2017 San Onofre Nuclear Generating Station
Annual Radiological Environmental Operating Report

SOUTHERN CALIFORNIA EDISON®

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License Numbers:
DPR-13, NPF-10, NPF-15

April 2018

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This 2017 Annual Radiological Environmental Operating Report (AREOR) for the San Onofre Nuclear Generating Station (SONGS) fulfills the requirements of Technical Specifications (TS) Section §D6.9.1.3 of SONGS Unit 1 License DPR-13, Section §5.7.1.2 of the permanently defueled SONGS Units 2 and 3 Licenses NPF-10 and NPF-15, respectively, and the Independent Spent Fuel Storage Installation (ISFSI) facility. The 2017 AREOR covers the results of the environmental monitoring performed around SONGS during the time period January 1, 2017 through December 31, 2017.

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Acronyms

AREOR	Annual Radiological Environmental Operating Report
CAB	Controlled Area Boundary
CDPH	California Department of Public Health
CEAL	Contracted Environmental Analysis Laboratory
DOE	Department of Energy
EAB	Exclusion Area Boundary
EPA	U.S. Environmental Protection Agency
ISFSI	Independent Spent Fuel Storage Installation
LLD	Lower Limit of Detection
LUC	Land Use Census
MDC	Minimum Detectable Concentration
MDD	Minimum Differential Dose
ND	Not Detectable
NEI	Nuclear Energy Institute
NRC	U.S. Nuclear Regulatory Commission
ODCM	Offsite Dose Calculation Manual
QA	Quality Assurance
QC	Quality Control
REMP	Radiological Environmental Monitoring Program
SAB	Site Area Boundary
TLD	Thermoluminescent Dosimeter

1 Executive Summary

On June 12, 2013, Southern California Edison notified the Nuclear Regulatory Commission (NRC) that it had permanently ceased operation for both Units 2 and 3 on June 7, 2013. While all power operations have ceased, spent fuel remains stored on site. San Onofre Nuclear Generating Station (hereafter referred to as San Onofre or SONGS) continues to fulfill its regulatory commitment to monitor the environment and potential exposure pathways. The REMP verifies that San Onofre has had no radiological impact to the surrounding environment or people and that it is within applicable state and federal regulations.

The Radiological Environmental Monitoring Program (REMP) includes the sampling of environmental media and measuring radiation levels in the environment surrounding SONGS. Its purpose is to identify any levels of radioactivity or radiation associated with SONGS that have a potential exposure to a member of the general public. This is accomplished through the measurement of direct radiation and by the sampling and analyses of various environmental media, including:

- soil
- shoreline sediment (beach sand)
- air (particulate & iodine)
- local crops
- non-migratory marine species
- kelp
- drinking water
- ocean water
- ocean bottom sediments

Samples are analyzed for both naturally occurring and SONGS plant-related radionuclides. A detailed description of the 2017 sampling locations and location maps are included in Appendix A of this report.

An independent assessment of environmental impact is performed by the California Department of Public Health (CDPH) through the collection and analysis of samples, placement of dosimeters and collection of air samples. In addition, the site participates in onsite and offsite inspections.

This report describes the REMP conducted at San Onofre and covers the period from January 1, 2017 through December 31, 2017. The REMP produces scientifically defensible data demonstrating no observable radiological environmental impact from SONGS. This report fulfills applicable license commitments, as described in DPR-13, NPF-10, NPF-15, and the Offsite Dose Calculation Manual (ODCM).

The REMP data collected during 2017, as in previous years, continues to be representative of background levels. The data is summarized in the Statistical Summary of REMP Data found in Appendix B. The radionuclides cesium-137 (Cs-137) in soil and iodine-131 (I-131) in kelp were detected above the minimum detectable concentration (MDC), with the Cs-137 being attributable to fallout from nuclear weapons testing and the Fukushima Daiichi accident in Japan and the I-131 associated with medical administrations. These isotopes have been detected at indicator locations, as well as at control locations, in past years. Naturally occurring radionuclides, including beryllium-7 (Be-7), potassium-40 (K-40), thorium-228 (Th-228) and thorium-230 (Th-230) were detected in both control and indicator locations at similar

concentrations and are not related to the operation of SONGS. Refer to Appendix B for a more detailed discussion.

There is a natural and manmade radiation background. Natural background is comprised of the terrestrial and cosmic radiation sources while manmade background results from past weapons testing fallout and routine medical applications. Prior to the construction of SONGS, environmental samples and measurements were collected and analyzed to determine the baseline natural radiation levels. The results from the indicator stations are compared to this pre-operational data, as well as control samples, to evaluate if changes in any radiation levels can be attributed to SONGS or other causes such as natural variations in the environment or manmade contributions.

In summary, the environmental monitoring data collected during 2017 supports a conclusion of no adverse effect on the population or the environment from SONGS. The radiation exposures to people living in the surrounding area from SONGS remains less than 2 mrem per year, which is a small fraction of the radiation exposures in the environment from the natural background from terrestrial and cosmic radiation.

2 Radiological Environmental Monitoring Program

2.1 Program Overview

A key purpose of the REMP is to characterize the radiological environment outside of the power block, providing data for assessing potential radiological impact resulting from the decommissioning activities for SONGS Units 2 and 3. It is designed and conducted:

- to detect any significant increase in the concentration of radionuclides in the pathways of exposure to the public,
- to detect any significant change in ambient gamma radiation levels, and
- to fulfill the radiological environmental monitoring requirements of the ODCM.

Exposure pathways are the different routes by which people can potentially be exposed to radiation or radioactive materials. The pathways may be characterized into four general types, shown below along with a brief description of the monitoring as performed at SONGS:

- **AIRBORNE**. The airborne pathway represents the inhalation intake of airborne radioactive materials. This pathway is sampled in areas around SONGS by continuously drawing air through specialized filters and charcoal cartridges 24 hours a day, 7 days a week. Although both units at SONGS have been shut down since January 2012, these air samples continue to be collected on a weekly basis.
- **WATERBORNE**. The waterborne pathways include the exposure to radioactive materials accumulated in aquatic biota (fish, shellfish) and in shoreline sediments. These pathways are assessed through the collection of fish and shellfish samples in the environment around the plant. Sediment samples are also collected to evaluate any long-term buildup in the environment.
- **INGESTION**. The ingestion pathway includes broadleaf vegetation, agricultural products, and food products. Atmospheric releases from the plant can deposit on these food products, representing an intake exposure pathway through the consumption of these food products. Samples of crops (e.g., tomato, lettuce, sorrel) are collected from the local area around the plant to evaluate any impact on this pathway.

- **DIRECT RADIATION**. The direct radiation pathway represents the external exposure from sources on the plant site and directly from any radioactive effluents released to the air or water. This direct environmental radiation dose is measured through the use of direct measurement dosimeters, such as thermoluminescent dosimeters (TLDs) or optically stimulated luminescence dosimeters (OSLs) that are placed around the plant site and in the local environment.

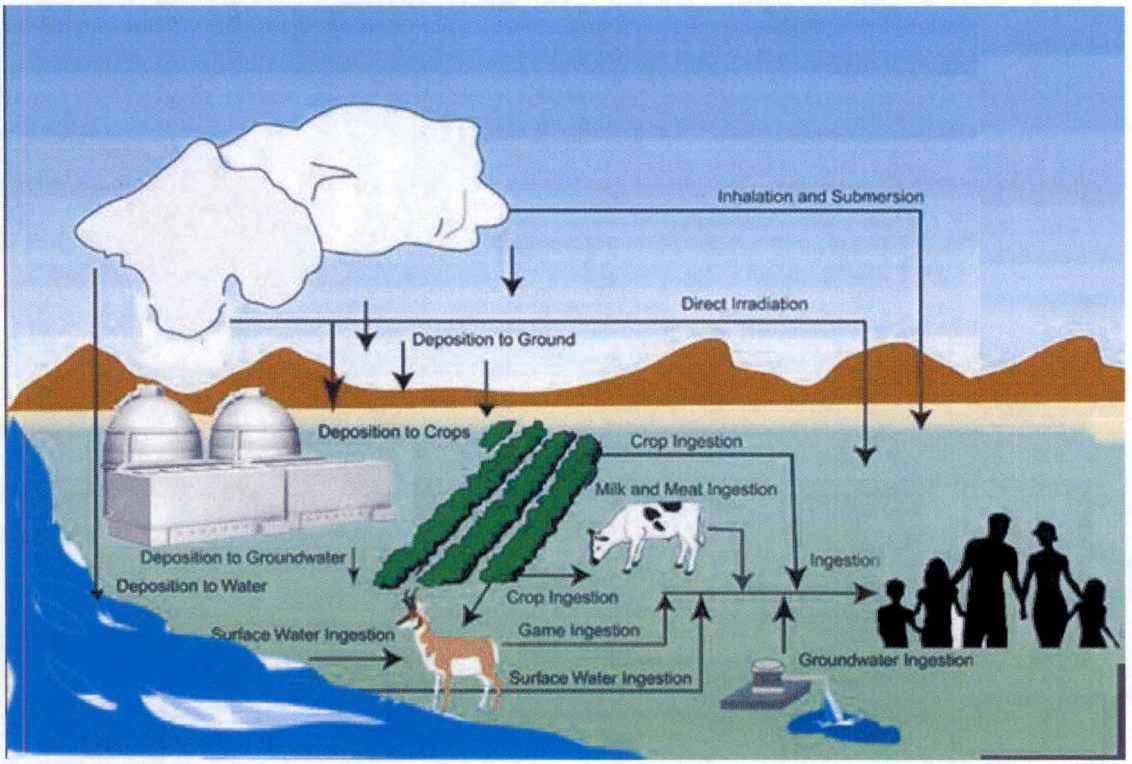

Figure 1 - Examples of Exposure Pathways

2.2 Site Area and Description

San Onofre Nuclear Generating Station is located next to San Onofre State Beach, adjoining Camp Pendleton Marine Corps Base, in San Diego County, 64 miles south of Los Angeles, California. At this time there are no operating reactors, but in the past, there were three operating pressurized water reactors with a total rated capacity of 2664 net megawatts electrical.

Figure 2 - SONGS 45 mile REMP Radius

Unit 1, rated at 410 net megawatts electrical, was supplied by Westinghouse Electric Company. Unit 1 began commercial operation on January 1, 1968. The unit was permanently shut down on November 30, 1992, and has been decommissioned. By August 31, 2004, all fuel was transferred to the Independent Spent Fuel Storage Installation (ISFSI). By November 29, 2006, all remaining monitored effluent pathways were permanently removed from service or routed to Unit 2 discharge to the outfall. Unit 1 is owned by Southern California Edison (80%) and San Diego Gas and Electric (20%).

Unit 2 and Unit 3 were supplied by Combustion Engineering, Inc., with turbine generators supplied by G.E.C. Turbine Generators, Ltd., of England. The units began commercial operation on August 18, 1983, and April 1, 1984, respectively, and were rated at 1127 net megawatts electrical each. The twin units are owned by Southern California Edison (78.21%), San Diego Gas and Electric (20%), and the City of Riverside (1.79%).

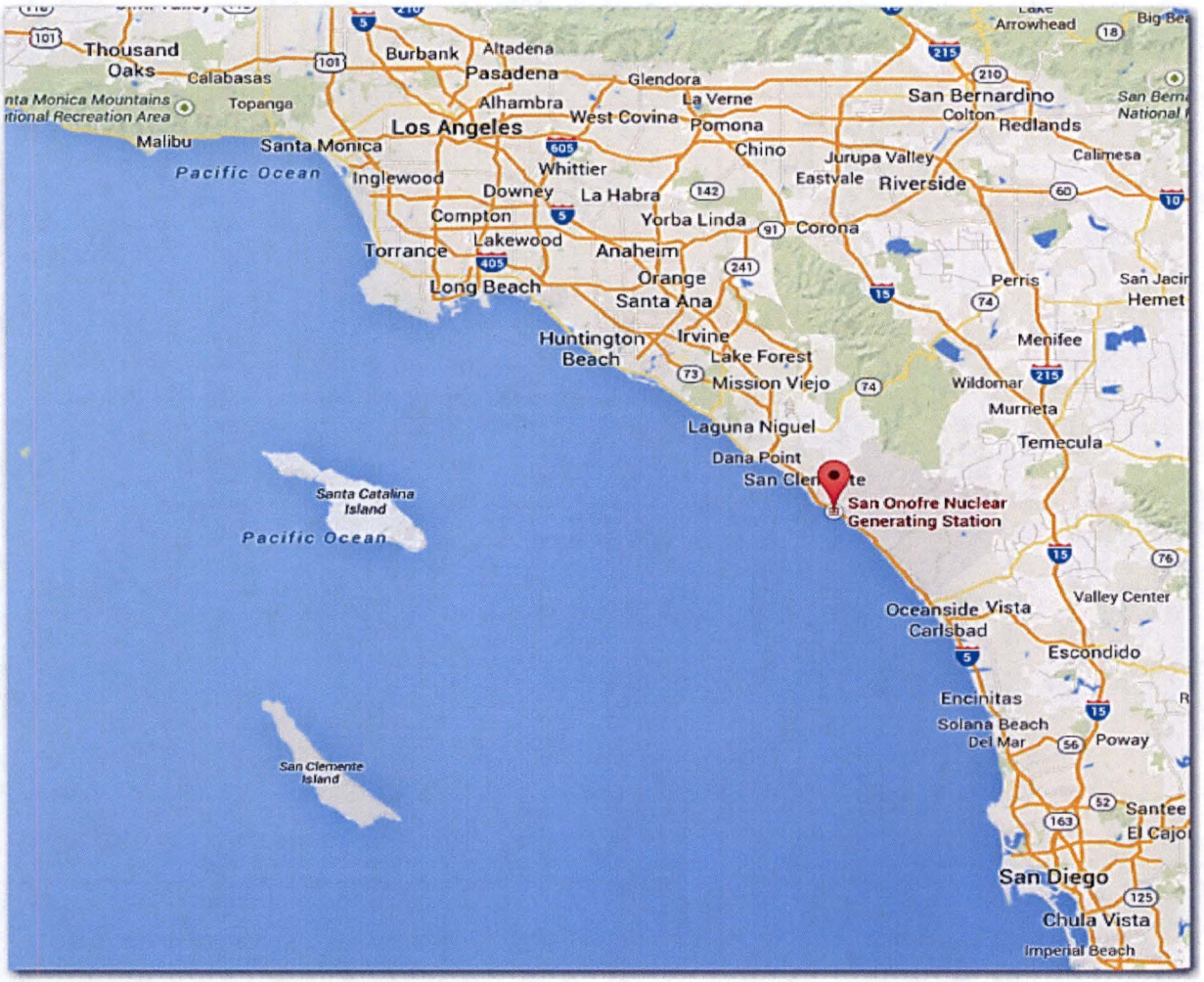

Figure 3 - SONGS Location

Effective December 29, 2006, the City of Anaheim transferred its ownership interests in San Onofre Units 2 and 3 and the entitlement to the Units 2 and 3 output to Southern California Edison Company, except that it retains its ownership interests in its spent nuclear fuel and Units 2 and 3's independent spent fuel storage installation located on the facility's site. In addition, the City of Anaheim retains financial responsibility for its spent fuel and for a portion of the Units 2 and 3 decommissioning costs. The City of Anaheim remains a licensee for purposes of its retained interests and liabilities. Southern California Edison notified the Nuclear Regulatory Commission (NRC) on June 12, 2013, that it had permanently ceased operation of Units 2 and 3 on June 7, 2013. The NRC notification, called a Certification of Permanent Cessation of Power Operations, sets the stage for SCE to begin preparations for decommissioning.

2.3 Sample Collection and Analyses

Samples of environmental media were obtained to meet the stated objectives. The selection of sample types was based on established important pathways for the transfer of radionuclides through the environment to exposures to individuals. Refer to Appendix A for a complete list of REMP sample locations as described in Table 5-4 of the ODCM.

Sampling locations have been selected, considering the local environmental characteristics, including meteorology, land use and water use data. Two types of sampling locations are defined. The first type, representing control stations, is located in areas that are beyond the measurable influence of San Onofre, typically at distance of greater than 5 miles away. The sample results from these stations are considered representative of background levels with no potential for contribution from releases and sources at SONGS. The control stations also serve as indicators of radioactive sources other than SONGS, such as nuclear medicine applications. The second type, representing indicator stations, is used to measure any radiation contributed to the environment caused by San Onofre. Indicator stations are located close to San Onofre (within 5 miles), reflecting the nearby areas to provide environmental measurements for releases from the plant. Indicator stations can be located either onsite or offsite.

As described in Section 4, below, the SONGS REMP is conducted in accordance with a Quality Assurance Program, meeting the requirements of NRC Regulatory Guide 4.15, Rev. 1. Samples are collected using approved methods; radiochemical analyses of these samples are performed using standardized analytical methods. The Contracted Environmental Analysis Laboratory (CEAL) participates in an inter-laboratory comparison program in partial fulfillment of the quality assurance requirements for environmental monitoring. The CEAL participated in cross check programs which meet the intent of Reg. Guide 4.15. See Appendix C for additional details.

2.3.1 Detection Limit Terminology

The United States Nuclear Regulatory Commission (NRC) requires that equipment and analytical methods used for radiological monitoring must be able to detect specified minimum limits for the type sample and the radionuclide of the analysis. The *a priori* detection capability for the analytical system used for the measurement is referred to as the Lower Limit of Detection (LLD). This LLD ensures that radiation measurements are sufficiently sensitive to detect any levels of concern and small changes in the environment. Samples with no detectable radiation levels are typically referred to as less than the minimum detectable concentration (MDC). The MDC is evaluated for each sample and is used to ensure that the specific analysis has sufficient sensitivity to detect levels consistent with the requirements for analysis by the system LLD. For a more thorough discussion, refer to NUREG/CR-4007.

- **Lower Limit of Detection (LLD)** - The LLD is the *a priori* (before the fact) lower limit of detection for the method used for the analysis. It is a measure of the detection capability for the analytical method and not for any single sample analysis. This value is calculated for each isotope and every matrix based on typical or expected values of decay time, sample size, counter efficiency, etc. The LLD values are listed in the ODCM and represent the detection capability that the analytical methods must meet for the 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, and counting efficiency for an individual sample analysis. 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" levels of radioactivity.

- No Detectable (ND) – "No Detectable" is used for direct radiation dosimeters, such as TLDs and OSLs data, to designate when the exposure measured is below the expected background exposure, plus a calculated uncertainty. The TLD will have measured radiation exposure, but the magnitude of the exposure is within the expected range, accounting for natural background and seasonal fluctuations. ND indicates that there was no exposure above the background variation that is attributable to SONGS.

The sampling and analyses for the REMP are conducted in a manner to ensure the detection capabilities meet the specified requirements.

2.4 Regulations and Guidance

- **10 CFR 50, Appendix I**

10 CFR 50, Appendix I establishes limits on releases of radioactivity to the environment and the resulting dose to the public. The limits are:

Source	NRC Limits for SONGS
Liquid Effluent	Less than or equal to 3 mrem/yr to whole body from all pathways of exposure Less than or equal to 10 mrem/yr to any organ from all pathways of exposure
Gaseous Effluents – Noble Gases	Less than or equal to 10 mrad/yr gamma air dose Less than 20 mrad/yr, beta air dose Less than 5 mrem/yr, total body dose to an offsite exposed individual of the public
Iodine-131, tritium and particulates with half-life greater than 8 days	Less than or equal to 15 mrem to any organ for an offsite individual from all pathways of exposure

- **40 CFR 190**

The Environmental Protection Agency (EPA) has established environmental radiation protection standards in 40 CFR 190 for the uranium fuel cycle that includes nuclear power plants. These limits are applicable to the sum of liquid effluent, gaseous effluents and direct radiation.

The dose limits from all applicable pathways to any offsite individual are

- 25 mrem/year to the whole body
- 75 mrem/year to the thyroid
- 25 mrem to any other organ

As discussed in the 2017 SONGS Annual Radioactive Effluent Release Report, the calculated dose to a member of the public as a result of SONGS is a small fraction of the dose standard established by the EPA. This conclusion is supported by the results of the REMP, as reflected by the absence of measurable levels of radiation or radioactive materials in the offsite environment attributable to SONGS.

The EPA established the following concentration limits for drinking water in 40 CFR 141:

Source	NRC Limits for SONGS
Gross Alpha	15 pCi/L
Gross Beta	50 pCi/L
Ra-226 and Ra-228 combined	5 pCi/L
Sr-90	8 pCi/L
Uranium	30 µG/L
Tritium	30,000 pCi/L (limit for saltwater site; no downstream drinking water supplier)

These limits were selected to ensure that no member of the public receives more than 4 mrem total body or organ dose, based on 2 liters per day drinking water intake. The sampling of ocean water and groundwater in and around the plant confirms that SONGS has no impact on public water supplies for the surrounding communities.

The following regulatory and industry guidance has been identified as applicable to the SONGS REMP with application as may be required.

- US NRC Regulatory Guide 4.1, Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants, 1975
- US NRC Regulatory Guide 4.2, Preparation of Environmental Reports for Nuclear Power Stations, 1976
- NUREG-0133, Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants
- US NRC 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, American National Standard Institute, "American National Standard Performance, Testing, And Procedural Specifications for Thermoluminescence Dosimetry (Environmental Application), 1975
- ANSI/HPS N13.37, "Environmental Dosimetry – Criteria for System Design and Implementation", 2014
- US NRC Regulatory Guide 4.15, Rev. 1, Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment, 1979
- NUREG-1576, Multi-agency Radiological Laboratory Analytical Protocols
- NUREG/CR-4007, Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements, 1984

2.5 NRC Reporting Levels

The NRC has established required reporting levels that represent thresholds above which an investigation is needed to evaluate and ensure compliance with radiation safety standards for the public. Licensed nuclear facilities must prepare a special report and increase their sampling if any measured level of radiation or radioactive material in an environmental sample is equal to or greater than the corresponding reporting level.

2.6 Summary of Analysis of Results and Trends

The 2017 SONGS REMP was conducted in accordance with 10 CFR 50, Appendix I, 10 CFR §50.36a, and Section 5.0 of the SONGS Offsite Dose Calculation Manual (ODCM). The REMP sample data have been summarized in the format specified in NUREG-1301. Data have been evaluated to identify the levels of any plant-related environmental radioactivity above background levels (i.e., plant-related contributions that are distinguishable from background). For data distinguishable from background, a comparison has been made between current environmental monitoring results and preoperational or previous operational data as appropriate, for trending environmental radioactivity resulting from plant operation.

To conform with 10 CFR Part 50, Appendix I, Section IV B.2, data on measurable levels of radiation and radioactive materials in the environment are provided to allow for a comparison to the predicted (calculated) values in the environment from radioactive material released in effluents.

The tabulated means, ranges, and standard deviations are presented in Appendix B. Comparisons with background and pre-operational baseline data are presented in Appendix D.

The REMP data are reviewed for accuracy, compared against NRC reporting levels, and entered into the REMP database. Measurements exceeding the administrative levels (10% of the NRC reporting levels) are flagged. Analyses are performed using instrumentation and methods that provide analytical results with a level of detection as required by the ODCM. 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 ensures that regulatory limits for the maximum LLD are met.

Table 1 - Maximum LLDs as Specified in SONGS ODCM

Analysis	Water (pCi/L)	Airborne Particulate or Gases (pCi/m^3)	Marine Animals (pCi/kg, wet)	Local Crops (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross beta	4	1E-02			
H-3	2000				
Mn-54	15		130		
Fe-59	30		260		
Co-58, 60	15		130		
Zn-65	30		260		
Zr-95, Nb-95	15				
I-131	1	7E-02		60	
Cs-134	15	5E-02	130	60	150
Cs-137	18	6E-02	150	80	180
Ba-140, La-140	15				

The impact of SONGS on the surrounding environment is assessed through a series of analyses. These analyses include: data reduction, comparisons of indicator to control locations (Appendix B); comparison of operational to preoperational environmental data (Appendix D); summary of deviations from sampling requirements and corrective actions taken (Appendix E); and the results of the 2017 Land Use Census (Appendix F).

The results of the 2017 monitoring program show no levels of direct radiation or radioactive materials from SONGS distinguishable from background in the offsite environment. Environmental samples from areas surrounding SONGS continue to indicate no radiological impacts from the plant. A detailed discussion of the 2017 analytical results is presented in Appendix B to Part II of this report. Analytical values from offsite indicator sample stations continue to trend with the control stations. With the exception of measured medical radioisotope iodine-131 in kelp, unrelated to SONGS, no measurements were distinguishable from background levels.

The data indicate that SONGS continues to have no measurable radiological impact on the environment or any member of the public during 2017. In addition, dose to members of the public attributable to SONGS related radiological activities remain well below regulatory limit of 100 mrem per year, as specified in 10 CFR 20, § 20.1301 and in keeping with the philosophy of "as low as is reasonably achievable" (ALARA), as specified in 10 CFR 20.1101(b).

The REMP data collected during 2017, as in previous years, continues to be in line with background levels. The data are summarized in the Statistical Summary of REMP Data found in Appendix B. Cesium-137 (Cs-137) is routinely identified in some soil samples and Iodine-131 (I-131) is found in some kelp samples. Cs-137 and I-131 are radionuclides that could be associated with releases from nuclear power plants, including SONGS. However, the level of Cs-137 found in soil is consistent with historical and expected Cs-137 concentrations from

nuclear weapons testing. Since SONGS is no longer operating, there is not a realistic generation source for I-131; therefore it is considered to be associated with use as medical administrations. It is no longer being generated as a fission product from the SONGS operation. And with its 8-day radioactive half-life, it is unrelated to any decommissioning activities at SONGS. Naturally occurring radionuclides, including beryllium-7 (Be-7), potassium-40 (K-40), thorium-228 (Th-228) and thorium-230 (Th-230) were detected in both control and indicator locations at similar concentrations and are not related to the operation of SONGS. Refer to Appendix B for a more detailed discussion.

3 Land Use Census

In accordance with 10CFR Part 50, Appendix I, Section IV.B.3, each year a Land Use Census is performed to identify any changes in the use of areas at and beyond the site boundary. Modifications to the monitoring program are made if required by the results of this census to reflect new or changes in locations for pathways of exposure around the plant. Appendix F of the report identifies changes to the census in 2017; no changes in the sampling media or sample locations were required. However, the SONGS indicator garden was relocated to a location near Air Sampler #11.

4 Quality Assurance

To assure quality of sample analyses, a portion of REMP is devoted to quality assurance. All REMP activities, including support contractors, are assessed as defined in Regulatory Guide 4.15, Rev. 1. The quality assurance program's main aspects include process quality control, instrument quality control, comprehensive data reviews, cross-check analyses, and audits. Routine REMP assessments ensure that the program, procedures and personnel are performing satisfactorily. Samples are collected using approved methods; radiochemical analyses of these samples are performed using standardized analytical methods. Quality audits and independent technical reviews help determine areas that need attention. These areas are addressed in accordance with the station's Corrective Action Program.

Duplicate sampling of the environment is performed by SONGS to demonstrate repeatability of the sample collection, preparation, and analysis process. Split sample analysis is performed for the evaluation of the precision and bias trends of the method of analysis without the added variables introduced by sampling. SONGS participates in a sample splitting program with the California Department of Public Health Radiological Health Branch (CDPH-RHB) in accordance with the site's REMP procedures.

GEL Laboratories, LLC (GEL) performs the radiochemistry analysis of samples noted within this report. GEL performs the requested analysis under its Quality Assurance Program, which meets the requirements of Title 10 Code of Federal Regulations Appendix B Part 50, ASME NQA-1 and Regulatory Guide 4.15 Revision 1. The measurement capabilities of the radiological laboratory are demonstrated by participating in an inter-laboratory measurement assurance program and performing duplicate and split sample analyses. Approximately 10% of the analyses performed are quality control samples, consisting of inter-laboratory measurement assurance program samples, duplicate samples, and split samples. The inter-laboratory measurement assurance program provides samples that are similar in matrix and size to those sampled and measured by the REMP. This program assures that equipment calibrations and sample preparation methods accurately measure radioactive material in samples. See Appendix C for detailed QA measurement data.

Stanford Dosimetry performs the environmental TLD analyses noted in this report. Stanford Dosimetry performs the requested analyses under its quality assurance program which meets the requirement of Title 10 Code of Federal Regulations Part 50, Appendix B, ASME NQA-1 and Regulatory Guide 4.15 Revision 1.

5 Program Deviations

Any deviation in the conduct of the program as required, either in terms of sample collection or analysis, requires an investigation as to the cause and identification of measures to prevent recurrence. Deviations from the sampling program or sensitivity requirements are acknowledged and explained in Appendix E to this report.

6 Conclusion

Radiological environmental data collected throughout 2017 have been evaluated to determine any impact that San Onofre operations has 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. Correlation of effluent concentrations to concentrations in the environment. Refer to Appendix B.

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 2017 against the levels observed in preoperational years.

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

This evaluation did not identify any radionuclides attributable to the operation of SONGS above background in any sample measurement or media. It is concluded that the operation of SONGS through 2017 had no observable radiological environmental impact.

7 References

1. SONGS Offsite Dose Calculation Manual (ODCM) Revision 11, Section 5.0, 2017.

2. SONGS Radiological Monitoring (RM) Procedures

   a. SDS-CH2-PGM-1006, Radiological Environmental Monitoring Program

   b. SDS-CH2-PCD-1023, Review, Analysis and Reporting of Radiological Environmental Monitoring Program (REMP) Data

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

APPENDIX A. SAMPLE TYPE AND SAMPLING LOCATIONS

Table 2 - Direct Radiation Measuring Locations

DIRECT RADIATION MEASURING LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
1	City of San Clemente (Former SDG&E Offices) (Control)	5.7	NW
2	Camp San Mateo – (MCB, Camp Pendleton)	3.6	N
3	Camp San Onofre – (MCB, Camp Pendleton)	2.8	NE
4	Camp Horno – (MCB, Camp Pendleton)	4.4	E
6	Old El Camino Real (AKA Old Highway 101)	3.0	ESE
8	Noncommissioned Officers' Beach Club	1.4	NW
10	Bluff	0.7	WNW
11	Former Visitors' Center	0.4[b]	NW
12	South Edge of Switchyard	0.2[b]	E
13	Southeast Site Boundary (Bluff)	0.4[b]	ESE
15	Southwest Site Boundary (Office Building)	0.1[b]	SSE
16	East Southeast Site Boundary	0.4[b]	ESE
19	San Clemente Highlands	4.9	NNW
22	Former US Coast Guard Station - San Mateo Point	2.7	WNW
23	SDG&E Service Center Yard (Control)	8.1	NW
31	Aurora Park - Mission Viejo (Control)	18.6	NNW
33	Camp Talega – (MCB, Camp Pendleton) (Control)	5.9	N
34	San Onofre School – (MCB, Camp Pendleton)	1.9	NW
35	Range 312 – (MCB, Camp Pendleton)	4.8	NNE
36	Range 208C – (MCB, Camp Pendleton)	4.1	NE
38	San Onofre State Beach Park	3.4	SE
40	SCE Training Center - Mesa	0.7	NNW
41	Old Route 101 – East	0.3[b]	E
44	Fallbrook Fire Station (Control)	17.7	E
46	San Onofre State Beach Park	1.0	SE
47	Camp Las Flores – (MCB, Camp Pendleton) (Control)	8.6	SE
49	Camp Chappo – MCB (Control)	12.9	ESE
50	Oceanside Fire Station (Control)	15.6	SE
53	San Diego County Operations Center (Control)	44.2	SE
54	Escondido Fire Station (Control)	31.8	ESE
55	San Onofre State Beach (U1 West)	0.2[b]	WNW

DIRECT RADIATION MEASURING LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
56	San Onofre State Beach (U1 West)	0.2[b]	W
57	San Onofre State Beach (Unit 2)	0.1[b]	SW
58	San Onofre State Beach (Unit 3)	0.1[b]	S
59	SONGS Meteorological Tower	0.3[b]	WNW
61	Mesa - East Boundary	0.7	N
62	MCB - Camp Pendleton	0.7	NNE
63	MCB - Camp Pendleton	0.6	NE
64	MCB - Camp Pendleton	0.6	ENE
65	MCB - Camp Pendleton	0.7	E
66	San Onofre State Beach	0.6	ESE
67	Former SONGS Evaporation Pond	0.6	NW
68	Range 210C – (MCB, Camp Pendleton)	4.4	ENE
73	South Yard Facility	0.4[b]	ESE
74	Oceanside City Hall (Backup 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	4.2	N
78	Horno Canyon (AKA Sheep Valley)	4.4	ESE

Table 3 – Airborne Radioactivity Sampling Locations

AIRBORNE (AP and AC) SAMPLING LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
1	City of San Clemente (City Hall)	5.1	NW
7	AWS Roof	0.18[b]	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
16	San Luis Rey Substation (Control)	16.7	SE

Table 4 – Soil Sampling Locations

SOIL (TSC SO) SAMPLING LOCATION[c]		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
1	Camp San Onofre	2.8	NE
2	Old Route 101 – (East Southeast)	3.0	ESE
3	Basilone Road / I-5 Freeway Off ramp	2.0	NW
5	Former Visitors Center	0.4[b]	NW
7	Prince of Peace Abbey – Oceanside (Control)	15	SE

Table 5 – Ocean Water Radioactivity Sampling Locations

OCEAN WATER (SW) SAMPLING LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
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
51	Unit 2 Conduit (not listed in the ODCM)	0.1	SW
52	Unit 3 Conduit (not listed in the ODCM)	0.1	SSW

Table 6 – Drinking Water Radioactivity Sampling Locations

DRINKING WATER (WGC DW) SAMPLING LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
4	Camp Pendleton Drinking Water Reservoir	2.0	NW
5	Oceanside City Hall (Control)	15.6	SE

Table 7 – Shoreline Sediment Radioactivity Sampling Locations

SHORELINE SEDIMENT (SSA SO) SAMPLING LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
1	San Onofre State Beach (Southeast)	0.6	SE
2	San Onofre Surfing Beach	0.8	WNW
3	San Onofre State Beach (Southeast)	3.5	SE
4	Newport Beach North End (Control)	29.1	NW

Table 8 – Local Crops Sampling Locations

LOCAL CROPS SAMPLING (TFB VG) LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
2	Oceanside (Control)	21	SE to ESE
6	SONGS Garden Mesa EOF	0.7	NNW

Table 9 – Non-Migratory Marine Animal Sampling Locations

MARINE ANIMAL (MOA) SAMPLING LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
A	Unit 1 Outfall	0.9	WSW
B	Units 2/3 Outfall	1.5	SSW
C	Laguna Beach (Control)	20 to 25	WNW to NW

Table 10 – Kelp Sampling Locations

KELP (VG) SAMPLING LOCATION[d]		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
A	San Onofre Kelp Bed	1.5	S
B	San Mateo Kelp Bed	3.8	WNW
C	Barn Kelp Bed	6.3	SSE
E	Salt Creek (Control)	11 to 13	WNW to NW

Table 11 – Backup Kelp Sampling Locations

Backup KELP (VG) SAMPLING LOCATION[d, e]		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
G	Capistrano Beach Reef (not listed in the ODCM)	8.9 to 9.1	NW
H	San Clemente Pier (not listed in the ODCM)	5.7 to 5.8	NW
I	Wheeler North Artificial Reef (not listed in the ODCM)	5.3	WNW

Table 12 – Ocean Bottom Sediment Sampling Locations

OCEAN BOTTOM (SEB SO) SAMPLING LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
B	Unit 1 Outfall	0.8	SSW
C	Unit 2 Outfall	1.6	SW
D	Unit 3 Outfall	1.2	SSW
E	Laguna Beach (Control)	20-25	NW
F	SONGS Up-coast	0.9	WSW
51	Unit 2 Conduit (not listed in the ODCM)	0.1	SW
52	Unit 3 Conduit (not listed in the ODCM)	0.1	SSW

NOTES

a Distance (miles) and Direction (sector) are measured relative to Units 2/3 midpoint as described in the ODCM Rev. 8. Direction determined from degrees true north.
b Distances are within the Units 2/3 SAB/EAB (Site Area Boundary/Exclusion Area Boundary)
c Soil samples are not required by Technical Specifications.
d Kelp samples are not required by Technical Specifications.
e Backup kelp sampling locations are only used if needed. In 2017, no samples were obtained from backup kelp sampling locations.
MCB Marine Corps Base (Camp Pendleton)

Table 13 - Sector and Direction Designations

DEGREES TRUE NORTH FROM SONGS 2 AND 3 MIDPOINT			NOMENCLATURE	
Sector Limit	**Center Line**	**Sector Limit**	**22.5^0 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

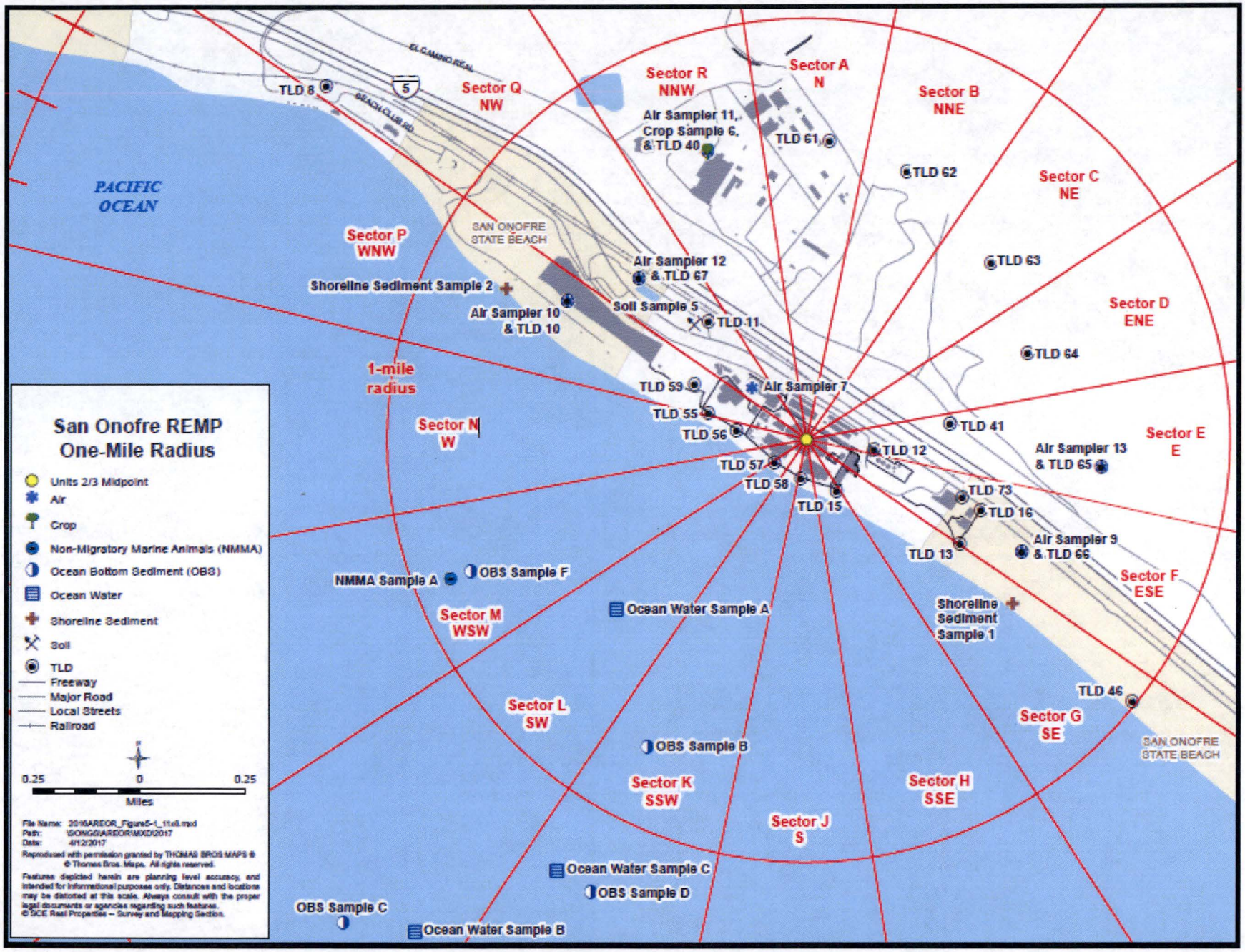

Figure 4 - SONGS REMP One Mile Radius

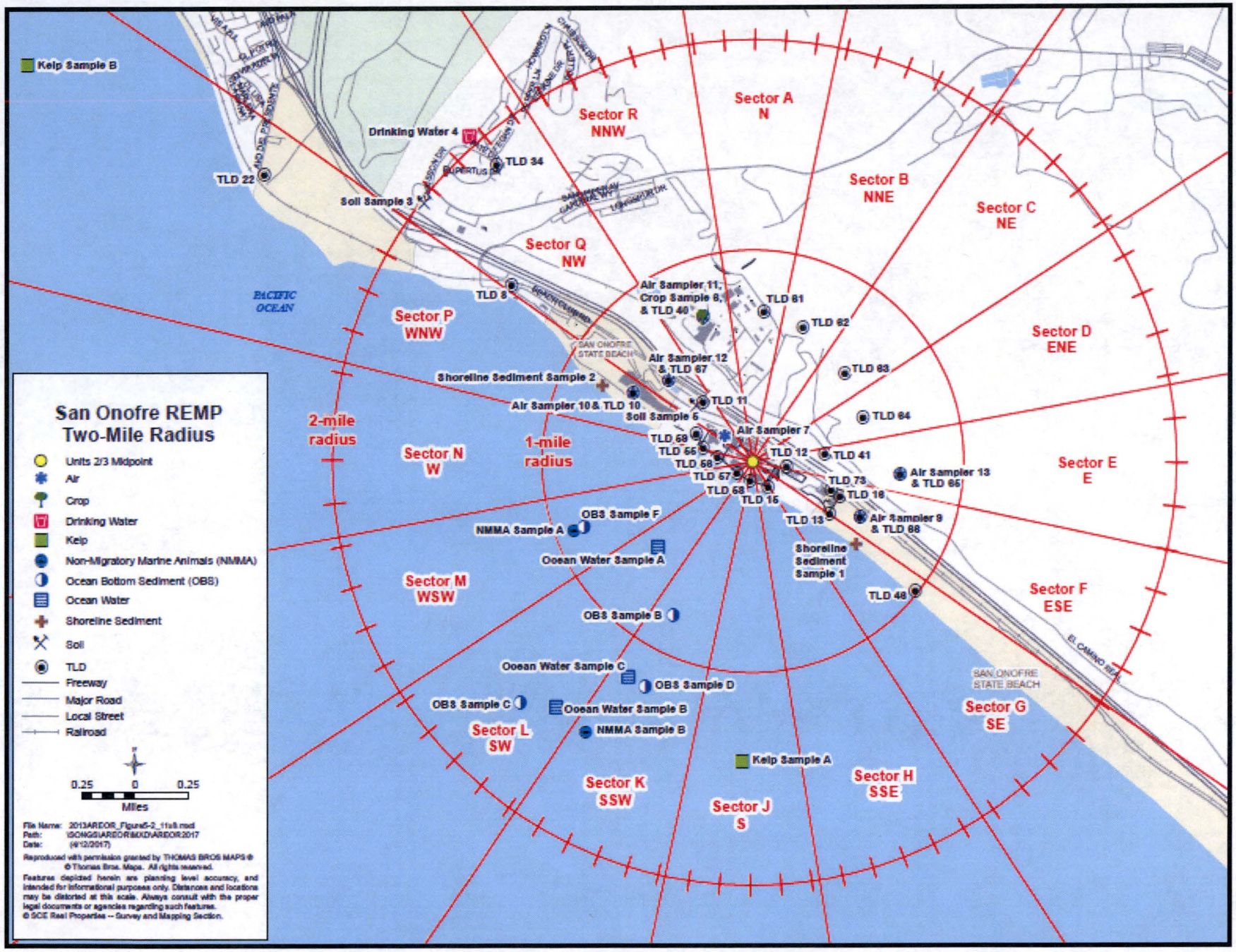

Figure 5 - SONGS REMP Two Mile Radius

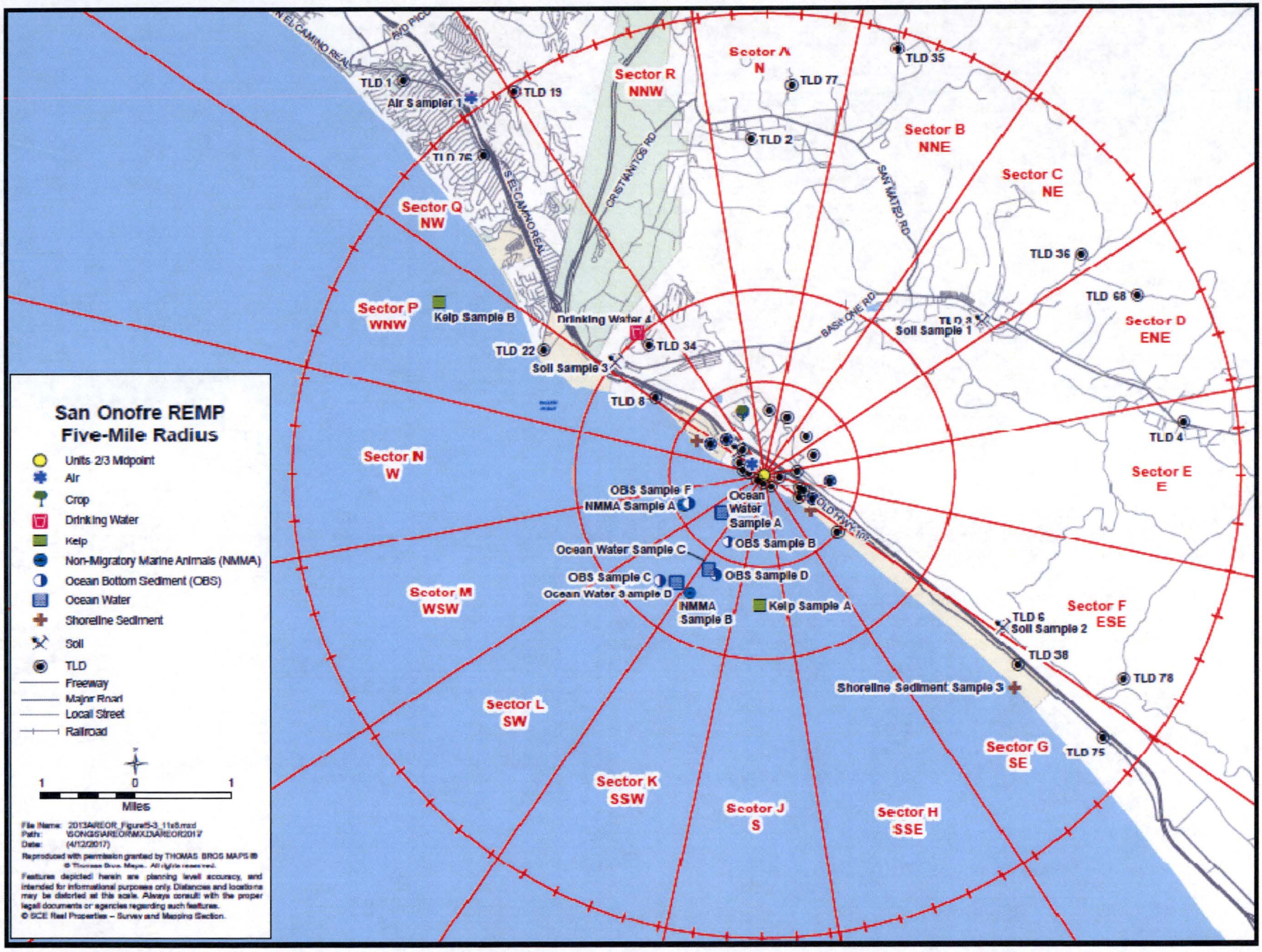

Figure 6 - SONGS REMP Five Mile Radius

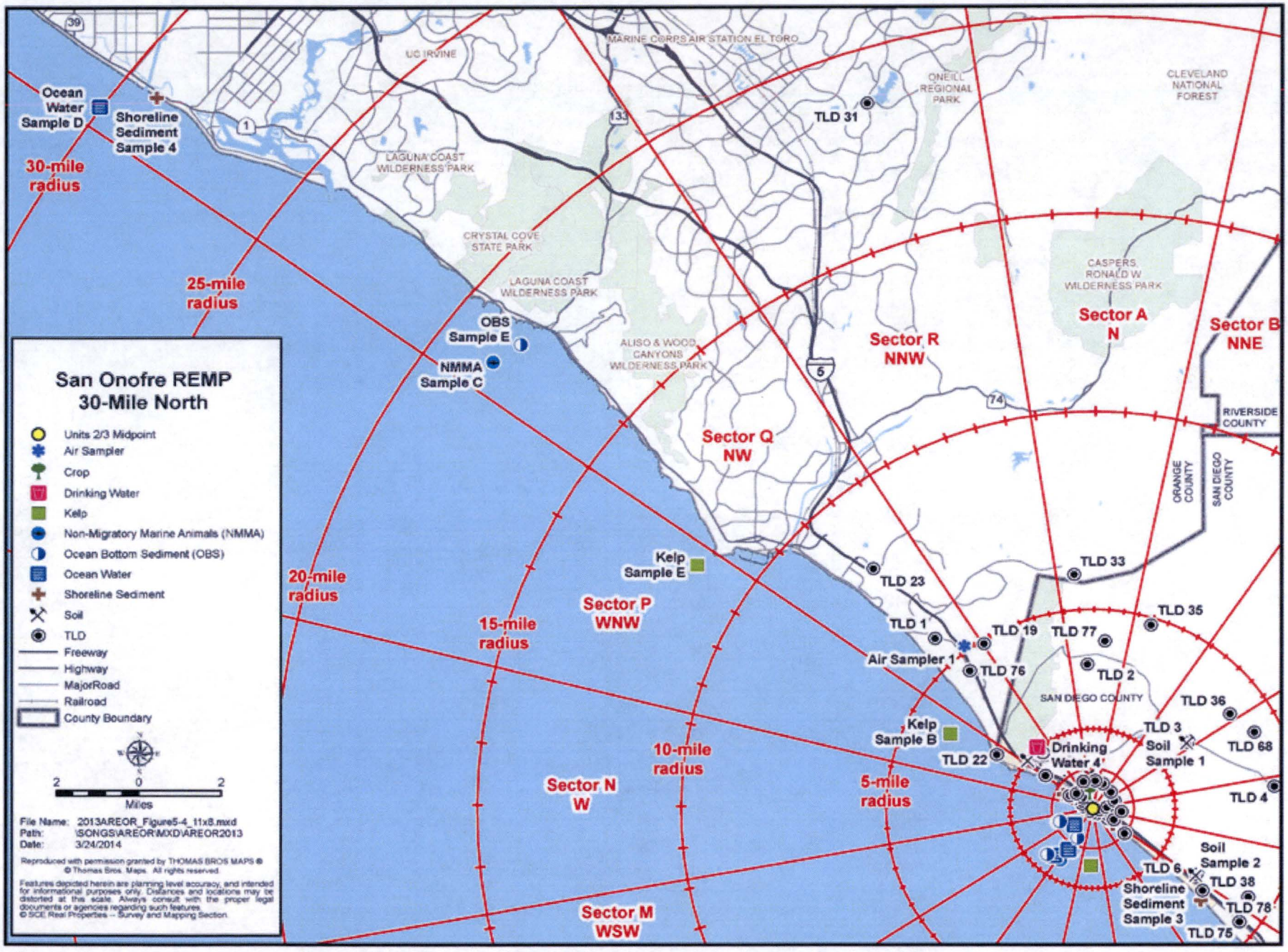

Figure 7 - SONGS REMP 30-mile Radius North

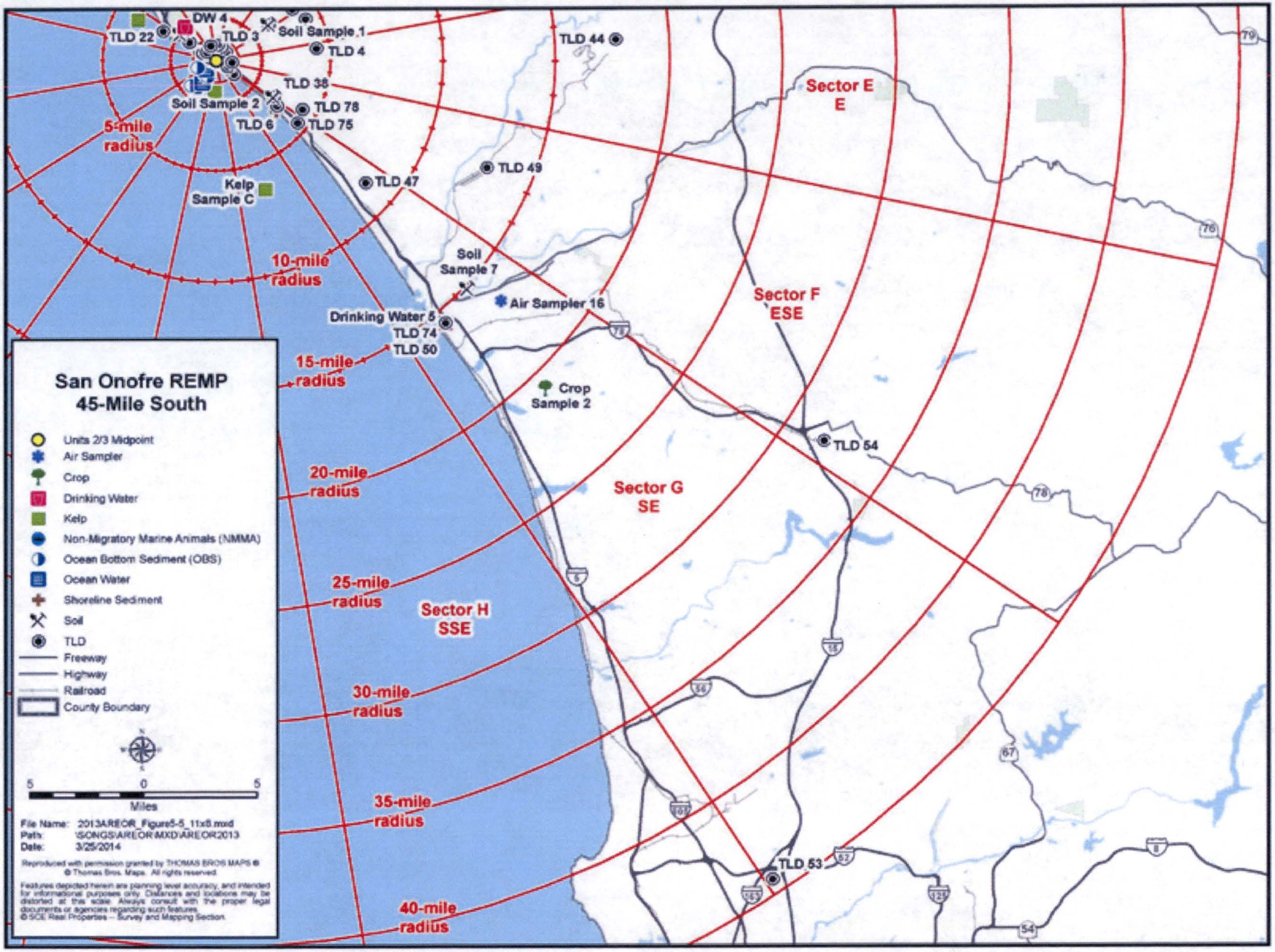

Figure 8 - SONGS REMP 45-mile Radius South

APPENDIX B. RESULTS AND DISCUSSIONS OF 2017 ENVIRONMENTAL DATA

To assess the changes or trends in the radioactivity level in the environment over the past year, the data from January 1, 2017 through December 31, 2017 were evaluated. A summary of the type and number of REMP samples obtained in 2017 appears in Table 14.

The analysis results, as presented below, support the conclusion that all measured levels of radioactivity are attributable to sources external to SONGS (fallout from the nuclear accident at the Fukushima Daiichi Nuclear Power Station, or Chernobyl, residual fallout from legacy atmospheric nuclear weapons testing, and discharge of medically administered I-131 from the San Juan Sewage Plant outfall). Cs-137 has been intermittently detected in the indicator and in the control soil samples in past years and no correlation between Cs-137 level in soil and proximity to the plant has been observed.

Cs-137 levels in marine animal flesh found in indicator samples closely mirror those found in control samples. We conclude that SONGS had no statistically significant radiological environmental impact during 2017.

Table 14 - REMP Sample Analysis Summary for 2017

Medium	Analysis Type	Sampling Frequency	# of Locations	Total # of Analyses in 2017[a]
Direct Radiation	Dosimetry	Quarterly	49	195[c]
Airborne Particulates	Gross Beta I-131	Weekly	8 8	415 415
	Gamma	Quarterly	8	32
Ocean Water	Gamma H-3	Monthly	4 4	48 48
	H-3	Quarterly	4	16
Drinking Water, Unfiltered	Gamma, H-3 Gross Beta	Monthly	2 2 2	24 24 24
Shoreline Sediment	Gamma	Semi-Annually	4	8
Ocean Bottom Sediment	Gamma	Semi-Annually	7	14
Marine Species, Flesh	Gamma	Semi-Annually	3	24
Local Crops	Gamma	Semi-Annually	2	10[b]
Kelp	Gamma	Semi-Annually	4	8
Soil	Gamma	Annually	5	5

NOTES

a. The total number of analyses includes environmental samples not required by the ODCM, such as ocean water and ocean bottom samples from locations not listed in the ODCM.
b. An extra sample of yellow squash was taken in the fall of 2017 at each location.
c. Environmental dosimeters used for ISFSI monitoring not included in this total.

A. Results and Discussions of 2017 Environmental Data

1. Direct Radiation

Direct gamma radiation is monitored in the environment by calcium sulfate ($CaSO_4$) Thermoluminescent Dosimeters (TLDs) placed at 49 locations and analyzed quarterly per ANSI/HPS N13.37-2014 standards. The natural direct gamma radiation varies according to location because of differences in the natural radioactive materials in the soil, soil moisture content, and other factors. Figure 9 compares the direct gamma radiation measurements for indicator and control locations with those from the site EAB. The values plotted are the averages for all of the stations according to type. The trends of Figure 9 clearly show that any contribution from SONGS to the off-site environment direct dose component is negligible, being indistinguishable from the background variation.

Beginning in October 2016, SONGS implemented new ANSI/HPS N13-37-2014 for environmental dosimetry system design and implementation. In accordance with this standard, the raw TLD results are adjusted by the exposure to air kerma (8.76 mGy/R) and air kerma to ambient dose (1.2 rem/Gy) conversion factors described in ANSI/HPS N13.37-2014, Section 3.2.1. This change results in a slight increase in the value of the dose, by a factor of 1.05 mrem/mR. Previous results in the AREOR were expressed in mR, but in keeping with ANSI N13.37, 2017 results are expressed in mrem.

TLDs located greater than five miles from SONGS are generally considered control TLDs. The indicator locations are selected as inner and outer rings as required by the ODCM. Additional TLDs are placed at locations of interest such as schools and hospitals. All 2017 control location TLD readings were below the minimum detectable dose and all 2017 indicator location readings outside the Exclusion Area Boundary (EAB) were below the minimum detectable dose.

The Annual Public Dose, as referenced in Table 15, is based on the potential member of the public exposure at the listed location. For offsite locations, the occupancy factor is 1, for potential full-time occupancy. For onsite locations, at or near the EAB/CAB, the occupancy factor is determined per SDS-RP1-PCD-1007, Direct Radiation Exposure Controls and Monitoring.

The data indicate detectable direct radiation measurements only in the immediate vicinity of SONGS, via those dosimeters placed either within or immediately adjacent to the EAB. The hypothetical maximum associated exposure to a member of the general public, adjusted for occupancy per SDS-RP1-PCD-1007, is less than 1 mrem per year as measured by this sample media. Refer to Table 15 for a summary of all 2017 SONGS REMP TLD data.

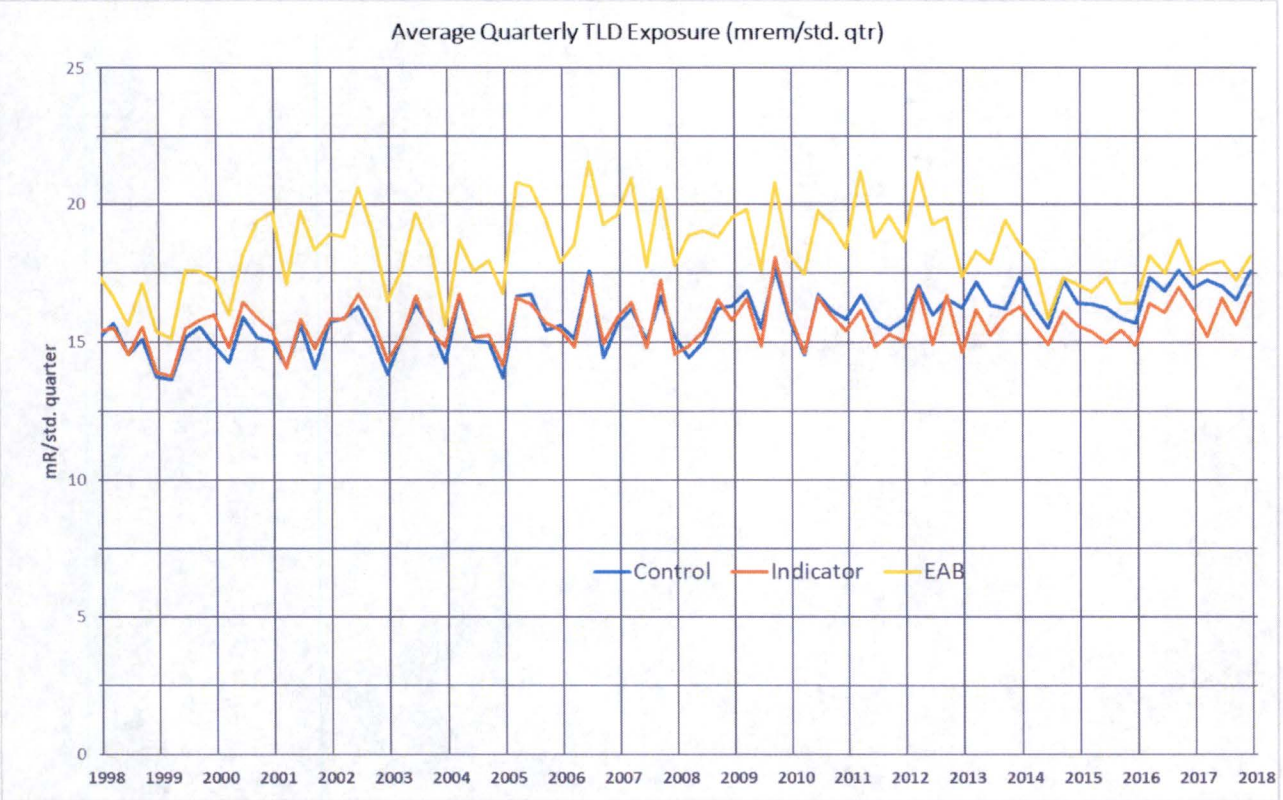

Figure 9 – SONGS REMP TLD data through 2017

Figure 9 compares environmental radiation levels of indicator and control locations for 2017 and previous years. These figures show the close correlation between the control and indicator location TLD exposure data. Beginning in 2016, the results have been increased by the conversion factors as described above. This increase, of roughly 1 mrem/quarter, can be seen in Figure 9 above.

Ten laboratory control TLDs were analyzed quarterly. TLD numbers 1, 23, 31, 33, 44, 47, 49, 50, 53, 54 and 74 are control TLDs. Separate TLDs are used to compensate for transit dose and a fade TLD is used to evaluate for the time and temperature dependent "fade" that may affect dosimeter data. After the samples were analyzed, the measured doses were corrected for pre and post field exposure times.

Neutron dosimeters were placed at REMP TLD station 55 and at selected locations around the Independent Spent Fuel Storage Installation (ISFSI). In 2017 no neutron radiation was detected at station 55. Some neutron radiation (up to 2.4 mrem/quarter) was detected at some of the ISFSI locations.

a. Direct Radiation baseline evaluation and estimation of natural background

An in-depth analysis of the environmental radiation results for the period of 2001 through 2010 was completed for all the monitoring locations. It can be inferred that if the standard deviation was low and no additional exposure above background was identified at a particular station, the average of that station's radiation exposure results should be equal to natural background (baseline) at that location. The baseline results for REMP TLDs have been summarized with the annual and quarterly values in the 2017 TLD Data Table. Natural background radiation is variable and a minor shift in location can yield a measurable change in background radiation. Therefore if a TLD is moved the baseline (background) for that location may be affected.

The baseline environmental exposure analysis of 2001 through 2010 environmental TLD results included an assessment of the standard deviation of the quarterly results and annual totals at each control location. This is an appropriate methodology to determine the ability to detect radiation exposure above background, described in ANSI/HPS N13.37-2014, "Environmental Dosimetry – Criteria for System Design and Implementation." The quarterly and annual results expressed in Table 15 are positive exposure if they exceed either 5 mrem quarterly or 10 mrem annually. If not, the measurement is noted as "ND" for "Not Detectable.

An empirical determination of the background baseline for stations within the Exclusion Area Boundary (EAB) is not possible due to the known plant related radiological activities (e.g., storage and transport of radioactive materials) that occurred during the baseline calculation study period. The average of the non-EAB stations close to the beach was approximately 15.8 mrem per quarter. A value of 15.8 mrem per quarter was conservatively selected as the baseline for the REMP stations located within the EAB.

In 1980 the Department of Energy (DOE) conducted an Aerial Radiological Survey of SONGS and the surrounding area. The baseline/background value of 15.8 mrem per standard quarter within the SONGS EAB is consistent with the 1980 gamma exposure rates reported by the DOE for the areas immediately north and south of SONGS, taking into account the reduction in environmental radioactivity and background dose rates caused by the decay of atmospheric nuclear weapons testing fallout since 1980.

Table 15 - SONGS REMP TLD Data

TLD (SCE-##)	Location	Distance (miles)	Qtr. Baseline (mrem)	2017 Quarterly Results (mrem)[f]				Baseline Adjusted Quarterly Results (mrem)				Ann. Baseline (mrem)	Annual Total (mrem)	Annual Facility Dose (mrem)	Annual Public[c] Dose (mrem)
				1	2	3	4	1	2	3	4				
1	City of San Clemente	5.7	18.4	17.9	18.1	17.3	18.6	ND	ND	ND	ND	73.5	71.8	ND	ND
2	Camp San Mateo – MCB	3.6	19.6	18.8	18.9	18.3	19.6	ND	ND	ND	ND	78.2	75.7	ND	ND
3	Camp San Onofre – MCB	2.8	17.2	16.9	17.7	16.7	18.3	ND	ND	ND	ND	68.9	69.6	ND	ND
4	Camp Horno – MCB	4.4	19.0	17.9	19.1	18.7	18.4	ND	ND	ND	ND	76.0	74.0	ND	ND
6	Old Route 101 (ESE)	3	12.0	9.7	12.8	10.8	12.1	ND	ND	ND	ND	47.9	45.3	ND	ND
8	Noncommissioned Officers' Beach Club	1.4	16.2	16.3	16.5	16.7	16.5	ND	ND	ND	ND	65.0	66.0	ND	ND
10	Bluff	0.7	17.2	16.0	17.0	15.8	17.7	ND	ND	ND	ND	69.1	66.6	ND	ND
19	San Clemente Highlands	4.9	18.7	18.3	19.7	18.7	19.3	ND	ND	ND	ND	75.0	76.0	ND	ND
22	Former US Coast Guard Station	2.7	18.8	17.9	19.2	17.8	19.4	ND	ND	ND	ND	75.4	74.3	ND	ND
23	SDG&E Service Center Yard (Control)	8.1	16.6	15.5	15.9	15.3	17.0	ND	ND	ND	ND	66.3	63.7	ND	ND
31	Aurora Park - Mission Viejo (Control)	18.6	19.4	19.3	19.6	19.4	19.6	ND	ND	ND	ND	77.9	77.9	ND	ND
33	Camp Talega – MCB (Control)	5.9	19.9	18.3	18.7	19.4	20.7	ND	ND	ND	ND	79.3	77.1	ND	ND
34	San Onofre School – MCB	1.9	17.0	16.3	17.3	16.0	16.7	ND	ND	ND	ND	68.0	66.2	ND	ND
35	Range 312 – MCB	4.8	17.8	16.1	15.5	15.5	16.4	ND	ND	ND	ND	71.0	63.5	ND	ND
36	Range 208C – MCB	4.1	20.5	19.4	21.1	19.2	20.8	ND	ND	ND	ND	81.8	80.5	ND	ND
38	San Onofre State Beach Park	3.4	15.0	13.4	15.3	13.7	14.1	ND	ND	ND	ND	60.1	56.5	ND	ND
40	SCE Training Center - Mesa	0.7	18.0	17.4	17.8	17.0	18.5	ND	ND	ND	ND	71.9	70.7	ND	ND
44	Fallbrook Fire Station (Control)	17.7	14.7	15.9	15.0	14.5	15.6	ND	ND	ND	ND	58.9	61.0	ND	ND
46	San Onofre State Beach Park	1	12.8	11.8[e]	12.4	12.7	13.5	ND	ND	ND	ND	51.2	50.4	ND	ND
47	Camp Las Flores – MCB (Control)	8.6	14.0	16.2	15.8	15.4	16.2	ND	ND	ND	ND	55.8	63.5	ND	ND
49	Camp Chappo – MCB (Control)	12.9	14.9	15.8	15.6	15.3	16.3	ND	ND	ND	ND	59.8	63.0	ND	ND
50	Oceanside Fire Station (Control)	15.6	17.4	18.2	17.7	16.6	17.6	ND	ND	ND	ND	69.7	70.0	ND	ND
53	San Diego County Operations Center (Control)	44.2	19.1	20.0	19.4	18.7	20.1	ND	ND	ND	ND	76.6	78.2	ND	ND
54	Escondido Fire Station (Control)	31.8	16.9	18.6	17.8	16.9	18.0	ND	ND	ND	ND	67.7	71.4	ND	ND
61	Mesa - East Boundary	0.7	16.2	15.1	15.6	15.1	16.7	ND	ND	ND	ND	64.9	62.5	ND	ND
62	Camp Pendleton	0.7	13.9	12.6	12.8	12.6	14.2	ND	ND	ND	ND	53.0	52.2	ND	ND
63	Camp Pendleton	0.6	14.6	14.1	14.7	13.8	14.8	ND	ND	ND	ND	58.3	57.5	ND	ND
64	Camp Pendleton	0.6	15.8	14.7	15.7	13.9	16.2	ND	ND	ND	ND	63.2	60.5	ND	ND

TLD (SCE-##)	Location	Distance (miles)	Qtr. Baseline (mrem)	2017 Quarterly Results (mrem)[f]				Baseline Adjusted Quarterly Results (mrem)				Ann. Baseline (mrem)	Annual Total (mrem)	Annual Facility Dose	Annual Public[c] Dose
65	Camp Pendleton	0.7	14.1	13.3	13.7	13.0	14.3	ND	ND	ND	ND	56.6	54.3	ND	ND
66	San Onofre State Beach	0.6	14.7	14.0	14.5	14.1	14.8	ND	ND	ND	ND	58.4	57.4	ND	ND
67	Former SONGS Evaporation Pond	0.6	17.8	17.1	17.9	16.9	18.3	ND	ND	ND	ND	71.2	70.2	ND	ND
68	Range 210C – MCB	4.4	15.8	16.4	16.6	15.6	18.1	ND	ND	ND	ND	63.3	66.7	ND	ND
74	Oceanside City Hall (Backup Control)	15.6	14.0	14.3	13.7	13.1	13.7	ND	ND	ND	ND	56.1	54.8	ND	ND
75	Gate 25 MCB	4.6	16.7	15.5	16.3	15.9	16.7	ND	ND	ND	ND	66.9	64.4	ND	ND
76	El Camino Real Mobil Station	4.6	18.2	18.4	18.9	18.2	18.8	ND	ND	ND	ND	73.0	74.3	ND	ND
77	Area 62 Heavy Lift Pad	4.2	20.2	18.5	20.9	19.3	20.5	ND	ND	ND	ND	80.8	79.2	ND	ND
78	Horno Canyon	4.4	11.7	11.6	13.7	11.4	11.8	ND	ND	ND	ND	46.9	48.5	ND	ND
11	Former Visitors' Center[a]	0.4	15.8	16.1	16.1	16.4	15.7	ND	ND	ND	ND	63.1	64.3	ND	ND
12	South Edge of Switchyard[a]	0.2	15.8	17.0	16.9	17.0	16.7	ND	ND	ND	ND	63.1	67.7	ND	ND
13	Southeast Site Boundary (Bluff)[a]	0.4	15.8	20.3	20.8	18.7	20.2	ND	5.1	ND	ND	63.1	80.1	17.0	0.0
15	Southeast Site Boundary (Office Bldg)[a]	0.1	15.8	20.3	21.5	19.9	21.5	ND	5.8	ND	5.8	63.1	83.3	20.3	0.7
16	East Southeast Site Boundary[a]	0.4	15.8	17.5	16.7	15.6	17.3	ND	ND	ND	ND	63.1	67.0	ND	ND
41	Old Route 101 – East[a]	0.3	15.8	15.7	15.8	15.4	16.3	ND	ND	ND	ND	63.1	63.0	ND	ND
55	San Onofre State Beach (U1 West)[a, d]	0.2	15.8	18.6	18.3	18.3	18.6	ND	ND	ND	ND	63.1	73.8	10.7	0.4
56	San Onofre State Beach (U1 West)[a]	0.2	15.8	15.4	17.6	15.1	17.2	ND	ND	ND	ND	63.1	65.3	ND	ND
57	San Onofre State Beach (Unit 2)[a]	0.1	15.8	16.7	15.8	16.6	16.9	ND	ND	ND	ND	63.1	66.0	ND	ND
58	San Onofre State Beach (Unit 3)[a]	0.1	15.8	17.6	17.7	17.2	17.1	ND	ND	ND	ND	63.1	69.5	ND	ND
59	SONGS Meteorological Tower[a]	0.3	15.8	19.9	19.6	19.3	20.6	ND	ND	ND	ND	63.1	79.3	16.3	0.9
73	South Yard Facility[a]	0.4	15.8	18.6	18.8	17.6	19.1	ND	ND	ND	ND	63.1	74.0	11.0	0.6

NOTES:

a. Station is within the Exclusion Area Boundary (EAB). The quarterly baseline has been estimated to be 15.0 mR within the EAB.
b. ND indicates that the TLD did not measure exposure greater than $3\sigma_Q$ or $3\sigma_A$ above the historical baseline, for that location. See ANSI/HPS N13.37-2014 for information on the determination of $3\sigma_Q$ or $3\sigma_A$.
c. Public dose is calculated based on an occupancy factor of 1 (full time exposure) for locations offsite. Public dose is calculated per SDS-RP1-PCD-1007 for locations in the EAB/CAB
d. Station 55 includes neutron dose, estimated using a neutron signal (R_n) conversion factor of 10.5*R_n/rem (HPSTID 08-015)
e. SCE-46 TLD lost in Q1. Calculated value is based on ratio of SCE-46 to nearby location SCE-66 in 2016 Q4.
f. 1.051 mrem/mR from ANSI N13.37-2014, Section 3.2.1

b. Quality Control Duplicate Direct Radiation Samples

Duplicate Quality Control (QC) TLD was installed adjacent to TLD #66. The duplicate TLDs agreed closely with the indicator TLDs, see Appendix C for results. These TLDs were not required by the ODCM and are not included in the Statistical Summary of REMP Data.

c. ISFSI Direct Radiation Samples

Independent Spent Fuel Storage Installation (ISFSI) TLDs were placed in the vicinity of the ISFSI. Data from these TLDs have not been included in the statistical summary of REMP data since these TLDs are not required by the ODCM. The ISFSI data are listed and discussed in Appendix I.

2. Airborne Particulate, Iodine, and Composite Isotopic Analyses

Air particulate samples were collected on a weekly basis from seven 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 ODCM.

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 energy lines or peaks associated with gamma radiation. Gross beta measurements can only be used as an indicator of potentially elevated levels; it does not identify specific radionuclides. Gross beta measurement data serves as a screening tool to determine if further analysis is required.

All weekly gross beta activity analysis results were above the MDC. The concentration of gross beta activity in the samples collected from the indicator locations ranged from 0.009 pCi/m^3 to 0.096 pCi/m^3, averaging 0.025 pCi/m^3 of air. The concentrations of gross beta activity in the samples from the control location ranged from 0.008 to 0.091 pCi/m^3, averaging 0.026 pCi/m^3 of air. There is seasonal variability to the gross beta results for air samplers, and the magnitude of the results in 2017 are not significantly different from what has been seen in previous years. Near the later portion of 2017, there was a noticeable increase in the gross beta data for all locations, both control and indicators. This trend will be monitored in 2018, and the fact that the trend is evident in both control and indicator locations shows that this is not the result of releases of radioactive material from SONGS.

Per the requirements of the 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 #16). The results showed that indicator locations maximum gross beta activity in air in 2017 was 0.096 pCi/m^3 which is less than 10 times the average background measured at the control location (0.026 pCi/m^3). No further action is required by the ODCM.

Indicator samples analyzed for I-131 were all identified below the MDC. No action was required by the ODCM.

In summary, average quarterly air particulate sample beta activity from the indicator stations and control station have been compared historically through 2017. The average of the indicators trends closely with the offsite control values. The comparison illustrates that SONGS has not contributed to detectable levels of radioactive material in the environment around the plant. There has been no detectable impact of the plant on air radioactivity. These stations are located near the site boundary downwind from the plant, based on the prevailing wind direction. The beta activity measured in the air particulate samples is from naturally occurring radioactive material. Gamma analyses are performed on quarterly composites of the air particulate samples to determine if any activity is from SONGS. The gamma analyses have revealed no radioactivity from SONGS.

3. Ocean Water

Monthly ocean water samples were collected from three indicator locations near each station discharge and from the control location at Newport Beach. The samples were analyzed for naturally-occurring and SONGS-related gamma-emitting radionuclides, including tritium. Quarterly composite ocean water samples were analyzed for tritium according to ODCM requirements.

Throughout 2017, only naturally occurring radionuclides were detected in the monthly gamma spectral analyses of ocean water. Monthly ocean water samples were also analyzed for tritium, consistent with the State of California Department of Public Health (DPH) split sample program. During 2017 all REMP ocean water sample results for tritium were below the count specific MDC.

The data indicate that the operation of SONGS had no measurable impact on the environment as measured by ocean water.

4. Drinking Water

In 2017, monthly drinking water samples were collected from one indicator location and from the Oceanside control location. Samples were analyzed for tritium, gross beta, and naturally occurring and SONGS related gamma emitting radionuclides. There is no drinking water pathway for liquid effluent at SONGS.

No station related radionuclides were detected in drinking water during 2017. Gross beta activity was identified in some samples, but gamma spectroscopy identified only natural radionuclides. The operation of SONGS had no impact on the environment as measured by drinking water.

5. Shoreline Sediment (Beach Sand)

Beach sand was collected semiannually in 2017 from three indicator locations and from a control location situated in Newport Beach. After collection, the samples were analyzed for plant related and naturally occurring radionuclides. Only naturally occurring radionuclides were detected in all samples. No plant related radionuclides were reported above the MDC. The operation of SONGS had no impact on the environment as measured in beach sand.

6. Ocean Bottom Sediments

Ocean bottom sediments were collected from three indicator locations and the Laguna Beach control location. The samples were analyzed by gamma spectral analysis for naturally occurring and station related radionuclides. Only naturally occurring radionuclides were detected in ocean bottom sediment samples collected during 2017.

Four non-ODCM 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. During 2017, all conduit sample analysis results were below the MDC for station related radionuclides. The operation of SONGS had no impact on the environment as measured by ocean bottom sediments.

7. Marine Species (Flesh)

Species of adult fish, crustacean and mollusks were collected on a semi-annual basis at the SONGS Unit 1 outfall, the SONGS Units 2/3 outfall and from Laguna Beach control location. The flesh portion of each sample type was analyzed for gamma-emitting station-related and naturally occurring radionuclides. The results were subsequently reported to SONGS 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. No plant related radionuclides were detected above the MDC.

Naturally-occurring radionuclides were detected in marine species samples collected during 2017. The operation of SONGS had no impact on the environment as measured by this sample medium.

8. Local Crops

Fleshy and leafy crops were collected semiannually in 2017 from the SONGS garden and from the control location 21 miles SE from SONGS Units 2/3 midpoint. Tomato, cabbage, sorrel and yellow squash were sampled in 2017, and only naturally occurring radionuclides were identified. No plant related radioactivity was detected. It is concluded that in 2017 SONGS had no measurable impact on local crops.

9. Soil

To determine if there is evidence of a build-up of radionuclides in the land near SONGS, indicator soil samples were collected from Camp San Onofre, Old Route 101, Basilone Road and the East Site Boundary (Former Visitor's center). A control sample was obtained from Prince of Peace Abbey in 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 the ODCM.

Soil samples were analyzed for naturally-occurring and SONGS-related gamma-emitting radionuclides using gamma spectral analysis. The 2017 soil samples showed measurable levels of naturally occurring radionuclides. Cs-137 was detected in two indicator samples (0.042 and 0.193 pCi/g) and the control sample (0.046 pCi/g). Cs-137 in environmental soil samples at these levels is often attributable to residual nuclear weapons testing fallout or to the Fukushima accident.

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. The presence of Cs-137 in the indicator and the control locations in previous years supports the conclusion that the major source of this radionuclide is fallout deposition. During 2017, the operation of SONGS did not have a measurable effect on the environment as measured by soil samples.

10. Kelp

Kelp was collected in April and October of 2017 from the San Onofre kelp beds, San Mateo kelp bed, Barn kelp bed, and from the Salt Creek control location. Upon collection, the samples were analyzed by gamma-spectral analysis for naturally-occurring and station-related radionuclides. Naturally occurring radionuclides (such as K-40, Th-234 and others) were detected in all samples in 2017, from both indicator and control locations. Iodine-131 was identified in all samples from April 2017, in both the indicator and control locations. I-131 was not detected in any of the October 2017 samples, however. Iodine-131 is a relatively short-lived radionuclide with an 8-day half-life. It is produced and released from operating nuclear power plants. SONGS is shutdown with the nuclear fuel stored in spent fuel pool so I-131 is not being generated. That, along with the fact that the I-131 was identified in either all samples (April) or no samples (October) indicates that these positive results are not from SONGS operations.

I-131 has been detected at indicator and control locations in previous years. I-131 data in ocean water samples near SONGS have been consistently indistinguishable radiologically from background. The northern control locations are too far away and in the predominantly upstream current direction for the I-131 activity to be attributable to SONGS. The Salt Creek control kelp sample station near the San Juan Sewage Plant outfall has consistently yielded the highest I-131 activity measured in kelp and has consistently yielded I-131 above radiological background. Figure 10 shows a relatively close correlation between indicator and control locations over an extended period, further supporting the assessment that the likely source for this radionuclide is external to SONGS. (Note: Figure 10 includes all I-131 results, including those that are below the MDC.)

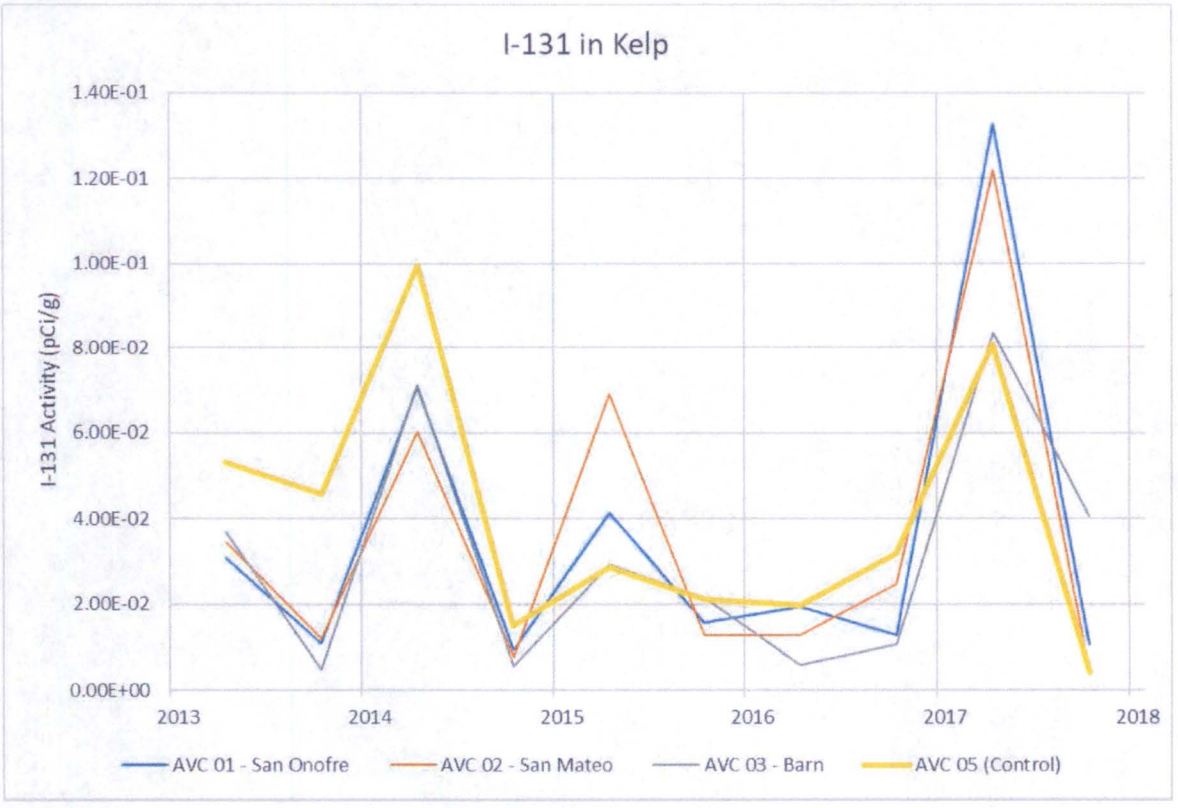

Figure 10 - I-131 in Aquatic Kelp

Refer to Figure 11 for the relative location of the kelp beds, the San Juan Sewage Plant outfall, and the SONGS outfalls. The data strongly support the conclusion that the I-131 detected in kelp is attributable to medically administered I-131 discharged through the San Juan Sewage Plant outfall and not to the operation of SONGS.

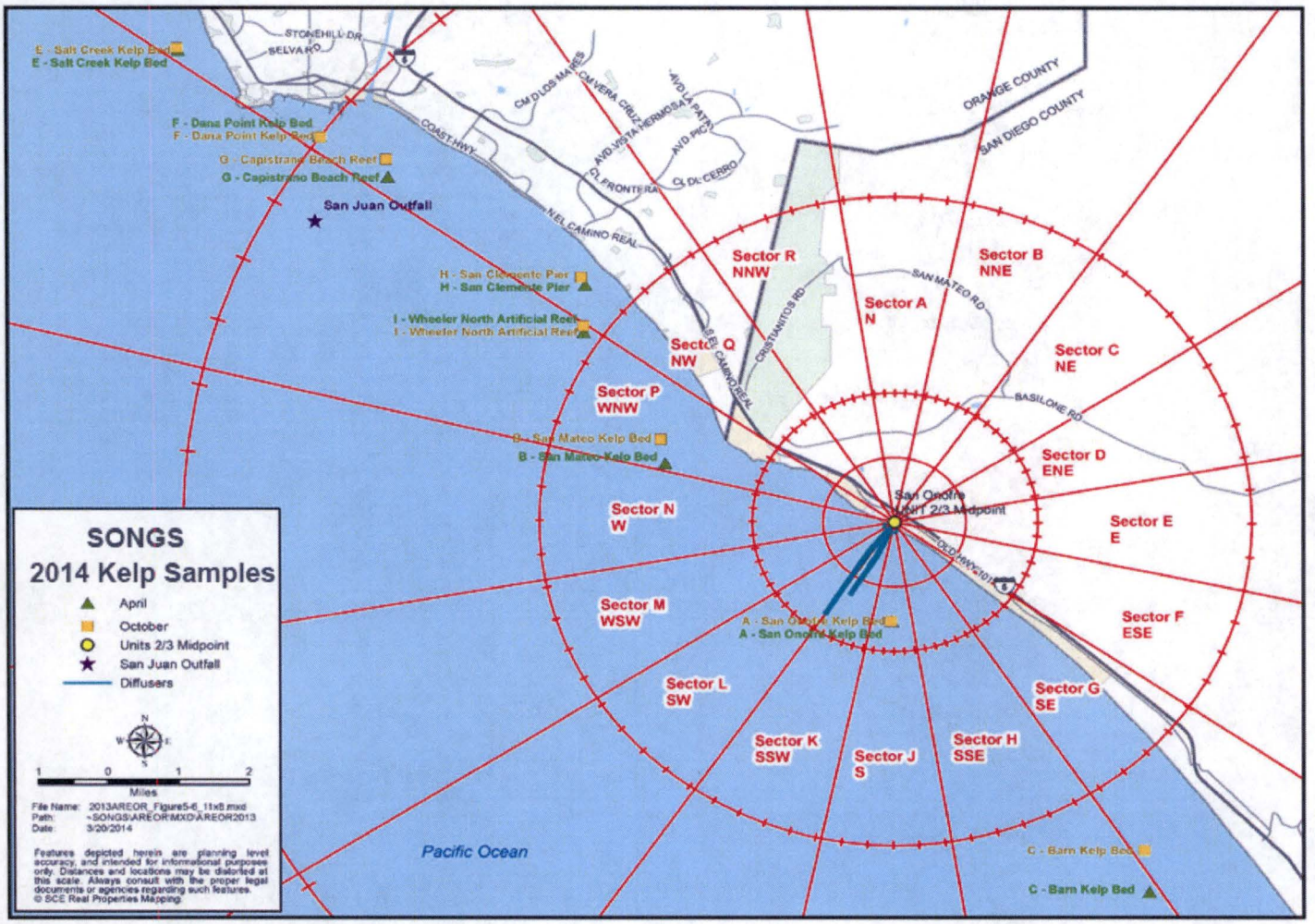

Figure 11 - Kelp Sampling Locations

11. Correlation of Effluent Concentration to Concentrations in the Environment

In accordance with 10 CFR 50 Appendix I, Section IV, B.2, data on measurable levels of radiation and radioactive materials in the environment have been evaluated to determine the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals from principal pathways of exposure.

REMP samples, both terrestrial and marine, indicated no accumulation of plant-related radioactivity in the environs. No samples exceeded investigation levels and, in fact, all samples with detectable activity were not statistically different from controls and were therefore attributed to non-plant-related sources-past nuclear weapons fallout, Chernobyl, Fukushima, and medical iodine releases in sewage. As such, the operations of SONGS did not have any measurable effect on the environment.

The regulatory requirement to evaluate the relationship between quantities of radioactive materials released in effluents and the resultant radiation doses to individuals may be summarized by the following conclusion:

Effluent program releases are evaluated annually to determine the receptor(s) with the highest hypothetical dose. The 2017 REMP sample data indicated no accumulation of plant-related radioactive materials in the offsite environment, thereby lending confirmation to the adequacy of the in-plant effluent controls program and dose assessments.

B. Statistical Summary of REMP Data For 2017

Table 16 - 2017 Quarterly Gamma Dose

Pathway (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
TLD Dose per 91 days (mrem/qtr)	Gamma 195	5	16.7 (151/151) (9.7 – 21.5)	Southeast Site Boundary (Office Bldg) 0.1 Mi. ESE	20.8 (4/4) (19.9 – 21.5)	17.0 (44/44) (13.1 – 20.7)	0

NOTES
- a Indicator location TLDs include all REMP TLDs 5.0 miles or closer to SONGS 2/3 midpoint
- b Control location TLDs include all REMP TLDs more than 5.0 miles from SONGS 2/3 midpoint
- c TLD data excludes QC TLDs, transit dose TLDs, and ISFSI TLDs

Table 17 – Weekly Airborne Particulates Gross Beta

Pathway (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
Air Filter Inhalation (pCi/m^3)	Gross Beta 415	0.01	0.025 (363/363) (0.009 – 0.096)	Mesa EOF 0.7 Mi. NNW	0.029 (52/52) (0.013 – 0.096)	0.026 (52/52) (0.008 – 0.091)	0

Table 18 – Weekly Radioiodine I-131 Activity

Pathway [a] (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD) [b]	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
Activated Charcoal Inhalation (pCi/m^3)	I-131 415	0.07	< LLD [c] (0/363)	< LLD	< LLD	< LLD (0/52)	0

NOTES

a This table summarizes the weekly air iodine-131 cartridge data above the MDC. Iodine-131 has an 8-day half-life. With reactor shutdown, it is no longer a radionuclide attributable to SONGS

b LLD is the a priori limit as prescribed by the ODCM.

c The Term <LLD as used means that results had no detectable activity above the minimum detectable.

Table 19 – Quarterly Composite Airborne Particulate Gamma Activity

Pathway (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
Air Filter Inhalation (pCi/m^3)	Gamma Isotopic 32	See Table 1	< LLD (0/28)	< LLD	< LLD	< LLD (0/4)	0

NOTES

a Natural occurring radionuclides (K-40, Th-234 and others) were observed in quarterly composite air samples in 2017.

Table 20 – Monthly Ocean Water Activity

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Ocean Water (pCi/L)	Gamma Isotopic	52	See Table 1	< LLD (0/50)	< LLD	< LLD	< LLD (0/12)	0

NOTES

a Natural occurring radionuclides (K-40 and others) were observed in samples in 2017.

Table 21 – Quarterly Ocean Water Tritium

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Ocean Water (pCi/L)	Tritium	16	2000	< LLD (0/12)	< LLD	< LLD	< LLD (0/4)	0

Table 22 – Monthly Drinking Water Activity

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Drinking Water (pCi/L)	Gamma Isotopic	24	See Table 1	< LLD (0/12)	< LLD	< LLD	< LLD (0/12)	0
Drinking Water (pCi/L)	Gross Beta	24	4	< LLD (2/12)	Oceanside City Hall 15.6 Miles SE[b]	3.71 (6/12) 2.37 – 5.64	3.71 (6/12) 2.37 – 5.64	0
Drinking Water (pCi/L)	H-3	24	2000	< LLD (0/12)	< LLD	< LLD	< LLD (0/12)	0

NOTES

a Natural occurring radionuclides (Pb-212, Pb-214, Th-228, Th-232 and others) were observed in samples in 2017.

b The location with the highest annual mean for drinking water gross beta is a control location.

Table 23 – Semi-annual Shoreline Sediment Gamma Activity (pCi/g)

Pathway (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
Beach Sand Direct Exposure (pCi/g)	Gamma Isotopic 8	See Table 1	< LLD (0/6)	< LLD	< LLD	< LLD (0/2)	0

NOTES

a Natural occurring radionuclides (Pb-212, Pb-214, Ra-226 and others) were observed in samples in 2017.

Table 24 – Semi-annual Ocean Bottom Sediment Gamma Activity (pCi/g)

Pathway (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
Waterborne Ocean Bottom Sediment (pCi/g)	Gamma Isotopic 14	See Table 1	< LLD (0/12)	< LLD	< LLD	< LLD (0/2)	0

NOTES

a Natural occurring radionuclides (Pb-212, Pb-214, Ra-226 and others) were observed in samples in 2017.

Table 25 – Semi-annual Marine Animal Gamma Activity (pCi/g)

Pathway (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
California Mussell Ingestion (pCi/g)	Gamma Isotopic 4	See Table 1	< LLD (0/4)	< LLD	< LLD	N/A	0
Keyhole Limpet Ingestion (pCi/g)	Gamma Isotopic 2	See Table 1	N/A	< LLD	< LLD	< LLD (0/2)	0
Spiny Lobster Ingestion (pCi/g)	Gamma Isotopic 6	See Table 1	< LLD (0/4)	< LLD	< LLD	< LLD (0/2)	0
Sheephead Ingestion (pCi/g)	Gamma Isotopic 5	See Table 1	< LLD (0/3)	< LLD	< LLD	< LLD (0/2)	0
Kelp Bass Ingestion (pCi/g)	Gamma Isotopic 3	See Table 1	< LLD (0/2)	< LLD	< LLD	< LLD (0/1)	0
Black Perch Ingestion (pCi/g)	Gamma Isotopic 1	See Table 1	< LLD (0/1)	< LLD	< LLD	N/A	0

NOTES

a Natural occurring radionuclides (K-40 and others) were observed in samples in 2017.

Table 26 – Semi-annual Local Crops Gamma Activity (pCi/g)

Pathway (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
Sorrell Ingestion (pCi/g)	Gamma Isotopic 2	See Table 1	< LLD (0/2)	< LLD	< LLD	N/A	0
Tomato Ingestion (pCi/g)	Gamma Isotopic 4	See Table 1	< LLD (0/2)	< LLD	< LLD	< LLD (0/2)	0
Cabbage Ingestion (pCi/g)	Gamma Isotopic 2	See Table 1	N/A	< LLD	< LLD	< LLD (0/2)	0
Yellow Squash Ingestion (pCi/g)	Gamma Isotopic 2	See Table 1	< LLD (0/1)	< LLD	< LLD	< LLD (0/1)	0

NOTES

a Natural occurring radionuclides (K-40 and others) were observed in samples in 2017.

Table 27 –Annual Soil Gamma Activity, 3" Depth (pCi/g)

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Soil Direct Radiation (pCi/g)	Gamma Isotopic	4	See Table 1	< LLD (0/3)	< LLD	< LLD	< LLD (0/1)	0
	Cs-137	4	0.18	0.117 (2/3) (0.042 – 0.19)	Old Route 101 3.0 Mi. ESE	0.193 (0.193 – 0.193)	0.046 (1/1) (0.046 – 0.046)	0

NOTES

a During 2017 naturally occurring K-40 and other radionuclides were detected above the MDC in most samples.

Table 28 –Semi-Annual Kelp Gamma Activity (pCi/g)

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Kelp Ingestion (pCi/g)	Gamma Isotopic	8	See Table 1	< LLD (0/6)	< LLD	< LLD	< LLD (0/2)	0
	I-131	8	0.06	0.113 (3/6) (0.008 – 0.113)	San Onofre Kelp Bed 1.5 Mi. S	0.133 (0.133 – 0.133)	0.008 (1/2) (0.008 – 0.008)	0

NOTES

a I-131 was confirmed above the MDC in 4 of 8 kelp samples. I-131 is known to be a constituent of sewage plant discharges due to medically administered I-131.

b During 2017 naturally occurring K-40 and other radionuclides were detected above the MDC in most samples

APPENDIX C. SUMMARY OF QUALITY CONTROL PROGRAMS

A. Summary

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, MBC Environmental, per the vendors Quality Assurance manual. REMP sample analysis is performed by the Contracted Environmental Analysis Laboratory (CEAL) in accordance with the Laboratory Quality Assurance Plan. During 2017 the CEAL was General Engineering Laboratory (GEL). The CEAL for REMP TLDs was Stanford Dosimetry.

B. Quarterly Duplicate TLDs

SONGS deployed a duplicate TLD package in the same location and canister as TLD 66. The quarterly dose measured by these separate TLD packages is statistically equivalent.

Table 29 - 2017 Quarterly Duplicate TLD Data Comparison

TLD #	1ST QUARTER (mR)	2ND QUARTER (mR)	3RD QUARTER (mR)	4TH QUARTER (mR)
TLD 66	13.28 ± 0.83	13.79 ± 0.72	13.46 ± 1.01	14.11 ± 0.87
TLD 200	13.02 ± 0.91	13.61 ± 1.00	13.18 ± 0.81	14.27 ± 0.49

NOTES:

a. Data is reported as mR per standard quarter ± 1 sigma

C. Annual Duplicate TLDs

SONGS deployed a 12-month duplicate TLD package in the same location and canister as TLD 67. The annual sum of the quarterly TLD 67 exposure data is not significantly different from the annual TLD 201 results for the 12 months from July 2016 through June 2017.

Table 30 - 2017 Duplicate TLD Data

TLD 67 (mR/year) (July 2016 to June 2017)	TLD 201 (mR/year) (July 2016 to June 2017)
68.1	66.1

D. Calibration of Air Sampler Volume Meters

Air samplers undergo annual calibration using standards referenced to NIST on all REMP air sampler gas meters. 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. For 2017, the calibration reports for five of the air samplers used in the REMP were reviewed. The as found condition of these samplers were that some (2/5) were negatively biased, up to 28% low (at a flow rate of 1.5 scfm). Others (3/5) were positively biased, up to 22% high. A review of the air particulate beta results over the course of the year did not indicate a particular bias for any particular sampler. The trends in the beta results over the course of the year were consistent regardless of which sampler (location) was being monitored.

E. Interlaboratory Cross-Check Program:

The CEAL participates in a number of independent cross check programs, including the National Institute of Standards and Technology (NIST) and Analytics cross-check programs. A summary of the cross-check data is included below. In the 1st quarter of 2017, the gross alpha analysis for water samples did not meet the applicable performance evaluation. This condition was identified and documented by GEL, via CARR170227-1085. The sample was re-analyzed with an acceptable result. In the 3rd quarter of 2017, the I-131 analysis for water was not acceptable. GEL CARR170828-1125 documented the issue, and the lab determined that the observed positive bias was an isolated occurrence and the laboratory's overall process is in control.

Per the 2017 Annual Environmental Quality Assurance (QA) Report, GEL was provided ninety-two (92) individual environmental analyses. The accuracy of each result reported to Eckert & Ziegler Analytics, Inc. is measured by the ratio of GEL's result to the known value. All results fell within GEL's acceptance criteria (100%)

In 2017, the environmental TLDs, routine quality control (QC) testing was performed for dosimeters issued by the Environmental Dosimetry Company (EDC). During 2017, 100% (72/72) of individual dosimeters evaluated against the EDC internal performance acceptance criteria (high-energy photons only) met the criterion for accuracy and 100% (72/72) met the criterion for precision.

The CEAL's performance meets the criteria described in Reg. Guide 4.15 and ANSI/HPS N13.37-2014.

F. Analytical Laboratory Cross Check Program Summary

GEL Laboratories LLC
a member of The GEL Group INC

PO Box 30712 Charleston, SC 29417
2040 Savage Road Charleston, SC 29407
P 843.556.8171
F 843.766.1178

gel.com

TABLE 2

GEL QUARTERLY INTERLABORATORY COMPARISON

January through March 2017

GEL Laboratories LLC
a member of The GEL Group INC
PO Box 30712 Charleston, SC 29417
2040 Savage Road Charleston, SC 29407
P 843.556.8171
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gel.com

PT Provide	Quarter / Year	Report Closing / Received Date	Sample Number	Sample Media	Units	Analyte	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
EZA	4th/2016	02/21/17	E11674	Cartridge	pCi	Iodine-131	9.60E+01	9.67E+01	0.99	Acceptable
EZA	4th/2016	02/21/17	E11675	Milk	pCi/L	Strontium-89	7.86E+01	7.42E+01	1.06	Acceptable
EZA	4th/2016	02/21/17	E11675	Milk	pCi/L	Strontium-90	7.50E+00	1.00E+01	0.75	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Iodine-131	1.08E+02	9.74E+01	1.11	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Cerium-141	1.55E+02	1.43E+02	1.09	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Chromium-51	3.29E+02	2.80E+02	1.18	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Cesium-134	1.67E+02	1.78E+02	0.94	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Cesium-137	1.43E+02	1.26E+02	1.13	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Cobalt-58	1.54E+02	1.46E+02	1.05	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Manganese-54	1.46E+02	1.29E+02	1.13	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Iron-59	1.45E+02	1.25E+02	1.16	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Zinc-65	2.68E+02	2.44E+02	1.10	Acceptable
EZA	4th/2016	02/21/17	E11676	Milk	pCi/L	Cobalt-60	1.87E+02	1.78E+02	1.05	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Iodine-131	1.06E+02	9.18E+01	1.15	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Cerium-141	1.47E+02	1.38E+02	1.06	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Chromium-51	3.03E+02	2.71E+02	1.12	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Cesium-134	1.59E+02	1.73E+02	0.92	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Cesium-137	1.38E+02	1.22E+02	1.13	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Cobalt-58	1.49E+02	1.42E+02	1.05	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Manganese-54	1.35E+02	1.25E+02	1.08	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Iron-59	1.35E+02	1.21E+02	1.12	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Zinc-65	2.61E+02	2.36E+02	1.10	Acceptable
EZA	4th/2016	02/21/17	E11677	Water	pCi/L	Cobalt-60	1.76E+02	1.72E+02	1.02	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Barium-133	86.7	85.6	72.0 - 94.2	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Cesium-134	51.2	52.6	42.4 - 57.9	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Cesium-137	118	112	101 - 126	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Cobalt-60	118	113	102 - 126	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Zinc-65	202	189	170 - 222	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Gross Alpha	71.6	52.3	27.3 - 65.5	Not Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Gross Alpha	69.6	52.3	27.3 - 65.5	Not Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Gross Beta	37.6	41.6	27.7 - 49.0	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Radium-226	12.3	12.7	9.48 - 14.7	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Radium-226	13.1	12.7	9.48 - 14.7	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Radium-226	14.2	12.7	9.48 - 14.7	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Radium-228	6.31	6.2	3.83 - 8.08	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Radium-228	6.36	6.2	3.83 - 8.08	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Uranium (Nat)	12.2	12.6	9.91 - 14.4	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	µg/L	Uranium (Nat) mass	19.7	18.4	14.5 - 21.1	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	µg/L	Uranium (Nat) mass	18.9	18.4	14.5 - 21.1	Acceptable

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PT Provide	Quarter / Year	Report Closing / Received Date	Sample Number	Sample Media	Units	Analyte	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Tritium	11300	12500	10900 - 13800	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Tritium	11600	12500	10900 - 13800	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Strontium-89	60.2	55.5	44.3 - 63.2	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Strontium-89	54.5	55.5	44.3 - 63.2	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Strontium-90	35.9	43.1	31.8 - 49.5	Acceptable
ERA	1st / 2017	2/27/2017	RAD-108	Water	pCi/L	Strontium-90	37.7	43.1	31.8 - 49.5	Acceptable

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TABLE 2

GEL QUARTERLY INTERLABORATORY COMPARISON

April through June 2017

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EZA	1st/2017	07/07/17	E11818	Cartridge	pCi	Iodine-131	9.93E+01	9.46E+01	1.05	Acceptable
EZA	1st/2017	07/07/17	E11819	Milk	pCi/L	Strontium-89	8.86E+01	9.96E+01	0.89	Acceptable
EZA	1st/2017	07/07/17	E11819	Milk	pCi/L	Strontium-90	1.97E+01	2.55E+01	0.77	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Iodine-131	9.57E+01	9.68E+01	0.99	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Cerium-141	1.21E+02	1.19E+02	1.02	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Chromium-51	1.76E+02	2.12E+02	0.83	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Cesium-134	1.71E+02	1.89E+02	0.9	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Cesium-137	2.31E+02	2.27E+02	1.02	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Cobalt-58	1.89E+02	1.78E+02	1.06	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Manganese-54	2.74E+02	2.49E+02	1.1	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Iron-59	1.35E+02	1.27E+02	1.06	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Zinc-65	3.22E+02	2.96E+02	1.09	Acceptable
EZA	1st/2017	07/07/17	E11820	Milk	pCi/L	Cobalt-60	2.85E+02	2.93E+02	0.97	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Iodine-131	9.68E+01	8.79E+01	1.1	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Cerium-141	1.24E+02	1.19E+02	1.05	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Chromium-51	2.43E+02	2.11E+02	1.15	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Cesium-134	1.84E+02	1.88E+02	0.98	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Cesium-137	2.49E+02	2.26E+02	1.1	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Cobalt-58	1.88E+02	1.77E+02	1.06	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Manganese-54	2.79E+02	2.48E+02	1.13	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Iron-59	1.46E+02	1.27E+02	1.15	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Zinc-65	3.36E+02	2.95E+02	1.14	Acceptable
EZA	1st/2017	07/07/17	E11821	Water	pCi/L	Cobalt-60	3.07E+02	2.92E+02	1.05	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Americium-241	65.7	67.0	46.9-87.1	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Cesium-134	1470	1550	1085-2015	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Cesium-137	679	611	428-794	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Cobalt-57	0.812		False Pos Test	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Cobalt-60	958	891	624-1158	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Iron-55	804	812	568-1056	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Manganese-54	1080	967	677-1257	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Nickel-63	-46		False Pos Test	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Plutonium-238	0.574	0.41	Sens. Eval.	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Plutonium-239/240	51.2	59.8	41.9-77.7	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Potassium-40	624	607	425-789	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Strontium-90	548	624	437-811	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Technetium-99	641	656	459-853	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	U-234/233	56.9	48.1	33.7-62.5	Acceptable

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MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Uranium-238	53.9	48.8	34.2-63.7	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaS36	Soil	Bq/Kg	Zinc-65	-4.0		False Pos Test	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Americium-241	0.8070	0.846	0.592-1.1	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Cesium-134	0.037		False Pos Test	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Cesium-137	12.2	11.1	7.8-14.4	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Cobalt-57	29.0	28.5	20.0-37.1	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Cobalt-60	12.8	12.3	8.6-16.0	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Hydrogen-3	245	249	174-324	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Iron-55	2.01	1.7	Sens. Eval.	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Manganese-54	15.7	14.9	10.4-19.4	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Nickel-63	13.6	12.2	8.5-15.9	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Plutonium-238	0.635	0.703	0.492-0.914	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Plutonium-239/240	0.841	0.934	0.654-1.214	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Potassium-40	276	254	178-330	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Radium-226	0.443	0.504	0.353-0.655	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Strontium-90	9.27	10.1	7.1-13.1	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Technetium-99	5.81	6.25	4.38-8.13	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Uranium-234/233	1.11	1.16	0.81-1.51	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Uranium-238	1.16	1.20	0.84-1.56	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-MaW36	Water	Bq/L	Zinc-65	-0.0504		False Pos Test	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-XaW36	Water	Bq/L	Iodine-129	0.01		False Pos Test	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	ug/sample	Uranium-235	0.058	0.0623	0.0436-0.0810	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	ug/sample	Uranium-238	8.49	8.6	6.0-11.2	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	ug/sample	Uranium-Total	8.55	8.7	6.1-11.3	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Americium-241	0.0366	0.0376	0.0263-0.0489	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Cesium-134	1.38	1.42	0.99-1.85	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Cesium-137	0.781	0.685	0.480-0.891	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Cobalt-57	1.77	1.70	1.19-2.21	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Cobalt-60	0.863	0.78	0.55-1.01	Acceptable

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MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Manganese-54	-0.0344		False Pos Test	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Plutonium-238	0.0539	0.0598	0.0419-0.0777	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Plutonium-239/240	0.0419	0.046	0.0322-0.0598	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Strontium-90	0.543	0.651	0.456-0.846	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Uranium-234/233	0.105	0.104	0.073-0.135	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Uranium-238	0.106	0.107	0.075-0.139	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdF36	Filter	Bq/sample	Zinc-65	1.34	1.29	0.9-1.68	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Americium-241	0.000411		False Pos Test	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Cesium-134	6.56	6.95	4.87-9.04	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Cesium-137	4.84	4.60	3.22-5.98	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Cobalt-57	0.0141		False Pos Test	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Cobalt-60	9.35	8.75	6.13-11.38	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Manganese-54	3.39	3.28	2.3-4.26	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Plutonium-238	0.0506	0.0598	0.0419-0.0777	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Plutonium-239/240	0.0754	0.089	0.062-0.166	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Strontium-90	1.50	1.75	1.23-2.28	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Uranium-234/233	0.19	0.179	0.125-0.233	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Uranium-238	1.930	0.186	0.130-0.242	Acceptable
MAPEP	2nd/2017	06/13/17	MAPEP-17-RdV36	Vegetation	Bq/sample	Zinc-65	6.26	5.39	3.77-7.01	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Actinium-228	1240	1240	795 - 1720	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Americium-241	480	448	262 - 582	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Bismuth-212	929	1240	330 - 1820	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Bismuth-214	2790	2750	1660 - 3960	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Cesium-134	8660	8860	5790 - 10600	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Cesium-137	8300	7500	5750 - 9650	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Cobalt-60	4620	4430	3000 - 6100	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Lead-212	1300	1240	812 - 1730	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Lead-214	3170	2890	1690 - 4310	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Manganese-54	<38.6	<1000	0.00 - 1000	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Plutonium-238	494	648	390 - 894	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Plutonium-239	442	484	316 - 669	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Potassium-40	11000	10600	7740 - 14200	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Strontium-90	6150	9150	3490 - 14500	Acceptable

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ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Thorium-234	3360	1940	614 - 3650	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Uranium-234	1820	1950	1190 - 2500	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Uranium-234	2030	1950	1190 - 2500	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Uranium-234	2410	1950	1190 - 2500	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Uranium-238	1800	1940	1200 - 2460	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Uranium-238	1970	1940	1200 - 2460	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Uranium-238	1450	1940	1200 - 2460	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Uranium-Total	3540	3980	2160 - 5250	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Uranium-Total	3750	3980	2160 - 5250	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Uranium-Total	4090	3980	2160 - 5250	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	µg/kg	Uranium-Total	3860	3980	2160 - 5250	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	µg/kg	Uranium-Total (mass)	5280	5800	3200 - 7290	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	µg/kg	Uranium-Total (mass)	5420	5800	3200 - 7290	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	µg/kg	Uranium-Total (mass)	5900	5800	3200 - 7290	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	µg/kg	Uranium-Total (mass)	4440	5800	3200 - 7290	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Soil	pCi/kg	Zinc-65	7020	6090	4850 - 8090	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Americium-241	1700	1860	1140 - 2470	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Cesium-134	1660	1830	1180 - 2380	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Cesium-137	2470	2500	1810 - 3480	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Cobalt-60	1350	1390	959 - 1940	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Curium-244	629	734	360 - 1140	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Manganese-54	<32.2	<300	0.00 - 300	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Plutonium-238	2880	3250	1940 - 4450	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Plutonium-239	1990	2150	1320 - 2960	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Potassium-40	30900	30900	22300 - 43400	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Strontium-90	701	726	414 - 963	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Uranium-234	2720	3090	2030 - 3970	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Uranium-234	3080	3090	2030 - 3970	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Uranium-238	2820	3060	2040 - 3890	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Uranium-238	3020	3060	2040 - 3890	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Uranium-Total	5970	6290	4260 - 7830	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Uranium-Total	5690	6290	4260 - 7830	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Uranium-Total	6238	6290	4260 - 7830	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	µg/kg	Uranium-Total (mass)	8910	9250	6200 - 11700	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	µg/kg	Uranium-Total (mass)	8440	9250	6200 - 11700	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	µg/kg	Uranium-Total (mass)	9030	9250	6200 - 11700	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Vegetation	pCi/kg	Zinc-65	907	853	615 - 1200	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Americium-241	80.6	76.4	47.1 - 103	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Cesium-134	1140	1100	700 - 1360	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Cesium-137	1490	1390	1040 - 1830	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Cobalt-60	1120	1030	797 - 1290	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Iron-55	242	256	79.4 - 500	Acceptable

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ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Manganese-54	<7.53	<50.0	0.00 - 50.0	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Plutonium-238	54.1	54.3	37.2 - 71.4	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Plutonium-239	58.2	62	44.9 - 81.0	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Strontium-90	52.2	52.4	25.6 - 78.5	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Uranium-234	71.1	73.1	45.3 - 110	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Uranium-234	79	73.1	45.3 - 110	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Uranium-238	70.7	72.4	46.8 - 100	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Uranium-238	77.1	72.4	46.8 - 100	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Uranium-Total	154	149	82.5 - 227	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Uranium-Total	145	149	82.5 - 227	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Uranium-Total	159.5	149	82.5 - 227	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	µg/Filter	Uranium-Total (mass)	230	217	139 - 306	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	µg/Filter	Uranium-Total (mass)	212	217	139 - 306	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	µg/Filter	Uranium-Total (mass)	231	217	139 - 306	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Zinc-65	1160	984	705 - 1360	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Gross Alpha	112	85.5	28.6 - 133	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Filter	pCi/Filter	Gross Beta	54.9	45.2	28.6 - 65.9	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Americium-241	150	140	94.3 - 188	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Cesium-134	2380	2510	1840 - 2880	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Cesium-137	1480	1400	1190 - 1680	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Cobalt-60	2570	2540	2210 - 2970	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Iron-55	923	984	587 - 1340	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Manganese-54	<6.36	<100	0.00 - 100	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Plutonium-238	108	128	94.7 - 159	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Plutonium-239	73.3	85.8	66.6 - 108	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Strontium-90	685	714	465 - 944	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-234	82.1	90.3	67.8 - 116	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-234	92	90.3	67.8 - 116	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-234	87.1	90.3	67.8 - 116	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-238	86.7	89.5	68.2 - 110	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-238	84.1	89.5	68.2 - 110	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-238	98	89.5	68.2 - 110	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-Total	181	184	135 - 238	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-Total	173	184	135 - 238	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-Total	180	184	135 - 238	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Uranium-Total	185	184	135 - 238	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	µg/L	Uranium-Total (mass)	270	268	214 - 324	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	µg/L	Uranium-Total (mass)	260	268	214 - 324	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	µg/L	Uranium-Total (mass)	252	268	214 - 324	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	µg/L	Uranium-Total (mass)	276	268	214 - 324	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Zinc-65	2160	1960	1630 - 2470	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Gross Alpha	125	89.5	31.8 - 139	Acceptable

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ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Gross Beta	59.6	61	34.9 - 90.4	Acceptable
ERA	2nd/2017	05/23/17	MRAD-26	Water	pCi/L	Tritium	18900	19400	13000 - 27700	Acceptable
ERA	2nd/2017	05/30/17	RAD-109	Water	pCi/L	Gross Alpha	79.7	75	39.5 - 92.3	Acceptable
ERA	2nd/2017	05/30/17	RAD-109	Water	pCi/L	Gross Alpha	72.9	75	39.5 - 92.3	Acceptable
ERA	2nd/2017	05/30/17	RAD-109	Water	pCi/L	Gross Alpha	72.9	75	39.5 - 92.3	Acceptable

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GEL QUARTERLY INTERLABORATORY COMPARISON

July through September 2017

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EZA	2nd/2017	08/02/17	E11873	Cartridge	pCi	Iodine-131	8.65E+01	8.46E+01	1.02	Acceptable
EZA	2nd/2017	08/02/17	E11874	Milk	pCi/L	Strontium-89	8.88E+01	9.26E+01	0.96	Acceptable
EZA	2nd/2017	08/02/17	E11874	Milk	pCi/L	Strontium-90	9.50E+00	1.35E+01	0.71	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Cerium-141	1.62E+02	1.51E+02	1.07	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Cobalt-58	1.53E+02	1.55E+02	0.98	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Cobalt-60	2.07E+02	1.91E+02	1.08	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Chromium-51	3.65E+02	3.15E+02	1.16	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Cesium-134	1.74E+02	1.88E+02	0.92	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Cesium-137	1.57E+02	1.50E+02	1.05	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Iron-59	1.28E+02	1.15E+02	1.11	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Iodine-131	9.93E+01	9.36E+01	1.06	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Manganese-54	1.95E+02	1.72E+02	1.14	Acceptable
EZA	2nd/2017	08/02/17	E11875	Milk	pCi/L	Zinc-65	2.18E+02	2.04E+02	1.07	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Cerium-141	2.09E+02	1.99E+02	1.05	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Cobalt-58	2.11E+02	2.04E+02	1.04	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Cobalt-60	2.57E+02	2.50E+02	1.03	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Chromium-51	4.41E+02	4.13E+02	1.07	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Cesium-134	2.38E+02	2.47E+02	0.96	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Cesium-137	2.20E+02	1.97E+02	1.12	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Iron-59	1.64E+02	1.51E+02	1.09	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Iodine-131	8.69E+01	8.12E+01	1.07	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Manganese-54	2.43E+02	2.25E+02	1.08	Acceptable
EZA	2nd/2017	08/02/17	E11876	Water	pCi/L	Zinc-65	2.95E+02	2.67E+02	1.10	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Barium-133	68.8	66.3	55.2 - 72.9	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Cesium-134	24.7	24.4	18.7 - 27.2	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Cesium-137	51.7	51.6	46.4 - 59.6	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Cobalt-60	97	88.6	79.7 - 99.8	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Zinc-65	39.7	32.7	27.3 - 41.6	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Gross Alpha	26.3	25.7	13.0 - 34.1	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Gross Alpha	31.9	25.7	13.0 - 34.1	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Gross Beta	54.4	63	43.5 - 69.6	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Radium-226	1.6	1.29	1.07 - 1.95	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Radium-226	1.21	1.29	1.07 - 1.95	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Radium-228	6.49	5.66	3.45 - 7.47	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Radium-228	5.59	5.66	3.45 - 7.47	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Uranium (Nat)	65	66.7	54.3 - 73.9	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Uranium (Nat)	66.2	66.7	54.3 - 73.9	Acceptable

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ERA	3rd / 2017	08/28/17	RAD - 110	Water	µg/L	Uranium (Nat) mass	97	98.1	79.8 - 109	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	µg/L	Uranium (Nat) mass	104.7	98.1	79.8 - 109	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Tritium	5120	5060	4340 - 5570	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Tritium	4620	5060	4340 - 5570	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Strontium-89	29.9	26.4	18.4 - 32.9	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Strontium-89	28.2	26.4	18.4 - 32.9	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Strontium-90	37.8	36	26.4 - 41.5	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Strontium-90	34	36	26.4 - 41.5	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Iodine-131	28	25.5	21.2 - 30.1	Acceptable
ERA	3rd / 2017	08/28/17	RAD - 110	Water	pCi/L	Iodine-131	33	25.5	21.2 - 30.1	Not Acceptable

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MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Cesium-134	10.50	11.5	8.1-15.0	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Cesium-137	16.800	16.3	11.2-21.2	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Cobalt-57	12.1	12.1	8.5-15.7	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Cobalt-60	10.800	10.7	7.5-13.9	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Hydrogen-3	250	258	181-335	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Iron-55	20.1	19.4	13.6-25.2	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Manganese-54	15.5	14.9	10.4-19.4	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Nickel-63	0.764	0	False Pos Test	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Plutonium-238	0.528	0.60	0.422-0.784	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Plutonium-239/240	0.654	0.781	0.547-1.015	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Potassium-40	-1.2	0	False Pos Test	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Radium-226	0.774	0.86	0.601-1.115	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Strontium-90	7.04	8	5.44-10.10	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Technetium-99	6.41	6.73	4.71-8.75	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Uranium-234/233	1.09	1.01	0.71-1.31	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Uranium-238	1.140	1.040	0.73-1.35	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-MaW37	Water	Bq/L	Zinc-65	17.3	15.5	10.9	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-XaW37	Alk. Water	Bq/L	Iodine-129	2.590	2.310	1.62-3.00	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	ug/sample	Uranium-235	0.0521	0.0507	0.0355-0.0659	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	ug/sample	Uranium-238	7.8	7.0	4.90-9.10	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	ug/sample	Uranium-Total	7.84	7.05	4.94-9.17	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Americium-241	0.053300	0	0.0458-0.0796	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Cesium-134	1.0300	1.00	0.7-1.30	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Cesium-137	0.88	0.82	0.57-1.07	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Cobalt-57	0.01	0.00	False Pos Test	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Cobalt-60	0.75	0.68	0.48-0.88	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Manganese-54	1.48	1.30	0.91-1.69	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Plutonium-238	0.0257	0.0298	0.0209-0.0387	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Plutonium-239/240	0.0408	0.0468	0.0328-0.0608	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Strontium-90	0.808	0.801	0.561-1.041	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Uranium-234/233	0.086	0.084	0.059-0.109	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Uranium-238	0.093	0.087	0.061-0.113	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdF37	Filter	Bq/sample	Zinc-65	1.2500	1.08	0.76-1.40	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Americium-241	0.080	0.077	0.054-0.1	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Cesium-134	2.30	2.32	1.62-3.02	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Cesium-137	0.0191	0.00	False Pos Test	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Cobalt-57	2.92	2.80	2.0-3.6	Acceptable

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MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Cobalt-60	2.24	2.07	1.45-2.69	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Manganese-54	2.78	2.62	1.83-3.41	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Plutonium-238	0.0762	0.0830	0.058-0.108	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Plutonium-239/240	0.104	0.108	0.076-0.140	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Strontium-90	0.960	1.23	0.86-1.6	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Uranium-234/233	0.162	0.159	0.111-0.207	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Uranium-238	0.166	0.163	0.114-0.212	Acceptable
MAPEP	4th/2017	12/01/17	MAPEP-17-RdV37	Vegetation	Bq/sample	Zinc-65	5.93	5.37	3.76-6.98	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Actinium-228	1200	1240	795 - 1720	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Americium-241	1180	1140	667 - 1480	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Bismuth-212	1600	1240	330 - 1820	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Bismuth-214	1460	1890	1140 - 2720	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Cesium-134	5770	6320	4130 - 7590	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Cesium-137	3940	3830	2930 - 4930	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Cobalt-60	4110	4130	2790 - 5690	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Lead-212	1270	1240	812 - 1730	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Lead-214	1720	1980	1160 - 2950	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Manganese-54	<29.2	<1000	<1000	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Plutonium-238	508	615	370 - 849	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Plutonium-239	578	506	331 - 699	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Potassium-40	10600	10600	7740 - 14200	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Strontium-90	2530	3460	1320 - 5470	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Thorium-234	4160	3690	1170 - 6940	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-234	4310	3720	2270 - 4770	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-234	3350	3720	2270 - 4770	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-234	3400	3720	2270 - 4770	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-238	3590	3690	2280 - 4680	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-238	4380	3690	2280 - 4680	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-238	3260	3690	2280 - 4680	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-Total	7732	7580	4110 - 10000	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-Total	7190	7580	4110 - 10000	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-Total	7780	7580	4110 - 10000	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Uranium-Total	8090	7580	4110 - 10000	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	µg/kg	Uranium-Total (mass)	12100	11100	6120 - 14000	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	µg/kg	Uranium-Total (mass)	10800	11100	6120 - 14000	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	µg/kg	Uranium-Total (mass)	12200	11100	6120 - 14000	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Soil	µg/kg	Uranium-Total (mass)	9770	11100	6120 - 14000	Acceptable

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ERA	4th/2017	11/17/17	MRAD-27	Soil	pCi/kg	Zinc-65	7380	6660	5300 - 8850	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Americium-241	681	670	410 - 891	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Cesium-134	1530	1670	1070 - 2170	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Cesium-137	1890	1840	1330 - 2560	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Cobalt-60	2320	2180	1500 - 3050	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Curium-244	2380	2790	1370 - 4350	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Manganese-54	<36.1	<300	<300	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Plutonium-238	3340	4180	2490 - 5720	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Plutonium-239	950	1060	651 - 1460	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Potassium-40	34900	30900	22300 - 43400	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Strontium-90	2580	2650	1510 - 3510	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Uranium-234	985	995	654 - 1280	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Uranium-234	1100	995	654 - 1280	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Uranium-238	1040	987	659 - 1250	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Uranium-238	821	987	659 - 1250	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Uranium-Total	2320	2030	1380 - 2530	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Uranium-Total	1845	2030	1380 - 2530	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Uranium-Total	2390	2030	1380 - 2530	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	µg/kg	Uranium-Total (mass)	3200	2980	2000 - 3780	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	µg/kg	Uranium-Total (mass)	2460	2980	2000 - 3780	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	µg/kg	Uranium-Total (mass)	3460	2980	2000 - 3780	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Vegetation	pCi/kg	Zinc-65	1670	1400	1010 - 1970	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Americium-241	15.4	14.9	9.18 - 20.2	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Cesium-134	1410	1440	916 - 1790	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Cesium-137	1010	954	717 - 1250	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Cobalt-60	296	271	210 - 339	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Iron-55	1010	1080	335 - 2110	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Manganese-54	<3.18	<50.0	<50.0	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Plutonium-238	61.8	63.9	43.8 - 84.0	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Plutonium-239	40.2	44.4	32.1 - 58.0	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Strontium-90	115	121	59.1 - 181	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Uranium-234	42.8	41.5	25.7 - 62.6	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Uranium-234	38.5	41.5	25.7 - 62.6	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Uranium-238	41.1	41.2	26.6 - 57.0	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Uranium-238	37.5	41.2	26.6 - 57.0	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Uranium-Total	82	84.6	46.8 - 129	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Uranium-Total	86.7	84.6	46.8 - 129	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Uranium-Total	83	84.6	46.8 - 129	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	µg/Filter	Uranium-Total (mass)	129	123	78.7 - 173	Acceptable

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ERA	4th/2017	11/17/17	MRAD-27	Filter	µg/Filter	Uranium-Total (mass)	124	123	78.7 - 173	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	µg/Filter	Uranium-Total (mass)	113	123	78.7 - 173	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Zinc-65	146	123	88.1 - 170	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Gross Alpha	60	50.1	16.8 - 77.8	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Filter	pCi/Filter	Gross Beta	68.3	61.8	39.1 - 90.1	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Americium-241	176	158	106 - 212	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Cesium-134	1340	1400	1030 - 1610	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Cesium-137	390	378	321 - 453	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Cobalt-60	1990	1830	1590 - 2140	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Iron-55	1550	1640	978 - 2230	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Manganese-54	<9.38	<100	<100	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Plutonium-238	136	158	117 - 197	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Plutonium-239	114	134	104 - 169	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Strontium-90	218	222	145 - 293	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Uranium-234	163	160	120 - 206	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Uranium-234	153	160	120 - 206	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Uranium-234	157	160	120 - 206	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Uranium-238	169	158	120 - 194	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Uranium-238	136	158	120 - 194	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Uranium-Total	306	325	239 - 420	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Uranium-Total	310	325	239 - 420	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Uranium-Total	343	325	239 - 420	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	µg/L	Uranium-Total (mass)	510	474	378 - 573	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	µg/L	Uranium-Total (mass)	463	474	378 - 573	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	µg/L	Uranium-Total (mass)	407	474	378 - 573	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Zinc-65	2090	1750	1460 - 2210	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Gross Alpha	109	113	40.1 - 175	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Gross Beta	127	130	74.4 - 193	Acceptable
ERA	4th/2017	11/17/17	MRAD-27	Water	pCi/L	Tritium	21100	22500	15100 - 32100	Acceptable
EZA	4th/2017	02/02/18	E12067	Cartridge	pCi	Iodine-131	4.84E+01	4.81E+01	1.01	Acceptable
EZA	4th/2017	02/02/18	E12068	Milk	pCi/L	Strontium-89	9.54E+01	9.23E+01	1.03	Acceptable
EZA	4th/2017	02/02/18	E12068	Milk	pCi/L	Strontium-90	1.34E+01	1.69E+01	0.79	Acceptable
EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Cerium-141	1.07E+02	9.83E+01	1.09	Acceptable
EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Cobalt-58	9.29E+01	8.99E+01	1.03	Acceptable
EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Cobalt-60	1.95E+02	1.73E+02	1.13	Acceptable
EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Chromium-51	2.69E+02	2.42E+02	1.11	Acceptable
EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Cesium-134	1.20E+02	1.25E+02	0.96	Acceptable

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EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Cesium-137	1.63E+02	1.41E+02	1.15	Acceptable
EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Iron-59	1.27E+02	1.13E+02	1.12	Acceptable
EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Iodine-131	6.59E+01	5.78E+01	1.14	Acceptable
EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Manganese-54	1.79E+02	1.61E+02	1.11	Acceptable
EZA	4th/2017	02/02/18	E12069	Milk	pCi/L	Zinc-65	2.34E+02	2.11E+02	1.11	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Cerium-141	6.60E+01	6.24E+01	1.06	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Cobalt-58	5.95E+01	5.70E+01	1.04	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Cobalt-60	1.15E+02	1.10E+02	1.05	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Chromium-51	1.68E+02	1.54E+02	1.09	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Cesium-134	7.47E+01	7.92E+01	0.94	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Cesium-137	9.31E+01	8.97E+01	1.04	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Iron-59	8.74E+01	7.19E+01	1.22	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Iodine-131	5.36E+01	4.95E+01	1.08	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Manganese-54	1.14E+02	1.02E+02	1.12	Acceptable
EZA	4th/2017	02/02/18	E12070	Water	pCi/L	Zinc-65	1.57E+02	1.34E+02	1.17	Acceptable

APPENDIX D. COMPARISON OF OPERATIONAL TO PREOPERATIONAL DATA

Comparison of Operational to Preoperational Data and Analysis of Trends

Unit 1 achieved criticality on June 14, 1967 and was permanently retired from service on November 30, 1992. Unit 2 attained initial criticality on July 26, 1982 and Unit 3 on August 29, 1983.

A variety of environmental samples were analyzed and the analytical results (January 1, 1979 to July 31, 1982) were compared with the 2017 operational data obtained for SONGS Units 2/3.

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

- External Radiation
- Air Particulates
- Radioiodine
- Ocean Water
- Shoreline Sediment (Sand)
- Ocean Bottom Sediments
- Marine Species
- Local Crops
- Soil
- Kelp
- Drinking Water

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 2/3. 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 2017 operational data are possible for each of the following exposure pathways: (1) direct radiation, (2) air particulates (inhalation), and (3) ocean water (marine pathway for ingestion). 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 near the SONGS Units 2/3 outfalls.

Currently the preoperational data are higher than the operational data. The decrease in radioactivity is due primarily to the cessation of nuclear weapons testing and to the decay of fallout radionuclides. There is a close correlation between indicator and control data over several decades. There are no indications of adverse effects from SONGS on the environment.

A. Direct Radiation

The direct radiation measurements for the SONGS REMP were made by TLDs on a quarterly collection cycle at 38 indicator locations and 11 control locations in 2017. (See Appendix I for ISFSI TLD data). The TLDs were located at inner and outer ring locations as specified by the ODCM. During the preoperational period from January 1979 to July 31, 1982, the indicator stations ranged from 16.1 to 46.6 mR. The preoperational indicator average was 25.3 mR. The preoperational control range was 19.3 to 30.1 and the control mean was 23.1 mR. During the 2017 operational year for Units 2/3, the routine indicator TLD locations ranged from 9.7 to 21.6 mrem, averaging 16.7 mrem while the control locations ranged from 13.1 to 20.7 mrem with an average of 17.0 mrem. Outside the EAB, all TLD results (control and indicator, for quarterly and annual measurements) are below each locations historical background plus the minimum differential dose (see ANSI/HPS N13.37-2014). Refer to Appendix B for a detailed discussion of the REMP TLD data.

Factors such as meteorology, local geology, the fallout from atmospheric nuclear weapons testing, and seasonal fluctuations account for the variability in the data as observed 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 of the manmade background from fallout from past nuclear weapons tests.

Figure 9 compares the environmental radiation levels of selected indicator and control locations. Simultaneous variation in the radiation levels at both the control and indicator locations shows that the variations are due to factors external to SONGS. Outside the EAB there were no measurable levels of increased direct radiation associated with SONGS as measured by TLD.

B. Airborne Particulates

From January 1979 through July 1982 (considered to be the preoperational period for SONGS Units 2/3), there was a 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 were attributable to the Chinese atmospheric nuclear weapons test conducted on October 15, 1980.

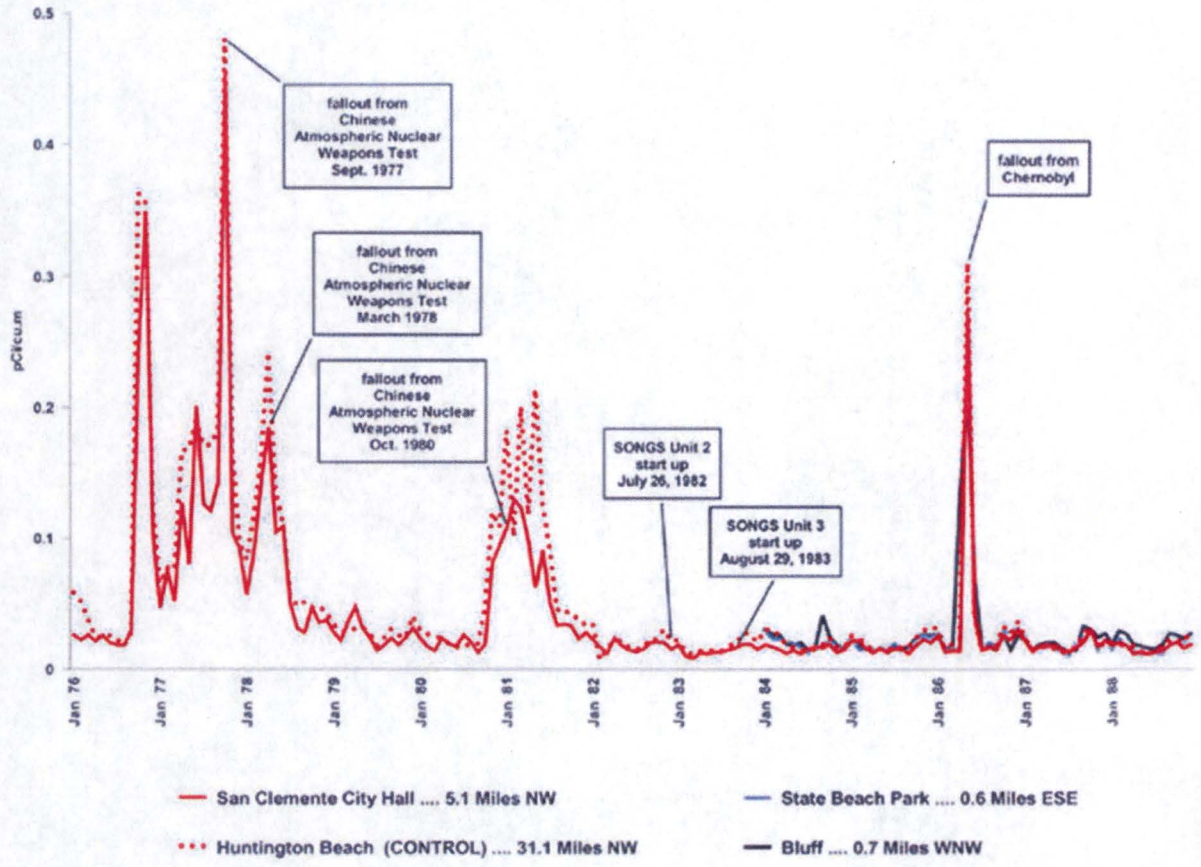

Figure 12 – Monthly Average Airborne Particulate Gross Beta Preoperational and Operational Data for Units 2 and 3, (1976 – 1988)

For 2017, the maximum monthly average airborne particulate gross beta result was approximately 0.029 pCi/m^3. This result is in line with both recent history and SONGS preoperational data.

C. Radioiodine

Most of the preoperational data for I-131 level was below the detection limit. All the 2017 operational I-131 data were below the detection limit. This is expected, as the shutdown and defueled SONGS is no longer producing I-131, and all previously produced I-131 has decayed away. SONGS had no effect on the environment as measured by the radioiodine cartridge data in 2017.

D. Ocean Water

Monthly ocean water samples were collected near each of the Station discharge outfalls, and from the Newport Beach control location. The ocean water samples are analyzed for naturally-occurring and station-related gamma-emitting radionuclides. Samples were 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.

The data for all plant related radionuclides at all ocean water locations during the 2017 operational period were not detectable and below the MDC. We conclude that the operation of SONGS had a negligible impact on the environment as measured by this sample medium.

E. Drinking Water

Due to its location on the beach, there is no drinking water pathway for SONGS. Nonetheless, drinking water samples from Oceanside and Camp Pendleton were collected and analyzed. No plant related radionuclides were detected during the 2017 operational period. Gross beta activity (from natural radionuclides) was detected during both the operational and preoperational periods at both the indicator and the control locations. No plant related radionuclides (including tritium) have been identified in 2017, and no trends have been noted. The operation of SONGS had no impact on the environment as measured by this exposure pathway.

F. Shoreline Sediments (Sand)

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

To assess the impact of SONGS operations on this environmental medium, preoperational data were compared to 2017 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 atmospheric nuclear weapons testing. No SONGS-related radionuclides were detected in shoreline sediment during the 2017 operational period. The operation of SONGS had no impact on the environment as measured by this exposure pathway.

Table 31 - Shoreline Sediment Concentration

		INDICATOR		CONTROL	
Radionuclide	**Period [a]**	**Range [b] (pCi/g, wet)**	**Average (pCi/g, wet)**	**Range (pCi/g, wet)**	**Average (pCi/g, wet)**
Cs-137	PreOp Operational	0.012 - 0.022 < LLD	0.019 < LLD	< LLD - 0.032 < LLD	< LLD < LLD
All other SONGS radionuclides	PreOp Operational [c]	< LLD < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD

NOTES:

a. Preoperational period is January 1979 – July 1982. Operational period is January 2017 – December 2017
b. LLD for operational data are listed in Appendix B
c. During 2017, all station related radionuclides from all sample locations were < LLD

G. Ocean Bottom Sediments

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.

During the 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.l 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.

Results of the 2017 data 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, 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 2017 was below the MDC, supporting the conclusion of no detectable impact on ocean bottom sediments from SONGS.

Table 32 - Ocean Bottom Sediment Concentration

		INDICATOR		CONTROL	
Radionuclide	**Period** [a]	**Range** [b] **(pCi/g, wet)**	**Average** [b] **(pCi/g, wet)**	**Range (pCi/g, wet)**	**Average (pCi/g, wet)**
Mn-54	PreOp Operational	0.015 - 0.49 < LLD	0.129 < LLD	< LLD < LLD	< LLD < LLD
Co-58	PreOp Operational	0.013 - 1.160 < LLD	0.199 < LLD	< LLD < LLD	< LLD < LLD
Co-60	PreOp Operational	0.014 - 8.100 < LLD	0.788 < LLD	< LLD < LLD	< LLD < LLD
Ag-110m	PreOp Operational	< LLD - 0.020 < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD
Cs-137	PreOp Operational	0.014 - 0.090 < LLD	0.039 < LLD	< LLD < LLD	< LLD < LLD
Ce-144	PreOp Operational	0.060 - 0.260 < LLD	0.160 < LLD	< LLD < LLD	< LLD < LLD
All other SONGS radionuclides	PreOp Operational [c]	< LLD < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD

NOTES:

a Preoperational period is January 1979 – July 1982. Operational period is January 2017 – December 2017

b LLD for operational data are listed in Appendix B

c During 2017, all station related radionuclides from all sample locations were < LLD

H. Marine Species (Flesh)

Non-migratory marine species are collected semi-annually near SONGS. As a norm, marine species caught by the SONGS outfalls and from Laguna Beach include various species of adult fish, crustacean and mollusks. Upon collection the flesh portion is analyzed for gamma-emitting radionuclides as specified in the ODCM. The results are subsequently reported as pCi/g, wet weight.

Results for several marine species for both the preoperational and 2017 operational periods for Units 2/3 are summarized in Table 33. The marine species used for purposes of comparison include: Sheephead (a fish), Blacksmith (a fish), Black Perch (a fish), Bay Mussel (a mollusk), and Spiny Lobster (a crustacean). Radionuclides analyzed but not included in Table 33 were below the lower limits of detection for both the preoperational and operational periods.

During the 2017 operational period, no SONGS related radionuclides were detected above the MDC. The data indicate no accumulation trends. The operation of SONGS in 2017 had no impact on the environment as measured by this exposure pathway.

Table 33 - Marine Species Concentration

		INDICATOR		CONTROL	
Radionuclide	**Period [a]**	**Range (pCi/g, wet)**	**Average (pCi/g, wet)**	**Range (pCi/g, wet)**	**Average (pCi/g, wet)**
Sheephead Flesh[d]					
Co-58	PreOp Operational	0.016 - 0.030 < LLD	0.023 < LLD	< LLD < LLD	< LLD < LLD
Co-60	PreOp Operational	0.005 - 0.044 < LLD	0.017 < LLD	< LLD < LLD	< LLD < LLD
Ag-110m	PreOp Operational	< LLD - 0.004 < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD
Cs-137	PreOp Operational	0.004 - 0.018 < LLD	0.007 < LLD	0.005 - 0.012 < LLD	0.007 < LLD
All other SONGS radionuclides	PreOp Operational	< LLD < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD
Black Perch Flesh					
Co-58	PreOp Operational	0.009-0.011 < LLD	0.010 < LLD	< LLD < LLD	< LLD < LLD
Co-60	PreOp Operational	0.004-0.045 < LLD	0.017 < LLD	< LLD < LLD	< LLD < LLD
Ag-110m	PreOp Operational	0.002-0.009 < LLD	0.006 < LLD	< LLD < LLD	< LLD < LLD
Cs-137	PreOp Operational	0.003-0.015 < LLD	0.008 < LLD	0.004-0.014 < LLD	0.009 < LLD

All other SONGS radionuclides	PreOp Operational	< LLD < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD
Mussel Flesh (Bay or California) [d]					
Mn-54	PreOp Operational	0.009 - 0.025 < LLD	0.017 < LLD	< LLD < LLD	< LLD < LLD
Co-58	PreOp Operational	0.008 - 0.080 < LLD	0.028 < LLD	-- < LLD	-- < LLD
Co-60	PreOp Operational	0.005 - 0.400 < LLD	0.077 < LLD	< LLD < LLD	< LLD < LLD
Cs-137	PreOp Operational	0.003 - 0.006 < LLD	0.004 < LLD	< LLD < LLD	< LLD < LLD
Ru-103	PreOp Operational	< LLD - 0.045 < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD
All other SONGS radionuclides	PreOp Operational	< LLD < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD
Spiny Lobster Flesh (Bay or California) [d]					
Co-58	PreOp Operational	0.007 - 0.270 < LLD	0.086 < LLD	< LLD < LLD	< LLD < LLD
Co-60	PreOp Operational	0.014 - 0.210 < LLD	0.060 < LLD	< LLD < LLD	< LLD < LLD
Cs-137	PreOp Operational	0.005 - 0.011 < LLD	0.008 < LLD	0.040 - 0.015 < LLD	0.008 < LLD
All other SONGS radionuclides	PreOp Operational	< LLD < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD

NOTES:

a Preoperational period is January 1979 – July 1982. Operational period is January 2017 – December 2017

b LLD for operational data are listed in Appendix B

c During 2017, all station related radionuclides from all sample locations were < LLD

d Species collected in 2017 include California Mussel, Sheephead, Kelp Bass, Keyhole Limpet and Spiny Lobster

I. Local Crops

In the preoperational period of January 1979 through July 1982, Sr-90 was detected in the control samples of kale, parsley, and squash. Naturally occurring 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.

During 2017, only natural radionuclides were identified in local crops, at both the indicator and control locations. The operation of SONGS had no impact on the environment as measured by this exposure pathway.

J. Soil

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.

The operation of SONGS had no impact on the environment as measured by this exposure pathway.

Table 34 - Soil Concentration

Radionuclide	Period	Indicator		Control	
		Range (pCi/g)	Average (pCi/g)	Range (pCi/g)	Average (pCi/g)
Sr-90	PreOp Operational	0.02 - 0.08 N/A	0.044 N/A	< LLD - 0.03 N/A	< LLD N/A
Cs-137	PreOp Operational	0.02 - 0.20 < LLD – 0.17	0.096 0.17	< LLD - 0.06 < LLD – 0.193	< 0.10 0.117
All other SONGS radionuclides	PreOp Operational	< LLD < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD

K. Kelp

Kelp is collected semiannually from three indicator locations and from a control location situated at Salt Creek. 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 2017 operational data in Table 35. Radionuclides detected during the preoperational period for SONGS include Mn-54, Co-60, Zr-95, I-131, and Cs-137.

During the 2017 operational period, I-131 was detected in three indicator and one control sample. No other station related isotopes were detected in kelp samples during the 2017 operational period. Figure 10 shows a close correlation between indicator and control sample locations over an extended period of time.

Although I-131 activity has been detected in kelp since 1977, there is no evidence that the concentration of I-131 or other station related radionuclides are a result of operations at SONGS. The presence of I-131 in kelp is apparently due to the sewer release of medical administrations of radioisotopes, 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 locations.

Table 35 - Kelp Concentration

Radionuclide	Period	Indicator		Control	
		Range (pCi/g)	Average (pCi/g)	Range (pCi/g)	Average (pCi/g)
Mn-54	PreOp Operational	< LLD - 0.005 < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD
Co-60	PreOp Operational	0.006 - 0.009 < LLD	0.008 < LLD	< LLD < LLD	< LLD < LLD
Zr(Nb)-95	PreOp Operational	0.014 - 0.090 < LLD	0.046 < LLD	0.018 - 0.053 < LLD	0.036 < LLD
I-131	PreOp Operational	0.006 - 0.024 0.084 – 0.133	0.013 0.113	0.008 - 0.030 0.081 – 0.081	0.014 0.081
Cs-137	PreOp Operational	0.004 - 0.071 < LLD	0.027 < LLD	< LLD < LLD	< LLD < LLD
All other SONGS radionuclides	PreOp Operational	< LLD < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD

The I-131 results in 2017 are much higher than found during the preoperational program. However, all of the positive results were from the April 2017 sampling and were found in both indicator and control sample locations. No I-131 was detected during the October 2017 sampling. These data, along with there no longer being a viable production mechanism for I-131 at SONGS, support the conclusion that the detection of I-131 in kelp is due to factors external to SONGS.

APPENDIX E. DEVIATIONS FROM ODCM SAMPLING REQUIREMENTS IN 2017

DEVIATIONS FROM ODCM SAMPLING REQUIREMENTS

Deviations from the 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 2017, the ODCM specified a priori LLD was achieved for all REMP samples. 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. The 2017 ODCM deviations had no meaningful impact on the REMP database and did not compromise the validity of the reported conclusions.

A. Direct Radiation

Thermoluminescent Dosimeters (TLDs)

1. During the 2017 1st quarter TLD change out on 4/5/2017, it was identified that TLD #46 (South State Parks Beach Trail #1) had the bottom of the TLD canister broken off (vandalism) and the TLD was missing. A new TLD canister and the 2nd quarter TLD was re-established at the location. This resulted in a total of 195 direct radiation samples on Table 14 instead of 196 samples.
2. Collection of three (3) TLDs located on Camp Pendleton was delayed for the second quarter due to denial of access from Range Control. TLDs are normally collected between April 1 and 10, however they were collected on April 18 (AR 0317-39889).

B. Air Sampling

At SONGS, there are a total of 7 Indicator and 1 Control Air Samplers.

Downtime for each air sampler in 2017 was due to weekly sample collection, annual Preventative Maintenance (PM), and the change outs for the flow meters/pumps was approximately 46 minutes for each sampler.

Weekly Change Out:	0.5 minutes (approx.) x 52 = 26 minutes
Annual PM	15 minutes (approx.)
Annual Flow meter/Pump change out	5 minutes (approx.)

Downtimes in excess of 1 hour are addressed below for each ODCM required air sample.

1) Air Sampler #13 (Camp Pendleton). On February 21, 2017, Camp Pendleton schedulers cancelled our access into Alpha-2 Training Area due to hazardous conditions created by rain storm on February 17, 2017. The roads in the area were impacted by flash flood conditions. The air sample was changed out on February 28, 2017 and analyzed. This resulted in one 14-day sample instead of two separate 7-day sample periods as required by the ODCM (AR # 0217-28430). Thus the total number of REMP air particulate samples listed on Table 14 was reduced to 415 samples for 2017.
2) On June 20, 2017, the air sampler pump failed after 95 hours of sample collection. The samples were collected and analyzed. There was no detectable licensed plant material on sample's media (AR 0617-23286).
3) On November 26, 2017 Air Sampler #13 was out of service from approximately 0138 to 0518, due to a power outage at the MESA.
4) On November 28, 2017 Air Sampler #13 was out of service from approximately 1202-1400, due to a power outage at the MESA.

In all these events, the Radiological Effluent and Environmental Specialist reviewed previous and post event's data to verify that all ODCM LLDs were met.

C. Ocean Water Sampling

No deviations were observed

D. Drinking Water

No deviations were observed

E. Shoreline Sediments

No deviations were observed

F. Ocean Bottom Sediments

No deviations were observed

G. Marine Species (Flesh)

No deviations were observed

H. Local Crops

No deviations were observed

I. Soil

No deviations were observed

J. Kelp

No deviations were observed

APPENDIX F. LAND USE CENSUS

Introduction

The regulatory basis for conducting a Land Use Census (LUC) is identified in 10CFR50, Appendix I, Sec IV.B.3. The purpose of the LUC is to "identify changes in the use of unrestricted areas and to permit modifications in monitoring program for evaluating doses to individuals from principle pathways of exposure."[1] In addition, Regulatory Guide 4.15, Rev. 1, section C3 address that "written procedures should be prepared, reviewed, and approved for activities involved in carrying out the monitoring program." The 2017 LUC was conducted to comply with the surveillance requirement as defined in the Offsite Dose Calculation Manual (ODCM) Section 5.2. The current Radiological Environmental Monitoring Program Procedure SO123-IX-1.20, Land Use Census, establishes the method of documenting and verifying land use results obtained in compliance to San Onofre's Technical Specifications and ODCM.

Executive Summary

The land area around San Onofre Nuclear Generating Station (SONGS) is not subject to significant change due to the nature of the land uses. The area around SONGS is divided into sixteen (16) geographical sectors. The Pacific Ocean and United States Marine Corps (USMC) Base Camp Pendleton comprise 13 of the 16 sectors surrounding SONGS. The City of San Clemente (a mature municipal area) and coastline comprise the remaining three sectors. Therefore, the characteristics of the local land area substantially inhibit significant land use changes.

Definition of Uses

Residence is defined as any structure (single-family house, apartment, mobile home, barracks or similar unit) that is occupied by an individual(s) or resident(s) for three months or longer in a given 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, campground hosts, 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 are cows, goats, and sheep whose milk is used in dairy products for human consumption.

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

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[1] 10 CFR 50 Appendix I, Section IV, B.3

Fresh, leafy vegetables include, but are not limited to, lettuce, cabbage and spinach.

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

The Land Use Census Scope

The land area around SONGS includes both Orange and San Diego counties. The Orange County portion includes a portion of the city of San Clemente (official population as of July 2016 is 65,309 per the city's demographics and statistical information website) and the San Clemente State Park. The San Diego County portion includes much of the (USMC) Base Camp Pendleton, San Onofre State Beach and Park, and SONGS itself.

The LUC map is divided into 16 geographical sectors: A, B, C, D, E, F, G, H, J, K, L, M, N, P, Q and R. The ODCM surveillance requirement is performed by identifying the location of the nearest garden greater than 500 square feet, nearest milk animals, nearest residence, and other identified land uses in each of the sixteen (16) geographical sectors within a distance of five (5) miles from San Onofre Units 2 and 3. In addition, the Land Use Census aids in detecting changes in the presence of hazardous manufacturing and handling facilities within the five (5) mile radius. The methodology consists of reviewing data from the previous LUC reports and verifying if any information has changed. The LUC is conducted and updated at least once per 12 months between the dates of June 1st and October 1st. Also, non-residential usage such as fire stations, surf camps and other potential pathways of exposure to an individual are identified due to the fact that these usages are closer to full time residence based on information provided by the appropriate point of contact or agency.

Sectors A, B, C, D, E, and F include land within the boundaries of (USMC) Base Camp Pendleton. The study area in sector G includes the area along the coast south of SONGS. Sectors H, J, K, L, M, and N are the Pacific Ocean, therefore no land use possible. Sectors P, Q, and R include a section of San Clemente and part of Camp Pendleton.

Research Methodology

Completion of the 2017 SONGS Land Use Census required conversations with agencies, organizations, individuals and field research. The Radiological Effluent and Environmental Specialist reviewed the previous 2016 LUC and associated documentation spreadsheet. Then the data was verified. If changes occurred, then changes were reflected in this Land Use Census. This was accomplished by contacting the point of contact for the appropriate agency, organization, or military base whom possessed knowledge on the land usage. The following agencies and organizations were contacted or additional information was researched through their respective websites:

- California Highway Patrol
- Orange County Agricultural
- State of California Department of Parks and Recreation, including San Onofre State Beach
- United States Border Patrol
- USMC Base, Camp Pendleton
- City of San Clemente

In cases where it was deemed appropriate, letters requesting information were sent to residents that in the past Land Use Census have identified gardens 500 square feet or greater. The

United States Border Patrol did not respond to our inquiries due to national security so an "estimated hours of occupancy" value of 2400 hours was utilized. It was determined that military personnel would have complete control over the land uses within their jurisdiction. Communication provided by the point of contacts from Camp Pendleton and State Parks was considered final. Agency contact and documentation were completed in compliance with the Land Use Census procedure.

Field Research

During and after the completion of the preliminary research, field research was undertaken to confirm initial findings and obtain further information necessary to complete the Land Use Census. Field research was initiated in mid-August 2017.

Data and Methodology Summary

The appropriate individual or organization was identified for each existing and new LUC location. The individual or organization was contacted to determine the use and occupancy for that location. For each LUC location, the appropriate individual was asked to provide an estimate of annual occupancy based on personal knowledge of the location. The information gathered is summarized in Table 1. Additional information, not required by the ODCM, has been included in Table 2 for historical trending purposes.

Documentation Spreadsheet

Throughout the study, records of contacts and findings were maintained in accordance with the Land Use Census Procedure, SO123-IX-1.20. A documentation spreadsheet was prepared and retained in the Radiological Effluents and Environmental files. The spreadsheet may have telephone notes, agency contacts, Southern California Edison (SCE) memoranda, and any other types of correspondence.

2017 Land Use Census Observations and Changes

The follow observations were noted:

- Historically, several gardens have been identified on Avendia Salvador and documented in the Land Use Census. A drive by was conducted and the following was observed:
    - Only a plot of land existed with an absence of a garden at 788 Avendia Salvador. Its designation was G-17. Since this plot of land has no garden, letters were sent to the owners at 786 Avendia Salvador and 790 Avendia Salvador addresses to verify any potential gardens.
    - The owner at 786 Avendia Salvador in San Clemente located in Sector R, stated that a garden existed on the property. The newly identified garden was given the designation G-19.
    - The owner at 790 Avendia Salvador stated that a garden no longer existed. This garden was given the designation G-20.
- The SONGS indicator garden was relocated to a location near Air Sampler #11 in order to return a portion of the MESA to the Department of the Navy. (from 0.4 miles NNW to 0.7 miles NNW).
- The sewage treatment plant that is northeast of the Mesa property was being upgraded with new storage tanks and equipment. Per the Camp Pendleton contact, this will not be manned continuously. The sewage treatment plant workers are required to check in on the facility 3 to 4 times a day.

Chemical and Toxic Waste

The presence of manufacturing facilities, chemical plants, and toxic waste sites was researched to provide information in detecting any hazardous chemicals, which could impede the operation of SONGS through fire, explosion, or chemical spills. Some manufacturing is located in the northeastern section of the city of San Clemente and is outside the study area. No such uses are allowed to exist in the commercial and residential areas of the city of San Clemente within the study area. In Camp Pendleton, there are no designated manufacturing or chemical use areas within the 5 mile radius of the plant based conversation with Camp Pendleton's Director of Community Plans and Liaison Office.

Milk Animals

No dairies or other facilities producing milk for human consumption were identified in 2017.

Meat Animals

No agricultural meat animals were identified during the 2017 LUC. The only known meat animal pathway land uses is recreational hunting. Deer graze year round on Camp Pendleton.

Growing Season for fleshy and leafy vegetables

Leafy vegetable samples are available at the SONGS garden year round. Fleshy and leafy vegetables were available approximately eight months during 2017 at the SONGS garden.

Desalination Plant in Carlsbad, California

The Carlsbad desalination plant (officially known as the Claude "Bud" Lewis Carlsbad Desalination Plant) opened on December 14, 2015. The plant is 27 miles south of SONGS. It is located on the coast adjacent to the north end of the Encina Power Station. The plant produces approximately 50 million gallons of water per day. It is the largest and most technologically advanced desalination plant in the Western Hemisphere. The plant produces enough water to meet the daily needs of 300,000 San Diego residents

Summary of Changes

For the period of July 1, 2016 to June 30, 2017, the Camp Pendleton deer hunting take data was updated and reflected in Table 3. Per the USMC wildlife biologist, the exact location of a particular kill was not known. The reported take area should be interpreted as an estimate of approximate location. Thus a deer reported taken in hunting area Alpha 2 may actually have been taken in an adjacent hunting area (such as Romeo 3 or Bravo 3). There were no changes to the estimated distances from SONGS to the nearest vegetation potentially consumed by deer from July 1, 2016 through June 30, 2017.

Distances to nearest vegetation typically consumed by deer:

Units 2/3 Sector	Distance from Units 2/3 (miles)
P	0.3
Q	0.3
R	0.2
A	0.1
B	0.1
C	0.1
D	0.1
E	0.2
F	0.3
G	0.1

Table 1 – SONGS 2017 Land Use Census

Units 2/3 Sector	LUC #	Residence	Miles from U2/3	Estimated hours of Maximum Occupancy	LUC #	Gardens	Miles from U2/3	LUC #	Other Specified Uses	Miles from U2/3	hours of Maximum Occupancy
A	R-A1	Camp San Mateo	3.6	FTR				O-8	Camp San Mateo Motor Pool	3.6	2,000
								22	SCE Land Uses	0.4	
B								O-9	USMC CP Sanitary Land Fill	2.1	816
C	R-C2	Camp San Onofre Fire Station #7 52 Area	2.4	FTR				O-10	Camp San Onofre (STP #11)	2.2	2,000
	R-C1	Camp san Onofre Barracks 524101	2.8	FTR							
	R-C3	Camp San Onofre Barracks	2.6	FTR							
D	R-D1	Camp San Onofre Barracks	3.0	FTR							
E	R-E1	Camp Horno Barracks	4.1	FTR				O-5	Camp Horno Motor Pool	4.0	2,500
F								O-1	San Onofre State Beach Guard Shack	0.8	1,500
								31A	Border Patrol Checkpoint (NB)	1.9	2,400*
								31B	Hwy Patrol Weigh Station (NB)	2.1	1,960
G	R-G1-	San Onofre State Park-campsite s#99-104 2 Camp Host Volunteers over 18 yrs.	3.0	FTR				O-2	San Onofre Beach Campground	1.8	720
								32	Hwy Patrol Weigh Station (SB)	2.1	1,960
								O-2A	Endless Summer Surf Camp (see notes) / Campground Host	2.8	4,380
								O-2B	YMCA Surf Camp (see notes)	2	576
	Sectors H, J, K, L, M, and N have no identified land uses These sectors are primarily the Pacific Ocean and contain only a small portion of the plant site, and a beach walkway providing access for state beach park users north & south of SONGS.										
P	R-P3	San Onofre Rec Beach (SORB)	1	FTR	G-3	4130 Calle Isabella	2.8	O-6	Surf Beach (Lifeguard)	0.5	800
	R-P2	San Mateo Point housing	2.7	FTR	G-14	4090 Calle Isabella	2.9	3	Trestles Beach Lookout tower	1.8	500
	R-P1	Cotton point Estates	2.7	FTR				O-2D	Summer Soul Surf Camp	0.5	440
Q	R-Q5	SORB Resident Employee	1.1	FTR	G-8	2240 Ave Salvador	4.1	O-3	State Park Office Trailer	0.69	2,000
	R-Q2	San Onofre III housing	1.4	FTR	G-5	1706 S Ola Vista	4.4	5	Surf Beach Guard Shack	0.7	1,500
	R-Q3	San Mateo Point Housing	2.7	FTR	G-15	130 Calle del Pacifico	4	18	SORB Lifeguard Tower	1.2	2,000
					G-18	115 Ave San Pablo	4.1	1A	SORB Campground Check-in	1.3	2,000
R	R-R1	San Onofre III housing	1.3	FTR	G-10	SONGS Garden	0.4				
					G-19	**788 Ave Salvador**	4.9				

Bold Text indicates a change from the 2016 LUC Data as of 9-30-2017 FTR - Full Time Residence

Table 2

Units 2/3 Sector	LUC #	Residence	Miles from U2/3	Estimated hours of Maximum Occupancy	LUC #	Gardens	Miles from U2/3	LUC #	Other Specified Uses	Miles from U2/3	Estimated hours of Maximum Occupancy
A	R-A2	SONGS Camp Mesa	0.4	FTR				24	Cristianitos Fire Station	5	3,984
B											
C											
D											
E											
F											
G					G-6	1315 S Ola Vista	4.6	O-2C	SurfCamp.com State Beach Surf Camp	2.3	
									did not occupy San Onofre Park in 2012		
Sectors H, J, K, L, M and N have no identified land uses. These sectors are primarily the Pacific Ocean and contain only a small portion of the plant site, and a beach walkway providing access for state beach park users north & south of SONGS.											
P	R-P5	Contractor overnight parking in Lot 4	**0.6**	**1040**							
Q	11	State Parks Main Offices	3.5	FTR	14	3 W San Antonio	4.3	7	SORB Clubhouse (permanently closed per USMC)		
					16	147 W Junipero:	4.1	8	USMC Exchange & Commissary	1.7	2,000
					G-6	1315 S Ola Vista	4.6	9	Basilone Road USMC Entry Gate	2	520
					G-16	432 Ave Crespi	3.8	12	San Mateo Campground	2.9	4,380
								17	Beach Concession (Pier Shack and Grill)	4.5	2,600
								13	Beach Concession (Califia Beach Café)	3.9	1,200
R	20	Sea Ridge Estates	4.5	FTR	G-17	**788 Ave. Salvador (This is an empty lot)**	**4.9**	19	Camp San Mateo (STP#12)	3.7	2,000
	R-R3	SONGS Dry Camping PL12	0.7	2136	G-20	**790 Ave. Salvador**	**4.9**	21	Cristianitos USMC Entry Gate	4.1	520
	R-R2	SONGS Camp Mesa (See notes for Table 1)	0.4	FTR				23	Cristianitos USMC Gas Station	4.1	2,000

Bold Text indicates a change from the 2016 LUC. Data as of 9-30-2017 FTR – Full Time Residence

NOTES FOR TABLES 1 AND 2

RESIDENCES

LUC#	Description
R-A1	CAMP SAN MATEO (barracks)-This is an employment and an FTR land use location for persons 17 and older.
R-A2, R-R2	CAMP MESA-Former FTR and is permanently closed.
R-C2	CAMP SAN ONOFRE FIRE STATION-This is an employment and FTR land use location for persons 18 and older
R-C1, R-C3, R-D1	CAMP SAN ONOFRE (barracks)-This is an employment and FTR land use locations for persons 17 and older
R-E1	CAMP HORNO (barracks)-This is an employment and a FTR land use location for persons 17 and older
R-G1	San Onofre State Park- (2) Camp Host Volunteers live FTR at campsites #99-104.
R-P1	COTTON POINT ESTATES-This is a FTR for all age groups
R-P2, R-Q3	SAN MATEO POINT HOUSING-This is a FTR for all age groups
R-Q2, R-R1	SAN ONOFRE III housing-This permanent housing development is a FTR for all age groups
R-P3, R-Q5	SAN ONOFRE RECREATION BEACH (SORB)-This is a FTR for SORB employees and campground hosts (age 18 & over). This is also a non-employment land use location (camping) for all age groups. A person or family may camp at SORB for a maximum of 60 days per calendar year

VEGETABLE GARDENS

Historically, several gardens have been identified on Avendia Salvador and documented in the Land Use Census. A drive by was conducted and the following was observed:

- Only a plot of land existed with an absence of a garden at 788 Avendia Salvador. Its designation was G-17. Since this plot of land has no garden, letters were sent to the owners at 786 Avendia Salvador and 790 Avendia Salvador addresses to verify any potential gardens.

- The owner at 786 Avendia Salvador in San Clemente located in Sector R, stated that a garden existed on the property. The newly identified garden was given the designation G-19.

- The owner at 790 Avendia Salvador stated that a garden no longer existed. This garden was given the designation G-20.

Based on the updated information, Figure 4 was revised to reflect the current active gardens.

OTHER LUC LOCATIONS CLOSER THAN THE CLOSEST RESIDENCE

LUC#	Description
O-1	SAN ONOFRE STATE BEACH GUARD SHACK-this is an employment land use location for persons 18 and older.
O-2	SAN ONOFRE BEACH CAMPGROUND-This is a non-employment (recreational) and use location for all age groups.
O-2A	ENDLESS SUMMER SURF CAMP/CAMPGROUND HOST-The Endless summer Surf Camp and the State Parks Campground host are located in spaces 100 to 103. The maximum occupancy for persons age 18 and older is 4380 hours. The maximum occupancy for persons 17 and younger is 360 hours. This is both an employment and a non-employment land use location.
O-2B	YMCA Surf Camp
O-2C	Summer Soul Surf Camp- Summer Soul Surf Camp is a day camp that takes place at Dog Patch beach in San Onofre Beach. The maximum occupancy for persons age 18 and older is 440 hours. The maximum occupancy for 17 and younger is 40 hours.
O-3	STATE PARK OFFICE TRAILER-This is an employment land use location for persons 18 and older.
O-5	CAMP HORNO MOTOR POOL-This is an employment land use location for persons 17 and older.
O-6	SURF BEACH (LIFEGUARD)-This is an employment land use location for persons 18 and older.
O-8	CAMP SAN MATEO MOTOR POOL-This is an employment land use location for persons 17 and older.
O-9	USMC CP SANITARY LANDFILL-This is an employment land use location for persons 18 and older.
O-10	CAMP SAN ONOFRE WASTE WATER TREATMENT PLANT (STP #11)-This is an employment land use location for persons 18 and older.
R-C2	SAN ONOFRE FIRE STATION #7 52 AREA-This is an employment land use location for persons 18 and older.
1A	SORB CAMPGROUND CHECKIN-This is an employment land use location for persons 18 and older.
3	TRESTLES BEACH LOOKOUT TOWER-This is an employment land use location for persons 18 and older.
5	SURF BEACH GUARD SHACK-This is an employment land use location for persons 18 and older.
18	SORB LIFEGUARD TOWER-This is an employment land use location for persons 18 and older.
22	SCE Land Uses-Are occupied by unmonitored SCE workers
31A	BORDER PATROL CHECKPOINT-This is an employment land use location for persons 18 and older.
31B 32	HIGHWAY PATROL WEIGH STATIONS-These are employment land use locations for persons 18 and older

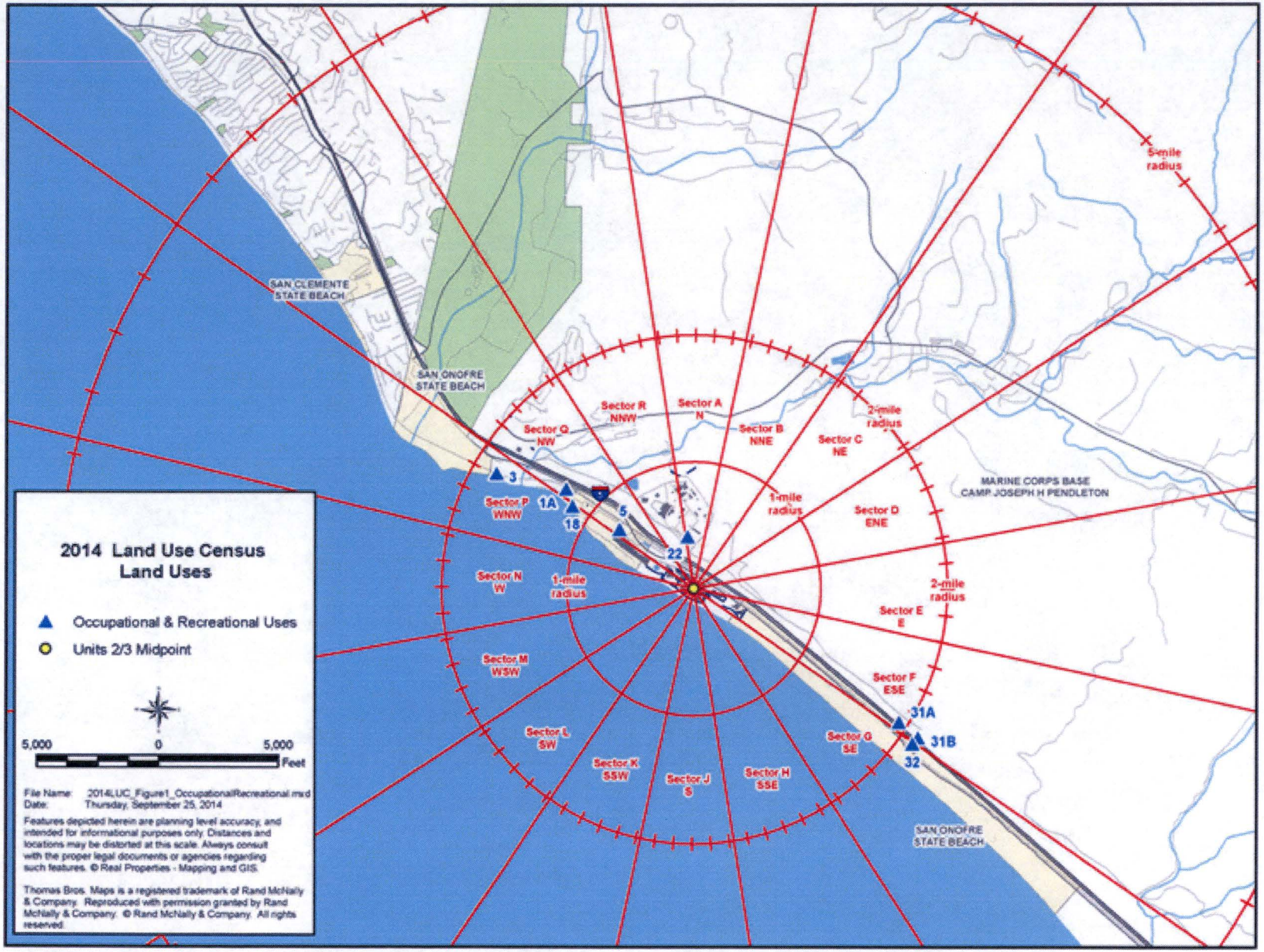
Table 2 Notes:

Table 2 locations are not mapped. The garden land uses listed in Table 2 do not exist (LUC #14 and LUC #16 gardens have been paved over and are no longer able to support vegetation growth). LUC G-6 and G-16 no longer have gardens on property. SONGS Camp Mesa is no longer a residence and is permanently closed. The "other specified uses" locations listed in Table 2 are further away from the midpoint of Units 2/3 that is closest to the full time residence (all age groups) in the corresponding sector. The residences listed in Table 2 are not the closest full time residence in the corresponding sector. The Table 2 locations have been retained for historical trending purposes and are not required by the ODCM. A review of the business need to continue including these locations was closed in March 2013 because these locations were used to track locations that in the past were input for R(i) tables' calculations and they need to remain in the LUC. Refer to NN (Nuclear Notification) 202232049. R-P5Contract Worker in Parking Lot 4-This was a 6 month residence for a contract worker that slept in personal vehicle in between shifts until 4/1/2013 (NN 202649118). This is an inactive residence.

Table 3 – Camp Pendleton Hunting Take Data. July 1, 2016 – June 30, 2017

Area	Deer Hunter Effort	Sm Game Hunter Effort	Deer	Coyote	Dove	Quail	Rabbit	Squirrel	Pigeon
	Hours	Hours							
Alpha-1 B(3),C(3.2)	227	17	1	0	0	0	0	0	0
Alpha-2 E(0.8),D(0.8),C(3)	93	25	2	0	0	0	0	0	0
Alpha-3 D(2.2)	60	320	0	0	0	23	11	6	0
Bravo-2 B(3.8), A(4.2)	77	145	1	0	0	1	2	0	0
Bravo-3 B(1.6),A(1.8),R(1.8)	60	250	0	0	0	0	0	0	0
Romeo-1 E(1)	29	5	1	0	0	0	0	0	0
Romeo-2 E(2.6)	99	28	4	0	0	1	0	0	0
Romeo-3 E(1.4), F(1.5)	88	52	3	0	0	4	0	0	0
Papa-2 & Tango F(5)	55	36	3	0	0	0	4	4	0
Totals	788	653	15	0	0	28	17	10	0

1. The total hunting hours includes time attributable to multiple individuals. This value bounds the maximally exposed individual.


SAN CLEMENTE STATE BEACH
SAN ONOFRE STATE BEACH
5-mile radius
2-mile radius
1-mile radius
Sector R NNW
Sector A N
Sector B NNE
Sector C NE
Sector D ENE
Sector E E
Sector F ESE
Sector G SE
Sector H SSE
Sector J S
Sector K SSW
Sector L SW
Sector M WSW
Sector N W
Sector P WNW
Sector Q NW
MARINE CORPS BASE CAMP JOSEPH H PENDLETON
3
1A
1B
5
22
31A
31B
32
2014 Land Use Census Land Uses
Occupational & Recreational Uses
Units 2/3 Midpoint
5,000 0 5,000 Feet
File Name: 2014LUC_Figure1_OccupationalRecreational.mxd
Date: Thursday, September 25, 2014
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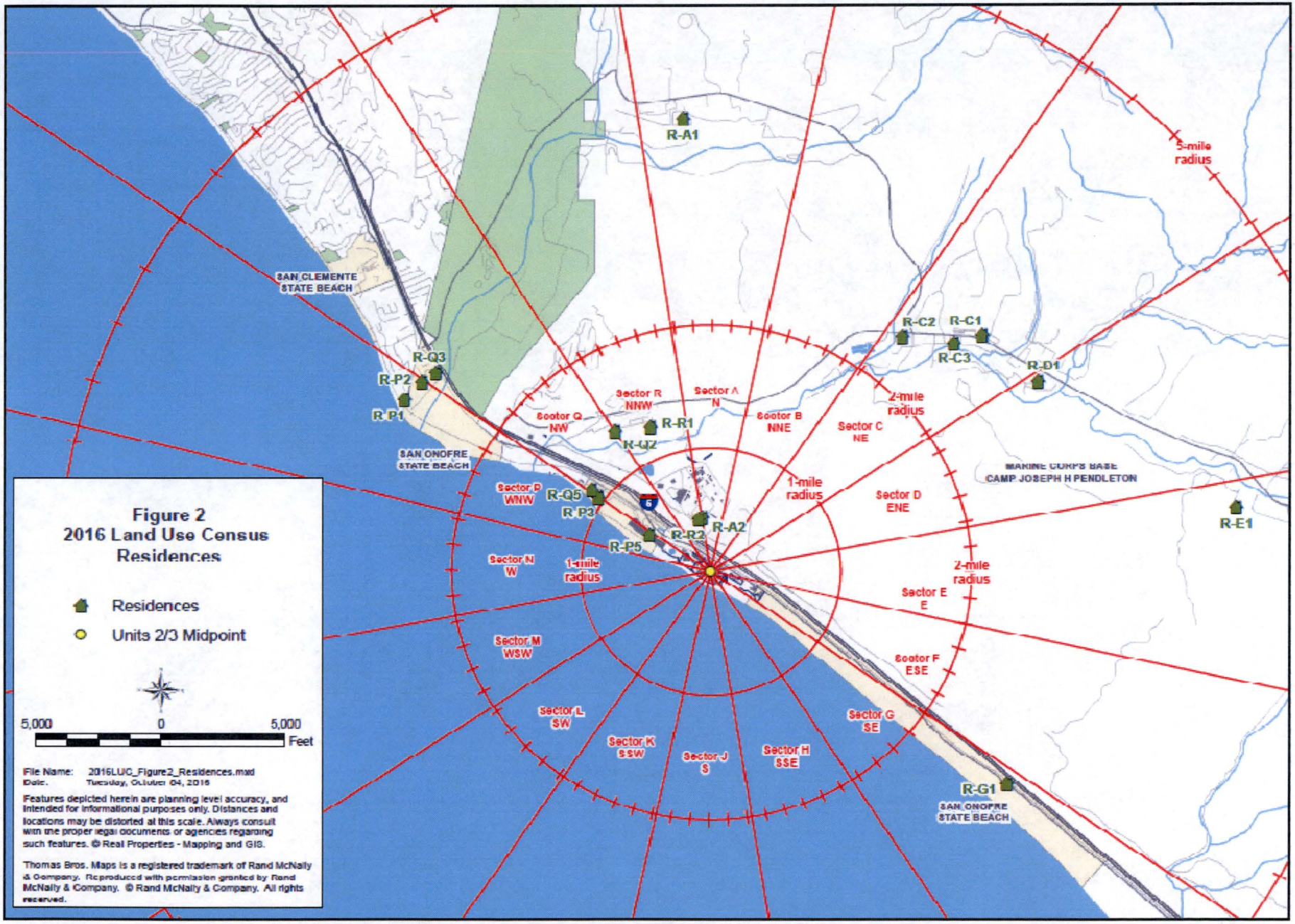
R-A1
5-mile radius
SAN CLEMENTE STATE BEACH
R-C2
R-C1
R-C3
R-D1
R-Q3
R-P2
R-P1
Sector R NNW
Sector A N
2-mile radius
Sector Q NW
R-R1
R-Q2
Sector B NNE
Sector C NE
SAN ONOFRE STATE BEACH
MARINE CORPS BASE CAMP JOSEPH H PENDLETON
Sector P WNW
R-Q5
R-P3
1-mile radius
Sector D ENE
R-R2
R-A2
R-E1
R-P5
Sector N W
1-mile radius
2-mile radius
Sector E E
Sector M WSW
Sector F ESE
Sector L SW
Sector G SE
Sector K SSW
Sector J S
Sector H SSE
R-G1
SAN ONOFRE STATE BEACH
Figure 2
2016 Land Use Census
Residences
Residences
Units 2/3 Midpoint
5,000
0
5,000
Feet
File Name: 2016LUC_Figure2_Residences.mxd
Date: Tuesday, October 04, 2016
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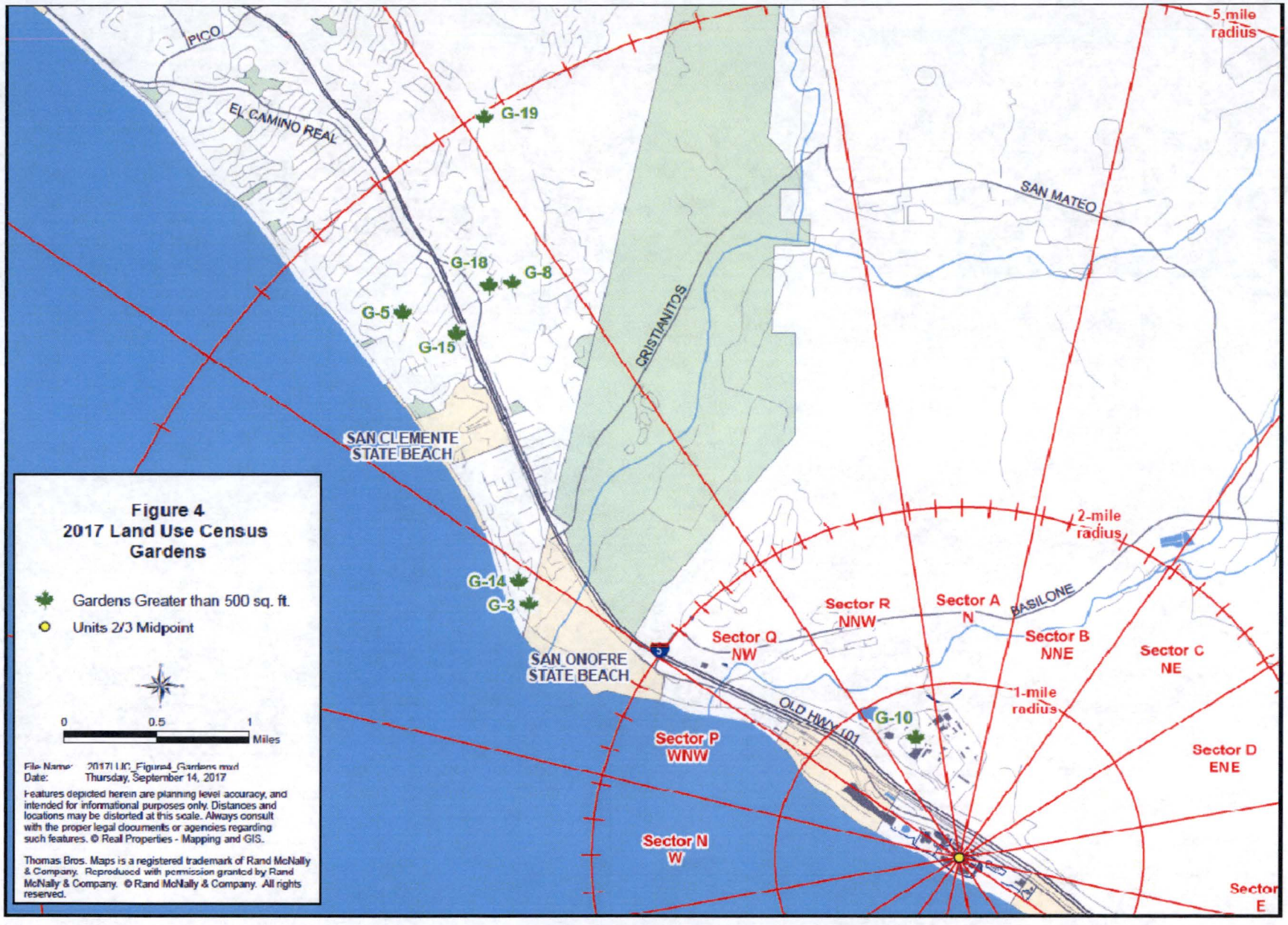
PICO
EL CAMINO REAL
G-19
G-18
G-8
G-5
G-15
CRISTIANITOS
SAN MATEO
5-mile radius
SAN CLEMENTE STATE BEACH
G-14
G-3
SAN ONOFRE STATE BEACH
Sector Q NW
Sector R NNW
Sector A N
BASILONE
Sector B NNE
Sector C NE
2-mile radius
1-mile radius
OLD HWY 101
G-10
Sector P WNW
Sector N W
Sector D ENE
Sector E
Figure 4
2017 Land Use Census
Gardens
Gardens Greater than 500 sq. ft.
Units 2/3 Midpoint
0 0.5 1
Miles
File Name: 2017LUC_Figure4_Gardens.mxd
Date: Thursday, September 14, 2017
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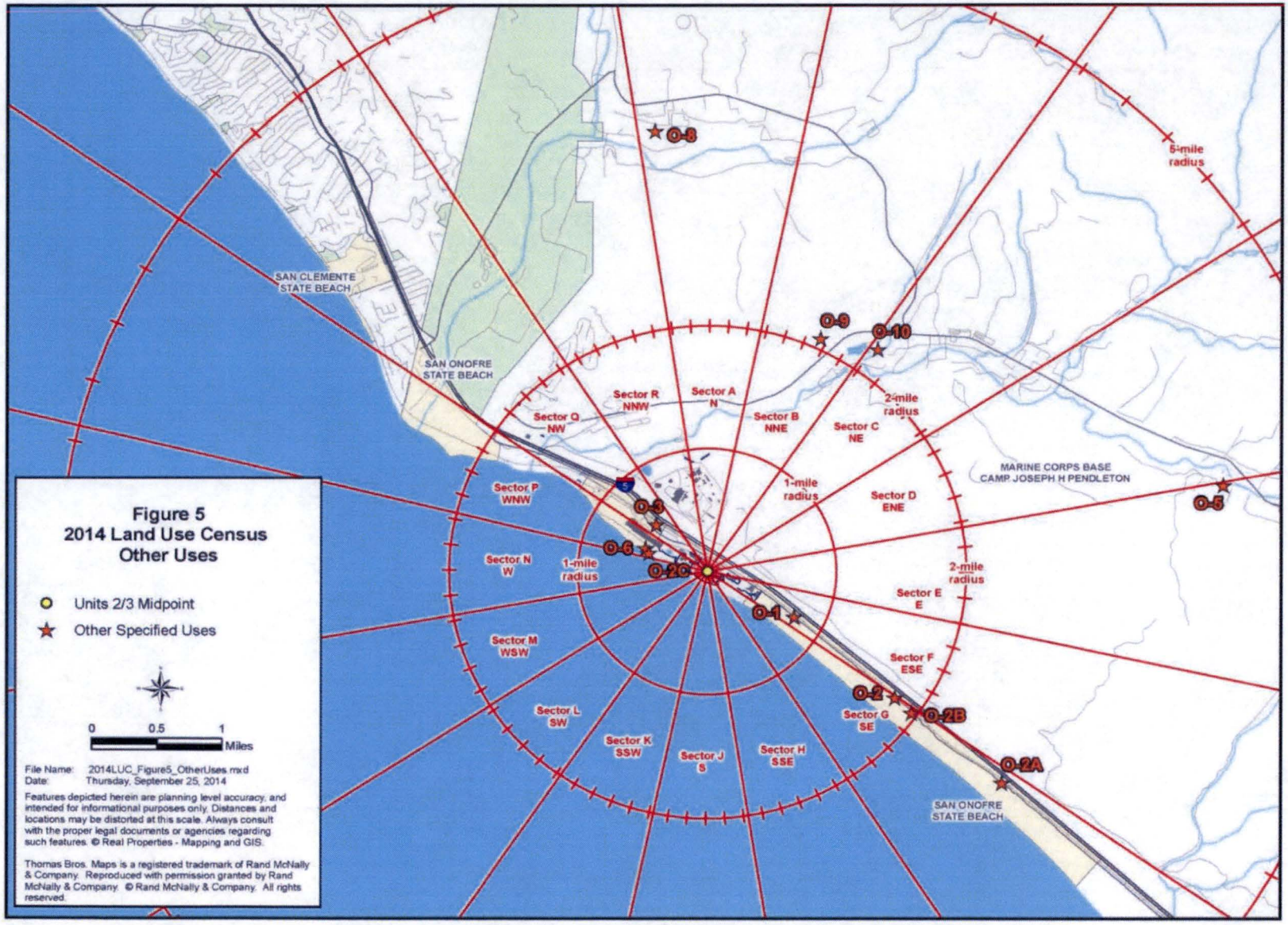
Figure 5
2014 Land Use Census
Other Uses
Units 2/3 Midpoint
Other Specified Uses
0 0.5 1
Miles
File Name: 2014LUC_Figure5_OtherUses.mxd
Date: Thursday, September 25, 2014
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O-8
O-9
O-10
O-3
O-6
O-2C
O-1
O-5
O-2
O-2B
O-2A
5-mile radius
2-mile radius
1-mile radius
SAN CLEMENTE STATE BEACH
SAN ONOFRE STATE BEACH
MARINE CORPS BASE CAMP JOSEPH H PENDLETON
Sector A N
Sector B NNE
Sector C NE
Sector D ENE
Sector E E
Sector F ESE
Sector G SE
Sector H SSE
Sector J S
Sector K SSW
Sector L SW
Sector M WSW
Sector N W
Sector P WNW
Sector Q NW
Sector R NNW

APPENDIX G. ERRATA TO PREVIOUS AREORs

The 2016 AREOR text references incorrect number of cross check samples and an incorrect acceptance rate. Per the 2016 Annual Environmental Quality Assurance (QA) Report, GEL performed 501 individual cross check analyses representative of samples analyzed for SONGS. The accuracy of each result reported to Eckert & Ziegler Analytics, Inc. is measured by the ratio of GEL's result to the known value. Over 98% of the cross-check sample results were acceptable, which satisfies GEL's QA criteria.

APPENDIX H. CDPH CO-LOCATED TLDs

CDPH TLDs CO-LOCATED WITH REMP TLDs DURING 2017

California Department of Public Health (CDPH) maintains a TLD program in the environs of SONGS. Per DPH (Department of Public Health) request, the results of CDPH dosimeters that are co-located with SONGS dosimeters are reported below.

Table 36. 2017 Data from REMP TLDs (mR/ standard quarter)

Location Number	Location Name	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
SCE-1, NRC -7, DPH #2	City of San Clemente	11	7	15	N/A
SCE-2, NRC -23, DPH #8	Camp San Mateo	13	9	16	11
SCE-3, NRC -19, DPH #9	Camp San Onofre	10	8	12	10
SCE-6, DPH #10	Old El Camino Real (Old Highway 101) (ESE)	4	3	5	3
SCE-10, NRC -12, DPH #6	Bluff (Adjacent to PIC #1) (San Onofre Surfing Beach)	13	6	14	8
SCE-22, NRC 11, DPH #4	Former US Coast Guard Station – San Mateo Point	14	10	14	11
SCE-34, NRC -14, DPH #5	San Onofre Elementary School	8	10	12	9
SCE-50, NRC 32, DPH #13	Oceanside Fire Station	9	9	12	9

Note: Requirements in the standard Technical Specifications (TS) adopted under the TS Improvement Program include reporting results of TLDs that are co-located with NRC dosimeters. The NRC dosimeters were exchanged by the CDPH under contract with the NRC. This contract expired in December 1997 and the NRC TLDs were no longer being deployed around SONGS. See Appendix I of the "1997 Radiological Environmental Operating Report", April, 1998

The CDPH TLD results confirm that SONGS does not have a significant impact on direct radiation exposures in the environment.

APPENDIX I. ISFSI TLD DATA

Summary

Per 10 CFR 72.126, SONGS implemented an area monitoring TLD program in the vicinity of the ISFSI. In the fourth quarter of 2001, 21 pre-operational TLDs were deployed in the area around the ISFSI foundation then under construction. This pre-operational TLD data are compared to the data obtained after the commencement of used fuel storage in the ISFSI for the purposes of estimating the additional exposure attributable to the operation of the ISFSI.

An evaluation of the entire REMP TLD database yielded an estimated background exposure rate of approximately 15 mR/std. quarter (91 days). However, some local variability within the CAB / EAB is to be attributable to factors external to SONGS. Another variable for the measured exposure rate is transit exposure to and from the TLD lab. The transit exposure is variable and is corrected by the lab. Therefore, a comparison of pre-operational data and operational data needs to be considered in conjunction with a comparison of ISFSI TLD data and the estimated baseline background exposure rate within the EAB.

Environmental exposure rates are variable and small changes in TLD location can measurably change the data. SONGS REMP TLD data show an environmental seasonal variability that does not appear to be related to any activities at SONGS. The ISFSI TLD data gathered to date appears to follow a similar seasonal variability (Figure 14). In addition to environmental factors, some non-ISFSI work activities at Unit 1 have elevated the pre-operational measured ISFSI TLD exposure.

The storage and transport of radioactive materials and waste near the location of the ISFSI foundation area in 2001 and 2002 appears to have elevated the exposure rates of TLDs 306 to 315. In addition, the movement of the Unit 1 reactor vessel in October 2002 caused a noticeable increase in the measured exposure for TLDs 301 to 315. The measured exposure rate for the ISFSI TLDs close to the ISFSI is consistent with the exposure rate expected from known radiological work activities. The elevated exposure rate from TLDs 301, 302, 303, 304, 323, 324, 325, 326, 327 and 328 is primarily due to the movement and storage of used fuel at the ISFSI.

In the second quarter of 2011 additional TLDs 327 and 328 were placed along the fence on the southwest side of the ISFSI. These TLDs routinely have the highest measured doses, as they did in 2017. These locations, however, are not accessible to members of the public. Publicly accessible REMP TLDs include SCE-55, SCE-56 and SCE-57. Only SCE-55 (San Onofre State Beach) recorded measurable dose, at approximately 14 mrem/yr. In 2016, additional ISFSI TLD locations were added immediately along the fence and seawall south and west of the ISFSI: Locations SCE-339, 340, 341, 342, 343 and 344 (see Figure 13).

Starting in the fourth quarter 2010 neutron dosimeters were placed in ISFSI TLD canisters 311, 324, 325, and 326. In the second quarter 2011 neutron dosimeters were also placed adjacent to TLDs 327 and 328. Beginning in the 4th quarter of 2016, neutron TLDs were co-located with locations SCE-339 through SCE-343. The neutron TLDs were added to obtain neutron information prior to the off load of spent fuel from Units 2 and 3.

The 2017 neutron TLDs identified measurable levels of neutron radiation from spent fuel in storage. A dose equivalent conversion factor for the TLD neutron signal of 10.5 mrem/mR neutron has been applied, based on a similar ISFSI facility at another site. It is being applied to the SONGS TLD results only to provide an estimate of the neutron dose equivalent being measured. The neutron dose is not significant, and has been included in the quarterly results for these locations in Table 37.

Neutron exposure during fuel transfer is measurable at the fence surrounding the storage facility at low levels, estimated to be less than 3 mrem per quarter. These measurements demonstrate that the neutron exposure is bounded by the projected neutron dose rates in calculation SCE-23-0508, is well within the limits specified in 10CFR72.104 (0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid and 0.25 mSv (25 mrem) to any other critical organ, and is consistent with known ISFSI radiological conditions. The measured ISFSI gamma TLD exposure rates were also determined to be consistent with the calculated ISFSI dose rates and known radiological conditions.

The results from all locations at the fence around the ISFSI pad show that a member of the public, if at those locations and adjusted for occupancy per SDS-RP1-PCD-1007, is less than 2 mrem per year, well below regulatory limits.

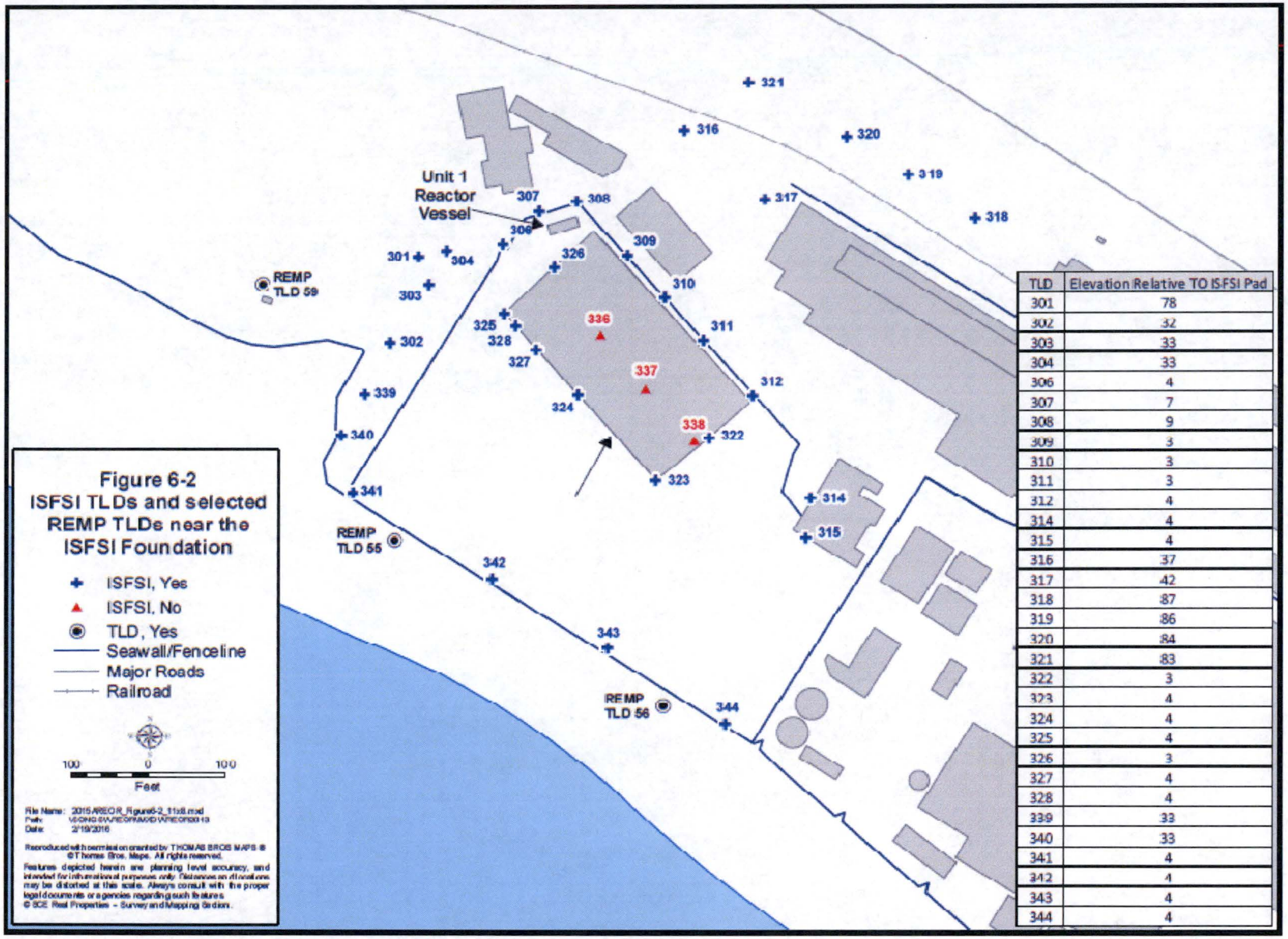
Table 37. 2017 ISFSI TLD Data

TLD (SCE-##)	Location[a]	Qtr. Baseline (mrem)	2017 Quarterly Results (mrem)[d]				Baseline Adjusted Quarterly Results (mrem)				Annual Dose (mrem)	Annual Facility Dose (mrem)	Annual Public Dose[b] (mrem)
			1	2	3	4	1	2	3	4			
301		15.8	18.0	18.0	17.1	17.5	ND	ND	ND	ND	70.6	ND	ND
302		15.8	21.1	21.6	19.8	19.4	5.3	5.8	ND	ND	81.9	18.9	1.1
303		15.8	21.1	20.8	19.7	20.5	5.4	5.0	ND	ND	82.1	19.0	1.1
304		15.8	20.7	20.4	19.2	19.5	ND	ND	ND	ND	79.8	16.7	1.0
306		15.8	21.0	20.8	19.1	19.2	5.3	5.0	ND	ND	80.2	17.1	1.0
307		15.8	17.5	16.6	15.4	15.4	ND	ND	ND	ND	64.9	ND	ND
308		15.8	19.4	19.3	17.6	18.4	ND	ND	ND	ND	74.7	11.6	0.7
309		15.8	19.9	20.4	18.9	18.2	ND	ND	ND	ND	77.5	14.4	0.8
310		15.8	20.3	20.5	18.5	19.2	ND	ND	ND	ND	78.4	15.3	0.9
311	ISFSI-01[c]	15.8	19.5	20.1	18.5	17.8	ND	ND	ND	ND	75.8	12.7	0.7
312		15.8	14.8	15.1	14.8	13.8	ND	ND	ND	ND	58.6	ND	ND
314		15.8	19.4	20.0	19.6	18.8	ND	ND	ND	ND	77.8	14.7	0.8
315		15.8	19.2	19.0	18.9	17.5	ND	ND	ND	ND	74.6	11.6	0.7
316		15.8	15.5	16.0	14.8	14.8	ND	ND	ND	ND	61.0	ND	ND
317		15.8	16.0	16.5	15.0	15.1	ND	ND	ND	ND	62.6	ND	ND
318[e]		15.8	18.4	19.1	18.4	17.4	ND	ND	ND	ND	73.2	10.1	0.6
319[e]		15.8	18.7	20.6	18.8	17.4	ND	ND	ND	ND	75.6	12.6	0.7
320[e]		15.8	18.2	18.9	18.2	17.7	ND	ND	ND	ND	73.0	ND	ND
321[e]		15.8	19.3	19.3	19.4	17.4	ND	ND	ND	ND	75.4	12.3	0.7
322		15.8	16.8	18.4	17.1	16.3	ND	ND	ND	ND	68.6	ND	ND
323		15.8	20.3	20.1	19.4	19.0	ND	ND	ND	ND	78.9	15.8	0.9
324	ISFSI-04[c]	15.8	23.9	25.0	23.1	21.7	8.1	9.2	7.3	5.9	93.7	30.6	1.7
325	ISFSI-03[c]	15.8	23.8	26.5	26.2	22.4	8.0	10.8	10.4	6.6	98.9	35.8	2.0
326	ISFSI-02[c]	15.8	24.7	22.5	22.7	19.2	8.9	6.7	6.9	ND	89.1	26.0	1.5
327	ISFSI-05[c]	15.8	43.4	48.7	44.5	49.2	27.6	32.9	28.8	33.4	185.8	122.7	7.0
328	ISFSI-06[c]	15.8	44.8	49.3	34.0	36.1	29.0	33.6	18.2	20.3	164.1	101.0	5.8
339	ISFSI-08[c]	15.8	20.0	20.7	19.2	19.4	ND	ND	ND	ND	79.2	16.2	0.9
340	ISFSI-09[c]	15.8	18.7	19.4	17.5	18.3	ND	ND	ND	ND	73.9	10.9	0.6
341	ISFSI-10[c]	15.8	19.7	21.6	18.6	18.9	ND	5.8	ND	ND	78.8	15.7	0.9
342	ISFSI-11[c]	15.8	21.3	21.6	20.0	20.0	5.6	5.9	ND	ND	83.0	19.9	1.1

TLD (SCE-##)	Location[a]	Qtr. Baseline (mrem)	2017 Quarterly Results (mrem)[d]				Baseline Adjusted Quarterly Results (mrem)				Annual Dose (mrem)	Annual Facility Dose (mrem)	Annual Public Dose[b] (mrem)
			1	*2*	*3*	*4*	*1*	*2*	*3*	*4*			
343	ISFSI-12[c]	15.8	21.4	22.5	18.9	20.9	5.6	6.7	ND	5.1	83.7	20.6	1.2
344		15.8	20.3	20.0	17.8	17.0	ND	ND	ND	ND	75.1	12.0	0.7
55	San Onofre State Beach (U1 West) ISFSI-07[c]	15.8	18.6	18.3	18.3	18.6	ND	ND	ND	ND	73.8	10.7	0.4
56	San Onofre State Beach (U1 West)	15.8	15.4	17.6	15.1	17.2	ND	ND	ND	ND	65.3	ND	ND
57	San Onofre State Beach (Unit 2)	15.8	16.7	17.7	16.6	16.9	ND	ND	ND	ND	67.9	ND	ND

Notes:

a. ISFSI TLDs are placed around the ISFSI pad, and not in locations accessible to the general public.
b. Public dose is based on the individual location occupancy as specified in SDS-RP1-PCD-1007.
c. Station includes neutron dose, estimated using a neutron signal (R_n) conversion factor of 10.5*R_n/rem (HPSTID 08-015)
d. 1.051 mrem/mR from ANSI N13.37-2014, Section 3.2.1
e. These TLDs are publicly accessible.



TLD	Elevation Relative TO IS-FSI Pad
301	78
302	32
303	33
304	33
306	4
307	7
308	9
309	3
310	3
311	3
312	4
314	4
315	4
316	37
317	42
318	87
319	86
320	84
321	83
322	3
323	4
324	4
325	4
326	3
327	4
328	4
339	33
340	33
341	4
342	4
343	4
344	4

Indicates historical TLD locations that are no longer used

Figure 13 – SONGS ISFSI and Selected REMP TLD Locations

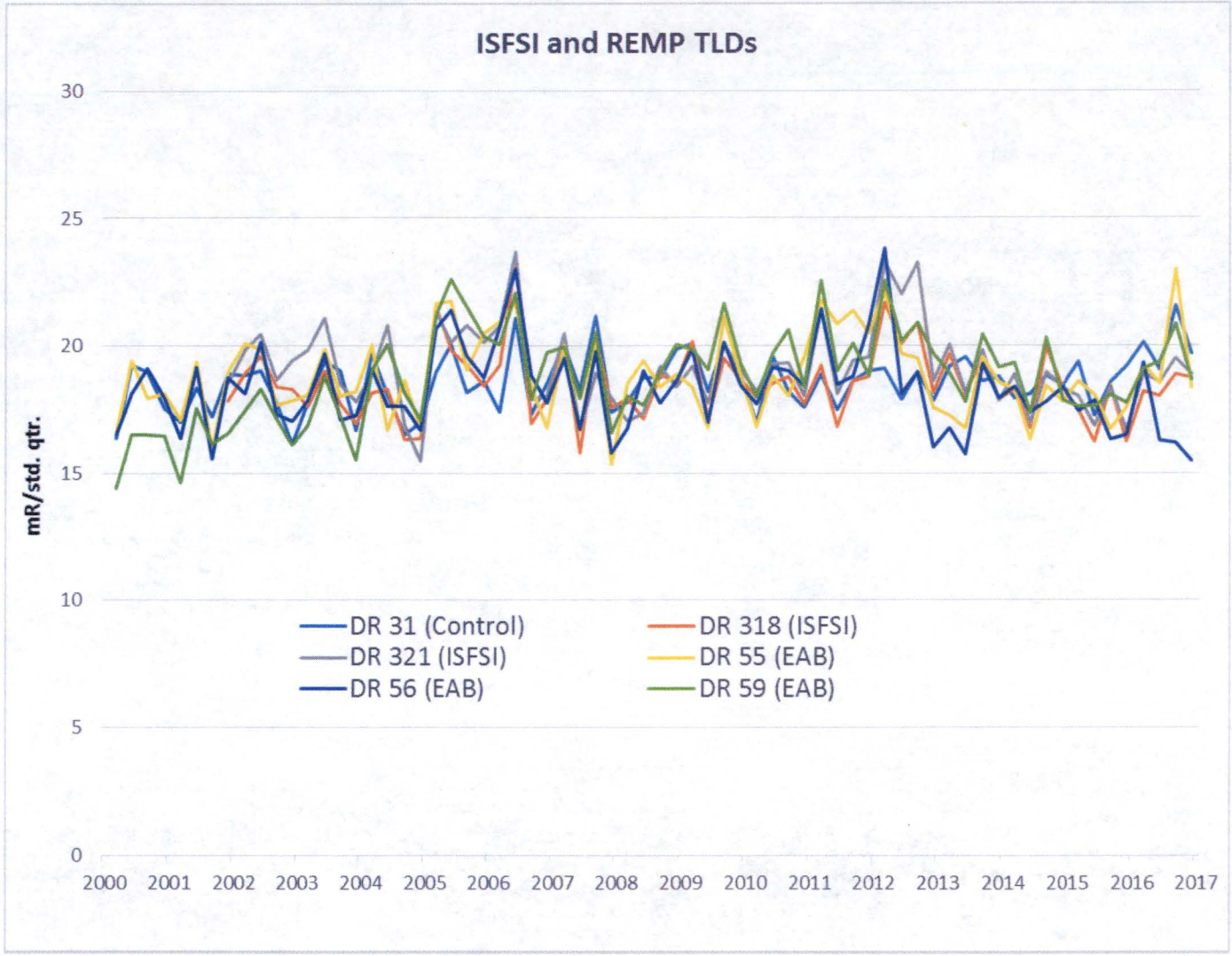


Figure 14 - ISFSI and REMP TLDs

APPENDIX J. OFFSITE GROUND WATER SAMPLING

Offsite Drinking Water Data

All investigations have shown that there are no drinking water pathways at SONGS. Figure 15 below illustrates groundwater well locations along with the flow of the groundwater. The operation of SONGS had no impact on drinking water wells in the vicinity of SONGS.

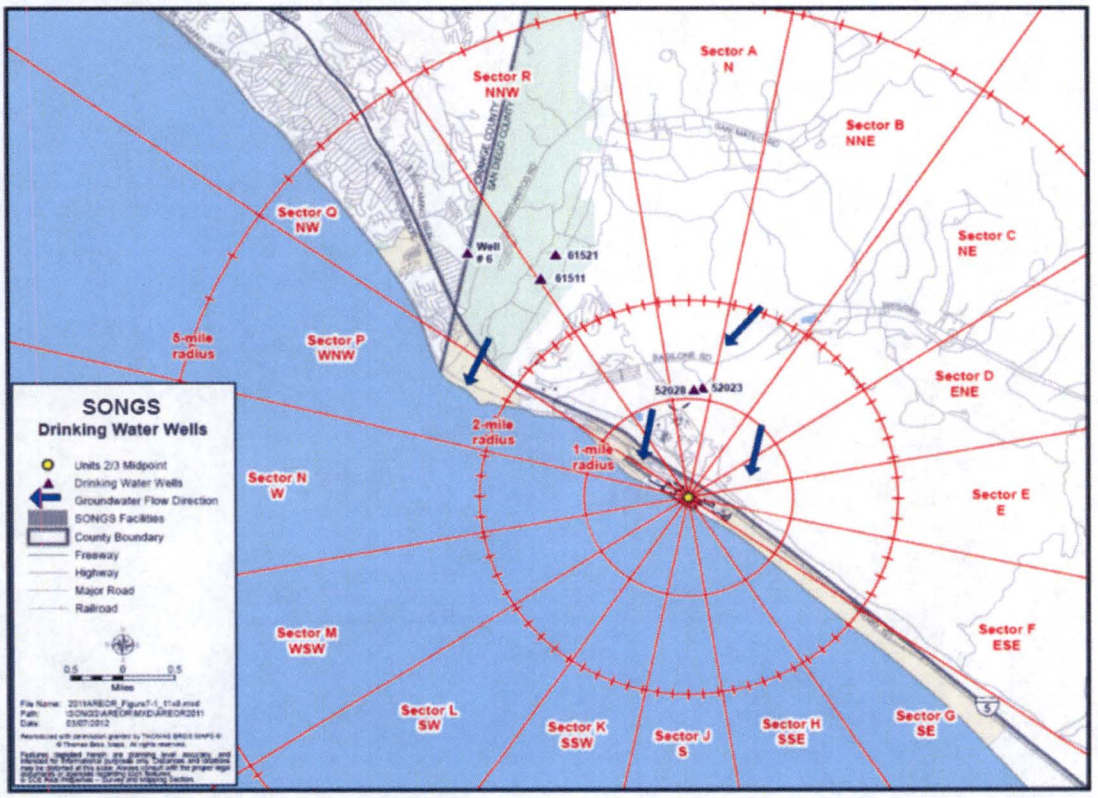


Figure 15 – Closest Drinking Water Wells

Glossary

a posteriori After the fact

a priori Before the fact

ALARA As Low As is Reasonably Achievable means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Cosmogenic nuclides Radionuclides (or isotopes) created when a high-energy cosmic ray interacts with the nucleus of an atom. These isotopes are produced within Earth materials such as rocks or soil, in Earth's atmosphere, and in extraterrestrial items such as meteorites. Radioactive isotopes beryllium-7 and beryllium-10 fall into this series of three light elements (lithium, beryllium, boron) formed mostly[citation needed] by cosmic ray spallation nucleosynthesis, both of these nuclides have half-lives too short for them to have been formed before the formation of the Solar System, and thus they cannot be primordial nuclides. Since the cosmic ray spallation route is the only possible source of beryllium-7 and beryllium-10 occurrence naturally in the environment, they are therefore cosmogenic.

Below is a list of radioisotopes formed by the action of cosmic rays in the atmosphere; the list also contains the production mode of the isotope.

Isotope	Mode of formation
^{3}H (tritium)	^{14}N (n, $^{12}C)^{3}H$
^{7}Be	Spallation (N and O)
^{10}Be	Spallation (N and O)
^{11}C	Spallation (N and O)
^{14}C	^{14}N (n, p) ^{14}C
^{18}F	^{18}O (p, n)^{18}F and Spallation (Ar)
^{22}Na	Spallation (Ar)
^{24}Na	Spallation (Ar)
^{28}Mg	Spallation (Ar)
^{31}Si	Spallation (Ar)
^{32}Si	Spallation (Ar)
^{32}P	Spallation (Ar)
^{34m}Cl	Spallation (Ar)
^{35}S	Spallation (Ar)
^{36}Cl	^{35}Cl (n, γ)^{36}Cl
^{37}Ar	^{37}Cl (p, n)^{37}Ar
^{38}Cl	Spallation (Ar)

^{39}Ar	^{38}Ar (n, γ)^{39}Ar
^{39}Cl	^{40}Ar (n, np)^{39}Cl & spallation (Ar)
^{41}Ar	^{40}Ar (n, γ)^{41}Ar
^{81}Kr	^{80}Kr (n, γ) ^{81}Kr

Decay Series

There are three naturally occurring decay series of heavy elements that transform into a series of various radioactive elements by releasing energy in the form of particles, (such as alpha or beta), and/or gamma rays to end in a stable form of non-radioactive Lead. All three decay series start with extremely long lived radioactive, heavy elements that can be measured in geologic time units. They are Uranium-238 with an approximate half-life of 4.5 billion years, Uranium -235 with a half-life of about 700 million years, and Thorium- 232 with a half-life of 14 billion years. All three series contain some more well-known radioactive species, Radium and Radon.

Distinguishable from background

Detectable concentration of a radionuclide that is statistically different from the background concentration of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques.

Dose

The amount of radiation that is absorbed by a person's body. In the radiation field the term dose is sometimes used interchangeably with dose equivalent, which is defined as the rem and described below.

fCi/m^3

acronym for a femto-curie per cubic meter, which is a concentration unit that defines how much radioactivity is present in a particular air volume, such as a cubic meter. A curie, named after its discoverers Pierre and Marie Curie, is defined as the rate at which a radioactive element transforms itself into another element that is most often another radioactive element. It is mathematically equivalent to 37 billion disintegrations or transformations per second. A "femto" is a scientific prefix for an exponential term that is equivalent to one quadrillionth (1/1,000,000,000,000,000).

Half-life

A measure of how fast half the mass of a radioactive element will transform itself into another element. Each radioactive element has its own unique rate of transformation. Consequently, if a radioactive element, such as Iodine-131 has a half-life of 8 days, then in 8 days half of the original amount of Iodine-131 will be gone; in another 8 days half of that half will be left and so on.

Gamma Spectroscopy

A scientific method used to analyze gamma rays emanating from radioactive elements. The analytical system determines the gamma ray energy which acts as a "fingerprint" for specific radioactive materials. For example, Potassium-40 (K-40) has a very, distinctive gamma energy at 1460 keV. This uniqueness allows the instrument to positively identify the K-40 1460 energy as its own unique fingerprint. A keV is an abbreviation for kilo electron volt, which is a measure of energy at the atomic level. A kilo is a scientific prefix for the multiplier 1,000.

Gross Beta	A simple screening technique employed to measure the total number of beta particles emanating from a potentially radioactive sample, with higher values usually indicating that the sample contains natural and/or man-made radioactive elements. High values would prompt further analyses to identify the radioactive species. A beta is a negatively charged particle that is emitted from the nucleus of an atom with a mass equal to that of an orbiting electron.
Liquid Scintillation	An analytical technique by which Tritium and many other radioactive contaminants in water are measured. A sample is placed in a special glass vial that already contains a special scintillation cocktail. The vial is sealed and the container vigorously shaken to create a homogeneous mix. When the tritium transforms or decays it emits a very low energy beta particle. The beta interacts with the scintillating medium and produces a light pulse that is counted by the instrument. Although a different scintillation cocktail is used, this is basically how radon in well water is measured.
Millirem (mrem)	one thousandth (1/1000) of a rem.
milliRoentgen (mR)	one thousandth (1/1000) of a Roentgen
pCi/kg	an acronym for a pico-curie per kilogram, which is a concentration unit that defines how much radioactivity is present in a unit mass, such as a kilogram. A "pico" is a scientific prefix for an exponential term that is equivalent to one trillionth (1/1,000,000,000,000).
pCi/L	an acronym for a pico-curie per liter, which is a concentration unit that defines how much radioactivity is present in a unit volume, such as a liter.
Rem	an acronym for roentgen equivalent man. It is a conventional unit of dose equivalent that is based on how much of the radiation energy is absorbed by the body multiplied by a quality factor, which is a measure of the relative hazard of energy transfer by different particles, (alpha, beta, neutrons, protons, etc.), gamma rays or x-rays. In comparison the average natural background radiation dose equivalent to the United States population is estimated to be 292 millirems per year, or 0.8 millirem per day, with 68 % of that dose coming from radon. A millirem is one thousandth, (1/1000), of a rem.
Roentgen	a special unit of exposure named after the discoverer of X-Rays, Wilhelm Roentgen. It is a measure of how much ionization is produced in the air when it is bombarded with X-Rays or Gamma Rays. Ionization is described as the removal of an orbital electron from an atom.
Skyshine	is radiation from a radioactive source that bounces off air molecules in the sky, much like a cue ball does off the banking of a billiard table, and is scattered/redirected back down to the earth.
Thermoluminescent Dosimeters (TLD)	very small plastic-like phosphors or crystals that are placed in a small plastic cage and mounted on trees, posts, etc. to absorb any radiation that impinges on the material. Special readers are then used to heat the plastic to release the energy that was stored when the radiation was absorbed by the plastic. The energy released is in the form of invisible light and that light is counted by the TLD reader. The intensity of the light emitted from the crystals is directly proportional to the amount of radiation that the TLD

	phosphor was exposed to.
Site Area Boundary (SAB)	SONGS SAB is defined as that line beyond which the land is not owned, leased, or otherwise controlled by the licensee; from ODCM definition.
Tritium (Hydrogen-3 or H-3)	a special name given to the radioactive form of Hydrogen usually found in nature. All radioactive elements are represented as a combination of their chemical symbol and their mass number. Therefore, Tritium, which is a heavy form of the Hydrogen molecule with one proton and two neutrons in the nucleus of its atom, is abbreviated and represented by its chemical symbol, H, for Hydrogen and 3 for the number of particles in its nucleus, or mass number. Similarly, other radioactive elements, such as Potassium-40, can be represented and abbreviated as K-40, and so on