SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.℠

P.O. Box 15830, Sacramento, CA 95852-1830; 1-888-742-SMUD (7683)

MPC&D 07-028

April 2, 2007

U.S. Nuclear Regulatory Commission
Attn.: Document Control Desk
Washington, DC 20555

Docket No. 50-312
Rancho Seco Nuclear Generating Station
License No. DPR-54
RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION

Attention: John Hickman

In your letter dated February 27, 2007, you requested additional information required to complete the NRC's review and approval of the Rancho Seco License Termination Plan (LTP) and associated environmental assessment. Attached is our response to your request.

Members of your staff with questions requiring additional information or clarification may contact Bob Jones at (916) 732-4843.

Sincerely,

for STR

Steve Redeker
Manager, Plant Closure & Decommissioning

Attachment

Cc w/ attachment: B.S. Mallett, NRC, Region IV

NMSS01

Response to RAIs Dated February 27, 2007

ENVIRONMENTAL ISSUES

1. Section 8.6.3.13, Aesthetics Issues, states that the District intends on leaving the major concrete plant structures in place after the completion of decommissioning and license termination. It is understood that temporary structures will be dismantled and removed.

    a. Please describe any plans for restoration, re-vegetation, and other permanent environmental measures (e.g., erosion controls) at the site (e.g., areas of the site where temporary structures will be dismantled and removed).

Response

In most cases, concrete floor slabs are abandoned in place as building structures are dismantled. In rare instances where erosion issues may be created by building dismantlement, asphalt paving, gravel, or re-seeding with native grasses will be used to prevent erosion.

An example of concrete floor slabs abandoned in place from dismantled structure is shown in the following before and after photographs.

Before

After

b. Please describe the approximate acreage of the site occupied by infrastructure (e.g., buildings, roads, parking lots) prior to decommissioning and what that acreage would be after the site is released from NRC licensing.

Response

The acreage of the site occupied by infrastructure (e.g., buildings, roads, parking lots) will not change after the site is released from NRC licensing. The majority of the infrastructure is contained within the existing 87-acre Industrial Area. The only exceptions are the Hazardous Material Warehouse, the Receiving Warehouse and portions of the paved site access road. The Hazardous Material Warehouse will be demolished down to its concrete pad prior to completion of the first phase of license termination. The fence enclosing the Industrial Area will not be removed during decommissioning. Upon completion of the first phase of license termination the Industrial Area will be maintained as an industrial site with access controlled by the SMUD Asset Protection Department (industrial security). The Interim Onsite Storage Building (IOSB), which will remain under the 10 CFR Part 50 license, will be contained within this industrial site. The Backup Control Center (BCC) in the former Administration Building, the Training and Records Building with occupied offices and the active switchyard will also be contained within this industrial site. The Independent Spent Fuel Storage Instillation (ISFSI), which is licensed under 10 CFR Part 72, is accessible only from the industrial site. No existing roads or parking lots will be removed during decommissioning. Upon completion of the second phase of license termination, access to the industrial site will continue to be controlled by the SMUD Asset Protection Department.

Before and after decommissioning aerial photographs of the Industrial Area are provided below.

Before

After

c. Please identify potential environmental effects (e.g., on migratory birds and raptors) from the structures (e.g., hyperbolic cooling towers) that will remain in place after unrestricted release of the site or portions of the site. Include any related requirements that will need to be complied with after release of the site or portions of the site from NRC licensing (e.g., avian protection related acts).

Response

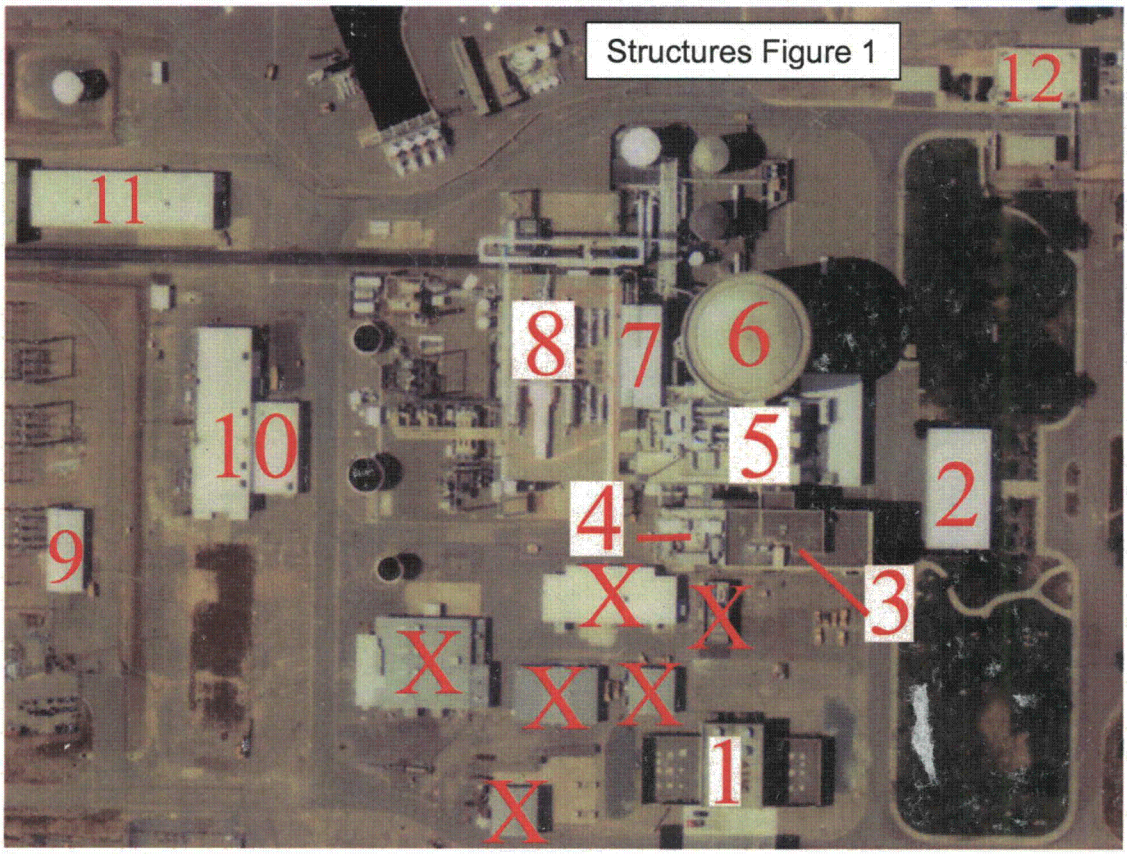
The environmental effects from the structures that will remain in place after unrestricted release of the site or portions of the site will be no different than the effects that existed during plant operation and the period of time following final plant shutdown and license termination. The remaining structures are large stationary objects that are readily observed by migratory birds and raptors and thus easily avoided. Removal of these structures would have a negative impact on the nesting of migratory swallows because large numbers of them build their mud nests on these structures.

The State of California is concerned about avian safety and has conducted numerous studies related bird fatalities caused by collision with overhead power lines and wind turbines used in the generation of electricity from wind power. However, they have not conducted studies of bird fatalities caused by collision with stationary structures. Also, the California Energy Commission has instituted an investigation into the development of statewide guidelines for reducing wildlife impacts from wind energy development.

d. Please provide a listing to clarify which specific structures will likely remain standing at the site after release from NRC licensing.

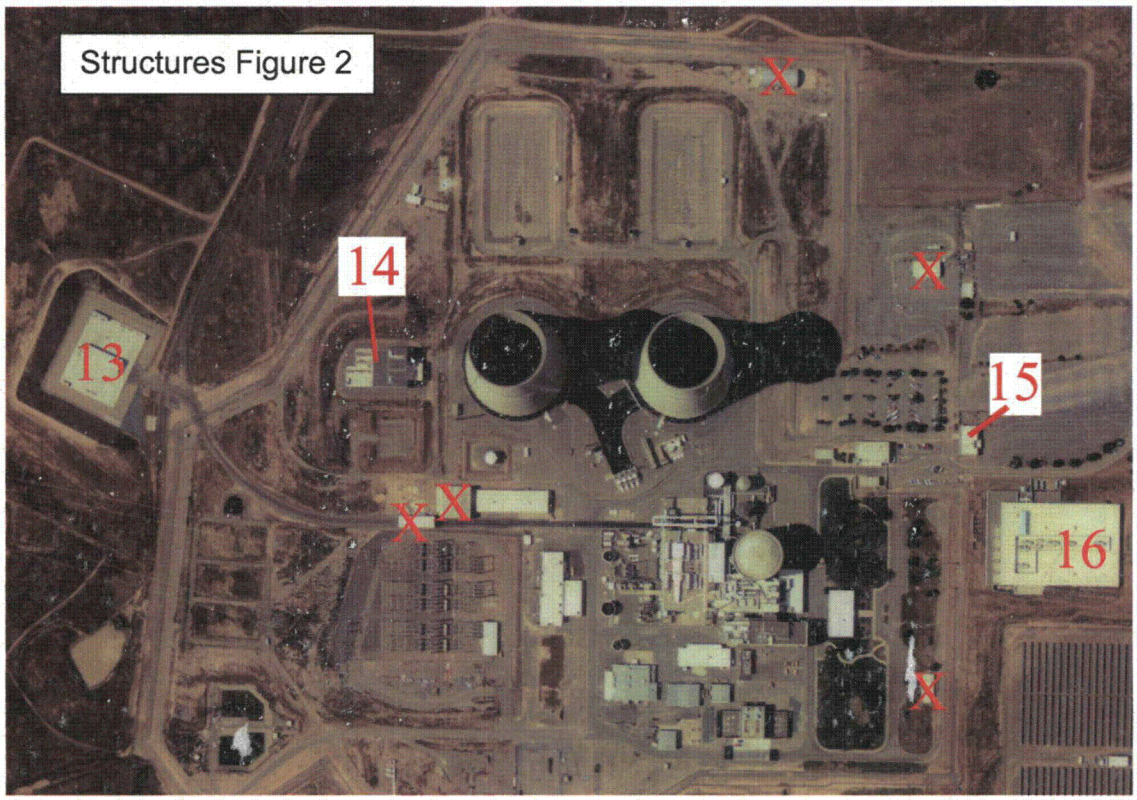
Response

Most of the major concrete structures will remain in place. All paved areas will remain paved. Below are "Structures Figure 1", showing the buildings located near the power block, and "Structures Figure 2", showing the remaining structures in the vicinity of the Industrial Area. A red "X" indicates that the structure has or is scheduled to be removed, leaving only the concrete pad of the structure for Final Status Survey. Note that the cooling towers and cooling tower basins will remain following License Termination. All planned structure demolition will occur before Final Status Surveys are complete for the first phase of the License Termination Plan (LTP).



The following buildings shown in "Structures Figure 1" will remain after License Termination:

1. TDI Diesel Buildings
2. Back-up Control Center (formerly Administrative Building)
3. Training & Records Building
4. Nuclear Service Electrical Building
5. Auxiliary Building
6. Reactor Containment Building
7. Spent Fuel Building
8. Turbine Building
9. Switchyard Control Building
10. Machine Shop (includes area formerly known as the "A" Warehouse)
11. "B" Warehouse
12. Personnel Access Portal (PAP) Building



The following buildings shown in "Structures Figure 2" will remain after License Termination:

13. ISFSI
14. Interim Onsite Storage Building
15. Receiving Warehouse
16. Unfinished Technical Support Building

2. Please summarize any changes that are planned for the site storm drain system and outfall discharge pipes, including the portions of the system that provide drainage from the switchyard and the Independent Spent Fuel Storage Installation (ISFSI).

Response

No changes are planned that will affect the storm drain outfall discharge pipes. Minor rerouting within the storm drain system will be required within the Industrial Area because of demolition activities but this rerouting will not affect the outfall discharge pipes. The switchyard is energized and being used by the Cosumnes Power Plant as discussed in Section 6.4.2.1 of the LTP. No changes have or are planned to be made to switchyard storm drain system. No changes will be made to the ISFSI storm drain system as a result of the 10 CFR Part 50 license termination.

3. Section 3.3.6.1, Deferred Activities, Storage of Class B and C Waste, states that it is the decision of the District management that acceptable waste disposal options for Class B and C waste do not exist at this time. Further, the waste will be stored in the IOSB until such time as an acceptable waste disposal site is available, when the waste will be shipped and the building will be decontaminated as required. Additionally, Section 8.3, Site Description After Unrestricted Release, states that the District intends to release the site for unrestricted use in two phases, with the majority of the site released in the first phase. The second phase is identified as release of the IOSB, which is indicated as remaining on the 10 CFR Part 50 license until the license is terminated with the unrestricted release of the IOSB.

   a. Please confirm that the current maintenance and monitoring procedures used for the site include the IOSB, including physical and radiation monitoring of the facility and waste containers. Please specifically confirm that the IOSB is addressed in the current environmental monitoring, emergency, and security plans.

Response

Rancho Seco implements its maintenance program on an ongoing basis to ensure that plant equipment maintains its required level of performance. The maintenance program applies to both the 10 CFR Part 50 decommissioning site and the 10 CFR Part 72 licensed Independent Spent Fuel Storage Installation (ISFSI). The maintenance program will continue to be implemented as long as the IOSB is operational and spent nuclear fuel is stored at the ISFSI.

The Rancho Seco Radiation Protection Plan discusses the philosophies, policies, and objectives of the radiological controls program. Implemented by site technical and administrative procedures, the radiological controls program is designed to control radiation hazards, avoid accidental radiation exposures, prevent unauthorized access to radioactive material, and to maintain radiation dose to workers and the public below regulatory limits and As Low as Reasonably Achievable (ALARA). The radiological controls program is integrated into all radiological operations at Rancho Seco, including the IOSB.

The radiological controls program applies to both the 10 CFR Part 50 decommissioning site and 10 CFR Part 72 licensed ISFSI. The radiological controls program will continue to be implemented as long as there is licensed radioactive material at the Rancho Seco site.

Radioactive waste procedure RP.309.IV.01, "IOS Building Operations" specifies the requirements for operational activities in the IOSB. This procedure addresses warehouse operations to ensure that stacking requirements are maintained and that dose rate limits are not exceeded. The procedure also addresses ventilation system operations, container handling and inspection requirements, and crane operations. These procedural requirements will remain in effect as long as the IOSB is operational.

The Rancho Seco Radiological Environmental Monitoring Program (REMP) is designed to meet applicable regulations and to provide an accurate assessment of the radiological environment in and around the environs of the Rancho Seco site. The REMP applies to both the 10 CFR Part 50 decommissioning site and 10 CFR Part 72 licensed ISFSI. The REMP will continue to be implemented as long as the spent nuclear fuel remains stored at the Rancho Seco ISFSI.

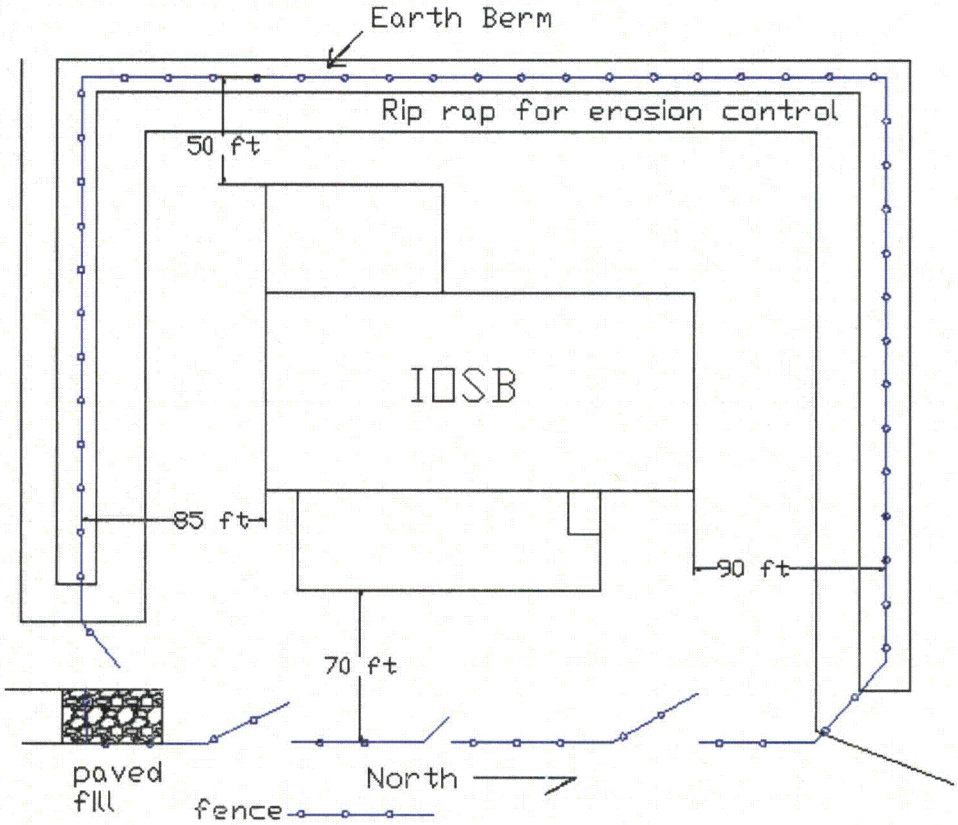
Similarly, the Rancho Seco Emergency Plan applies to both the 10 CFR Part 50 decommissioning site and the 10 CFR Part 72 ISFSI. As decommissioning progresses and the radiological source term is reduced, the emergency planning requirements may also be reduced without reducing the effectiveness of the plan. The emergency plan will remain in effect long as the spent nuclear fuel remains stored at the Rancho Seco ISFSI.

The Rancho Seco 10 CFR Part 50 licensed facility is exempt from 10 CFR Part 73 security requirements. Accordingly, the IOSB is not covered under an NRC-approved security plan. SMUD provides industrial security for the 10 CFR Part 50 site. SMUD management determines the level of security provided for the Rancho Seco Industrial Area.

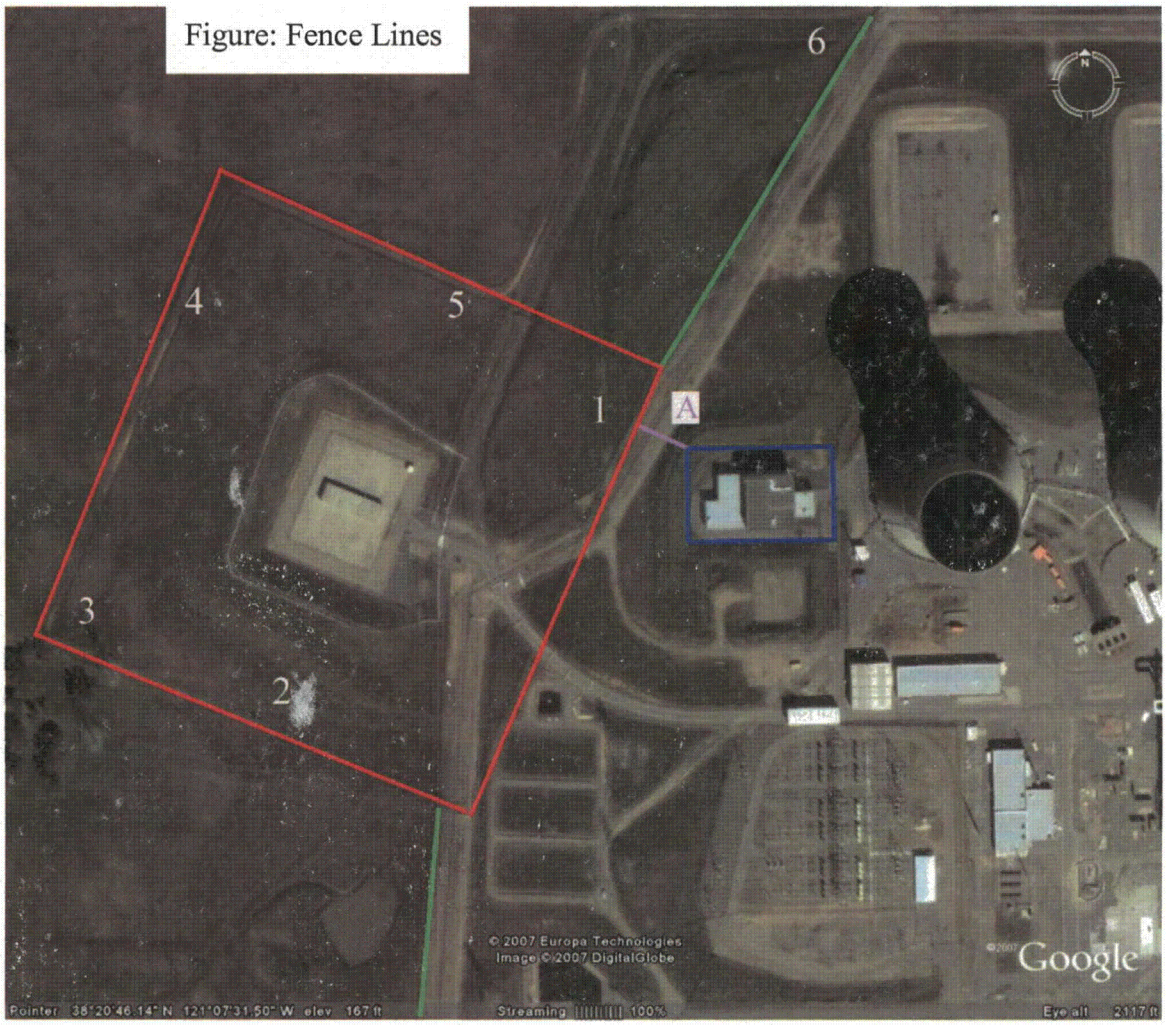
b. Please identify the approximate area size and location of the fence line and gate for the portion of the site that will remain on the license with the IOSB and the relationship to the spent fuel storage area, including both the distances between the spent fuel and the IOSB fence lines. Also, indicate the location and expected readings for maximum radiation levels between the IOSB and spent fuel storage area. If the land between the spent fuel storage area and IOSB is not going to remain on the license, indicate the anticipated maximum radiation doses in this region where unrestricted release is occurring between the two fence lines and provide the analysis to assure that 10 CFR Part 20 public dose limits will not be exceeded (using dose contributions from the ISFSI, released area, and IOSB). Additionally, please identify these locations on a map or diagram.

Response

The figure "Proposed IOSB Fence" below shows the building footprint and relative locations of the bermed area, the boundary fence, the gates east of the IOSB and the approximate distances of the fence lines to the nearest portions of the building. The total footprint that the 10 CFR Part 50 licensed site will occupy after Phase 1 of License Termination is encompassed by the rectangular area within the fence, and is approximately 300-feet east-to-west by 160-feet north-to-south. The total area is approximately 1.1 acres.



The figure "Fence Lines" below indicates the approximate location of the fence line proposed for the IOSB (shown in blue) and the approximate location of the 100-meter fence that is in place around the ISFSI (in red). The green lines approximate the current outer portion of the industrial area fence that will remain in place. The purple line labeled "A" is the shortest distance between the IOSB and ISFSI fences, which is approximately 130 feet. Access to the area within the red lines is controlled by the 10 CFR Part 72 license. Access to the area within the blue lines will be controlled by the 10 CFR Part 50 License between Phase I and Phase II of License Termination.



Radiation levels outside of the fence lines of both facilities are statistically not distinguishable from background. The Radiological Environmental Monitoring Program measures the long-term dose rates at locations around site, including around the perimeter of the ISFSI. Personnel dosimeters are placed on the 100-meter fence at the locations indicated with white numerals in the figure "Fence Lines" above. The tables below indicate the results of quarter-long monitoring with dose given in mRem/quarter. Locations 1 through 6 refer to the locations in the figure. Locations C-1 through C-6 are "control" locations, away from the site, used to determine the local background radiation levels in the area.

Data for the years 1997, 1998, 2001, and 2006 are included. Fuel storage into the ISFSI commenced in 2001, and was completed in 2002. 1997 and 1998 provide indication of the levels in the area prior to placing fuel into the ISFSI. The last Class B and C waste to be stored in the IOSB was generated during the segmentation of the Reactor Vessel Internals. The project was complete and all the waste intended for storage between Phase I and Phase II was in storage in the IOSB by the end of the 2nd quarter of 2006. Even though there is an apparent increase in the total dose received by the dosimeters at the ISFSI boundary compared to the dose of the control locations,

the difference remains statistically small. Mathematically, comparing the highest average indicator locations with the lowest average control locations in any given year results in a difference of 2.5 mrem/quarter or 10 mrem/year due to the ISFSI.

In 2006, after all waste intended for storage was actually in storage at the IOSB, surveys were performed outside the perimeter fence surrounding the IOSB using 2" X 2" NaI detectors. These surveys were conducted to determine if the waste in storage at the IOSB would interfere with the planned MARSSIM surveys of the surrounding areas for License Termination. The surveys indicated that the gamma field along the fence was the same as the gamma field measured in Class 3 areas that are shown through sampling and laboratory analysis to have no detectable contamination from plant origin. Since the surveys, which indicated levels of 6,000 to 8,000 cpm, are no different than background in a Class 3 area, the dose consequences are not greater than that from a Class 3 soil survey unit. To date, no Class 3 soil survey units have indicated measurable contamination of plant origin above background. Therefore, it can be assumed that the dose resulting from occupancy in these areas would be less then 10% of the 25 mrem/year allowed dose, or less than 2.5 mrem/year.

Since the land areas around the ISFSI are either non-impacted (North, West, South areas surrounding the ISFSI), or Class 3 areas (East of ISFSI), worst case dose impact from residual radioactivity would be less than 10% of the annual limit, or 2.5 mrem/year. Combined with a maximum 10 mrem/year from the ISFSI and 2.5 mrem/year from the IOSB, the resulting dose to an industrial worker occupying the land areas between these two facilities would be a maximum of 15 mrem/year, which is below the 25 mrem/year limit allowed for license termination.

Year	1997				
Quarter	Q1	Q2	Q3	Q4	Avg
Location					
1	13.1	14.1	16.4	15.4	14.8
2	16.0	15	14.8	16.4	15.6
3	13.8	14.7	16.2	15.6	15.1
4	14.2	16.3	15.9	16.1	15.6
5	17.5	15.4	16.1	19	17.0
6	13.9	14.4	14.7	15.7	14.7
Qtr Avg	14.8	15.0	15.7	16.4	15.4
C-1	12.7	14.4	15.3	16.6	14.8
C-2	14.2	17.5	Note 1	21.1	17.6
C-3	11.7	12.6	15.5	15.8	13.9
C-4	12.7	15.3	14.1	14.8	14.2
C-5	11.0	13.9	14.2	13.9	13.3
C-6	13.7	14.4	14.7	16.7	14.9
Qtr Avg	12.7	14.7	14.8	16.5	14.8

Year	1998				
Quarter	Q1	Q2	Q3	Q4	Avg
Location					
1	13.6	14.1	14.2	15.6	14.4
2	13.6	14.1	16.8	15.4	15.0
3	14.4	14.0	15.0	15.4	14.7
4	20.7	14.6	14.3	15.2	16.2
5	15.9	14.6	15.2	15.6	15.3
6	14.1	17.4	14.2	15.7	15.4
Qtr Avg	15.4	14.8	15.0	15.5	15.2
C-1	15.4	17.2	13.9	14.3	15.2
C-2	17.2	16.3	19.3	16.5	17.3
C-3	12.4	13.8	12.8	13.3	13.1
C-4	15.7	14.3	14.0	15.4	14.9
C-5	13.7	13.5	13.1	13.6	13.5
C-6	11.8	13.8	14.2	14.6	13.6
Qtr Avg	14.4	14.8	14.6	14.6	14.6

Year	2001				
Quarter	Q1	Q2	Q3	Q4	Avg
Location					
1	17.0	15.0	15.0	14.0	15.3
2	17.0	18.0	19.0	18.0	18.0
3	18.0	17.0	17.0	18.0	17.5
4	17.0	17.0	17.0	18.0	17.3
5	18.0	17.0	18.0	17.0	17.5
6	16.0	16.0	14.0	14.0	15.0
Qtr Avg	17.2	16.7	16.7	16.5	16.8
C-1	16.0	15.0	17.0	17.0	16.3
C-2	22.0	19.0	20.0	Note 1	20.3
C-3	14.0	Note 1	14.0	15.0	14.3
C-4	17.0	15.0	17.0	22.0	17.8
C-5	15.0	12.0	13.0	12.0	13.0
C-6	16.0	18.0	15.0	11.0	15.0
Qtr Avg	16.7	15.8	16.0	15.4	16.1

Year	2006				
Quarter	Q1	Q2	Q3	Q4	Avg
Location					
1	25.0	25.0	19.0	21.0	22.5
2	18.0	22.0	21.0	20.0	20.3
3	19.0	19.0	18.0	19.0	18.8
4	24.0	24.0	20.0	24.0	23.0
5	19.0	21.0	18.0	17.0	18.8
6	23.0	23.0	20.0	21.0	21.8
Qtr Avg	21.3	22.3	19.3	20.3	20.8
C-1	Note 2	Note 2	Note 2	Note 2	Note 2
C-2	19.0	20.0	Note 1	21.0	20.0
C-3	17.0	16.0	14.0	15.0	15.5
C-4	18.0	21.0	22.0	19.0	20.0
C-5	Note 2	Note 2	Note 2	Note 2	Note 2
C-6	17.0	20.0	16.0	18.0	17.8
Qtr Avg	17.8	19.3	17.3	18.3	18.3

Note 1: No data available, the dosimeters were missing when collected for end of the quarter monitoring.
Note 2: Monitoring at these locations ceased after 2004 as the REMP program was reduced.

c. Please identify access roads and paths that will continue to exist after the first phase of site release and will be located nearest to the new IOSB fence line, including location and distance from the IOSB. Clarify whether access to these roads and paths are controlled in some way or available for public access. Please include travel volume estimates for these roads and paths. Additionally, please identify the locations on a map or diagram.

Response

The figures "Structures Figure 2" and "Fence Lines" included earlier provide aerial views of the areas around the IOSB. The nearest "road" would be the area just east of the IOSB, where the controlled access fence will be placed approximately 70 feet from the eastern wall of the IOSB. The road west of the IOSB is also at its closest point approximately 70 feet away from the North-West corner of the IOSB, but a berm separates the building from the surrounding areas on all sides but the East.

All of these roads are within the Industrial Area. Access to the Industrial Area post-License Termination has been discussed thoroughly in Section 6.4.2 of the LTP. As an update to that information, the Backup Control Center (Building "2" in figure "Structures Figure 1" included above) is now operational and has been used to operate the District's electrical distribution system. The District will maintain a level of access control to the current Industrial Area in order to maintain the security required by the Federal Energy

Regulatory Commission (FERC) and other regulatory agencies governing reliability of electrical distribution systems. The public will not have free access to these areas.

d. Please indicate if there are plans to store non-radioactive waste in the IOSB. Also, clarify whether or not there are any plans to store waste from other facilities at the IOSB and whether or not this waste is radioactive waste.

Response

There are no plans to store any waste other than Class B and Class C radioactive wastes generated at the Rancho Seco facility. Publicly elected representatives from other portions of the state of California have proposed storage of radioactive materials generated at other locations (i.e., radiologically contaminated medical waste) due to the implementation of the Low Level Waste Policy Act, and the lack of an in-compact disposal site for California waste generators. However, the District Board of Directors, and District management and staff strongly oppose storage of any materials at Rancho Seco other than the Class B and Class C radioactive wastes generated at the facility.

4. Section 8.5.1.3.1, Land Use, states that the Rancho Seco Updated Safety Analysis Report (USAR) Figure 2.2-6 provides a detailed description of all agricultural and residential activities within a 5-mile radius of the site, and USAR Figures 2.2-7, 2.2-8, and 2.2-9 identify agricultural activities within a 50-mile radius.

   a. The Defueled Safety Analysis Report (DSAR), Amendment 2, Section 1.1, Introduction, states that the DSAR replaced the USAR as the primary licensing basis document applicable to Rancho Seco in the Permanently Defueled Mode. Further, Figure 2.2-4 of this document appears to be the only figure in the DSAR that identifies agricultural uses. Given these differences in descriptions between the Supplemental Environmental Report reference to the USAR and the DSAR, please provide new copies of the appropriate figures that identify current agricultural and residential activities to better assure that our review is addressing the applicable information.

Response

Attached below are Figures 2.2-7, 2.2-8, and 2.2-9 of the Rancho Seco USAR. These figures represent the agricultural activities within a 50-mile radius of the plant.

The USAR represented the licensing basis for Rancho Seco when the plant was still operating. USAR, Amendment 8 was in effect when SMUD submitted the original Decommissioning Plan and the associated Supplement to Rancho Seco Environmental Report – Post Operating License Stage. After Rancho Seco shut down permanently, the DSAR replaced the USAR as the primary licensing basis document to reflect the operation of Rancho Seco in the permanently de-fueled mode.

After all of the fuel was placed in dry storage, the DSAR was further reduced to reflect that the Emergency Planning Zone (EPZ) was limited to the Industrial Area boundary. With the reduced size of the EPZ, a detailed description of the surrounding area (e.g., population and land use) were no longer relevant and were removed from the DSAR. Historical information remains available in USAR Amendment 8.

Agricultural activities within the 50-mile radius remain largely unchanged. Two notable changes are wine grapes planted to the north and west of the plant and construction of the Cosumnes Power Plant approximately ½ mile south of the Rancho Seco facility and within the 2,480 acre SMUD owned site.

b. Please identify references used for any information provided. Further, please include a brief written explanation of the figures provided.

Response

Figures 2.2-7, 2.2-8, and 2.2-9 are contained in USAR, Amendment 8.

Figure 2.2-7 shows fruit, nut, and field crops, Figure 2.2-8 shows pastureland and rangeland, and Figure 2.2-9 shows land used for dairy cattle.

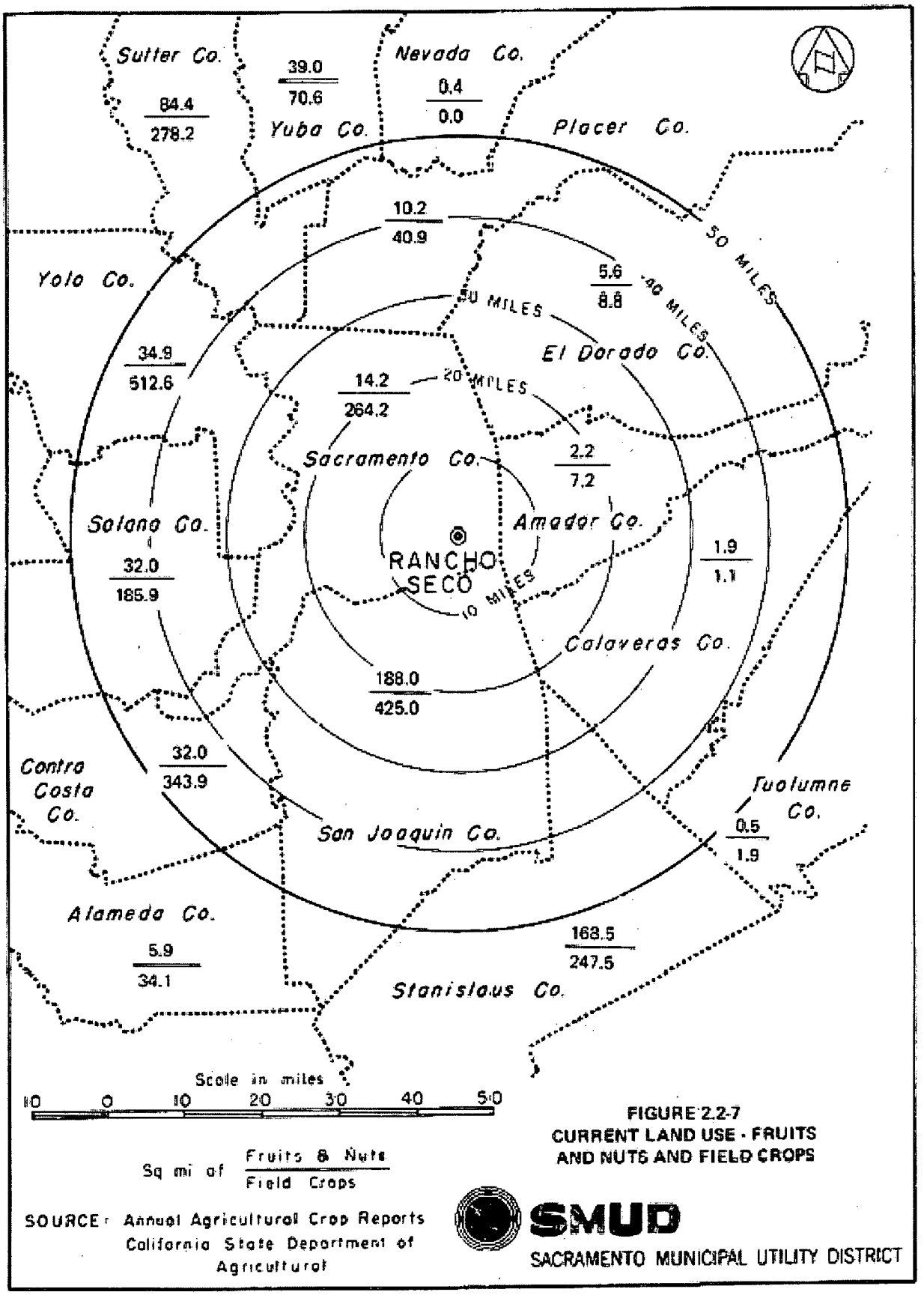


FIGURE 2.2-7
CURRENT LAND USE - FRUITS AND NUTS AND FIELD CROPS

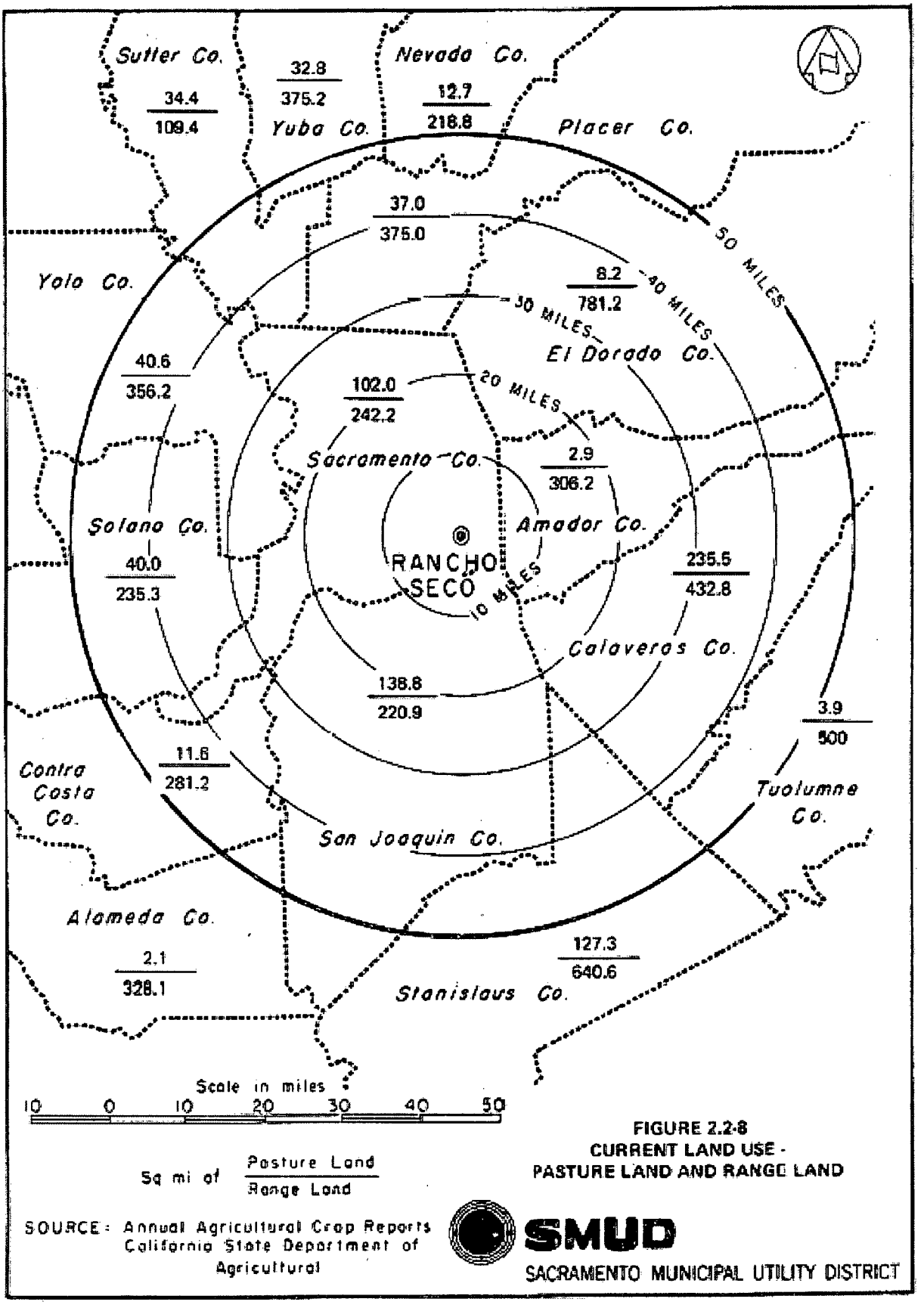


FIGURE 2.2-8
CURRENT LAND USE -
PASTURE LAND AND RANGE LAND

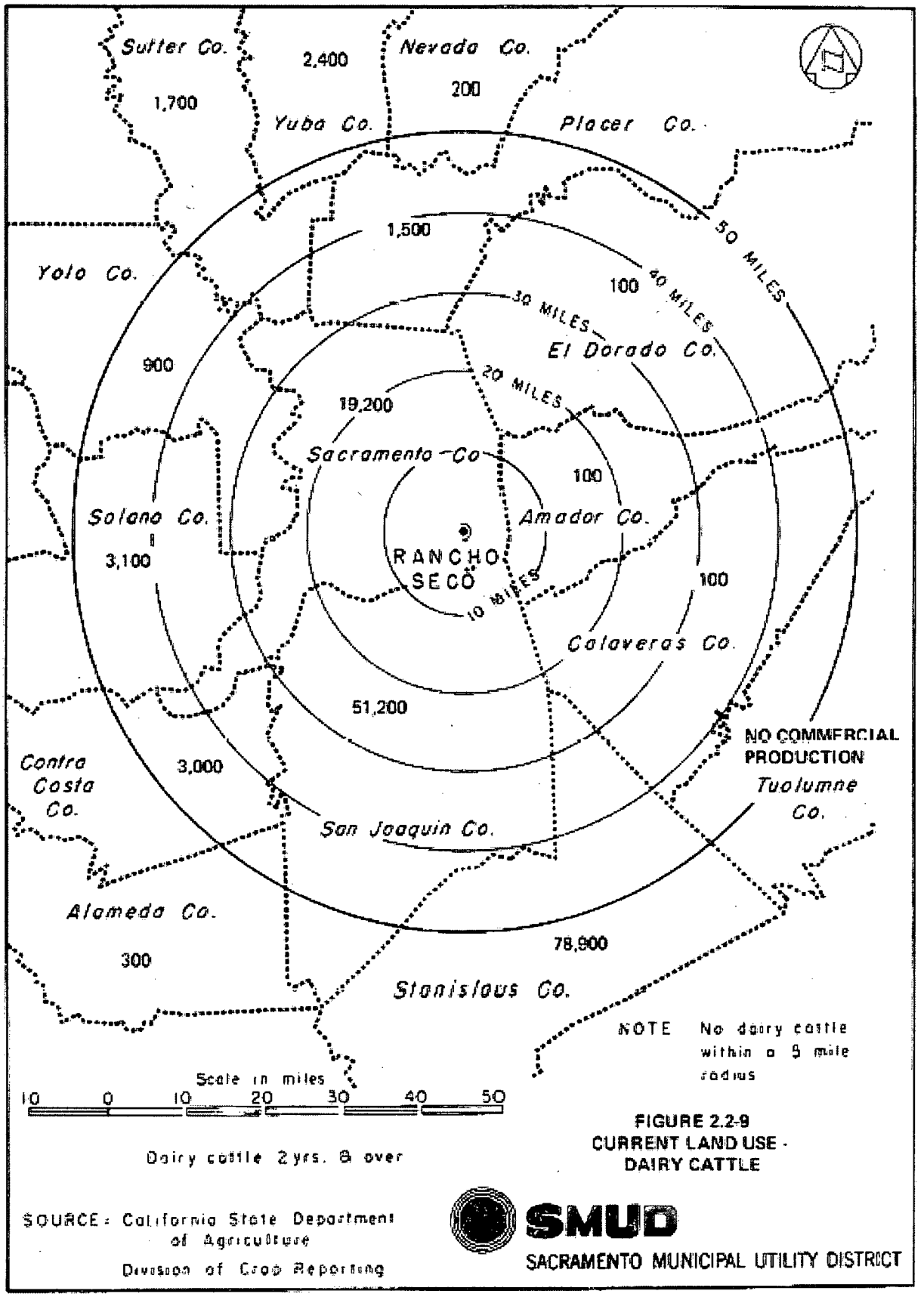


FIGURE 2.2-9
CURRENT LAND USE - DAIRY CATTLE

5. Section 8.5.4.1, Hydrology, states that within recent times no flooding or inundation from storms or runoff has occurred within the site boundaries. Further, it is highly unlikely that the site could be flooded, even with abnormal rainfall intensities.

   a. Please identify what period of years the wording "in recent times" is intended to include.

Response

The term "within recent historical times" has been used in Rancho Seco licensing basis documents without definition beginning with the Preliminary Safety Analysis Report (PSAR) submittal and currently exists in the DSAR. As indicated in the response to RAI 5.c below, the Rancho Seco site is outside the 100-year floor plain. Therefore, term "within recent historical times" can be defined as a period of time greater than 100 years.

   b. Please provide the specific reference(s) for the source(s) of both the "recent times" determination and conclusion that it is highly unlikely that the site could be flooded.

Response

Please refer to the response to RAI 5.c below.

   c. Please identify the location of the nearest flooding outside of the current site boundaries for the same period of years or at least the last 100 years, whichever is the longest period of time.

Response

The answer to this RAI was provided in response to RAI No. 40 contained in the first set of RAIs. Creeks, streams, rivers and other surface water drainage features along with flood elevations are shown on Figures 2-2 and 2-3 in the Hydrogeological Characterization Report. 100-year flood plain maps for the immediate areas surrounding the Rancho Seco site are shown on Figure 2-3. General 100-year flood area information for Sacramento County may be viewed at http://www.msa.saccounty.net/waterresources/floodready/FloodMap.pdf. Figure 2-3 from the Hydrogeological Characterization Report is provided on the next page followed by a portion of the map located at the referenced url, which shows the 100-year flood plain near the Rancho Seco site location without contour lines. As shown on the two maps, the nearest 100-year flood plain outside of the current site boundaries results from Hadseville Creek north of Twin Cities Road (Hwy 104) across from the main entrance to the site.

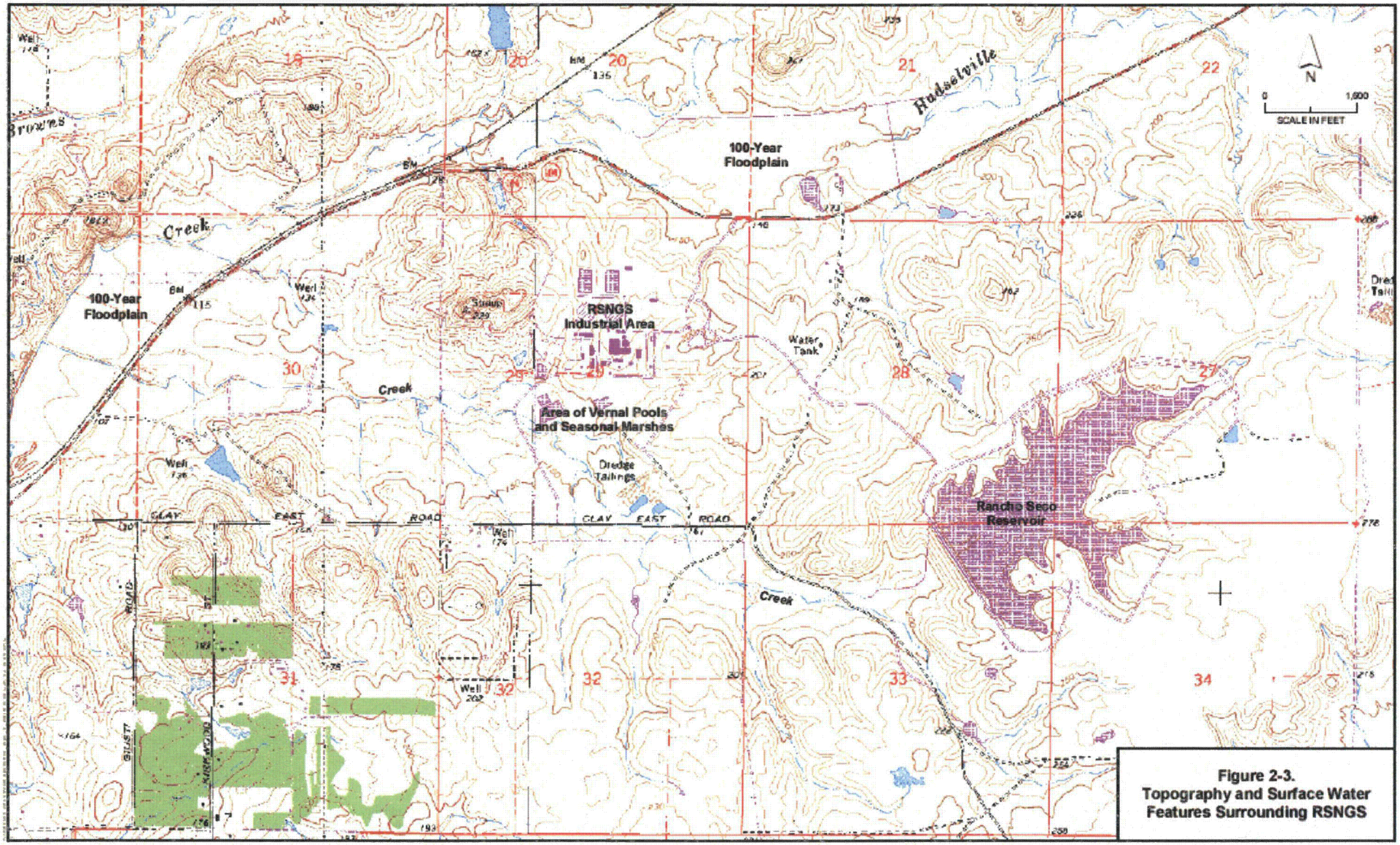
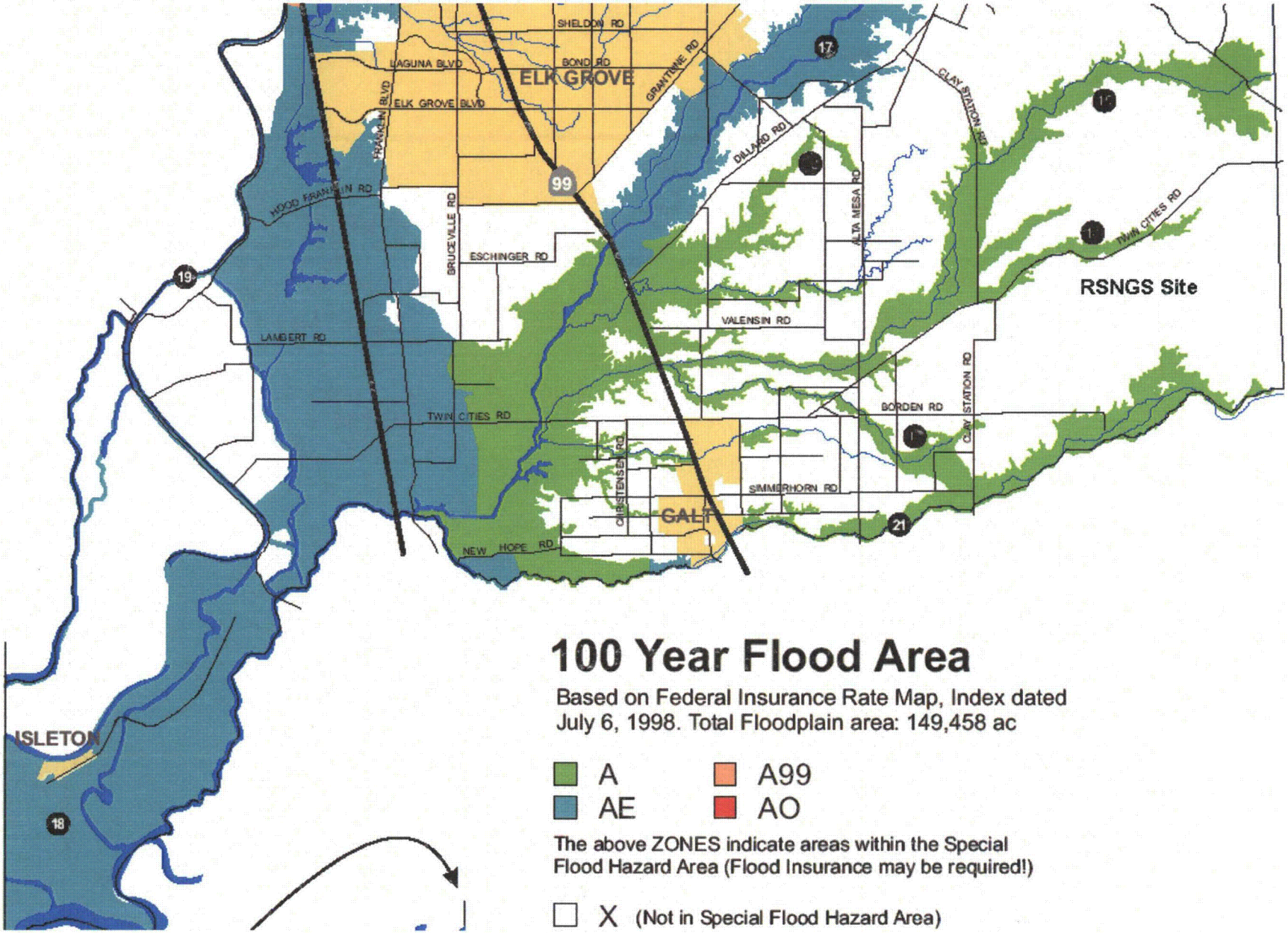


Figure 2-3. Topography and Surface Water Features Surrounding RSNGS



100 Year Flood Area

Based on Federal Insurance Rate Map, Index dated July 6, 1998. Total Floodplain area: 149,458 ac

A
A99
AE
AO

The above ZONES indicate areas within the Special Flood Hazard Area (Flood Insurance may be required!)

X (Not in Special Flood Hazard Area)

6. Throughout the plan and, especially, in Chapter 2, Site Characterization, the terms Industrial Area, Area 8, Impacted Area, and Un-Impacted area are used (example: Sections 2.1.7.3, 2.1.10, and Section 2 figures).

   a. Please clarify the size of each area (e.g., acres), other than the Industrial Area (already indicated in the LTP).

Response

LTP Figure 2-1 shows the Industrial Area of the Rancho Seco site. As stated in LTP Section 1.3.2 "Site Description," the Industrial Area is 87 acres. LTP Section 2.1.8.4 "Area 8" defines Area 8 as being the Industrial Area. Therefore, the size of Area 8 is also 87 acres.

LTP Figure 2-2 shows the Impacted Area. The size of the Impacted Area is approximately 165 acres. Accordingly, the size of the Un-Impacted Area is approximately 2,315 acres.

   b. Please clarify the location of barriers and access points (e.g., fences and gates) that are currently associated with these areas and will remain after these areas are released from licensing. Further, identify the type and location of any new barriers or access points that will be established with release of these areas.

Response

LTP Figure 2-1 shows the Industrial Area including the Industrial Area fence line. Access to the Industrial Area is through the gate at the Personnel Access Portal (PAP) building. The Industrial Area fence will remain in place after decommissioning is completed.

There is also a fence, with a personnel gate and a vehicle gate, surrounding the ISFSI. This fence will remain in place as long as the ISFSI is operational. Access to the ISFSI also requires access to the Industrial Area.

Before the completion of the first phase of decommissioning, SMUD will construct a fence, with gates for personnel and vehicle access, around the IOSB. Upon completion of the first phase of decommissioning, the fence surrounding the IOSB will define the 10 CFR Part 50 licensed site until the completion of the second (last) phase of decommissioning and termination of the 10 CFR Part 50 license.

   c. Please clarify the location and approximate size (e.g., acres) of all recreational areas in the vicinity of Rancho Seco and the approximate distance from the Industrial Area. Include a listing of recreational activities, for areas not already described. Please clarify the location of any water recreation areas and their position along the hydrogradient (e.g., up-gradient,

down-gradient) from the Industrial Area. A size estimate for Rancho Seco Lake is already provided, but clarifications are needed regarding what recreational activities take place at the lake.

Response

The land surrounding the Rancho Seco site is almost exclusively agricultural. The hydrogradient of the site runs from northeast to southwest.

The Castle Oaks golf course, located in the city of Ione, is approximately 10 miles east of the site. The Dry Creek golf course, located in Galt, CA is approximately 10 miles southwest of Rancho Seco and is down-gradient from the site. The Rancho Murieta golf course is located approximately 10 miles north of the site.

A portion of Lake Camanche reservoir is approximately 10 miles southeast of the Rancho Seco site. Lake Camanche covers 12 square miles, is 150 feet deep, and has 53 miles of shoreline when full. Both the North and South shore provide a variety of recreational activities and services including tent and RV camping, cottage rentals, boat rentals, boat launch, and fishing.

Lake Amador is approximately 13 miles east of Rancho Seco. The lake is approximately 400 acres with approximately 13 ½ miles of shoreline. Recreational activities include tent and RV camping, boating, picnicking, and fishing.

Recreational activities at Rancho Seco Park include picnicking, tent and RV camping, boating, fishing, and swimming. The park also has a 75-acre wildlife compound, located just southwest of the lake's dam, and a seven-mile nature trail that starts at the north end of the lake.

The nature trail is the product of a partnership between SMUD and The Nature Conservancy. In 1999, The Nature Conservancy purchased 12,000 acres of the Howard Ranch, which is located adjacent to Rancho Seco Lake. The conservancy placed permanent protective restrictions on the property and resold the land to a local cattleman. The Howard Ranch remains a working private cattle ranch.

The conservancy hired the California Conservation Corps to construct the trail, which was opened to the public in June 2006. SMUD provides road access to the nature trail as well as public parking at the trailhead. SMUD also provides ongoing maintenance on the trail.

7. Sections 8.7.1, Federal Requirements, and 8.7.2, State and Local Requirements, identify regulations, permits, licenses, notifications, and approvals that are in place during decommissioning.

   a. From these Sections, please provide a listing of local, State, and Federal regulations that will continue during the period when only the IOSB remains

on the NRC license, as well as, afterward, when the entire site is released from the license.

Response

During the period when only the IOSB remains on the NRC 10 CFR Part 50 license and the ISOB remains under the 10 CFR Part 72 license, all of the Federal, State and local requirements listed in Sections 8.7.1 and 8.7.2 will continue to apply. When the entire site is released from both licenses, the NRC requirements listed in Section 8.7.1.1 will no longer apply; however, the Cal/OSHA and EPA requirements listed in Sections 8.7.1.2 and 8.7.1.3 and the State and local requirements listed in Section 8.7.2 will continue to apply because the site will be maintained as an industrial site.

b. The Federal Requirements listing indicates that Rancho Seco must comply with the U.S. Environmental Protection Agency regulations for underground storage tanks (Part 280 of 40 CFR). Please clarify whether any tanks will remain on the site after the site is released from NRC licensing. If so, please identify their past and, if applicable, continued use, as well as any performance issues.

Response

There currently are no underground storage tanks on the Rancho Seco site and none are planned to be added after the site is released from NRC licensing.

8. Section 8.5.1.3.3, Water Supply, identifies that potable water comes from four wells and one well serves a residence located at the northeastern corner of the site.

a. Please summarize plans for operation of the plant's water supply system with release of the site from NRC licensing.

Response

The plant's water supply system will remain in operation after the release of the site from NRC licensing.

b. Please specify the approximate distance between the current Industrial Area fence and the residence located on the site.

Response

The distance between the Industrial Area fence and the residence located on the Rancho Seco site is approximately 1 mile.

IN SITU GAMMA SPECTROSCOPY ISSUES

General Discussion of In Situ Gamma Spectroscopy at Rancho Seco

There appears to be confusion over the use of *in situ* gamma spectroscopy at Rancho Seco for final status survey (FSS). The system used is the Canberra ISOCS system consisting of either HPGe or NaI detectors that have been characterized by the manufacturer such that they can be accurately employed with any source geometry that can be adequately described by the "geometry composer". Not only does this mean that National Institute of Standards and Technology (NIST) traceable sources are not required for every geometry used but it also means that a given spectrum can be analyzed using multiple geometries with a high level of accuracy. It is this capability that allows the spectrum collected from a large area to be analyzed as a small hot spot at the edge of the field of view by directly comparing source activities rather than efficiencies or some other parameter. This makes it simple to determine the ratio of the small area source response to that of the large area source response. By establishing the investigation level at the level of the elevated measurement comparison (EMC) divided by the ratio of the two responses, an analytical result less than the investigation criterion means that a small hot spot with an activity greater than the EMC value could not be present within the field of view. This approach does assume the activity in the hot spot and the large field of view is homogeneous, as does MARSSIM.

As stated in the referenced ORISE comments (ADAMS ML06360021) on *in situ* gamma spectroscopy, MARSSIM does not consider discrete radioactive particles (DRPs). There have been almost as many ways of dealing with DRPs as there have been Decommissioning or License Termination Plans. Many LTPs made no mention of particles at all (e.g., Trojan, Big Rock Point, and Hadem Neck). The Shelwell site, which underwent decommissioning outside of Columbus, Ohio in 1998, determined the probability of finding a particle in a given 1 m^2; determined the potential number of particles per year that could be ingested or inhaled; and the resultant "expectation dose". Maine Yankee and Yankee Rowe determined the sensitivity of their method of walkover scan with respect to DRPs to be 1 uCi of Co-60. Meanwhile, the NRC has not published the DRP sensitivity of the walkover scan described in NUREG-1575 nor have they determined an activity of DRP that is dose significant from the standpoint of 10 CFR Part 20.1402.

The decommissioning rule requires licensees to determine the potential annual dose to the average member of the critical group. Of the few reference documents available that discuss the dosimetry of DRPs, only NCRP-130, "Biological Effects and Exposure Limits for Hot Particles", discusses the dose to the lung or GI tract from the inhalation or ingestion of a DRP. NCRP-130 does not provide a dose per unit activity for either inhalation or ingestion, it rather references the use of dose factors (such as those found in Federal Guidance Report FGR-11) for the insoluble form of the particular radionuclide. The report does stress that inhalation or ingestion is an extremely unlikely event based on industry experience and the physical characteristics of DRPs. This is further supported by an NRC "Regulatory Analysis of Revisions to 10CFR20 Unified Skin Dose Limit October 2001" which stated that a survey of nuclear plant experience

with DRPs showed that, of the 15,068 DRPs reported, only 0.2% involved both a skin contamination and an activity of >1 uCi. Given the unlikely nature of an inhalation or ingestion event and the very limited number of workers potentially exposed under the industrial worker scenario, it seems unlikely that DRP internal exposure is a credible scenario for the average member of the industrial worker group.

Because of the difficulties presented by DRPs, the emphasis for decommissioning is placed on prevention and control measures. Each operating power plant developed a "hot particle" control program that covered detection, prevention, control, and dosimetry for DRPs. At Rancho Seco, that program is still being administered by the Radiation Protection Group for decommissioning activities. Controls are established for remediation of survey areas as necessary based on characterization data. During structure remediation, both beta and gamma sensitive instruments are used to evaluate the effectiveness of structure decontamination. Once it appears that residual activity is less than the derived concentration guideline level (DCGL), areas are vacuumed, wiped down, or otherwise cleaned prior to FSS. Before the final survey can begin, access controls are established at the entrance to the survey area to prevent recontamination. These measures make it highly unlikely that a DRP will be present in the survey area.

The likelihood of finding DRPs is greatest within Class 1 structures and least within Class 3 soils. This means that the decontamination, detection, and control measures are being applied to the proper areas. It also means that the lower *in situ* gamma spectroscopy MDAs will be achieved in the areas where greater detection sensitivity is desirable. Rancho Seco decommissioning technical basis document DTBD 06-003, "Use of *In Situ* Gamma Spectroscopy for FSS," recommends the use of supplemental NaI detector scans for soils with a high potential for DRPs (i.e., Class 1 soil). These practices taken in total minimize the potential for significant undetected DRPs in FSS areas.

Hot Particles

9.[1] During a recent visit to the site, the NRC staff observed "Hot Particle" control areas. Please provide a historical assessment of hot particles at Rancho Seco. Please describe how your hot particle survey program relates to the remediation and final status survey programs. Please provide a technical bases for the hot particle detection program.

Response

While Rancho Seco has detected hot particles on site during its history, the numbers and activities associated with the particles have not been as great as some other facilities. The number of particles detected per year since decommissioning

[1] The numbering of the "In Situ Gamma Spectroscopy Issues" RAIs has been revised to continue the numbering sequence used for the "Environmental Issues" RAIs.

began in 1990 is approximately 14 with an average activity of 0.013 μCi and a maximum of 0.36 μCi.

Rancho Seco relies on Site Characterization to properly identify Class 1 areas, including whether particles are present, and the Hot Particle Program to identify and control any particles actually found. When these areas are ready for remediation, radiological controls are established based on characterization data. These controls limit access into and out of the areas; detect and control contamination sources, including DRPs if necessary; and monitor remediation progress with repetitive surveys until the area is ready for final survey. By the time the area is turned over for FSS it has undergone multiple courses of decontamination and survey with many different types of survey instruments to ensure it will meet the release criteria, including the EMC.

The hot particle controls observed by the NRC were put in place as a precaution given the types of activities being performed at the time (e.g., vessel segmentation in the reactor building, pipe decontamination in the Aux Building), not because large numbers of particles have been recently detected. The presence of particles in Class 2 and 3 areas is extremely unlikely as evidenced by the very low activity levels reported in those FSS surveys. Particles are more likely to be found in Class 1 structures and on the soil adjacent to them. These are the areas requiring more remediation and more surveys with more than one type of instrument which increases the likelihood of detection if particles are present.

The Hot Particle Program is covered in the attached procedure RP.305.09E, "Hot Particle Controls". The Program described in procedure RP.305.09E is consistent with similar programs used throughout the nuclear utility industry. The Program has been in place for several years and has been successful in detecting and controlling particles as part of the site Radiation Protection Program.

The technical basis for the Hot Particle Control Program used at Rancho Seco is the same as that used throughout the nuclear industry. It is based on the referenced industry guidelines (viz., NRC IN 87-39, NRC IE Notice 86-23, and NRC IN 90-48) and is used to detect, control and remove particles from FSS areas during the remediation process. Its implementation ensures that when final surveys are performed there should be no DRPs in the survey area just as there should be no significant areas above the DCGL.

10. In DTBD-06-003, Rancho Seco identifies the method for determining the Investigation Criteria. DTBD-06-003 states:

    "Determination of the Investigation Criteria is based on taking a series of measurements using the detector in a standard geometry, such as a disk, located at a defined distance from the detector. The required geometry parameters are entered into the geometry composer and the acquired spectra area analyzed using the standard geometry. A new geometry is then developed

which reduces the source to an area of 1 m^2 located at the periphery of the detector field of view. The original spectra are then re-analyzed using the new , small source area geometry. The ratio of the full field of view activity to the small source activity is determined and the ratio is multiplied by the $DCGL_{emc}$ for a 1 m^2 area which becomes the Investigation Criterion."

How does Rancho Seco determine if the activity measured is uniform activity, a hot particle, or a smaller area that exceeds the $DCGL_{emc}$ averaged over an area less than 1 m^2?

Response

The detailed investigation survey, performed following detection of an elevated area, is the mechanism used to determine the size of the source causing the elevated reading. *In situ* gamma spectroscopy is typically used to perform scan surveys of land and structures. The purpose of the scan survey is to identify areas for further investigation based on detecting an elevated measurement result. It doesn't matter whether the elevated measurement is caused by a large area of uniform activity, a small area with high activity or a discrete particle. As long as the measurement exceeds the investigation criterion, the scan area will require further investigation to determine the actual location, size, homogeneity, and level of activity responsible for the elevated measurement.

11. DTBD-06-003 states, "*It is anticipated that final surveys will typically be performed with the detector at a distance of 2 m to 3 m from the source with a 90 degree collimator installed. This geometry defines a detector field of view (FOV) of 12 m^2 to 28 m^2.*"

    What is the minimal detectable activity (MDA) using a 12 m^2 FOV vs using a 28 m^2 FOV, assuming a hot particle is present in the FOV on soil and structure surfaces, at a depth of 2 cm in concrete and at a depth of 15 cm in soil?

Response

Count times are established to achieve the required MDAs so there is no difference in MDAs between either a 12 m^2 FOV or a 28 m^2 FOV. MDAs for soil are typically $\leq$ 0.5 pCi/g and for structure surfaces are typically $\leq$ 1,500 dpm/100 cm^2. Scan measurements are made using the "count to MDA" function which ensures that the MDA achieved will meet the investigation criterion, however count times are usually in the 600 to 1,000 second range. The table below shows the typical minimum particle activities detectable for the geometries indicated based on actual MDAs for the given FOV. The 2 cm depth for concrete structures refers to the possibility of contamination slightly below the surface rather than a discrete particle embedded in concrete.

MDAs For Particles With Various Geometries		
ISOCS Geometry & FOV	Particle Located In Center	Particle Located At Edge*
Soil Surface, 28 m^2	< 0.4 uCi Co-60	< 1.1 uCi Co-60
Soil at 15 cm, 28 m^2	1.7 uCi Co-60	4.3 uCi Co-60
Concrete Surface, 3 m^2	0.9 uCi Co-60	2.5 uCi Co-60
Containment Liner, 28 m^2	1.4 uCi Co-60	3.6 uCi Co-60

The MDAs for Co-60 particles are presented because they are the most common particle.

*The MDAs do not reflect the lower activities resulting from the overlapping fields of view for Class 1 areas.

12. If such a hot particle exists, how does ISOCS determine its position in the FOV?

Response

As explained in RAI #10 above, the *in situ* scan measurement is not used to locate the position of the elevated activity but rather is used to identify a scan grid for further evaluation. The identified grid is investigated using a separate written survey plan that may include the use of gas proportional detectors, NaI detectors, volumetric samples, or additional *in situ* measurements with reduced fields of view. It is the investigation measurements that identify the location, source and activity of the elevated reading.

13. Based on the MDAs for hot particles, what is the dose implication if such a hot particle is present?

Response

For particles buried in soil, the direct dose from a 4 uCi particle of Co-60 for 2,000 hours of exposure (based on the industrial worker scenario) at 100 cm is 1.2 mRem/y. The detection methodology is more sensitive for particles on the soil surface and a 1 uCi Co-60 particle for 2,000 hours of exposure at 100 cm would be 2.6 mRem/y. These particles are easily detectable in the presence of underlying soil with little or no significant activity above background (i.e., Class 2 and 3 survey units) and the total dose would be less than 10 CFR Part 20, Subpart E limits.

Combining 2"x2" NaI scan surveys with *in situ* scans for Class 1 soil surveys ensures that discrete particles of significant activity (i.e., greater than 1 uCi on the surface) would be detected in order to meet 10 CFR Part 20, Subpart E limits.

Discrete particle contaminations of personnel typically occur indoors. The indoor areas are more likely to have discrete particles present prior to remediation and close proximity to the particle is usually needed for a worker to become contaminated. The performance of multiple surveys of structures during remediation and FSS make such contamination events unlikely.

In Situ Gamma Systems at Rancho Seco

14.[2] Please provide the technical bases that assures that the DCGL and elevated concentrations do not exceed the depth of 15 cm of soil or 2 cm of surface on structures? Please provide your bases for MDAs taking into consideration the spatial and volumetric measurements you plan to make.

Response

The soil remediation techniques used and the post-remediation surveys conducted ensure that FSS scans are only performed on a soil source depth of 15 cm. The *in situ* geometry used for soil measurements is defined for a depth of 15 cm and the geometry used for structures is defined for a depth of 2 cm or more. Volumetric samples are taken at the prescribed depths to accurately determine the "as left" activity. Attached is the revised DTBD 06-003, "Use of *In Situ* Gamma Spectroscopy for Final Site Survey", which presents the MDAs and investigation criteria for homogeneous sources. The "count to MDA" feature ensures that the MDA achieved is appropriate for the investigation criterion of a given measurement, including consideration of DRPs, if necessary. DTBD 06-003, Rev. 0 was previously submitted to the NRC with all attachments. The attachments were not changed in Rev.1; therefore, the Rev. 1 without attachments is provided in Attachment 2.

15. Soil moisture can adversely impact the quality of ISOCS measurements. How does Rancho Seco identify and adjust for soil moisture while using ISOCS?

Response

DTBD 06-003 describes the use of massimetric efficiency to reduce the impact of media density or moisture effects. Soil scans are not performed during the rainy season because of the difficulty of getting equipment into the field when the ground is very soft. During the dry season, the ground has little residual moisture. With MDAs of 1 pCi/g or less and DCGLs of 50 pCi/g, there is little effect on the scan evaluation even if soil moisture induced an error of 10 to 15 percent. Furthermore, for soil surveys, the direct measurements are typically volumetric soil samples that are dried and counted in the laboratory which eliminates the moisture effect altogether.

[2] The numbering of the "In Situ Gamma Systems at Rancho Seco" RAIs has been revised to continue the numbering sequence from the "Hot Particles" RAIs.

16. Describe how the proposed ISOCS measurements with the proposed FOV will meet the DQOs for the FSS.

Response

The MDAs for *in situ* gamma spectroscopy are a very small fraction of the DCGLs for either soil or concrete (less than 3.5%) and the use of conservative investigation criteria ensure that elevated measurements are identified and investigated in order to demonstrate compliance with the Elevated Measurements Criteria. This ensures that the DQOs will be met.

17. How does Rancho Seco use the naturally occurring radionuclides that will be identified in the ISOCS measurements to assure quality operations or to identify equipment malfuntion?

Response

When the FSS Engineers review the *in situ* gamma spectroscopy results, they note the presence of naturally-occurring radionuclides and whether the activity levels are consistent with known site levels. They also note whether the reported photo peaks are at the proper energy location within the spectrum and if the full width half maximum (FWHM) values meet the analytical specification. These evaluations, coupled with the daily pre- and post-QC source counts, ensure proper operation of the detectors.

OTHER

18.[3] In Section 6.4.2, pg. 6-6. Rancho Seco identifies an "industrial worker scenario for surface and subsurface soil exposures" for unrestricted release. It further states in Section 6.4.2.1 that "...the public does not have ready access to the remaining areas of the site". More specifically, please provide assurances as to how RS will maintain these areas under the industrial worker scenario after the first phase and after the second phase (See Section 8.3 Site Description After Unrestricted Release, pg. 8-4). What mechanism will RS use to maintain these areas as an industrial worker scenario?

Response

No controls are required to be implemented after license termination because Rancho Seco is being decommissioned under 10 CFR Part 20.1402 for unrestricted release, not under 10 CFR Part 20.1403 for license termination under restricted conditions.

[3] The numbering of the "Other" RAIs has been revised to continue the numbering sequence from the "In Situ Gamma Systems at Rancho Seco" RAIs.

Justification for selection of an industrial worker scenario for surface and subsurface soil exposures to use while performing dose modeling was provided in Section 6.4.2 of the LTP. Section 6.4.2 concluded that it is reasonable to assume that the District will retain ownership of the site for the foreseeable future and that members of the public will not have ready access to Impacted Areas of the site. Section 6.8 of the LTP compared alternative exposure scenarios for Impacted Area soils. Section 6.8.2 evaluated the most conservative exposure scenario, the resident farmer scenario. Section 6.8.2 concluded that, after a period of approximately 30 years, Rancho Seco would comply with the requirements of 10 CFR Part 20.1402 even under a resident farmer scenario. Therefore, the foreseeable future only needs to consider a period of 30 years following the first phase of license termination.

The entire 2,480 acres of SMUD owned property is surrounded by some type of fencing, usually cattle fencing. The response to RAI No. 1.b. discusses the fate of the existing Industrial Area during the foreseeable future. The fence enclosing the Industrial Area will not be removed during decommissioning. Upon completion of the first phase of license termination the Industrial Area will be maintained as an industrial site with access controlled by the SMUD Asset Protection Department (industrial security). The IOSB, which will remain under the 10 CFR Part 50 license until completion of the second phase of license termination, will be contained within this industrial site. The Backup Control Center in the Administration Building, the Training and Records Building with occupied offices and the active switchyard will also be contained within this industrial site. Upon completion of the second phase of license termination, access to the industrial site will continue to be controlled by the SMUD Asset Protection Department. This can reasonably be assumed to include at least a period of 30 years following completion of the first phase of license termination.

SUPPLEMENTAL INFORMATION[4]

The site reservoir (i.e., Rancho Seco Lake) was designed to supply emergency plant cooling water in the event that water from Folsom South Canal was not available. The lake is located approximately 2 miles southeast of the Industrial Area boundary.

The dam is under the jurisdiction of the State of California, Division of Dam Safety. Accordingly, it is designed and constructed to standards established by the State of California, which include consideration for earthquakes.

The probability of a sudden failure of an earth structure is very small. However, as part of the original plant licensing, the effects on the plant of a dam failure or other sudden release of water were evaluated. The analysis showed that an instantaneous break 50 feet wide, the full height of the dam, occurring simultaneously with the peak flow from the design storm will not flood the plant site. The resulting flow would have had a water surface that would have been more than 10 feet below any of the plant safety features.

[4] Information requested during a March 19, 2007 conference call between NRC and Rancho Seco personnel.

Attachment 1

Hot Particle Controls Procedure RP.305.09E

MANUAL: RADIATION CONTROL MANUAL	NUMBER: RP.305.09E REVISION: 4
TITLE: HOT PARTICLE CONTROLS	PAGE 1 OF 16
LEAD DEPARTMENT: RP/ Chemistry	EFFECTIVE DATE:

REVISION SUMMARY:

1. Removed references to RP Responders. RP Responder Program has been deleted.
2. Added clarification to "Prerequisites" section.
3. Added clarification to section 6.6.1 for RWP requirements
4. Revised section on Hot Particle Control Exemptions. Deleted section on "Operations activities, inspections, and I&C functions".
5. Revised section on Hot Particle survey requirements for clarification.

1. **PURPOSE**

1.1. To provide the Radiation Protection requirements for Hot Particle control, assessment and response (COMMITMENT: Ref. 2.2.1).

2. **REFERENCES/ COMMITMENT DOCUMENTS**

2.1. References

2.1.1. Title 10, Code of Federal Regulations, Part 20, Standards For Protection Against Radiation

2.1.2. U.S. Nuclear Regulatory Information Notice, Number 87-39, Control of Hot Particle Contamination at Nuclear Power Plants.

2.1.3. U.S. Nuclear Regulatory IE Information Notice, Number 86-23, Excessive Skin Exposures Due To Contamination With Hot Particles.

2.1.4. U.S. Nuclear Regulatory Information Notice, Number 90-48, Enforcement Policy For Hot Particle Exposures.

2.1.5. RP.305.04, Radiation Work Permits

2.1.6. RP.305.07, Area Definitions, Posting, and Requirements

2.1.7. RP.305.08A, Routine and Radiation Work Permit Surveys

2.1.8. RP.305.09A, Removal of Tools and Equipment From Controlled Areas

2.1.9. RP.305.09B, Personnel Contamination Monitoring

2.1.10. RP.305.09C, Decontamination Procedures

2.1.11. RP.305.09D, Personnel and Clothing Decontamination and Reports

2.2. Commitment Documents

2.2.1. LER 88-003, Personnel Overexposure Due to a Hot Particle

3. DEFINITIONS

3.1. HOT PARTICLES - Highly radioactive (activity greater than 25,000 ccpm at 0.5 inches with an RM-14 equipped with an HP-260 probe or equivalent), discrete, small particles of either irradiated Fuel Fragments or neutron activated corrosion and wear products.

3.2. ZONE 1 – An area verified to be free of Hot Particles and unlikely to become contaminated with Hot Particles.

3.3. ZONE 2 – HOT PARTICLE BUFFER ZONE - An area verified to be free of Hot Particles but having the potential of becoming contaminated with Hot Particles.

3.4. ZONE 3 - HOT PARTICLE ZONE (HPZ) - An area known or suspected to contain Hot Particles.

4. PREREQUISITES

4.1. All persons entering Hot Particle Zones shall be familiar with the Hot Particle Controls in effect in the area they are working in. Specific information on Hot Particle controls for work areas is listed on the applicable RWP for the area. General information on Hot Particle controls is available from RP Supervision and RP Technicians assigned coverage in the work areas.

5. PRECAUTIONS

5.1. Hot Particles, identified on personnel, must be located and removed in an expeditious manner.

5.2. The RWP contains specific requirements for Hot Particle control.

6. PROCEDURE

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6.6 Hot Particle Work Requirements
6.7 Response to Hot Particle Detection Outside HPZs
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6.10 Response to Hot Particles on Personnel in an HPZ
6.11 Protective Clothing
6.12 Removal of Contaminated Equipment from an HPZ
6.13 Personnel Egress from Hot Particle Zones
6.14 Hot Particle Trash
6.15 Deposting Hot Particle Zones

6.1. Establishing Hot Particle Zones

6.1.1. RP Supervision is responsible for establishing Hot Particle Zones (HPZ) and implementing Hot Particle controls.

6.1.2. Establish HPZs for work in areas that meet either of the following criteria:

6.1.2.1. The area or component is known to be contaminated with Hot Particles.

6.1.2.2. Work is performed in an area or on a component/system that is suspected to contain Hot Particles based on previous findings of Hot Particles or plant conditions.

6.1.3. Review each job individually to determine the need for Hot Particle controls. Typical areas where Hot Particle controls may be implemented include systems or components that have come into direct contact with primary coolant, spent fuel coolant, or fuel handling equipment.

6.1.4. Areas with contamination levels greater than or equal to 150,000 dpm/ 100 cm^2 are normally controlled as HPZs because it is difficult to verify the absence of Hot Particles.

6.1.5. At the discretion of RP Supervision, the following activities and equipment are normally exempt from Hot Particle controls:

6.1.5.1. RP and Chemistry sampling evolutions, samples, and surveys that do not require whole body entry into a posted HPZ.

6.1.5.2. Closed component internals such as Tygon tubing (or equivalent) used to direct leakage to drains, unless working on the component.

6.2. Posting Requirements For Hot Particle Zones

NOTE
Hot Particle controls do not take the place of, NOR have more importance than normal contamination control requirements.

6.2.1. Post the HPZ and the Hot Particle Buffer Zone (Zone 2) in accordance with RP.305.07.

6.2.2. A physical barrier (i.e., herculite pen, railing, or wall) around an HPZ, eliminates the requirement to establish a Hot Particle Buffer Zone.

6.2.3. Zone 1 areas are not required to be specifically identified or posted.

6.3. Hot Particle Survey Methods

> NOTE
> It is prudent to use tape to remove hot particle contamination from workers as surveys are performed.

6.3.1. Direct Survey

6.3.1.1. A direct survey refers to measuring contamination where it exists using a survey instrument or frisker.

6.3.1.2. A direct survey is preferred in the following instances:

6.3.1.2.1. On personnel when background levels are not restrictive

6.3.1.2.2. On irregular surfaces and for detecting "fixed" Hot Particles (i.e., cracks and crevices)

6.3.1.2.3. When precise location of particle is desired

6.3.1.3. A direct survey should be performed in a slow, deliberate manner, taking time to cover all areas.

6.3.1.4. Perform direct surveys of personnel working in an HPZ, if possible. Survey the whole body, concentrating on areas of the body that are suspect to high contamination levels, i.e., hands, knees, feet, etc., at the frequency specified in 6.5.5.

6.3.1.5. Identified Hot Particles should be captured using tape, masslinn, or similar method.

6.3.2. Indirect Survey

6.3.2.1. An indirect survey refers to measuring removed contamination using a wipe technique (masslinn, tape, etc.).

6.3.2.2. An indirect survey is preferred in the following instances:

6.3.2.2.1. When covering large surface areas

6.3.2.2.2. To effectively pick up Hot Particles

6.3.2.2.3. In high background areas to minimize time spent in the area.

6.4. Hot Particle Identification Techniques

6.4.1. The described techniques apply to Hot Particles that have been secured in masslinn, tape, etc.

6.4.2. Lay the masslinn or tape out flat in a low background area and slowly frisk at a distance of 1/2 inch using an RM-14/ HP-260, or equivalent, on fast response. IF the contamination levels are greater than 50,000 ccpm, THEN a Ludlum-177, at 1/2 inch, OR an open window R0-2, at a distance of 1 inch (from the source to the detector window), may be used.

6.4.3. IF areas of significantly higher activity are found, THEN cut the masslinn (or tape) into smaller pieces in order to isolate the particle. Refer to RP.305.09D for dose estimate methods.

6.4.3.1. Use a RP Badge, or material of equivalent density thickness, as a shield between the Hot Particle and the frisker probe or the open window R0-2.

6.4.3.2. IF the count/ dose rate decreases dramatically when shielded, i.e., by 90%, THEN suspect a Co-60 crud particle.

6.4.3.3. IF the count/ dose rate does not decrease dramatically when shielded, i.e., less than 50%, THEN suspect a Fuel Fragment.

6.4.4. Place the piece of material containing the Hot Particle in a container and seal the edges with tape. Include date, time, and the appropriate survey number or contamination report number.

6.4.5. Unless otherwise specified by RP Supervision, send the particle(s) for isotopic analysis.

6.5. Hot Particle Survey Requirements

6.5.1. HPZs are not required to be surveyed for Hot Particles when no work is being performed in that HPZ.

6.5.2. When no work is in progress in an HPZ, survey areas for Hot Particles at the following frequency as a minimum:

6.5.2.1. Zone 1 areas and walkways at least weekly

6.5.2.2. Zone 2 (established buffer zone) prior to HPZ entry

6.5.3. When Hot Particle work is in progress, survey all directly adjacent Zone 1 and Zone 2 areas once per shift. Include step off pads in this survey.

6.5.4. For work in an HPZ, perform Hot Particle surveys upon initial entry and during work evolutions that may increase the potential for spreading Hot Particles.

6.5.5. Guidelines for performing personnel Hot Particle Surveys [based on the detected Hot Particle activity found using an RO-2 (open window - closed window, at 1 inch)] are:

6.5.5.1. Every 4 hours:	<5 mR/hr
6.5.5.2. Every 2 hours:	5 to 15 mR/hr
6.5.5.3. Once per hour (not to exceed 60 min.):	16 to 30 mR/hr
6.5.5.4. Contact RP Supervision and evaluate decontaminating area:	>30 mR/hr

> Note
> For areas, which have detected hot particle activity greater than 30 mR/hr, decontaminating the area should be considered.

6.5.6. In areas where general area dose rates are very high, i.e., hundreds of mR/hr or greater, Hot Particles may be difficult to detect. In these instances, survey for Hot Particles per the guidance of RP Supervision.

6.5.7. Document the performance of all Hot Particles surveys per RP.305.08A and include the following information:

6.5.7.1. Whether or not Hot Particles were found

6.5.7.2. CCPM or open window minus closed window reading for Hot Particles detected

6.5.7.3. Frequency that personnel were surveyed for Hot Particles, if applicable

6.6. Hot Particle Work Requirements

6.6.1. RWP Requirements:

6.6.1.1. A Radiation Work Permit (RWP), which allows work in a HPZ, is required for all work performed in an HPZ in accordance with RP.305.04.

6.6.2. Continuous Radiation Protection coverage is required for all entries into HPZs.

6.6.3. Mark the RWP with the words HOT PARTICLE CONTROLS in the special instructions block of the RWP. Special instructions will be used to clarify Hot Particle Controls.

6.6.4. The normal frequency for surveying the personnel working in the HPZ should not exceed 4 hours. Specify the frequency in the special instructions block of the RWP.

6.6.5. Before starting work, a job briefing is required for RWPs that cover work in HPZs.

6.6.5.1. The Hot Particle Job Briefing should address, as a minimum, the following:

6.6.5.1.1. RWP requirements and any special instructions

6.6.5.1.2. Purpose of the periodic personnel surveys and the expected job evolutions that may require special surveys.

6.6.5.1.3. Response to discovering or suspecting personnel Hot Particle contamination

6.6.5.1.4. The proper undressing practices and sequence to prevent personnel contamination.

6.6.5.2. Document the required information on a Hot Particle Briefing Attendance Sheet, RAD-182 (Enclosure 8.1) by checking off each item.

6.6.5.2.1 An ALARA Job Planning meeting can suffice for a Hot Particle Briefing

6.6.5.3. Place the completed Hot Particle Briefing Attendance Sheet in the appropriate RWP File.

> Note:
> An ALARA Job Planning Meeting held and documented in accordance with RP.315.I.03, "ALARA Job Planning Guidelines" may be substituted for the requirements of 6.6.5.2 and 6.6.5.3.

6.7. Response to Hot Particle Detection Outside HPZs

6.7.1. Contain/ isolate the particle(s) and measure dose/ count rates.

6.7.2. Stop work or traffic in the area, if necessary.

6.7.3. Notify RP Supervision.

6.7.4. Document required information on survey in accordance with Step 6.5.7 and send particles for analysis as described in Steps 6.4.4 and 6.4.5.

6.7.5. Perform follow-up surveys in the affected area to determine the extent of the Hot Particle problem.

6.7.6. RP Supervision will determine the cause, if possible, and implement corrective actions such as decontamination or increased survey frequency, if necessary.

6.8. Response to Hot Particles on Personnel Outside HPZs

6.8.1. IF a Hot Particle is found on a person who has not been in an HPZ, THEN decontaminate the individual.

6.8.2. Notify RP Supervision.

6.8.3. Perform dose estimates as required in accordance with RP.305.09D.

6.8.4. Evaluate the situation AND perform follow up surveys to determine the extent of the problem (i.e., survey the areas the contaminated individual had been in or walked through to see if more Hot Particles are present).

6.8.5. Document survey information in accordance with Step 6.5.7 and send particles for analysis per Steps 6.4.4 and 6.4.5.

6.9. Response to Hot Particle Detection in an HPZ

6.9.1. IF Hot Particles greater than 30 mR/hr are found on equipment or in the area, THEN isolate and remove the particles to prevent worker contamination.

6.9.2. Notify RP Supervision, who will evaluate the need for decontamination.

6.9.3. Resurvey the affected area to determine the extent of the problem.

6.9.4. Follow guidance in Section 6.10 if Hot Particles are found on the workers.

6.10. Response to Hot Particles on Personnel in an HPZ

6.10.1. IF particles greater than 30 mR/hr [RO-2 (open window - closed window, at 1 inch)] are detected, THEN have the worker remove the outer layer of Protective Clothing and exit the HPZ into Zone 2.

6.10.1.1. Survey the worker's inner set of PCs to determine the presence of Hot Particles. IF Hot Particles are found or suspected, THEN have the worker remove the remaining PCs, cross the SOP to Zone 1, AND proceed to a PCM-1B.

6.10.1.2. IF Hot Particles are not found or suspected on the inner layer of PCs, THEN the worker may don a new set of outer PCs AND return to work.

6.10.1.3 Notify RP Supervision

6.10.2. IF a direct OR indirect survey indicates less than 30 mRem/hr on the worker, THEN remove any particles detected AND the worker may continue.

6.11. Protective Clothing

6.11.1 The following Protective Clothing may be used for performing work in an HPZ. RP Supervision will determine the Protective Clothing requirements for each job evolution.

6.11.1.1. Second pair of outer coveralls (paper, charkate, plastic, nylon), with all seams taped (a second pair of cloth coveralls may be allowed for welders).

6.11.1.2. Second pair of rubber gloves taped to outer coveralls

6.11.1.3. Second hood, securely taped to outer coveralls

6.11.1.4. Respirator taped to outer hood

6.11.1.5. Second pair of high-top booties taped to outer coveralls and flats over the second pair of high-top booties.

6.12. Removal of Contaminated Equipment from an HPZ.

6.12.1. All items leaving an HPZ should be wiped down with masslinn, or equivalent or surveyed directly for Hot Particles per Section 6.3.

6.12.2. IF no Hot Particles are found, THEN handle items in accordance with RP.305.09A.

6.12.3. Securely package items having, or suspected of having, Hot Particles in a double bag, or similar equipment:

6.12.3.1. Wipe down and survey the exterior of the first bag while in the HPZ.

6.12.3.2. Place the first bag into the second bag in Zone 2. Survey the exterior of the second bag to verify surfaces are free from Hot Particles.

6.12.3.3. Use a "J" seal, or similar method, to ensure that no inner surfaces of the bags are accessible.

6.12.4. Label the package to include at least the following information (a sticker may be used):

HOT PARTICLE CONTACT mR/hr DATE AND RP TECHNICIAN'S INITIALS

6.13. Personnel Egress from Hot Particle Zones

6.13.1. Carefully wipe off any Respiratory Protection Equipment used, remove outer Protective Clothing and respiratory equipment, AND cross the Step-Off Pad. A RP Technician (if available, see note above) should assist in the removal of Protective Clothing.

6.13.2. Survey the personnel in accordance with Section 6.3.

6.13.2.1. IF no Hot Particles are found, THEN the workers should exit the Hot Particle Buffer Zone.

6.13.2.2. IF Hot Particles are found, THEN follow the guidance of Section 6.7.

6.13.3. Survey the removed Protective Clothing and Respiratory Protection Equipment for Hot Particles.

6.13.3.1. IF no Hot Particles are found, THEN put the clothing and respiratory equipment in normal receptacles.

6.13.3.2. IF Hot Particles are found, THEN handle the items in accordance with Steps 6.12.3 and 6.12.4.

6.14. Hot Particle Trash

6.14.1. IF Hot Particles are found during the job, THEN segregate the trash as Hot Particle Trash and handle it as follows:

6.14.1.1. Survey the package per Section 6.3.

6.14.1.2. Label the package per Step 6.12.3.

6.14.1.3. Store the package in a posted Hot Particle Trash Area.

6.14.1.4. Compact the Hot Particle Trash separately from normal radioactive trash using Hot Particle Controls.

6.14.2. IF Hot Particles are not found, THEN segregate trash per RP.305.09A.

6.15. Deposting Hot Particle Zones

6.15.1. Before removing Hot Particle controls and deposting an HPZ, RP Supervision must evaluate the status of the work and work area to determine if the Hot Particle controls can be downgraded.

6.15.2. IF the potential source of Hot Particles is contained, the HPZ is surveyed per Step 6.3 AND no Hot Particles are found, THEN the area may be deposted from HPZ controls prior to continuation of work in the area, with approval by RP Supervision.

6.15.3. Do not perform the evaluation while work is being performed in the area.

6.15.4. If this has not already been performed, survey Protective Clothing, any tools or equipment, trash containers, and bags for Hot Particles. This may require removing the plastic bags from the barrels before performing the surveys.

6.15.5. Document all survey results per Step 6.5.7.

6.15.6. The approval for release is to be noted on the RP Log, and ALARA Job Tracking File (AJTF) as appropriate.

7. RECORDS

7.1. The following individual/ packaged documents and related correspondence completed as a result of the performance or implementation of this procedure are records. They shall be transmitted to Records Management in accordance with RSAP-0601, Nuclear Records Management.

7.1.1. Hot Particle Briefing Attendance Sheet

8. ENCLOSURES

8.1. Hot Particle Briefing Attendance Sheet (RAD-182)

HOT PARTICLE BRIEFING ATTENDANCE SHEET

RWP: _____ DATE/TIME: _____

TASK DESCRIPTION: _____

LOCATION: _____
BRIEFING PERFORMED BY: _____
RWP REQUIREMENTS: _____
PERIODIC PERSONNEL SURVEYS, EXPECTED SPECIAL SURVEYS: _____
RESPONSE TO DISCOVERED OR SUSPECTED HOT PARTICLES: _____
PROPER DRESSING/UNDRESSING PRACTICES: _____
BRIEFING COMMENTS: _____

Sample

PRINT NAME			CRAFT

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ENCLOSURE 8.1
PAGE 1 OF 1

Attachment 2

DTBD 06-003, Rev. 2

Rancho Seco Nuclear Generating Station **Decommissioning Technical Basis Document**	**DTBD–06-003** **Revision No. 1** **DPT 06-036** **RIC 2A.900**

Use of In Situ Gamma Spectroscopy for Final Site Survey

PREPARED BY: G.D. Pillsbury _____ _____
Author Date

REVIEWED BY: _____ _____
Technical Reviewer Date

REVIEWED BY: _____ _____
QA Reviewer Date

APPROVED BY: _____ _____
Principal Radiological Engineer Date

1.0 Purpose

The purpose of this DTBD is to describe the use of in situ gamma spectroscopy for performing final surveys.

2.0 Discussion

The intent is to employ a Canberra characterized HPGe detector (40% rel. efficiency) coupled to an MCA using Canberra Genie software for performing gamma spectrum analyses of various media for final site surveys. Acquisition of a characterized detector allows the use of the geometry composer software to model actual survey unit conditions in order to obtain accurate gamma survey results. Use of the geometry composer also allows the determination of investigation criteria which will identify the possible presence of an elevated area of residual activity within the detector field of view exceeding the EMC value for the survey medium.

3.0 Definitions

Investigation criterion- An activity limit at which further evaluation of the survey data is required. NUREG-1575, Table 5.8, lists recommended levels for survey unit investigation which are similar to those specified in the RSNGS LTP. The investigation criteria used for in situ measurements is based on preventing the EMC value in a 1 m^2 area from being exceeded. Because the criterion is a derived value rather than a simple multiple of the DCGL, it can be thought of as an "effective" criterion.

4.0 Technical Position

In situ gamma spectroscopy can be effectively employed to perform final surveys at MDCs comparable to those typically achieved with hand-held instruments without the possibility of failing to detect an area of elevated activity greater than the EMC value. The EMC value is applied to a 1 m^2 land area consistent with NUREG-1575 recommendations given the low dose rates and the very large area factors associated with smaller areas. In situ gamma spectroscopy can be used for any situation in which the contaminant is a gamma emitter and the source geometry can be defined by the geometry composer.

5.0 Limitations

This technical position can only be met using a characterized detector with geometry composer software using approved procedures (Ref. 7.3) unless geometry-specific, NIST traceable calibration sources equal to the size of the detector field of view for each media are obtained. In situ gamma spectroscopy may not be appropriate for performing soil scans in areas

with a risk of discrete particle contamination. Use of 2"x2" NaI detector scans are recommended for this situation.

6.0 Technical Bases

Canberra has developed a HPGe detector which has been exposed to gamma sources at multiple points in space in order to determine the detector response to gamma photons which interact with the detector and which originate from any location about the detector. The software uses an iterative discrete ordinate attenuation computation routine to predict the detector response when particular geometry features such as source to detector distances, shielding materials, thickness of source or shield materials, source and shield densities, source to detector angles, and source configurations are entered into the geometry composer. These features allow the same spectrum to be analyzed using more than one geometry. It is this capability which makes possible the identification and evaluation of hot spots using the investigation criterion.

A description and documentation of the characterization of the Canberra HPGe detector (S/N 3920) is contained in Attachment 8.1.

It is anticipated that final surveys will typically be performed with the detector at a distance of 2 m to 3 m from the source with the 90 degree collimator installed. This geometry defines a detector field of view (FOV) of 12 m^2 to 28 m^2. Due to the critical relationship of the geometries to the analytical results, only approved geometries will be used for FSS surveys.

The gamma spectroscopy analysis report provides the total activity detected within the field of view of the detector and reported in units of pCi/g, pCi/m^2 or dpm/m^2. For spectra collected using the 90 degree collimator, the FOV is the source to detector distance (which is equal to the radius of the FOV) squared and multiplied by pi.

Concrete source activity depths will typically be set at 2 cm and soil source activity depths will typically be set at 15 cm. These values are consistent with site characterization experience and NUREG-1575 assumptions. These source geometries allow for the collection of spectra with MDA values for the nuclides of interest (i.e., Cs-137 and Co-60) at approximately 0.3 pCi/g for soil and 500 to 1500 dpm/100 cm^2 for concrete. Since the MDA values are three percent or less of the respective DCGLs for soils and structure surfaces, the chances of making a Type 1 error is less than 0.05 for reasonable count times of 20 to 60 minutes. The "count to MDA" feature of the Canberra software will be employed to ensure that the desired MDAs are achieved.

Factors Affecting Detector Efficiency

Factors such as sample moisture content, soil density, and overlying water could adversely impact detector efficiency. In situ gamma spectroscopy is typically used as a scan method to detect areas of elevated activity, not for direct measurement of soil activity to determine compliance with the DCGLs. Soil density and moisture content don't have a significant effect on scan results. However, the impact is further reduced by using the "massimetric efficiency" for analysis. Use of the "massimetric efficiency" determines efficiency as c/m per unit activity per gram of sample. This means that soil survey depths of 15 cm or more are seen as infinite and soil density can vary by a factor of 2 with no impact on efficiency according to Canberra "Model S573 ISOCS Calibration Software Manual" (pgs. 163, 165).

The soil around the RSNGS site is extremely dry for most of the year. The survey data sheets taken into the field by the survey techs are used to document any standing water found in the scan area so that the geometry can be adjusted to account for the shielding effect. Soil samples used for direct measurements are sieved, dried, and weighed before counting in the lab so their results are not impacted by moisture at all.

Furthermore, the analytical results of NORM in soil scans can be used to identify possible impacts on efficiency so that the geometry can be adjusted to account for such adverse effects. Typical indicator nuclides are K-40 and Pb-212/214.

Investigation Criteria

Determination of the Investigation Criteria is based on taking a series of measurements using the detector in a standard geometry, such as a disk, located at a defined distance from the detector. The required geometry parameters are entered into the geometry composer and the acquired spectra are analyzed using the standard geometry. A new geometry is then developed which reduces the source to an area of 1 m^2 located at the periphery of the detector field of view. The original spectra are then re-analyzed using the new, small source area geometry (Attachment 8.2). The ratio of the full field of view activity to the small source activity is determined and the ratio is multiplied by the $DCGL_{EMC}$ for a 1 m^2 area which becomes the Investigation Criterion. Any in situ measurement which equals or exceeds the Investigation Criterion, when analyzed using the full field of view geometry, requires further evaluation to rule out the possibility of a small elevated area of activity within the detector field of view.

For structure surveys, an initial geometry was constructed using a circular plane with a source depth of 2 cm, a radius of 3 m and a source to detector distance of 3 m. A series of spectra were collected using this geometry with the 90 degree collimator attached to the detector. The

spectra were collected from a concrete wall with low, but detectable levels of Cs-137 and Co-60. Analytical results were presented in pCi per m^2 and Cs-137 data are shown converted to dpm/100 cm^2 in order to demonstrate the sensitivity of the analyses (Co-60 was not converted due to higher ambient levels of cobalt in the survey area and background was not subtracted from any of the data).

Following the original analyses, the data were re-evaluated using a geometry having a 2 cm thick source of 1 m^2 placed at the periphery of the field of view. The analytical results for the small area sources were compared to the result for the large area sources (i.e., the 28 m^2 field of view). The ratio of the small source to large source activity is the factor by which the DCGLemc must be divided by to derive the Investigation Criterion as shown in the table below.

Table 1. Geometry Comparison For Investigation Criteria

Sample #	Nuclide	28 m^2 source in 28 m^2 FOV Geometry pCi/ m^2	dpm/100 cm^2	1 m^2 source in 28 m^2 FOV Geometry pCi/m^2	Ratio (Small to Large)
CRC002	Cs-137	115684	2568	3058937	26.4
	Co-60	922077		24604310	26.7
CRC003	Cs-137	30368	674	803012	26.4
	Co-60	1182335		31550640	26.7
CRC004	Cs-137	84654	1879	2238500	26.4
	Co-60	1176505		31394350	26.7
CRC005	Cs-137	646634	14355	17099200	26.4
	Co-60	653756		17444690	26.7
CRC006	Cs-137	271698	6032	7184433	26.4
	Co-60	708836		18915281	26.7
CRC007	Cs-137	54494	1210	1441027	26.4
	Co-60	835538		22298770	26.7
CRC008	Cs-137	36151	803	955918	26.4
	Co-60	640738		17097850	26.7
CRC009	Cs-137	26204	582	692930	26.4
	Co-60	417889		11151050	26.7
CRC010	Cs-137	46540	1033	1230622	26.4
	Co-60	1052418		28080790	26.7
CRC011	Cs-137	98584	2189	2606865	26.4
	Co-60	965999		25775990	26.7
CRC012	Cs-137	298052	6617	7881140	26.4
	Co-60	792048		21134200	26.7
CRC013	Cs-137	434564	9647	11491151	26.4
	Co-60	1065999		28444600	26.7
CRC014	Cs-137	230746	5123	6101277	26.4

	Co-60	456766		12186860	26.7
CRC015	Cs-137	607692	13491	16068710	26.4
	Co-60	393634		10504530	26.7
CRC016	Cs-137	356727	7919	9432931	26.4
	Co-60	161815		4316970	26.7
CRC017	Cs-137	309195	6864	8175661	26.4
	Co-60	313478		8364573	26.7
CRC018	Cs-137	156929	3484	4149533	26.4
	Co-60	770318		20555180	26.7
CRC019	Cs-137	75953	1686	2008371	26.4
	Co-60	1048337		27974780	26.7
Mean Cs dpm/100 cm^2			4786	Mean Ratio	26.6

The gross beta-gamma DCGL for structures based on the established nuclide fraction and conditions stated in DTBD 05-015 is 43,000 dpm/100 cm^2. Applying the area factor for a 1 m^2 area of 14.9 results in a DCGLemc of 640,700 dpm/100 cm^2. The apparent geometry correction factor for a 1 m^2 elevated area at the edge of the detector field of view of 28 m^2 is 26.6 as shown above. Dividing the DCGLemc value by the geometry factor gives an Investigation Criterion of 24,000 dpm/100 cm^2 or 1.08E+6 pCi/m^2 or 3.04e+7 pCi in a 28 m^2 field of view circular plane geometry. This means that as long as the in situ gamma spectroscopy result does not exceed 24,000 dpm/100 cm^2, there cannot be an undetected elevated area within the field of view of 1 m^2 which exceeds the DCGLemc. Any analytical result greater than the Investigation Criterion would require further evaluation to ensure compliance with the EMC criterion. Investigation measures include, but are not limited to, performing additional surveys using reduced source to detector distances, scanning with 2" by 2" NaI detectors, collecting volumetric samples, or other appropriate measures to detect small, elevated areas within the original FOV.

The data (Table 2) also indicate that the typical concrete surface MDAs for a 1200 second count of 1318 dpm/100 cm^2 for Cs-137 and 562 dpm/100 cm^2 for Co-60 are a small fraction of the surface DCGL of 43,000 dpm/100 cm^2.

Table 2. Concrete Surface 28 m^2 FOV MDA Values

Sample #	Cs MDA (pCi/m^2)	Co MDA (pCi/m^2)
CRC002	66400	23500
CRC003	64900	30300
CRC004	84700	35200
CRC005	60900	26800
CRC006	66600	25800
CRC007	50600	27900
CRC008	49800	20200

CRC009	47900	25000
CRC010	53600	27300
CRC011	56300	26200
CRC012	61800	21900
CRC013	74800	32900
CRC014	54600	18300
CRC015	50900	18100
CRC016	41100	20100
CRC017	52900	17900
CRC018	66500	28800
CRC019	64300	29500
Mean	59397	25317
dpm/100 cm^2	1318	562

Soils have been surveyed using in situ gamma spectroscopy with a geometry that evaluates soil activity to a depth of 15 cm over the detector FOV. Soil Investigation Criteria have been determined (Table 3) in a manner similar to that used for structures. The one square meter $DCGL_{EMC}$ for Cs-137 would be 596 pCi/g for a DCGL of 52.8 pCi/g and an area factor of 11.3 and for Co-60 would be 148 pCi/g for a DCGL of 12.6 pCi/g and an area factor of 11.8. The Investigation Criterion for Cs-137 is 23.6 pCi/g and for Co-60 is 5.7 pCi/g. The MDAs achievable are on the order of 0.15 pCi/g for Cs-137 and Co-60 which is more than adequate for the soil DCGLs at RSNGS. Investigation Criteria are established to ensure the $DCGL_{EMC}$ will not go undetected in a small elevated area at the edge of the FOV. Given the MDAs and Investigation Criteria for soil, final surveys can be performed on soil with a Type 1 error of 0.05 using in situ gamma spectroscopy for scans.

Table 3. Soil Geometry Comparison

Sample #	Nuclide	28 m^2 source in 28 m^2 FOV Geometry (pCi/g)	1 m^2 source in 28 m^2 FOV Geometry (pCi/g)	Ratio (Small to Large)
S3M005	Cs-137	0.376	9.517	25.31
	Co-60	<0.220	<5.71	25.95
S3M006	Cs-137	0.480	12.155	25.32
	Co-60	<0.152	<3.93	25.86
S3M007	Cs-137	0.310	7.842	25.30
	Co-60	<0.129	<3.35	25.97
S3M008	Cs-137	0.288	7.298	25.34
	Co-60	<0.143	<3.71	25.94
S3M009	Cs-137	0.319	8.072	25.30
	Co-60	<0.148	<3.84	25.95
S3M010	Cs-137	<0.167	Obtained as a	background

	Co-60	<0.138	count	
S3M011	Cs-137	<0.143	3.624	25.34
	Co-60	<0.142	<3.68	25.92
S3M012	Cs-137	0.431	10.923	25.34
	Co-60	<0.137	<3.55	25.91
S3M013	Cs-137	0.411	10.412	25.33
	Co-60	<0.153	<3.96	25.88
S3M014	Cs-137	0.273	6.910	25.31
	Co-60	<0.142	<3.68	25.92
S3M015	Cs-137	0.468	11.841	25.30
	Co-60	<0.135	<3.49	25.85
S3M017	Cs-137	0.554	14.018	25.30
	Co-60	<0.148	<3.84	25.95
S3M018	Cs-137	0.372	9.416	25.31
	Co-60	<0.161	<4.18	25.96
S3M019	Cs-137	0.376	9.527	25.34
	Co-60	<0.176	<4.55	25.85
S3M020	Cs-137	0.435	10.022	25.34
	Co-60	<0.147	<3.81	25.92
Mean	Cs-137			25.3
	Co-60			25.9

As demonstrated above, in situ gamma spectroscopy can be employed for performing final surveys with adequate sensitivity of analysis. For uses not specifically described in this DTBD, a specific geometry (approved per DSIP 0530) must be created, source to detector distances, use of collimation and count times or required MDC must be specified to ensure DQOs are met. When scanning, the MDC achieved must be shown to be less than the $DCGL_{EMC}$ value for the survey unit. Since MDCs similar to those achieved with lab instrumentation can be met with reasonable count times, as long as the correct number of measurements are taken and any adjustment for EMC criteria has been made, use of in situ gamma spectroscopy should be able to achieve Type I and II errors of 0.05. The use of Investigation Criteria ensure that small, elevated areas of activity within the detector field of view will not go undetected or investigated.

7.0 References

7.1 DTBD 05-015, "Structure Nuclide Fractions and DCGLs".

7.2 DTBD 05-014, "Soil Nuclide Fractions and DCGLs".

7.3 DSIP 0530, "Operation of the ISOCS Portable Gamma Spectroscopy System".

8.0 Attachments

8.1 ISOCS Detector Characterization

8.2 Concrete Surface Measurements for Determination of Investigation Criteria

8.3 Soil Measurements for Determination of Investigation Criteria

9.0 RESPONSIBLE INDIVIDUAL

George Pillsbury