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Al Bates
Manager
Regulatory Affairs &
Nuclear Oversight

May 7, 2019

10 CFR 50.36a

ATTN: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Subject: **Docket Nos. 50-206, 50-361, 50-362 and 72-41**
2018 Annual Radiological Environmental Operating Report
San Onofre Nuclear Generating Station (SONGS) Units 1, 2 and 3 and Independent Spent Fuel Storage Facility

Dear Sir or Madam:

As required by San Onofre Nuclear Generating Station (SONGS) Unit 1 Permanently Defueled Technical Specification (TS) Section D6.9.1.3 and SONGS Units 2 and 3 Permanently Defueled TS Section 5.7.1.2, "Annual Radiological Environmental Operating Report," Southern California Edison (SCE) is submitting the 2018 Annual Radiological Environmental Operating Report (AREOR) for SONGS Units 1, 2 and 3. The AREOR covers the operation of SONGS during January 1, 2018 through December 31, 2018 and includes summaries, interpretations, and analyses of trends of the results of the Radiological Environmental Monitoring Program (REMP).

In addition, the AREOR includes the results for direct radiation monitoring near the Independent Spent Fuel Storage Installation.

This letter does not contain any commitments.

If you have any questions or require additional information, please contact me at (949) 368-6945.

Sincerely,

Enclosure: 2018 San Onofre Nuclear Generating Station Annual Radiological Environmental Operating Report

cc: S. Morris, Regional Administrator, NRC Region IV
M. G. Vaaler, NRC Project Manager, SONGS Units 1, 2 and 3
I. Schneider, California Department of Public Health

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Enclosure

2018 San Onofre Nuclear Generating Station Annual Radiological Environmental Operating Report

San Onofre Nuclear Generating Station
2018
Annual Radiological Environmental Operating Report

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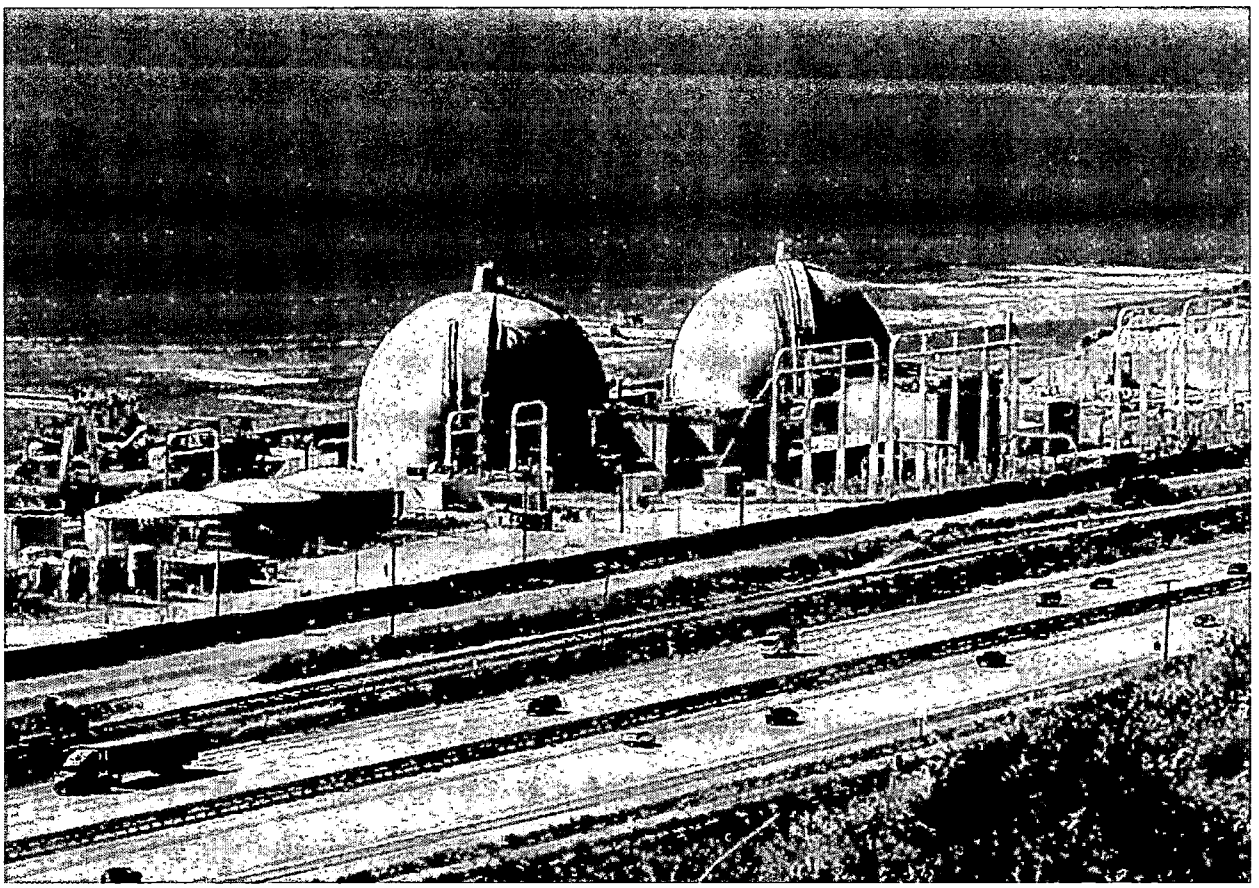
License Numbers:
DPR-13, NPF-10, NPF-15



This 2018 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 2018 AREOR covers the results of the environmental monitoring performed around SONGS during the time period January 1, 2018 through December 31, 2018.

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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 Radiological Environmental Monitoring Program (REMP) supports the conclusion that San Onofre has had an inconsequential radiological impact on the environment and that it is well within applicable state and federal regulations.

The (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 2018 sampling locations and location maps are included in Appendix A of this report.

The California Department of Public Health (CDPH) Drinking Water and Sanitation Laboratory participated in an inter-laboratory split sampling program with SONGS, including ocean water tritium samples and gamma isotopic samples from various environmental media. The results are discussed in Appendix C. The CDPH also conducted a direct radiation (TLD) monitoring program in conjunction with SONGS. Refer to Appendix H.

This report describes the REMP as conducted at SONGS during the period from January 1, 2018 through December 31, 2018. The REMP produces scientifically defensible data indicating SONGS had no significant radiological environmental impact in 2018. This report fulfills applicable license commitments, as described in DPR-13, NPF-10, NPF-15, and the Offsite Dose Calculation Manual (ODCM).

Beyond the immediate area of the ISFSI, the REMP data collected during 2018, 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). Cs-137 in soil is attributable to fallout from nuclear weapons testing and sources external to SONGS such as the Chernobyl accident. I-131 is detected in kelp due to the sewage discharge of medically administered I-131 and to the high biomagnification factor for iodine in kelp. 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 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 2018 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 1 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

Program Overview

The purpose of the REMP is to characterize the radiological environment outside of the power block and to detect potential radiological impacts resulting from activities at SONGS Units 2 and 3. The REMP monitors credible pathways of exposure to the public and fulfills 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) that are placed around the plant site and in the local environment.

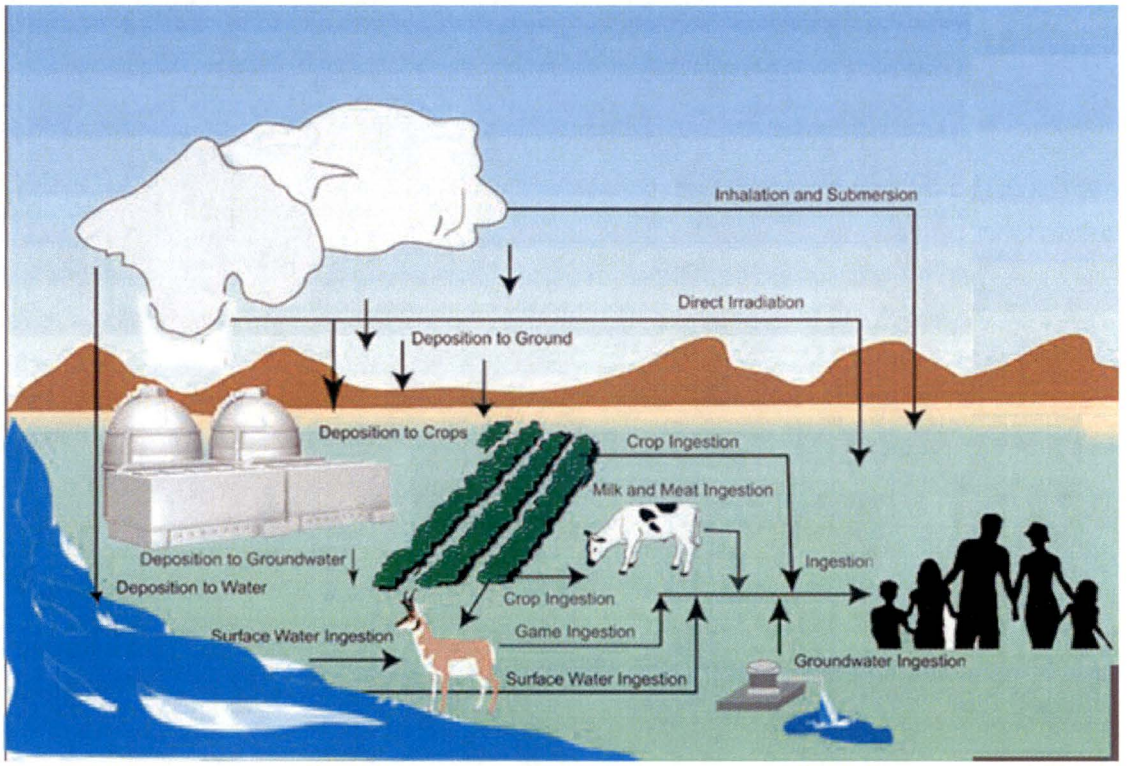


Figure 1 - Examples of Exposure Pathways

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.

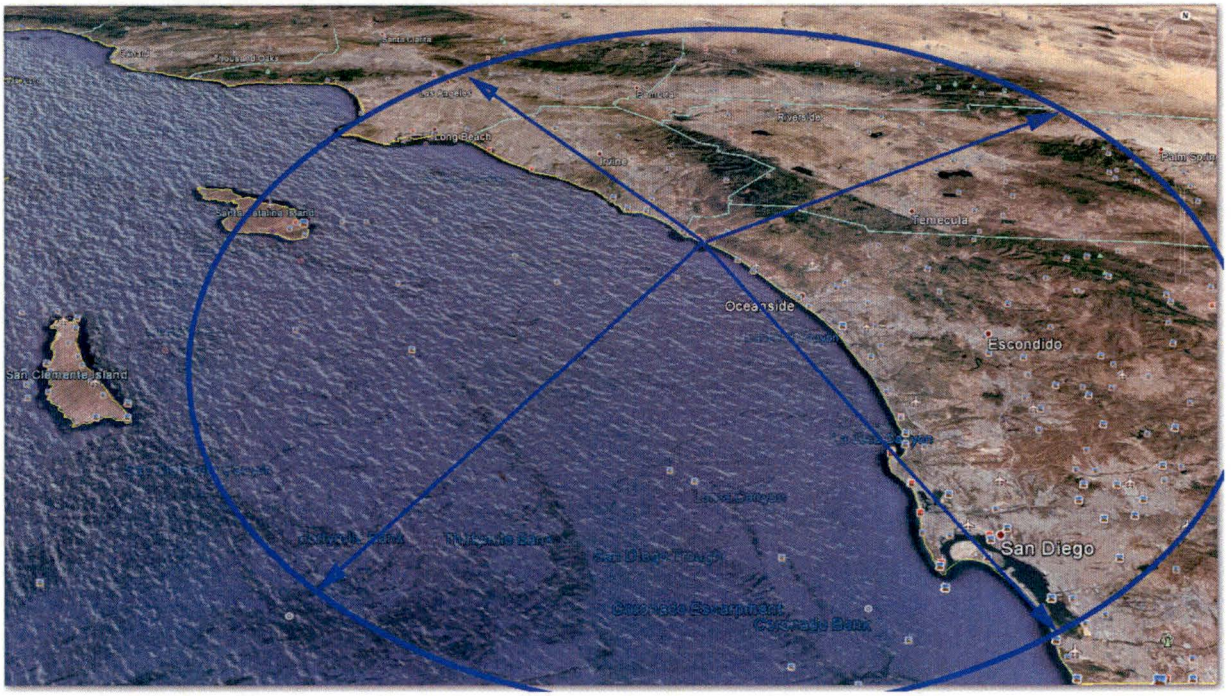


Figure 2 - SONGS 45 mile REMP Radius

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%).

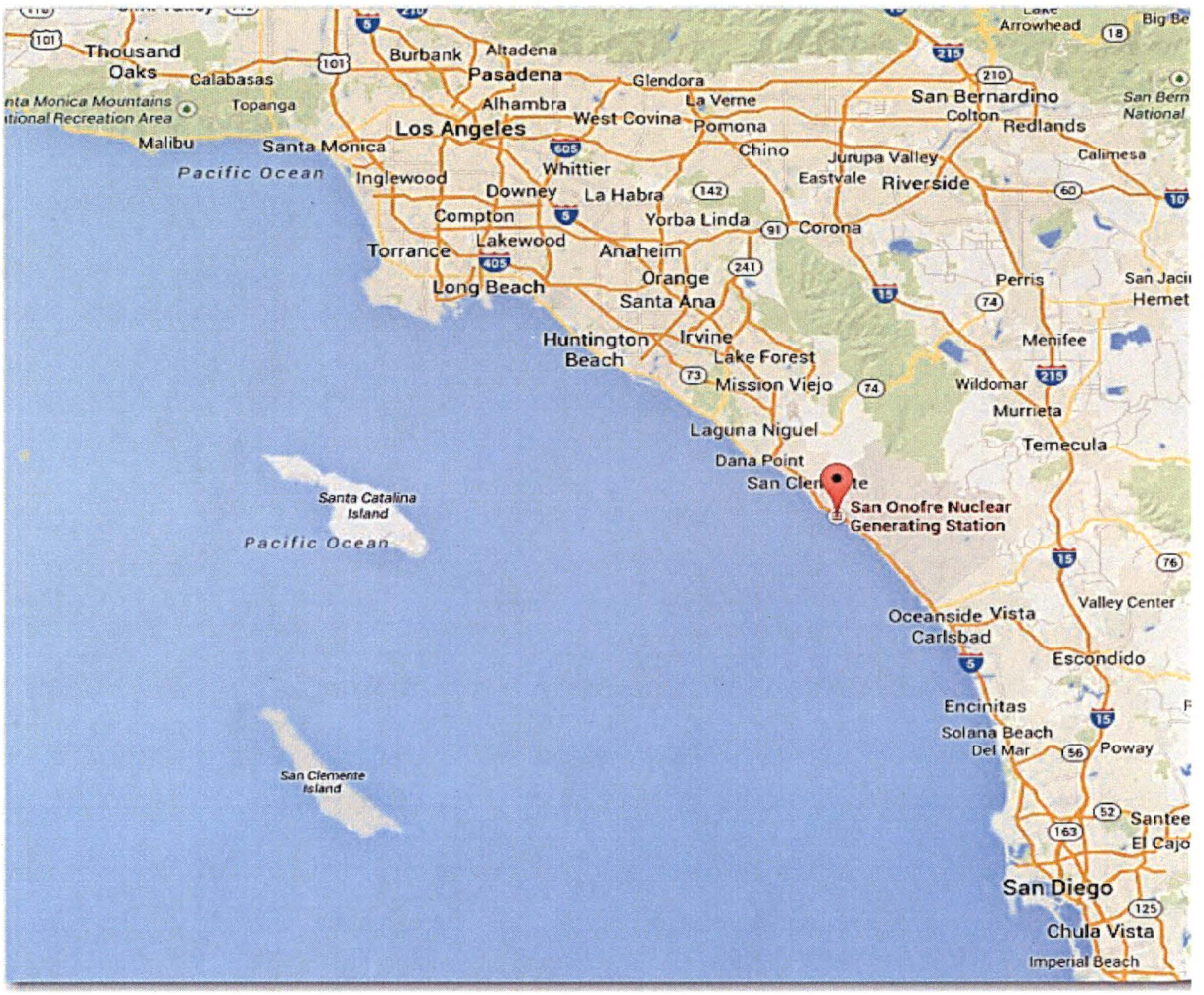


Figure 3 - SONGS Location

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.

Sample Collection and Analyses

Samples of environmental media were obtained in accordance with the requirements of the ODCM to meet the regulatory requirements. Refer to Appendix A for a complete list of REMP sample locations as described in Table 5-4 of the ODCM.

Indicator samples close to SONGS are compared to control samples located in areas that are beyond the measurable influence of San Onofre. The control sample results 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 unrelated to activities at SONGS, such as sewage plant discharges of nuclear medicine applications or nuclear fallout attributable to external sources (legacy fallout from nuclear weapons, the nuclear accident at Chernobyl, and the nuclear accident at Fukushima). The indicator location samples are used to detect environmental radioactivity attributable to SONGS. Indicator sample locations 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.

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 each 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 radionuclides. Values flagged by the CEAL as being confirmed above the MDC are presumed to detected levels of radioactivity.

- **No Detectable (ND)** – The term ND refers to Thermoluminescent Dosimeter (TLD) data analyzed per ANSI 13.37-2014 (Environmental Dosimetry-Criteria for System Design and Implementation) that is less than the ANSI calculated detection limit above a specific location's baseline. A baseline is calculated per ANSI methods for each specific location because the direct radiation signal is a strong function of very local conditions. If the TLD data for a specific location is less than that specific location's baseline plus the ANSI calculated detection limit then the value is ND for that specific measurement.

The sampling and analyses for the REMP are conducted in accordance with the ODCM and the applicable regulatory requirements.

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 2018 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 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 10 CFR 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

NRC Reporting Limits

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 if any environmental sample value exceeds the corresponding reporting limit. SONGS did not submit any special reports to the NRC in 2018, as no reporting limits were exceeded.

Summary of Analysis of Results and Trends

The 2018 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 and are compared against NRC reporting levels. 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.

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				

Table 1 - Maximum LLDs as Specified in SONGS ODCM

The impact of SONGS on the surrounding environment is assessed through a series of analyses. These analyses include: 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 2018 Land Use Census (Appendix F).

A detailed discussion of the 2018 analytical results is presented in this report. Analytical values from offsite indicator sample stations continue to trend with the control stations. The only anthropogenic radionuclides detected in REMP samples were not related to SONGS. The medical radioisotope, iodine-131, discharged to the ocean through sewage plant outfalls, was detected in kelp. The Cs-137 detected in soil is attributable to legacy nuclear weapons testing fallout and other events (Chernobyl) unrelated to SONGS.

The data indicate that SONGS had no significant radiological impact on the environment during 2018. 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 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. However, the level of Cs-137 found in control and indicator samples or soil is consistent with historical and expected Cs-137 concentrations from nuclear weapons testing. Since SONGS is no longer operating, it is not plausible for SONGS to generate or discharge I-131 (half-life 8 days). The I-131 in kelp is unrelated to any 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 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 2018; no changes in the sampling media or sample locations were required.

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.

The California Department of Public Health (CDPH) participates in a split sampling program in accordance with the site's REMP procedures. Duplicate radiological split sampling 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. The 2018 CDPH data is substantially similar to the 2018 SONGS REMP data with the exception of I-131 in kelp. The SONGS lab detected I-131 in kelp; the CDPH lab did not detect I-131 in kelp.

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 2018 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 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 2018 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 SONGS above background in any REMP sample. It is concluded that activities at SONGS in 2018 had no observable radiological environmental impact.

7 References

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

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	Southeast 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
56	San Onofre State Beach (U1 West)	0.2[b]	W

DIRECT RADIATION MEASURING LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
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	Former 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)	29.2	NW

Table 8 – Local Crops Sampling Locations

LOCAL CROPS SAMPLING (TFB VG) LOCATION		DISTANCE[a] (miles)	DIRECTION[a] (Sector)
2	Oceanside (Control)	15 to 25	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 to SE
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. 13. 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 2018, 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

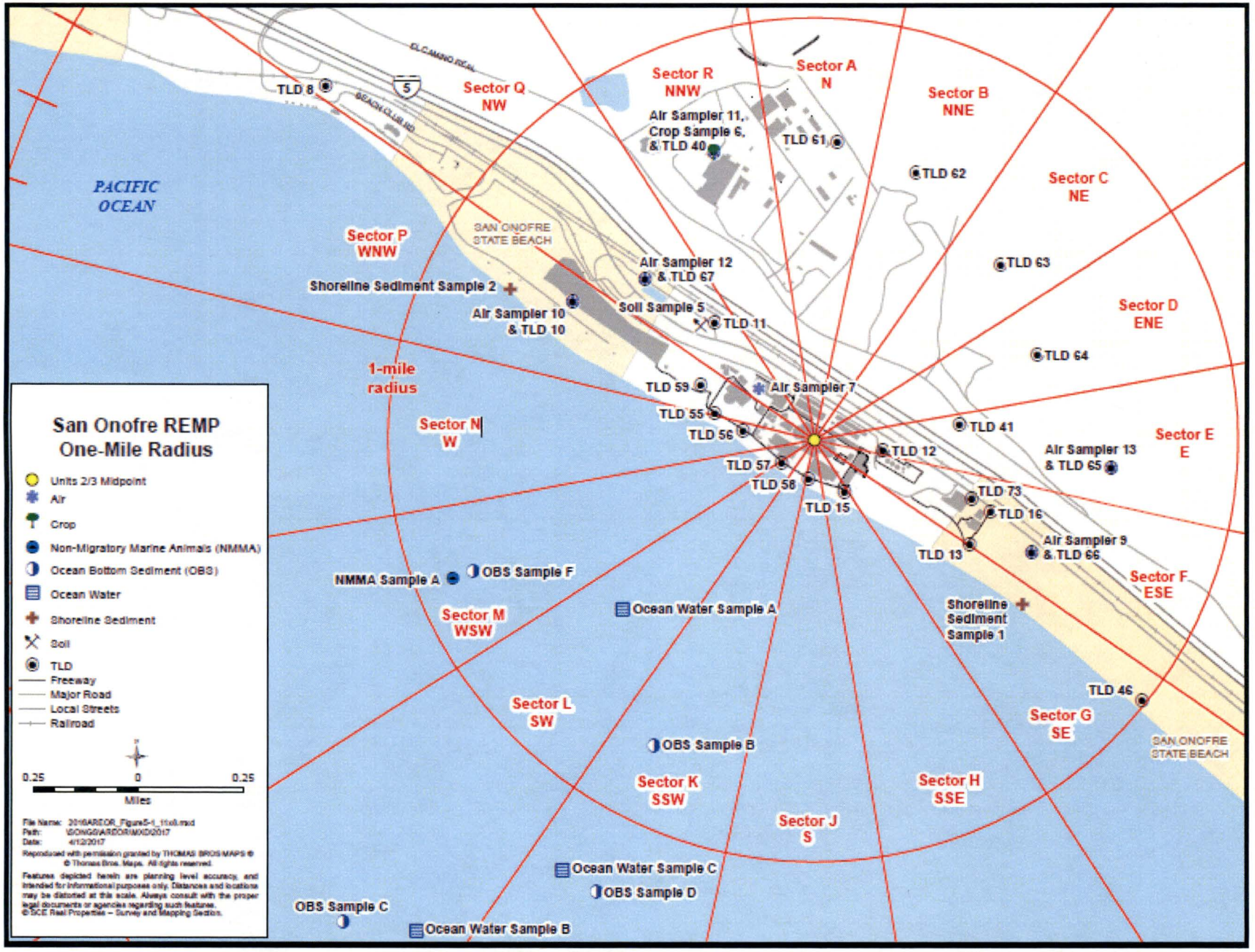


Figure 4 - SONGS REMP One Mile Radius

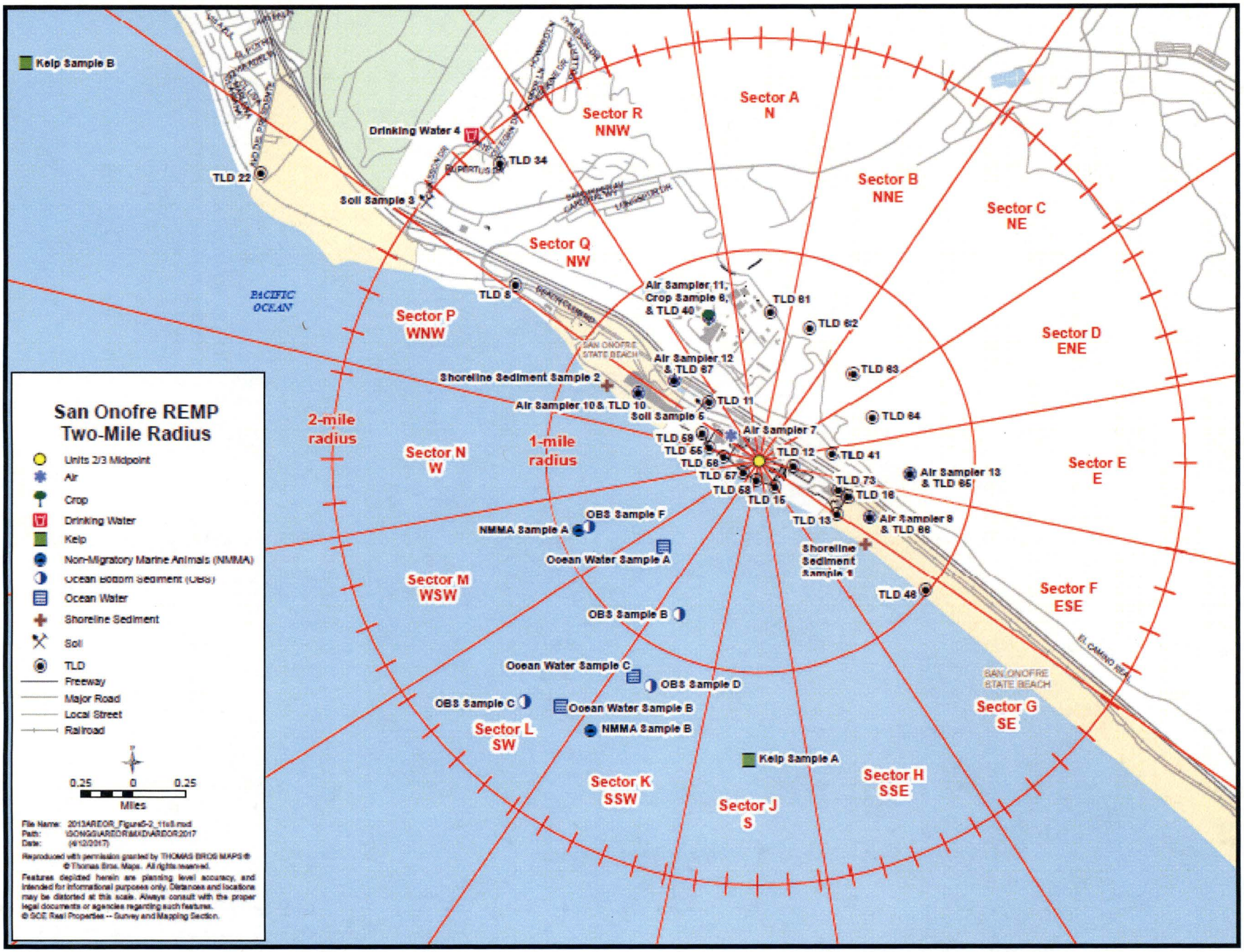


Figure 5 - SONGS REMP Two Mile Radius

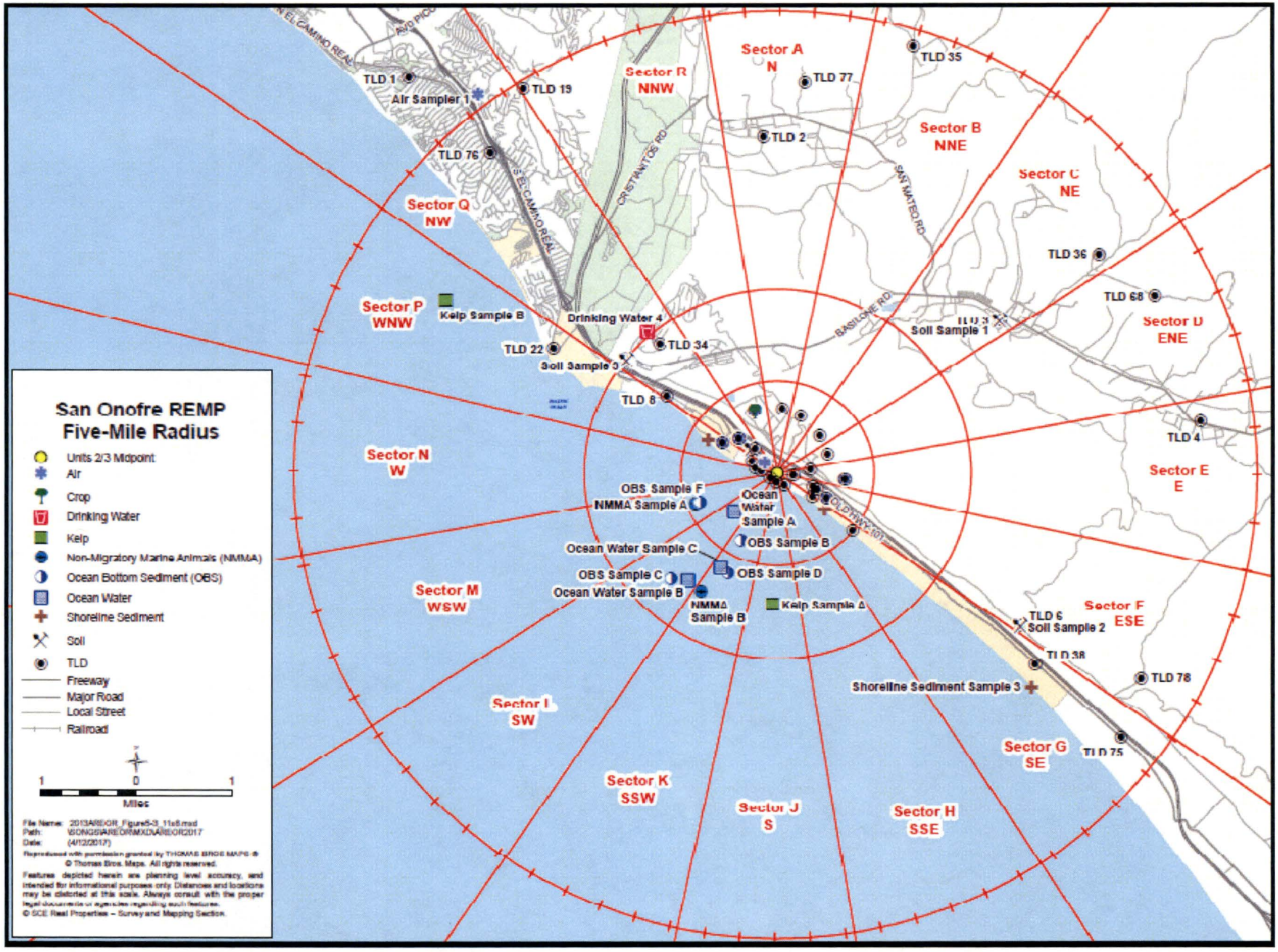


Figure 6 - SONGS REMP Five Mile Radius

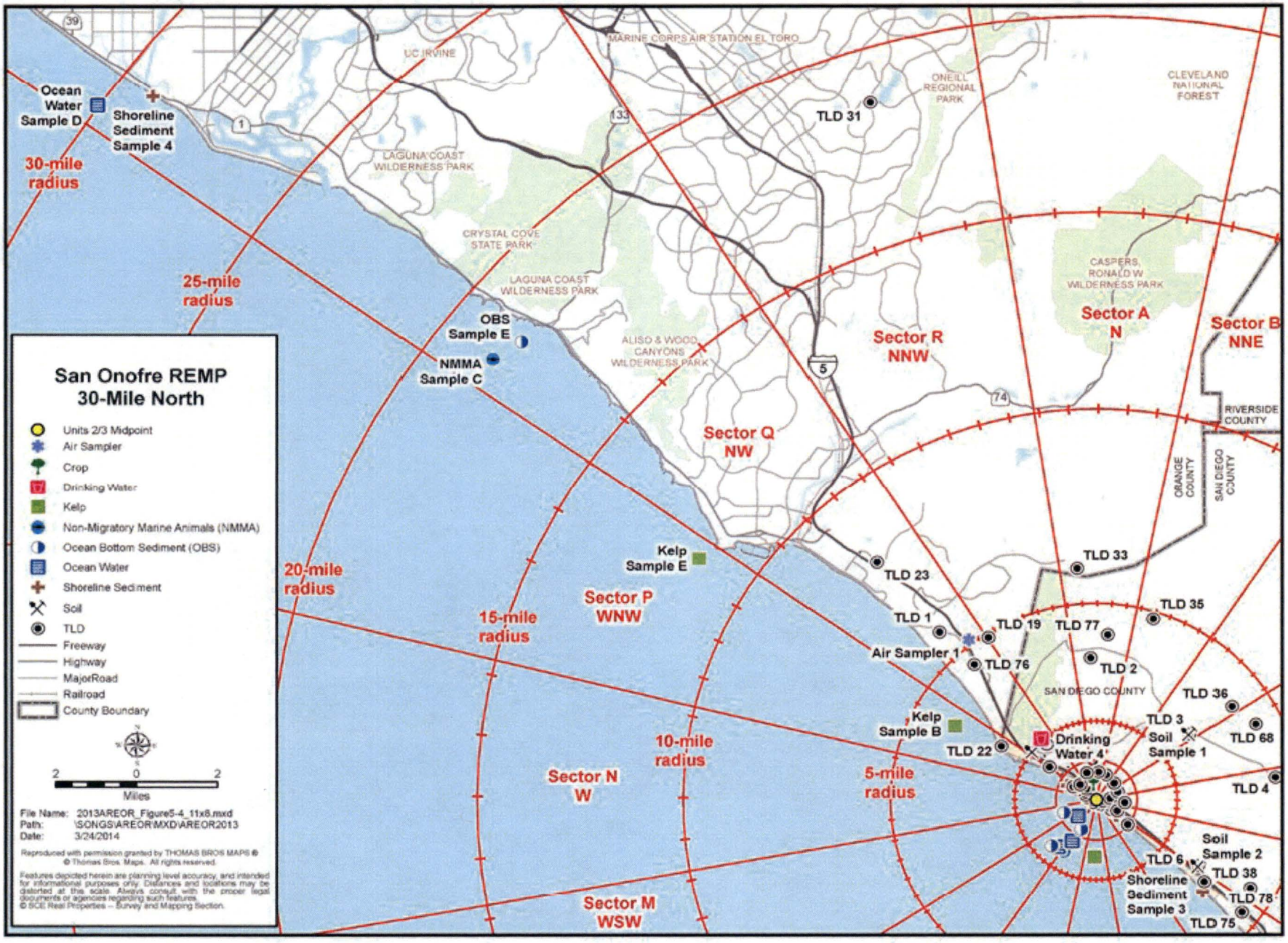


Figure 7 - SONGS REMP 30-mile Radius North

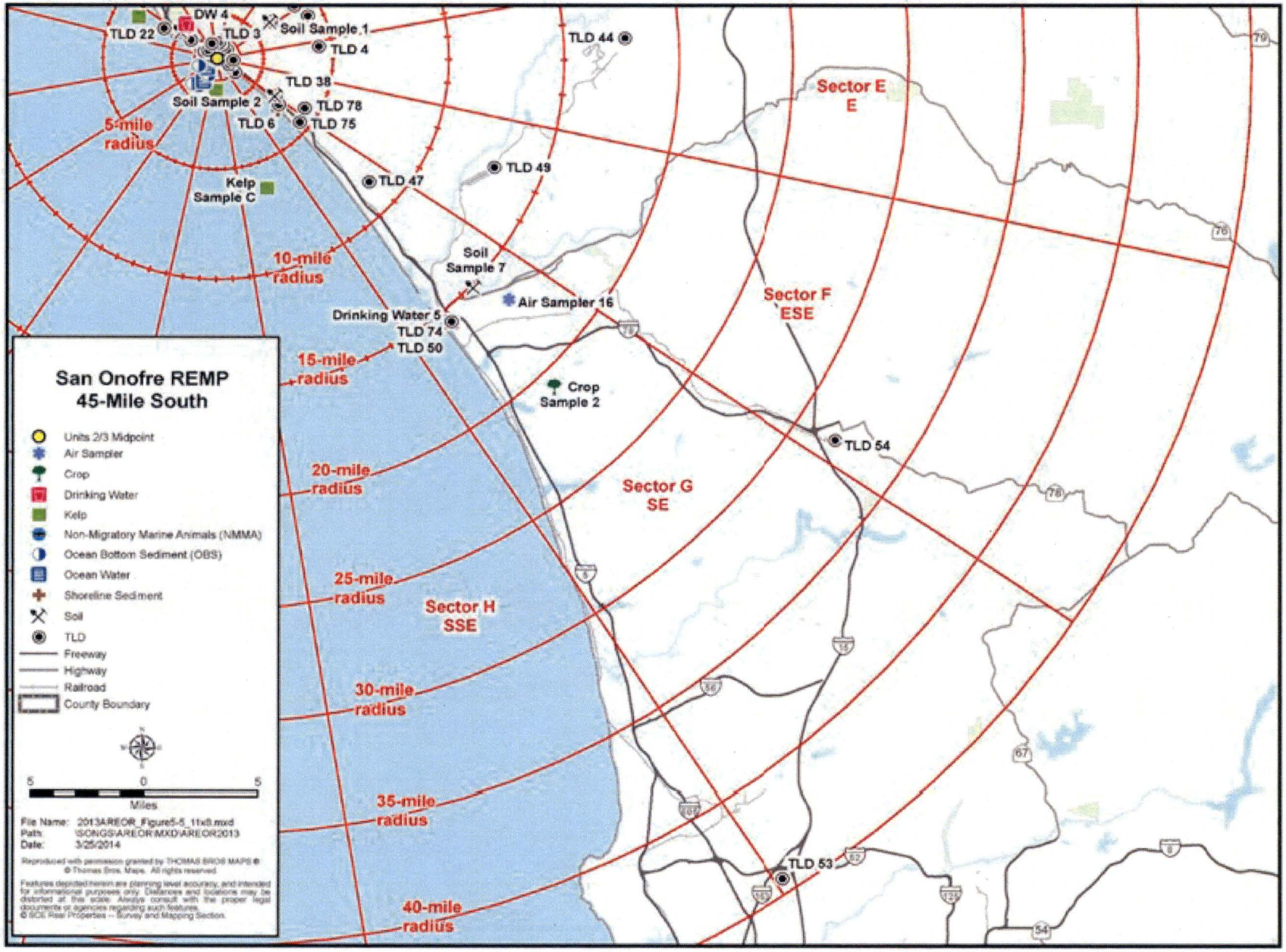


Figure 8 - SONGS REMP 45-mile Radius South

APPENDIX B. RESULTS AND DISCUSSIONS OF 2018 ENVIRONMENTAL DATA

Summary

A summary of the type and number of REMP samples obtained in 2018 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.

Table 14 - REMP Sample Analysis Summary for 2018

Medium	Analysis Type	Sampling Frequency	# of Locations	Total # of Analyses in 2018[a]
Direct Radiation	Dosimetry	Quarterly	49	195[c]
Airborne Particulates	Gross Beta I-131	Weekly	8 8	416 416
	Gamma	Quarterly	8	32
Ocean Water	Gamma H-3	Monthly	4 4	52 52
	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	9[b]
Kelp	Gamma	Semi-Annually	4	6[d]
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 sorrel was taken in the spring of 2018 at the SONGS garden.
c. Environmental dosimeters used for ISFSI monitoring not included in this total. REMP TLD #22 was not available for the second quarter 2018. See Appendix E.
d. Kelp canopy was absent from two locations in October 2018. See Appendix E.

Results and Discussions of 2018 Environmental Data

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 the methodology described in ANSI/HPS N13.37-2014, "Environmental Dosimetry – Criteria for System Design and Implementation." All 2018 TLD data from locations outside the SONGS Exclusion Area Boundary (EAB) were below the minimum detectable dose. 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 SONGS EAB. 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 one, for potential full-time occupancy. For onsite locations, at or near the EAB/CAB, the occupancy factor is determined per SDS-RP3-PCD-1014, Direct Radiation Exposure Controls and Monitoring. The hypothetical maximum associated exposure to a member of the general public, adjusted for occupancy, is less than 1 mrem per year as calculated using the ANSI method. Refer to Table 15 for a summary of all 2018 SONGS REMP TLD data. Refer to Appendix I (ISFSI TLD DATA) for a discussion of the 2018 ISFSI direct radiation data.

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 2018 no neutron radiation was detected at station 55. Some neutron radiation (a maximum of 2.5 mrem) was detected at some of the SONGS ISFSI locations.

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 REMP TLD 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 Table 15.

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 natural direct gamma radiation varies according to location because of differences in the natural radioactive materials in the soil, soil moisture content, buildings, and other factors.

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 location. This is an appropriate methodology to determine the ability to detect radiation exposure above background, described in ANSI/HPS N13.37-2014. The quarterly and annual results expressed in Table 15 are positive exposure if they exceed either 5 mrem above the baseline quarterly or 10 mrem above the baseline 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 nearby proxy locations outside the EAB was used to estimate the baseline within the EAB. 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)	2018 Quarterly Results (mrem)				Baseline Adjusted Quarterly Results (mrem)				Ann. Baseline (mrem)	Annual Total (mrem)	Annual Facility Dose (mrem)	Annual Public[e] Dose (mrem)
				1	2	3	4	1	2	3	4				
1	City of San Clemente	5.7	18.4	19.2	16.4	17.6	17.6	ND	ND	ND	ND	73.6	70.8	ND	ND
2	Camp San Mateo – MCB	3.6	19.6	19.2	18.9	19.5	19.6	ND	ND	ND	ND	78.2	77.1	ND	ND
3	Camp San Onofre – MCB	2.8	17.2	16.7	16.9	16.7	17.0	ND	ND	ND	ND	69.0	67.3	ND	ND
4	Camp Horno – MCB	4.4	19.0	19.2	17.8	18.5	18.0	ND	ND	ND	ND	76.1	73.4	ND	ND
6	Old Route 101 (ESE)	3.0	12.0	11.1	10.5	10.6	11.4	ND	ND	ND	ND	47.9	43.6	ND	ND
8	Noncommissioned Officers' Beach Club	1.4	16.2	15.6	15.6	15.6	15.2	ND	ND	ND	ND	64.8	62.1	ND	ND
10	Bluff	0.7	17.2	17.3	16.2	16.4	16.4	ND	ND	ND	ND	69.0	66.3	ND	ND
19	San Clemente Highlands	4.9	18.7	18.9	18.1	19.0	18.0	ND	ND	ND	ND	74.8	74.0	ND	ND
22[b]	Former US Coast Guard Station	2.7	18.8	19.4	---	19.6	18.8	ND	N/A	ND	ND	75.3	57.8	N/A	N/A
23	SDG&E Service Center Yard (Control)	8.1	16.6	16.9	15.1	17.1	15.9	ND	ND	ND	ND	66.4	65.1	ND	ND
31	Aurora Park - Mission Viejo (Control)	18.6	19.4	20.6	19.2	19.9	20.0	ND	ND	ND	ND	77.8	79.8	ND	ND
33	Camp Talega – MCB (Control)	5.9	19.9	19.8	18.9	20.2	17.8	ND	ND	ND	ND	79.5	76.7	ND	ND
34	San Onofre School – MCB	1.9	17.0	17.9	15.8	15.8	16.6	ND	ND	ND	ND	68.1	66.1	ND	ND
35	Range 312 – MCB	4.8	17.8	16.0	15.8	15.3	16.5	ND	ND	ND	ND	71.1	63.5	ND	ND
36	Range 208C – MCB	4.1	20.5	19.8	19.8	19.7	19.4	ND	ND	ND	ND	82.0	78.7	ND	ND
38	San Onofre State Beach Park	3.4	15.0	14.9	13.3	14.0	13.4	ND	ND	ND	ND	60.1	55.7	ND	ND
40	SCE Training Center - Mesa	0.7	18.0	17.6	17.3	16.6	17.0	ND	ND	ND	ND	71.9	68.5	ND	ND
44	Fallbrook Fire Station (Control)	17.7	14.7	15.4	13.8	15.5	14.2	ND	ND	ND	ND	58.9	58.9	ND	ND
46	San Onofre State Beach Park	1.0	12.8	14.5	12.9	13.0	13.2	ND	ND	ND	ND	51.3	53.7	ND	ND
47	Camp Las Flores – MCB (Control)	8.6	14.0	15.7	16.0	15.8	15.8	ND	ND	ND	ND	55.9	63.3	ND	ND
49	Camp Chappo – MCB (Control)	12.9	14.9	16.3	15.1	15.6	15.7	ND	ND	ND	ND	59.7	62.7	ND	ND
50	Oceanside Fire Station (Control)	15.6	17.4	17.6	16.7	17.1	17.1	ND	ND	ND	ND	69.8	68.4	ND	ND
53	San Diego County Operations Center (Control)	44.2	19.1	20.2	18.7	21.0	19.6	ND	ND	ND	ND	76.5	79.5	ND	ND
54	Escondido Fire Station (Control)	31.8	16.9	18.5	16.9	18.0	17.5	ND	ND	ND	ND	67.7	70.8	ND	ND
61	Mesa - East Boundary	0.7	16.2	15.7	15.2	15.1	15.7	ND	ND	ND	ND	64.8	61.7	ND	ND
62	Camp Pendleton	0.7	13.9	13.2	12.6	12.5	13.2	ND	ND	ND	ND	55.5	51.5	ND	ND
63	Camp Pendleton	0.6	14.6	14.7	13.7	14.7	13.9	ND	ND	ND	ND	58.4	56.9	ND	ND
64	Camp Pendleton	0.6	15.8	15.9	14.8	15.9	15.2	ND	ND	ND	ND	63.1	61.8	ND	ND

TLD (SCE-##)	Location	Distance (miles)	Qtr. Baseline (mrem)	2018 Quarterly Results (mrem)				Baseline Adjusted Quarterly Results (mrem)				Ann. Baseline (mrem)	Annual Total (mrem)	Annual Facility Dose (mrem)	Annual Public[e] Dose (mrem)
				1	2	3	4	1	2	3	4				
65	Camp Pendleton	0.7	14.1	13.7	13.0	13.5	13.2	ND	ND	ND	ND	56.3	53.3	ND	ND
66	San Onofre State Beach	0.6	14.7	14.6	14.1	14.0	14.0	ND	ND	ND	ND	58.9	56.8	ND	ND
67	Former SONGS Evaporation Pond	0.6	17.8	18.3	17.2	18.1	17.7	ND	ND	ND	ND	71.1	71.3	ND	ND
68	Range 210C – MCB	4.4	15.8	16.8	16.3	16.2	16.5	ND	ND	ND	ND	63.1	65.8	ND	ND
74	Oceanside City Hall (Backup Control)	15.6	14.0	15.0	13.7	14.8	13.4	ND	ND	ND	ND	55.9	56.8	ND	ND
75	Gate 25 MCB	4.6	16.7	17.6	15.9	16.9	17.1	ND	ND	ND	ND	66.9	67.4	ND	ND
76	El Camino Real Mobil Station	4.6	18.2	19.2	17.9	18.9	18.6	ND	ND	ND	ND	72.7	74.6	ND	ND
77	Area 62 Heavy Lift Pad	4.2	20.2	19.8	19.5	19.9	19.1	ND	ND	ND	ND	80.7	78.3	ND	ND
78	Horno Canyon	4.4	11.7	12.7	11.7	11.7	12.1	ND	ND	ND	ND	46.7	48.2	ND	ND
11	Former Visitors' Center[a]	0.4*	15.8	17.0	16.3	16.1	15.6	ND	ND	ND	ND	63.1	65.0	ND	ND
12	South Edge of Switchyard[a]	0.2*	15.8	17.0	16.8	16.8	17.7	ND	ND	ND	ND	63.1	68.3	ND	ND
13	Southeast Site Boundary (Bluff)[a]	0.4*	15.8	20.2	19.6	22.5	22.0	ND	ND	6.8	6.2	63.1	84.4	21.3	ND
15[c]	Southeast Site Boundary (Office Bldg)[a]	0.1*	15.8	22.1	19.3	17.0	17.2	6.3	ND	ND	ND	63.1	75.5	12.4	ND
16	East Southeast Site Boundary[a]	0.4*	15.8	15.4	14.9	14.1	16.8	ND	ND	ND	ND	63.1	61.2	ND	ND
41	Old Route 101 – East[a]	0.3*	15.8	16.2	16.1	15.8	15.6	ND	ND	ND	ND	63.1	63.7	ND	ND
55	San Onofre State Beach (U1 West)[a, d]	0.2*	15.8	20.4	19.4	18.5	18.8	ND	ND	ND	ND	63.1	77.0	13.9	ND
56	San Onofre State Beach (U1 West)[a]	0.2*	15.8	19.6	15.6	16.9	18.1	ND	ND	ND	ND	63.1	70.2	ND	ND
57	San Onofre State Beach (Unit 2)[a]	0.1*	15.8	17.4	16.5	17.2	17.3	ND	ND	ND	ND	63.1	68.5	ND	ND
58	San Onofre State Beach (Unit 3)[a]	0.1*	15.8	18.9	16.3	18.2	17.5	ND	ND	ND	ND	63.1	70.9	ND	ND
59	SONGS Meteorological Tower[a]	0.3*	15.8	19.4	19.3	20.1	19.4	ND	ND	ND	ND	63.1	78.1	15.0	ND
73	South Yard Facility[a]	0.4*	15.8	19.4	17.3	18.0	18.8	ND	ND	ND	ND	63.1	73.4	10.3	ND

* Indicates that the station is within the EAB (Exclusion Area Boundary). The baseline has been estimated to be 15.8 mrem per standard 91-day quarter within the EAB.

a Indicates on site location. The dose to members of the public is based on a default non-office area annual occupancy time of 500 hours per year.

b SCE-22 TLD was lost during second quarter. Since empirical TLD data is only available for three quarters, the annual dose for TLD 22 is not available.

c TLD-15 was moved during the second quarter to avoid construction damage. The result of 18.35 mR (19.3 mrem) is based on the actual portion of the quarter that TLD 15 was at the location 15 and the known exposure rates at the alternate locations.

d. A neutron TLD was collocated at location 55 during each quarter. These neutron TLDs had no detectable neutron signal in any quarter of 2018.

e. Adjusted for occupancy in accordance with SDS-RP3-PCD-1014

Quality Control Duplicate Direct Radiation Samples

Duplicate Quality Control (QC) TLD was installed adjacent to TLD #66 and TLD # 67. 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.

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 because they are not included in the ODCM. The ISFSI data are listed and discussed in Appendix I.

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. Gross beta measurements are used to identify samples with elevated levels of radioactivity for further analysis. The gross beta analysis does not identify specific radionuclides.

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 0.006 pCi/m^3 to 0.096 pCi/m^3, averaging 0.032 pCi/m^3 of air. The concentrations of gross beta activity in the samples from the control location ranged from 0.014 to 0.091 pCi/m^3, averaging 0.036 pCi/m^3 of air. There is seasonal variability to the gross beta results for air samplers, and the magnitude of the results in 2018 are not significantly different from what has been seen in previous years. In 2018, there was a noticeable increase in the average gross beta data for all locations, both control and indicators. This trend will be monitored in 2019. The fact that the trend is evident in both control and indicator locations shows that this is attributable to a factor external to 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 2018 was 0.096 pCi/m^3 which is less than 10 times the average background measured at the control location (0.036 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.

The average quarterly air particulate sample beta activity from the indicator stations and control station have been compared through 2018. The average of the indicator data trends closely with the average of the control data. The gross beta data results indicate that the trends identified are attributable to a macro-environmental cause not related to SONGS. 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 anthropogenic radioactivity related to SONGS.

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 2018, 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 (CDPH) split sample program. During 2018 all the SONGS REMP and the duplicate CPDH tritium in ocean water sample results less than detectable.

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

Drinking Water

In 2018, 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 2018. Gross beta activity was identified in some samples, but gamma spectroscopy identified only natural radionuclides. SONGS had no impact on the environment as measured by drinking water.

Shoreline Sediment (Beach Sand)

Beach sand was collected semiannually in 2018 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. SONGS had no impact on the environment as measured in beach sand.

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 2018.

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 2018, all conduit sample analysis results were below the MDC for station related radionuclides. SONGS had no impact on the environment as measured by ocean bottom sediments.

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 edible 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. Naturally-occurring radionuclides were detected in marine species samples collected during 2018. SONGS had no impact on the environment as measured by this sample medium.

Local Crops

Fleshy and leafy crops were collected semiannually in 2018 from the SONGS garden and from the control location 21 miles SE from SONGS Units 2/3 midpoint. Tomato, cabbage, lettuce, sorrel and squash were sampled in 2018, and only naturally occurring radionuclides were identified. No plant related radioactivity was detected. It is concluded that in 2018 SONGS had no measurable impact on local crops.

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 2018 soil samples showed measurable levels of naturally occurring radionuclides. Cs-137 was detected in two indicator samples (0.096 and 0.106 pCi/g) and the control sample (0.0996 pCi/g). Cs-137 in soil samples at these levels is attributable to factors external to SONGS (residual nuclear weapons testing fallout, the Chernobyl accident).

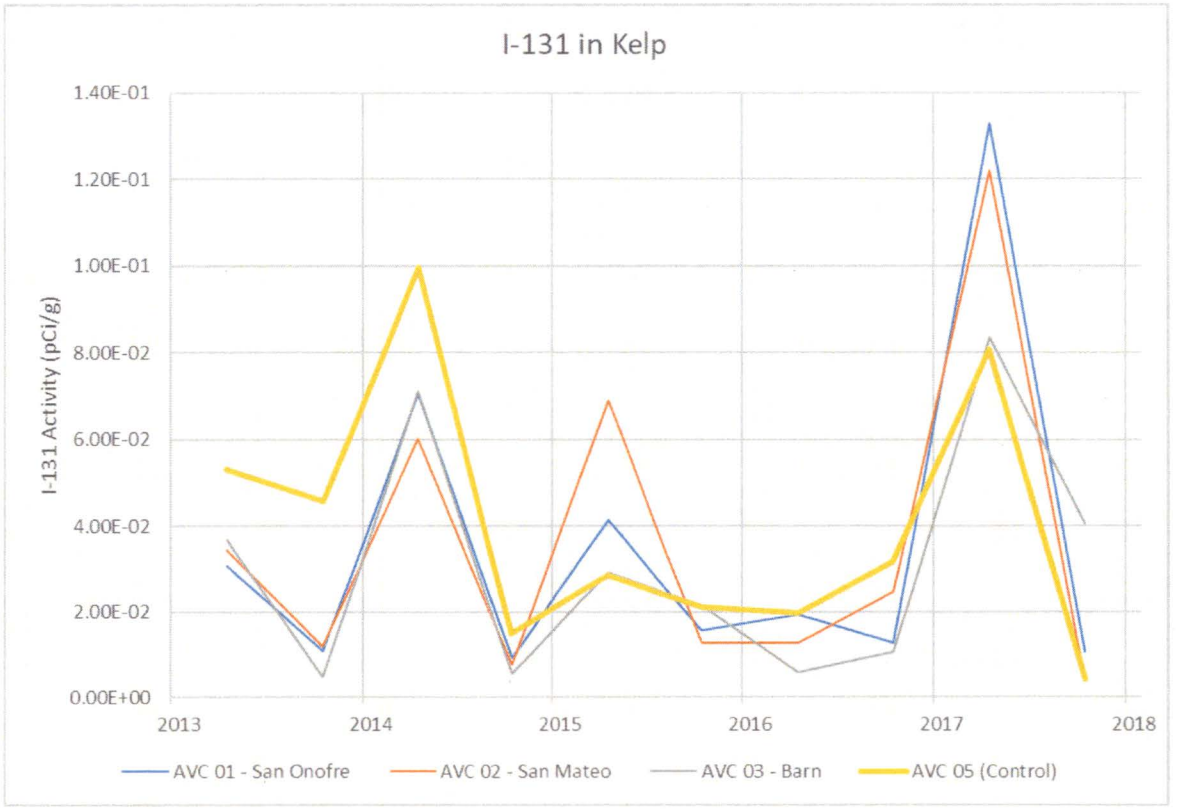
Cs-137 and strontium-90 (Sr-90) were detected in soil profile analyses conducted in previous years. These radionuclides are attributable to the nuclear weapons testing fallout depositing on soil and retention of these radionuclides due to their long half-lives. The presence of Cs-137 in the indicator and in the control locations at similar levels supports the conclusion that the source of this radionuclide to a factor external to SONGS (fallout deposition). During 2018, SONGS did not have a detectable effect on the environment as measured by soil samples.

Kelp

Kelp was collected in April and October of 2018 from the San Onofre kelp bed, San Mateo kelp bed, Barn kelp bed, and from the Salt Creek control location. 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 six kelp samples collected in 2018. Iodine-131 (half-life 8 days) was identified in three of the four samples collected in April 2018 (at two indicator locations and at the control location). Iodine-131 was not detected in the two kelp samples collected in October 2018. SONGS is permanently shut down and the nuclear fuel is not in the reactor vessel. Therefore, Iodine-131 is not being generated at SONGS. The iodine-131 detected in kelp is attributable to sewage plant discharges of medically administered iodine-131.

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 9 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 9 includes all I-131 results, including those that are below the MDC.)

Figure 9 - I-131 in Aquatic Kelp



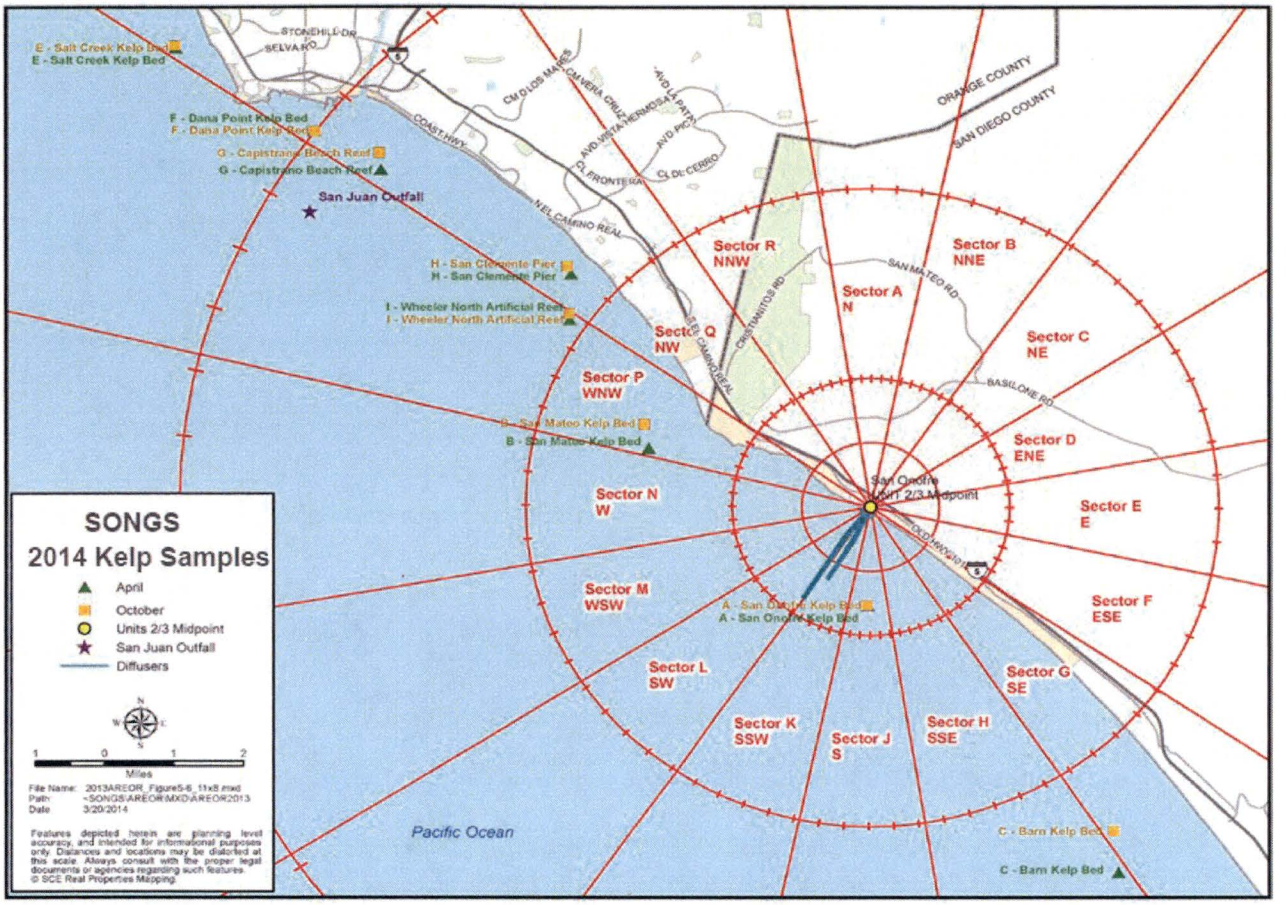


Figure 10 - Kelp Sampling Locations

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 SONGS.

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. Samples with detectable activity were not statistically different from control samples. Plant related radionuclides detected during 2018 were attributed to sources external to SONGS (past nuclear weapons fallout, Chernobyl, Fukushima, and medical iodine releases in sewage). 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 2018 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.

Statistical Summary of REMP Data for 2018

For the tables below, the numbers in parentheses next to the mean value indicate number of samples with positive results compared to the total number of samples. The smaller font numbers in parentheses indicate the range of results.

Table 16 - 2018 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 (155/155) (10.5 – 22.5)	Southeast Site Boundary (Bluff) 0.4 Mi. SE	21.1 (4/4) (19.6– 22.5)	17.1 (40/40) (13.4 – 21.0)	0

NOTES:

- Indicator location TLDs include all REMP TLDs 5.0 miles or closer to SONGS 2/3 midpoint and TLD#1 (City of San Clemente)
- Control location TLDs include all REMP TLDs more than 5.0 miles from SONGS 2/3 midpoint, excluding TLD #1 (City of San Clemente)
- TLD data excludes QC TLDs, transit dose TLDs, and ISFSI TLDs
- Table 16 is based on NUREG 1301 methodology and not ANSI 13-37 methodology.

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 416	0.01	0.032 (364/364) (0.006 – 0.096)	San Luis Rey Substation 16.7 Mi. SE	0.036 (52/52) (0.014 – 0.091)	0.036 (52/52) (0.014 – 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-131 416	0.07	< MDC	< MDC	< MDC	< MDC (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 <MDC 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)	Be-7	32	N/A	0.121 (28/28) (0.076 – 0.152)	San Luis Rey Substation 16.7 Mi. SE	0.141 (4/4) (0.111 – 0.187)	0.141 (4/4) (0.111 – 0.187)	0
	Cs-134	32	0.05	< MDC	< MDC	< MDC	< MDC	0
	Cs-137	32	0.06	< MDC	< MDC	< MDC	< MDC	0

NOTES:
a Natural occurring radionuclides (K-40, Th-234 and others) were observed in quarterly composite air samples in 2018.

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)	K-40	52	N/A	350 (40/40) (303 – 405)	Outfall Unit 3 1.2 Mi. SSW	359 (12/12) (328 – 384)	344 (12/12) (315 – 369)	4
	Ba-140	52	15	< MDC	< MDC	< MDC	< MDC	4
	Cs-134	52	15	< MDC	< MDC	< MDC	< MDC	4
	Cs-137	52	18	< MDC	< MDC	< MDC	< MDC	4
	Co-58	52	15	< MDC	< MDC	< MDC	< MDC	4
	Co-60	52	15	< MDC	< MDC	< MDC	< MDC	4
	I-131	52	15	< MDC	< MDC	< MDC	< MDC	4
	Fe-59	52	30	< MDC	< MDC	< MDC	< MDC	4
	La-140	52	15	< MDC	< MDC	< MDC	< MDC	4
	Mn-54	52	15	< MDC	< MDC	< MDC	< MDC	4
	Nb-95	52	15	< MDC	< MDC	< MDC	< MDC	4
	Tritium	52	2000	< MDC	< MDC	< MDC	< MDC	4
	Zn-65	52	30	< MDC	< MDC	< MDC	< MDC	4
	Zr-95	52	15	< MDC	< MDC	< MDC	< MDC	4

NOTES:
a Natural occurring radionuclides (K-40 and others) were observed in the 2018 ocean water samples.

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	< MDC	< MDC	< MDC	< MDC	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)	Gross Beta 24	4	2.27 (3/12) (1.49 – 3.62)	Oceanside City Hall 15.6 Mi. SE	3.78 (9/12) (2.14 – 7.64)	3.78 (9/12) (2.14 – 7.64)	0
	Ba-140 24	15	< MDC	< MDC	< MDC	< MDC	0
	Cs-134 24	15	< MDC	< MDC	< MDC	< MDC	0
	Cs-137 24	18	< MDC	< MDC	< MDC	< MDC	0
	Co-58 24	15	< MDC	< MDC	< MDC	< MDC	0
	Co-60 24	15	< MDC	< MDC	< MDC	< MDC	0
	I-131 24	15	< MDC	< MDC	< MDC	< MDC	0
	Fe-59 24	30	< MDC	< MDC	< MDC	< MDC	0
	La-140 24	15	< MDC	< MDC	< MDC	< MDC	0
	Mn-54 24	15	< MDC	< MDC	< MDC	< MDC	0
	Nb-95 24	15	< MDC	< MDC	< MDC	< MDC	0
	Tritium 24	2000	< MDC	< MDC	< MDC	< MDC	0
	Zn-65 24	30	< MDC	< MDC	< MDC	< MDC	0
	Zr-95 24	15	< MDC	< MDC	< MDC	< MDC	0

NOTES:

a Natural occurring radionuclides (such as Be-7) were detected in the 2018 air particulate samples.

b The location with the highest annual mean for drinking water gross beta is the 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)	K-40	8	N/A	11.9 (6/6) (5.19 – 17.7)	Newport Beach 29.2 Mi NW	22.1 (2/2) (19.7 – 24.5)	22.1 (2/2) (19.7 – 24.5)	0
	Cs-134	8	150	< MDC	< MDC	< MDC	< MDC	0
	Cs-137	8	180	< MDC	< MDC	< MDC	< MDC	0

NOTES:
a Natural occurring radionuclides such as K-40 were detected in the 2018 shoreline sediment samples.

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)	K-40	14	N/A	16.5 (12/12) (13.5 – 19.5)	Laguna Beach 20 - 25 Mi NW	20.2 (2/2) (19.8 – 20.6)	20.2 (2/2) (19.8 – 20.6)	0
	Cs-134	14	150	< MDC	< MDC	< MDC	< MDC	0
	Cs-137	14	180	< MDC	< MDC	< MDC	< MDC	0

NOTES:
a Natural occurring radionuclides such as K-40 were detected in the 2018 ocean bottom sediment samples.

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)		
Non-Migratory Marine Animals (pCi/g)	K-40		N/A	3.23 (17/17) (1.40 – 4.28)	Unit 1 Outfall 0.9 Mi. WSW	3.25 (9/9) (1.40 – 4.15)	3.05 (8/8) (0.846 – 4.90)	0
	Cs-134	24	130	< MDC	< MDC	< MDC	< MDC	0
	Cs-137	24	150	< MDC	< MDC	< MDC	< MDC	0
	Co-58	24	130	< MDC	< MDC	< MDC	< MDC	0
	Co-60	24	130	< MDC	< MDC	< MDC	< MDC	0
	Fe-59	24	260	< MDC	< MDC	< MDC	< MDC	0
	Mn-54	24	130	< MDC	< MDC	< MDC	< MDC	0
	Zn-65	24	260	< MDC	< MDC	< MDC	< MDC	0

NOTES:

a Natural occurring radionuclides (K-40 and others) were detected in the 2018 non-migratory marine animal samples.

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)		
Local Crops ingestion (pCi/g)	K-40	9	N/A	3.79 (5/5) (3.08 – 4.61)	SONGS Garden 0.7 Mi. NNW	3.79 (5/5) (3.08 – 4.61)	1.94 (4/4) (1.28 – 2.58)	0
	Cs-134	9	60	< MDC	< MDC	< MDC	< MDC	0
	Cs-137	9	80	< MDC	< MDC	< MDC	< MDC	0
	I-131	9	60	< MDC	< MDC	< MDC	< MDC	0

NOTES:

a Natural occurring radionuclides (K-40 and others) were observed in the 2018 local crop samples.

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)	K-40	5	N/A	14.6 (4/4) (7.12 – 18.5)	Basilone Rd/I-5 2.0 Mi. NW	18.5 (1/1) (18.5 – 18.5)	2.88 (1/1) (2.88 – 2.88)	0
	Cs-134	5	60	< MDC	< MDC	< MDC	< MDC	0
	Cs-137	5	80	0.101 (2/4) (0.096 – 0.106)	Camp San Onofre 2.8 Mi. NE	0.106 (1/1) (0.106 – 0.106)	0.099 (1/1) (0.099 – 0.099)	0

NOTES:

a K-40 and other radionuclides were detected in the 2018 REMP soil samples.

b The Cs-137 detected in the control and in two indicator samples at the same level (0.1 pCi/g) in soil samples are due to factors external to SONGS (legacy fallout from nuclear weapons testing, and Chernobyl) and are not attributable to SONGS.

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)	K-40	6	N/A	10.8 (5/5) (8.23 – 13.4)	Salt Creek 11 - 13 Mi. WNW-NW	14.1 (1/1) (14.1 - 14.1)	14.1 (1/1) (14.1 - 14.1)	0
	I-131	6	0.06	0.051 (4/5) (0.018 - 0.104)	San Mateo Kelp Bed 3.8 Mi. WNW	0.104 (1/2) (0.104 – 0.104)	0.06 (1/1) (0.06 – 0.06)	0

NOTES:

a The I-131 analysis results was confirmed above the MDC in control and indicator samples is attributable to sewage plant discharges of medically administered I-131. Kelp has an iodine bio-magnification factor of 1100.

b K-40 and other naturally occurring radionuclides were detected in the 2018 kelp samples.

APPENDIX C. SUMMARY OF QUALITY CONTROL PROGRAMS

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 2018 the CEAL was General Engineering Laboratory (GEL). The CEAL for REMP TLDs was Stanford Dosimetry.

Quarterly Duplicate TLDs

SONGS deployed a duplicate TLD package in the same canister as TLD 66 and annual duplicate TLD package in the canister for as TLD 67. The quarterly dose measured by these duplicate TLD packages is statistically equivalent.

Table 29 - 2018 Quarterly Duplicate TLD Data Comparison

TLD #	1ST QUARTER (mR) +/- 1 sigma	2ND QUARTER (mR) +/- 1 sigma	3RD QUARTER (mR) +/- 1 sigma	4TH QUARTER (mR) +/- 1 sigma
TLD 66	13.91 ± 0.98	13.44 ± 0.90	13.33 ± 0.80	13.32 ± 0.89
TLD 200	13.46 ± 0.73	13.10 ± 0.84	13.46 ± 0.61	13.56 ± 0.75

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

Annual Duplicate TLDs

SONGS deployed an annual duplicate TLD package in the same location and canister as REMP TLD 67. The average four quarterly TLD 67 exposure results (expressed in units of mR/91 days) is statistically equal to the annual TLD 201 results (also in units of mR/91 days) for the period spanning July 2017 to June 2018.

Table 30 - 2018 Annual Duplicate TLD Data compared to quarterly data from the same canister

TLD 67 (mR/91 days+/- one sigma) (July 2017 to June 2018)	TLD 201 (mR/91 days +/- one sigma) (July 2017 to June 2018)
16.82 +/-0.82	16.71 +/- 0.81

Calibration of Air Sampler Volume Meters

All REMP air sampler volume meters are calibrated annually using standards referenced to NIST. Calibration of all REMP air samplers is verified quarterly to ensure the volume meters remain within limits and the meters are removed from service if they fail a quarterly test. This is an *a posteriori* review of the volume meter performance to evaluate method bias and to identify possible outlier analysis results. A bias was not detected in 2018. 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, within the limitations of the gross beta method of analysis.

Interlaboratory Cross-Check Program

The State of California Department of Public health (CDPH) participates in a comprehensive radiological environmental split sampling program in conjunction with SONGS. In 2018 the CDPH acquired split samples, collected by an independent third party, from the following SONGS media: atmospheric radioactivity, non-migratory marine animals, kelp, ocean bottom sediments, ocean water gamma emitters, and ocean water tritium.

The CDPH also conducts a parallel terrestrial direct radiation (TLD) measurement effort at SONGS. Refer to Appendix H for a discussion of the CDPH TLD data.

CPDH Atmospheric Radioactivity Gross Beta, I-131 and quarterly gamma analysis results were substantially similar to the SONGS results for the same media. As expected, both the CDPH DWRL (Drinking Water and Radiation Laboratory) and the SONGS contracted laboratory (GEL) found a gross beta signal above the detection limit. Both labs detected naturally occurring Be-7 in the quarterly composite gamma particulate media samples. Both labs did not detect anthropogenic radionuclides in the split samples with the exception of kelp. The SONGS lab (GEL) reported I-131 above the MDC; the CDPH lab did not detect I-131 in kelp. Both labs detected naturally occurring K-40 in the sediment, ocean water, and non-migratory marine animals. The SONGS and the CDPH analysis results for all 2018 tritium in ocean water samples were less than detectable. Refer to the tabulated results below.

CDPH and SONGS split sample TRITIUM in ocean water

SPLIT SAMPLE LOCATION		Sample Date	SONGS tritium data		CDPH tritium data	
			H-3 result +/- 2 sigma (pCi/L)	MDC	H-3 result +/- uncertainty (pCi/L)	MDC
A	Station Discharge Outfall - Unit 1	1/15/2018	-31 +/- 227	388	-188 +/- 135	240
		2/15/2018	-49 +/- 376	638	-123 +/- 137	240
		3/19/2018	191 +/- 276	428	56 +/- 125	212
		4/18/2018	15 +/- 319	319	31 +/- 130	221
		5/15/2018	113 +/- 266	427	-106 +/- 139	243
		6/18/2018	-18 +/- 293	495	-160 +/- 138	243
		7/16/2018	-25 +/- 406	686	24 +/- 126	216
		8/15/2018	240 +/- 324	501	70 +/- 127	216
		9/17/2018	-234 +/- 306	550	10 +/- 129	221
		10/16/2018	-51 +/- 310	530	-2 +/- 129	221
		11/15/2018	125 +/- 140	194	104 +/- 131	221
		12/18/2018	24 +/- 411	685	143 +/- 132	221

SPLIT SAMPLE LOCATION		Sample Date	SONGS tritium data		CDPH tritium data	
			H-3 result +/- 2 sigma (pCi/L)	MDC	H-3 result +/- uncertainty (pCi/L)	MDC
B	Outfall - Unit 2	1/15/2018	-71 +/- 231	403	-112 +/-.137	240
		2/15/2018	-69 +/- 371	633	-211 +/- 135	240
		3/19/2018	211 +/- 284	437	21 +/- 130	221
		4/18/2018	128 +/- 331	535	-10 +/- 129	221
		5/15/2018	101 +/- 266	429	-148 +/- 138	243
		6/18/2018	134 +/-.303	489	9 +/- 142	243
		7/16/2018	-240 +/-	386	46 +/- 127	216
		8/15/2018	106 +/- 313	506	63 +/- 127	216
		9/17/2018	-83 +/- 321	551	-22 +/- 128	221
		10/16/2018	-53 +/- 305	521	-1 +/- 129	221
		11/15/2018	39 +/- 122	192	105 +/- 131	221
		12/18/2018	-205 +/- 388	689	81 +/- 131	221
C	Outfall - Unit 3	1/15/2018	-12 +/- 236	398	-140 +/- 136	240
		2/15/2018	296 +/- 401	630	-239 +/- 134	240
		3/19/2018	79 +/- 268	434	-24 +/- 129	221
		4/18/2018	109 +/- 327	532	-12 +/- 129	221
		5/15/2018	129 +/- 275	439	-49 +/- 141	243
		6/18/2018	66 +/- 299	492	-44 +/- 141	243
		7/16/2018	307 +/- 441	685	90 +/- 128	216
		8/15/2018	246 +/- 328	507	-7 +/- 126	216
		9/17/2018	-34 +/- 329	557	-33 +/- 128	221
		10/16/2018	108 +/- 324	524	-52 +/- 127	221
		11/15/2018	-22 +/- 109	190	133 +/- 132	221
		12/18/2018	-24 +/- 408	690	112 +/- 132	221
D	Newport Beach (Control)	1/15/2018	133 +/- 256	403	-154 +/- 136	240
		2/15/2018	178 +/- 392	632	-249 +/- 134	240
		3/19/2018	81 +/- 268	435	-5 +/- 129	221
		4/18/2018	129 +/- 323	522	19 +/- 130	221
		5/15/2018	-129 +/- 271	477	-86 +/- 140	243
		6/18/2018	-20 +/- 292	493	-122 +/- 139	243
		7/16/2018	-72 +/- 404	692	27 +/- 126	216
		8/15/2018	138 +/- 315	503	80 +/- 128	216
		9/17/2018	221 +/-330	551	65 +/- 130	221
		10/16/2018	297 +/-340	519	12 +/- 129	221
		11/15/2018	17 +/-119	193	95 +/- 131	221
		12/18/2018	-275 +/-381	691	121 +/- 132	221

Note that the EPA drinking water maximum permissible tritium activity is 20,000 pCi / liter.

The SONGS contracted lab (GEL) 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. Non-agreement results were resolved in accordance with GEL's corrective action program.

Per the 2018 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 2018, the environmental TLDs, routine quality control (QC) testing was performed for dosimeters issued by the Environmental Dosimetry Company (EDC). During 2018, 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 GEL and Stanford Dosimetry performance meets the criteria described in Reg. Guide 4.15 and ANSI/HPS N13.37-2014.

Analytical Laboratory Cross Check Program Summary

TABLE 1 - 2018 RADIOLOGICAL PROFICIENCY TESTING RESULTS AND ACCEPTANCE CRITERIA

PT Provider	Quarter / Year	Report Closing / Received Date	Sample Number	Sample Media	Units	Analyte	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Barium-133	97.6	95.1	80.2 - 105	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Cesium-134	64.9	65.6	53.4 - 72.2	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Cesium-137	117	112	101 - 126	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Cobalt-60	122	114	103 - 128	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Zinc-65	320	277	249 - 324	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Gross Alpha	67.7	72.4	38.1 - 89.2	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Gross Alpha	66.4	72.4	38.1 - 89.2	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Gross Beta	47.6	54.8	37.5 - 61.7	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Radium-226	16.2	14.2	10.6 - 16.3	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Radium-226	16.3	14.2	10.6 - 16.3	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Radium-226	5	4.21	2.43 - 5.81	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Radium-228	4.44	4.21	2.43 - 5.81	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Radium-228	65.4	58.6	47.8 - 64.5	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Uranium (Nat)	56.4	58.6	47.8-64.5	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Uranium (Nat)	65.4	58.6	47.8 - 64.5	Not Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	µg/L	Uranium (Nat) mass	97.6	86.2	70.3 - 94.9	Not Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	µg/L	Uranium (Nat) mass	93.3	86.2	70.3 - 94.9	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Tritium	20000	21200	18600 - 23300	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Tritium	20200	21200	18600 - 23300	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Strontium-89	59.7	65.2	52.9 - 73.2	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Strontium-89	68.6	65.2	52.9 - 73.2	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Strontium-90	36.1	39.2	28.8 - 45.1	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Strontium-90	36.9	39.2	28.8 - 45.1	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Iodine-131	25.3	28.1	23.4 - 33.0	Acceptable
ERA	1st / 2018	2/26/18	RAD-112	Water	pCi/L	Iodine-131	28.6	28.1	23.4 - 33.0	Acceptable
EZA	1st / 2018	05/11/18	E12171	Cartridge	pCi	Iodine-131	9.20E+01	8.52E+01	0.97	Acceptable
EZA	1st / 2018	05/11/18	E12172	Milk	pCi/L	Strontium-89	9.16E+01	9.01E+01	1.02	Acceptable
EZA	1st / 2018	05/11/18	E12172	Milk	pCi/L	Strontium-90	8.00E+01	1.25E+02	0.64	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Iodine-131	1.05E+02	1.08E+02	0.97	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Cerium-141	7.23E+01	7.70E+01	0.94	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Cobalt-58	1.11E+02	1.14E+02	0.97	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Cobalt-60	1.90E+02	1.87E+02	1.02	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Chromium-51	3.00E+02	3.26E+02	0.92	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Cesium-134	1.58E+02	1.80E+02	0.88	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Cesium-137	1.75E+02	1.72E+02	1.02	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Manganese-54	1.36E+02	1.31E+02	1.04	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Iron-59	1.52E+02	1.39E+02	1.10	Acceptable
EZA	1st / 2018	05/11/18	E12173	Milk	pCi/L	Zinc-65	2.73E+02	2.44E+02	1.12	Acceptable
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Iodine-131	9.37E+01	9.10E+01	1.03	Acceptable
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Cerium-141	7.86E+01	7.34E+01	1.07	Acceptable
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Chromium-51	3.44E+02	3.10E+02	1.11	Acceptable
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Cesium-134	1.61E+02	1.71E+02	0.94	Acceptable
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Cesium-137	1.64E+02	1.64E+02	1.00	Acceptable
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Cobalt-58	1.92E+02	1.78E+02	1.08	Acceptable
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Manganese-54	1.36E+02	1.25E+02	1.09	Acceptable
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Iron-59	1.48E+02	1.32E+02	1.12	Acceptable

PT Provider	Quarter / Year	Report Closing / Received Date	Sample Number	Sample Media	Units	Analyte	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Zinc-65	2.53E+02	2.33E+02	1.09	Acceptable
EZA	1st / 2018	05/11/18	E12174	Water	pCi/L	Cobalt-60	1.92E+02	1.78E+02	1.08	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Actinium-228	1300	1240	818 - 1560	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Americium-241	97	74.7	40.3 - 106	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Bismuth-212	1410	1240	355 - 1850	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Bismuth-214	1200	1760	845 - 2620	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Cesium-134	4780	5330	3640 - 6370	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Cesium-137	4150	4210	3180 - 5320	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Cobalt-60	7880	8060	6350 - 9950	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Lead-212	1210	1240	865 - 1570	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Lead-214	1470	1850	777 - 2910	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Plutonium-238	1460	1470	733 - 2230	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Plutonium-239	1240	1330	725 - 1910	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Potassium-40	10300	10600	7300 - 12700	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Strontium-90	2950	4500	1400 - 7010	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Thorium-234	2240	1800	680 - 3080	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-234	2190	1820	853 - 2380	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-234	1830	1820	853 - 2380	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-234	1160	1820	853 - 2380	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-238	1530	1800	988 - 2420	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-238	2000	1800	988 - 2420	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-238	2020	1800	988 - 2420	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-Total	4670	3700	2050 - 4780	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-Total	4210	3700	2050 - 4780	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-Total	4020	3700	2050 - 4780	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Uranium-Total	2690	3700	2050 - 4780	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	µg/kg	U-Total (mass)	6030	5400	2440 - 7290	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	µg/kg	U-Total (mass)	4880	5400	2440 - 7290	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	µg/kg	U-Total (mass)	6050	5400	2440 - 7290	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	µg/kg	U-Total (mass)	6970	5400	2440 - 7290	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Soil	pCi/kg	Zinc-65	2150	1990	1590 - 2710	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Americium-241	3900	3880	2400 - 5480	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Cesium-134	2150	1950	1290 - 2600	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Cesium-137	2720	2160	1660 - 2910	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Cobalt-60	672	491	385 - 642	Not Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Curium-244	2620	2630	1480 - 3270	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Manganese-54	<32.9	<300	<300	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Plutonium-238	2370	2020	1400 - 2600	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Plutonium-239	4760	4160	2880 - 5270	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Potassium-40	37500	30900	23200 - 39100	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Strontium-90	3220	3330	1880 - 4340	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Uranium-234	5220	4050	2850 - 5170	Not Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Uranium-238	5150	4010	2830 - 5020	Not Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Uranium-Total	10800	8240	5260 - 11100	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	µg/kg	U-Total (mass)	15500	12100	9290 - 15000	Not Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Zinc-65	3420	2400	1790 - 3560	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Uranium-Total	5690	6290	4260 - 7830	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Uranium-Total	6238	6290	4260 - 7830	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	µg/kg	U-Total (mass)	8910	9250	6200 - 11700	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	µg/kg	U-Total (mass)	8440	9250	6200 - 11700	Acceptable

PT Provider	Quarter / Year	Report Closing / Received Date	Sample Number	Sample Media	Units	Analyte	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	µg/kg	U-Total (mass)	9030	9250	6200 - 11700	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Veg.	pCi/kg	Zinc-65	907	853	615 - 1200	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Americium-241	80.6	76.4	47.1 - 103	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Cesium-134	1140	1100	700 - 1360	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Cesium-137	1490	1390	1040 - 1830	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Cobalt-60	1120	1030	797 - 1290	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Iron-55	242	256	79.4 - 500	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Manganese-54	<7.53	<50.0	0.00 - 50.0	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Plutonium-238	54.1	54.3	37.2 - 71.4	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Plutonium-239	58.2	62	44.9 - 81.0	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Strontium-90	52.2	52.4	25.6 - 78.5	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Uranium-234	71.1	73.1	45.3 - 110	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Uranium-234	79	73.1	45.3 - 110	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Uranium-238	70.7	72.4	46.8 - 100	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Uranium-238	77.1	72.4	46.8 - 100	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Uranium-Total	154	149	82.5 - 227	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Uranium-Total	145	149	82.5 - 227	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Uranium-Total	159.5	149	82.5 - 227	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	µg/Filter	U-Total (mass)	230	217	139 - 306	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	µg/Filter	U-Total (mass)	212	217	139 - 306	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	µg/Filter	U-Total (mass)	231	217	139 - 306	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Zinc-65	1160	984	705 - 1360	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Gross Alpha	112	85.5	28.6 - 133	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Filter	pCi/Filter	Gross Beta	54.9	45.2	28.6 - 65.9	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Americium-241	150	140	94.3 - 188	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Cesium-134	2380	2510	1840 - 2880	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Cesium-137	1480	1400	1190 - 1680	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Cobalt-60	2570	2540	2210 - 2970	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Iron-55	923	984	587 - 1340	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Manganese-54	<6.36	<100	0.00 - 100	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Plutonium-238	108	128	94.7 - 159	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Plutonium-239	73.3	85.8	66.6 - 108	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Strontium-90	685	714	465 - 944	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-234	82.1	90.3	67.8 - 116	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-234	92	90.3	67.8 - 116	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-234	87.1	90.3	67.8 - 116	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-238	86.7	89.5	68.2 - 110	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-238	84.1	89.5	68.2 - 110	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-238	98	89.5	68.2 - 110	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-Total	181	184	135 - 238	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-Total	173	184	135 - 238	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-Total	180	184	135 - 238	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Uranium-Total	185	184	135 - 238	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	µg/L	U-Total (mass)	270	268	214 - 324	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	µg/L	U-Total (mass)	260	268	214 - 324	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	µg/L	U-Total (mass)	252	268	214 - 324	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	µg/L	U-Total (mass)	276	268	214 - 324	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Zinc-65	2160	1960	1630 - 2470	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Gross Alpha	125	89.5	31.8 - 139	Acceptable
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Gross Beta	59.6	61	34.9 - 90.4	Acceptable

PT Provider	Quarter / Year	Report Closing / Received Date	Sample Number	Sample Media	Units	Analyte	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
ERA	2nd/2018	05/22/18	MRAD-28	Water	pCi/L	Tritium	18900	19400	13000 - 27700	Acceptable
EZA	2nd/2018	07/07/18	E12171	Cartridge	pCi	Iodine-131	7.22E+01	7.16E+01	1.01	Acceptable
EZA	2nd/2018	07/07/18	E12172	Milk	pCi/L	Strontium-89	9.58E+01	8.46E+01	1.13	Acceptable
EZA	2nd/2018	07/07/18	E12172	Milk	pCi/L	Strontium-90	8.47E+00	1.14E+01	0.74	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Iodine-131	7.89E+01	7.19E+01	1.10	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Cerium-141	9.01E+01	8.22E+01	1.10	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Cobalt-58	9.26E+01	8.90E+01	1.04	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Cobalt-60	1.18E+02	1.13E+02	1.04	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Chromium-51	2.58E+02	2.39E+02	1.08	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Cesium-134	1.10E+02	1.14E+02	0.97	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Cesium-137	1.04E+02	9.88E+01	1.05	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Manganese-54	1.42E+02	1.30E+02	1.09	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Iron-59	8.87E+01	8.60E+01	1.03	Acceptable
EZA	2nd/2018	07/07/18	E12173	Milk	pCi/L	Zinc-65	1.83E+02	1.57E+02	1.16	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Iodine-131	7.31E+01	7.44E+01	0.98	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Cerium-141	1.02E+02	8.58E+01	1.19	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Chromium-51	2.73E+02	2.49E+02	1.10	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Cesium-134	1.06E+02	1.19E+02	0.89	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Cesium-137	9.86E+01	1.03E+02	0.96	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Cobalt-58	9.76E+01	9.29E+01	1.05	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Manganese-54	1.47E+02	1.35E+02	1.09	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Iron-59	1.08E+02	8.97E+01	1.20	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Zinc-65	1.97E+02	1.64E+02	1.20	Acceptable
EZA	2nd/2018	07/07/18	E12174	Water	pCi/L	Cobalt-60	1.22E+02	1.18E+02	1.03	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Americium-241	1.84		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Cesium-134	1.85		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Cesium-137	4.85	4.6	Sens. Eval.	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Cobalt-57	798	826	578-1074	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Cobalt-60	581	560	392-728	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Iron-55	67		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Manganese-54	1060	1010	707-1313	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Nickel-63	1.05		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Plutonium-238	42.7	45.2	31.6-58.8	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Pu-239/240	46.9	50.8	35.6-66.0	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Potassium-40	649	577	404-750	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Strontium-90	-1.08		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Technetium-99	890	980	686-1274	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	U-234/233	58.9	52.9	37.0-68.8	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Uranium-238	134	141	99-183	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaS38	Soil	Bq/Kg	Zinc-65	1060	960	672-1248	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Americium-241	0.685	0.709	0.496-0.922	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Cesium-134	9.140	10.2	7.1-13.3	Acceptable

PT Provider	Quarter / Year	Report Closing / Received Date	Sample Number	Sample Media	Units	Analyte	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Cesium-137	12.8	12.2	8.5-15.9	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Cobalt-57	-0.042		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Cobalt-60	12.1	11.5	8.1-15.0	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Hydrogen-3	1.14		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Iron-55	11.90	11.1	7.8-14.1	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Manganese-54	9.35E-04		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Nickel-63	14.5	14.0	9.8-18.2	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Plutonium-238	0.014	0.023	Sens. Eval.	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Pu-239/240	0.586	0.600	0.420-0.780	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Potassium-40	-0.23		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Radium-226	0.249	0.257	0.180-0.334	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Strontium-90	10.70	11.400	8.0-14.8	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Technetium-99	3.84	4.4	3.06-5.68	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Uranium- 234/233	0.45	0.43	0.301-0.559	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Uranium-238	0.48	0.44	0.306-0.568	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-MaW38	Water	Bq/L	Zinc-65	15.7	14.30	0.0-18.6	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	ug/sample	Uranium-235	0.076	0.0739	0.0517-0.0961	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	ug/sample	Uranium-238	10.60	10.4	7.3-13.5	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	ug/sample	Uranium-Total	10.68	10.5	7.4-13.7	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Americium-241	0.0646	0.0670	0.047-0.087	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Cesium-134	0.72	0.675	0.473-0.878	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Cesium-137	-0.023		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Cobalt-57	1.22	1.18	0.83-1.53	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Cobalt-60	0.010		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Manganese-54	1.08	1.03	0.72-1.34	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Plutonium-238	0.0440	0.0445	0.0312-0.0579	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Pu-239/240	0.0010		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Strontium-90	0.840	1.010	0.71-1.31	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Uranium- 234/233	0.121	0.124	0.087-0.161	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Uranium-238	0.126	0.128	0.090-0.166	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdF38	Filter	Bq/sample	Zinc-65	1.54	1.33	0.93-1.73	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Americium-241	0.107	0.106	0.074-0.138	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Cesium-134	3.17	3.23	2.26-4.2	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Cesium-137	4.03	3.67	2.57-4.77	Acceptable

PT Provider	Quarter / Year	Report Closing / Received Date	Sample Number	Sample Media	Units	Analyte	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Cobalt-57	4.76	4.42	3.09-5.75	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Cobalt-60	2.49	2.3	1.60-2.98	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Manganese-54	3.02	2.66	1.86-3.46	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Plutonium-238	0.0005		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Pu-239/240	0.0679	0.0770	0.054-0.1	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Strontium-90	0.61	0.675	0.473-0.878	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Uranium- 234/233	0.21	0.179	0.125-0.233	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Uranium-238	0.197	0.186	0.130-0.242	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Zinc-65	0.02		False Pos Test	Acceptable
MAPEP	2nd/2018	05/31/18	MAPEP- 18-XaW38	Water	Bq/L	Iodine-129	2.00	1.93	1.35-2.51	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Barium-133	28.5	25.6	19.9 - 29.4	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Cesium-134	15.9	15.7	11.4 - 18.2	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Cesium-137	196	192	173 - 213	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Cobalt-60	122	119	107 - 133	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Zinc-65	196	177	159 - 208	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Gross Alpha	15.5	16	7.79 - 22.6	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Gross Alpha	18.2	16	7.79 - 22.6	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Gross Beta	43.6	49	33.2 - 56.1	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Radium-226	8.44	9.08	6.81 - 10.6	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Radium-228	2.72	2.28	1.07 - 3.60	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Radium-228	3.3	2.28	1.07 - 3.60	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Uranium (Nat)	53.8	51.8	42.2 - 57.1	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Uranium (Nat)	50.3	51.8	42.2 - 57.1	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	µg/L	Uranium (Nat) mass	80.3	75.5	61.5 - 83.2	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	µg/L	Uranium (Nat) mass	78.36	75.5	61.5 - 83.2	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	µg/L	Uranium (Nat) mass	77.8	75.5	61.5 - 83.2	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Tritium	19900	20400	17900 - 22400	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Tritium	21200	20400	17900 - 22400	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Strontium-89	61.5	62.7	50.7 - 70.6	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Strontium-89	69	62.7	50.7 - 70.6	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Strontium-90	34.4	40.1	29.5 - 46.1	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Strontium-90	36.2	40.1	29.5 - 46.1	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Iodine-131	25.6	28.1	23.4 - 33.0	Acceptable
ERA	3rd / 2018	08/23/18	RAD - 114	Water	pCi/L	Iodine-131	28.7	28.1	23.4 - 33.0	Acceptable
EZA	3rd/2018	11/12/18	E12240	Cartridge	pCi	Iodine-131	7.95E+01	8.03E+01	0.99	Acceptable
EZA	3rd/2018	11/12/18	E12241	Milk	pCi/L	Strontium-89	8.57E+01	8.17E+01	1.05	Acceptable
EZA	3rd/2018	11/12/18	E12241	Milk	pCi/L	Strontium-90	9.22E+00	1.48E+01	0.62	Acceptable
EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Iodine-131	7.18E+01	5.82E+01	1.23	Acceptable
EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Cerium-141	1.43E+02	1.28E+02	1.12	Acceptable
EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Chromium-51	2.54E+02	2.65E+02	0.96	Acceptable
EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Cesium-134	1.18E+02	1.23E+02	0.96	Acceptable
EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Cesium-137	1.53E+02	1.47E+02	1.04	Acceptable
EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Cobalt-58	1.54E+02	1.44E+02	1.07	Acceptable
EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Manganese-54	1.84E+02	1.67E+02	1.09	Acceptable

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EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Iron-59	1.20E+02	1.19E+02	1.01	Acceptable
EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Zinc-65	2.44E+02	2.01E+02	1.22	Acceptable
EZA	3rd/2018	11/12/18	E12242	Milk	pCi/L	Cobalt-60	2.02E+02	1.90E+02	1.06	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Iodine-131	6.76E+01	6.25E+01	1.08	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Cerium-141	1.48E+02	1.33E+02	1.11	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Chromium-51	2.92E+02	2.75E+02	1.06	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Cesium-134	1.20E+02	1.28E+02	0.94	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Cesium-137	1.64E+02	1.54E+02	1.07	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Cobalt-58	1.53E+02	1.50E+02	1.02	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Manganese-54	1.91E+02	1.74E+02	1.1	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Iron-59	1.39E+02	1.24E+02	1.12	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Zinc-65	2.41E+02	2.09E+02	1.15	Acceptable
EZA	3rd/2018	11/12/18	E12243	Water	pCi/L	Cobalt-60	2.09E+02	1.98E+02	1.06	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Actinium-228	3740	3280	2030 - 4540	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Americium-241	891	937	459 - 1420	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Bismuth-212	3990	3400	1810 - 4990	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Bismuth-214	1310	1370	841 - 1900	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Cesium-134	5710	5400	3200 - 7600	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Cesium-137	4160	3910	2340 - 5480	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Cobalt-60	4940	4890	3410 - 6370	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Lead-212	4250	3380	2050 - 4720	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Lead-214	1590	1450	883 - 2020	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Manganese-54	<32.8	<1000	<1000	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Plutonium-238	1090	1150	662 - 1650	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Plutonium-239	735	756	561 - 950	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Potassium-40	24800	24300	17300 - 31400	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Strontium-90	4580	4340	2240 - 6440	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Thorium-234	1610	1470	549 - 2390	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Uranium-234	1730	1050	105 - 2370	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Uranium-234	1230	1050	105 - 2370	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Uranium-234	1060	1050	105 - 2370	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Uranium-238	1210	1030	103 - 2740	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Uranium-238	1100	1030	103 - 2740	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Uranium-238	660	1030	103 - 2740	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Uranium-Total	2320	2030	203 - 4560	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Uranium-Total	1890	2030	203 - 4560	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	Uranium-Total	2830	2030	203 - 4560	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	U-Total (mass)	2010	2420	242 - 6320	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	pCi/kg	U-Total (mass)	3300	2420	242 - 6320	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	µg/kg	U-Total (mass)	2010	2420	242 - 6320	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	µg/kg	U-Total (mass)	3620	2420	242 - 6320	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Soil	µg/kg	Zinc-65	4310	4020	2650 - 5380	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Americium-241	1770	1750	1080 - 2470	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Cesium-134	2000	1970	1310 - 2620	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Cesium-137	692	613	471 - 825	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Cobalt-60	1930	1810	1420 - 2370	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Curium-244	4840	4840	2730 - 6020	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Manganese-54	<52.1	<300	<300	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Plutonium-238	3280	3240	2240 - 4180	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Plutonium-239	3170	3070	2120 - 3890	Acceptable

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ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Potassium-40	38600	34500	25900 - 43700	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Strontium-90	6220	5930	3340 - 7730	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Uranium-234	1800	1670	1170 - 2130	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Uranium-238	1780	1660	1170 - 2080	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Uranium-Total	3710	3390	2170 - 4570	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	U-Total (mass)	5360	4990	3830 - 6180	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Veg.	pCi/kg	Zinc-65	2380	2230	1660 - 3310	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Americium-241	62	64.1	45.8 - 85.5	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Cesium-134	862	921	597 - 1130	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Cesium-137	373	373	306 - 489	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Cobalt-60	1200	1130	960 - 1440	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Iron-55	899	910	332 - 1450	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Manganese-54	<5.41	<50.0	<50.0	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Plutonium-238	34.5	34.9	26.3 - 42.9	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Plutonium-239	11.7	11.2	8.37 - 13.5	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Strontium-90	87.6	89.4	56.5 - 122	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Uranium-234	55.1	52.1	38.6 - 61.0	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Uranium-234	49	52.1	38.6 - 61.0	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Uranium-238	51.1	51.6	39.0 - 61.6	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Uranium-238	47.4	51.6	39.0 - 61.6	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Uranium-Total	102.5	106	77.4 - 126	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Uranium-Total	103	106	77.4 - 126	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	µg/Filter	U-Total (mass)	153	156	125 - 183	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	µg/Filter	U-Total (mass)	142	156	125 - 183	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Zinc-65	771	660	541 - 1010	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Gross Alpha	54.2	55.3	28.9 - 91.1	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Filter	pCi/Filter	Gross Beta	75.6	86.5	52.4 - 131	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Americium-241	164	172	118 - 220	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Cesium-134	2200	2310	1740 - 2540	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Cesium-137	910	898	769 - 1020	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Cesium-137	910	898	769 - 1020	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Cobalt-60	1630	1510	1300 - 1730	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Iron-55	2610	1580	928 - 2300	Not Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Manganese-54	<6.61	<100	<100	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Plutonium-238	108	141	84.8 - 183	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Plutonium-239	125	163	101 - 201	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Strontium-90	321	275	198 - 340	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Uranium-234	94	91.6	69.7 - 105	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Uranium-234	95.8	91.6	69.7 - 105	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Uranium-234	84.6	91.6	69.7 - 105	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Uranium-238	93.3	90.8	70.4 - 107	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Uranium-238	88.3	90.8	70.4 - 107	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Uranium-238	88.5	90.8	70.4 - 107	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Uranium-238	93.3	90.8	70.4 - 107	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Uranium-Total	184.3	187	146 - 213	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Uranium-Total	178	187	146 - 213	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	µg/L	U-Total (mass)	265	273	221 - 310	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Zinc-65	1990	1790	1590 - 2260	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Gross Alpha	166	183	66.8 - 252	Acceptable
ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Gross Beta	91	99.4	49.7 - 137	Acceptable

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ERA	4th/2018	11/20/18	MRAD-29	Water	pCi/L	Tritium	3030	3020	2280 - 3680	Acceptable
EZA	4th/2018	01/23/19	E12346	Cartridge	pCi	Iodine-131	8.92E+01	8.98E+01	0.99	Acceptable
EZA	4th/2018	01/23/19	E12347	Milk	pCi/L	Strontium-89	8.67E+01	9.19E+01	0.94	Acceptable
EZA	4th/2018	01/23/19	E12347	Milk	pCi/L	Strontium-90	1.07E+01	1.33E+01	0.80	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Iodine-131	9.58E+01	9.33E+01	1.03	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Cerium-141	1.37E+02	1.33E+02	1.03	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Chromium-51	2.66E+02	2.98E+02	0.89	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Cesium-134	1.52E+02	1.71E+02	0.89	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Cesium-137	1.25E+02	1.21E+02	1.03	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Cobalt-58	1.19E+02	1.19E+02	1.00	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Manganese-54	1.70E+02	1.54E+02	1.10	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Iron-59	1.25E+02	1.14E+02	1.09	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Zinc-65	2.75E+02	2.64E+02	1.04	Acceptable
EZA	4th/2018	01/23/19	E12348	Milk	pCi/L	Cobalt-60	2.12E+02	2.12E+02	1.00	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Iodine-131	8.19E+01	8.04E+01	1.02	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Cerium-141	1.26E+02	1.24E+02	1.02	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Chromium-51	3.20E+02	2.78E+02	1.15	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Cesium-134	1.41E+02	1.60E+02	0.88	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Cesium-137	1.21E+02	1.13E+02	1.07	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Cobalt-58	1.09E+02	1.11E+02	0.99	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Manganese-54	1.51E+02	1.44E+02	1.05	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Iron-59	1.16E+02	1.07E+02	1.09	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Zinc-65	2.76E+02	2.46E+02	1.12	Acceptable
EZA	4th/2018	01/23/19	E12349	Water	pCi/L	Cobalt-60	2.06E+02	1.98E+02	1.04	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Americium-241	55.4	55.5	38.9-72.2	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Cesium-134	693.00	781	547-1015	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Cesium-137	598	572	400-744	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Cobalt-57	1080	958	671-1245	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Cobalt-60	595.000	608	426-790	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Iron-55	434	512	358-666	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Manganese-54	0.24		False Pos Test	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Nickel-63	793	765	536-995	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Plutonium-238	55.2	57.0	39.9-74.1	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Pu-239/240	-0.33	0.34	Sens. Eval	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Potassium-40	556	566	396-736	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Strontium-90	162	193	135-251	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Technetium-99	239	252	176-328	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	U-234/233	113	160	112-208	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Uranium-238	224	276	193-359	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaS39	Soil	Bq/Kg	Zinc-65	537.0	500	350-650	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Americium-241	0.007		False Pos Test	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Cesium-134	7.94	8.7	6.1-11.3	Acceptable

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MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Cesium-137	7.41	6.9	4.8-9.0	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Cobalt-57	15.1	14.9	10.4-19.4	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Cobalt-60	0.0408		False Pos Test	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Hydrogen-3	331	338	237-439	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Iron-55	8.41	9.0	6.3-11.7	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Manganese-54	13.2	12.5	8.8-16.3	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Nickel-63	6.14	7.0	4.9-9.1	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Plutonium-238	0.591	0.67	0.472-0.876	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Pu-239/240	0.801	0.928	0.650-1.206	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Potassium-40	0.884		False Pos Test	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Radium-226	0.566	0.44	0.309-0.575	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Strontium-90	8.24	9.41	6.59-12.23	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Technetium-99	3.87	3.39	2.73-4.41	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Uranium- 234/233	2.13	2.11	1.48-2.74	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Uranium-238	2.170	2.180	1.53-2.83	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-MaW39	Water	Bq/L	Zinc-65	8.52	7.53	5.27-9.79	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	ug/sample	Uranium-235	0.0936	0.0913	0.0650 - 0.1208	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	ug/sample	Uranium-238	13.4	12.7	8.9 - 16.5	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	ug/sample	Uranium-Total	13.5	12.8	9.0 - 16.6	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Americium-241	0.0919	0.0913	0.0639 - 0.1187	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Cesium-134	0.431	0.444	0.311 - 0.577	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Cesium-137	0.338	0.345	0.242 - 0.449	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Cobalt-57	0.598	0.592	0.414 - 0.770	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Cobalt-60	0.338	0.294	0.206 - 0.382	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Manganese-54	0.326	0.266	0.186 - 0.346	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Plutonium-238	0.000398	0.0011	Sens. Evaluation	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Pu-239/240	0.0672	0.0698	0.0489 - 0.0907	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Strontium-90	-0.026		False Pos Test	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Uranium- 234/233	0.148	0.152	0.106 - 0.198	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Uranium-238	0.150	0.158	0.111 - 0.205	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdF38	Filter	Bq/sample	Zinc-65	0.229	0.201	Sens. Evaluation	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Americium-241	0.0851	0.0930	0.065-0.121	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Cesium-134	1.74	1.94	1.36-2.52	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Cesium-137	2.42	2.36	1.65-3.07	Acceptable

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MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Cobalt-57	3.24	3.31	2.32-4.30	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Cobalt-60	1.69	1.68	1.18-2.18	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Manganese-54	2.59	2.53	1.77-3.29	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Plutonium-238	0.0680	0.070	0.049-0.091	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Pu-239/240	0.0605	0.0620	0.043-0.081	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Strontium-90	0.718	0.791	0.554-1.028	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Uranium- 234/233	0.136	0.138	0.097-0.179	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Uranium-238	0.140	0.143	0.100-0.186	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-RdV38	Veg.	Bq/sample	Zinc-65	1.51	1.37	0.96-1.78	Acceptable
MAPEP	4th/2018	12/03/18	MAPEP- 18-XaW39	Alk. Water	Bq/L	Iodine-129	1.63	1.62	1.13-2.11	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 2018 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 2018 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 atmospheric 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.

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 2018. (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 2018 operational year for Units 2/3, the SONGS REMP TLD data was processed in accordance with ANSI/HPS 13.37-2014. 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.

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 TLDs.

Airborne Particulates

From January 1979 through December 2018 (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.

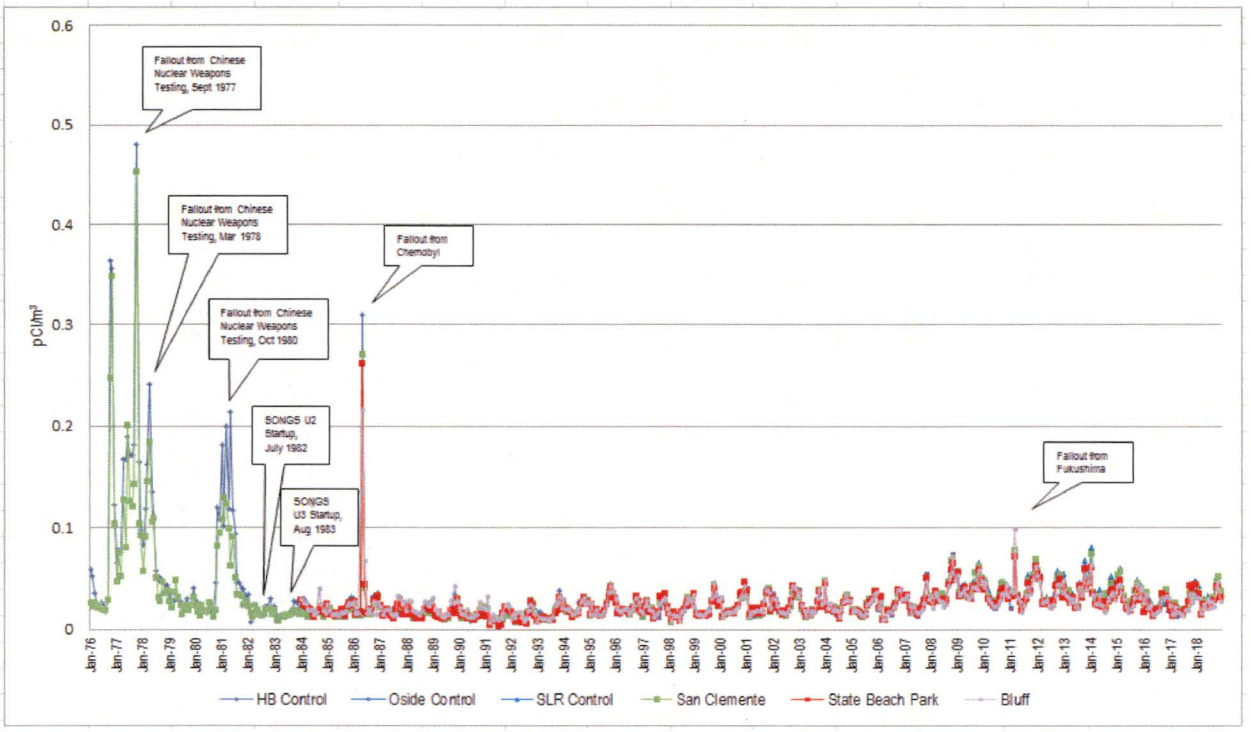


Figure 11 - Monthly Average Airborne Particulate Gross Beta Preoperational and Operational Data for Units 2 and 3, (1976 – 2018)

For 2018, the maximum monthly average airborne particulate gross beta result was approximately 0.036 pCi/m^3. This result is in line with both recent history and SONGS preoperational data.

Radioiodine

Most of the preoperational data for I-131 level was below the detection limit. All the 2018 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 2018.

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 in and from the Newport Beach control location.

The data for all plant related radionuclides at all ocean water locations during the 2018 operational period were not detected. SONGS had no impact on the environment as measured by this exposure pathway in 2018.

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 2018 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 2018, and no trends have been noted. SONGS had no impact on the environment as measured by this exposure pathway.

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 2018 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 2018 operational period. SONGS had no impact on the environment as measured by this exposure pathway in 2018.

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 2018 – December 2018
b. LLD for operational data are listed in Appendix B
c. During 2018, all station related radionuclides from all sample locations were < LLD

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 preoperational period samples was 0.06 and 0.26 pCi/g, respectively.

Results of the 2018 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 2018 was below the MDC, supporting the conclusion of no detectable impact on ocean bottom sediments from SONGS. SONGS had no impact on the environment as measured by this exposure pathway in 2018.

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 2018 – December 2018

b LLD for operational data are listed in Appendix B

c During 2018, all station related radionuclides from all sample locations were < LLD

Marine Species (Flesh)

Non-migratory marine species are collected semi-annually near SONGS. Non-migratory marine animals are collected near the SONGS outfalls and from Laguna Beach and 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 2018 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 2018 operational period, no SONGS related radionuclides were detected above the MDC. The data indicate no accumulation trends. SONGS had no impact on the environment as measured by this exposure pathway in 2018.

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 2018 – December 2018

b LLD for operational data are listed in Appendix B

c During 2018, all station related radionuclides from all sample locations were < LLD

d Samples collected in 2018 include crustaceae, mollusks, and two adult species of fish.

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 2018, only natural radionuclides were identified in local crops, at both the indicator and control locations. SONGS had no impact on the environment as measured by this exposure pathway in 2018.

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. SONGS had no impact on the environment as measured by this exposure pathway in 2018.

Table 34 - Soil Concentration

		Indicator		Control	
Radionuclide	Period	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 – 0.10	0.096 0.10	< LLD - 0.06 0.99	< 0.10 0.099
All other SONGS radionuclides	PreOp Operational	< LLD < LLD	< LLD < LLD	< LLD < LLD	< LLD < LLD

Kelp

Kelp is collected semiannually from three indicator locations and from a control location situated at Salt Creek. 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 2018 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 2018 operational period, I-131 was detected in two indicator and one control samples. No other station related isotopes were detected in kelp samples during the 2018 operational period. Figure 9 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 concentrations of I-131 are a result of operations at SONGS. The presence of I-131 in kelp is 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 < LLD – 0.104	0.013 0.077	0.008 - 0.030 0.018	0.014 0.018
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 2018 are higher than found during the preoperational program. However, all of the positive results were from the April 2018 sampling and were found in both indicator and control sample locations. No I-131 was detected during the October 2018 sampling. Since there is no longer a viable production mechanism for I-131 at SONGS, it is reasonable to conclude that the detection of I-131 in kelp is due to factors external to SONGS. SONGS had no impact on the environment as measured by this exposure pathway in 2018.

APPENDIX E. DEVIATIONS FROM ODCM SAMPLING REQUIREMENTS IN 2018

DEVIATIONS FROM ODCM SAMPLING REQUIREMENTS

Deviations from the ODCM sampling requirements are identified below in accordance with section 5.0 of the ODCM. During 2018, 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, external power outages, and other unavoidable deviations. The 2018 ODCM deviations had no meaningful impact on the REMP data and does not compromise the validity of the reported conclusions.

Direct Radiation

Thermoluminescent Dosimeters (TLDs)

1. TLD # 15 was moved off station during a portion of the second quarter 2018 exposure collection period because planned adjacent construction activity was likely to damage the TLD package. The TLD data was calculated using the known exposure rates off station, the known time off station, the known time on station, and the measured total gamma exposure to the TLD # 15 package during the second quarter of 2018. Thus, direct radiation data was available for TLD # 15 based on empirical measurements during the second quarter of 2018.
2. TLD # 22 (former USCG Station San Mateo) was removed from its station by unknown external action (possible vandalism) sometime during the second quarter of 2018. Thus, no empirical TLD # 22 data exists to report for this location during the second quarter 2018.

Air Sampling

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

Downtime for each air sampler in 2018 was due to weekly sample collection, quarterly calibrator flow comparison checks, scheduled air sampler motor assembly / calibrator change-outs, and preventative air sampler motor assembly change-outs which was conducted if a motor assembly was observed to show signs of degraded performance (excessive bearing noise, vane erosion, flow decline, etc.). During 2018, there were no avoidable deviations from the ODCM. The unavoidable ODCM deviations (routine planned air sampler maintenance and one unplanned external power outage) constituted less than 3 hours per air sampler during 2018.

Routine unavoidable air sampler down time (per sampler) includes the following:

Weekly sample collection events:	0.5 minutes (approx.) x 52 = 26 minutes
Quarterly calibrator comparison check:	5 minutes (approx.) x 4 = 20 minutes
Other air sampler maintenance:	10 minutes (approx.)

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

1) Air Sampler #1 (San Clemente City Hall) experienced approximately 1.2 hours of down time during the sample collection period ending 3/13/2018. This was attributable to an external power outage.

Note: Christmas fell on the normal REMP air sample collection day (Tuesday) in 2018. The REMP air sampling was completed the next day. This resulted in an eight-day collection period followed by a six-day collection period in 2019. No downtime resulted. The acceptable time frame for surveillances described in Section 6 of the ODCM is the surveillance interval + 25% of the surveillance periodicity. This action did not result in a deviation from the ODCM.

Note: Air samples collected on 9/11/2018 could not be shipped until 9/12/2018 due to the impact of Hurricane Florence on shipping. This did not result in a deviation from the ODCM or procedures.

Ocean Water Sampling

No deviations were observed

Drinking Water

No deviations were observed

Shoreline Sediments

No deviations were observed

Ocean Bottom Sediments

No deviations were observed

Marine Species (Flesh)

No deviations were observed

Local Crops

No deviations were observed

Soil

No deviations were observed

Kelp

Kelp samples are not required by Section 5.1 of the ODCM. Normally, four kelp beds are collected twice a year for a total of eight kelp samples. Four samples were collected in April 2018. In October 2018, only two kelp beds had sufficient canopy to provide a sample. There were a total of six kelp samples in 2018 instead of the normal eight samples. This did not constitute a deviation from the ODCM.

APPENDIX F. LAND USE CENSUS

Introduction

The regulatory basis for conducting a Land Use Census (LUC) is identified in 10CFR50, Appendix I, Section IV.B.3. The site specific regulatory position (NUREG 0490 sec. 2.4.4) describes atmospheric dispersion and assumes a ground plane release. Therefore, the purpose of the LUC is to "identify the location of the nearest garden of greater than 500 square feet producing leafy vegetables, the nearest milk animals, and the nearest residence in each of the 16 meteorological sectors within a distance of five miles from SONGS Units 2 and 3." Using the procedurally described criteria will always identify the critical receptor in each sector for a ground plane release. This meets the NUREG 0490 requirement for a surveillance program "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." 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 2018 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 SDS-CH2-PCD-1012, Land Use Census, establishes the method of documenting and verifying Land Use Census results in compliance with the ODCM.

Executive Summary

The land area around 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 the SONGS seawall beach walkway (open to unrestricted use by members of the general public) comprise six sectors. The United States Marine Corps (USMC) Base Camp Pendleton and the San Onofre State Beach Campground comprise 7 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.

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 2017 is 65,267 per the US Census 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 Park, the SONGS seawall beach walkway, 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. Other Specified Use locations, such as fire stations, surf camps, and other potential pathways of exposure to an individual, may be identified if these locations are closer to SONGS than the closest full time residence for all age groups. An Other Specified Use location is not identified if a higher occupancy Other Specified Use location in that sector is closer to SONGS.

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 include the beach seawall walkway which may be open to the general public for non-employment usage. The non-employment use observed on this walkway is the recreational pedestrian transit between the beaches north and south of SONGS. Sectors P, Q, and R include a section of San Clemente, the San Onofre State Park, and part of Camp Pendleton.

Research Methodology

Completion of the 2018 SONGS Land Use Census required field research and communication with agencies, organizations, and individuals. The Radiological Effluent and Environmental Program (REMP) Specialist reviewed and verified the 2017 LUC and associated documentation. If changes occurred, then changes were reflected in the 2018 land use census. Information gathered by communication with the cognizant point of contact for the appropriate agency, organization, or military base. The following agencies and organizations were contacted. Information was also researched through the agency websites.

- California Highway Patrol
- State of California Department of Parks and Recreation, including San Onofre State Beach
- Orange County Agricultural Commissioner
- United States Border Patrol
- US Census Bureau
- Endless Summer Surf Camp
- San Onofre Recreation Beach (SORB) management
- Marine Corps Base Camp Pendleton (CPEN), Community Plans and Liaison office

As per the LUC procedure, if the existence of a garden greater than 500 square feet at a candidate location could not be determined from the street, then a garden greater than 500 square feet was presumed to exist at that location. Department of Homeland Security (Border Patrol) management personnel provided occupancy data for the Border Patrol check point. Communication provided by the points of contact from Camp Pendleton and State Parks was considered to be conclusive. 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 August 2018 and completed in October 2018.

Data and Methodology Summary

The closest candidate residence, garden, dairy within five miles of SONGS was identified for each of the 16 sectors. If there were Other Specified Uses (including both employment and non-employment related locations) closer than the closest residence, then these locations were also noted in the appropriate LUC map. 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.

Objective Evidence File

Throughout the study, records of contacts, phone notes, meeting minutes, emails, and field survey notes were maintained in accordance with the Land Use Census Procedure, SDS-CH2-PCD-1012. A documentation portfolio was prepared and retained in the plant retrievable record system.

2018 Land Use Census Observations and Changes

The following observations and changes were noted:

- The closest garden (greater than 500 square feet) in each sector was identified.
- In Sector P the closest garden is located at 4130 Calle Isabella (LUC # G-3).
- In Sector Q the closest garden is located at 130 Calle Pacifica (LUC # G-15).
- In Sector R the closest garden is located at 786 Avenida Salvador (LUC # G-19).
- The SONGS garden is also located in Sector R (LUC # G-10). However, the SONGS garden is a source of leafy and fleshy samples to satisfy the REMP local crop sampling requirement. The SONGS garden is not used for human consumption and is 0.7 miles from SONGS. In the 2017 LUC, the SONGS garden was reported to be 0.4 miles from SONGS in Sector R.

- LUC # R-P3 and R-Q5 are San Onofre Recreational Beach (SORB) camping areas that are closest to SONGS in sector P and sector Q respectively. In 2014, the SORB discontinued the campground host program. R-P3 (the campground host location) is no longer a Full Time Residence (FTR). The SORB employee who lived in location R-Q5 has retired and R-Q5 is no longer an FTR. The current SORB policy is to allow only eligible persons to camp at the SORB for no more than ninety (90) days per year. No one is allowed to live full-time on the SORB property. Thus, R-P3 and R-Q5 have been changed to residences with a maximum occupancy of 2160 hours per year (90 X 24) for all age groups. LUC # R-P3 and R-Q5 were identified as FTR in the 2017 LUC.
- The occupancy for the Border Patrol Station changed from 2400 to 2000 hours per year based on information from the on-site management. The California Highway Patrol weigh station changed from 1960 to 2000 hours based on an interview with the on-site management.
- LUC # R-G1 (San Onofre State Park campground host) occupied spaces 103 to 104 in 2018. The reported location was 99-104 in the 2017 LUC. This location is 2.9 miles from SONGS. The distance was reported as 3.0 miles in 2017 LUC.
- Other Specified Use locations were included only if there were no Other Specified Use locations with a higher occupancy closer to SONGS in the same sector. Accordingly, some Other Specified Use locations identified in the 2017 LUC are not identified in the 2018 LUC.
- LUC # O2B (YMCA Surf Camp) is not included because LUC # O-2 (San Onofre Beach Campground) is closer and has a higher occupancy for all ages.
- LUC # R-C1 (Camp San Onofre Barracks) is not included because R-C3 (Camp San Onofre Barracks) is closer to SONGS in sector P.
- LUC # R-P1 (Cotton Point Estates) is not included because LUC # R-P2 (San Mateo Point Housing) is closer.
- LUC # R-Q3 (San Mateo Point Housing) is not included because LUC # R-Q2 (San Onofre III Housing) is closer in Sector Q.
- LUC # 3 (Trestles Beach Lookout Tower) is not included because R-P3 (San Onofre Recreational Beach (SORB)) and LUC # O-6 (Surf Beach (Lifeguard)) are both closer to SONGS and both have a greater occupancy for all ages.
- LUC # 31B (Hwy Patrol Weigh Station (NB)) is not included because LUC # 31A (Border Patrol Checkpoint (NB)) is closer has the same occupancy.
- Only the closest garden in each sector is identified. Therefore, gardens G-5 (1706 S Ola Vista), G-8 (2240 Ave Salvador), G-14 (4090 Calle Isabella), and G-15 (130 Calle del Pacifica) are not included.
- The occupancy for the Endless Summer Surf Camp changed from 4380 to 2880 hours for adults. LUC # O-2A
- The Summer Soul Surf Camp moved to the San Clemente State Beach. The new location is further from SONGS than the closest residence. Therefore, this location is not included in the 2018 LUC. LUC # O-2D

Chemical and Toxic Waste

The presence of manufacturing facilities, chemical plants, and toxic waste sites was determined by field survey. Per direct observation, no chemical of toxic waste facility with the potential to affect SONGS exists within the study area.

Milk Animals

No dairies or other facilities producing milk for human consumption were identified in 2018.

Meat Animals

No agricultural meat animals were identified during the 2018 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

Fleshy and leafy vegetables were available approximately eight months during 2018 at the SONGS garden.

Summary of Changes

1. For the period of July 1, 2017 to June 30, 2018, the Camp Pendleton deer hunting take data was updated and is 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, 2017 through June 30, 2018.

   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 2018 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	Estimated hours of Maximum
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-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	**2,000**
G	R-G1	San Onofre State Park-Host sites **# 103-104**	**2.9**	FTR				O-2	San Onofre Beach Campground - all ages	1.8	720
								32	Hwy Patrol Weigh Station (SB)	2.1	**2,000**
								O-2A	Endless Summer Surf Camp sites **99-101** (see notes)	2.8	**2,880**
	Sectors H, J, K, L, M, and N have only non-employment related other specified uses (recreational transit via the beach walkway). These sectors are primarily the Pacific Ocean and contain only a small portion of the plant site, and the beach walkway providing access for state beach park users north & south of SONGS.										
P	R-P3	San Onofre Rec Beach (SORB)	1	**2160**				O-6	Surf Beach (Lifeguard)	0.5	800
	R-P2	San Mateo Point housing	2.7	FTR	G-3	4130 Calle Isabella	2.8				
Q	R-Q5	SORB Recreational Beach	1.1	**2160**	G-15	130 Calle del Pacifico	4	O-3	State Park Office Trailer	0.6	2,000
	R-Q2	San Onofre III housing	1.4	FTR				5	Surf Beach Guard Shack	0.7	1,500
								1A	SORB Campground Check-in	1.3	2,000
R	R-R1	San Onofre III housing	1.3	FTR	G-10	SONGS Garden	**0.7**				
					G-19	786 Ave Salvador	4.9				

Bold Text indicates a change from the 2017 LUC Data as of 10-3-2018 FTR - Full Time Residence

NOTES FOR TABLE 1

RESIDENCES

LUC#	Description
R-A1	CAMP SAN MATEO (barracks)-This is an employment and an FTR land use location for person 17 and older
R-C2	CAMP SAN ONOFRE FIRE STATION-This is an employment and FTR land use location for persons 18 and older.
R-C3	CAMP SAN ONOFRE (barracks)-This is an employment and FTR land use location 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 #103 - 104.
R-P2	SAN MATEO POINT HOUSING-This is a FTR for all age groups.
R-R1	San Onofre III housing is located in sector Q and R.
R-Q2	This permanent housing development is a FTR for all ages.
R-P3 R-Q5	SAN ONOFRE RECREATION BEACH (SORB) – R-P3 and R-Q5 are temporary residences for military and other personnel eligible to use SORB facilities. Persons of all ages may stay up to 90 days per year (2160 hours). The campground hosts and employee residences were terminated in 2014 and 2015

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:

- The closest garden in Sector R is G-19 (786 Avendia Salvador).
- The closest garden in Sector Q is G-15 (130 Calle del Pacifico).
- The closest garden in Sector P is G-3 (4130 Calle Isabella).
- No gardens were identified in the remaining 13 sectors within the study area.

Based on the updated information, Figure 4 was revised to reflect the closest currently active gardens in each sector.

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. A camper may stay a maximum of 30 days (720 hours).
O-2A	ENDLESS SUMMER SURF CAMP/CAMPGROUND HOST-The Endless Summer Surf Camp is located in spaces 99 to 101. The maximum occupancy for persons age 18 and older is 2880 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-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.

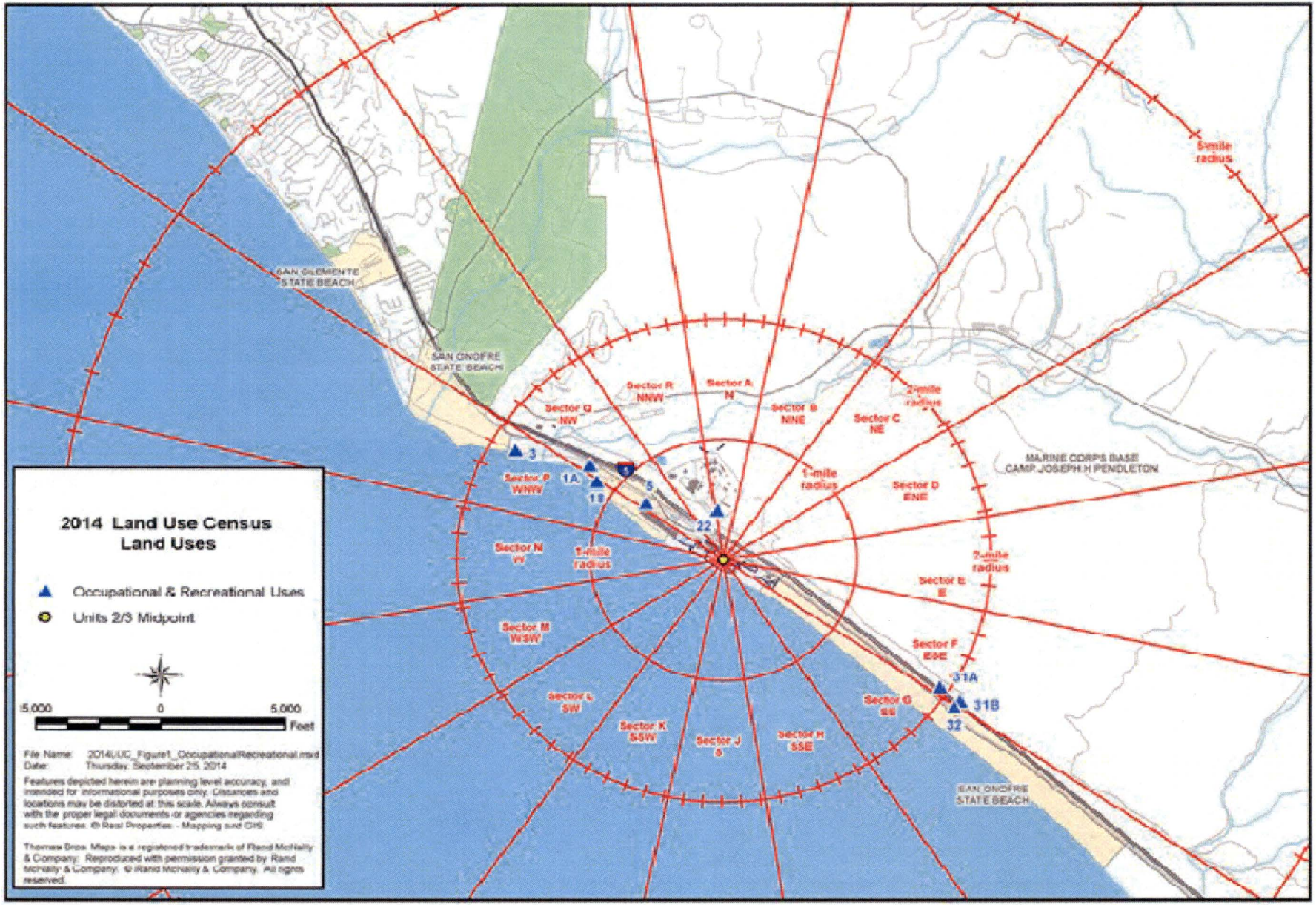
LUC#	Description
O-8	CAMP SAN MATEO MOTOR POOL-This is an employment land use location for persons 17 and older.
O-9	USMC CP SANITARY LANDFILL-This is an employment land use location for persons 18 and older.
O-10	CAMP SAN ONOFRE WASTE WATER TREATMENT PLANT (STP #11)-This is an employment land use location 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.
5	SURF BEACH GUARD SHACK-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.
32	SOUTHBOUND HIGHWAY PATROL WEIGH STATION-This is an employment land use location for persons 18 and older.

SONGS BEACH WALKWAY - The occupancy of the beach walkway running parallel to and adjacent to the SONGS seawall immediately next to the seawall was closed off for all of 2018 with barricades at both the north and south entrances. The occupancy for this area, normally open to the general public, is estimated to be no more than 8 hours per year using normal LUC occupancy estimation protocols. The source data for the occupancy estimate was provided by the SDS maintenance supervisor responsible for seawall maintenance activities and by EIX SONGS security personnel. The 2017 Annual Radiological Environmental Operating Report (AREOR) assigned an occupancy of 500 hours (reference attachment 5.1 of procedure SDS-RP3-PCD-1014, Direct Radiation Exposure Controls and Monitoring).

Table 3 – Camp Pendleton Hunting Take Data. July 1, 2017 – June 30, 2018

Area	Deer Hunter Effort	Sm Game Hunter Effort	Deer	Coyote	Dove	Quail	Rabbit	Squirrel	Pigeon
	Hours	Hours							
Alpha-1 B(3),C(3.2)	75	70	0	0	0	0	0	0	0
Alpha-2 E(0.8),D(0.8),C(3)	62	12	0	0	0	0	0	0	0
Alpha-3 D(2.2)	115	33	2	0	2	2	0	0	0
Bravo-2 B(3.8), A(4.2)	18	100	1	0	0	5	2	0	0
Bravo-3 B(1.6),A(1.8),R(1.8)	23	42	0	0	0	1	0	0	0
Romeo-1 E(1)	92	41	1	0	0	5	0	11	0
Romeo-2 E(2.6)	247	21	4	0	0	3	0	0	0
Romeo-3 E(1.4), F(1.5)	88	0	1	0	0	4	0	0	0
Papa-2 & Tango F(5)	423	65	7	0	0	0	2	5	0
Totals	1143	384	16	0	2	20	4	16	0

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


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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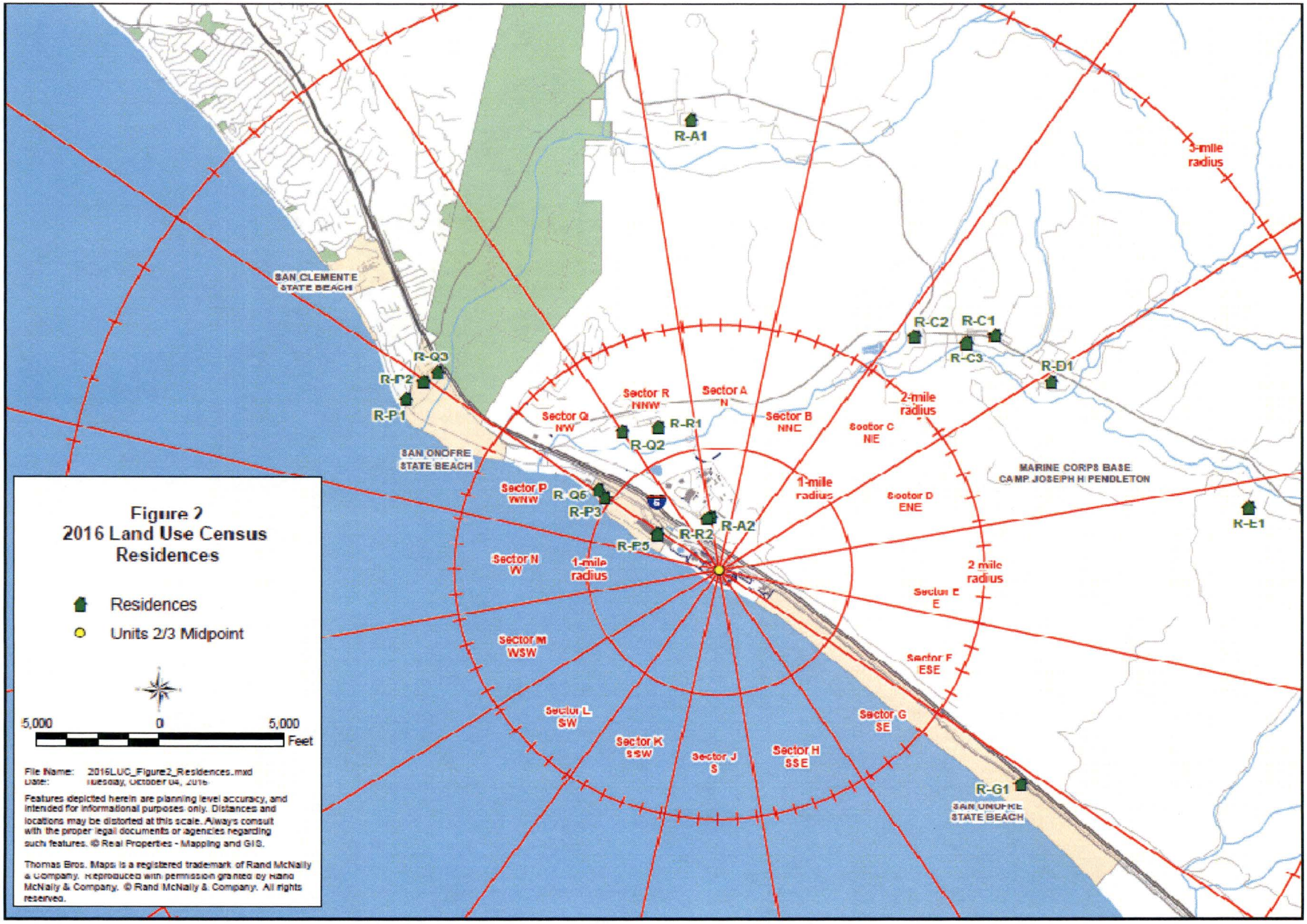
SAN CLEMENTE STATE BEACH
SAN ONOFRE STATE BEACH
Sector P WNW
Sector Q NW
Sector R NNW
Sector A N
Sector B NNE
Sector C NE
Sector D ENE
Sector E E
Sector F ESE
Sector G SE
Sector H SSE
Sector J S
Sector K SSW
Sector L SW
Sector M WSW
Sector N W
1-mile radius
2-mile radius
5-mile radius
MARINE CORPS BASE CAMP JOSEPH H PENDLETON
SAN ONOFRE STATE BEACH


R-A1
3-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
Sector Q NW
R-R1
R-Q2
Sector B NNE
2-mile radius
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-A2
R-R2
R-P5
R-E1
Sector N W
1-mile radius
2 mile radius
Sector E E
Sector M WSW
Sector F ESE
Sector L SW
Sector K SSW
Sector J S
Sector H SSE
Sector G SE
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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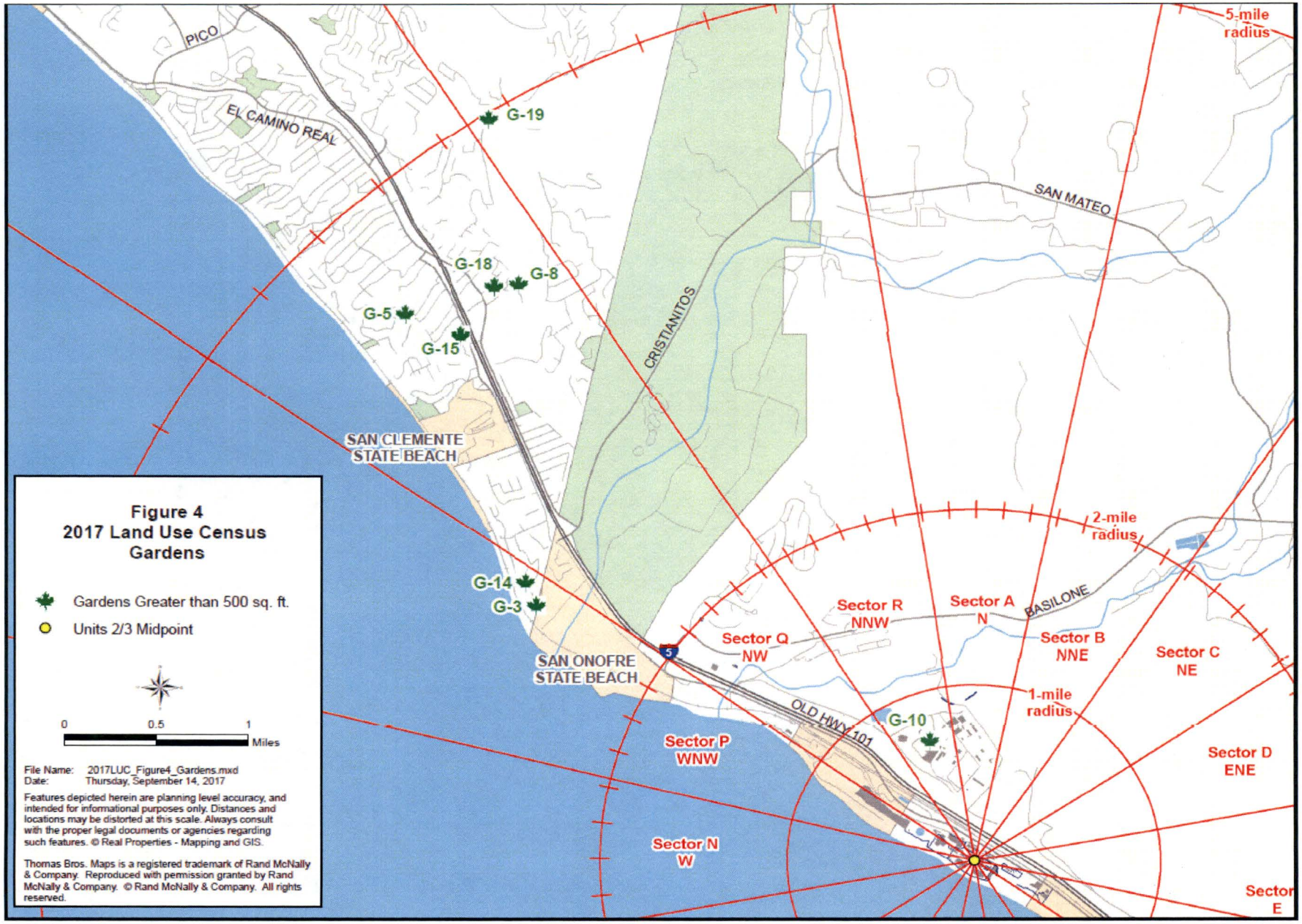
PICO
EL CAMINO REAL
G-19
SAN MATEO
G-18
G-8
G-5
G-15
CRISTIANITOS
SAN CLEMENTE STATE BEACH
5-mile radius
2-mile radius
G-14
G-3
Sector R NNW
Sector A N
BASILONE
Sector Q NW
Sector B NNE
Sector C NE
SAN ONOFRE STATE BEACH
1-mile radius
OLD HWY 101
G-10
Sector P WNW
Sector D ENE
Sector N W
Sector E
Figure 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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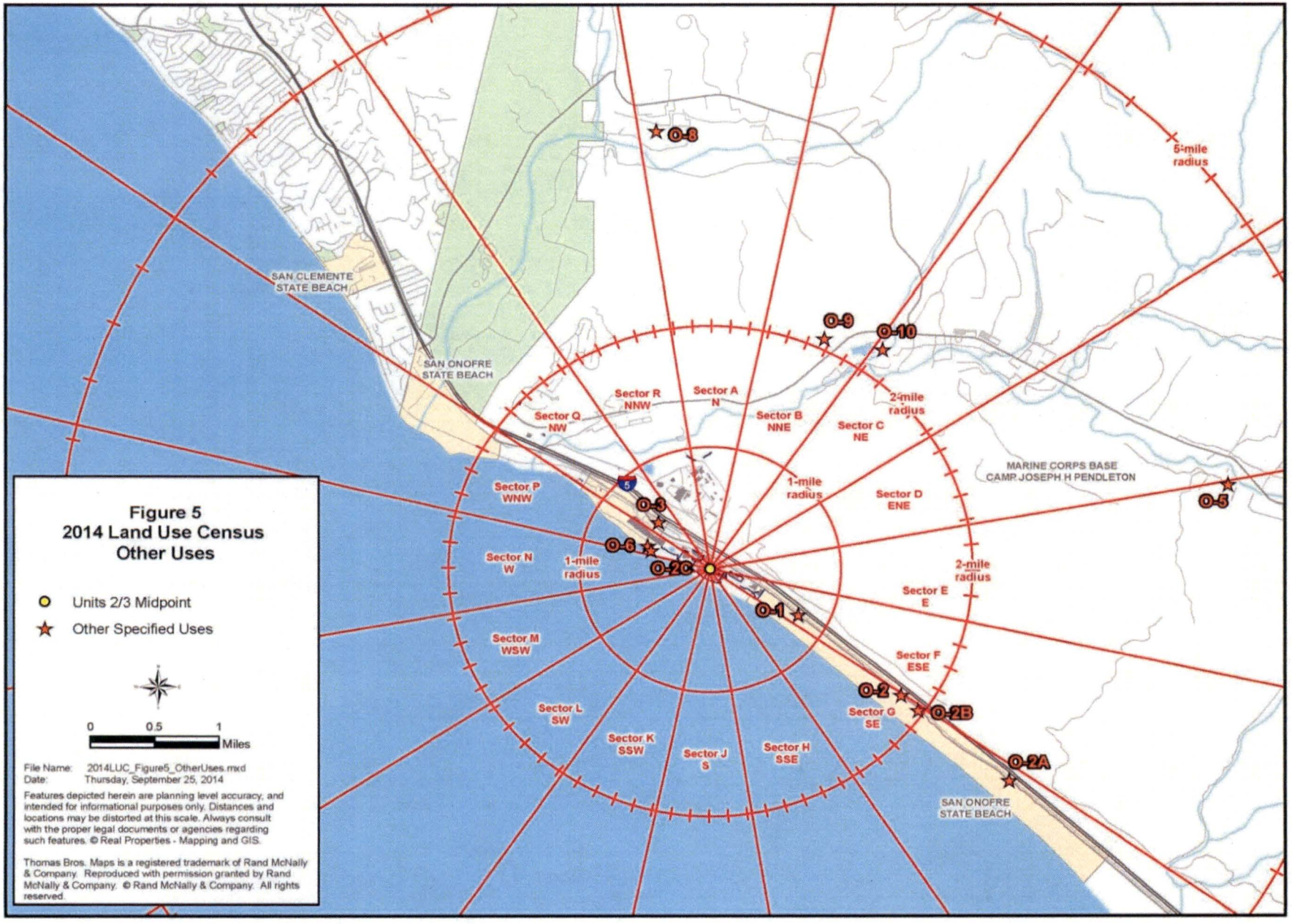
Figure 5
2014 Land Use Census
Other Uses
Units 2/3 Midpoint
Other Specified Uses
0 0.5 1
Miles
File Name: 2014LUC_Figure5_OtherUses.mxd
Date: Thursday, September 25, 2014
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O-8
O-9
O-10
O-3
O-6
O-2C
O-1
O-2
O-2B
O-2A
O-5
5-mile radius
2-mile radius
1-mile radius
1-mile radius
2-mile radius
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
SAN CLEMENTE STATE BEACH
SAN ONOFRE STATE BEACH
SAN ONOFRE STATE BEACH
MARINE CORPS BASE CAMP JOSEPH H PENDLETON

APPENDIX G. ERRATA TO PREVIOUS AREORs

The SONGS garden was moved in the 4th quarter of 2015 to a distance of 0.7 miles. While this fact was captured in the 2016 and 2017 AREOR, the Land Use Census, Table 1 shows an incorrect distance of 0.4 miles. There is no adverse impact to the REMP or Effluents program due to the error.

APPENDIX H. CDPH CO-LOCATED TLDs

DATA FROM THE CDPH TLDs CO-LOCATED WITH SONGS REMP TLDs DURING 2018

California Department of Public Health (CDPH) maintains a TLD program in the environs of SONGS. Per CDPH (Department of Public Health) request, the 2018 exposure results from the CDPH dosimeters are reported in the table below. The Location Numbers refer to the current SDS (SONGS Decommissioning Solutions) alphanumeric location identifier, the former NRC alphanumeric location identifier, and the current CDPH location number.

Table 36. 2018 State of California Data from the CDPD TLD program (mR/ standard quarter)

Location Numbers	Location Name	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
SDS-1, NRC-7, CDPH #2	City of San Clemente	5	8	12	12
SDS-22, NRC-11, CDPH #4	Former US Coast Guard Station – San Mateo Point	6	9	15	14
SDS-34, NRC-14, CDPH #5	San Onofre Elementary School	7	8	13	29
SDS-10, NRC-12, CDPH #6	Bluff (Adjacent to PIC #1) (San Onofre Surfing Beach)	5	10	11	13
SDS-16, CDPH #7	East Southeast Site Boundary	6	6	11	7
SDS-2, NRC-23, CDPH #8	Camp San Mateo	8	10	15	13
SDS-3, NRC-19, CDPH #9	Camp San Onofre	7	12	9	13
SDS-6, CDPH #10	Old El Camino Real (Old Highway 101) (ESE)	3	6	4	91*
SDS-50,NRC-32, CDPH #13	Oceanside Fire Station	5	10	13	12

* CDPH RHB is investigating the anomaly of the TLD reading. This was discussed on a phone call on 4/14/19 @1345 with CDPH State enforcement Chief and SCE's Manager of RP and Chemistry. This issue has been entered into SCE's Corrective Action Program for documentation.

Note: Requirements were 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 program does not conform to the same environmental dosimeter standard (ANSI N13.37-2014) used to generate direct radiation data for the SONGS REMP TLD program. The different methodologies and the different units of measurement make it unsuitable to directly compare the REMP TLD data to the CDPH TLD data. The CDPH TLD data is more erratic and exhibits a greater number of outliers than the SONGS REMP data. The CDPH data does not consider the location specific baselines. Therefore, the CDPH TLD data cannot be properly adjusted for the large effects that minor changes in location can have on the analysis. However, within the limitations of the CDPH data, the results do support the conclusions of the SONGS REMP TLD program.

APPENDIX I. ISFSI TLD DATA

Summary

Per 10 CFR 72.126, SONGS implemented an area monitoring TLD program in the vicinity of the ISFSI.

An evaluation of the entire REMP TLD database yielded an estimated background exposure rate of approximately 15.8 mrem/std. quarter (91 days). However, some local variability within the CAB / EAB is to be attributable to factors external to SONGS. 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 are not related to any activities at SONGS. The ISFSI TLD data gathered to date follow a similar seasonal variability (Figure 13).

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 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 2018. 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 2018 neutron TLDs identified measurable levels of neutron radiation from spent fuel in storage. A dose equivalent conversion factor for the TLD neutron signal based on a similar ISFSI facility at another site was adopted to estimate the neutron dose rate at SONGS. 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.

The results from all locations at the fence around the ISFSI pad show that a member of the public, when adjusted for occupancy per SDS-RP3-PCD-1014, is less than 1 mrem per year.

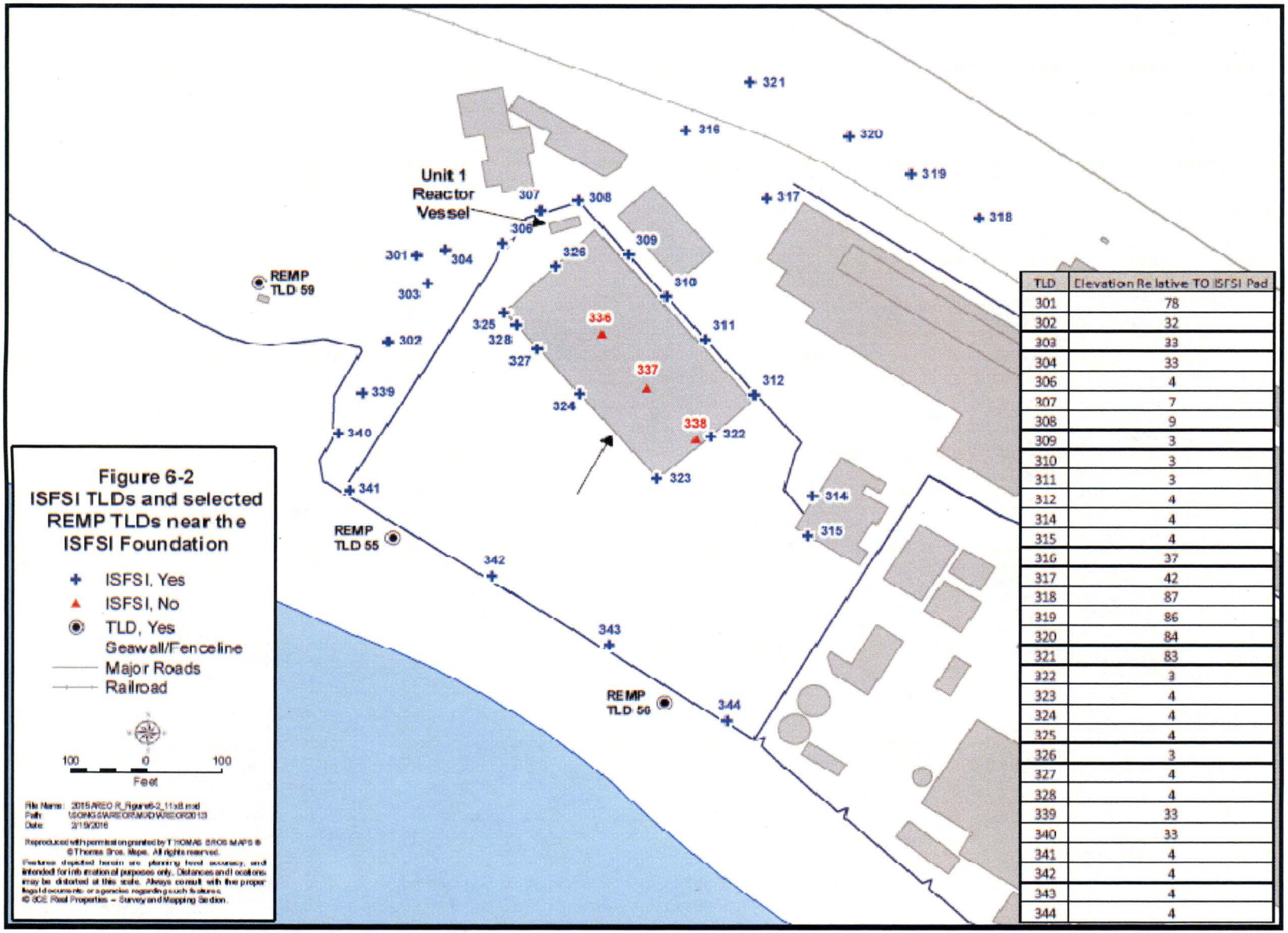
Table 37. 2018 ISFSI TLD Data

TLD (SCE-##)	Location[a]	Qtr. Baseline (mrem)	2018 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	18.5	18.4	18.6	18.1	ND	ND	ND	ND	73.7	10.6	ND
302		15.8	22.4	23.0	24.4	21.8	6.7	7.2	8.6	6.1	91.6	28.6	ND
303		15.8	20.9	22.4	22.2	21.0	5.2	6.6	6.5	5.3	86.6	23.5	ND
304		15.8	22.0	21.1	21.5	20.2	6.2	5.3	5.7	ND	84.8	21.7	ND
307		15.8	17.0	15.7	16.6	19.4	ND	ND	ND	ND	68.6	ND	ND
308		15.8	20.3	18.7	19.2	18.3	ND	ND	ND	ND	76.5	13.4	ND
309		15.8	20.7	19.3	19.5	19.4	ND	ND	ND	ND	79.0	15.9	ND
310		15.8	20.9	19.1	19.8	20.2	5.1	ND	ND	ND	80.1	17.0	ND
311	ISFSI-01[c]	15.8	20.4	19.0	19.3	19.5	ND	ND	ND	ND	78.3	15.2	ND
312		15.8	16.5	16.8	15.6	16.0	ND	ND	ND	ND	64.8	ND	ND
314		15.8	21.0	19.3	19.6	20.1	5.2	ND	ND	ND	80.0	17.0	ND
315		15.8	20.7	18.7	19.8	19.9	ND	ND	ND	ND	79.0	16.0	ND
316		15.8	17.0	15.8	16.2	17.2	ND	ND	ND	ND	66.3	ND	ND
317		15.8	17.7	16.1	16.1	17.4	ND	ND	ND	ND	67.4	ND	ND
318[e]		15.8	19.4	18.2	19.0	19.3	ND	ND	ND	ND	75.9	12.8	ND
319[e]		15.8	18.9	17.8	18.5	19.4	ND	ND	ND	ND	74.5	11.5	ND
320[e]		15.8	19.2	17.5	19.4	19.6	ND	ND	ND	ND	75.7	12.6	ND
321[e]		15.8	19.6	18.7	19.1	19.2	ND	ND	ND	ND	76.6	13.6	ND
322		15.8	21.4	25.0	18.8	19.2	5.6	9.2	ND	ND	84.3	21.3	ND
323		15.8	40.8	51.2	24.5	20.9	25.1	35.4	8.8	5.1	137.4	74.4	ND
324	ISFSI-04[c]	15.8	25.8	27.5	28.0	26.4	10.0	11.7	12.2	10.6	107.6	44.6	ND
325	ISFSI-03[c]	15.8	25.6	24.8	26.8	26.3	9.8	9.0	11.0	10.5	103.4	40.4	ND
326	ISFSI-02[c]	15.8	22.3	20.0	23.0	21.0	6.5	ND	7.2	5.2	86.3	23.2	ND
327	ISFSI-05[c]	15.8	46.6	44.6	43.0	40.9	30.9	28.9	27.3	25.1	175.2	112.1	ND
328	ISFSI-06[c]	15.8	46.4	35.8	37.7	34.6	30.7	20.1	22.0	18.9	154.6	91.6	ND
339	ISFSI-08[c]	15.8	21.5	22.7	23.7	22.1	5.7	6.9	8.0	6.4	90.0	26.9	ND
340	ISFSI-09[c]	15.8	20.2	20.3	21.8	19.2	ND	ND	6.0	ND	81.6	18.5	ND
341	ISFSI-10[c]	15.8	19.6	21.1	23.6	21.9	ND	5.3	7.8	6.1	86.2	23.1	ND
342	ISFSI-11[c]	15.8	22.5	26.8	25.5	23.4	6.7	11.1	9.7	7.6	98.2	35.1	ND

TLD (SCE-##)	Location[a]	Qtr. Baseline (mrem)	2018 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	21.6	25.1	25.0	21.6	5.8	9.3	9.3	5.8	93.3	30.3	ND
344		15.8	21.0	20.9	21.4	21.0	5.2	5.1	5.6	5.3	84.3	21.2	ND
55 [(f)(e)]	San Onofre State Beach (U1 West) ISFSI-07[c]	15.8	20.4	19.4	18.5	18.8	ND	ND	ND	ND	77.0	13.9	ND
56 [e]	San Onofre State Beach (U1 West)	15.8	19.6	15.6	16.9	18.1	ND	ND	ND	ND	70.2	ND	ND
57 [e]	San Onofre State Beach (Unit 2)	15.8	17.4	16.5	17.2	17.3	ND	ND	ND	ND	68.5	ND	ND
59	SONGS Meteorological Tower	15.8	19.4	19.3	20.1	19.4	ND	ND	ND	ND	78.1	15.0	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-RP3-PCD-1014.
c. Station includes neutron dose, estimated using a neutron signal conversion factor measured at a similar ISFSI installation (HPSTID 08-015)
d. 1.051 mrem/mR from ANSI N13.37-2014, Section 3.2.1
e. These TLDs are publicly accessible.
f. TLD # 55 did not have a detectable neutron signal in 2018



TLD	Elevation Relative TO ISFSI 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

Δ Indicates historical TLD locations that are no longer used

Figure 12 - SONGS ISFSI and Selected REMP TLD Locations

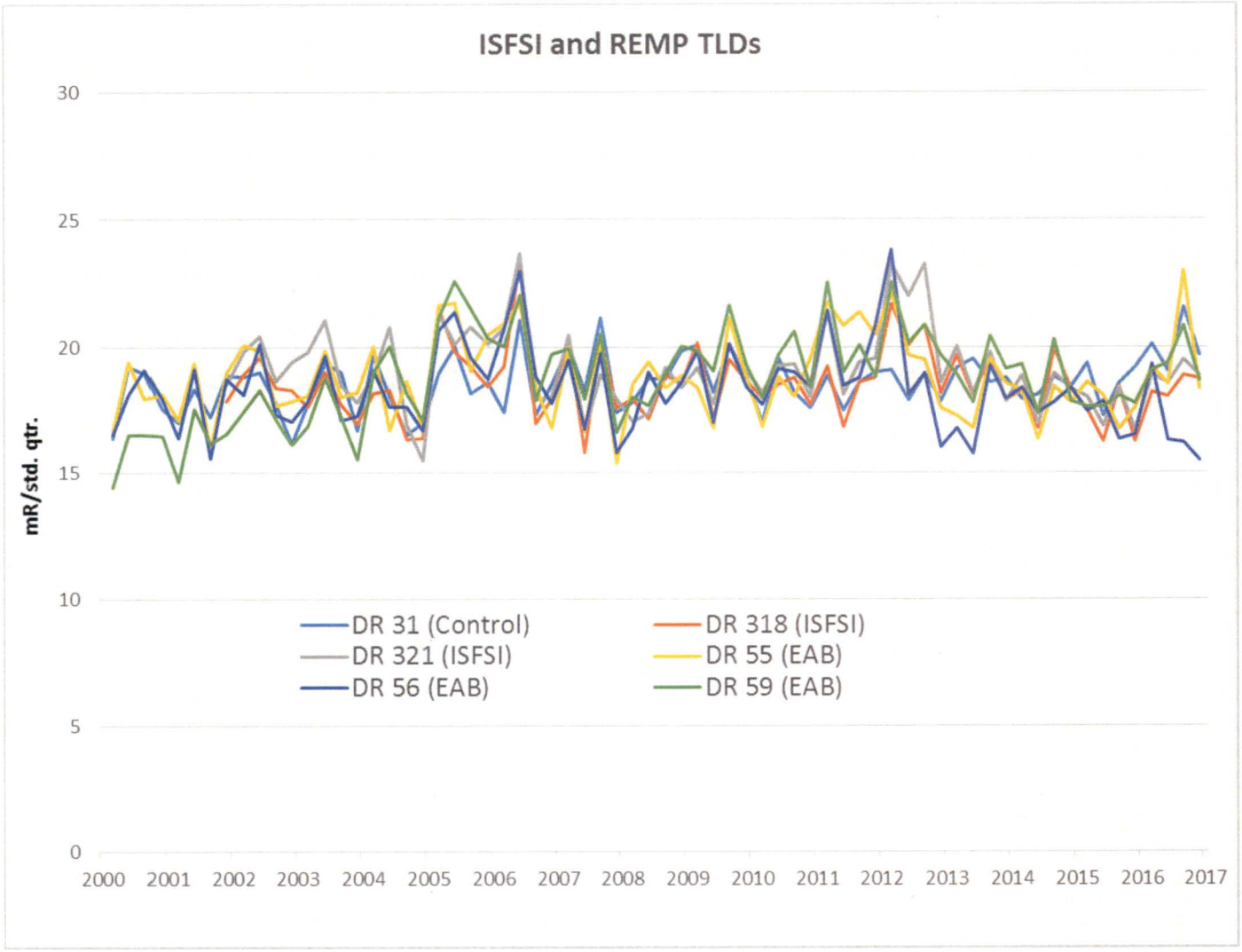


Figure 13 - ISFSI and REMP TLDs

ISFSI Sample Plan TLDs

In accordance with site REMP procedures SONGS developed a TLD sample plan (SDS-CH2-PLN-001) to evaluate potential enhancements to the ISFSI direct radiation environmental monitoring program at SONGS. The initial data from this sample plan is summarized in Table 38. Sample Plan TLD 79B (located at the northwest corner of the ISFSI, about 25 meters due north of REMP TLD 55) is the only Sample Plan TLD with an annual facility dose greater than ND.

Table 38. ISFSI Sample Plan TLD Data

#	Location	Quarterly Baseline (mrem)	2018 Quarterly Results (mrem)				Baseline Adjusted 2018 Quarterly Results (mrem)				Annual Baseline	Annual Monitoring Data (mrem)	Annual Facility Dose (mrem)	Annual* Dose to Member of Public (mrem)
			1	2	3	4	1	2	3	4				
SCE-79B	Seawall at NW Corner of ISFSI	15.8	20.1	18.2	20.2	20.7	ND	ND	ND	ND	63.1	79.2	16.1	ND
SCE-80B	Seawall, 30 meters SE of TLD 55	15.8	19.4	17.5	16.9	16.8	ND	ND	ND	ND	63.1	70.6	ND	ND
SCE-81B	Seawall, 70 meters SE of TLD 55	15.8	19.6	16.7	16.9	16.3	ND	ND	ND	ND	63.1	69.3	ND	ND
BLUFF B	NW of ISFSI on bluff	15.8	18.2	17.5	18.1	17.4	ND	ND	ND	ND	63.1	71.2	ND	ND
PL 3 #1	Parking lot 3, 30 meters NW of TLD 321	15.8	N/A(1)	17.5	18.1	19.5	ND	ND	ND	ND	63.1	55.0	ND	ND
PL 3 #2	Parking lot 3, 60 meters NW of TLD 321	15.8	N/A(1)	18.6	20.1	20.3	ND	ND	ND	ND	63.1	59.0	ND	ND

1 Locations PL 3 #1 and PL 3 #2 were not monitored in the first quarter.

* Adjusted for occupancy in accordance with SDS-RP3-PCD-1014.

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. SONGS had no impact on drinking water wells in the vicinity of SONGS.

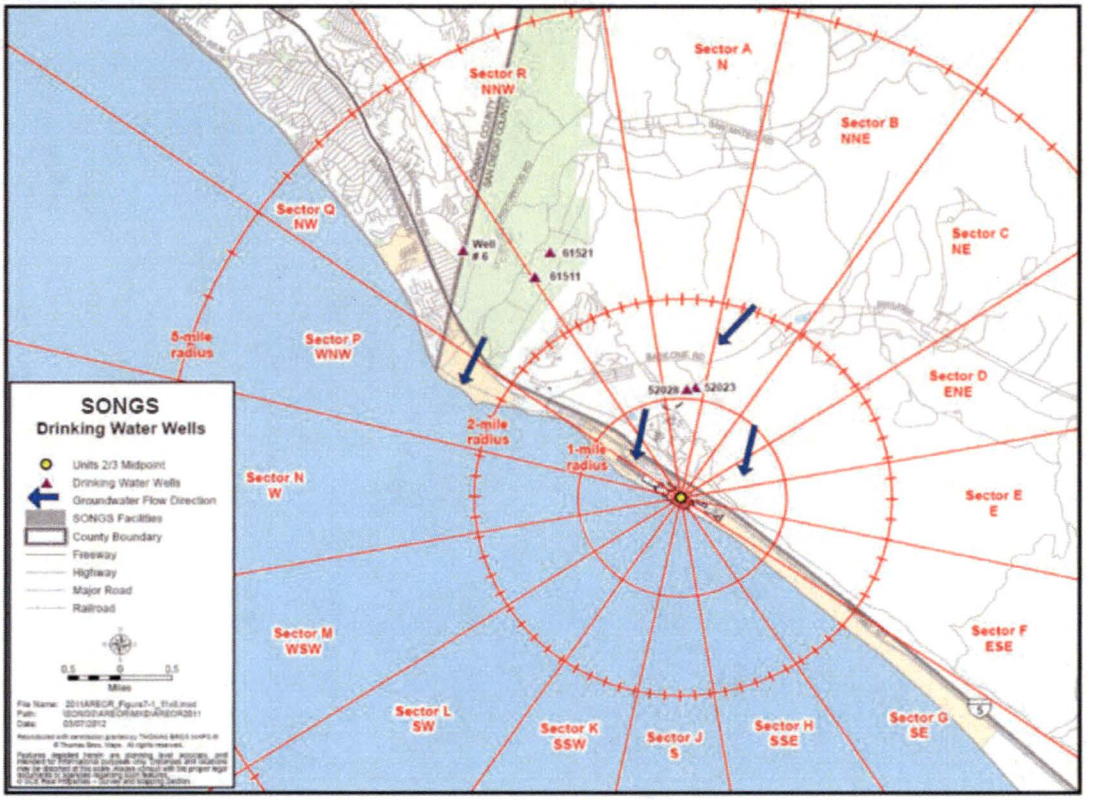


Figure 14 - Closest Drinking Water Wells

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 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	Isotope	Mode of formation
^{3}H (tritium)	^{14}N (n, $^{12}C)^{3}H$	^{32}P	Spallation (Ar)
^{7}Be	Spallation (N and O)	^{34m}Cl	Spallation (Ar)
^{10}Be	Spallation (N and O)	^{35}S	Spallation (Ar)
^{11}C	Spallation (N and O)	^{36}Cl	^{35}Cl (n, γ)^{36}Cl
^{14}C	^{14}N (n, p) ^{14}C	^{37}Ar	^{37}Cl (p, n)^{37}Ar
^{18}F	^{18}O (p, n)^{18}F and Spallation (Ar)	^{38}Cl	Spallation (Ar)
^{22}Na	Spallation (Ar)	^{39}Ar	^{38}Ar (n, γ)^{39}Ar
^{24}Na	Spallation (Ar)	^{39}Cl	^{40}Ar (n, np)^{39}Cl & spallation (Ar)
^{28}Mg	Spallation (Ar)	^{41}Ar	^{40}Ar (n, γ)^{41}Ar
^{31}Si	Spallation (Ar)	^{81}Kr	^{80}Kr (n, γ) ^{81}Kr
^{32}Si	Spallation (Ar)		

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 at that location.
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.
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 screening technique employed to measure the total number of beta particles emanating from a radioactive sample, without isotopic identification. At SONGS samples with an elevated gross beta are analyzed by gamma spectroscopy to identify the specific radionuclides causing the elevated gross beta signal. A beta particle is a negatively charged particle a mass equal to that of an orbiting electron.
Liquid Scintillation	The analytical technique by which tritium activity is measured in water. A sample is placed in a glass vial containing scintillation cocktail. The mixture is sealed and homogenized. When the tritium 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.
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.
Thermolumines cent 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)	H-3 is the naturally occurring radioactive form of Hydrogen. 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-3, 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.