.20	2.5	12	0.22	5.3	12	0.22	5.5
1971	12	0.36	23	12	0.19	128	12	0.15	3.8	12	0.18	6.2	12	0.16	6.4
1970	12	0.44	24	12	0.23	165	12	0.15	3.7	12	0.15	6.9	12	0.12	7.4
1969	12	0.35	27	12	0.28	166	12	0.04	4.0	12	0.07	5.9	11	0.10	5.7
1968	11	0.32	24	11	0.39	170	8	0.05	4.6	11	0.23	8.1	12	0.33	7.7
1967	12	0.40	24	12	0.38	180	12	0.07	5.8	12	0.19	6.6	10	0.17	7.0
1966	3	0.39	25	3	1.1	108	3	0.75	2.5	9	0.11	5.8	8	1.1	6.3

[a] The change in alpha activity after 1983 is the result of an improved calibration method that provides a true measure of alpha activity in thick samples rather than the relative values used previously. This is discussed in detail in Part III, Section A. Values for 1985 using the prior method would be as follows:

Bell Creek mud:	0.55	Interim retention pond:	0.09
Bell Creek vegetation:	0.07	Final retention pond:	0.15
Bell Creek water:	0.03		

TABLE A-5

AMBIENT AIR RADIOACTIVITY CONCENTRATION DATA--1966 THROUGH 1985

Year	De Soto Site Average (10^{-12} uCi/ml)			SSFL Site Average (10^{-12} uCi/ml)		
	Number of Samples	Alpha	Beta	Number of Samples	Alpha	Beta
1985	544	0.0026	0.044	2450	0.0020	0.040
1984	712	0.0019	0.027	2461	0.0014	0.024
1983	644	0.0024	0.026	2328	0.0010	0.023
1982	727	0.0017	0.026	2347	0.0013	0.022
1981	704	0.0069	0.12	2518	0.0068	0.12
1980	685	0.0065	0.039	2342	0.0064	0.035
1979	697	0.0066	0.021	2519	0.0065	0.020
1978	713	0.0084	0.091	2402	0.0072	0.088
1977	729	0.0066	0.17	2438	0.0066	0.17
1976	719	0.0067	0.096	2520	0.0065	0.11
1975	709	0.0063	0.076	2450	0.0060	0.073
1974	663	0.0056	0.16	2477	0.0057	0.16
1973	715	0.0075	0.041	2311	0.0072	0.038
1972	708	0.0085	0.14	2430	0.0086	0.14
1971[a]	730	0.0087	0.30	2476	0.0086	0.33
1970	668	-	0.34	2434	-	0.36
1969	687	-	0.27	2364	-	0.26
1968	650	-	0.32	2157	-	0.32
1967	712	-	0.39	2400	-	0.41
1966	706	-	0.18	2205	-	0.17

[a]Ambient air alpha radioactivity values were included in the beta values and not reported separately prior to 1971.

0003Y/sjv

APPENDIX B
ENVIRONMENTAL MONITORING PROGRAM QUALITY CONTROL

This appendix describes the quality assurance (QA) elements that are incorporated into the Rocketdyne program to ensure that data produced are as meaningful as possible.

PROCEDURES

Procedures followed include sample selection; sample collection; packaging, shipment and handling of samples for off-site analysis; preparing and analyzing samples; using radioactive reference standards; calibration methods and instrument QA; and evaluating and reporting data.

RECORDS

Records generally cover the following processes: field sample collection and laboratory identification coding; sample preparation method; radioactivity measurements (counting) of samples, instrument backgrounds, and analytical blanks; and data reduction and verification.

Quality control records for laboratory counting systems include the results of measurements of radioactive check sources, calibration sources, backgrounds, and blanks, as well as a complete record of all maintenance and service.

Records relating to overall laboratory performance include the results of analysis of quality control samples such as analytical duplicates, interlaboratory cross-check samples and other quality control analyses; use of standard (radioactive) reference materials to prepare working standards; and calibration of analytical balances.

The following specific elements of quality control are used for the Rocketdyne program:

1) Reagent Quality--Reagent-grade chemicals and certified grade counting gas used.

2) Laboratory Ventilation--Room air supply is controlled to minimize temperature variance and dust incursion.

3) Laboratory Contamination--Periodic laboratory contamination surveys for fixed and removable surface contamination are performed. Areas are cleaned routinely and decontaminated when necessary.

4) Control Charts--Background and reference source control charts for counting equipment are maintained to evaluate stability and response characteristics.

5) Laboratory Intercomparisons--Rockwell participates in the DOE-EML-QAP, and also participates in the DOE Environmental Dosimeter Intercomparison Project.

6) Duplicate Samples--Duplicate samples are obtained monthly at randomly selected environmental sampling locations. Analytical data are statistically evaluated to determine the correlation coefficients for each media type for the annual sample set.

7) Calibration Standards--Counting standard radioactivity values are traceable to the National Bureau of Standards primary standards.

APPENDIX C

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD CRITERIA FOR DISCHARGING NONRADIOACTIVE CONSTITUENTS FROM ROCKETDYNE DIVISION, SSFL

The discharge of an effluent in excess of the limits given in Table C-1 is prohibited.

TABLE C-1

NPDES NO. CA00-01309, ORDER 84-85, EFFECTIVE 17 SEPTEMBER 1984

Constituent	Discharge Rate (lb/day)*	Concentration Limit (mg/liter)
	30-Day Average	Maximum
Total dissolved solids	1,267,680	950
Chloride	200,160	150
Sulfate	400,320	300
Suspended solids[a]	66,720	-
Settleable solids[a]	-	-
BOD_5	26,690	30
Oil and grease	13,350	15
Chromium	6.67	-
Fluoride	1,340	1.0
Boron	1,340	1.0
Residual chlorine	-	0.1
Fecal coliform (MPN/100 ml)	-	2.2
Surfactants (as MBAS)	667	0.5
pH		6.0 to 9.0

[a]Not applicable to discharges containing rainfall runoff during or immediately after periods of rainfall.

[b]Wastewater shall be considered adequately disinfected if the median number of coliform organisms does not exceed 23/100 ml.

*Based on a total waste flow of 160 x 10^6 gal/day.

APPENDIX D

REFERENCES

1. DOE Order 5484.1

2. DOE Order 5480.1A

3. Code of Federal Regulations, Title 10, Part 20 (10 CFR 20)

4. California Radiation Control Regulations, California Administrative Code, Title 17, Public Health

5. California Regional Water Quality Control Board, Los Angeles Region, Order No. 84-85, NPDES No. CA0001309, Effective 17 September 1984

6. R. E. Moore, 1979. AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Doses to Man from Airborne Releases of Radionuclides, ORNL-5532

7. D. E. Dunning, Jr., 1981. Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities, Volume III, ORNL/NUREG/TM-190

8. J. P. Corley, ed., "Committed Dose Equivalent Tables for U.S. Department of Energy Population Dose Calculations," U.S. Department of Energy, Office of Operational Safety

9. J. D. Moore, "Radiological Environmental Monitoring Program," N001O5P000001, Rocketdyne Division, Rockwell International (9 July 1984)

10. J. D. Moore, "Radiological Environmental Monitoring Program Sampling Procedures, Analysis Procedures, and Radioactivity Measurement Methods," N001DWP000008, Rockwell International, Rocketdyne Division (9 July 1984)

11. J. D. Moore, "Radiological Environmental Monitoring Program Quality Assurance," N001DWP000009, Rocketdyne Division, Rockwell International (25 September 1984)

12. "Investigation of Hydrogeologic Conditions - Santa Susana Field Laboratory, Ventura County, California," Hargis & Associates, Inc., Tucson, Arizona (22 February 1985)

APPENDIX E

EXTERNAL DISTRIBUTION

1. Radiologic Health Branch, Department of Health Services, California
2. Occupational Health and Radiation Management, Los Angeles County Health Department, California
3. Resources Management Agency, County of Ventura, California
4. U.S. Nuclear Regulatory Commission, Region V, Walnut Creek, California
5. U.S. Nuclear Regulatory Commission, Office of Inspection and Enforcement, Washington, D.C.
6. U.S. Department of Energy, Environment, Safety and Quality Assurance Division, San Francisco Operations Office, California
7. U.S. Department of Energy, Office of Operational Safety, EP-32, Technical Information Center, Washington, D.C.
8. Rocky Flats Plant, Health, Safety, and Environment, Colorado
9. Rockwell Hanford Operations, Safety and Quality Assurance, Washington

APPENDIX F

ALTERNATIVE UNITS FOR RADIOLOGICAL DATA

	In Non-SI Units	In SI Units	Conversion Factor From Non-SI to SI Units[a]
Activity concentrations (Environmental)			
Airborne particulates and gas	pCi/m^3	Bq/m^3	3.70E - 02
Liquids (water, milk, etc.)	pCi/L	Bq/L	3.70E - 02
Solids (soil, sediment, vegetation, foodstuff, etc.)	pCi/g	Bq/kg	3.70E - 05
Activity concentrations (effluent)			
Gas (air)	(μCi/mL)[b]	Bq/m^3	3.70E + 10
Liquid	(μCi/mL)[b]	Bq/L	3.70E + 07
Exposure rate (environment)	R/h	C/kg h	2.58E - 10
Absorbed dose	mrad	Gy	1.00E - 05
Dose equivalent	mrem	Sv	1.00E - 05
Dose equivalent rate (commitment)	mrem/year	Sv/year	1.00E - 05

[a]To convert non-SI units to SI units, multiply the non-SI units by the conversion factor.
[b]Adopted because of established convention and use in maximum permissible concentration (MPC) tabulations.

0003Y/bjb