SAFETY EVALUATION BY OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

RELATED TO FINAL STATUS SURVEYS FOR

CAISSON SURVEY UNITS NOL01-09/NOL01-09-FSR

FACILITY OPERATING LICENSE NO. DPR-7

PACIFIC GAS AND ELECTRIC COMPANY

HUMBOLDT BAY POWER PLANT UNIT 3

DOCKET NO. 50-133

1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed Final Status Survey Reports (FSSR) for "two" survey units designated by the licensee as NOL01-09 and NOL01-09-FSR as provided by letter dated April 1, 2020 (Agencywide Documents Access and Management System [ADAMS] accession number ML20092M643). The survey units were established to represent the Caisson removal excavation footprint (NOL01-09) and the Final Site Restoration of the Caisson removal footprint (NOL01-09-FSR). The licensee's Final Status Survey (FSS) design criteria, implementation of the Data Quality Objectives (DQOs) process, and survey approach/methods were reviewed by the NRC staff. For each survey unit, the NRC staff assessed the final results against the licensee's release criteria from the approved Humboldt Bay License Termination Plan (LTP) (the LTP approved at the time of the initial submittal of the FSSRs can be found at ADAMS Accession No. ML18066A137 while concurrent modifications to the LTP during this FSSR review can found at ADAMS Accession Nos. ML21039A515 and ML21140A395). The NRC staff considered all evaluated portions of the two survey units as a combined survey unit needing to meet the unrestricted release criteria of Title 10 of the *Code of Federal Regulations* (10 CFR) 20.1402. The NRC staff consider the residual radioactivity in the survey unit to meet the release criteria, if the most conservative portion of each feature (e.g., soil feature, surface feature, etc.) in the survey unit, when summed, demonstrate compliance with the Derived Concentration Guideline Level (DCGL) which conservatively assumes all soil is surface soil. The NRC staff's analysis is provided below.

2.0 EVALUATION

NOL01-09 (Caisson Excavation footprint)

The survey unit designated as NOL01-09 was classified by the licensee as a Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 1 unit and is described as an approximately 884 m^2 area. The licensee describes the survey unit as an area that resulted from excavation of below grade sections of the Refuel Building. The footprint of this survey unit formerly included the dry well and liner; activated concrete around the core region; embedded piping systems and associated drains; suppression chamber and remaining downcomer piping; spent fuel pool (SFP) walls, sheet piles around the SFP; timber piles, access shaft, radwaste and off-gas tunnels; emergency escape hatch; valve gallery and associated piping systems; and sumps and concrete tremie seals. The survey of the excavation footprint encompassed the bottom of the excavation. The license surveyed the dewatering wells at a previous time.

However, the license did assess these survey results collectively for this survey unit. Survey unit NOL-09 is bounded on all sides by the Cutter Soil Mix (CSM) wall with the exception of the West side which is bounded by survey unit OOL03-02. Because the CSM wall was created using a mixture of slightly contaminated soil, a dose contribution from that matrix was also included in the assessment of this survey unit.

Soil/Land Area

The LTP requires that the licensee perform a gamma walkover scan on 100% of Class 1 areas for the FSS. The licensee believes it met this requirement for NOL01-09 because it performed this type of scan on approximately 100% of the area within the survey unit. The NRC staff consider this scan coverage to represent a reasonable effort to meet the Class 1 scan coverage LTP requirements and is consistent with MARSSIM recommendations for scan coverage in Class 1 areas.

The licensee reviewed characterization and remediation survey data to identify the radionuclides of concern (ROCs) that must be included in the survey for survey unit NOL01-09 (i.e., the ROCs that are not “insignificant radionuclides”). Radionuclides Am-241, C-14, Co-60, Cs-137, Eu-152, Eu-154, and Sr-90 were determined by the licensee to be the radionuclides that could potentially be present for this survey unit with Co-60 and Cs-137 being the most prevalent. The licensee determined by applying the DQOs process approved in the LTP that there was insufficient characterization data to support a position that hard to detect (HTD) radionuclides were not present at significant levels (i.e., >10% of the release criteria). Therefore, the licensee determined for this survey unit that samples designated to be used for statistical analysis would be analyzed for the full suite of HTD nuclides. In addition, two samples would be randomly selected for split sample analysis. These split samples would be analyzed for all site ROCs at an off-site laboratory with the exception of Sr-90 and H-3, which were conducted on-site. For practical purposes, the licensee eventually reported the analytical results of all site ROCs for this survey unit for each sample.

The NRC staff reviewed the licensee’s sample analysis results and verified that no ROCs other than Co-60 or Cs-137 were present at concentrations greater than the minimum detectable concentration (MDC). However, a few ROCs other than Cs-137 and Co-60 were detected at concentrations greater than the MDC in split samples analyzed by Oak Ridge Institute of Science and Education (ORISE, an NRC independent contractor) during a confirmatory survey. The ORISE confirmatory survey (ADAMS Accession No. ML18100A014), involved a scan of the excavation footprint and collection of three investigative samples. These investigative samples were split with the licensee who similarly analyzed the samples for comparison. Trace levels of various transuranic nuclides and tritium were detected in the ORISE samples but the sum-of-fractions (SOF) determination for these samples did not exceed 0.36, which meets the licensee’s criteria for decommissioning. However, it was noted by ORISE that contamination in at least one sample was likely due to a discrete particle instead of diffuse radioactive contamination. In the licensee’s analysis of the split samples, it noted that “Am-241, Eu-152, Eu-154, C-14, and Sr-90 were identified in a commodity removed from an investigation sample,” and “that a discrete anomaly totaling approximately 0.03 uCi was removed from sample NOL-01-09-020-F-I during preparation.” NRC staff confirmed the commodity discussed is the discrete particle initially identified by ORISE and discussed further below.

During clarification calls between the NRC staff and the licensee, the licensee explained that the reason that the ORISE sample results identified trace levels of some radionuclides while the licensee's sample results did not is because the respective laboratories did not utilize the same methods. The licensee stated that it was for this reason that ORISE was able to achieve MDC's of almost an order of magnitude less than what was required of the licensee. The NRC staff consider this a reasonable explanation and the MDCs achieved by the licensee were consistent with commitments in the LTP (≤ 50% of the DCGL per Section 5.5.3 of the LTP). NRC staff also note that the HTD ROCs were also evaluated in these survey units (even when results were less than the MDC) consistent with MARSSIM and NRC guidance.

With respect to the discrete particle identified by the licensee, the licensee responded to Request for Additional Information (RAI) 3 (ADAMS Accession No. ML21165A092) explaining that a discrete particle was remediated and disposed as waste when encountered. The licensee stated that the particle was removed from the sample prior to processing in order for the sample analysis to be comparable to the ORISE split sample (NRC staff note that the particle was assessed separately from the sample). The licensee said it felt that addressing this situation by simply removing discrete particles when encountered was appropriate and that no particles were known to be present at the time of the FSS (i.e., that this is a stand-alone anomaly). The licensee verbally explained that it was possible that the particle was generated after the licensee did the initial scanning for release of the survey unit during remediation of one of the wells in the excavation. While the licensee did scan after the remediation of the well (the dewatering wells are discussed later), the sample containing the particle was not immediately adjacent to the well area. Also, the licensee scanned the entire excavation area along with ORISE during the confirmatory survey and did not identify any additional discrete particles. The licensee stated that it is very unlikely that additional particles are present in this survey unit. The NRC staff find the licensee's explanation sufficient, in this case, because staff do not believe there is a strong likelihood of discrete particles remaining in the area of significant activity that would justify additional surveys/remediation of materials now approximately 80 feet beneath the ground surface and which should pose negligible future public risk. While the licensee's scanning survey after the well remediation was insufficient as demonstrated by the discrete particle miss, the confirmatory survey identified only this one area where a "miss" occurred and it was addressed at that time by inclusion in sampling and subsequent disposal as waste.

Based on previous survey data (documented in Table 1.3 of the FSSR) and using Type 1 and Type 2 error rates of 0.05 for, the licensee determined that 15 samples were required consistent with Table 5-5 of MARSSIM. These 15 samples were systematically laid out consistent with MARSSIM in a triangular pattern with a randomized start. Samples were collected from 0" to 6" depth and analyzed for the radionuclides discussed previously (all ROCs consistent with Table 6.4 of the LTP). The NRC staff noted that the licensee did not initially report on all ROCs established in Table 6.4 of the LTP and multiple RAIs and the licensee's responses on this subject occurred and are available in ADAMS with all pertinent data eventually being submitted. In response to RAI (ADAMS Accession No. ML21063A474), Table 9, the licensee provided all analytical results for all ROCs in the statistical samples for this land feature. It is worth noting that the FSSR hypothetical dose estimate for this survey unit initially presented to the NRC by the licensee from these sample results was 2.69 mrem/y while the dose predicted using all data provided in response to RAIs was later estimated at 2.33 mrem/y. This occurred because the

licensee incorrectly used negative average concentrations for some ROCs to assess hypothetical exposures and more negative data was included in the later estimate. This approach is not accepted by the NRC staff. The NRC staff independently assessed the hypothetical exposure and, when disregarding the negative average ROC contributions, calculated a hypothetical exposure of 3.28 mrem/y.

The licensee's survey results indicated none of the soil samples collected for non-parametric statistical testing contained significant residual radioactivity (i.e., all were <20% of the DCGLs). The same is true of investigative samples obtained in the survey unit. No soil samples triggered an investigation. Because no single sample exceeded a SOF of 1, the statistical test (i.e., Sign Test) was not required. As such, the licensee acknowledged that the Sign Test was performed (by inspection) on the data and compared to the original assumptions of the DQOs, and that "performing the test is unnecessary as it is passed by inspection." This statement remains accurate even when considering all the ROC data in Table 9 of the RAI response.

While the NRC staff agree with the licensee that the survey unit passes by inspection, staff noted that the licensee used negative average values when determining a final SOF value for the survey unit. As previously noted, NRC staff consider it inappropriate to use negative values in this fashion because SOF values are essentially comparisons to a dose-based criteria and negative values would correlate to a negative exposure/dose which is not realistic. When this issue was raised with the licensee, the licensee stated it was consistent with guidance to use all values, positive or negative, to assess a survey unit and that negative values were an expected occurrence when a radionuclide is either not present or present at levels very close to background. Staff somewhat agree in that it is expected that negative values would be part of the data set used for statistical comparisons. Also, the average survey unit concentration is typically calculated using all measurements, including both positive and negative results. However, if a negative average concentration value is derived, the NRC staff do not think it is appropriate to use this negative concentration to calculate a negative hypothetical dose and compare it to a dose-based criteria; instead it should be zeroed out so that it does not imply a negative exposure. NRC staff note that doing so had relatively negligible effects in this case (an increase of less than 1 mrem/y hypothetical dose).

Dewatering Wells

Four dewatering wells were present in the footprint of Survey Unit NOL01-09 and were evaluated separately from the soil in the survey unit. These wells were designated as the Northeast (NE) well (the NE well had to be remediated prior to survey), the Southeast well, the Southwest well and the Northwest well. After the NE well dewatering pump stopped operating, surface water was directed into this well. Elevated radiation levels were subsequently detected near the NE well casing. The licensee concluded that elevated measurements were due to contaminated material inside the well. Approximately 10 feet of sludge was found above the pump in the NE well, which was assumed to have accumulated after the pump failure occurred. The licensee stated that the material in the sludge consisted of concrete dust that was suspended in water and which had an extremely small particle size. The sludge was removed from the well; however, residual contamination remained within the gravel pack surrounding the well casing. The licensee stated that this material is located at a depth of approximately 100 feet below the surface after site remediation. Except for the NE well, no contamination was identified in the other wells and they were subsequently closed consistent with county requirements and not considered further. The dose contribution of soil and sediment surrounding the NE Well is described in a document titled "NE Caisson Dewatering Well

Assessment, Calculation NX-203," (ADAMS Accession Nos. ML21165A116 and ML21165A117). The NRC staff requested clarification on this document and that the dose contribution be recalculated and provided in response to RAI-7 (ADAMS Accession No. ML21063A474). The NRC staff's evaluation of the NE well dose focuses on the information in response to RAIs.

As previously stated, contamination was found inside the NE Well. The licensee reported that the pea gravel in the gravel pack prevented the migration of the concrete fines out into the surrounding soil which caused the gravel pack to plug and for sludge to build up in the well casing itself. The licensee discounted the probability of a non-homogeneous distribution of contaminated material within the gravel pack based on the extremely small particle size of the concrete dust suspended in the water discharged to the NE well casing.

The licensee analyzed two samples of the residual material from the well: a sample collected from the bottom of the well after pump removal and a composite sample collected from the sediment dewatering box upon source term remediation. The activity in the sample taken from the bottom of the well was dominated by Cs-137 (Case 1) and the activity in the composite sample was dominated by Eu-152 (Case 2). The licensee also measured the exposure rate inside the well using a Sodium Iodide (NaI) gamma pipe detector. The maximum observed exposure rate was 16.3 µR/hr at about the -10' elevation in the well.

The licensee used MicroShield to calculate projected exposure rates in the well based on the isotopic mixtures observed in the two samples. The licensee claimed these calculations accounted for shielding from the gravel and moisture. The calculated exposure rates were 81 µR/hr and 80 µR/hr for Case 1 and Case 2, respectively. Because the measured exposure rate was equal to 20% of the calculated exposure rate, it was assumed that the overall concentrations of the radionuclides in the gravel pack were equal to 20% of the concentrations in the sludge samples.

The licensee evaluated the dose from the material in the gravel pack using the standard MARSSIM equation for elevated measurements using the area factors associated with a 1 m^2 elevated area. This approach assumes that the contaminated material is at the surface, though this material is actually located about 100 feet below final grade. Elevated area doses were calculated for both the Case 1 and Case 2 mixtures and the resulting doses were 4.42 mrem/yr and 3.14 mrem/yr respectively (HBL-20-001). The licensee concluded that the radionuclide mixture observed in the Case 2 sample was more representative of the contaminated material remaining in the gravel pack because: the ratio of Cs to Eu in that sample was more in line with the Cs to Eu ratios observed in the original sludge samples and because the Case 1 sample was only a grab sample from the bottom of the well casing which may have been from a time prior to residual radioactivity build up in the gravel pack.

The licensee ultimately assigned a potential dose value of 3.13 mrem/y from the material remaining in and surrounding the NE well. The NRC staff concluded that the methodology used by the licensee to calculate the dose from the elevated area using previously approved area factors is acceptable, in this case, because it is consistent with guidance in MARSSIM. In addition, the approach of calculating the dose from residual radioactivity in the well using the MARSSIM equation for elevated areas is conservative because that equation assumes that the material is located at the surface, and the residual radioactivity in the well is located approximately 100 feet below the final grade in this area. This limits the potential exposure of an individual to the material and the material located between the contaminated material and the surface provides shielding that would greatly reduce any potential *in situ* external dose. The

NRC staff concluded that the most likely exposure scenario for this material would be an individual who drills a well or otherwise digs into the contaminated material and brings it to the surface. If the material with residual radioactivity is brought to the surface, the material would be mixed with a significant amount of the material above it, which would result in the dilution of the residual radioactivity. For these reasons, the NRC staff concludes that the approach used by the licensee to estimate the dose from the well is acceptable and the approach would result in a projected dose that bounds a potential future dose.

The NRC staff agrees with the licensee that the composite sample taken from the material located in the sediment dewatering box after well remediation would provide the best representation of the radionuclide mixture present in the gravel pack for the well given that the composite sample was taken from the bulk material remaining in the well. Additionally, the highest dose rates in the well were observed at a location above the location of the pump. The NRC staff further agrees that the small particle size of the material in the sludge makes it much more likely that the overall concentration of the residual contamination in the gravel pack for the well is relatively homogeneous. However, the NRC staff does think that there is still some possibility of the concentration in the gravel pack having some heterogeneity and that there is a possibility that the concentration at some locations could exceed the concentration assumed in the dose assessment for the residual contamination in the gravel pack. However, as described below, dose evaluations performed by the licensee and independent calculations by the NRC estimated that the projected dose from the material in the well will remain acceptable even if the concentrations are higher than assumed.

The NRC staff performed independent calculations of the potential dose for both the Case 1 and Case 2 radionuclide mixtures and obtained comparable results as the licensee. Additionally, the NRC staff performed independent calculations of the potential dose based on the measured concentrations in the Case 1 and Case 2 samples without applying the factor of 0.20 to the concentrations (i.e., without any assumed mixing with the gravel in the gravel pack). In both cases, the results were still less than 25 mrem/yr. These results indicate that even if there are areas with higher concentrations of sludge, the potential dose is expected to still be acceptable. Even if using all of the ROC data (provided in response to RAI, ADAMS Accession No. ML21063A474, Table 12), NRC staff were able to independently calculate the hypothetical dose for the well to be 3.13 mrem/y, the same as the licensee. Additionally, these calculations do not take credit for the depth of the material below the ground surface and credit is not taken for the dilution of the residual radioactivity with material located above it that is expected to occur if the material is brought to the surface and the resulting decrease in the projected dose. For these reasons, the NRC staff concludes that the dose calculations performed by the licensee for the NE well are adequate to demonstrate that the potential dose from the residual radioactivity is consistent with the NRC criteria of 25 mrem/yr in 10 CFR 20.1402.

Also associated with the wells is the fact that the licensee assessed surface contamination in the abandoned well casings. Based on its survey, the licensee determined that a potential exposure from contaminated piping would be 0.01 mrem/y. This value is added to the previously discussed evaluation to derive a total potential dose contribution from the wells and surrounding residual radioactivity of 3.14 mrem/y. The NRC staff notes that the licensee did not provide the survey data for the well casings. The NRC staff considered that the remaining well casing is abandoned significantly below final site grade and the likelihood of it impacting future site occupants is negligible compared to the surrounding residual radioactivity that was otherwise considered. As such, staff did not request the surveys which the licensee performed of the well casing.

CSM Wall

The licensee considered dose contribution from the CSM wall, essentially another land feature, in the NOL01-09 survey unit. The CSM wall encircles survey unit NOL01-09 similar to walls of a "tube" with the excavation footprint at the base of the tube. The footprint of survey unit NOL01-09-FSR incorporates both the footprint of survey unit NOL01-09 (after site restoration) and the CSM wall footprint. The CSM wall soil was characterized prior to the wall being constructed using a mixture of concrete, bentonite clay, and soil from the CSM wall footprint. The characterization results of eleven approximately eighty-foot-deep borings from the CSM wall footprint were presented in the FSSR in Table 1.1. Soil from each boring was composited and analyzed for plant related radionuclides except for HTD radionuclides (with the exception of H-3 and Sr-90 which were included in most sample analysis). The licensee noted that only Cs-137 was detected in the CSM wall at concentrations greater than the MDC from these analyses. One sample was analyzed for the full suite of HTD radionuclides although the data was not presented in the FSSR. The NRC staff questioned why not all ROCs were reported in the original summary table and, in Table 3 of the response to RAIs (Adams Accession No. ML21063A474), the licensee revised its characterization data table for the CSM wall to include seven easy to detect (ETD) ROCs and disregard the previously supplied partial data sets for select HTD ROCs. It also revised its estimate of the hypothetical dose from the reported ROCs from 1.4 mrem/y in the original FSSR to 1.18 mrem/y again using negative average data to improperly assign a negative hypothetical exposure for some ROCs. When disregarding the negative average concentrations, the hypothetical exposure remains unchanged at 1.4 mrem/y. The licensee noted that this should be relatively conservative as approximately half of the wall volume was displaced by the concrete and clays used to create the wall structure. Again, it is noted that the wall characterization data was collected prior to wall being constructed.

NRC staff again note that the seven reported ROCs were only a partial data set of the site ROCs. It is presumed that the licensee anticipated accounting for the HTD ROCs in accordance with the position paper provided in the same submittal; however, this would still leave one HTD ROC (C-14) not accounted for. In the position paper, the licensee states that "C-14 was not considered a potential radionuclide of concern outside the Reactor Caisson survey unit because it is implausible that neutron activated concrete would be present in any other survey unit." NRC staff noted that the average C-14 concentration in Survey Unit NOL01-09 (the Caisson Excavation) is 0.0422 pCi/g and contributed only 0.2 mrem/y to the hypothetical exposure while the site average concentration of C-14 was negative in value. Because the CSM Wall is evaluated as part of the Caisson survey unit, NRC staff consider it reasonably conservative to consider C-14 contributions consistent with that found in the Caisson excavation. The remaining HTD ROCs would either contribute 0.187 mrem/y, consistent with Table 5 of the position paper, or at most 2.9 mrem/y as per Table 8 of the position paper. In this case, NRC staff believe it appropriate to conservatively bound the concentrations and potential impact of residual radioactivity in the CSM Wall to 4.5 mrem/y (1.4 mrem/y from ETD ROCs as documented in Table 3 of HBL-21-002, 2.9 mrem/y from HTD ROCs as documented in Table 8 of the position paper [Attachment 1 to HBL-21-002], and 0.2 mrem/y from C-14 as documented in Table 9 of HBL-21-002).

The NRC staff agree with the licensee that the concentrations provided in Table 3 and NRC staff's estimates to bound the concentrations of HTD radionuclides likely results in a bounding estimate for potential exposure because the average concentration of residual radioactivity in the wall is likely overestimated due to dilution of the soil with concrete and clay during wall construction and because the DCGLs being applied are also conservative as they were not

developed with consideration of the unique characteristics of the wall with regards to size, shape, and permeability. It is also noted that the licensee maintains that the Quality Control (QC) sample indicated no radionuclides other than Cs-137 were present at concentrations greater than the MDC. Regardless, the NRC staff concluded that the licensee should have considered the contribution from all ROCs as committed to in the LTP for this land feature and that, doing so, would have relatively minimal impact. As such, the NRC staff consider that an estimated CSM wall hypothetical dose contribution of 4.5 mrem/y, would likely be bounding for this land feature and should be used to demonstrate compliance with the 25 mrem/y unrestricted release criterion.

Groundwater

While ingestion of contaminated groundwater was identified as a pathway of concern for the average member of the critical group in the LTP, it was not addressed in the original FSSR submittal other than the fact that ingestion of groundwater was considered in the development of the DCGLs. In response to RAI 1 (ADAMS Accession No. ML20247J598), the licensee provided groundwater monitoring results from 2015, 2016, and 2017, three years during which the licensee maintains groundwater was most likely to have been impacted due to decommissioning work. Groundwater well monitoring was discontinued in accordance with the LTP during the site decommissioning due to various construction type activities occurring which made maintaining the wells impractical.

Based on the reported groundwater sample results, none of the wells sampled during this period demonstrated detectable contamination for Co-60, Cs-137, or H-3. The licensee also monitored for gross alpha and beta activity during this period and some detectable alpha activity was reported in 2015 while detectable beta activity was sporadic, although mostly not detectable, in wells during the 2015-2017 period. The NRC staff reviewed the reported MDC values and noted that the MDCs for Co-60, Cs-137, and H-3 were typically around 5 pCi/L, 5 pCi/L, and 300 pCi/L, respectively. Conservatively assuming these concentrations in groundwater, the staff compared these MDC values to the respective liquid effluent concentration values in 10 CFR 20, Appendix B, Table 2 to derive an estimated potential exposure of less than 1 mrem/y from residual radioactivity in groundwater. While the groundwater monitoring results were not encompassing of all the ROCs for the site, NRC staff consider it adequate to conservatively assume the identified radionuclides are present at the typical MDC value because gross alpha/beta results were not indicative of any significant activity exceeding the MDC values or “missed” ROCs.

Also, while the NRC staff agree with the licensee that it is unlikely ingestion of contaminated groundwater at the site would occur due to tidal basin flow affecting groundwater potability and limited impact of past plant operations to the available drinking water aquifers, staff consider it is reasonably conservative to assume some contaminated groundwater could be present and ingested by future site occupants because the licensee did not justify disregarding this potential pathway in its LTP. As such, NRC staff find it reasonable to conservatively bound a hypothetical dose contribution through ingestion of existing residual radioactivity in groundwater equivalent to the typical MDC values and corresponding to 1 mrem/y even though this was not addressed by the licensee in its FSSR.

NOL01-09-FSR (Final Site Restoration Survey)

The survey unit designated as NOL01-09-FSR consists of the excavation footprint (NOL01-09) as well as the footprint of the CSM wall which surrounded the excavation after being backfilled with reuse material. The total footprint was 1,351 m^2 in area which meets the MARSSIM limitation for Class 1 survey unit area. The survey was conducted after placing soil and rubble generated from the excavation of Class 1 areas but before the addition of 2 feet of clean fill material used to bring the entirety of the area to grade. The survey was essentially of the surface of the backfill material used to bring the excavation up to within the final 2' of grade.

The material used to backfill the excavation was previously removed from Class 1 areas and assessed by the Licensee's GARDIAN system which is a large container gamma spectroscopy measurement system. While the system was acknowledged as occasionally allowing contaminated discrete material through without being detected (contaminated concrete is specifically noted in the FSSR), the licensee amended its process to include spreading assessed material in a laydown area and then scanning by hand to identify and remove any commodities (discrete contaminated materials).

Top of Backfill

The licensee's LTP requires 100% of Class 1 areas to receive gamma walkover scan coverage during FSS, and the scan survey completed for NOL01-09-FSR was performed over approximately 100% of the area. This coverage is consistent with MARSSIM recommendations for scan coverage in Class 1 areas.

The licensee determined through its DQOs process that Cs-137 and Co-60 were the only nuclides that could potentially be present in the surface of the backfilled material based on characterization data with Cs-137 being the primary contaminant of concern due to its longer half-life (30.17 years). The licensee utilized the scaled DCGL for Cs-137 (7.65 pCi/g) as the criteria for the survey unit. The licensee determined the required number of soil samples using a Type 1 and Type 2 error of 0.05 and a relative shift of 2. The required number of samples was 15 consistent with Table 5.5 of MARSSIM, and the licensee obtained 15 soil samples based on a randomized start and triangular grid spacing. A scan investigation was established for anything detectable above background. These investigation levels are consistent with investigation levels described in Table 5-5 of the licensee's LTP, and consistent with Table 5.8 of MARSSIM.

In addition to gamma measurements, the licensee performed analyses for HTD radionuclides on 2 randomly selected samples from the survey unit, which included alpha spectroscopy, gas proportional counting, and liquid scintillation depending on the radionuclide and the measurement method. This frequency of HTD analyses is consistent with guidance from MARSSIM Section 4.3.2.

The licensee's survey results indicated that Cs-137 was the only site ROC identified above the detection limit in soil samples collected for non-parametric statistical testing with the maximum value being less than 1% of the Cs-137 DCGL, and neither of the 2 HTD samples identified ROCs at concentrations exceeding the MDC. No soil samples triggered an investigation. Because no sample exceeded the DCGL, the statistical test (i.e., Sign Test) was not required. The licensee acknowledged that the Sign Test was performed (by inspection) on the data and compared to the original assumptions of the DQOs, and that "performing the test is unnecessary as it is passed by inspection."

The licensee reported in Table 4.2 of the FSSR that the average Cs-137 in survey unit NOL-01-09-FSR is 0.0262 pCi/g, corresponding to 0.08 mrem/y. The NRC staff independently verified this result from the Cs-137 data provided in Table 3.3 of the FSSR. However, the NRC staff recognized that Cs-137 alone (Cs-137 is only one of 21 ROCs for the site) is not adequate for the survey and is inconsistent with Table 6.4 of the LTP which identifies the ROCs for the site. The licensee states in the FSSR that none of the initially unaddressed ROCs were detected in any of the samples collected and the mean concentrations of the unaddressed ROCs were primarily negative with only two having means slightly elevated above zero but still less than the MDC. The NRC staff questioned this situation and considered the information provided in response to RAIs (ADAMS Accession No ML21063A474) and find that both the deselected ETD ROCs included in Table 4 of the response to RAIs and the deselected HTD ROCs would be bounded by the data in Table 8 of the response to RAIs (2.9 mrem/y potential dose summed with a C-14 dose of 0.2 mrem/y as previously discussed for the CSM Wall) when summed with the Cs-137 dose of 0.1 mrem/y, in total. As such, the NRC staff find it reasonably conservative to bound the survey unit NOL01-09-FSR (top layer of soil) as having a hypothetical dose impact of 3.2 mrem/y because the licensee did not appropriately consider all site ROCs in its estimate of 0.08 mrem/y.

Bulk of Backfill Material

The NRC staff questioned the representativeness of the backfill material being surveyed. The survey of NOL01-09-FSR essentially represented only the surface of an approximately 80’ depth of material. In response to RAI-4 (ADAMS Accession No. ML21165A092), the licensee clarified that it had run all material through the GARDIAN system which was a bulk material measuring system. About 1/3 of the material had come from the Caisson excavation with the remainder coming from the reuse storage area of the discharge canal. In their response, the licensee stated:

- Of 1,435 truckloads of caisson material scanned (constituting about 1/3 of the backfill material for the caisson excavation), 138 indicated positive Cs-137 results
- The average Cs-137 indicated concentration for the positive results was 0.66 pCi/g
- The maximum Cs-137 positive result was 2.71 pCi/g
- The average Cs-137 MDC for the 1,297 truckloads with no positive results was 0.31 pCi/g
- The average concentration using both positive results and MDCs for Cs-137 was about 0.35 pCi/g
- Although there were about 4 or 5 positive results in the 1,435 truckloads for Co-60, these were in the same range as the MDA values of about 0.25 pCi/g
- The sum of fractions (SOF) for Cs-137 and Co-60 using MDC and positive results for the caisson excavated material indicates about 11 percent of a DCGL (SOF of 0.11)

The remainder of fill material was pulled from the reuse storage area of the discharge canal. This remaining backfill material is the same material that was used to complete the backfill of the trailer city area and final elevation of the discharge canal area.

- From a review of the analytical sampling of this backfill material from these areas, an MDC of approximately 0.1 pCi/g for Cs-137 was estimated. This value would be indicative of the remainder of the reuse material used to complete the backfill of the CSM wall excavation.

- It would also be expected that a majority of the non-positive GARDIAN results would have similar analytical MDC results of less than the 0.31 pCi/g observed through the GARDIAN systems.
- Although MARSSIM and the LTP do not require HTD samples for reuse material, HTD data from the trailer city and discharge areas for samples sent for analysis indicated no positive values above the laboratory's detection limit. Deselection of the HTD isotopes would indicate less than a possible additional 10 percent of a DCGL.

It is NRC staff's understanding that, while the surface of the backfill material meets the release criteria at a fraction of the DCGL (a SOF of 0.003 or 0.083 mrem/y due to Cs-137 alone), the majority of the backfill material was not adequately characterized by means of sampling for all ROCs. As such, the NRC staff have to consider the information provided by the licensee in response to RAI as being more representative of the majority of the backfill material which is conservatively assumed to have a SOF value of 0.24 (a hypothetical dose contribution of 5.95 mrem/y based on a SOF of 0.11 from Cs-137 and Co-60 [from bullet #7 above] summed with a SOF of 0.12 from HTD ROCs [from Table 8 of the position paper] and a contribution from C-14 of 0.2 mrem/y as described previously in the CSM Wall evaluation). NRC staff find this should conservatively bound both the detected Cs-137 and Co-60 and the hypothetical dose contribution from the remaining ROCs which were not detected at concentrations above the MDC in the soil.

3.0 CONCLUSION

The NRC staff concludes that the survey data presented in the FSSRs and RAI responses for survey units NOL01-09 (Caisson Excavation) and NOL01-09-FSR (Caisson Final Status Remediation) are adequate but the licensee's explanation of how it evaluated them against the LTP requirements is unclear in many aspects. In the initial reports submitted with the application, the licensee did not provide its evaluation of the data to estimate the potential residual radioactivity in groundwater, the bulk of the backfill material, nor all of the ROCs for the site. Also, the deselection process of ROCs was inconsistent with that described in the LTP which resulted in the licensee amending its LTP with regards to the process for deselecting and accounting for inconsequential site ROCs. While response to RAIs did result in sufficient data, in the NRC staff's opinion, to provide reasonable assurance that the licensee demonstrated compliance with the unrestricted release criteria of 10 CFR 20.1402 (25 mrem/y). The NRC staff found it necessary to separately address each feature that was considered and then selectively sum the most conservative elements to bound the hypothetical exposure likely to occur. The following table shows the NRC staff's consideration of potential dose to future site occupants vs the licensee's evaluation. The NRC staff's review resulted in five comments for the licensee to consider as additional FSSs are completed. These comments are presented in the following section.

Summary of Staff vs Licensee evaluation of
combined survey units NOL01-09 and NOL01-09-FSR

Media	Description	Licensee's estimate of potential dose (mrem/y)	NRC staff's estimate of potential dose (mrem/y)	Explanation for the Difference between Estimated potential dose
Soil	NOL01-09 soil samples	2.33	3.28	Licensee used negative average concentration-based values in determining SOF
	NOL01-09-FSR soil samples	0.18	3.2	Licensee used negative avg conc. values + NRC used bounding HTD ROC dose
	Fill material estimates (not surface)	n/a	5.25	NRC considered fill material + bounding HTD ROC contribution, not considered by licensee
	CSM Wall	1.4/1.18	4.5	Licensee used negative avg. conc. values; NRC staff used bounding HTD contribution + C-14 contribution
Soil Elevated Area	NE Well elevated area	3.13	3.13	
Surfaces	Well casing	0.01	0.01	
Groundwater		n/a	1	See GW evaluation in this SER…not considered by licensee
Total All Pathway Dose Estimate		**5.47**	**9.44**	**Both are < 25 mrem/y**

Totals exclude values in shaded cells because these are considered redundant evaluations that are bounded by the evaluations included.

For each FSSR, the NRC finds that the total all pathway dose estimate is well below the dose criteria for unrestricted release of 25 mrem/y. Therefore, the NRC staff finds the FSS data and the results as determined by the NRC, to be acceptable and each of the survey units and complaint with the requirements of the LTP and the applicable regulations in 10 CFR 20.1402.

The NRC staff concludes that 1) the FSS was effectively conducted in accordance with the LTP, as amended, even though scanning surveys were initially deficient as demonstrated by the discrete particle detected during confirmatory surveys. NRC staff independently evaluated data in the FSSRs and in response to RAIs and, in concurrence with the approved revised LTP, found the data adequate; (2) the FSSR and RAI responses contain the information identified in NUREG-1757, "Consolidated NMSS Decommissioning Guidance," Section 4.5; and (3) the FSS results demonstrate that the residual radioactivity in survey unit(s) NOL01-09 and NOL01-09-FSR meet the radiological criteria for unrestricted release identified in the LTP. The staff's conclusion is based on its review of PGE's FSSRs, survey release records, responses to RAIs, and the results of confirmatory surveys conducted by ORISE.

4.0 COMMENTS

1. The LTP for Humboldt Bay NPP listed multiple radionuclides in Table 6-4 as ROCs. The licensee should address each of these ROCs in future FSSR's for each media being evaluated and not just those exceeding the MDC in samples. Each ROC not directly reported in the survey data should be assumed to be "deselected" and addressed through that process.

2. Ingestion of residual radioactivity in groundwater is a potential pathway of concern as described in the LTP. Future FSSRs should include discussion of the ROCs in groundwater and the potential exposure through that pathway.

3. Surveys of the surface of backfilled material only makes sense if the depth of backfill is relatively minimal and can be considered "well mixed." Staff suggest that future surveys of significantly backfilled areas that are not well mixed throughout should consider representative sampling of the total volume of material or sampling and development of ROC databases of the backfill material as it is being collected or distributed.

4. "Stacked" survey units to reflect the excavation (i.e., subsurface) vs the backfilled excavation are difficult to interpret with regards to how a survey unit should be evaluated. A better approach from evaluating them separately may be to recognize that the primary media in both "survey units" is soil and conservatively select the larger potential dose from either the bottom of the excavation or the backfill material to conservatively assess the combined "survey units." Staff consider this reasonably conservative because the licensee is conservatively using DCGLs developed for surface soil for its evaluations of each feature while both "surfaces" being evaluated are actually subsurface and mixing would occur if excavation were to bring residual radioactivity to the surface.

5. Archiving samples until the project ends would allow for analysis of HTD ROCs if QC data indicate such may be present and should be considered.