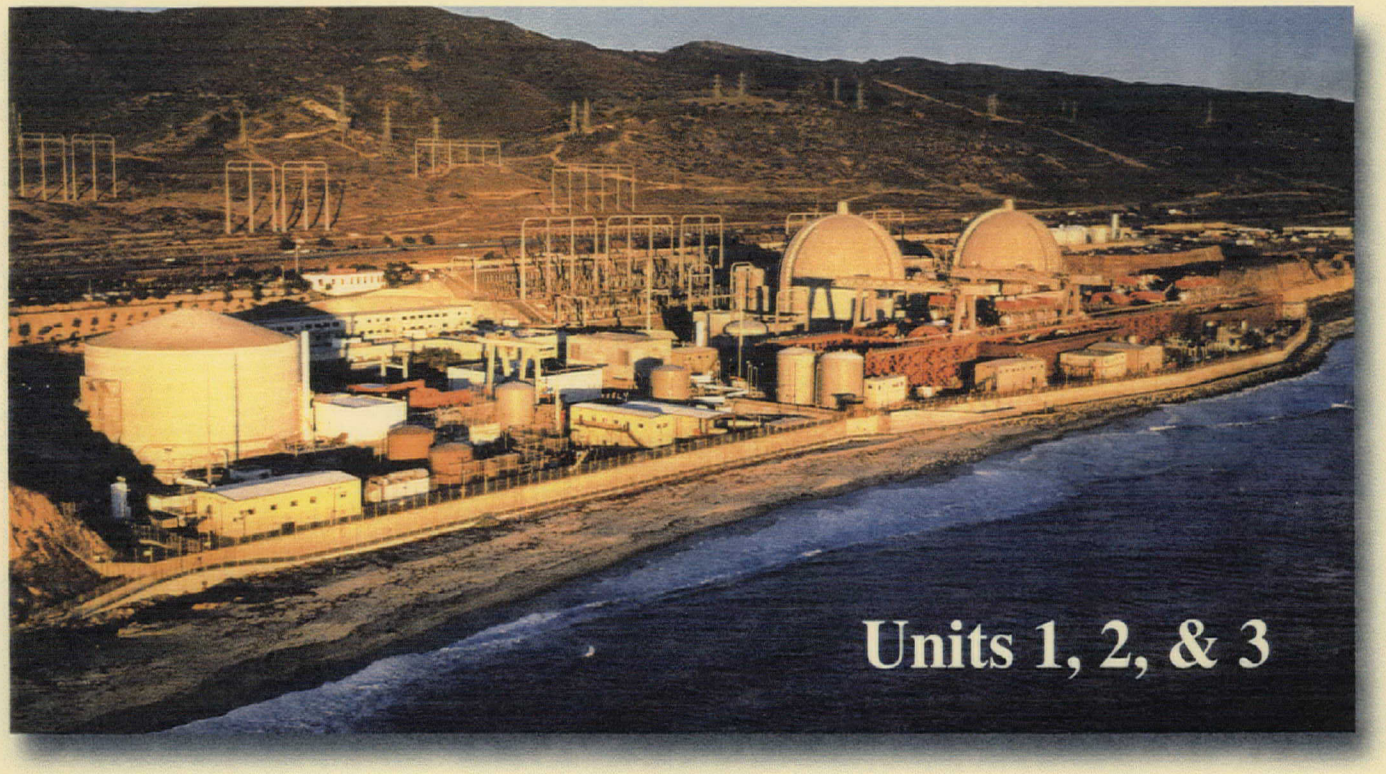
1998 Radiological Environmental Operating Report

San Onofre Nuclear Generating Station



Southern California Edison

An Edison International Company

San Diego Gas and Electric Company

Docket Nos. 50-206, 50-361, 50-362
License Nos. DPR-13, NPF-10, NPF-15

APRIL 1999

SOUTHERN CALIFORNIA EDISON
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1998 ANNUAL

RADIOLOGICAL ENVIRONMENTAL

OPERATING REPORT

San Onofre Nuclear Generating Station

UNITS 1, 2, & 3

Southern California Edison

An *Edison International* Company

San Diego Gas and Electric Company

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Executive Summary

The data from the San Onofre Nuclear Generating Station (SONGS) Radiological Environmental Monitoring Program (REMP) clearly indicates that SONGS had no measurable radiological environmental impact during 1998.

Preparation of the 1998 Annual Radiological Environmental Operating Report (AREOR) used the data reduction protocol described in NUREG/CR-4007. A meaningful analysis of data at, near, or below the detection limit must necessarily involve a consideration of the degrees of uncertainty associated with the data. Excluding naturally occurring radionuclides, approximately 5% of the 1998 SONGS REMP data set was above the critical level (1.64 sigma), which is characteristic of a database consisting entirely of values statistically equal to zero. The data above the critical level have been summarized in table B-3 of Appendix B. The plant related radionuclides (Cs-137 in soil and I-131 in kelp) detected at the 3 sigma (99%) confidence level may be attributable to fallout from nuclear weapons testing (Cs-137) and medical administrations of radionuclides (I-131). These isotopes have been detected at indicator as well as control locations in past years. The naturally occurring radionuclides (Be-7, K-40, and Th-228) detected at the 99% detection confidence level were observed in both control and indicator locations at substantially similar concentrations and are not related to the operation of SONGS. The balance of 1998 SONGS REMP database displays behavior statistically equal to a null set. Refer to Appendix B for a more detailed discussion.

INTRODUCTION

SONGS consists of three pressurized water nuclear reactors housed in separate containment buildings. Unit 1 attained initial criticality June 1967 and was permanently retired from service in November 1992. Unit 2 and Unit 3 attained initial criticality in July 1982 and August 1983, respectively, and have been in operation to date.

The purpose of the REMP is to quantify ambient radiation levels in the environs of SONGS, and to identify and quantify concentrations of radioactivity in various environmental media in the vicinity of SONGS which have a potential radiation exposure pathway to man. Thermoluminescent dosimeters (TLDs) were used to measure direct radiation levels. Sampled environmental media include soil, shoreline sediment (beach sand), air (particulate & iodine), local crops, non-migratory marine species, kelp, drinking water, ocean water, and ocean bottom sediments. Each of the samples was analyzed for both naturally-occurring and SONGS-related radionuclides.

The REMP is conducted in accordance with Section 5.0 of the SONGS Unit 1 and 2/3 Offsite Dose Calculation Manuals (ODCM).

To conform with 10CFR Part 50, Appendix I, Section IV-B.2, measured radioactivity concentrations in the environmental samples have been compared against predicted (calculated) ones to evaluate the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals from principal pathways of exposure.

This comparison was documented in Appendix D of the 1993 AREOR, issued April, 1994. During 1998 no plant related radionuclides attributable to the operation of SONGS were detected.

A land use census was performed in 1998 to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the monitoring program are made if required by the results of this census. Appendix F of the report identifies changes to the census and the resultant dose increase, if any, to individuals from principal pathways of exposures in conformance with 10CFR Part 50, Appendix I, Section IV. B.3.

OBJECTIVES

1. To fulfill the radiological environmental monitoring requirements of the ODCM and the Technical Specifications.

2. To detect any significant increase in the concentration of radionuclides in critical pathways.

3. To detect any significant change in ambient gamma radiation levels.

4. To verify that the operation of SONGS Units 1, 2 and 3 have no assessable detrimental effects on the health and safety of the public or the environment.

SAMPLE COLLECTION

Samples of various environmental media were obtained in order to meet the stated objectives. The selection of sample types was based on established critical pathways for the transfer of radionuclides through the environment to individuals, and the evaluation of data during the operational phase. Sampling locations were determined with consideration given to site meteorology, local demography, and land uses.

Sampling locations were divided into two classes, indicator and control. Control stations were at locations considered to be unaffected by SONGS operations. All others are considered indicator locations and may be potentially effected by SONGS operations.

SOURCES OF RADIOACTIVITY

Plant-specific radionuclides are produced in the normal operation of a nuclear power plant. Most of the fission products are retained within the fuel and its cladding. A small fraction of fission products such as cesium-137 (Cs-137) and iodine-131 (I-131), and activation products such as cobalt-60 (Co-60), are present in the primary reactor cooling system. Noble gases are also produced during the fission process.

Radioactive liquid and gaseous waste releases to the ocean and the atmosphere may contain very minute concentrations of plant-produced radionuclides. The airborne radioactive noble gases released are mostly xenon and krypton, which are inert (non-reactive). They do not concentrate in the body, but they may contribute to human radiation exposure as an immersion source for whole body exposure. Xenon-133 and xenon-135 are the major radioactive noble gases released to the atmosphere, and their calculated offsite beta and gamma air doses are less than 0.1 mrad per year.

The releases of iodines and particulates in the gaseous and liquid effluents are small. The major radionuclides of interest are I-131, Cs-134, Cs-137, Co-58, and Co-60. The total releases for these radionuclides were well below applicable regulatory limits.

Tritium (H-3), the radioactive isotope of hydrogen, is the predominant radionuclide in the liquid effluents and is also present in gaseous effluents. Tritium is produced in the reactor water (coolant) as a result of Boron activation and other nuclear reactions.

EXPOSURE PATHWAY

Figure 1 illustrates various exposure pathways resulting in radiation dose to the surrounding population from operation of a nuclear facility. Only a few pathways will have real dose potential and require detailed calculations.

a. External Exposure

External exposure to people during normal operations will include radioactive gases in gaseous effluent plumes, radionuclides deposited on soil, and vegetation, or shoreline sediments. Direct exposure from radionuclides in water during recreation or commercial fishing activity is insignificant. Accumulation in sediments has the greater potential as a source of exposure. Gamma dosimeters (TLDs) are the usual means of measuring direct radiation exposure since significant dose contributors are gamma-emitters.

b. Internal Exposure

The release of radioactivity in liquid effluents involves pathways such as fish consumption and direct exposure from the ocean water by swimming and the shoreline activities. Consumption of fish or crops from the area receiving liquid effluents and breathing contaminated air from the gaseous effluents releases are the most probable sources of internal exposure.

The doses calculated from gaseous effluent, tritium, radioiodines, and particulates of the gaseous effluent within a five-mile distance from the plant were summarized in Appendix D of the 1993 AREOR. Refer to the 1993 AREOR for detailed information on this analysis.

REGULATORY LIMITS, GUIDANCE, AND REQUIREMENTS

* 10CFR50

  The Code of Federal Regulations Title 10, Part 50, Appendix I.

* 40CFR190

  The EPA has established environmental radiation protection standards for nuclear power plants in 40CFR190. The standards for normal operation recommended that the dose from all discharges of radioactivity should not exceed 25 mrem/yr. These limits are applicable to the sum of both liquid and gaseous effluents and direct radiation. The environmental doses calculated at SONGS are a small fraction of the dose limits established by the Environmental Protection Agency (EPA).

* 10CFR20

  10CFR20, Appendix B, Tables 2 and 3, "Effluent Concentrations" and "Concentration for release to Sewerage"

Guidance:

* Regulatory Guide 4.1

  Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants, 1975

* Regulatory Guide 4.2

  Preparation of Environmental Reports for Nuclear Power Stations, 1976

* Regulatory Guide 4.8

  Environmental Technical Specifications for Nuclear Power Plants, 1975

* Regulatory Guide 4.13

  Performance, Testing, and Procedural Specification for Thermoluminescent Dosimetry: Environmental Applications, 1977

* NUREG-0133

  Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants

* Regulatory Guide 1.109

  Calculation of Annual Doses to Man from Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I, 1977

* NUREG-1301

  Offsite Dose Calculations Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, Generic Letter 89-01, Supplement No. 1, 1991

* ANSI N545 (TLD's)

  American National Standard Performance, Testing, And Procedural Specifications for Thermoluminesence Dosimetry (Environmental Application), 1975

* Regulatory Guide 4.15

  Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment, 1979

* NUREG/CR-4007 Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements, 1984

DATA MANAGEMENT

The tabulated means, ranges and standard deviations presented in Appendix B were calculated following the standard format specified in Regulatory Guide 4.8, the Radiological Assessment Branch Technical Position, revision 1, 1979, and in accordance with the protocol outlined in NUREG/CR-4007. The REMP software package was used to perform the statistical analysis and tabulation of the data.

The REMP data are reviewed for accuracy and comparison against NRC reporting levels, and then entered into the REMP database. One of the REMP menus flags measurements exceeding the administrative levels (10% of the NRC reporting levels) established by Southern California Edison (SCE). The *a posteriori* minimum detectable concentration (MDC) is compared to the maximum value for the *a priori* Lower Limit of Detection (LLD) specified in the ODCM. This insures that regulatory limits for the maximum LLD are met.

The impact of SONGS on the surrounding environment was assessed through a series of analyses. These analyses included: data reduction, comparisons of indicator to control locations, and summary (Appendix B); comparison of operational to preoperational environmental data (Appendix D); summary of deviations from sampling requirements and corrective actions taken (Appendix E); and finally the results of the 1998 Land Use Census reports including changes in the Land Uses from the previous year (Appendix F).

All Radiological Environmental Monitoring activities for San Onofre are assessed by Quality Assurance requirements as defined in Regulatory Guide 4.15. The Contracted Environmental Analysis Laboratory (CEAL) participated in the EPA interlaboratory comparison program as part of quality assurance requirements for environmental monitoring. In anticipation of the discontinuance of the EPA cross check program, the CEAL initiated participation on alternate cross check programs which meet the intent of Reg Guide 4.15. A split sampling program was conducted in cooperation with the State of California Department of Health Services. Refer to Appendix C.

DETECTION LIMIT TERMINOLOGY

This report utilizes four distinct terms to describe the concept of "lower limit of detection" at various detection confidence levels. The terms are briefly defined below. For a more thorough discussion the reader should refer to NUREG/CR-4007.

Critical level - Defined as 1.64 sigma. For a sufficiently large database of isotopically analyzed sample results, with the "true" activity being equal to zero, approximately 5% of the results should be above the critical level. The 1998 SONGS REMP data above the critical level have been summarized in table B-3 of Appendix B. Approximately 5% of the total listed analyses are above the critical level.

Lower Limit of Detection (LLD) - The LLD is the *a priori* (before the fact) lower limit of detection. This value is calculated for each isotope and every matrix based on typical or expected values of decay time, sample size, counter efficiency, etc. These values are listed in the ODCM and represent the maximum permissible value for the "lower limit of detection" for specified sample media.

Minimum Detectable Concentration (MDC) - The MDC is the *a posteriori* (after the fact) lower limit of detection based on actual decay time, measured sample size, counter efficiency as determined by recent calibration, etc. The MDC is compared to the LLD to verify that the measurement met the ODCM requirements for the maximum value of the LLD for the listed analytes. Values above the MDC are presumed to represent "detected" activity at the 95% detection confidence level.

Three sigma (99% confidence level) - Sample analysis results above this level are "detected" with less than a 1 % probability of a "false positive."

CONCLUSION

Levels of radioactivity in environmental media are a function of several factors including: site release rates; meteorology; number, location, size and date of nuclear weapons tests; seasonal variability of fallout; soil conditions; local terrain and variability in the natural environment.

Radiological environmental data collected throughout 1998 have been evaluated to determine the impact, if any, of San Onofre operations on the surrounding environment. To accomplish this, several methods of evaluation were employed, namely:

1. Compilation and verification of all data, as well as a determination of those data considered to be significantly greater than background levels.

2. Environmental dose calculations and correlation of effluent releases with environmental concentrations (Refer to the 1993 AREOR). For 1998 a correlation between effluent releases and environmental levels is not possible because no activity attributable to the operation of SONGS was detected in the environment.

3. Examination of time-dependent variations of pertinent radioisotopes in selected environmental media throughout the year at both indicator and control locations.

4. Comparison of radioactivity in various media in 1998 against the levels observed in pre-operational years.

5. Historical trending of radionuclides in various media during operational years.

In comparing these findings to the conservatively-defined limits of the facility operating licenses, it is concluded that the radiological environmental impact of the operation of SONGS through 1998 has been negligible, and the resulting dose to man is negligible.

REFERENCES

1. 10CFR20, 10CFR50

2. 1993 Radiological Environmental Operating Report for San Onofre Nuclear Generating Station, April 30, 1994.

3. Land Use Census for SONGS Units l, 2 and 3 Radiological Environmental Monitoring Program, October 1998.

4. ODCM (Offsite Dose Calculation Manual) for SONGS Units 1, 2 and 3, Section 5.0, 1998.

5. SONGS Radiological Monitoring (RM) Procedures: SO123-RM-1 (SO123-IX-1.10).

6. L. Currie. 1968 "Limits for the Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Analytical Chemistry, vol. 40 pp. 586-593

APPENDIX A

SAMPLE TYPE AND SAMPLING LOCATION

Summary of REMP sample location changes for 1998

Soil Sample # 6, Oceanside City Hall (new CONTROL location) was first collected in December 1998.

Drinking Water Sample # 5, Oceanside City Hall (New CONTROL) was collected as the only drinking water CONTROL sample starting January 1998.

Direct Radiation (TLD) location #'s 75, 76, 77, and 78 were added to the REMP to enhance coverage of the outer ring in the 4 to 5 mile distance from Units 2/3 midpoint.

Crop sample location # 6, SONGS Garden, was added to the REMP effective March 1998. This sample location was installed to provide indicator fleshy and leafy crop samples from a location under SCE control. This location was installed in response to several instances of unavailable indicator crop samples.

TABLE A-1

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE * (miles)	DIRECTION * (Sector)
Direct Radiation ***			
1	City of San Clemente (Former SDG&E Offices)	5.7	NW
2	Camp San Mateo - MCB	3.5	N
3	Camp San Onofre - MCB	2.6	NE
4	Camp Horno - MCB	4.5	E
6	Old Route 101 (East-Southeast)	3.0	ESE
8	Noncommissioned Officers Beach Club	1.4	NW
10	Bluff (Adjacent to PIC #1)	0.7	WNW
11	Former Visitor's Center	0.4 **	NW
12	South of Switchyard	0.2 **	E
13	Southeast Site Boundary (Bluff)	0.4 **	ESE
15	Southeast Site Boundary (Office Building)	0.1 **	SSE
16	East Southeast Site Boundary	0.4 **	ESE
17	Transit Dose	---	---
18	Transit Dose	---	---
19	San Clemente Highlands	5.0	NNW
22	Former US Coast Guard Station - San Mateo Point	2.7	WNW
23	Samaritan Hospital - San Clemente	8.1	NW

* Distance (miles) and Direction (sector) are measured relative to Units 2 & 3 midpoint. Direction determined from degrees true north.

** Distances are within the Units 2 & 3 Site Boundary (0.4 mile in all sectors) and not required by Technical Specification.

*** Out of sequence Sample numbers due to program modifications

MCB Marine Corp Base Camp Pendleton

PIC Pressurized Ion Chamber

TABLE A-1

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE * (miles)	DIRECTION * (Sector)
Direct Radiation (Continued) ***			
31	Aurora Park - Mission Viejo (CONTROL)	18.6	NNW
33	Camp Talega - MCB	5.7	N
34	San Onofre School - MCB	1.9	NW
35	Range 312 - MCB	4.7	NNE
36	Range 208C - MCB	4.2	NE
38	San Onofre State Beach Park	3.3	SE
40	SCE Training Center - Mesa (Adjacent to PIC #3)	0.7	NNW
41	Old Route 101 - East	0.3 **	E
44	Fallbrook Fire Station	17.7	E
46	San Onofre State Beach Park	0.9	SE
47	Camp Las Flores - MCB	8.6	SE
49	Camp Chappo - MCB	12.8	ESE
50	Oceanside Fire Station (CONTROL)	15.6	SE
53	San Diego County Operations Center	44.3	SE
54	Escondido Fire Station	31.8	ESE
55	San Onofre State Beach (Unit 1, West Southwest)	0.2 **	W

* Distance (miles) and Direction (sector) are measured relative to Units 2 & 3 midpoint. Direction is determined from degrees true north.

** Distances are within the Units 2 & 3 Site Boundary (0.4 mile in all sectors) and not required by Technical Specification.

*** Out of sequence Sample numbers due to program modifications

MCB Marine Corp Base Camp Pendleton

PIC Pressurized Ion Chamber

TABLE A-1

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE * (miles)	DIRECTION * (Sector)
Direct Radiation (Continued) ***			
56	San Onofre State Beach (Unit 1, Southwest)	0.2 **	W
57	San Onofre State Beach (Unit 2)	0.1 **	WSW
58	San Onofre State Beach (Unit 3)	0.1 **	S
59	SONGS Meteorological Tower	0.3 **	WNW
60	Transit Control Storage Area	---	---
61	Mesa - East Boundary (Adjacent to PIC #4)	0.7	N
62	MCB - Camp Pendleton (Adjacent to PIC #5)	0.6	NNE
63	MCB - Camp Pendleton (Adjacent to PIC #6)	0.6	NE
64	MCB - Camp Pendleton (Adjacent to PIC #7)	0.6	ENE
65	MCB - Camp Pendleton (Adjacent to PIC #8)	0.7	E
66	San Onofre State Beach (Adjacent to PIC #9)	0.6	ESE
67	Former SONGS Evaporation Pond (Adjacent to PIC #2)	0.6	NW
68	Range 210C - MCB	4.3	ENE
73	South Yard	0.4 **	ESE
74	Oceanside City Hall (Back-up CONTROL)	15.6	SE
75	Gate 25 MCB	4.6	SE
76	El Camino Real Mobil Station	4.6	NW
77	Area 62 Heavy Lift Pad	4.3	N
78	Sheep Valley	4.4	ESE

* Distance (miles) and Direction (sector) are measured relative to Units 2 & 3 midpoint. Direction is determined from degrees true north.

** Distances are within the Units 2 & 3 Site Boundary and are not required by Technical Specification.

*** Out of sequence Sample numbers due to program modifications

MCB Marine Corp Base Camp Pendleton

PIC Pressurized Ion Chamber

TABLE A-1

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE * (miles)	DIRECTION * (Sector)
Airborne ***			
1	City of San Clemente (City Hall)	5.1	NW
7	AWS Roof	0.18 **	NW
9	State Beach Park	0.6	ESE
10	Bluff	0.7	WNW
11	Mesa EOF	0.7	NNW
12	Former SONGS Evaporation Pond	0.6	NW
13	Marine Corp Base (Camp Pendleton East)	0.7	E
14	Mesa Medical Facility	0.7	NNW
15	Oceanside City Hall (Control)	15.6	SE
Soil Samples			
1	Camp San Onofre	2.6	NE
2	Old Route 101 - East Southeast	3.0	ESE
3	Basilone Road / I-5 Freeway Off ramp	2.0	NW
5	Former Visitor's Center (East Site Boundary)	0.4 **	NW
6	Oceanside (CONTROL)	16.0	SE

* Distance (miles) and Direction (sector) are measured relative to Units 2 & 3 midpoint. Direction is determined from degrees true north.

** Distances are within the Units 2 & 3 Site Boundary (0.4 mile in all sectors) and not required by Technical Specification.

*** Out of sequence Sample numbers due to program modifications

TABLE A-1

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE * (miles)	DIRECTION * (Sector)
Ocean Water			
A	Station Discharge Outfall - Unit 1	0.6	SW
B	Outfall - Unit 2	1.5	SW
C	Outfall - Unit 3	1.2	SSW
D	Newport Beach (CONTROL)	30.0	NW
Drinking Water			
4	Camp Pendleton Drinking Water Reservoir	2.2	NNW
5	Oceanside City Hall (CONTROL)	15.6	SE
Shoreline Sediment (Beach Sand)			
1	San Onofre State Beach	0.6	SE
2	San Onofre Surfing Beach	0.8	WNW
3	San Onofre State Beach	3.5	SE
4	Newport Beach North End (CONTROL)	29.2	NW
Local Crops			
1	San Clemente Ranch	2.6	NW
2	Southeast of Oceanside (CONTROL)	15-25	SE to ESE
4	San Clemente Residence (Ola Vista)	4.4	NW
6	SONGS Garden	0.4	NNW

* Distance (miles) and Direction (sector) are measured relative to Units 2 & 3 midpoint. Direction is determined from degrees true north.

TABLE A-1

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

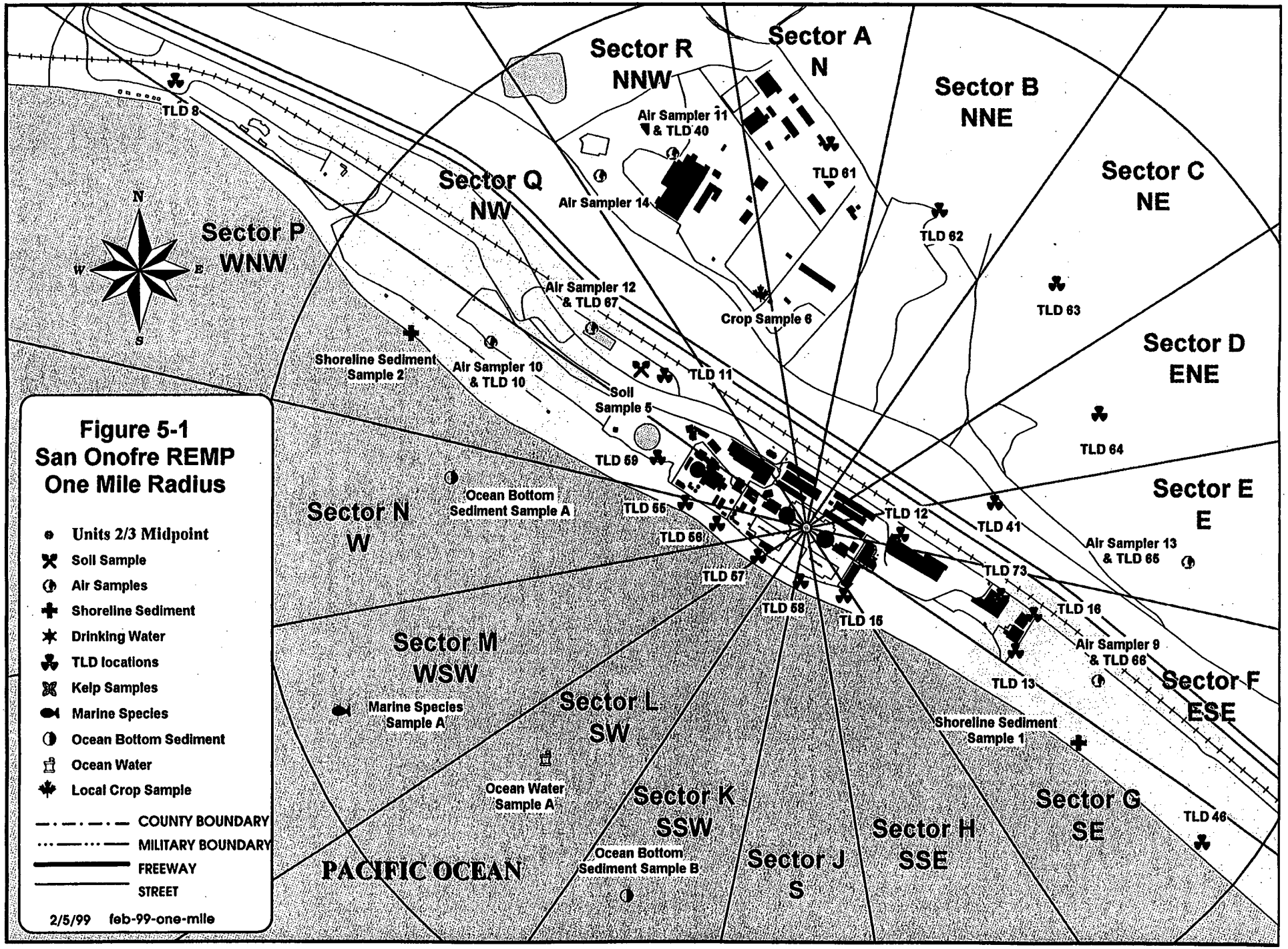
	TYPE OF SAMPLE AND SAMPLING LOCATION	DISTANCE * (miles)	DIRECTION * (Sector)
Non-Migratory Marine Animals			
A	Unit 1 Outfall	0.9	WSW
B	Units 2 and 3 Outfall	1.5	SSW
C	Laguna Beach (CONTROL)	18.2	NW
Kelp			
A	San Onofre Kelp Bed	1.5	S
B	San Mateo Kelp Bed	3.8	WNW
C	Barn Kelp Bed	6.3	SSE
D	Laguna Beach (CONTROL)	15.6	NW
Ocean Bottom Sediments			
A	Unit 1 Outfall (0.5 mile East)	0.6	W
B	Unit 1 Outfall (0.6 mile West)	0.8	SSW
C	Unit 2 Outfall	1.6	SW
D	Unit 3 Outfall	1.2	SSW
E	Laguna Beach (CONTROL)	18.2	NW

* Distance (miles) and Direction (sector) are measured relative to Units 2 & 3 midpoint. Direction is determined from degrees true north.

TABLE A-2

SECTOR AND DIRECTION DESIGNATION FOR REMP SAMPLE LOCATION MAP

DEGREES TRUE NORTH FROM SONGS 2 AND 3 MIDPOINT			NOMENCLATURE	
Sector Limit	Center Line	Sector Limit	22.5° Sector	Direction
348.75	0 & 360	11.25	A	N
11.25	22.5	33.75	B	NNE
33.75	45.0	56.25	C	NE
56.25	67.5	78.75	D	ENE
78.75	90.0	101.25	E	E
101.25	112.0	123.75	F	ESE
123.75	135.0	146.25	G	SE
146.25	157.0	168.75	H	SSE
168.75	180.0	191.25	J	S
191.25	202.5	213.75	K	SSW
213.75	225.0	236.25	L	SW
236.25	247.5	258.75	M	WSW
258.75	270.0	281.25	N	W
281.25	292.5	303.75	P	WNW
303.75	315.0	326.25	Q	NW
326.25	337.5	348.75	R	NNW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Sector M
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Sector N
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Sector P
WNW
Sector Q
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S
E
W
TLD 8
Air Sampler 11
& TLD 40
Air Sampler 14
TLD 61
TLD 62
TLD 63
TLD 64
Crop Sample 6
Air Sampler 12
& TLD 67
Shoreline Sediment
Sample 2
Air Sampler 10
& TLD 10
Soil
Sample 5
TLD 11
TLD 59
Ocean Bottom
Sediment Sample A
TLD 55
TLD 56
TLD 57
TLD 58
TLD 15
TLD 12
TLD 41
Air Sampler 13
& TLD 65
TLD 73
TLD 16
Air Sampler 9
& TLD 66
TLD 13
Shoreline Sediment
Sample 1
TLD 46
Marine Species
Sample A
Ocean Water
Sample A
Ocean Bottom
Sediment Sample B
PACIFIC OCEAN
Figure 5-1
San Onofre REMP
One Mile Radius
Units 2/3 Midpoint
Soil Sample
Air Samples
Shoreline Sediment
Drinking Water
TLD locations
Kelp Samples
Marine Species
Ocean Bottom Sediment
Ocean Water
Local Crop Sample
COUNTY BOUNDARY
MILITARY BOUNDARY
FREEWAY
STREET
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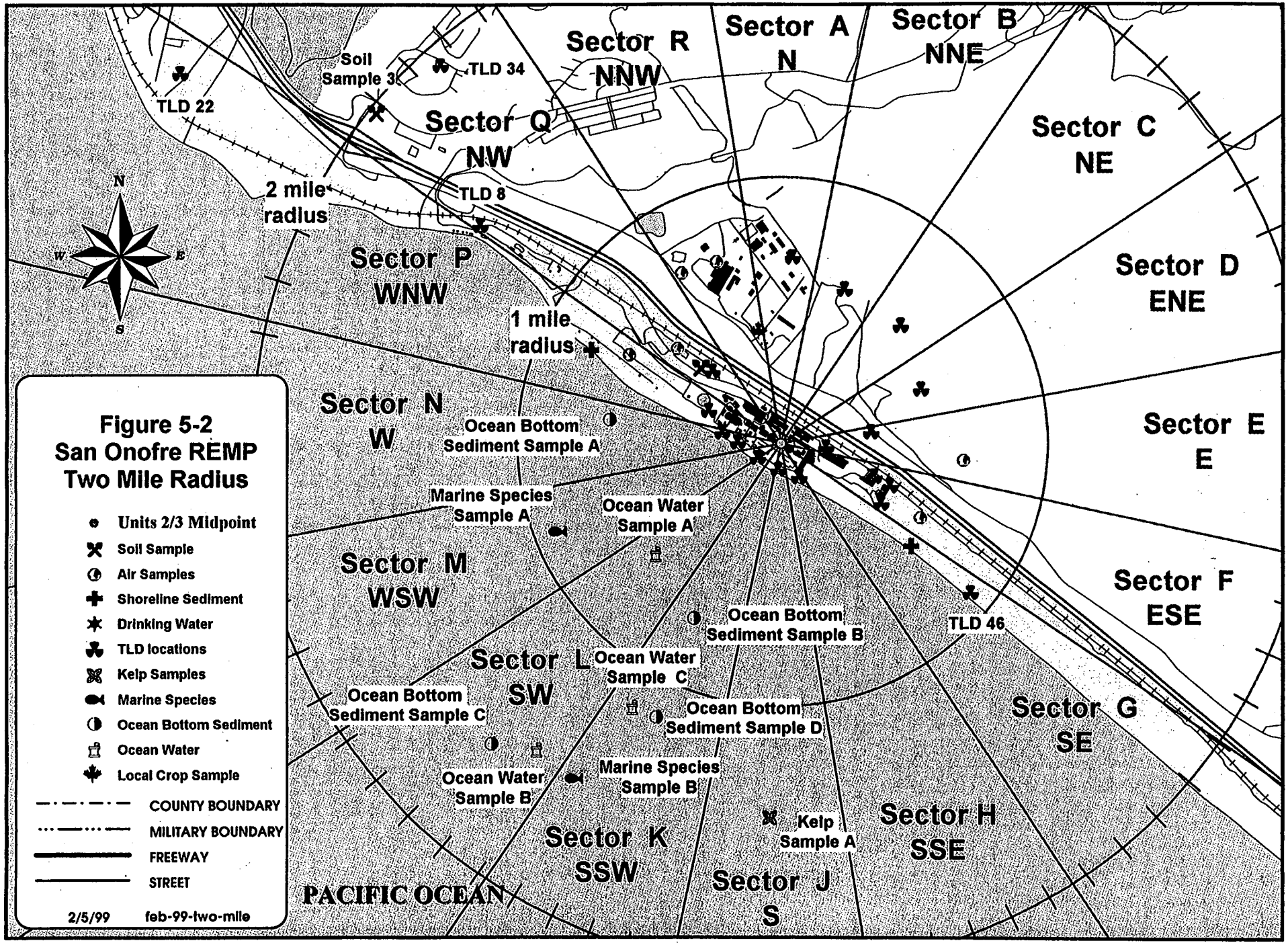
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Sector P
WNW
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Sample 3
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Ocean Bottom
Sediment Sample A
Marine Species
Sample A
Ocean Water
Sample A
Ocean Bottom
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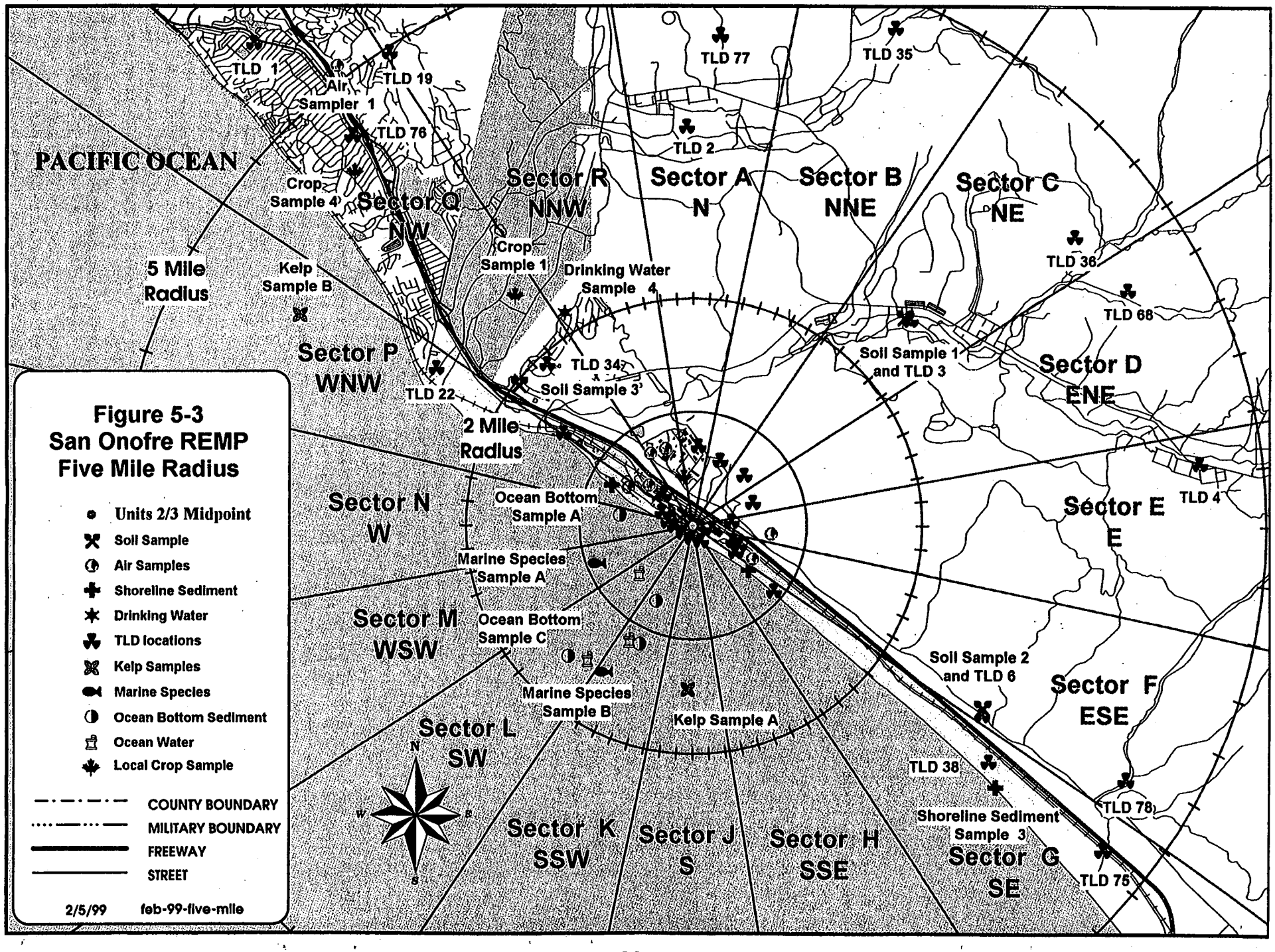
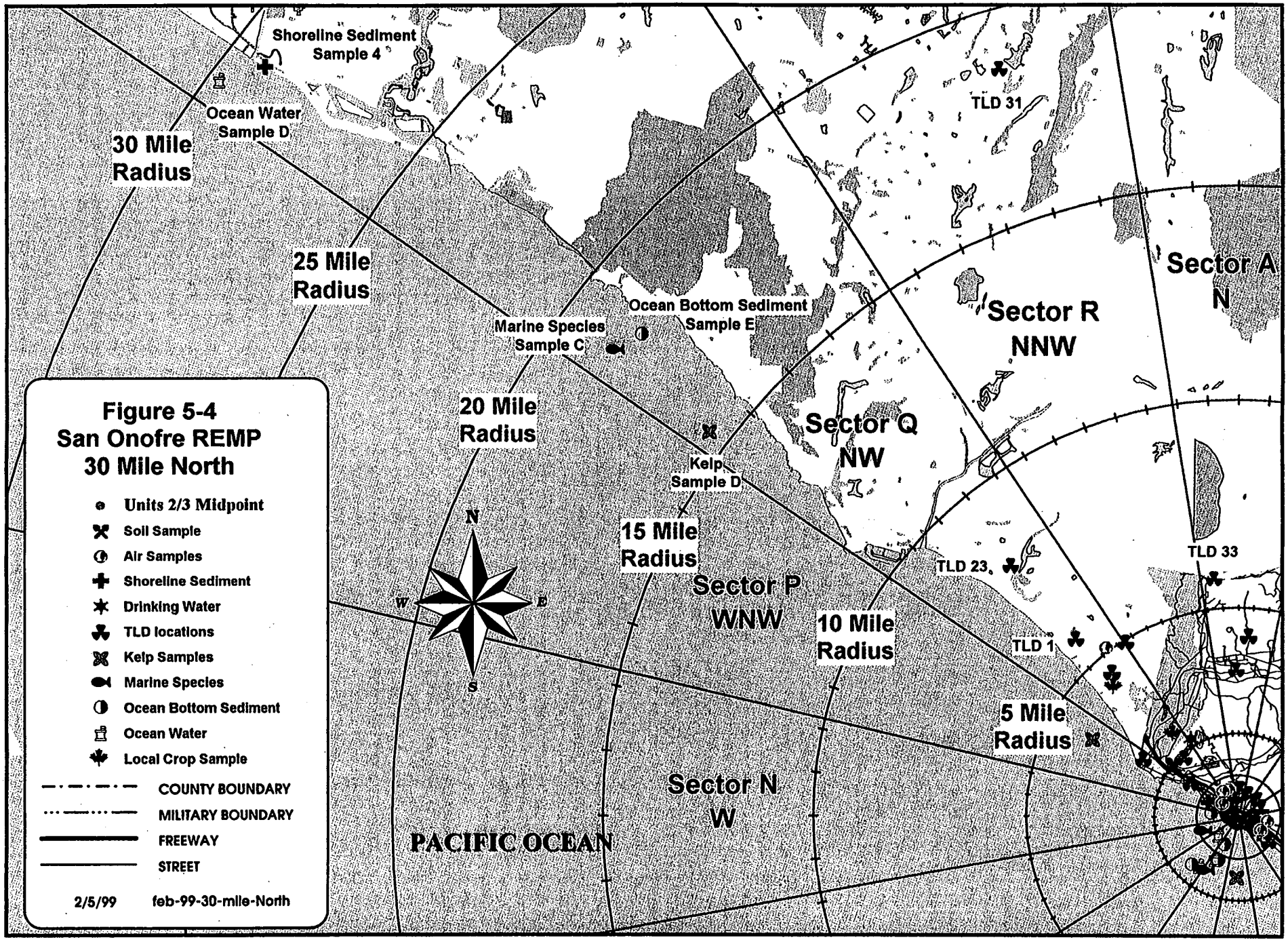
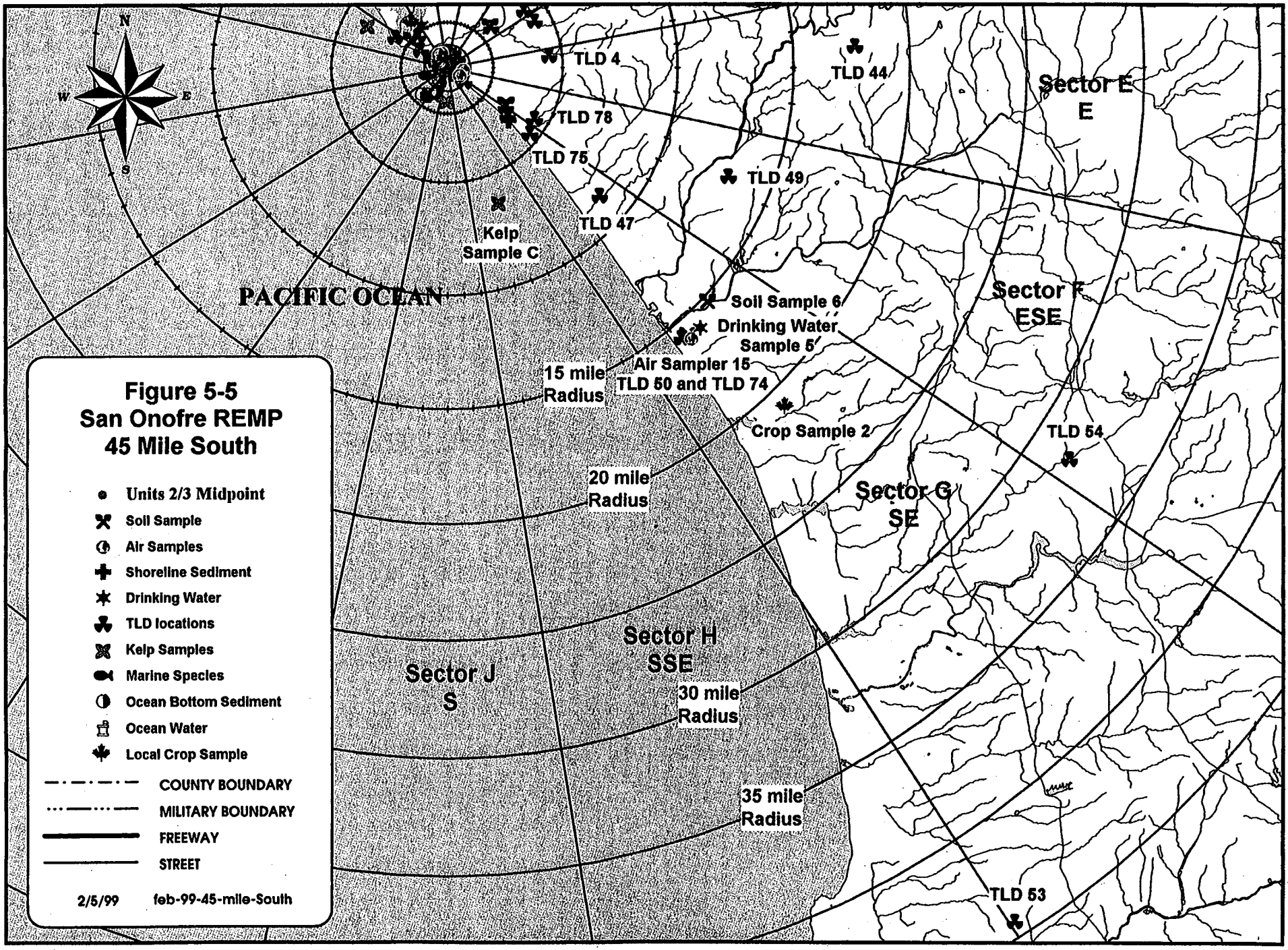
TLD 46
Ocean Water
Sample C
Ocean Bottom
Sediment Sample C
Ocean Bottom
Sediment Sample D
Ocean Water
Sample B
Marine Species
Sample B
Kelp
Sample A
PACIFIC OCEAN
Figure 5-2
San Onofre REMP
Two Mile Radius
Units 2/3 Midpoint
Soil Sample
Air Samples
Shoreline Sediment
Drinking Water
TLD locations
Kelp Samples
Marine Species
Ocean Bottom Sediment
Ocean Water
Local Crop Sample
COUNTY BOUNDARY
MILITARY BOUNDARY
FREEWAY
STREET
2/5/99
feb-99-two-mile


PACIFIC OCEAN
TLD 1
Air Sampler 1
TLD 19
TLD 76
TLD 77
TLD 35
TLD 2
Crop Sample 4
Sector Q NW
Sector R NNW
Sector A N
Sector B NNE
Sector C NE
5 Mile Radius
Kelp Sample B
Crop Sample 1
Drinking Water Sample 4
TLD 36
TLD 68
Sector P WNW
TLD 34
Soil Sample 3
TLD 22
Soil Sample 1 and TLD 3
Sector D ENE
2 Mile Radius
Sector N W
Ocean Bottom Sample A
TLD 4
Sector E E
Marine Species Sample A
Sector M WSW
Ocean Bottom Sample C
Soil Sample 2 and TLD 6
Sector F ESE
Marine Species Sample B
Kelp Sample A
Sector L SW
TLD 38
TLD 78
Shoreline Sediment Sample 3
Sector K SSW
Sector J S
Sector H SSE
Sector G SE
TLD 75
N
W
E
S
Figure 5-3
San Onofre REMP
Five Mile Radius
Units 2/3 Midpoint
Soil Sample
Air Samples
Shoreline Sediment
Drinking Water
TLD locations
Kelp Samples
Marine Species
Ocean Bottom Sediment
Ocean Water
Local Crop Sample
COUNTY BOUNDARY
MILITARY BOUNDARY
FREEWAY
STREET
2/5/99
feb-99-five-mile


Shoreline Sediment Sample 4
Ocean Water Sample D
30 Mile Radius
25 Mile Radius
20 Mile Radius
15 Mile Radius
10 Mile Radius
5 Mile Radius
Marine Species Sample C
Ocean Bottom Sediment Sample E
Kelp Sample D
TLD 31
TLD 33
TLD 23
TLD 1
Sector A N
Sector R NNW
Sector Q NW
Sector P WNW
Sector N W
PACIFIC OCEAN
N
S
E
W
Figure 5-4
San Onofre REMP
30 Mile North
Units 2/3 Midpoint
Soil Sample
Air Samples
Shoreline Sediment
Drinking Water
TLD locations
Kelp Samples
Marine Species
Ocean Bottom Sediment
Ocean Water
Local Crop Sample
COUNTY BOUNDARY
MILITARY BOUNDARY
FREEWAY
STREET
2/5/99
feb-99-30-mile-North


N
W
E
S
TLD 4
TLD 44
Sector E
E
TLD 78
TLD 75
TLD 49
TLD 47
Kelp
Sample C
PACIFIC OCEAN
Soil Sample 6
Drinking Water
Sample 5
Sector F
ESE
15 mile
Radius
Air Sampler 15
TLD 50 and TLD 74
Crop Sample 2
TLD 54
20 mile
Radius
Sector G
SE
Sector H
SSE
Sector J
S
30 mile
Radius
35 mile
Radius
TLD 53
Figure 5-5
San Onofre REMP
45 Mile South
Units 2/3 Midpoint
Soil Sample
Air Samples
Shoreline Sediment
Drinking Water
TLD locations
Kelp Samples
Marine Species
Ocean Bottom Sediment
Ocean Water
Local Crop Sample
COUNTY BOUNDARY
MILITARY BOUNDARY
FREEWAY
STREET
2/5/99
feb-99-45-mile-South

APPENDIX B

SUMMARY, RESULTS, AND DISCUSSIONS

OF 1998 ENVIRONMENTAL DATA

SUMMARY

To assess the changes or trends in the radioactivity level in the environment over the past year, the data from January 1998 to December 1998 were evaluated. The 1998 REMP data were evaluated according to the criteria described in NUREG/CR-4007 and with the methodology described by Currie (1968).* The REMP data above the critical level (1.64 times one sigma) was reduced and tabulated in Table B-3 in accordance with the format specified in Reg Guide 4.8. It should be noted that in an ideal database with the "true" value of each data point equal to zero, five (5)% of the values should be expected to be above the critical level. Note that the summary in Table B-3 lists analysis results above the critical level constituting approximately five (5)% of the total number of values below the *a posteriori* Minimum Detectable Concentration (MDC). Thus the 1998 SONGS REMP database, when examined in accordance with the Currie data reduction protocol, leads to the conclusion that SONGS had no statistically significant radiological environmental impact. A summary of the type and number of REMP samples obtained in 1998 appears in Table B-2.

As noted above, the SONGS REMP data base behaves substantially similar to a data base with values statistically indistinguishable from zero for station related isotopes. The exceptions, summarized in Table B-1, include eight (8) isotopically analyzed samples with station related activity reported above the *a posteriori* MDC. All sample values were significantly less than the NRC reporting levels. I-131 was detected in kelp and Cs-137 was detected in soil and in one Ocean Bottom Sediment sample. These radionuclides have been detected in CONTROL as well as indicator locations in previous years. Cs-137 is commonly detected in environmental sediment samples because of fallout from weapons testing. Cs-137 has been intermittently detected in CONTROL soil samples in past years and no correlation between Cs-137 level and proximity to the plant has been observed. The data strongly suggest that the low level Cs-137 in certain sediment samples is due to fallout and is not due to the operation of SONGS. I-131 is a medically administered radionuclide which is often detected in sewage plant outfalls, including those routed to the Pacific Ocean. I-131 has been detected in CONTROL and indicator Kelp samples in past years. The Kelp CONTROL sample I-131 level has typically been slightly higher than the indicator sample I-131 concentration, suggesting that the source of the I-131 is external to SONGS. We conclude that SONGS had a negligible radiological environmental impact during 1998.

Historical trending of data near and below the detection limits is necessarily limited. The concentration of radionuclides in the environs of SONGS has trended downward since the early to mid 1980s. In the past three years only a few REMP analysis results have been above the detection limit. These isotopes are detected in CONTROL as well as indicator locations and there are known sources for these radionuclides external to SONGS. The overall trend of the REMP data at SONGS is *de minimis* levels of anthropogenic radioactivity with occasional samples showing radioactivity above the *a posteriori* MDC. The 1993 AREOR included detailed historical data.

* L. Currie. 1968 "Limits for the Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Analytical Chemistry, vol. 40 pp. 586-593

RESULTS AND DISCUSSIONS OF 1998 ENVIRONMENTAL DATA

A. Direct Radiation

The purpose of this program element was to measure the quarterly environmental gamma radiation in the vicinity of SONGS. To accomplish this task, calcium sulfate ($CaSO_4$) thermoluminescent dosimeters (TLDs) were placed at a minimum of 30 indicator and CONTROL locations. They were collected and analyzed quarterly in accordance with ANSI-N545 standards. TLDs within five miles of SONGS were considered indicator locations. TLDs located greater than five miles from SONGS were considered CONTROL locations. The indicator locations are selected as inner and outer rings for all three Units as required by Unit 1 and Units 2/3 Offsite Dose Calculation Manuals (ODCMs). Additional TLDs are placed at locations of interest such as schools and hospitals.

Six laboratory CONTROL TLDs were analyzed quarterly. TLD numbers 17, 18, and 60 are used for background dose normalization. TLDs #A and #B are used to compensate for transit dose. A fader TLD is used to compensate for the time and temperature dependent "fade" associated with this type of dosimeter.

After the samples were analyzed, the measured doses were corrected for pre and post field exposure times. The average indicator location dose was 15.1 mR with a range of 9.8 to 20.0 mR. The average CONTROL location dose was 14.8 mR with a range of 11.3 to 18.6 mR. The 1998 REMP TLD data has been grouped into four categories based on distance from SONGS for the purposes of trending any correlation between distance from SONGS and total annual dose.

1998 REMP TLD data (Average Dose vs. Distance from SONGS)

	Average Quarterly Dose in mR
TLDs < 0.5 miles from SONGS	15.4
TLDs > 0.5 miles AND < 1.0 mile from SONGS	14.3
TLDs > 1.0 mile AND < 5.0 miles from SONGS	15.3
TLDs > 5 miles from SONGS (CONTROL TLDs)	14.8

These data indicate no correlation between total dose and distance from SONGS. The variations in the average dose is approximately equal to the median one sigma variation of measurement (1.00 mR per quarter). Statistically, the CONTROL and indicator doses are equal. The indicator location at the Area 62 Heavy lift pad (location # 77, at 4.3 miles N of Units 2/3 midpoint) had the highest TLD reading in the third quarter (20.0 mrem), with an annual dose of 74.2 mrem (uncorrected for background). Since TLDs closer than location # 77 had a lower dose we conclude that the slightly elevated dose at location # 77 is due to some local environmental condition and is not due to the operation of SONGS. The operation of SONGS had no measurable impact on this sample medium.

Figures 2A & 2B compare environmental radiation levels of indicator and CONTROL locations for the operational year 1998 and for previous years. These figures show the close correlation between the CONTROL and indicator location TLD dose data.

Nonroutine Direct Radiation Samples

During 1998, twelve additional TLD sample locations were installed to ensure verbatim compliance with the SONGS emergency plan. These TLDs were not required by the ODCM, but the sample results are included in Table B-3.

B. Airborne Particulate, Iodine, and Composite Isotopic Analyses

Air particulate samples were collected on a weekly basis from eight indicator locations and from one CONTROL location. The samples were analyzed for gross beta activity, I-131, and composited quarterly for gamma isotopic analysis. Sample locations were selected according to the requirements of the Unit 1 and Units 2/3 Offsite Dose Calculation Manuals.

Gross beta analysis is a measure of total radioactivity of beta-emitting radionuclides in a sample. Beta radiation is emitted by many radionuclides, but beta decay gives a continuous energy spectrum rather than the discrete lines or peaks associated with gamma radiation. Gross beta measurements only indicate whether the sample contains normal or abnormal concentrations of beta-emitting radionuclides and does not identify specific radionuclides. Gross beta measurement data serves as a screening tool to determine if further analysis is required.

Nearly all gross beta activity analysis results were above the 3 sigma confidence level (99% probability of activity being present). The concentration of gross beta activity in the samples collected from the indicator locations ranged from 0.0035 to 0.049 pCi/m^3, averaging 0.0187 pCi/m^3 of air. The concentrations of gross beta activity in the samples from the CONTROL location ranged from 0.0061 to 0.043 pCi/m^3, averaging 0.0183 pCi/m^3 of air. The CONTROL and indicator locations gross beta data show a close correlation. Figures 3E and 3F show the variation in gross beta activity level in 1998 at different locations. These graphs show a close correlation between the indicator and CONTROL location data. Effective January 1998, the CONTROL location was changed from Huntington Beach (31.1 miles NW) to Oceanside City Hall (15.6 miles SE).

Per the requirements of Unit 1 and Units 2/3 ODCM, Section 5, Table 5.1, an assessment was performed to determine whether the gross beta activity of the indicators exceeded 10 times the background (CONTROL location #15). The results showed that indicator locations maximum gross beta activity in air in 1998 was 0.049 pCi/m^3 and the CONTROL locations average was 0.0183 pCi/m^3. No action was taken since the indicator location value did not exceed ten times the annual average gross beta activity of the CONTROL.

All samples analyzed for I-131 were less than the 3 sigma confidence level and all I-131 samples were less that the *a priori* lower limit of detection (LLD). The airborne indicator and CONTROL I-131 REMP samples taken in 1998 at SONGS were statistically indistinguishable from zero.

The quarterly composite gamma spectral analysis analyses yielded only naturally occurring beryllium-7 (Be-7) at the 3 sigma confidence level. For station related isotopes the balance of the airborne gamma isotopic database is statistically indistinguishable from database with zero activity.

We conclude that the operation of SONGS had no detectable impact on this sample medium.

Nonroutine Airborne Particulate, Iodine, and Composite Isotopic Analyses

Air sampler 7, AWS Building Roof, is well within the Exclusion Area Boundary and is not required by the ODCM. This air sampler provides a basis for evaluating any airborne emissions that might impact workers in the major office area on the site. Those individuals are defined as members of the public according to 10 CFR 20.1003 and meet the dose limits of 10 CFR 20.1301. Air sample 7 was processed for particulate gross beta, I-131, and quarterly composite gamma isotopic analysis. Results are included in Table B-3.

Air sampler 51, Blind Duplicate, is not required by the ODCM. The basis for this air sampler is found in Regulatory Guide 4.15. A sample duplicate program is recommended for those sample media yielding analysis results consistently above the *a priori* LLD. The only REMP sample category meeting this criteria is the airborne particulate gross beta. Air Sampler 51 is analyzed for gross beta only. A summary of the gross beta duplicate range control chart range data is included in Appendix C.

Air sampler 30 was installed to compensate for an extended unavoidable power outage which kept Air sampler 13 out of service for three weeks. Air sampler 30 is 0.2 miles in Sector E. Air sampler 13 is 0.7 miles in Sector E. Gross Beta, I-131, and the gamma isotopic data for air sampler 30 are included in Table B-3.

C. Ocean Water

Monthly ocean water samples were collected from indicator locations in the vicinity of each station discharge and from the CONTROL location at Newport Beach. The samples were analyzed for naturally-occurring and SONGS-related gamma-emitting radionuclides. Quarterly composite ocean water samples were analyzed for tritium according to ODCM requirements. Naturally occurring potassium-40 (K-40) was detected in all ocean water samples obtained in 1998. No SONGS related radionuclides were detected in this sample medium during 1998.

Four non-routine ocean water samples were obtained from two locations, Unit 2 outfall conduit and Unit 3 outfall conduit. The conduit samples were collected to measure the radiological environmental effect potentially resulting from the minor conduit leakage

Throughout 1998 only naturally occurring K-40 was detected at the 99% confidence level in the monthly gamma spectral analyses of ocean water. No station related radionuclides were detected above the *a posteriori* MDC in this sample type during 1998. Excluding K-40 the ocean water gamma isotopic database is statistically indistinguishable from a database with zero activity.

The data indicate that SONGS operations had no measurable impact on this environmental medium.

D. Drinking Water

In 1998, drinking water samples were collected on a monthly basis from three indicator locations and from the Oceanside CONTROL location. Samples were analyzed for tritium, gross beta, and 28 naturally-occurring and SONGS-related gamma emitting radionuclides. There is no drinking water pathway for liquid effluent at SONGS.

Only gross beta was consistently detected at the 99% confidence level. The gross beta data indicate the CONTROL location typically had detectable gross beta and the indicator location often had no detectable gross beta activity. No station related radionuclides were detected in drinking water during 1998. Excluding gross beta, the drinking water gamma isotopic database is statistically indistinguishable from a database with zero activity. The operation of SONGS had no impact on this sample medium.

E. Shoreline Sediment (Beach Sand)

Beach sand was collected semiannually in 1998 from three indicator locations and from a CONTROL location situated in Newport Beach. After collection, the samples were analyzed for 28 different plant-related and naturally-occurring radionuclides. Only naturally occurring K-40 and thorium-228 (Th-228) were detected at the 99% confidence level. No plant related radionuclides were reported above the *a posteriori* MDC. The operation of SONGS had no detectable impact on this sample medium.

F. Ocean Bottom Sediments

Ocean bottom sediments were collected in the vicinity of each of the three SONGS discharge locations and at the Newport Beach CONTROL location. The samples were analyzed by gamma-spectral analysis for 28 naturally-occurring and station-related radionuclides. K-40 and Th-228 were detected at the 99% confidence level in all ocean bottom sediment samples collected during 1998.

Four non-routine ocean bottom sediment samples were obtained from two locations, Unit 2 outfall conduit and Unit 3 outfall conduit. The conduit samples were collected to measure the radiological environmental effect potentially resulting from the minor conduit leakage. A Cs-137 peak was detected in one of these samples although the analysis results were less than the *a posteriori* MDC. A recount yielded a result slightly above the MDC. These results are summarized in Table B-2.

We conclude that the operation of SONGS had no significant effect on this sample medium.

G. Non-Migratory Marine Species (Flesh)

Species of adult fish, crustacea and mollusks, were collected on a semi annual basis at the SONGS Unit 1 outfall, at the SONGS Units 2 and 3 outfall and from Laguna Beach. The flesh portion of each sample type was analyzed for 28 gamma-emitting station-related and naturally occurring radionuclides. The results were subsequently reported to Edison in terms of wet sample weights. Because results based on a wet sample weight are most useful for calculating doses, the results of sample analyses are summarized in terms of "as received" wet weights.

Naturally-occurring K-40 was detected in most samples at the 99% confidence level in all Marine Species samples collected during 1998. No plant related isotopes were reported above the *a posteriori* MDC. SONGS operations had no measurable impact on this environmental medium. The potential dose to members of the public from consumption of marine species near SONGS is not detectable.

H. Local Crops

Fleshy crops were collected semiannually in 1998 from the San Clemente Ranch, the SONGS garden, a San Clemente residence, and from a CONTROL location near Oceanside. The crop samples were analyzed quantitatively for 28 gamma-emitting radionuclides, both natural and plant related.

Naturally occurring Be-7 and K-40 were detected at the 99% confidence level in samples obtained from both CONTROL and indicator locations. No SONGS related isotopes were reported above the *a posteriori* MDC. Based on these data, it was concluded that SONGS operations had no detectable impact on this environmental medium and that the potential dose to members of the public from consumption of crops near SONGS is negligible.

I. Soil

To determine if there is evidence of a build-up of radionuclides in the land near SONGS, indicator soil samples were collected from the East Site Boundary (Former Visitor's center), Old Route 101, Basilone Road, and Camp San Onofre. A CONTROL sample was obtained from Oceanside. Surface soil was collected from all indicator and CONTROL locations at the depth of 3 inches. The sampling protocol is consistent with the procedure described in HASL-300. Soil sampling is not required by ODCMs.

Soil samples were analyzed for 28 naturally-occurring and SONGS-related gamma-emitting radionuclides using gamma spectral analysis. All 1998 soil samples yielded naturally occurring K-40 and Th-228 above the 3 sigma (99%) confidence level. Cs-137, above the 99% confidence level, was detected in two indicator samples. Cs-137 is often detected in environmental sediment samples and the presence of Cs-137 is most likely related to nuclear weapons testing fallout. No other plant related radionuclides were reported above the *a posteriori* MDC.

Cs-137 and strontium-90 (Sr-90) were detected in soil profile analyses conducted in previous years. These radionuclides are mostly due to the nuclear weapons testing fallout depositing on soil and retention of these radionuclides due to their long half lives. Cesium-137 in soil with

high clay content usually binds to the silicate structure more than rocky type soil. This can be seen in location No. 1 (Camp San Onofre) and location No. 2 (Old Route 101), which have higher clay contents and higher concentrations of Cs-137. The presence of Cs-137 in the CONTROL location in previous years supports the conclusion that the major source of this radionuclide is due to fallout deposition. Since the termination of atmospheric nuclear weapons testing the trend has continued downward in this sample media. Refer to the 1993 AREOR for a more detailed discussion of Cs-137 and other potentially SONGS related isotopes detected in soil. The Cs-137 activity can be attributed to atmospheric nuclear weapons tests and not SONGS operations. During 1998, SONGS had a negligible impact on this sample medium.

J. Kelp Sampling

Kelp was collected during April and October 1998 from the San Onofre, San Mateo, and Laguna Beach CONTROL location (15.6 miles NW). Upon collection, the samples were analyzed by gamma-spectral analysis for 28 different naturally-occurring and Station-related radionuclides. The radionuclides detected in 1998 were K-40 and I-131. K-40 is naturally occurring and not related to the operation of SONGS. I-131 was detected in two indicator locations, as well as the alternate CONTROL location. I-131 is often detected in Sewage Plant outfalls, including those routed to the Pacific Ocean. I-131 has been detected at both Indicator and CONTROL locations in previous years. The northern CONTROL location is too far away and in the predominantly upstream current direction for the I-131 activity to be attributable to SONGS. The presence of low levels of I-131 in the indicator locations may be due to the operation of SONGS or it may be related to the up coast sewage discharge of medically administered I-131. During 1998 the alternate Salt creek CONTROL location (9.9 miles WNW) sample yielded the highest level of I-131 (1.05 E-1/pCi/g).

Because the I-131 activity detected in kelp during 1998 was higher in the CONTROL location than in the indicator locations, it was concluded that the operation of SONGS had no measurable impact on this sample medium.

TABLE B-1
Summary of SONGS related Gamma Isotopic Analyses above MDC

Sample Media & location	Radio-nuclide	Sample Value	MDC (*a posteriori*)	Three Sigma Confidence level
Ocean Bottom [1] Sediment Location # 51 SONGS Unit 2 Conduit 20OCT98	Cs-137 Cs-137	39 E-3 pCi/g[2] 25 E-3 pCi/g[3]	60 E-3 pCi/g 24 E-3 pCi/l	51 E-3 pCi/g 21 E-3 pCi/l
Aquatic Kelp San Onofre Kelp Bed Station A 21APR98	I-131	76 E-3 pCi/g	59 E-3 pCi/g	58 E-3 pCi/g
Aquatic Kelp San Mateo Kelp Bed Station B 21APR98	I-131	55 E-3 pCi/g	26 E-3 pCi/g	35 E-3 pCi/g
Aquatic Kelp Salt creek, alternate CONTROL location Station D 21APR98	I-131	105 E-3 pCi/g	30 E-3 pCi/g	43 E-3 pCi/g
Aquatic Kelp San Onofre Kelp Bed Station A 20OCT98	I-131	34 E-3 pCi/g	19 E-3 pCi/g	27 E-3 pCi/g
Aquatic Kelp San Mateo Kelp Bed Station B 20OCT98	I-131	95 E-3 pCi/g	49 E-3 pCi/g	55 E-3 pCi/g
Soil 16DEC98 Camp San Onofre Location # 1	Cs-137	66 E-3 pCi/g	37 E-3 pCi/g	34 E-3 pCi/g
Soil 16DEC98 Old Route 101 Location # 2	Cs-137	76 E-3 pCi/g	34 E-3 pCi/g	36 E-3 pCi/g

(1) A Cs-137 peak was noted during the first gamma scan, but the activity was less than the *a posteriori* MDC. A recount was requested in order to verify the presence of Cs-137 in this sample.
(2) First reported analysis results
(3) Sample recount analysis results

TABLE B-2

REMP SAMPLE ANALYSIS SUMMARY FOR 1998

Medium	Analysis Type	Sampling Frequency	# of Locations	Total # of Analysis in 1998
Direct Radiation	Dosimetry	Quarterly	61	216
Airborne Particulates	Gross Beta	Weekly	11	521
Charcoal Cartridge	I-131	Weekly	10	469
Airborne Particulates	Ge (Li) Scan	Quarterly	10	37
Ocean Water	Ge (Li) Scan	Monthly	4	48
Ocean Water	H-3	Quarterly	4	16
Drinking Water, Unfiltered	Ge (Li) Scan	Monthly	2	24
	H-3		2	24
	Gross Beta		2	24
Shoreline Sediment	Ge (Li) Scan	Semi-Annually	4	8
Ocean Bottom Sediment	Ge (Li) Scan	Semi-Annually	5	10
Marine Species, Flesh	Ge (Li) Scan	Semi-Annually	3	24
Crops	Ge (Li) Scan	Semi-Annually	4	13
Kelp	Ge (Li) Scan	Semi-Annually	4	6
Soil	Ge (Li) Scan	Annually	5	5

TABLE B-3

STATISTICAL SUMMARY OF RADIOLOGICAL ENVIRONMENTAL MONITORING DATA FOR 1998

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY
SAN ONOFRE NUCLEAR GENERATING STATION

DOCKET NOS. 50-206, 50-361, 50-362
SAN DIEGO COUNTY, CALIFORNIA

REPORTING PERIOD: January 1, 1998 to December 31, 1998

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range) (1)(3)	Location with Highest Annual Mean Name, Distance and Direction	Location with Highest Annual Mean Mean (Range)	Control Locations Mean (Range) (2)	Number of Nonroutine Reported Measurements (3)
TABLE 1A Quarterly Gamma Exposure (millirem)							
	Gamma Exposure 206	5	15.10 (172/ 172) (9.81-19.99)	Area 62 Heavy Lift Pad 4.3 Mi. N	18.55 (2/ 2) (17.1-19.99)	14.77 (34/ 34) (11.28-18.59)	28

(1) Indicator location data includes all TLD's less than 5 miles from SONGS Unit 2/3 Midpoint.
(2) Control location data includes all TLD's greater than 5 miles from SONGS.
(3) Indicator location data includes 28 nonroutine reported analyses from TLD's deployed to ensure full conformity to the SONGS emergency plan.

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY
SAN ONOFRE NUCLEAR GENERATING STATION

DOCKET NOS. 50-206, 50-361, 50-362
SAN DIEGO COUNTY, CALIFORNIA

REPORTING PERIOD: January 1, 1998 to December 31, 1998

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range) (1)	Location with Highest Annual Mean Name, Distance and Direction	Location with Highest Annual Mean Mean (Range)	Control Locations Mean (Range)	Number of Nonroutine Reported Measurements (1)
TABLE 2 Weekly Airborne Particulates Gross Beta Activity (pCi/cu.m)							
	Gross Beta 521	0.01	0.0187 (416/417) (0.00347- 0.04929)	Mesa Medical Facility 0.7 Mi. NNW	0.0196 (52/ 52) (0.0056- 0.0474)	0.0183 (52/ 52) (0.00608- 0.0434)	107

(1) Nonroutine reported measurements include the following auxiliary indicator sample locations:
Air Sampler #7, AWS Building Roof, is well within the Exclusion Area Boundary and is not necessary to comply with ODCM requirements.
Air Sampler #30, was installed to compensate for an extended unavoidable power outage which kept Air Sampler #13 out of service for three weeks.
Air Sampler #51, Blind Duplicate, is not required by the ODCM. It is collocated with Air Sampler #9.

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY
SAN ONOFRE NUCLEAR GENERATING STATION

DOCKET NOS. 50-206, 50-361, 50-362
SAN DIEGO COUNTY, CALIFORNIA

REPORTING PERIOD: January 1, 1998 to December 31, 1998

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range) (1)	Location with Highest Annual Mean Name, Distance and Direction	Location with Highest Annual Mean Mean (Range)	Control Locations Mean (Range)	Number of Nonroutine Reported Measurements (1)
TABLE 3 Weekly Radioiodine I-131 Activity (pCi/cu.m)							
	I-131 469	0.07	0.0155 (18/365) (0.0098-0.0211)	Mesa EOF 0.7 mi NNW	0.0189 (2/ 52) (0.0166-0.0211)	0.0147 (2/ 52) (0.0134-0.0159)	55

(1) Nonroutine reported measurements include the following auxiliary indicator sample locations:
Air Sampler #7, AWS Building Roof, is well within the Exclusion Area Boundary and is not necessary to comply with ODCM requirements.
Air Sampler #30, was installed to compensate for an extended unavoidable power outage which kept Air Sampler #13 out of service for three weeks.

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY
SAN ONOFRE NUCLEAR GENERATING STATION

DOCKET NOS. 50-206, 50-361, 50-362
SAN DIEGO COUNTY, CALIFORNIA

REPORTING PERIOD: January 1, 1998 to December 31, 1998

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range) (1)	Location with Highest Annual Mean: Name, Distance and Direction	Location with Highest Annual Mean: Mean (Range)	Control Locations Mean (Range)	Number of Nonroutine Reported Measurements (1)
TABLE 4A Quarterly Composite Airborne Particulates Gamma Spectral Analysis (pCi/cu.m)							
Ag-110m	37	0.0025	0.0008 (1/ 29) (0.0008-0.0008)	City of San Clemente 5.1 Mi NW	0.0008 (1/ 4) (0.0008-0.0008)	<LLD (0/ 4)	5
Be-7	37	0.035	0.0911 (29/ 29) (0.0515-0.1719)	MCB, Camp Pendleton East 0.7 Mi E	0.1037 (4/ 4) (0.0715-0.1308)	0.0998 (4/ 4) (0.0761-0.1556)	5
Ce-141	37	0.005	0.0015 (2/ 29) (0.0013-0.0016)	Mesa EOF 0.7 Mi NNW	0.0015 (2/ 4) (0.0013-0.0016)	<LLD (0/ 4)	5

(1) Nonroutine reported measurements include the following auxiliary indicator sample locations:
Air Sampler #7, AWS Building Roof, is well within the Exclusion Area Boundary and is not necessary to comply with ODCM requirements.
Air Sampler #30, was installed to compensate for an extended unavoidable power outage which kept Air Sampler #13 out of service for three weeks.

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TABLE 4A (Cont) Quarterly Composite Airborne Particulates Gamma Spectral Analysis (pCi/cu.m)							
	Co-58 37	0.0025	0.0012 (1/ 29) (0.0012-0.0012)	Former SONGS Evaporation Pond 0.6 Mi NW	0.0012 (1/ 4) (0.0012-0.0012)	<LLD (0/ 4)	5
	Cs-134 37	0.05	0.0004 (1/ 29) (0.0004-0.0004)	Oceanside City Hall (CONTROL) 15.6 Mi SE	0.0006 (1/ 4) (0.0006-0.0006)	0.0006 (1/ 4) (0.0006-0.0006)	5
	Cs-137 37	0.06	<LLD (0/ 29)		----- (0/ 1)	<LLD (0/ 4)	5
	K-40 37	0.03	0.0133 (1/ 29) (0.0133-0.0133)	Mesa Medical Facility 0.7 Mi NNW	0.0133 (1/ 4) (0.0133-0.0133)	<LLD (0/ 4)	5

(1) Nonroutine reported measurements include the following auxiliary indicator sample locations:
Air Sampler #7, AWS Building Roof, is well within the Exclusion Area Boundary and is not necessary to comply with ODCM requirements.
Air Sampler #30, was installed to compensate for an extended unavoidable power outage which kept Air Sampler #13 out of service for three weeks.

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TABLE 4A (Cont) Quarterly Composite Airborne Particulates Gamma Spectral Analysis (pCi/cu.m)							
	Nb-95 36	0.006	<LLD (0/ 28)	Oceanside City Hall (CONTROL) 15.6 Mi. SE	0.0020 (1/ 4) (0.002-0.002)	0.0020 (1/ 4) (0.0020-0.0020)	5
	Ru-103 37	0.005	0.0013 (4/ 29) (0.0011-0.0016)	Mesa Medical Facility 0.7 Mi NNW	0.0016 (1/ 4) (0.0016-0.0016)	<LLD (0/ 4)	5
	Ru-106 37	0.015	0.0075 (1/ 29) (0.0075-0.0075)	Mesa Medical Facility 0.7 Mi NNW	0.0075 (1/ 4) (0.0075-0.0075)	0.0034 (0/ 4) (0.0034-0.0034)	5

(1) Nonroutine reported measurements include the following auxiliary indicator sample locations:
Air Sampler #7, AWS Building Roof, is well within the Exclusion Area Boundary and is not necessary to comply with ODCM requirements.
Air Sampler #30, was installed to compensate for an extended unavoidable power outage which kept Air Sampler #13 out of service for three weeks.

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TABLE 4A (Cont) Quarterly Composite Airborne Particulates Gamma Spectral Analysis (pCi/cu.m)								
AcTh-228	36	0.005	0.0019 (1/ 28) (0.0019-0.0019)	State Beach Park 0.6 Mi ESE	0.0019 (1/ 4) (0.0019-0.0019)	<LLD	(0/ 4)	5
Zn-65	37	0.004	0.0025 (2/ 29) (0.0011-0.0040)	Former SONGS Evaporation Pond 0.6 Mi NW	0.0040 (1/ 4) (0.004-0.004)	<LLD	(0/ 4)	5
Zr-95	37	0.005	0.0019 (3/ 29) (0.0016-0.0024)	State Beach Park 0.6 Mi ESE	0.0024 (1/ 4) (0.0024-0.0024)	<LLD	(0/ 4)	5

(1) Nonroutine reported measurements include the following auxiliary indicator sample locations:
Air Sampler #7, AWS Building Roof, is well within the Exclusion Area Boundary and is not necessary to comply with ODCM requirements.
Air Sampler #30, was installed to compensate for an extended unavoidable power outage which kept Air Sampler #13 out of service for three weeks.

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Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range) (1)	Location with Highest Annual Mean Name, Distance and Direction	Location with Highest Annual Mean Mean (Range)	Control Locations Mean (Range)	Number of Nonroutine Reported Measurements (1)
TABLE 5 Monthly Ocean Water Gamma Spectral Analysis (pCi/l)							
	Ag-110m 52	9	2.6605 (2/ 40) (2.437-2.884)	(C) Outfall - U3 1.2 Mi SSW	2.6605 (2/ 12) (2.437-2.884)	<LLD (0/ 12)	4
	Ba-140 52	15	3.0040 (1/ 40) (3.004-3.004)	(A) U1 Station Discharge Outfall 0.6 Mi SW	3.0040 (1/ 12) (3.004-3.004)	<LLD (0/ 12)	4
	Be-7 52	50	18.8300 (2/ 40) (14.45-23.21)	(B) Outfall - U2 1.5 Mi SW	23.2100 (1/ 12) (23.21-23.21)	<LLD (0/ 12)	4
	Ce-141 52	10	3.1215 (2/ 40) (2.681-3.562)	(C) Outfall - U3 1.2 Mi SW	3.5620 (1/ 12) (3.562-3.562)	<LLD (0/ 12)	4
	Ce-144 52	35	15.4750 (2/ 40) (14.32-16.63)	(A) U1 Station Discharge Outfall 0.6 Mi SW	16.6300 (1/ 12) (16.63-16.63)	11.2575 (2/ 12) (9.785-12.73)	4

(1) Indicator locations include 2 nonroutine sample locations - Unit 2 Conduit (#51) and Unit 3 Conduit (#52). The nonroutine samples are collected twice per year. All other samples are collected monthly.

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					Name, Distance and Direction	Mean (Range)		
TABLE 5 (Cont.) Monthly Ocean Water Gamma Spectral Analysis (pCi/l)								
	Co-57	52	5	2.1875 (4/ 40) (1.431-3.328)	Unit 2 Conduit 0.1 Mi SW	3.328 (1/ 2) (3.328-3.328)	1.711 (1/ 12) (1.711-1.711)	4
	Co-58	52	15	<LLD (0/ 40)	(D) Newport Beach 30 Mi NW	1.748 (1/ 12) (1.748-1.748)	1.748 (1/ 12) (1.748-1.748)	4
	Co-60	52	15	3.288 (3/ 40) (2.047-4.263)	(A) U1 Station Discharge Outfall 0.6 Mi SW	3.9085 (2/ 12) (3.554-4.263)	1.67 (2/ 12) (1.593-1.74)	4
	Cr-51	52	60	<LLD (0/ 40)	(D) Newport Beach 30 Mi NW	19.66 (1/ 12) (19.66-19.66)	19.6600 (1/ 12) (19.66-19.66)	4

(1) Indicator locations include 2 nonroutine sample locations - Unit 2 Conduit (#51) and Unit 3 Conduit (#52). The nonroutine samples are collected twice per year. All other samples are collected monthly.

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Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range) (1)	Location with Highest Annual Mean		Control Locations Mean (Range)	Number of Nonroutine Reported Measurements (1)
					Name, Distance and Direction	Mean (Range)		
TABLE 5 (Cont.) Monthly Ocean Water Gamma Spectral Analysis (pCi/l)								
	Cs-134	52	15	1.81 (3/ 40) (1.652-2.062)	(A) U1 Station Discharge Outfall 0.6 Mi SW	1.857 (2/ 12) (1.652-2.062)	<LLD (0/ 12)	4
	Cs-137	52	18	2.362 (2/ 40) (2.298-2.426)	(C) Outfall - U3 1.2 Mi SSW	2.362 (2/ 12) (2.298-2.426)	<LLD (0/ 12)	4
	Fe-59	52	30	6.7175 (2/ 40) (6.559-6.876)	Unit 2 Conduit 0.1 Mi SW	6.876 (1/ 2) (6.876-6.876)	5.356 (1/12) (5.356-5.356)	4
	I-131	52	15	4.5205 (2/ 40) (3.288-5.753)	(C) Outfall - U3 1.2 Mi SSW	5.753 (1/ 12) (5.753-5.753)	3.365 (1/ 12) (3.365-3.365)	4
	K-40	52	120	327.0 (40/ 40) (258-403)	Unit 3 Conduit 0.1 Mi SSW	376.6 (2/ 2) (364.2-388.9)	337.2 (12/12) (295.8-388.5)	4

(1) Indicator locations include 2 nonroutine sample locations - Unit 2 Conduit (#51) and Unit 3 Conduit (#52). The nonroutine samples are collected twice per year. All other samples are collected monthly.

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TABLE 5 (Cont.) Monthly Ocean Water Gamma Spectral Analysis (pCi/l)								
	La-140	52	15	3.4546 (1/ 40) (3.4546-3.4546)	(A) U1 Station Discharge Outfall 0.6 Mi SW	3.4546 (1/ 12) (3.4546-3.4546)	<LLD (0/ 12)	4
	Mn-54	52	15	2.539 (2/ 40) (2.187-2.891)	(A) U1 Station Discharge Outfall 0.6 Mi SW	2.891 (1/ 12) (2.891-2.891)	1.559 (1/ 12) (1.559-1.559)	4
	Mo-99	52	2000	136.1 (2/ 40) (113.6-158.6)	(B) Outfall U2 1.5 Mi SW	158.6 (1/ 12) (158.6-158.6)	<LLD (0/ 12)	4
	Nb-95	52	15	3.734 (1/ 40) (3.734-3.734)	Unit 2 Conduit 0.1 Mi SW	3.734 (1/ 2) (3.734-3.734)	<LLD (0/ 12)	4
	Np-239	52	1700	<LLD (0/ 40)	(D) Newport Beach 30 Mi NW	78.43 (1/ 12) (78.43-78.43)	78.43 (1/ 12) (78.43-78.43)	4

(1) Indicator locations include 2 nonroutine sample locations - Unit 2 Conduit (#51) and Unit 3 Conduit (#52). The nonroutine samples are collected twice per year. All other samples are collected monthly.

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TABLE 5 (Cont.) Monthly Ocean Water Gamma Spectral Analysis (pCi/l)								
	Ru-103	52	8	1.578 (1/ 40) (1.578-1.578)	(C) Outfall - U3 1.2 Mi SSW	1.578 (1/ 12) (1.578-1.578)	<LLD (0/ 12)	4
	Ru-106	52	60	20.67 (1/ 40) (20.67-20.67)	(C) Outfall - U3 1.2 Mi SSW	20.67 (1/ 12) (20.67-20.67)	<LLD (0/ 12)	4
	Sb-124	52	20	8.472 (1/ 40) (8.472-8.472)	(C) Outfall - U3 1.2 Mi SSW	8.472 (1/ 12) (8.472-8.472)	3.673 (1/ 12) (3.673-3.673)	4
	Se-75	52	8	2.512 (3/ 40) (1.905-3.071)	(A) U1 Station Discharge Outfall 0.6 Mi SW	2.8155 (2/ 12) (2.56-3.071)	<LLD (0/ 12)	4

(1) Indicator locations include 2 nonroutine sample locations - Unit 2 Conduit (#51) and Unit 3 Conduit (#52). The nonroutine samples are collected twice per year. All other samples are collected monthly.

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TABLE 5 (Cont.) Monthly Ocean Water Gamma Spectral Analysis (pCi/l)								
	Te(l)-132	52	150	16.19 (3/ 40) (12.56-21.41)	(A) U1 Station Discharge Outfall 0.6 Mi SW	18.01 (2/ 12) (14.61-21.41)	<LLD (0/ 12)	4
	AcTh-228	52	25	7.82 (4/ 40) (7.474-8.259)	(A) U1 Station Discharge Outfall 0.6 Mi SW	7.875 (3/ 12) (7.474- 8.259)	<LLD (0/ 12)	4
	Zn-65	52	30	<LLD (0/ 40)	(D) Newport Beach 30 Mi NW	6.384 (1/ 12) (6.384-6.384)	6.384 (1/ 12) (6.384-6.384)	4
	Zr-95	52	15	2.996 (2/ 40) (2.363-3.629)	(C) Outfall - U3 1.2 Mi SSW	3.629 (1/ 12) (3.629-3.629)	<LLD (0/ 12)	4

(1) Indicator locations include 2 nonroutine sample locations - Unit 2 Conduit (#51) and Unit 3 Conduit (#52). The nonroutine samples are collected twice per year. All other samples are collected monthly.

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TABLE 7 Quarterly Composite Ocean Water Tritium Activity (pCi/l)									
H-3	16	2000	<LLD	(0/ 12)	-----	(0/ 4)	<LLD	(0/ 4)	0

(1) Nonroutine ocean water samples #51 & #52 were not analyzed for Tritium

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					Name, Distance and Direction	Mean (Range)		
TABLE 9A Monthly Drinking Water Analysis (pCi/l)								
	Ba-140	24	15	<LLD (0/ 12)	Oceanside Control 15.6 Mi SE	5.538 (1/ 12) (5.538-5.538)	5.538 (1/ 12) (5.538-5.538)	0
	Be-7	24	50	21.215 (2/ 12) (20.08-22.35)	Camp Pendleton 2.2 Mi NNW	21.215 (2/ 12) (20.08-22.35)	<LLD (0/ 12)	0
	Ce-141	24	10	3.209 (1/ 12) (3.209-3.209)	Oceanside Control 15.6 Mi SE	4.081 (1/ 12) (4.081-4.081)	4.081 (1/ 12) (4.081-4.081)	0
	Ce-144	24	35	13.8225 (4/ 12) (13.19-14.51)	Camp Pendleton 2.2 Mi NNW	13.8225 (4/ 12) (13.19-14.51)	<LLD (0/ 12)	0
	Co-57	24	60	<LLD (0/ 12)	Oceanside Control 15.6 Mi SE	1.903 (1/ 12) (1.903-1.903)	1.903 (1/ 12) (1.903-1.903)	0
	Co-58	24	15	<LLD (0/ 12)		----- (0/ 12)	<LLD (0/ 12)	0

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TABLE 9A (Cont.) Monthly Drinking Water Analysis (pCi/l)								
	Co-60	24	15	1.759 (1/ 12) (1.759-1.759)	Oceanside Control 15.6 Mi SE	2.348 (1/ 12) (2.348-2.348)	2.348 (1/ 12) (2.348-2.348)	0
	Cs-134	24	15	<LLD (0/ 12)	Oceanside Control 15.6 Mi SE	1.894 (1/ 12) (1.894-1.894)	1.894 (1/ 12) (1.894-1.894)	0
	Cs-137	24	18	<LLD (0/ 12)		----- (0/ 12)	<LLD (0/ 12)	0
	Fe-59	24	30	<LLD (0/ 12)		----- (0/ 12)	<LLD (0/ 12)	0
	Gross Beta	24	4	2.973 (12/ 12) (1.699-3.895)	Oceanside Control 15.6 Mi SE	5.095 (12/ 12) (2.757-10.419)	5.095 (12/ 12) (2.757-10.419)	0
	H-3	24	3000	517.6 (1/ 12) (517.6-517.6)	Camp Pendleton 2.2 Mi NNW	517.6 (1/ 12) (517.6-517.6)	371.2 (1/ 12) (371.2-371.2)	0

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					Name, Distance and Direction	Mean (Range)		
TABLE 9A (Cont.) Monthly Drinking Water Analysis (pCi/l)								
	I-131	24	15	4.144 (1/ 12) (4.144-4.144)	Camp Pendleton 2.2 Mi NNW	4.144 (1/ 12) (4.144-4.144)	<LLD (0/ 12)	0
	K-40	24	120	<LLD (0/ 12)	Oceanside Control 15.6 Mi SE	39.07 (1/ 12) (39.07-39.07)	39.07 (1/ 12) (39.07-39.07)	0
	La-140	24	15	<LLD (0/ 12)	Oceanside Control 15.6 Mi SE	6.37 (1/ 12) (6.37-6.37)	6.37 (1/ 12) (6.37-6.37)	0
	Mn-54	24	15	<LLD (0/ 12)		----- (0/ 12)	<LLD (0/ 12)	0
	Nb-95	24	15	2.808 (2/ 12) (1.608-4.008)	Camp Pendleton 2.2 Mi NNW	2.808 (2/ 12) (1.608-4.008)	<LLD (0/ 12)	0
	Np-239	24	1700	95.76 (1/ 12) (95.76-95.76)	Camp Pendleton 2.2 Mi NNW	95.76 (1/ 12) (95.76-95.76)	<LLD (0/ 12)	0

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TABLE 9A (Cont.) Monthly Drinking Water Analysis (pCi/l)											
	Ru-106	24	60	14.9 (14.9-14.9)	(1/ 12)	Oceanside Control 15.6 Mi SE	22.67 (22.67-22.67)	(1/ 12)	22.67 (22.67-22.67)	(1/ 12)	0
	Se-75	24	8	<LLD	(0/ 12)	Oceanside Control 15.6 Mi SE	1.8635 (1.296-2.431)	(2/ 12)	1.8635 (1.296-2.431)	(2/ 12)	0
	Te(l)-132	24	150	19.9 (19.9-19.9)	(1/ 12)	Camp Pendleton 2.2 Mi NNW	19.9 (19.9-19.9)	(1/ 12)	<LLD	(0/ 12)	0
	AcTh-228	24	25	10.63 (7.64-14.37)	(3/ 12)	Camp Pendleton 2.2 Mi NNW	10.63 (7.64-14.37)	(3/ 12)	<LLD	(0/ 12)	0
	Zn-65	24	30	<LLD	(0/ 12)	Oceanside Control 15.6 Mi SE	6.6765 (6.017-7.336)	(2/ 12)	6.6765 (6.017-7.336)	(2/ 12)	0
	Zr-95	24	13.5	<LLD	(0/ 12)		-----	(0/ 12)	<LLD	(0/ 12)	0

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					Name, Distance and Direction	Mean (Range)		
TABLE 10 Semi-Annual Shoreline Sediment Gamma Spectral Analysis (pCi/g)								
	Ba-140	8	0.73	0.1115 (1/ 6) (0.1115-0.1115)	San Onofre State Beach 0.6 Mi SE	0.1115 (1/ 2) (0.1115-0.1115)	<LLD (0/ 2)	0
	Be-7	8	1.0	0.1615 (1/ 6) (0.1615-0.1615)	San Onofre State Beach 0.6 Mi SE	0.1615 (1/ 2) (0.1615-0.1615)	<LLD (0/ 2)	0
	Cs-134	8	0.15	<LLD (0/ 6)		----- (0/ 2)	<LLD (0/ 2)	0
	Cs-137	8	0.18	0.0216 (1/ 6) (0.0216-0.0216)	Newport Beach North End 29.2 Mi. NW	0.0228 (1/ 2) (0.0228-0.0228)	0.0228 (1/ 2) (0.0228-0.0228)	0
	K-40	8	2.20	14.64 (6/ 6) (12.97-17.36)	Newport Beach North End 29.2 Mi NW	19.43 (2/ 2) (14.71-24.15)	19.43 (2/ 2) (14.71-24.15)	0

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TABLE 10 (Cont.)
Semi-Annual Shoreline Sediment
Gamma Spectral Analysis (pCi/g)

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Number of Nonroutine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
La-140	8	0.84	0.1282 (1/ 6) (0.1282-0.1282)	San Onofre State Beach 0.6 Mi SE	0.1282 (1/ 2) (0.1282-0.1282)	<LLD (0/ 2)	0
Mn-54	8	0.12	<LLD (0/ 6)	Newport Beach North End 29.2 Mi NW	0.023 (1/ 2) (0.023-0.023)	0.023 (1/ 2) (0.023-0.023)	0
Ru-106	8	1.35	0.1374 (1/ 6) (0.1374-0.1374)	San Onofre State Beach 0.6 Mi SE	0.1374 (1/ 2) (0.1374-0.1374)	<LLD (0/ 2)	0
AcTh-228	8	0.74	0.1923 (4/ 6) (0.1754-0.224)	Newport Beach North End 29.2 Mi NW	1.0994 (2/ 2) (0.4198-1.779)	1.0994 (2/ 2) (0.4198-1.779)	0

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Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Number of Nonroutine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
TABLE 10 (Cont.) Semi-Annual Shoreline Sediment Gamma Spectral Analysis (pCi/g)							
	Zn-65 8	0.65	<LLD (0/ 6)	Newport Beach North End 29.2 Mi NW	0.2471 (1/ 2) (0.2471-0.2471)	0.2471 (1/ 2) (0.2471-0.2471)	0

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Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range) (1)	Location with Highest Annual Mean Name, Distance and Direction	Location with Highest Annual Mean Mean (Range)	Control Locations Mean (Range)	Number of Nonroutine Reported Measurements (1)
TABLE 11 Semi-Annual Ocean Bottom Sediment Gamma Spectral Analysis (pCi/g)								
	Ba-140	14	0.73	0.1125 (2/ 12) (0.1011-0.1239)	Unit 2 Conduit 0.1 Mi SW	0.1239 (1/ 2) (0.1239-0.1239)	<LLD (0/ 2)	4
	Be-7	14	1.0	0.2424 (2/ 12) (0.1998-0.2849)	(C) U2 Outfall 1.6 Mi SW	0.2849 (1/ 2) (0.2849-0.2849)	<LLD (0/ 2)	4
	Co-60	14	0.15	0.0233 (1/ 12) (0.0233-0.0233)	(A) U1 Outfall	0.0233 (1/ 2) (0.0233-0.0233)	<LLD (0/ 2)	4
	Cs-134	14	0.15	0.0191 (2/ 12) (0.0170-0.0211)	(D) U3 Outfall 1.2 Mi SSW	0.0211 (1/ 2) (0.0211-0.0211)	<LLD (0/ 2)	4
	Cs-137	14	0.18	0.0345 (2/ 12) (0.0304-0.0387)	Unit 2 Conduit 0.1 Mi SW	0.0387 (1/ 2) (0.0387-0.0387)	0.0286 (1/ 2) (0.0286-0.0286)	4
	K-40	14	2.20	15.16 (12/ 12) (13.3-19.33)	Unit 2 Conduit 0.1 Mi SW	17.34 (2/ 2) (15.95-18.73)	13.70 (2/ 2) (9.642-17.76)	4

(1) Indicator locations include 2 nonroutine sample locations - Unit 2 Conduit (#51) and Unit 3 Conduit (#52). The nonroutine samples are collected twice per year. All other samples are collected monthly.

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TABLE 11 (Cont.) Semi-Annual Ocean Bottom Sediment Gamma Spectral Analysis (pCi/g)							
	La-140 14	0.84	0.1294 (2/ 12) (0.1163-0.1425)	Unit 2 Conduit 0.1 Mi SW	0.1425 (1/ 2) (0.1425-0.1425)	<LLD (0/ 2)	4
	Ru-103 14	0.14	0.0222 (2/ 12) (0.0189-0.0255)	(B) Unit 1 Outfall 0.8 Mi SSW	0.0222 (2/ 2) (0.0189-0.0255)	<LLD (0/ 2)	4
	Ru-106 14	1.35	0.1445 (2/ 12) (0.1445-0.1445)	Unit 2 Conduit 0.1 Mi SW	0.1445 (1/ 2) (0.1445-0.1445)	<LLD (0/ 2)	4
	Se-75 14	0.15	0.036 (1/ 12) (0.036-0.036)	(D) Unit 3 Outfall 1.2 Mi SSW	0.036 (1/ 2) (0.036-0.036)	<LLD (0/ 2)	4
	AcTh-228 14	0.74	0.5374 (12/ 12) (0.1519-0.7877)	(C) Unit 2 Outfall 1.6 Mi SW	0.7112 (2/ 2) (0.6347-0.7877)	0.3175 (2/ 2) (0.1185-0.5165)	4
	Zn-65 14	0.65	0.0516 (1/ 12) (0.0516-0.0516)	(D) Unit 3 Outfall 1.2 Mi SSW	0.0516 (1/ 2) (0.0516-0.0516)	<LLD (0/ 2)	4

(1) Indicator locations include 2 nonroutine sample locations - Unit 2 Conduit (#51) and Unit 3 Conduit (#52). The nonroutine samples are collected twice per year. All other samples are collected monthly.

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				Name, Distance and Direction	Mean (Range)		
TABLE 12A Semi-Annual Non-Migratory Marine Animals Analysis (pCi/g) (Flesh Type)							
Bay Mussel	Co-58	1	0.13	<LLD (0/ 1)	----- (0 / 1)	<LLD (0/ 0)	0
Bay Mussel	Co-60	1	0.13	0.0115 (1/ 1) (0.0115-0.0115)	(B)Units 2/3Outfall 1.5 Mi SSW 0.0115 (1/ 1) (0.0115-0.0115)	<LLD (0/ 0)	0
Bay Mussel	Cs-134	1	0.13	<LLD (0/ 1)	----- (0 / 1)	<LLD (0/ 0)	0
Bay Mussel	Cs-137	1	0.15	<LLD (0/ 1)	----- (0 / 1)	<LLD (0/ 0)	0
Bay Mussel	Fe-59	1	0.26	<LLD (0/ 1)	----- (0 / 1)	<LLD (0/ 0)	0
Bay Mussel	K-40	1	1.40	1.871 (1/ 1) (1.871-1.871)	(B)Units 2/3Outfall 1.5 Mi SSW 1.871 (1/ 1) (1.871-1.871)	<LLD (0/ 0)	0
Bay Mussel	Mn-54	1	0.13	0.0166 (1/ 1) (0.0166-0.0166)	(B)Units 2/3Outfall 1.5 Mi SSW 0.0166 (1/ 1) (0.0166-0.0166)	<LLD (0/ 0)	0
Bay Mussel	Se-75	1	0.075	0.0233 (1/ 1) (0.0233-0.0233)	(B)Units 2/3Outfall 1.5 Mi. SSW 0.0233 (1/ 1) (0.0233-0.0233)	<LLD (0/ 0)	0

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				Name, Distance and Direction	Mean (Range)		
TABLE 12A (Cont.) Semi-Annual Non-Migratory Marine Animals Analysis (pCi/g) (Flesh Type)							
Bay Mussel	Zn-65	1	0.26	<LLD (0/ 1)	-----	(0 / 1) <LLD (0/ 0)	0
Ca Corbina	Be-7	2	0.60	0.1463 (1/ 2) (0.1463-0.1463)	(B) Units 2/3 Outfall 1.5 Mi SSW	0.1463 (1/ 1) (0.1463-0.1463)	<LLD (0/ 0) 0
Ca Corbina	Co-58	2	0.13	0.0217 (1/ 2) (0.0217-0.0217)	(B) Units 2/3 Outfall 1.5 Mi SSW	0.0217 (1/ 1) (0.0217-0.0217)	<LLD (0/ 0) 0
Ca Corbina	Co-60	2	0.13	<LLD (0/ 2)	-----	(0/ 1) <LLD (0/ 0)	0
Ca Corbina	Cs-134	2	0.13	<LLD (0/ 2)	-----	(0/ 1) <LLD (0/ 0)	0
Ca Corbina	Cs-137	2	0.15	0.015 (1/ 2) (0.015-0.015)	(B) Units 2/3 Outfall 1.5 Mi SSW	0.015 (1/ 1) (0.015-0.015)	<LLD (0/ 0) 0
Ca Corbina	Fe-59	2	0.26	<LLD (0/ 2)	-----	(0/ 1) <LLD (0/ 0)	0
Ca Corbina	K-40	2	1.40	3.187 (2/ 2) (2.834-3.54)	(B) Units 2/3 Outfall 1.5 Mi SSW	3.54 (1/ 1) (3.54-3.54)	<LLD (0/ 0) 0

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				Name, Distance and Direction	Mean (Range)			
TABLE 12A (Cont.) Semi-Annual Non-Migratory Marine Animals Analysis (pCi/g) (Flesh Type)								
Ca Corbina	Mn-54	2	0.13	0.0194 (1/ 2) (0.0194-0.0194)	(B) Units 2/3 Outfall 1.5 Mi SSW	0.0194 (1/ 1) (0.0194-0.0194)	<LLD (0/ 0)	0
Ca Corbina	Mo-99	2	51.0	2.276 (1/ 2) (2.276-2.276)	(A) Unit 1 Outfall 0.9 Mi WSW	2.276 (1/ 1) (2.276- 2.276)	<LLD (0/ 0)	0
Ca Corbina	Zn-65	2	0.26	<LLD (0/ 2)		----- (0/ 1)	<LLD (0/ 0)	0
Fish, Perch	Co-58	4	0.13	0.0229 (1/ 2) (0.0229-0.0229)	(B) Units 2/3 Outfall 1.5 Mi SSW	0.0229 (1/ 1) (0.0229-0.0229)	<LLD (0/ 2)	0
Fish, Perch	Co-60	4	0.13	<LLD (0/ 2)		----- (0/ 1)	<LLD (0/ 2)	0
Fish, Perch	Cs-134	4	0.13	<LLD (0/ 2)		----- (0/ 2)	<LLD (0/ 2)	0
Fish, Perch	Cs-137	4	0.15	<LLD (0/ 2)		----- (0/ 1)	<LLD (0/ 2)	0
Fish, Perch	Fe-59	4	0.26	0.0756 (2/ 2) (0.0728-0.0784)	(A) Unit 1 Outfall 0.9 Mi WSW	0.0784 (1/ 1) (0.0784-0.0784)	<LLD (0/ 2)	0

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TABLE 12A (Cont.) Semi-Annual Non-Migratory Marine Animals Analysis (pCi/g) (Flesh Type)							
Fish, Perch	K-40	4	1.40	3.51 (3.28-4.15) (2/ 2)	(C) Laguna Beach 18.2 Mi NW	3.9325 (3.305-4.56) (2/ 2)	3.9325 (3.305-4.56) (2/ 2)	0
Fish, Perch	Mn-54	4	0.13	<LLD (0/ 2)		----- (0/ 2)	<LLD (0/ 2)	0
Fish, Perch	Zn-65	4	0.26	<LLD (0/ 2)		----- (0/ 1)	<LLD (0/ 2)	0
Kelp Bass	Co-58	1	0.13	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0
Kelp Bass	Co-60	1	0.13	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0
Kelp Bass	Cs-134	1	0.13	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0
Kelp Bass	Cs-137	1	0.15	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0

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TABLE 12A (Cont.) Semi-Annual Non-Migratory Marine Animals Analysis (pCi/g) (Flesh Type)										
Kelp Bass	Fe-59	1	0.26	<LLD	(0/ 1)	-----	(0/ 1)	<LLD	(0/ 0)	0
Kelp Bass	K-40	1	1.40	4.043 (4.043-4.043)	(1/ 1)	(A) Unit 1 Outfall 0.9 Mi WSW	4.043 (4.043-4.043)	(1/ 1)	<LLD	(0/ 0)	0
Kelp Bass	Mn-54	1	0.13	<LLD	(0/ 1)	-----	(0/ 1)	<LLD	(0/ 0)	0
Kelp Bass	Zn-65	1	0.26	<LLD	(0/ 1)	-----	(0/ 1)	<LLD	(0/ 0)	0
Keyhole Limpet	Co-58	2	0.13	<LLD	(0/ 0)	-----	(0/ 2)	<LLD	(0/ 2)	0
Keyhole Limpet	Co-60	2	0.13	<LLD	(0/ 0)	-----	(0/ 2)	<LLD	(0/ 2)	0
Keyhole Limpet	Cs-134	2	0.13	<LLD	(0/ 0)	-----	(0/ 2)	<LLD	(0/ 2)	0
Keyhole Limpet	Cs-137	2	0.15	<LLD	(0/ 0)	-----	(0/ 2)	<LLD	(0/ 2)	0
Keyhole Limpet	Fe-59	2	0.26	<LLD	(0/ 0)	-----	(0/ 2)	<LLD	(0/ 2)	0

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				Name, Distance and Direction	Mean (Range)		
TABLE 12A (Cont.) Semi-Annual Non-Migratory Marine Animals Analysis (pCi/g) (Flesh Type)							
Keyhole Limpet	K-40	2	1.40	<LLD (0/ 0)	(C) Laguna Beach 18.2 Mi NW	0.9603 (2/ 2) (0.9311-0.9894)	0.9603 (2/ 2) (0.9311-0.9894)	0
Keyhole Limpet	Mn-54	2	0.13	<LLD (0/ 0)		----- (0/ 2)	<LLD (0/ 2)	0
Keyhole Limpet	Ru-106	2	0.65	<LLD (0/ 0)	(C) Laguna Beach 18.2 Mi NW	0.0955 (1/ 2) (0.0955-0.0955)	0.0955 (1/ 2) (0.0955-0.0955)	0
Keyhole Limpet	Zn-65	2	0.26	<LLD (0/ 0)		----- (0/ 2)	<LLD (0/ 2)	0
Lobster	Co-57	6	0.04	0.0192 (1/ 4) (0.0192-0.0192)	(A) Unit 1 Outfall 0.9 Mi WSW	0.0192 (1/ 2) (0.0192-0.0192)	<LLD (0/ 2)	0
Lobster	Co-58	6	0.13	<LLD (0/ 4)		----- (0/ 2)	<LLD (0/ 2)	0
Lobster	Co-60	6	0.13	<LLD (0/ 4)		----- (0/ 2)	<LLD (0/ 2)	0
Lobster	Cr-51	6	0.70	<LLD (0/ 4)	(C) Laguna Beach 18.2 Mi NW	0.2509 (1/ 2) (0.2509-0.2509)	0.2509 (1/ 2) (0.2509-0.2509)	0

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				Name, Distance and Direction	Mean (Range)		
TABLE 12A (Cont.) Semi-Annual Non-Migratory Marine Animals Analysis (pCi/g) (Flesh Type)							
Lobster	Cs-134	6	0.13	<LLD (0/ 4)	----- (0/ 2)	<LLD (0/ 2)	0
Lobster	Cs-137	6	0.15	<LLD (0/ 4)	----- (0/ 2)	<LLD (0/ 2)	0
Lobster	Fe-59	6	0.26	<LLD (0/ 4)	----- (0/ 2)	<LLD (0/ 2)	0
Lobster	K-40	6	1.40	3.8638 (4/ 4) (3.636-4.058)	(A) Unit 1 Outfall 0.9 Mi WSW	3.928 (2/ 2) (3.798-4.058)	3.4995 (2/ 2) (3.383-3.616)	0
Lobster	Mn-54	6	0.13	<LLD (0/ 4)	(C) Laguna Beach 18.2 Mi NW	0.0175 (1/ 2) (0.0175-0.0175)	0.0175 (1/ 2) (0.0175-0.0175)	0
Lobster	AcTh-228	6	0.30	0.0889 (1/ 4) (0.0889-0.0889)	(B) Units 2/3 Outfall 1.5 Mi SSW	0.0889 (1/ 2) (0.0889-0.0889)	<LLD (0/ 2)	0
Lobster	Zn-65	6	0.26	<LLD (0/ 4)	----- (0/ 2)	<LLD (0/ 2)	0

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				Name, Distance and Direction	Mean (Range)		
TABLE 12A (Cont.) Semi-Annual Non-Migratory Marine Animals Analysis (pCi/g) (Flesh Type)							
Sea Hare	Co-58 3	0.13	0.028 (1/ 3) (0.028-0.028)	(A) Unit 1 Outfall 0.9 Mi WSW	0.028 (1/ 2) (0.028-0.028)	<LLD (0/ 0)	0
Sea Hare	Co-60 3	0.13	<LLD (0/ 3)		----- (0/ 2)	<LLD (0/ 0)	0
Sea Hare	Cs-134 3	0.13	<LLD (0/ 3)		----- (0/ 1)	<LLD (0/ 0)	0
Sea Hare	Cs-137 3	0.15	<LLD (0/ 3)		----- (0/ 1)	<LLD (0/ 0)	0
Sea Hare	Fe-59 3	0.26	<LLD (0/ 3)		----- (0/ 2)	<LLD (0/ 0)	0
Sea Hare	K-40 3	1.40	1.8437 (3/ 3) (1.739-2.03)	(A) Unit 1 Outfall 0.9 Mi WSW	1.8845 (2/ 2) (1.739-2.03)	<LLD (0/ 0)	0
Sea Hare	Mn-54 3	0.13	<LLD (0/ 3)		----- (0/ 1)	<LLD (0/ 0)	0
Sea Hare	Ru-103 3	0.095	0.0196 (1/ 3) (0.0196-0.0196)	(A) Unit 1 Outfall 0.9 Mi WSW	0.0196 (1/ 2) (0.0196-0.0196)	<LLD (0/ 0)	0

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				Name, Distance and Direction	Mean (Range)		

TABLE 12A (Cont.)
Semi-Annual Non-Migratory
Marine Animals Analysis (pCi/g) (Flesh Type)

Sea Hare	Zn-65	3	0.26	<LLD	(0/ 3)		-----	(0/ 1)	<LLD	(0/ 0)	0
Sheephead	Co-58	5	0.13	<LLD	(0/ 3)		-----	(0/ 1)	<LLD	(0/ 2)	0
Sheephead	Co-60	5	0.13	<LLD	(0/ 3)		-----	(0/ 2)	<LLD	(0/ 2)	0
Sheephead	Cr-51	5	0.70	0.2052 (0.2052-0.2052)	(1/ 3)	(B) Units 2/3 Outfall 1.5 Mi SSW	0.2052 (0.2052-0.2052)	(1/ 2)	<LLD	(0/ 2)	0
Sheephead	Cs-134	5	0.13	<LLD	(0/ 3)		-----	(0/ 2)	<LLD	(0/ 2)	0
Sheephead	Cs-137	5	0.15	<LLD	(0/ 3)		-----	(0/ 2)	<LLD	(0/ 2)	0
Sheephead	Fe-59	5	0.26	<LLD	(0/ 3)		-----	(0/ 2)	<LLD	(0/ 2)	0
Sheephead	K-40	5	1.40	3.7063 (3.149-4.586)	(3/ 3)	(A) Unit 1 Outfall 0.9 Mi WSW	4.586 (4.586-4.586)	(1/ 1)	4.311 (4.228-4.394)	(2/ 2)	0
Sheephead	Mn-54	5	0.13	<LLD	(0/ 3)		-----	(0/ 2)	<LLD	(0/ 2)	0

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TABLE 12A (Cont.) Semi-Annual Non-Migratory Marine Animals Analysis (pCi/g) (Flesh Type)							
Sheephead	Ru-103	5	0.095	0.0241 (1/ 3) (0.0241-0.0241)	(B) Units 2/3 Outfall 1.5 Mi SSW	0.0241 (1/ 2) (0.0241-0.0241)	<LLD (0/ 2)	0
Sheephead	Sb-124	5	0.19	0.0441 (1/ 3) (0.0441-0.0441)	(B) Units 2/3 Outfall 1.5 Mi SSW	0.0441 (1/ 2) (0.0441-0.0441)	<LLD (0/ 2)	0
Sheephead	Zn-65	5	0.26	<LLD (0/ 3)	(C) Laguna Beach 18.2 Mi NW	0.0375 (1/ 2) (0.0375-0.0375)	0.0375 (1/ 2) (0.0375-0.0375)	0

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SAN DIEGO COUNTY, CALIFORNIA

REPORTING PERIOD: January 1, 1998 to December 31, 1998

Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)		Location with Highest Annual Mean			Control Locations Mean (Range)		Number of Nonroutine Reported Measurements
					Name, Distance and Direction	Mean (Range)				
TABLE 13A Semi-Annual Local Crops Gamma Spectral Analysis (pCi/g)										
Baby Squash	Cr-51	1	0.40	<LLD	(0/ 0)	SE of Oceanside 22 Mi SE	0.0424	(1/ 1)	0.0424 (0.0424-0.0424)	(1/ 1)	0
Baby Squash	Cs-134	1	0.06	<LLD	(0/ 0)		-----	(0/ 1)	<LLD	(0/ 1)	0
Baby Squash	Cs-137	1	0.08	<LLD	(0/ 0)		-----	(0/ 1)	<LLD	(0/ 1)	0
Baby Squash	I-131	1	0.06	<LLD	(0/ 0)		-----	(0/ 1)	<LLD	(0/ 1)	0
Baby Squash	K-40	1	0.85	<LLD	(0/ 0)	SE of Oceanside 22 Mi SE	3.466 (3.466-3.466)	(1/ 1)	3.4660 (3.466-3.466)	(1/ 1)	0
Baby Squash	Mn-54	1	0.04	<LLD	(0/ 0)	SE of Oceanside 22 Mi SE	0.0063 (0.0063-0.0063)	(1/ 1)	0.0063 (0.0063-0.0063)	(1/ 1)	0
Cauliflower Leaves	Cs-134	1	0.06	<LLD	(0/ 1)		-----	(0/ 1)	<LLD	(0/ 0)	0
Cauliflower Leaves	Cs-137	1	0.08	<LDD	(0/ 1)		-----	(0/ 1)	<LLD	(0/ 0)	0

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TABLE 13A (Cont.) Semi-Annual Local Crops Gamma Spectral Analysis (pCi/g)								
Cauliflower Leaves	I-131	1	0.06	<LLD (0/ 1)		----- (0/ 0)	<LLD (0/ 0)	0
Cauliflower Leaves	K-40	1	0.85	4.248 (1/ 1) (4.248-4.248)	Residence San Clemente 4.4 Mi NW	4.248 (1/ 1) (4.248-4.248)	<LLD (0/ 0)	0
Cauliflower Leaves	Np-239	1	0.70	0.0786 (1/ 1) (0.0786-0.0786)	Residence San Clemente 4.4 Mi NW	0.0786 (1/ 1) (0.0786-0.0786)	<LLD (0/ 0)	0
Cauliflower Leaves	Ru-103	1	0.04	0.0158 (1/ 1) (0.0158-0.0158)	Residence San Clemente 4.4 Mi NW	0.0158 (1/ 1) (0.0158-0.0158)	<LLD (0/ 0)	0
Collard Greens	Be-7	2	0.30	<LLD (0/ 1)	SE of Oceanside 22 Mi SE	0.0401 (1/ 1) (0.0401-0.0401)	0.0401 (1/ 1) (0.0401-0.0401)	0

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TABLE 13A (Cont.) Semi-Annual Local Crops Gamma Spectral Analysis (pCi/g)								
Collard Greens	Co-57	2	0.025	0.0067 (1/ 1) (0.0067-0.0067)	SONGS Garden 0.4 Mi NNW	0.0067 (1/ 1) (0.0067-0.0067)	<LLD (0/ 1)	0
Collard Greens	Cs-134	2	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 1)	0
Collard Greens	Cs-137	2	0.08	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 1)	0
Collard Greens	I-131	2	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 1)	0
Collard Greens	K-40	2	0.85	3.206 (1/ 1) (3.206-3.206)	SE of Oceanside 22 Mi SE	3.594 (1/ 1) (3.594-3.594)	3.594 (1/ 1) (3.594-3.594)	0
Collard Greens	Ru-106	2	0.46	<LLD (0/ 1)	SE of Oceanside 22 Mi SE	0.0546 (1/ 1) (0.0546-0.0546)	0.0546 (1/ 1) (0.0546-0.0546)	0
Collard Greens	AcTh-228	2	0.19	0.0356 (1/ 1) (0.0356-0.0356)	SONGS Garden 0.4 Mi NNW	0.0356 (1/ 1) (0.0356-0.0356)	<LLD (0/ 1)	0

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					Name, Distance and Direction	Mean (Range)			
TABLE 13A (Cont.) Semi-Annual Local Crops Gamma Spectral Analysis (pCi/g)									
Lettuce	Be-7	1	0.30	0.1419 (1/ 1) (0.1419-0.1419)	Residence San Clemente 4.4 Mi NW	0.1419 (1/ 1) (0.1419-0.1419)	<LLD	(0/ 0)	0
Lettuce	Cs-134	1	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD	(0/ 0)	0
Lettuce	Cs-137	1	0.08	<LLD (0/ 1)		----- (0/ 1)	<LLD	(0/ 0)	0
Lettuce	I-131	1	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD	(0/ 0)	0
Lettuce	K-40	1	0.85	3.26 (1/ 1) (3.26-3.26)	Residence San Clemente 4.4 Mi NW	3.26 (1/ 1) (3.26-3.26)	<LLD	(0/ 0)	0
Lettuce	Te(I)-132	1	0.22	0.0699 (1/ 1) (0.0699-0.0699)	Residence San Clemente 4.4 Mi NW	0.0699 (1/ 1) (0.0699-0.0699)	<LLD	(0/ 0)	0

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Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean: Name, Distance and Direction	Location with Highest Annual Mean: Mean (Range)	Control Locations Mean (Range)	Number of Nonroutine Reported Measurements
TABLE 13A (Cont.) Semi-Annual Local Crops Gamma Spectral Analysis (pCi/g)							
Sorrel	Be-7	1	0.30	0.0640 (1/ 1) (0.06-0.06)	SONGS Garden 0.4 Mi NNW	0.06 (1/ 1) (0.06-0.06)	<LLD (0/ 0)	0
Sorrel	Cs-134	1	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0
Sorrel	Cs-137	1	0.08	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0
Sorrel	I-131	1	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0
Sorrel	K-40	1	0.85	3.259 (1/ 1) (3.259-3.259)	SONGS Garden 0.4 Mi NNW	3.259 (1/ 1) (3.259-3.259)	<LLD (0/ 0)	0
Sorrel	Sb-124	1	0.11	0.0074 (1/ 1) (0.0074-0.0074)	SONGS Garden 0.4 Mi NNW	0.0074 (1/ 1) (0.0074-0.0074)	<LLD (0/ 0)	0
Strawberry	Ag-110m	1	0.06	0.0115 (1/ 1) (0.0115-0.0115)	San Mateo Canyon (San Clemente Ranch) 2.6 Mi NW	0.0115 (1/ 1) (0.0115-0.0115)	<LLD (0/ 0)	0

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Medium or Pathway Sampled (Unit of Measurement)	Type and Total Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)		Number of Nonroutine Reported Measurements
					Name, Distance and Direction	Mean (Range)			
TABLE 13A (Cont.) Semi-Annual Local Crops Gamma Spectral Analysis (pCi/g)									
Strawberry	Be-7	1	0.30	0.0704 (1/ 1) (0.0704-0.0704)	San Mateo Canyon (San Clemente Ranch) 2.6 Mi NW	0.0704 (1/ 1) (0.0704-0.0704)	<LLD	(0/ 0)	0
Strawberry	Cs-134	1	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD	(0/ 0)	0
Strawberry	Cs-137	1	0.08	<LLD (0/ 1)		----- (0/ 1)	<LLD	(0/ 0)	0
Strawberry	I-131	1	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD	(0/ 0)	0
Strawberry	K-40	1	0.85	2.014 (1/ 1) (2.014-2.014)	San Mateo Canyon (San Clemente Ranch) 2.6 Mi NW	2.014 (1/ 1) (2.014-2.014)	<LLD	(0/ 0)	0
Swiss Chard	Be-7	1	0.30	<LLD (0/ 0)	SE of Oceanside 22 Mi SE	0.4045 (1/ 1) (0.4045-0.4045)	0.4045 (0.4045-0.4045)	(1/ 1)	0
Swiss Chard	Cs-134	1	0.06	<LLD (0/ 0)		----- (0/ 1)	<LLD	(0/ 1)	0
Swiss Chard	Cs-137	1	0.08	<LLD (0/ 0)		----- (0/ 1)	<LLD	(0/ 1)	0

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					Name, Distance and Direction	Mean (Range)		
TABLE 13A (Cont.) Semi-Annual Local Crops Gamma Spectral Analysis (pCi/g)								
Swiss Chard	I-131	1	0.06	<LLD (0/ 0)		----- (0/ 1)	<LLD (0/ 1)	0
Swiss Chard	K-40	1	0.85	<LLD (0/ 0)	SE of Oceanside 22 Mi SE	3.4290 (1/ 1) (3.429-3.429)	3.4290 (1/ 1) (3.429-3.429)	0
Swiss Chard	Sb-124	1	0.11	<LLD (0/ 0)	SE of Oceanside 22 Mi SE	0.0242 (1/ 1) (0.0242-0.0242)	0.0242 (1/ 1) (0.0242-0.0242)	0
Tomato	Co-57	4	0.025	<LLD (0/ 2)	SE of Oceanside 22 Mi SE	0.0066 (1/ 2) (0.0066-0.0066)	0.0066 (1/ 2) (0.0066-0.0066)	0
Tomato	Co-60	4	0.045	0.0107 (1/ 2) (0.0107-0.0107)	San Mateo Canyon (San Clemente Ranch) 2.6 Mi NW	0.0107 (1/ 1) (0.0107-0.0107)	<LLD (0/ 2)	0
Tomato	Cs-134	4	0.06	0.0136 (1/ 2) (0.0136-0.0136)	Residence San Clemente 4.4 Mi NW	0.0136 (1/ 1) (0.0136-0.0136)	<LLD (0/ 2)	0

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					Name, Distance and Direction	Mean (Range)		
TABLE 13A (Cont.) Semi-Annual Local Crops Gamma Spectral Analysis (pCi/g)								
Tomato	Cs-137	4	0.08	<LLD (0/ 2)	SE of Oceanside 22 Mi SE	0.0042 (1/ 2) (0.0042-0.0042)	0.0042 (1/ 2) (0.0042-0.0042)	0
Tomato	I-131	4	0.06	<LLD (0/ 2)		----- (0/ 2)	<LLD (0/ 2)	0
Tomato	K-40	4	0.85	2.4945 (2/ 2) (2.169-2.82)	Residence San Clemente 4.4 Mi NW	2.82 (1/ 1) (2.82-2.82)	1.887 (2/ 2) (1.787-1.987)	0
Tomato	Mn-54	4	0.04	0.0155 (1/ 2) (0.0155-0.0155)	Residence San Clemente 4.4 Mi NW	0.0155 (1/ 1) (0.0155-0.0155)	<LLD (0/ 2)	0
Tomato	Se-75	4	0.045	<LLD (0/ 2)	SE of Oceanside 22 Mi SE	0.0049 (1/ 2) (0.0049-0.0049)	0.0049 (1/ 2) (0.0049-0.0049)	0
Zucchini	Ce-141	1	0.055	0.0056 (1/ 1) (0.0056-0.0056)	SONGS Garden 0.4 Mi NNW	0.0056 (1/ 1) (0.0056-0.0056)	<LLD (0/ 0)	0

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				Name, Distance and Direction	Mean (Range)			
TABLE 13A (Cont.) Semi-Annual Local Crops Gamma Spectral Analysis (pCi/g)								
Zucchini	Co-60	1	0.045	0.0051 (1/ 1) (0.0051-0.0051)	SONGS Garden 0.4 Mi NNW	0.0051 (1/ 1) (0.0051-0.0051)	<LLD (0/ 0)	0
Zucchini	Cs-134	1	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0
Zucchini	Cs-137	1	0.08	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0
Zucchini	I-131	1	0.06	<LLD (0/ 1)		----- (0/ 1)	<LLD (0/ 0)	0
Zucchini	K-40	1	0.85	2.086 (1/ 1) (2.086-2.086)	SONGS Garden 0.4 Mi NNW	2.086 (1/ 1) (2.086-2.086)	<LLD (0/ 0)	0
Zucchini	Ru-106	1	0.46	0.0364 (1/ 1) (0.0364-0.0364)	SONGS Garden 0.4 Mi NNW	0.0364 (1/ 1) (0.0364-0.0364)	<LLD (0/ 0)	0

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					Name, Distance and Direction	Mean (Range)		
TABLE 14 Annual Soil Analysis Depth: 3" (pCi/g)								
	Ce-141	5	0.18	<LLD (0/ 4)	Oceanside 16 Mi SE	0.0342 (1/ 1) (0.0342-0.0342)	0.0342 (1/ 1) (0.0342-0.0342)	0
	Cs-134	5	0.15	<LLD (0/ 4)		----- (0/ 1)	<LLD (0/ 1)	0
	Cs-137	5	0.18	0.0522 (3/ 4) (0.0147-0.0760)	Old Route 101 ESE 3 Mi ESE	0.0759 (1/ 1) (0.0759-0.0759)	<LLD (0/ 1)	0
	K-40	5	2.20	14.329 (4/ 4) (5.646-19.24)	Basilone Rd/I-5 Freeway Off Ramp 2 Mi NW	19.24 (1/ 1) (19.24-19.24)	11.6400 (1/ 1) (11.64-11.64)	0
	Se-75	5	0.15	0.0222 (1/ 4) (0.0222-0.0222)	Basilone Rd/I-5 Freeway Off Ramp 2 Mi NW	0.0222 (1/ 1) (0.0222-0.0222)	0.0171 (1/ 1) (0.0171-0.0171)	0

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				Name, Distance and Direction	Mean (Range)		
TABLE 14 (Cont.) Annual Soil Analysis Depth: 3" (pCi/g)							
	AcTh-228 5	0.74	0.5367 (4/ 4) (0.2341-0.7883)	Basilone Rd/I-5 Freeway Off Ramp 2 Mi NW	0.7883 (1/ 1) (0.7883-0.7883)	0.5313 (1/ 1) (0.5313-0.5313)	0

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					Name, Distance and Direction	Mean (Range)		
TABLE 15 Semi-Annual Kelp Analysis (pCi/g)								
macrocystis p.	Cs-137	6	0.08	<LLD (0/ 4)	(D) Laguna Beach (CONTROL) 15.6 Mi NW	0.0047 (1/ 2) (0.0047-0.0047)	0.0047 (1/ 2) (0.0047-0.0047)	
macrocystis p.	I-131	6	0.06	0.0649 (4/ 4) (0.0340-0.0953)	(B) San Mateo Kelp Bed 3.8 Mi WNW	0.0751 (2/ 2) (0.0548-0.0953)	0.0687 (2/ 2) (0.0326-0.1047)	0
macrocystis p.	K-40	6	0.85	8.937 (4/ 4) (8.182-9.333)	(D) Laguna Beach (CONTROL) 3.8 Mi WNW	11.33 (2/ 2) (11.16-11.5)	11.33 (2/ 2) (11.16-11.5)	0
macrocystis p.	Mn-54	6	0.04	0.0044 (1/ 4) (0.0044-0.0044)	(A) San Onofre Kelp Bed 1.5 Mi S	0.0044 (1/ 2) (0.0044-0.0044)	<LLD (0/ 2)	0

APPENDIX C

SUMMARY OF 1998 QUALITY CONTROL PROGRAMS

All REMP samples are collected, shipped, and analyzed in accordance with NRC Regulatory Guide 4.15. Marine radiological environmental samples are collected by a vendor, Ogden Environmental Services, per the vendor's Quality Assurance manual. REMP sample analysis is performed by the Contracted Environmental Analysis Laboratory (CEAL) in accordance with the Laboratory Quality Assurance Plan. During 1998 the CEAL was Yankee Atomic Environmental Laboratory (now Duke Engineering Services).

INTERLABORATORY CROSS-CHECK PROGRAM:

US EPA National Exposure Research Laboratory
Environmental Laboratory Performance Evaluation
1998

The results of the available 1998 interlaboratory cross-check program between the Environmental Protection Agency (EPA) and our CEAL (EPA code EL) have been summarized in Table C-1. The mean results of cross-check analyses have been evaluated against the EPA control limits. Values outside the control limits were evaluated and resolved. Likewise, the "normalized ranges" as calculated by EPA have been investigated against the control limits. Trend analyses of the results were performed on the values that are within the control limits to determine if they exhibit a trend toward these limits. No adverse trends were observed in the CEAL's 1998 QA Reports.

The final EPA cross check samples were distributed during the fourth quarter of 1998. EPA has indicated that they will no longer provide this service to environmental laboratories. The CEAL has initiated participation in alternate interlaboratory cross-check programs in anticipation of the elimination of the EPA program. The CEAL participates in a number of independent cross check programs, including the NIST and Analytics cross-check programs. A summary of the available 1998 Analytics cross check data is included in Table C-2. The CEAL's performance meets the criteria described in Reg Guide 4.15.

SPLIT SAMPLING PROGRAM WITH DHS

The California Department of Health Services (DHS) supervises the performance of split and duplicate sampling of selected media at the NRC licensed nuclear power plants in California. Radiochemical analysis is performed by the Sanitation and Radiation Laboratory (SRL); TLD processing is performed by a contractor. The DHS has not completed the 1997 report summarizing the split sample results.

BLIND DUPLICATE QUALITY CONTROL SAMPLES

In accordance with the protocol outlined in Reg Guide 4.15 SONGS conducted a blind duplicate sampling program using the gross beta particulate in air media. Data for the range chart quality control limits was generated using a duplicate air sampler co-located alternately with Air Sampler # 9. Range control limits, acceptance criteria, and sampling frequency were established in accordance with the procedure described in Standard Methods.* For all of 1998 the duplicate results met the acceptance criteria. No adverse trends were observed.

* Standard Methods for the examination of Water and Wastewater 19th Edition (1995), Water Environment Federation

COMPARISON OF TLD AND PIC DATA

The SONGS REMP measures direct radiation at the various indicator and CONTROL locations with Thulium doped $CaSO_4$ Panasonic Thermoluminescient Dosimeters (TLDs). The TLDs are collected quarterly and the corresponding dose is measured by the contracted laboratory. Transit dose and fade is compensated for in the reported results. A number of the REMP TLDs are located adjacent to Pressurized Ion Chamber (PIC) direct radiation dose rate meters. Data from the PICs is fed into a central processing unit with readouts near the control room. The PICs serve to provide real time monitoring of the radiation dose rates in the inner ring of SONGS. PIC data from the first and second quarter of 1998 were assembled and the average dose rate was converted to a quarterly total dose. The resulting PIC measured total quarterly dose compare favorably to the measured TLD total quarterly dose as shown in the tables below.

TLD phosphors tend to over-respond to the lower energy levels and the TLD package has a thin lead shielding to compensate for this over-response. The complete TLD packages meet the requirements of ANSI N545. The energy response data for the PICs was not reviewed for this report. The PIC energy response is presumed to be relatively linear.

FIRST QUARTER 1998 PIC / TLD DATA COMPARISON

	PIC-1 & TLD 10	PIC-2 & TLD 67	PIC-3 & TLD 40	PIC-4 & TLD 61	PIC-6 & TLD 63	PIC-9 & TLD 66
Average PIC Dose Rate in mR/hour	7.67E-3	7.91E-3	7.67E-3	7.36E-3	6.72E-3	6.24E-3
PIC total quarterly dose in mR (90day)	16.57	17.08	16.57	15.89	14.51	13.47
TLD measured quarterly dose in mR +/- one sigma (empirical)	16.33 +/- 1.33	16.76 +/- 1.05	16.23 +/- 1.02	14.85 +/- 1.07	14.43 +/- 1.18	13.86 +/-1.02
Within one sigma	YES	YES	YES	YES	YES	YES

SECOND QUARTER 1998 PIC / TLD DATA COMPARISON

	PIC-1 & TLD 10	PIC-2 & TLD 67	PIC-3 & TLD 40	PIC-4 & TLD 61	PIC-6 & TLD 63	PIC-9 & TLD 66
Average Dose Rate in mR/hour	7.65E-3	8.05E-3	7.47E-3	7.34E-3	6.61E-3	6.18E-3
PIC total quarterly dose in mR (90day)	16.52	17.38	16.13	15.86	14.28	13.36
TLD measured quarterly dose in mR +/- one sigma (empirical)	15.73 +/- 1.03	16.81 +/- 1.05	16.53 +/- 1.10	15.07 +/- 1.25	13.59 +/- 0.96	13.06 +/-0.83
Within one sigma	YES	YES	YES	YES	YES	YES

CALIBRATION OF AIR SAMPLER VOLUME METERS

The Shop Services and Instrumentation Division of SCE performs an annual calibration procedure using standards referenced to NIST on all REMP air sampler gas meters. The acceptance criterion is +/- 5% of the known volume. When the gas meters are removed from service, the meter is calibrated and the calibration reports are reviewed for bias. This is an *a posteriori* review of the gas meter performance to evaluate method bias and to identify possible outlier analysis results. In 1998 four (4) out of fourteen (14) gas meters failed to meet this criterion at all calibrated flow rates. The flow rate of interest was not affected, therefore, there was no impact. Three (3) gas meters were removed from service because they became inoperable during sample collection. The malfunctions appear to have affected only three of the 521 samples collected during 1998. The "as found" calibration status of the inoperable meters is not available. The volumes were estimated based on the average volume of the previous three weeks. A review of the gross beta data has revealed no meaningful anomalies. Thus no discernable impact to the REMP database or conclusions resulted from having used the inoperable gas meters.

SONGS has taken action to resolve the issue of inoperable and or out of tolerance gas meters. Replacement electronic mass flow meters have been purchased. Installation of the replacement meters is scheduled to be completed by mid 1999.

TABLE C-1

1998 EPA Cross Check Program Summary

Date	Sample Type	Analyte	Mean CEAL ± s.d.	Known EPA ± expected bias	Control Limit	CEAL Mean to Control Limit Eval
Jan. 16	Water (pCi/l)	Sr-90	28.39 ± 1.24	32.0 ± 5.0	23.3 - 40.7	Agreement
Jan. 30	Water (pCi/l)	Gross Alpha	7.26 ± 0.98	30.5 ± 7.6	0.0 - 13.7	Agreement
Jan. 30	Water (pCi/l)	Gross Beta	9.77 ± 1.30	4.3 ± 5.0	17.3 - 43.7	Non-Agreement (1)
Feb. 6	Water (pCi/l)	I-131LL	108.91 ± 1.38	104.9 ± 10.5	86.7 - 123.1	Agreement
Feb. 13	Water (pCi/l)	Ra-226	16.77 ± 0.66	16.0 ± 2.4	11.8 - 20.2	Agreement
Feb. 13	Water (pCi/l)	Ra-228	33.70 ± 1.23	33.3 ± 8.3	18.9 - 47.7	Agreement
Feb. 13	Water (pCi/l)	Nat U	28.89 ± 1.00	32.0 ± 3.0	26.8 - 37.2	Agreement
Mar. 13	Water (pCi/l)	H-3	2095.33 ± 48.33	2155.0 ± 348.0	1551.2 - 2758.8	Agreement
Apr. 21	Water (pCi/l)	Co-60	48.17 ± 0.88	50.0 ± 5.0	41.3 - 58.7	Agreement
Apr. 21	Water (pCi/l)	Cs-134	21.17 ± 0.71	22.0 ± 5.0	13.3 - 30.7	Agreement
Apr. 21	Water (pCi/l)	Cs-137	9.10 ± 0.73	10.0 ± 5.0	1.3 - 18.7	Agreement
Apr. 21	Water (pCi/l)	Nat U	4.07 ± 0.09	5.0 ± 3.0	0.0 - 10.2	Agreement
Apr. 21	Water (pCi/l)	Ra-226	17.44 ± 0.80	15.0 ± 2.3	11.0 - 19.0	Agreement
Apr. 21	Water (pCi/l)	Ra-228	8.97 ± 1.05	9.3 ± 2.3	5.3 - 13.3	Agreement
Apr. 21	Water (pCi/l)	Sr-90	15.47 ± 0.75	18.0 ± 5.0	9.3 - 26.7	Agreement

(1) The contracted laboratory does not perform gross beta on mixed matrices because they calibrate at one energy level.

TABLE C-1

1998 EPA Cross Check Program Summary

Date	Sample Type	Analyte	Mean CEAL ± s.d.	Known EPA ± expected bias	Control Limit	CEAL Mean to Control Limit Eval
Jun. 5	Water (pCi/l)	Ba-133	37.56 ± 0.90	40.0 ± 5.0	31.3 - 48.7	Agreement
Jun. 5	Water (pCi/l)	Co-60	11.82 ± 0.57	12.0 ± 5.0	3.3 - 20.7	Agreement
Jun. 5	Water (pCi/l)	Cs-134	27.87 ± 0.84	31.0 ± 5.0	22.3 - 39.7	Agreement
Jun. 5	Water (pCi/l)	Cs-137	35.07 ± 1.09	35.0 ± 5.0	26.3 - 43.7	Agreement
Jun. 5	Water (pCi/l)	Zn-65	103.94 ± 2.74	104.0 ± 10.0	86.7 - 121.3	Agreement
Jun. 12	Water (pCi/l)	Nat U	3.44 ± 0.04	3.0 ± 3.0	0.0 - 8.2	Agreement
Jun. 12	Water (pCi/l)	Ra-226	4.73 ± 0.23	4.9 ± 0.7	3.7 - 6.1	Agreement
Jun. 12	Water (pCi/l)	Ra-228	2.38 ± 0.53	2.1 ± 0.5	1.2 - 3.0	Agreement
Jul. 17	Water (pCi/l)	Sr-89	20.78 ± 1.22	21.00 ± 5.0	12.3 - 29.7	Agreement
Jul. 17	Water (pCi/l)	Sr-90	8.11 ± 0.59	7.00 ± 5.00	0.0 - 15.7	Agreement
Jul. 24	Water (pCi/l)	Gross Alpha	5.44 ± 1.02	7.20 ± 5.00	0.0 - 15.9	Agreement
Jul. 24	Water (pCi/l)	Gross Beta	13.51 ± 1.10	13.94 ± 5.45	4.47 - 23.42	Agreement
Aug. 7	Water (pCi/l)	H-3	17550.7 ± 157.10	17996.0 ± 1800.0	14873.1-21118.9	Agreement
Sep. 11	Water (pCi/l)	I-131	5.61 ± 0.71	6.10 ± 2.00	2.60 - 9.60	Agreement
Sep. 18	Water (pCi/l)	Ra-226	1.71 ± 0.10	1.70 ± 0.30	1.20 - 2.20	Agreement
Sep. 18	Water (pCi/l)	Ra-228	6.19 ± 0.80	5.70 ± 1.40	3.30 - 8.10	Agreement
Sep. 18	Water (pCi/l)	Nat U	8.47 ± 0.10	9.10 ± 3.00	3.90 - 14.30	Agreement

TABLE C-1

1998 EPA Cross Check Program Summary

Date	Sample Type	Analyte	Mean CEAL ± s.d.	Known EPA ± expected bias	Control Limit	CEAL Mean to Control Limit Eval
Oct. 20	Water (pCi/l)	Ra-226	5.13 ± 0.15	4.5 ± 0.7	3.3 - 5.7	Agreement
Oct. 20	Water (pCi/l)	Ra-228	1.27 ± 0.76	1.5 ± 0.4	0.8 - 2.2	Agreement
Oct. 20	Water (pCi/l)	Nat. U	13.77 ± 0.57	18.1 ± 3.0	12.9 - 23.3	Agreement
Oct. 20	Water (pCi/l)	Sr-89	18.33 ± 0.58	19.0 ± 5.0	10.3 - 27.7	Agreement
Oct. 20	Water (pCi/l)	Sr-90	7.00 ± 0.0	8.0 ± 5.0	0.0 - 16.7	Agreement
Oct. 20	Water (pCi/l)	Co-60	21.0 ± 1.0	21.0 ± 5.0	12.3 - 29.7	Agreement
Oct. 20	Water (pCi/l)	Cs-134	6.33 ± 0.58	6.0 ± 5.0	0.0 - 14.7	Agreement
Nov. 6	Water (pCi/l)	Cs-137	49.67 ± 1.15	50.0 ± 5.0	41.3 - 58.7	Agreement
Nov. 6	Water (pCi/l)	Co-60	37.0 ± 1.0	38.0 ± 5.0	29.3 - 46.7	Agreement
Nov. 6	Water (pCi/l)	Zn-65	131.0 ± 2.65	131.0 ± 13.0	108.4 - 153.6	Agreement
Nov. 6	Water (pCi/l)	Cs-134	103.0 ± 1.73	105.0 ± 5.0	96.3 - 113.7	Agreement
Nov. 6	Water (pCi/l)	Cs-137	111.0 ± 2.0	111.0 ± 6.0	100.6 - 121.4	Agreement
Nov. 6	Water (pCi/l)	Ba-133	53.67 ± 2.08	56.0 ± 6.0	45.6 - 66.4	Agreement

TABLE C-2

1998 ANALYTICS CROSS-CHECK PROGRAM SUMMARY

Sample Number	Quarter / Year	Sample Media	Analyte / Nuclide	Units	Reported Value	Known Value	Ratio CEAL Analytics	Evaluation
E1337-162	1st / 98	Water	I-131	pCi/l	901	90	1.00	Agreement
E1337-162	1st / 98	Water	I-131LL	pCi/l	92	90	1.02	Agreement
E1337-162	1st / 98	Water	Ce-141	pCi/l	59	58	1.02	Agreement
E1337-162	1st / 98	Water	Cr-51	pCi/l	171	167	1.02	Agreement
E1337-162	1st / 98	Water	Cs-134	pCi/l	68	70	0.97	Agreement
E1337-162	1st / 98	Water	Cs-137	pCi/l	136	134	1.01	Agreement
E1337-162	1st / 98	Water	Mn-54	pCi/l	111	111	1.00	Agreement
E1337-162	1st / 98	Water	Fe-59	pCi/l	82	79	1.04	Agreement
E1337-162	1st / 98	Water	Zn-65	pCi/l	120	118	1.02	Agreement
E1337-162	1st / 98	Water	Co-60	pCi/l	70	71	0.99	Agreement
E1337-162	1st / 98	Water	Alpha	pCi/l	42	38	1.11	Agreement
E1337-162	1st / 98	Water	Beta	pCi/l	308	269	1.14	Agreement
E1337-162	1st / 98	Water	U-238	pCi/l	31	30	1.03	Agreement
E1337-162	1st / 98	Water	U-234	pCi/l	30	29	1.03	Agreement

TABLE C-2

1998 ANALYTICS CROSS-CHECK PROGRAM SUMMARY

Sample Number	Quarter / Year	Sample Media	Analyte / Nuclide	Units	Reported Value	Known Value	Ratio CEAL Analytics	Evaluation
E1337-162	1st / 98	Water	Pu-238	pCi/l	72	75	0.96	Agreement
E1337-162	1st / 98	Water	Pu-239	pCi/l	43	42	1.02	Agreement
E1337-162	1st / 98	Water	Ra-226	pCi/l	56	53	1.06	Agreement
E1337-162	1st / 98	Water	Ra-228	pCi/l	47	46	1.02	Agreement
E1340-162	1st / 98	Milk	I-131	pCi/l	84	82	1.02	Agreement
E1340-162	1st / 98	Milk	I-131LL	pCi/l	83	82	1.01	Agreement
E1340-162	1st / 98	Milk	Ce-141	pCi/l	73	70	1.04	Agreement
E1340-162	1st / 98	Milk	Cr-51	pCi/l	204	201	1.01	Agreement
E1340-162	1st / 98	Milk	Cs-134	pCi/l	83	84	0.99	Agreement
E1340-162	1st / 98	Milk	Cs-137	pCi/l	171	161	1.06	Agreement
E1340-162	1st / 98	Milk	Mn-54	pCi/l	139	133	1.05	Agreement
E1340-162	1st / 98	Milk	Fe-59	pCi/l	100	95	1.05	Agreement
E1340-162	1st / 98	Milk	Zn-65	pCi/l	147	142	1.04	Agreement
E1340-162	1st / 98	Milk	Co-60	pCi/l	86	85	1.01	Agreement
E1340-162	1st / 98	Milk	Sr-89	pCi/l	55	53	1.04	Agreement
E1340-162	1st / 98	Milk	Sr-90	pCi/l	45	44	1.02	Agreement
E1421-162	2nd / 98	Milk	I-131LL	pCi/l	67	67	1	Agreement
E1421-162	2nd / 98	Milk	I-131	pCi/l	71	67	1.06	Agreement

TABLE C-2

1998 ANALYTICS CROSS-CHECK PROGRAM SUMMARY

Sample Number	Quarter / Year	Sample Media	Analyte / Nuclide	Units	Reported Value	Known Value	Ratio CEAL Analytics	Evaluation
E1421-162	2nd / 98	Milk	Ce-141	pCi/l	102	99	1.03	Agreement
E1421-162	2nd / 98	Milk	Cr-51	pCi/l	128	132	0.97	Agreement
E1421-162	2nd / 98	Milk	Cs-134	pCi/l	97	95	1.02	Agreement
E1421-162	2nd / 98	Milk	Cs-137	pCi/l	74	70	1.06	Agreement
E1421-162	2nd / 98	Milk	Mn-54	pCi/l	111	106	1.05	Agreement
E1421-162	2nd / 98	Milk	Fe-59	pCi/l	46	45	1.02	Agreement
E1421-162	2nd / 98	Milk	Zn-65	pCi/l	124	122	1.02	Agreement
E1421-162	2nd / 98	Milk	Co-60	pCi/l	144	143	1.01	Agreement
E1417-162	2nd / 98	Filter	Ce-141	pCi/Filter	80	85	0.94	Agreement
E1417-162	2nd / 98	Filter	Cr-51	pCi/Filter	111	113	0.98	Agreement
E1417-162	2nd / 98	Filter	Cs-134	pCi/Filter	84	82	1.02	Agreement
E1417-162	2nd / 98	Filter	Cs-137	pCi/Filter	62	61	1.02	Agreement
E1417-162	2nd / 98	Filter	Mn-54	pCi/Filter	96	91	1.05	Agreement
E1417-162	2nd / 98	Filter	Fe-59	pCi/Filter	43	39	1.10	Agreement
E1417-162	2nd / 98	Filter	Zn-65	pCi/Filter	114	105	1.09	Agreement
E1417-162	2nd / 98	Filter	Co-60	pCi/Filter	116	124	0.94	Agreement
E1417-162	2nd / 98	Filter	Sr-89	pCi/Filter	140	142	0.99	Agreement
E1417-162	2nd / 98	Filter	Sr-90	pCi/Filter	49	51	0.96	Agreement

TABLE C-2

1998 ANALYTICS CROSS-CHECK PROGRAM SUMMARY

Sample Number	Quarter / Year	Sample Media	Analyte / Nuclide	Units	Reported Value	Known Value	Ratio CEAL Analytics	Evaluation
E1417-162	2nd / 98	Filter	Alpha	pCi/Filter	36	36	1.00	Agreement
E1417-162	2nd / 98	Filter	Beta	pCi/Filter	220	212	1.04	Agreement
E1420-162	2nd / 98	Water	H-3	pCi/l	5697	6007	0.95	Agreement
E1537-162	3rd / 98	Milk	I-131LL	pCi/l	87	90	0.97	Agreement
E1537-162	3rd / 98	Milk	I-131	pCi/l	96	90	1.07	Agreement
E1537-162	3rd / 98	Milk	Ce-141	pCi/l	145	146	0.99	Agreement
E1537-162	3rd / 98	Milk	Cr-51	pCi/l	180	186	0.97	Agreement
E1537-162	3rd / 98	Milk	Cs-134	pCi/l	80	82	0.98	Agreement
E1537-162	3rd / 98	Milk	Cs-137	pCi/l	134	134	1.00	Agreement
E1537-162	3rd / 98	Milk	Mn-54	pCi/l	77	74	1.04	Agreement
E1537-162	3rd / 98	Milk	Fe-59	pCi/l	66	63	1.05	Agreement
E1537-162	3rd / 98	Milk	Zn-65	pCi/l	201	195	1.03	Agreement
E1537-162	3rd / 98	Milk	Co-60	pCi/l	146	148	0.99	Agreement
E1537-162	3rd / 98	Milk	Sr-89	pCi/l	62	51	1.22	Agreement
E1537-162	3rd / 98	Milk	Sr-90	pCi/l	72	81	0.89	Agreement
E1534-162	3rd / 98	Water	I-131LL	pCi/l	78	79	0.99	Agreement
E1534-162	3rd / 98	Water	I-131	pCi/l	82	79	1.04	Agreement

TABLE C-2

1998 ANALYTICS CROSS-CHECK PROGRAM SUMMARY

Sample Number	Quarter / Year	Sample Media	Analyte / Nuclide	Units	Reported Value	Known Value	Ratio CEAL Analytics	Evaluation
E1534-162	3rd / 98	Water	Ce-141	pCi/l	129	129	1.00	Agreement
E1534-162	3rd / 98	Water	Cr-51	pCi/l	172	165	1.04	Agreement
E1534-162	3rd / 98	Water	Cs-134	pCi/l	71	73	0.97	Agreement
E1534-162	3rd / 98	Water	Cs-137	pCi/l	117	119	0.98	Agreement
E1534-162	3rd / 98	Water	Mn-54	pCi/l	66	66	1.00	Agreement
E1534-162	3rd / 98	Water	Fe-59	pCi/l	59	55	1.07	Agreement
E1534-162	3rd / 98	Water	Zn-65	pCi/l	175	173	1.01	Agreement
E1534-162	3rd / 98	Water	Co-60	pCi/l	129	131	0.98	Agreement
E1534-162	3rd / 98	Water	Alpha	pCi/l	61	66	0.92	Agreement
E1534-162	3rd / 98	Water	Beta	pCi/l	190	198	0.96	Agreement
E1534-162	3rd / 98	Water	Sr-89	pCi/l	83	84	0.99	Agreement
E1534-162	3rd / 98	Water	Sr-90	pCi/l	47	51	0.92	Agreement

APPENDIX D

COMPARISON OF OPERATIONAL TO PREOPERATIONAL DATA AND ANALYSIS OF TRENDS

Comparison of Operational to Preoperational Data / Trend Analysis

Unit 1 became critical on June 14, 1967 and was permanently retired from service on November 30, 1992. Unit 2 attained initial criticality on July 26, 1982. Unit 3 attained initial criticality on August 29, 1983. Units 2 and 3 were operational for all of 1998. There were short periods of time during 1998 when Units 2 and 3 were not operating.

A variety of environmental samples were analyzed and the analytical results (January 1, 1979 to July 31, 1982) were compared with the 1998 operational data obtained for SONGS Units 2 and 3, which is the subject post-operational period for SONGS Unit 1.

The following media were evaluated and compared with the operational data of SONGS Units 1, 2 and 3:

A.	External Radiation	F.	Ocean Bottom Sediments
B.	Air Particulates	G.	Marine Species
C.	Radioiodine	H.	Local Crops
D.	Ocean Water	I.	Soil
E.	Shoreline Sediment (sand)	J.	Kelp
		K.	Drinking Water

All of the measurements obtained from the SONGS Unit 1 operational Radiological Environmental Monitoring Program (REMP) during the period from January 1979 to July 1982 are used as the preoperational baseline for SONGS Units 2 and 3. This is in accordance with San Onofre Units 2/3, Environmental Report, Operating License Stage, Appendix 6A, Pre-operational Radiological Environmental Monitoring, May 31, 1978. Comparisons of preoperational data to 1998 operational data are possible for each of the exposure pathways to man, namely: (1) direct radiation, (2) air particulates (inhalation), and (3) ocean water (waterborne). Comparisons can also be made between preoperational and operational data for ocean bottom sediment data to ascertain if there has been any significant increase in radioactivity in ocean bottom sediments in the vicinity of the SONGS Units 2 and 3 outfalls.

A. Direct Radiation

SONGS Unit 1:

No direct radiation data were obtained in the preoperational period of 1964 to 1967 to compare with the operational data.

SONGS Units 2 and 3:

Direct radiation measurements were made quarterly at 50 indicator locations and 11 CONTROL locations in 1998. Direct radiation samples (TLDs) were collected at a number of inner and outer ring locations as specified by the ODCMs. During the preoperational period from January 1979 to July 31, 1982, the indicator stations ranged from 16.1 to 46.6 millirem. The preoperational

indicator average was 25.3. The preoperational CONTROL range was 19.3 to 30.1 and the CONTROL mean was 23.1. During the 1998 operational year for Units 2 and 3, the indicator TLD locations ranged from 9.8 to 20.0 millirem, averaging 15.1 millirem while the CONTROL locations ranged from 11.3 to 18.6 millirem with an average of 14.8 millirem.

Factors such as meteorology, geographic location, the fallout from atmospheric nuclear weapons testing, and seasonal fluctuations account the variability in the data seen during the preoperational period for each location. The decrease in radiation levels at all TLD sample locations is attributable to the curtailment of the atmospheric nuclear weapons testing, and the continued decay fission products from previous nuclear weapons tests.

The range of quarterly direct radiation doses was larger at both indicator and CONTROL locations during the preoperational period than during the 1998 operational period for SONGS Units 2 and 3. The larger range observed during the preoperational time span may be attributable to Communist Chinese atmospheric nuclear weapons tests on March 14, 1978 and on October 15, 1980. The large range of annual direct radiation levels seen at all TLD sample locations during 1986 and 1987 is attributable to the Chernobyl Nuclear Power Plant accident that occurred April 26, 1986.

Figures 2A & 2B compare the environmental radiation levels of selected indicator and CONTROL locations during the operational and preoperational periods. From 1978 to 1998 a decreasing trend can be observed, due to the curtailment of atmospheric nuclear weapons testing and the decay of residual fallout. Simultaneous variation in the radiation levels at both the CONTROL and indicator locations show that the variations are due to factors external to SONGS. The operation of SONGS had no detectable impact on this sample medium.

B. Air Particulates

SONGS Unit 1:

Before SONGS Unit 1 attained initial criticality, samples of air particulate gross beta activity were collected from indicator and CONTROL locations. During the preoperational period of 1964-1967, detectable gross beta activity at the indicator locations ranged from 0.030 to 3.810 pCi/m^3, averaging 0.253 pCi/m^3. The CONTROL location of Huntington Beach (HBGS) had an average gross beta activity of 0.306 ranging from 0.04 to 2.77 pCi/m^3. During 1998, the gross beta activity at the indicator locations ranged from 0.0035 to 0.049 pCi/m^3, and averaging 0.0187 pCi/m^3. The Oceanside CONTROL location gross beta activity ranged from 0.0061 to 0.043 pCi/m^3 with an average of 0.0183 pCi/m^3. The decrease in activity levels between 1965 and 1998 is ascribed to the curtailment of atmospheric nuclear weapons testing and the resultant decrease in fallout.

Valid comparisons of preoperational data to the 1998 postoperational data are difficult to make because the preoperational background levels are elevated by a factor of about ten due to the atmospheric nuclear weapons testing fallout.

SONGS Units 2 and 3:

From January 1979 through July 1982 (considered to be the preoperational period for SONGS Units 2 and 3), there is a period of noticeably higher gross beta activity in air at all sample locations. This period extends from the fourth quarter of 1980 through the fourth quarter of 1981. These higher activity levels are attributable to the Communist Chinese atmospheric nuclear weapons test conducted on October 15, 1980.

Figures 3A and 3B compare the monthly average gross beta particulate in air activity levels of selected indicator locations with the CONTROL location over a period of 21 years (January 1977 to December 1998). The data clearly show a close correlation between the indicator and control locations for the entire time period covered. The various spike increases in gross beta activity at all sample locations are closely grouped and timed to coincide with known events external to SONGS with worldwide radiological impact. These events include: Communist Chinese atmospheric nuclear weapons testing on September 17, 1977; March 14, 1978; October 15, 1980; and the April 1986 Chernobyl accident. The graphs (Figures 3A and 3B) show that the environmental levels of gross beta remained substantially similar at both the indicator and the CONTROL locations over an extended period of time, with both CONTROL and indicator locations showing simultaneous variations of equal magnitude. There is a very close correlation between the monthly average indicator and CONTROL gross beta activity over an extended period of time. The fluctuations in gross beta activity are not attributable to SONGS and are the result of other environmental phenomena and seasonal variations.

The Communist Chinese testing of October 1980 deposited a large amount of radioactivity in California and raised the background level. During this period the highest gross beta activity was observed at the Huntington Beach CONTROL station (0.29 pCi/m^3 on the collection period ending May 11, 1981). The dispersion of the radioactive plume and its travel throughout the country affected the environmental levels at all the locations being studied. The fallout from the weapons testing raised the background radiation level in this sample medium by approximately one order of magnitude. The decrease in gross beta activity level after mid-1981 is ascribed to the curtailment of the Chinese weapons testing. Since the end of the weapons testing the overall trend of the data has been a decrease in the annual average gross beta particulate in air activity to a level of approximately 0.02 pCi/m^3.

The average activity in all the indicator locations during operational period of January to December 1998 was 0.0187 pCi/m^3. During 1998 the CONTROL average was 0.0183 pCi/m^3. There is a close correlation between the weekly indicator and CONTROL gross beta activity during 1998. Refer to Figures 3C. The operation of SONGS has had no detectable impact on this sample medium.

C. Radioiodine

SONGS Unit 1:

No preoperational data is available. All 1998 data was below both the *a priori* LLD (0.07 pCi/m^3) and the lower, count specific, *a posteriori* MDC.

SONGS Units 2 and 3:

Most of the preoperational and all of the 1998 operational data for I-131 level were below the detection limit.

D. Ocean Water

SONGS Unit 1:

No samples were obtained for the preoperational period of SONGS Unit 1.

SONGS Units 2 and 3:

Ocean water samples were collected on a monthly basis in the vicinity of each of the Station discharge outfalls, which served as indicator locations and from the Newport Beach CONTROL location. The ocean water samples are analyzed for naturally-occurring and station-related gamma-emitting radionuclides. They are composited quarterly and analyzed for tritium.

During the preoperational period, naturally-occurring potassium-40 was detected in each of the samples collected from both indicator and CONTROL locations. Other gamma-emitting radionuclides were detected in only one ocean water sample. In May 1980, Co-58, Co-60, Cs-134, and Cs-137 were detected in an ocean water sample collected from the SONGS Unit 1 outfall. Concentrations of the radionuclides in this sample were 11, 6, 380, and 430 pCi/l, respectively. Tritium was also detected in two of the ocean water samples collected in May 1980 from the SONGS Unit 2 outfall and from the Newport Beach CONTROL location. Reduction in effluent activity through programmatic changes at Unit 1 may have reduced activity levels in ocean water.

For tritium and all SONGS related radionuclides the data collected at all locations during the 1998 operational period was below both the *a priori* LLD and the lower *a posteriori* MDC. We conclude that the operation of SONGS has had a negligible impact on this sample medium.

E. Shoreline Sediments (Sand)

SONGS Unit 1:

Shoreline Sediment samples were not collected during the preoperational period for SONGS 1.

SONGS Units 2 and 3:

Beach sand is collected semiannually from three indicator locations and from a CONTROL location situated at Newport Beach. The samples are analyzed for 28 naturally-occurring and plant-related radionuclides.

To assess the impact of SONGS operations on this environmental medium, preoperational data were compared to 1998 operational data. The radionuclide detected in shoreline sediment in the preoperational time frame was Cs-137 with a range of 0.012 to 0.022 pCi/g, averaging 0.019 in 5 sediment samples. One CONTROL sample with a Cs-137 activity of 0.032 pCi/g was observed in July 1979. The presence of Cs-137 in both CONTROL and indicator locations during the preoperational period leads to the conclusion that the root cause is external to SONGS and is most likely attributable to Communist Chinese atmospheric nuclear weapons testing. No SONGS-related radionuclides were detected in shoreline sediment during the 1998 operational period, thus the impact of SONGS on this environmental medium is considered to be negligible.

F. Ocean Bottom Sediments

SONGS Unit 1:

Ocean bottom sediment samples were not collected during the preoperational phase of Unit 1, and, therefore, no comparison can be made. However, operational data for SONGS 1 did not reveal the presence of any significant radioactivity in the sediment samples.

SONGS Units 2 and 3:

During the preoperational and operational periods, representative samples of ocean bottom sediments were collected semiannually from each of the Station discharge outfalls and from a CONTROL station in Laguna Beach. The samples were analyzed for naturally occurring and SONGS related radionuclides. The results of the analyses are listed in Table D-1B. It is clear in surveying the data that the concentration of each of the radionuclides has decreased with time or has been consistently below the lower limit of detection.

SONGS-related radionuclides were also detected in samples collected during preoperational period. Manganese-54 (Mn-54) was detected in 5 of the 28 samples. The concentrations of Mn-54 in these samples ranged from 0.015 to 0.49 pCi/g, averaging 0.13 pCi/g. Cobalt-58 (Co-58) was detected in nine samples. The concentration of Co-58 in the samples ranged from 0.013 to 1.16 pCi/g, averaging 0.20 pCi/g. Cobalt-60 (Co-60) was measured in 15 of the 28 samples. The concentration of Co-60 in the sample ranged from 0.014 to 8.1 pCi/g, averaging 0.79 pCi/g. Cs-137 was also detected in 16 of the 28 samples. The concentrations of Cs-137 in the samples ranged from 0.014 to 0.090 pCi/g, averaging 0.039 pCi/g. Cerium-144 (Ce-144) was found in two samples. The concentration of Ce-144 in the samples was 0.06 and 0.26 pCi/g, respectively.

The results indicate that there has not been a build-up of radionuclides with time in ocean bottom sediments near SONGS. The results also indicate notable decrease in the concentrations of plant-related radionuclides in the ocean bottom sediment. Although Co-58, Co-60, silver-110m (Ag-110m), and Cs-137 are normally associated with nuclear power operations, preoperational study reveals no accumulation trend for these radionuclides, and no increase in levels for these radionuclides was detected during the operational period.

The concentration of station-related radionuclides in all ocean bottom sediment samples analyzed in 1998 was below the *a priori* LLD as well as below the lower *a posteriori* MDC. We conclude that operation of SONGS Units 2 and 3 has had a negligible impact upon this environmental medium.

TABLE D-1A

SHORELINE SEDIMENTS CONCENTRATION (pCi/g, wet weight)
PREOPERATIONAL AND OPERATIONAL DATA*
SONGS UNITS 2 AND 3

		INDICATOR		CONTROL	
Radionuclide**	**Period**	**Range**	**Average**	**Range**	**Average**
Cs-137	PreOp	0.012-0.022	0.019	<LLD-0.032	<LLD
All other measured SONGS related radionuclides	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

TABLE D-1B

OCEAN BOTTOM SEDIMENTS CONCENTRATION (pCi/g, wet weight)
PREOPERATIONAL AND OPERATIONAL DATA*
SONGS UNITS 2 AND 3

		INDICATOR		CONTROL	
Radionuclide**	**Period**	**Range**	**Average**	**Range**	**Average**
Mn-54	PreOp	0.0150-0.49	0.129	<LLD	<LLD
Co-58	PreOp	0.013-1.160	0.199	<LLD	<LLD
Co-60	PreOp	0.014-8.100	0.788	<LLD	<LLD
Ag-110m	PreOp	<LLD-0.020	<LLD	<LLD	<LLD
Cs-137	PreOp	0.014-0.090	0.039	<LLD-0.043	<LLD
Ce-144	PreOp	0.060-0.260	0.160	<LLD	<LLD
All other measured SONGS related radionuclides (1)	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

* PreOp = January 1979 to July 1982; Operational - January to December 1998

** During January to December 1998 all station related Radionuclides from all sample locations were < LLD

LLD Lower limits of detection are listed in Appendix B.

(1) A recount of one indicator ocean bottom sediment sample obtained during 1998 yielded a result of 0.025 pCi/g Cs-137.

G. Marine Species (Flesh)

SONGS Unit 1:

Marine species were not collected during the preoperational period for SONGS Unit 1. No comparison with operational data is possible.

SONGS Units 2 and 3:

Non-migratory marine species were collected semi-annually near SONGS to determine the amount of radioactivity that could be consumed by man or in the food chain to man. Marine species caught by the SONGS outfalls and from Laguna Beach include two species of adult fish, crustacea and mollusks. Upon collection, the flesh portion is analyzed for three naturally-occurring radionuclides and for 16 gamma-emitting, station-related radionuclides as specified in the ODCM. The results are subsequently reported as pCi/gram wet weight.

Results for several marine species for both the preoperational and 1998 operational periods for Units 2 and 3 are summarized in Table D-2. The marine species used for purposes of comparison include: sheephead (a fish), black perch (a fish), bay mussel (a mollusk), spiny lobster (a crustacea), sea hare (a mollusk), and keyhole limpet (a mollusk). Radionuclides analyzed but not included in Table D-2 were below the lower limits of detection for both the preoperational and operational periods.

During the 1998 operational period, no SONGS related radionuclides were detected at either the *a priori* LLD or the lower *a posteriori* MDC. The data indicate no accumulation trends. The operation of SONGS Units 2 and 3 in 1998 has had no measurable impact on this environmental medium.

MARINE SPECIES CONCENTRATIONS (pCi/g, wet weight) PREOPERATIONAL AND 1998 OPERATIONAL DATA (SONGS UNITS 2/3)

Sheephead Flesh**

		INDICATOR		CONTROL	
Radionuclide	**Period**	**Range**	**Average**	**Range**	**Average**
Co-58	PreOp	0.016-0.030	0.023	<LLD	<LLD
Co-60	PreOp	0.005-0.044	0.017	<LLD	<LLD
Cs-137	PreOp	0.004-0.018	0.007	0.005-0.012	0.007
All other measured SONGS related radionuclides	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

Black Perch Flesh**

		INDICATOR		CONTROL	
Radionuclide	**Period**	**Range**	**Average**	**Range**	**Average**
Co-58	PreOp	0.009-0.011	0.010	<LLD	<LLD
Co-60	PreOp	0.004-0.045	0.017	<LLD	<LLD
Ag-110m	PreOp	0.002-0.009	0.006	<LLD	<LLD
Cs-137	PreOp	0.003-0.015	0.008	0.004-0.014	0.009
All other measured SONGS related radionuclides	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

* **PreOp = January 1979 to July 1982; Operational - January to December 1998**

** **During January to December 1998 all station related Radionuclides from all sample locations were < LLD**

LLD **Lower limits of detection are listed in Appendix B.**

MARINE SPECIES CONCENTRATIONS (pCi/g, wet weight) PREOPERATIONAL AND OPERATIONAL DATA (SONGS UNITS 2/3)

Bay Mussel Flesh**

		INDICATOR		CONTROL	
Radionuclide	**Period**	**Range**	**Average**	**Range**	**Average**
Mn-54	PreOp	0.009-0.025	0.017	<LLD	<LLD
Co-58	PreOp	0.008-0.080	0.028	--	--
Co-60	PreOp	0.005-0.40	0.077	<LLD	<LLD
Cs-137	PreOp	0.003-0.006	0.004	<LLD	<LLD
Ru-103	PreOp	<LLD-0.045	<LLD	<LLD	<LLD
All other measured SONGS related radionuclides	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

Spiny Lobster Flesh**

		INDICATOR		CONTROL	
Radionuclide	**Period**	**Range**	**Average**	**Range**	**Average**
Co-58	PreOp	0.007-0.270	0.086	<LLD	<LLD
Co-60	PreOp	0.014-0.210	0.060	<LLD	<LLD
Cs-137	PreOp	0.005-0.011	0.008	0.040-0.015	0.008
All other measured SONGS related radionuclides	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

* **PreOp = January 1979 to July 1982; Operational - January to December 1998**

** **During January to December 1998 all station related Radionuclides from all sample locations were < LLD**

LLD **Lower limits of detection are listed in Appendix B.**

MARINE SPECIES CONCENTRATIONS (pCi/g, wet weight) PREOPERATIONAL AND OPERATIONAL DATA (SONGS UNITS 2/3)

Sea Hare Flesh**

		INDICATOR		CONTROL	
Radionuclide	**Period**	**Range**	**Average**	**Range**	**Average**
Co-57	PreOp	0.006-0.017	0.009	<LLD	<LLD
Co-58	PreOp	0.006-12.4	1.233	<LLD	<LLD
Co-60	PreOp	0.016-2.000	0.448	0.003-0.027	0.013
Zn-65	PreOp	<LLD-0.10	<LLD	<LLD	<LLD
Ag-110m	PreOp	0.018-0.50	0.138	0.020-0.039	0.030
Cs-137	PreOp	<LLD-0.004	<LLD	<LLD-0.005	<LLD
All other measured SONGS related radionuclides	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

Keyhole Limpet (Flesh)**

		INDICATOR		CONTROL	
Radionuclide**	**Period**	**Range**	**Average**	**Range**	**Average**
Co-58	PreOp	0.007-0.101	0.054	<LLD-0.190	<LLD
Co-60	PreOp	0.021-0.040	0.033	<LLD-0.022	0.022
Ag-110m	PreOp	0.033-0.101	0.054	0.005-0.042	0.022
Cs-137	PreOp	<LLD	<LLD	<LLD-0.005	<LLD
All other measured SONGS related radionuclides	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

* **PreOp = January 1979 to July 1982; Operational - January to December 1998**

** **During January to December 1998 all station related Radionuclides from all sample locations were < LLD**

LLD **Lower limits of detection are listed in Appendix B.**

H. Local Crops

SONGS Unit 1:

During the preoperational phase of Unit 1, local crops were collected semiannually from both indicator and CONTROL locations, and subsequently analyzed for Sr-90. The range was 0.008 to 0.030 pCi/g wet weight. The average Sr-90 value was 0.022 pCi/g wet weight. Sr-90 is a common fission product likely due to atmospheric weapons tests.

During the 1998 operational period only naturally occurring radionuclides were detected in the crop samples.

SONGS Units 2 and 3:

In the preoperational period of January 1979 through July 1982, Sr-90 was detected in the CONTROL samples of kale, parsley, and squash. Naturally occuring K-40 was detected in cucumber, kale, and tomato samples from the indicator and CONTROL locations. Ce-144 and Zr-95 were detected in one sample of parsley at the CONTROL location at concentrations of 0.12 and 0.09 pCi/g, wet weight respectively.

In the 1998 operational period, only naturally occurring radionuclides were detected in the crop samples. The data indicate that the concentration of SONGS related radionuclides have decreased over time in this sample medium. This decrease is attributable to the termination of atmospheric nuclear weapons testing. The operation of SONGS has not had a measurable impact on this medium.

I. Soil

SONGS Unit 1:

No soil data were available for Unit 1 preoperational phase so a comparison cannot be made. However, gamma isotopic analysis of soil does not show any significant level of radioactivity. No accumulation pattern of plant-related radionuclides in the soil has been observed in the last 20 years.

SONGS Units 2 and 3:

A comparison of operational and preoperational data does not reveal any accumulation pattern of SONGS related isotopes in soil. The intermittent detection of Cs-137 in both indicator and CONTROL locations is due to residual fallout from atmospheric nuclear weapons testing.

J. Kelp

SONGS Unit 1:

Samples of kelp were not collected and analyzed during the preoperational period for SONGS Unit l. No comparison with operational data is possible.

SONGS Units 2 and 3:

Kelp is collected semiannually from three indicator locations and from a CONTROL location situated in Laguna Beach. After collection, the samples are analyzed by gamma-spectral analysis for naturally-occurring and SONGS-related radionuclides.

To assess the impact of SONGS operations on kelp, preoperational data were compared to 1998 operational data in Table D-4. Radionuclides detected during the preoperational period for SONGS Units 2 and 3 include Mn-54, Co-60, Zr-95, I-131, and Cs-137.

During the 1998 operational period, I-131 was detected in five (5) samples. The 1998 kelp sample with the highest level of I-131 (1.05 pCi/g) was obtained from the Laguna Beach CONTROL location. No other station related isotopes were detected in kelp samples during the 1998 operational period.

Although I-131 activity has been randomly detected in kelp since 1977, there is no evidence that the concentration of I-131 or other station related radionuclides in kelp is increasing near SONGS. I-131 in kelp is most likely due to the sewer release of medical administrations, since it has been detected consistently in CONTROL as well as indicator locations. Since 1988 the concentration of I-131, when detected, has typically been highest at the CONTROL location. This data supports the conclusion that during the Units 2/3 operational period, the detection of I-131 in kelp is primarily due to factors external to SONGS.

K. Drinking Water

No plant related radionuclides were detected during the 1998 operational period. Gross beta activity was detected during both the operational and preoperational periods at both the indicator and the CONTROL locations. No trends have been noted. There is no drinking water pathway for SONGS. The operation of SONGS has had no detectable impact on this sample media.

TABLE D-3

SOIL PREOPERATIONAL AND OPERATIONAL DATA* (pCi/g, dry weight)
SONGS UNITS 2 and 3

		INDICATOR		CONTROL	
Radionuclide	**Period**	**Range**	**Average**	**Range**	**Average**
Sr-90	PreOp	0.02-0.08	0.044	<LLD-0.03	<LLD
Cs-137	PreOp	0.02-0.20	0.096	<LLD-0.06	<LLD
Cs-137	Operational	< LLD-0.076	<LLD	<LLD	<LLD
All other measured SONGS related radionuclides	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

TABLE D-4

KELP PREOPERATIONAL AND OPERATIONAL DATA* (pCi/g, wet weight)
SONGS UNITS 2 AND 3

		INDICATOR		CONTROL	
Radionuclide	**Period**	**Range**	**Average**	**Range**	**Average**
Mn-54	PreOp	<LLD-0.005	<LLD	<LLD	<LLD
Co-60	PreOp	0.006-0.009	0.008	<LLD	<LLD
Zr(Nb)-95	PreOp	0.014-0.090	0.046	0.018-0.053	0.036
I-131	PreOp	0.006-0.024	0.013	0.008-0.030	0.014
I-131	Operational	<LLD-0.095	<LLD	<LLD-0.105	<LLD
Cs-137	PreOp	0.004-0.009	0.006	<LLD	<LLD
All other measured SONGS related radionuclides	PreOp	< LLD	< LLD	< LLD	< LLD
	Operational	< LLD	< LLD	< LLD	< LLD

* **PreOp = January 1979 to July 1982; Operational - January to December 1998**
LLD Lower limits of detection are listed in Appendix B.

APPENDIX E

DEVIATIONS FROM ODCM SAMPLING REQUIREMENTS

IN 1998

DEVIATIONS FROM THE ODCM SAMPLING REQUIREMENTS

Deviations from the Offsite Dose Calculation Manual (ODCM) sampling requirements are identified below in accordance with section 5.0 of the ODCM. The performance standard for environmental data collection of 95% was met for all sample types. During 1998 the ODCM specified *a priori* LLD was achieved for every REMP sample obtained. Deviations from the ODCM were associated with external factors not within the control of REMP personnel such as limited availability of Marine Samples at the locations specified in the ODCM. These minor unavoidable deviations from the ODCM had no meaningful impact on the REMP database and did not compromise the validity of the reported conclusions.

PART I TERRESTRIAL SAMPLING

A. WEEKLY AIR SAMPLING

Downtime for each air sampler in 1998 due to weekly sample collection, annual preventive maintenance (PM) and the annual gas meter change out was approximately 46 minutes for each sampler.

Weekly Change out:	Approximately 0.5 minutes x 52 = 26 minutes
Annual PM:	Approximately 15 minutes
Annual Gas Meter change out:	Approximately 5 minutes

Down times in excess of 1 hour are described below for each air sample. Air samplers were subject to a higher incidence of external power outages than has been experienced in recent years. The power outage episodes have not had a meaningful impact to the REMP data. Air sampler availability remains well above 95% for all except one air sampler. During 1998, air sampler 13 had an availability of 93% based on the total number of hours out of service during the year. For each collection period and at every sample location a sample was obtained from either the normal routine air sampler or from a compensatory air sampler. See discussion in "Air Sampler 13 (Camp Pendleton East)" following.

Air Sampler 1 (City of San Clemente):

No deviations were observed.

Air Sampler 9:

No deviations were observed.

Air Sampler 10 (Bluff):

Air sampler 10 was out of service for a total of 139.7 hours or 1.6% of the year, during the collection period ending September 15. No data anomalies were noted during the September 15 collection period.

Air Sampler 10 experienced several anomalously low volumes during the collection periods ending September 22 and September 29. The corresponding gross beta activity (pCi/m^3) for air sampler 10 during the collection period ending September 29 was anomalously high when compared to the other air samplers. The gas meter was changed out and the gross beta activity for air sampler 10 returned to a normal range during the next sample collection period.

External power interruptions caused air sampler 10 to be out of service for a portion of three collection periods in November 1998. Even though the volume was reduced, the measured activity of each of the samples was roughly comparable to other REMP gross beta activity air samples collected at the same time.

Air Sampler 11 (EOF):

Air sampler 11 was out of service for 3.8 hours during the collection period ending September 15, 1998; but the corresponding gross beta data was in the same range as the other REMP air samplers.

The inlet to air sampler 11 was blocked by an impinged insect during the collection period ending December 8, 1998. Abnormally low gross beta activity (less than the *a posteriori* MDC) was observed during this collection period. The line was unplugged and the sampler was returned to service. The data returned to a range comparable to the other REMP air samplers.

Air Sampler 12 (Former SONGS Evaporation Pond):

An external power outage caused air sampler 12 to be out of service for a portion of the collection period ending September 15, 1998. No data anomalies were noted.

Air Sampler 13 (Camp Pendleton East):

A power outage caused air sampler 13 to be out of service for part of the collection period ending January 13, 1998, but no data anomalies were observed. The power outage continued until January 30, 1998 because heavy rain and mud slides prevented repair crews from safely reaching the remote 12 kV power line. Air sampler 13 is at a distance of 0.7 miles in Sector E. As a compensatory measure, another air sampler, designated as air sampler 30, was installed at a location 0.2 miles in the same sector. This particular location was chosen because it was the nearest accessible location to air sampler 13, within the same sector, notwithstanding that it is within the Site Boundary. During each sample collection period a sample was obtained from

either sampler 13 or sampler 30 (compensatory 13). Data obtained were roughly comparable to data from the other samplers during the same collection periods.

An external power outage caused air sampler 13 to be out of service for a portion of the collection period ending April 14, 1998. No data anomalies were noted during this collection period.

A power outage external to the sampler caused air sampler 13 to be out of service for a portion of the collection period ending May 5, 1998. The gross beta activity from sampler 13 was slightly lower than the activity from the other samplers during this collection period.

An external power outage caused air sampler 13 to be out of service for a portion of the collection period ending September 15, 1998. No data anomalies were noted.

Air sampler 13 was out of service a total of 585.8 hours during 1998 or 6.7% of the year. This is slightly less than the desired availability of 95%. No significant impact to the REMP resulted because a compensatory sampler was installed in a timely manner.

Air Sampler 14 (Mesa Medical Facility):

No deviations were observed.

Air Sampler 15 (Oceanside CONTROL):

No deviations were observed.

Summary of Air Sampler Corrective Actions

The primary cause of air sampler down time in 1998 continues to be external power supply interruptions. Most of these power interruptions are not under the direct control of Edison personnel and no compensatory action is available. Some failures have been attributed to a problem with the main 4 kV power line. Corrective maintenance has been completed and SONGS now has the ability to switch to an alternate line if the 4kV failure should occur again.

The useful life of the vacuum pump motor assemblies is estimated to be five years based on the recommendation of the manufacturer and upon experience. If the internal components (motor and control valve) are replaced the useful life may be extended. SONGS has initiated a five year replacement schedule for the REMP air samplers. The replacement cycle has been completed for the current five year period. Each REMP air sampler is either new or has a new vacuum motor installed. The REMP air sampler maintenance plan has resulted in a 100% reliability for REMP air samplers during 1998. During 1998 the REMP air samplers experienced no down time attributable to motor or vacuum pump assembly failure. All the down time experienced during 1998 was caused by external power failures.

The total volume measuring devices (gas meters) have experienced a higher than expected failure rate and out of tolerance as found calibration reports. As a compensatory measure SONGS has purchased electronic mass flow meters which are expected to be more reliable based on industry experience with this type of equipment. Installation of the new mass flow meters is anticipated to be completed by July 1, 1999.

B. DIRECT RADIATION

No deviations were observed.

C. LOCAL CROPS

During 1998, CONTROL leafy local crop samples were obtained from a location 16.4 miles ESE. CONTROL fleshy local crop samples were obtained from the location 16.4 miles ESE and from a location 20.8 miles SE. Both locations are within the area designated by the ODCM for CONTROL crop samples.

D. SHORELINE SEDIMENTS

No deviations were observed.

E. DRINKING WATER

No deviations were observed.

F. SOIL

No deviations were observed.

PART II MARINE SAMPLING

A. NON-MIGRATORY MARINE ANIMALS

Samples were collected from the specified ODCM sample location when samples were available at that location. When the specified sample type was not available at the ODCM listed location alternate locations were selected based on sample availability and proximity to the specified sample location. All indicator samples were obtained within two miles of the associated outfall. In some cases the indicator species is not the same as the control species due to limited availability at the indicator location.

Samples were obtained from the following locations relative the midpoint of Units 2/3 during 1998:

April 1998	Sample A Unit 1 lobster	0.9 miles SW
	Sample A Unit 1 kelp bass and corbina	0.8 miles SW
	Sample A Unit 1 aplysia (sea hare)	0.6 miles W
April 1998	Sample B Units 2/3 lobster	0.6 miles SSE
	Sample B Units 2/3 sheephead	1.4 miles SW
	Sample B Units 2/3 corbina	0.8 miles SW
	Sample B Units 2/3 mytilus (bay mussel)	0.7 miles SW
April 1998	Sample C North CONTROL all species	17.1 miles NW
October 1998	Sample A Unit 1(lobster, sheephead, and black perch)	0.9 miles SW
	Sample A Unit 1 aplysia (sea hare)	0.6 miles W
October 1998	Sample B Units 2/3 lobster	1.8 miles S
	Sample B Units 2/3 sheephead & black perch	1.5 miles SW
	Sample B Units 2/3 aplysia (sea hare)	0.6 miles W
October 1998	Sample C North CONTROL all species	17.2 miles NW

The ODCM specified sample locations for non-migratory marine animals are as follows:

Sample A Unit 1 Outfall	0.9 miles WSW
Sample B Units 2/3 Outfall	1.5 miles SSW
Sample C Laguna Beach (CONTROL)	18.2 miles NW

B. OCEAN WATER SAMPLING

Sample A Outfall-Unit 1

All samples taken 0.6 miles SW (No deviations)

Sample B Outfall-Unit 2

The monthly 1998 ocean water samples were taken in the range of 1.3 to 1.6 miles SSW to SW. Unit 2 outfall is through an extended diffuser line which is about 0.5 miles long, stretching from approximately 1.1 to 1.6 miles from SONGS. The diffuser line is located in Sector L (SW) very close to the border of Sector M (SSW). All 1998 samples were taken close to the Unit 2 discharge and meet the intent of the REMP sampling requirements.

Sample C Outfall-Unit 3

The 1998 ocean water samples were taken in the range of 1.0 to 1.3 miles SW. The Unit 3 diffuser portion of the outfall extends approximately 0.7 miles to 1.2 miles from the midpoint of Units 2/3. The samples were obtained from an area very close to the Unit 3 diffusers. The contracted marine sample collection vendor has been instructed to obtain the indicator ocean water samples from a location where the discharge from the associated SONGS' outfall can be observed. Weather and water conditions do not always permit the discharge line to be observed. The intent of the REMP requirements were met.

Sample D Newport Beach (CONTROL)

The 1998 samples were taken in the range of 27.0 to 29.0 miles NNW to NW. The purpose of this CONTROL sample is to obtain a background sea water sample far enough from SONGS to be completely unaffected by the operation of SONGS. The samples collected during 1998 satisfied this goal and met the intent of the REMP requirements.

The ODCM Specified locations for ocean water samples are as follows:

Sample A	Station Discharge Outfall Unit 1	0.6 miles SW
Sample B	Outfall Unit 2	1.5 miles SW
Sample C	Outfall Unit 3	1.2 miles SSW
Sample D	Newport Beach (CONTROL)	30.0 miles NW

C. OCEAN BOTTOM SEDIMENTS

Sample A Unit 1 Outfall (0.5 miles East) - Both the April and October 1998 samples were obtained from a location 0.6 miles SSW. ODCM specified location 0.6 miles W.

Sample B Unit 1 Outfall (0.6 miles West) - Both the April and October samples were obtained from a location 0.7 miles WSW. ODCM specified location 0.8 miles SSW.

Sample C Unit 2 Outfall - The April 1998 sample was obtained 1.5 miles SSW. The October 1998 sample was obtained 1.4 miles SSW. ODCM specified location 1.6 miles SW.

Sample D Unit 3 Outfall - The April 1998 sample was obtained from a location 1.1 miles SSW. The October 1998 sample was obtained from a location 0.9 miles SSW. The ODCM specified location is 1.2 miles SSW.

Sample E Laguna Beach (CONTROL) - Both the April and October 1998 samples were obtained from a location 17.1 miles NW. The ODCM specified location is 18.2 miles NW.

Actual sample location depends on sediment availability which is a function of seasons, currents, and other macro environmental factors. The actual exact sample location has been determined

for each of the past three years via a Differential Global Positioning System (DGPS) receiver. When sufficient DGPS data is available the approximate location of the sites associated with most frequently assessable ocean bottom sediment samples will be incorporated into the ODCM. The ocean bottom sampling is performed only twice per year; sufficient data is expected to be available in 2001.

D. KELP

Sample A San Onofre Kelp Bed - The April 1998 sample was obtained 1.7 miles SSW from Units 2/3 midpoint. The October 1998 sample was obtained from a location 1.8 miles SSW from Units 2/3. The ODCM specified location is 1.5 miles S.

Sample B San Mateo Kelp Bed - The April 1998 sample was obtained from a location 2.7 miles WNW from Units 2/3 midpoint. The October 1998 sample was obtained from a location 3.1 miles WNW from Units 2/3 midpoint. The ODCM specified location is 3.8 miles WNW.

Sample C Barn Kelp - The Barn Kelp Bed was not present during 1998 and no sample from this bed was obtained during 1998. Sea Urchin predation has temporarily eliminated this Bed.

Sample D Laguna Beach (CONTROL) - The Laguna beach bed was not in bloom during 1998. A CONTROL sample was obtained from the Salt Creek alternate CONTROL location. The April 1998 sample was obtained 11.3 miles WNW. The October 1998 sample was obtained 9.9 miles WNW. The ODCM specified location is 15.6 miles NW.

Kelp is intermittently available at the various local kelp forests. Sea urchin population, El Nino and La Nina weather phenomena and other macro-environmental factors determine Kelp sample availability. Samples were obtained from the kelp canopy closest to the ODCM specified location.

PART III NON ROUTINE SAMPLES OBTAINED DURING 1998

Direct Radiation Samples:

In order to ensure verbatim conformity with the SONGS Emergency Plan (E Plan) a number of TLDs were deployed around SONGS during 1998 to bring the total number of TLDs up to the number specified in the E Plan. TLDs EP76, EP77, EP78, EP79, EP80, EP81, EP82, EP83, EP84 , EP85, and EP86 were deployed in locations along Basilone Road and along the Old Highway 101 near the SONGS high voltage transmission lines. These TLDs were not used to meet any REMP or ODCM related sampling goal. Data from these TLDs are included in Table B-3.

Air Samples:

Air sampler 7 provides a basis for evaluating any airborne emissions that might impact workers in the major office area at SONGS. Air sampler 30 was installed to compensate for an extended, unavoidable power outage which kept air sampler 13 out of service for 3 weeks. Air sampler 51 was installed to provide a duplicate gross beta sample in accordance with Reg. Guide 4.15.

Air Sampler 7	AWS Roof	0.2 miles NW
Air Sampler 30	Compensatory for 13	0.2 miles E
Air Sampler 51	Blind Duplicate	0.6 miles ESE

Ocean Water and Ocean Bottom Sediment Samples:

There is a minor leak in both the Unit 2 and Unit 3 outfall conduit. In order to ensure that no detectable radiological environmental impact results from this discharge, ocean water and an ocean bottom sediment sample were obtained from near the vicinity of each leak. Data from these samples is included in Table B-3.

Unit 2 Conduit	0.1 miles SW
Unit 3 Conduit	0.1 miles SSW

APPENDIX F

LAND USE CENSUS

INTRODUCTION

Southern California Edison conducted the annual 1998 Land Use Census (LUC) in accordance with section 5.2 of the Offsite Dose Calculation Manual (ODCM). The purpose of the LUC is to identify important radiological pathways to humans. The LUC identifies the nearest residences, milk animals, meat animals, gardens of at least 500 square feet that produce fleshy or leafy vegetables, and other specified uses (campgrounds, employment, etc.) in each of the meteorological landward sectors within five miles of SONGS. Results are summarized in Table F-1 and F-2 at the end of this appendix.

THE STUDY AREA

The study area includes half of the city of San Clemente (population estimated at 48,250 as of January 1, 1998), the San Clemente State Park, U.S. Marine Corps Base Camp Pendleton (MCB), San Onofre State Beach and Park, the San Clemente Ranch, the former U. S. Coast Guard Station at San Mateo Point, and SONGS.

METHODOLOGY

A review of the 1997 LUC and documentation notebook was conducted. Verification and revision of the 1997 data was accomplished by inquiry to the cognizant agency, organization, or individual possessing direct knowledge of the item being verified.

The garden census was performed by examining aerial photographs taken August 12, 1998. The photographic image areas which appeared to correspond to likely garden locations were converted to street addresses. The identified locations and residences were visited and the occupants interviewed to determine if a vegetable garden was present. Four (4) previously unidentified gardens (> 500 sq ft) growing leafy vegetables were identified within the study area. Edison personnel planted a garden on site to ensure sample availability.

The closest residence was established in each sector by correspondence with cognizant authorities (City of San Clemente Planning Department and USMC Camp Pendleton). The meat and milk animal survey was performed by contacting the natural resources office on Camp Pendleton. Information on other uses was obtained by contacting the appropriate organizations.

DEFINITIONS

Residence is defined as any structure (single-family house, apartment, mobile home, barracks or similar unit) occupied by individual(s) for three months (2,000 hours) or longer per year.

Other Specified Use is defined as a location occupied by members of the general population as other than their primary residence. The use is divided into two categories: employment and non-employment related.

Employment use is defined as a location occupied by members of the general population engaged in normal work activities regardless of the length of time spent at the location, and regardless of its permanence, including concession stands, restaurants, markets and guard shacks.

Non-employment-related use is defined as a location occupied by members of the general population who are not engaged in normal work activities, including campgrounds, temporary housing, time-share condominiums, motels, hotels, schools and beaches.

Milk animals include, but are not limited to cows, goats and sheep, whose milk is used in dairy products for human consumption.

Meat animals include, but are not limited to deer, other game animals, cattle, goats and sheep, whose meat is used for human consumption.

Leafy vegetables include, but are not limited to lettuce, cabbage, collard greens, Bok choi, sorrel, and spinach.

Fleshy vegetables include, but are not limited to tomatoes, cucumbers, cauliflower, squash, beans, zucchini, and sweet corn.

SUMMARY OF CHANGES FROM THE 1997 CENSUS

1. Hunting. The 1998 LUC includes revised base hunting take and range information.
2. SONGS was not in a outage during the study period (June 1, 1998 through October 1, 1998). The outage residents noted in the 1997 LUC were not present.
3. Some occupancy and worker population summary changes were noted at the Highway Patrol Weigh Station.
4. Some worker occupancy information at the San Clemente Ranch was updated. The area under cultivation at the San Clemente Ranch was reduced to a total 505 acres. In 1997 the ranch cultivated 540 acres.
5. A new housing project is under construction at the old San Mateo US Coast Guard Station.
6. Four new gardens > 500 square feet were identified within the study area. The SONGS garden was sampled for the first time.

TABLE F-1
1998 SONGS Units 2/3 LUC Five Mile Radius Summary Sheet

Land Use Sector (22-1/2°)	Nearest Residence (2,000 Hrs/Yr)		Closest Other Specified Uses			Nearest Meat Animals	
	Location (Miles)	Description (LUC#)	Location (Miles)	Description (LUC#)	Max Rept Person Exp (Hrs/Yr)	Location (Miles)	Description
West Northwest (P)	2.8	Old Nixon Estate (R-P1)	0.5	Surf Beach (O-6)	667	--	NONE
Northwest (Q)	1.2	Maintenance Yard on 51 (R-Q1)	0.6	State Park Office Trailer (O-3)	400	--	NONE
North Northwest (R)	1.3	San Onofre Mobile Homes (R-R1)	2.6	San Clemente Ranch Packing (O-7)	3,500	1.8	Hunting (Dove)
North (A)	3.6	Camp San Mateo (R-A1)	3.6	Camp San Mateo Motor Pool (O-7)	2,000	1.8	Hunting (Dove)
North Northeast (B)	--	--	2.1	Sanitary Landfill (O-9)	2,000	1.6	Hunting (Dove)
Northeast (C)	2.5	Camp San Onofre Fire Station (R-C2)	2.2	Camp San Onofre Sewage Treatment Plant (O-10)	2,000	1.0	Hunting (Deer)
East Northeast (D)	3.0	Camp San Onofre (R-D1)	3.7	Camp Horno Sewage Treatment Plant (O-4)	2,000	0.8	Hunting (Deer)
East (E)	4.1	Camp Horno (R-E1)	4.0	Camp Horno Motor Pool (O-5)	2,000	0.8	Hunting (Deer)
East Southeast (F)	--	--	0.8	San Onofre State Beach Entrance Guard Shack (O-1)	1,500	1.5	Hunting (Deer)
Sotheast (G)	--	--	0.9	San Onofre Beach Campground (O-2)	720	--	NONE

Notes: All distances are in miles from SONGS 2/3 site reference point (midpoint between SONGS Units 2 & 3 containment buildings). All sectors include 22-1/2° with "A" sector centered on True North. Sectors H, J, K, L, M, and N are oceanward sectors and land uses are not applicable. A "residence" is a location occupied by an individual 2,000 hours or more in a year.

TABLE F-1
1998 SONGS Units 2/3 LUC Five Mile Radius Summary Sheet

Land Use Sector (22-1/2°)	Nearest Leafy Vegetable Garden		Nearest Fleshy Vegetable Garden	
	Location (Miles)	Description (LUC#)	Location (Miles)	Description (LUC#)
West Northwest (P)	2.8	Old Nixon Estate (G-3)	2.8	Old Nixon Estate (G-3)
Northwest (Q)	4.1	Residence 2240 Avenida San Salvador ** (G-8)	2.2	San Clemente Ranch (G-2)
North Northwest (R)	0.4	SONGS Garden (G-10) **	0.4	SONGS Garden (G-10) **
North (A)	--	--	--	--
North Northeast (B)	--	--	--	--
Northeast (C)	--	--	--	--
East Northeast (D)	--	--	--	--
East (E)	--	--	--	--
East Southeast (F)	--	--	--	--
Sotheast (G)	--	--	--	--

Note: All distances are in miles from SONGS 2/3 site reference point (midpoint between SONGS Units 2 & 3 containment buildings). All sectors include 22-1/2° with "A" sector centered on True North. Sectors H, J, K, L, M, and N are oceanward sectors and land uses are not applicable. A "residence" is a location occupied by an individual 2,000 hours or more in a year.

** Denotes change from 1997 Land Use Census based on updated survey data

TABLE F-2
1998 SONGS Unit 1 Land Use Census Summary Sheet (Five-Mile Radius)

Land Use Sector (22-1/2°)	Nearest Residence (2,000 Hrs/Yr)		Closest Other Specified Uses			Nearest Meat Animals	
	Location (Miles)	Description (LUC#)	Location (Miles)	Description (LUC#)	Max Rept Person Exp (Hrs/Yr)	Location (Miles)	Description
West Northwest (P)	2.6	Old Nixon Estate (R-P1)	0.4	Surf Beach (O-6)	667	--	NONE
Northwest (Q)	1.0	Maintenance Yard on 51 (R-Q1)	0.5	State Park Office Trailer (O-3)	400	--	NONE
North Northwest (R)	1.2	San Onofre Mobile Homes (R-R1)	2.4	San Clemente Ranch Packing (O-7)	3,500	1.6	Hunting (dove)
North (A)	3.5	Camp San Mateo (R-A1)	3.5	Camp San Mateo Motor Pool (O-7)	2,000	1.7	Hunting (dove)
North Northeast (B)	--	--	2.1	Sanitary Landfill (O-9)	2,000	1.6	Hunting (dove)
Northeast (C)	2.6	Camp San Onofre Fire Station (R-C2)	2.3	Camp San Onofre Sewage Treatment Plant (O-10)	2,000	1.1	Hunting (deer)
East Northeast (D)	3.0	Camp San Onofre (R-D1)	3.8	Camp Horno Sewage Treatment Plant (O-4)	2,000	1.0	Hunting (deer)
East (E)	4.2	Camp Horno (R-E1)	4.2	Camp Horno Motor Pool (O-5)	2,000	1.0	Hunting (deer)
East Southeast (F)	--	--	1.0	San Onofre State Beach Entrance Guard Shack (O-1)	1,500	1.7	Hunting (deer)
Sotheast (G)	--	--	1.1	San Onofre Beach Campground (O-2)	720	--	NONE

Notes:
All distances are in miles from the midpoint of SONGS Unit 1 Plant Vent Stack.
All sectors include 22-1/2° with "A" sector centered on True North.
A "residence" is a location occupied by an individual 2,000 hours or more in a year.
Sectors H, J, K, L, M, and N are oceanward sectors and land uses are not applicable.

TABLE F-2
1998 SONGS Unit 1 Land Use Census Summary Sheet (Five-Mile Radius)

Land Use Sector (22-1/2°)	Nearest Leafy Vegetable Garden		Nearest Fleshy Vegetable Garden	
	Location (Miles)	Description (LUC#)	Location (Miles)	Description (LUC#)
West Northwest (P)	2.6	Old Nixon Estate (G-3)	2.6	Old Nixon Estate (G-3)
Northwest (Q)	3.9	2240 Avenida San Salvador ** (G-8)	2.0	San Clemente Ranch (G-2)
North Northwest (R)	--	--	0.4	San Clemente Ranch (G-1)
North (A)	--	--	--	--
North Northeast (B)	0.3	SONGS Garden ** (G-10)	0.3	SONGS Garden ** (G-10)
Northeast (C)	--	--	--	--
East Northeast (D)	--	--	--	--
East (E)	--	--	--	--
East Southeast (F)	--	--	--	--
Sotheast (G)	--	--	--	--

Notes: ** Denotes change from 1997 Land Use Census based on updated survey data.
All distances are in miles from SONGS Unit 1 Plant Vent Stack.
All sectors include 22-1/2° with "A" sector centered on True North.

APPENDIX G

FIGURES FOR 1998

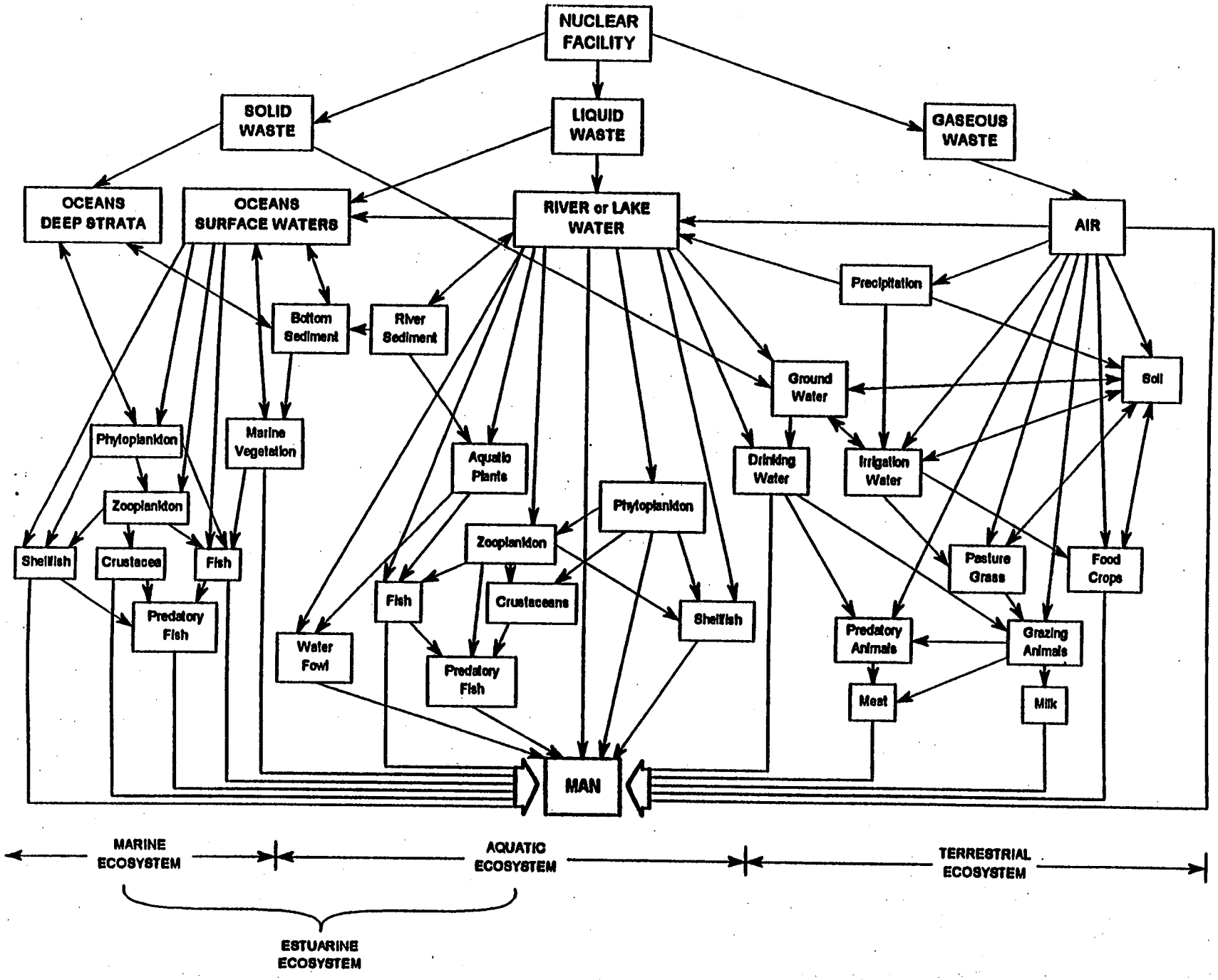

Figure 1. Potential Radiation Exposure Pathways Leading to Man

Direct Radiation Monitoring
Quarterly Environmental TLD dose measurements in mR
Selected TLDs located very close to SONGS vs. Selected CONTROL TLDs

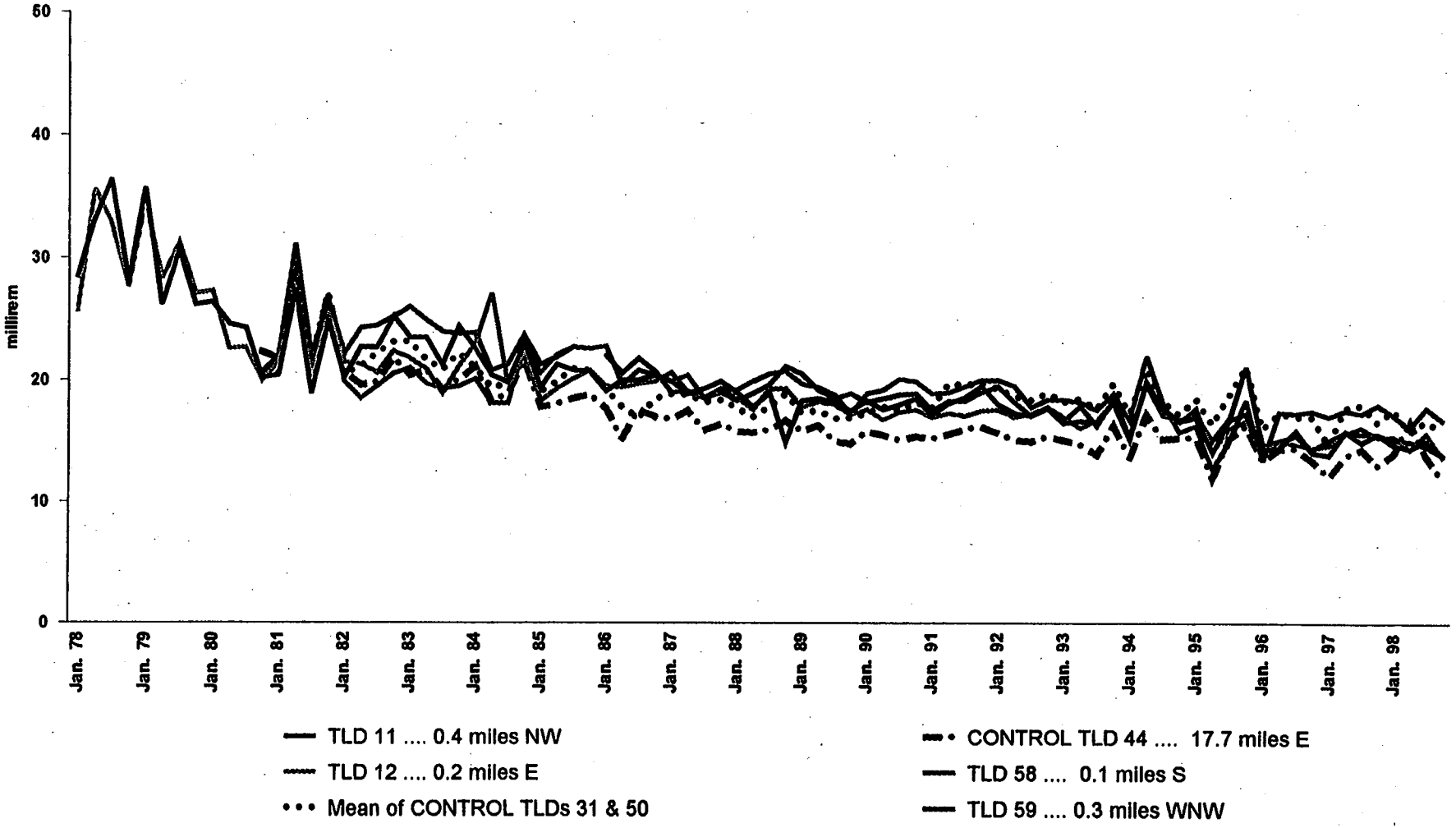

Figure 2A

Direct Radiation Monitoring
Quarterly Environmental TLD dose measurements in mR
Selected Outer Ring locations vs. Selected CONTROL locations

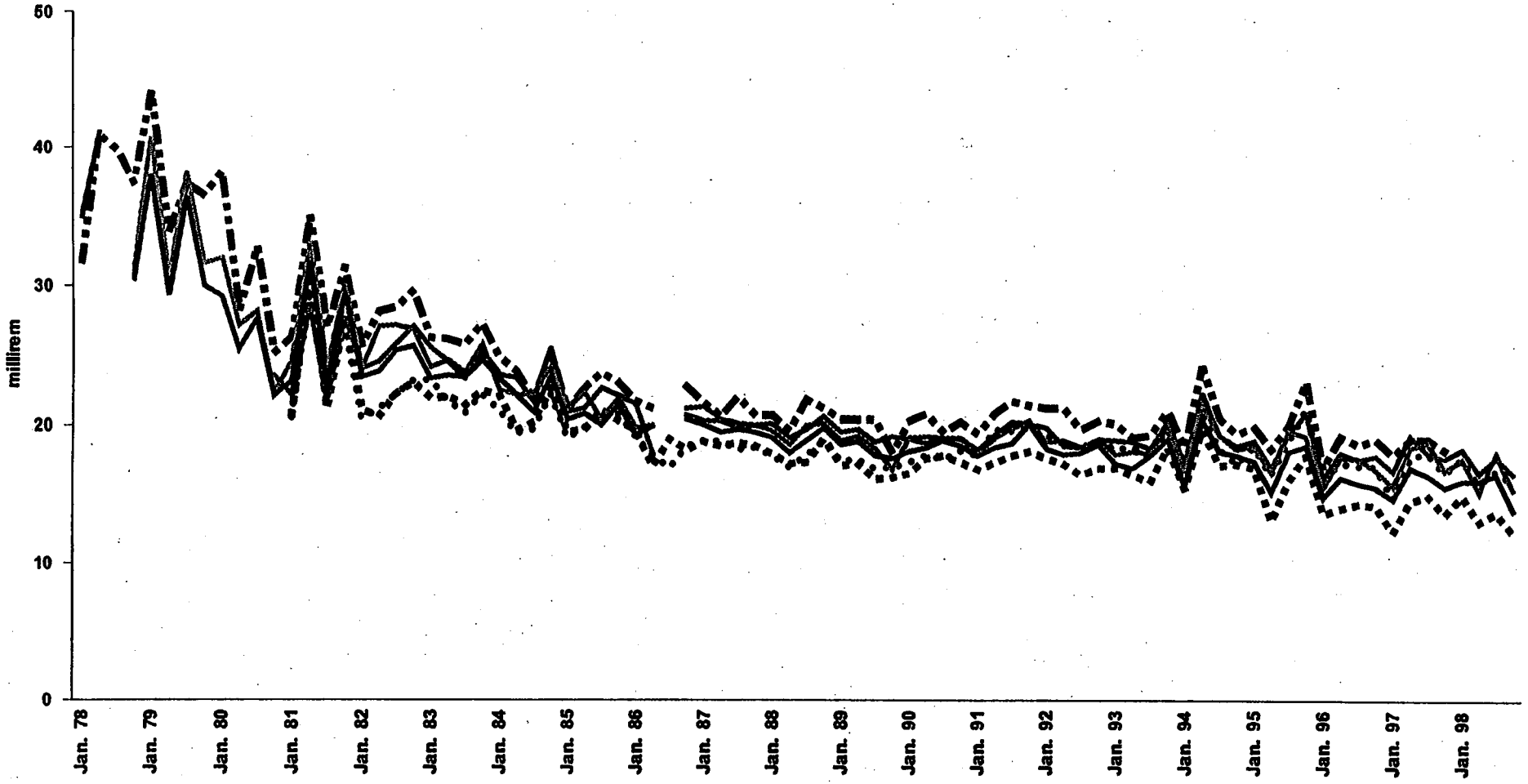

Figure 2B

Monthly Average Airborne Particulate Gross Beta Activity
Operational Data for SONGS Units 2 and 3

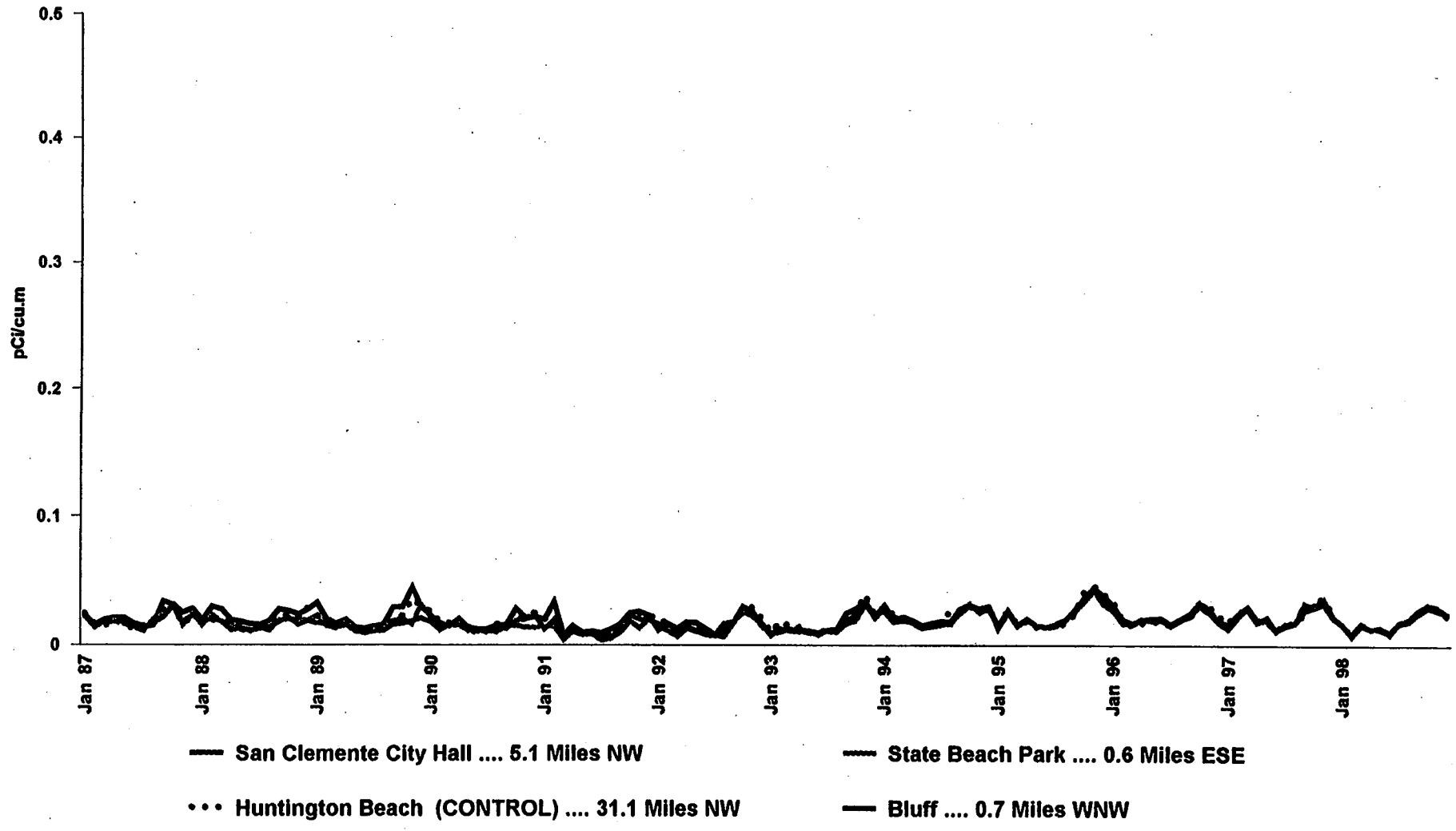

Figure 3A

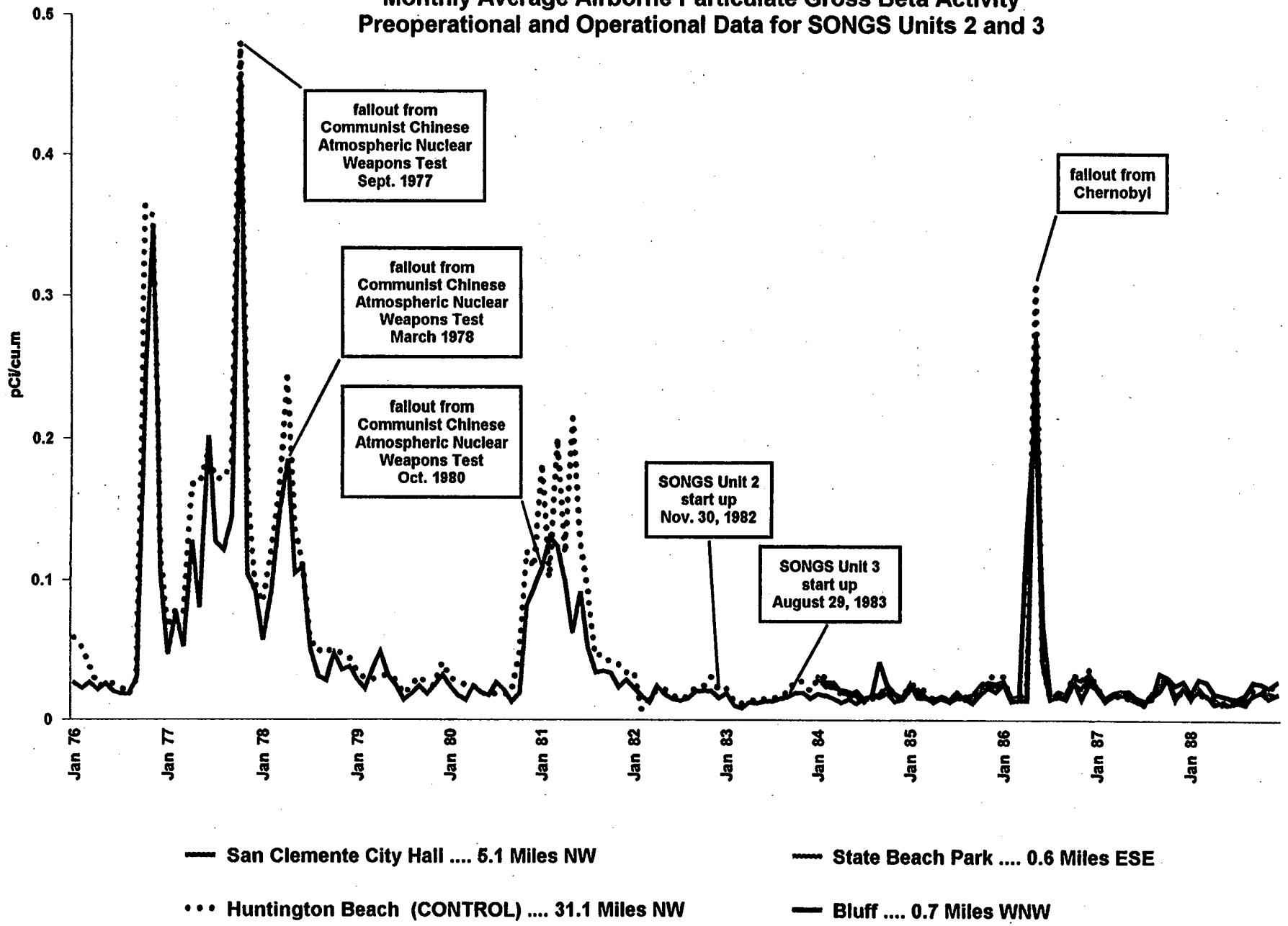
Monthly Average Airborne Particulate Gross Beta Activity
Preoperational and Operational Data for SONGS Units 2 and 3
pCi/cu.m
0.5
0.4
0.3
0.2
0.1
0
fallout from Communist Chinese Atmospheric Nuclear Weapons Test Sept. 1977
fallout from Communist Chinese Atmospheric Nuclear Weapons Test March 1978
fallout from Communist Chinese Atmospheric Nuclear Weapons Test Oct. 1980
SONGS Unit 2 start up Nov. 30, 1982
SONGS Unit 3 start up August 29, 1983
fallout from Chernobyl
Jan 76
Jan 77
Jan 78
Jan 79
Jan 80
Jan 81
Jan 82
Jan 83
Jan 84
Jan 85
Jan 86
Jan 87
Jan 88
San Clemente City Hall .... 5.1 Miles NW
State Beach Park .... 0.6 Miles ESE
Huntington Beach (CONTROL) .... 31.1 Miles NW
Bluff .... 0.7 Miles WNW

Figure 3B

Weekly Airborne Particulate Gross Beta Activity
SONGS Units 1, 2 and 3

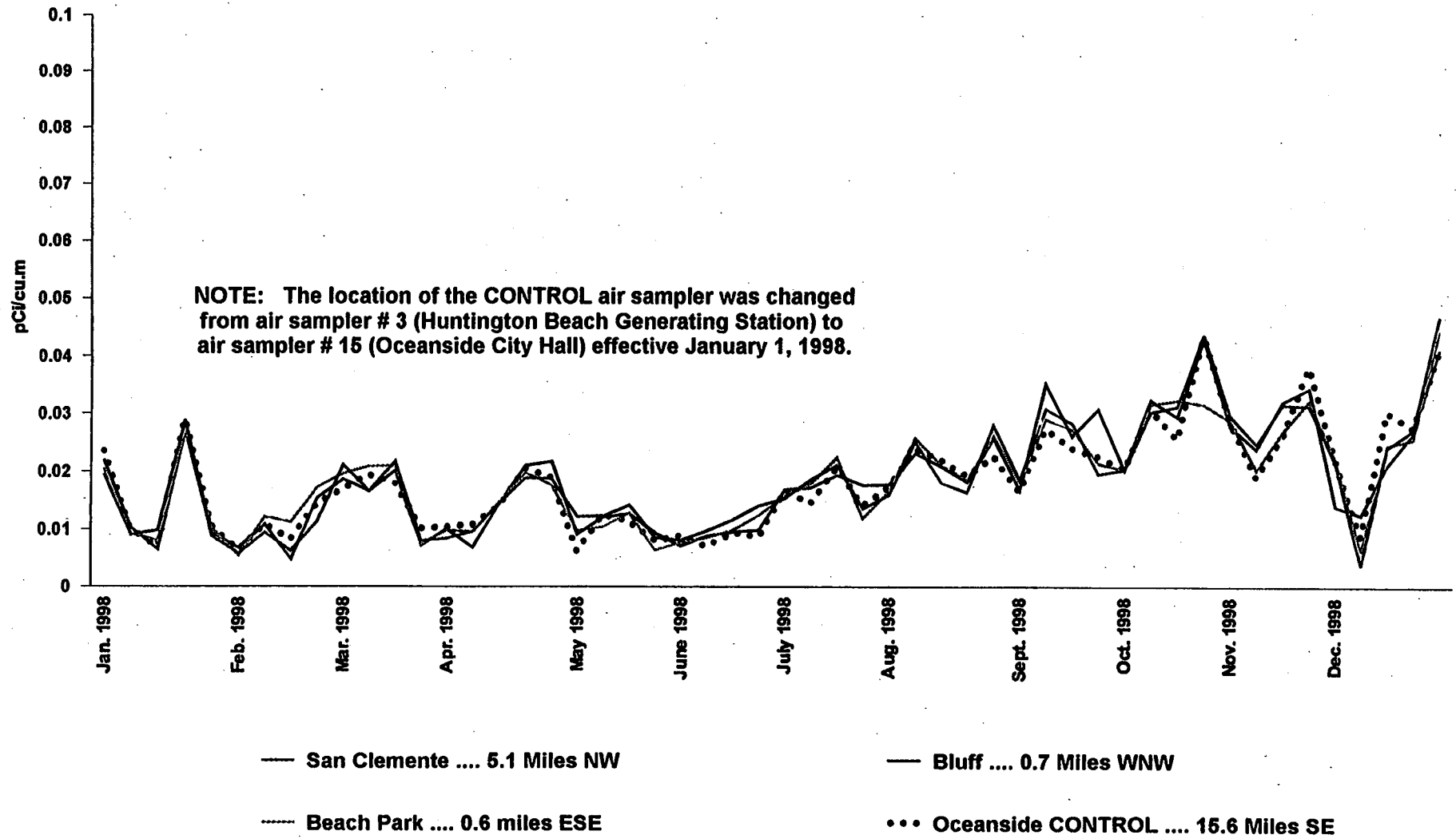

Figure 3C

APPENDIX H

ERRATA TO THE 1997 AREOR

The following errors were detected in the 1997 AREOR:

Page 9 — Indicator leafy sample # 3 was deleted. The 1997 AREOR reported that indicator sample # 13 was deleted.

Page 23 — The REMP data above the critical level was reduced in Table B-3. The 1997 AREOR reported that this data was listed in Table B-2.

Page 30 — One of the aquatic Kelp samples reported to have I-131 above the *a posteriori* MDC was identified as Station B San Onofre Kelp Bed. The true location is Sample B San Mateo Kelp Bed.

APPENDIX I

REMP TLDs CO-LOCATED WITH NRC TLDs During 1998

Requirements in the standard Technical Specifications adopted under the Technical Specifications Improvement Program include reporting results of those thermoluminescent dosimeters (TLDs) that are co-located with NRC dosimeters. The NRC dosimeters were exchanged by the California Department of Health Services (DHS) under a contract with the NRC. This contract expired in December 1997 and the NRC TLDs are no longer being deployed around SONGS. During the most recent NRC audit of the SONGS REMP the NRC indicated that they have no plans to deploy TLDs in the environs of SONGS.

The DHS also maintains a TLD program in the environs of SONGS. The DHS direct radiation monitoring program uses Radiation Detection Corporation (RDC) TLDs.

The below listed quarterly TLD data is from the SCE TLD program. NRC & RDC data are not listed. The NRC location numbers refer to the locations in the previous program, terminated before 1998.

		1998 Data from SCE TLDs			
Location Number	Location Name	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
SCE -1 , NRC -7, RDC -55	San Clemente	18.4	15.6	16.7	16.2
SCE -2, NRC -23, RDC -61	Camp San Mateo	17.7	18.4	18.5	16.4
SCE -3, NRC -19, RDC -62	Camp San Onofre	16.0	16.0	16.5	13.9
SCE -6, RDC -63	Old Route 101 (East-Southeast)	10.6	10.5	11.1	9.8
SCE 10, NRC -12, RDC -59	San Onofre Surfing Beach	16.3	15.7	15.7	15.0
SCE 16, RDC 60 *	ESE Site boundary	16.1	16.1	17.0	15.1
SCE 22, NRC 11, RDC 57	Coast Guard Station	17.6	15.3	17.5	15.9
SCE -34, NRC -14, RDC 58	San Onofre Elementary School	16.2	14.8	15.9	14.7
SCE 41, NRC 25, RDC 64**	Old Route 101 (Unit 3)	14.8	13.5	15.6	13.5
SCE 50, NRC 32, RDC 66	Oceanside Fire Station	16.6	14.5	15.9	15.5

* SCE 16 is approximately 15 meters from RDC 60. RDC 60 is across Basilone Rd.

** SCE 41 is approximately 120 meters from RDC 64. Results included per DHS request.