UNITED STATES
NUCLEAR REGULATORY COMMISSION
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MEMORANDUM TO: Stephen Koenick, Chief
Low Level Waste Branch
Division of Decommissioning, Uranium Recovery and Waste Programs

THRU: Christepher McKenney, Chief ***/RA/***
Risk and Technical Analysis Branch
Division of Decommissioning, Uranium Recovery and Waste Programs

FROM: Cynthia Barr, Sr. Systems Performance Analyst ***/RA/***
Risk and Technical Analysis Branch
Division of Decommissioning, Uranium Recovery and Waste Programs

SUBJECT: DETAILED TECHNICAL INFORMATION FROM U.S. NUCLEAR REGULATORY COMMISSION AUGUST 13 – 14, 2018, ONSITE OBSERVATION VISIT REPORT FOR THE SAVANNAH RIVER SITE TANK FARMS

The U.S. Nuclear Regulatory Commission (NRC) staff conducted an onsite observation visit on August 13 – 14, 2018, at the Savannah River Site (SRS) F-Area and H-Area Tank Farms (TFs) to assess compliance with the performance objectives in 10 CFR Part 61, Subpart C for low-level waste disposal in accordance with NRC staff's Monitoring Plan for the TFs developed in 2015 (the Monitoring Plan is available via the NRC Agencywide Documents Access and Management System (ADAMS) at Accession No. ML15238A761). The main activities conducted during the August 2018 TFs Onsite Observation Visit (OOV) included the following: (1) discuss tank closure status; (2) tour the General Separations Area (GSA) streams; (3) discuss the Tank 12 and Tank 18 waste release testing; (4) discuss the GSA PORFLOW Model; (5) discuss the *Tank 12 and Tank 16 Grouting* Technical Review Report (TRR); (6) discuss the *Tank 12 Inventory and Special Analysis Document* TRR; (7) discuss the *TFs Environmental Monitoring* TRR; and (8) discuss U.S. Department of Energy and NRC contractor research.

The OOV activities are consistent with the activities described in the NRC Guidance Memorandum for the August 2018 OOV dated July 12, 2018 (ADAMS Accession No. ML18192A328). The Guidance Memorandum was developed using the NRC staff's 2015 Monitoring Plan for the TFs, which should be consulted for additional information (ADAMS Accession No. ML15238A761). Technical details regarding the results of the OOV are provided in the enclosure.

CONTACT: Cynthia Barr, NMSS/DUWP
(301) 415-4015

S. Koenick

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Enclosure:
DETAILED TECHNICAL INFORMATION FROM NRC AUGUST 13 – 14, 2018, ONSITE OBSERVATION VISIT TO SAVANNAH RIVER SITE TANK FARMS

DISTRIBUTION: (w/ enclosure)

LDesotell
RGladney
LParks
MFuhrmann
GAlexander
DPickett david.pickett@swri.org
CDinwiddie cdinwiddie@swri.edu

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OFFICE	DUWP	DUWP	DUWP	DUWP
NAME	CBarr	HFelsher	CMcKenney	CBarr
DATE	01/25/19	01/25/19	01/29/1901	02/01/19

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Technical Discussion – Tank Closure Status

The U.S. Department of Energy (DOE) discussed Tank 12 closure activities since the 2016 Tank Farms (TF) Onsite Observation Visit (OOV) and since the U.S. Nuclear Regulatory Commission (NRC) issued the *Tank 12 and Tank 16 Grouting* TRR, where the DOE switched to Grade 120 slag. The DOE discussed work stoppages related to groundwater in-leakage into the Tank 12 annulus. The DOE discussed the cleaning of Tank 15, which contains almost all H-Canyon Modified (HM) PUREX processed waste. The waste in Tank 15 has high aluminum content, is very viscous, and is difficult to remove. Four submersible mixing pumps (SMP) were used to retrieve waste in Tank 15. The DOE discussed that the Tank 15 waste was being transferred to Tank 13 where it is slurried and sent to Tank 51 for sludge batch preparation. Tank 13 contains four SMPs; but, one SMP has failed. The failed SMP in Tank 13 is being replaced with a Commercial SMP (CSMP). The DOE discussed the modular Tank Closure Cesium Removal (TCCR) technology currently being deployed to treat Tank 10 waste. The TCCR technology was designed to remove Cesium (Cs) from the waste stream before transfer to the Saltstone Disposal Facility. In the TCCR, four shielded ion exchange columns that contain CST (Crystalline Silicotitanate) are used to remove the Cs.

Tour – General Separations Area (GSA) Streams

The DOE provided a tour, partly on foot and partly by vehicle, of the GSA streams. The NRC staff observed several tributaries and outfalls near the TFs or associated with TFs plumes.

The first stop was a drive-by observation of Four Mile Branch (FMB) from a bridge on the way from C-Area to HTF. The next stop was an observation of a tributary of FMB near HTF. The downcutting was significant at this location (several feet). A road over the tributary had been washed out and the culvert that had been part of the earthen road (allowing the stream to pass from one side of the road to the other) had been broken apart and was deposited in the tributary.

The next stop was near piezometer FGW023 to the west of the biomass facility in the Western Groundwater Operable Unit (WGOU). There was a rock apron thought to be erosion control for surface water runoff from the biomass facility. The DOE showed the NRC the piezometer FGW023 location near the peripheral edge of the WGOU non-volatile beta plume. Groundwater seeps were observed at this location further down on the drainage to Upper Three Runs (UTR), which was indicative of baseflow rather than surface water runoff.

An outfall location just south of the FTF provides storm water drainage for FTF. A large culvert drains water to a rock-lined drainage with a concrete barrier to dampen flow from large storm events. The tour also included the Crouch Branch tributary to UTR. Here, the water was very clear and the stream bed was very sandy. The stream flow was low at this location, as well; but, was more substantial than in tributaries to FMB. Further upgradient on the UTR from Crouch Branch Station 1 (CBS1), the Gordon Confining Unit is exposed. This location may be observed in a future OOV.

<u>Technical Discussion – Tank 12 and Tank 18 Waste Release Testing</u>

The DOE briefed the NRC staff on activities related to Tank 12 and Tank 18 waste release testing.

The DOE is conducting new waste release testing on Tank 12, investigating the same radionuclides that were studied during Tank 18 waste release testing: Neptunium (Np), Technetium (Tc), Uranium (U), Plutonium (Pu), and Iodine (I). The DOE contractors discussed the creation of a new Tank 12 composite sample using a ratio of approximately 3.5:1 for mound to floor waste. The DOE contractors discussed the instability of the pH, with constant consumption of caustic, which may have been caused by the dissolution of aluminum.

The DOE contractors also discussed the high demand for reagents used to lower the E_h. The NRC staff commented that the Tank 18 waste release testing results showed that, although the DOE is using the best thermodynamic database available, the geochemical modeling is, in many cases, unable to accurately predict the solubility limiting phases and solubilities of these unique tank wastes. The DOE indicated that it is not currently looking to revise its geochemical models. In response to an NRC staff question, the DOE contractor (Savannah River National Laboratory (SRNL)) staff clarified that it thought that the E_h endpoints could not be achieved using reasonable oxidants and reductants. Therefore, SRNL indicated that the E_h endpoints would not likely be achieved in the field. The NRC staff commented that it was not clear that the experiments had reached a steady-state condition, because several constituent concentrations were still trending up at the conclusion of the waste release experiment.

The NRC staff indicated that the DOE should review the experimental studies for Pu that were used to support the thermodynamic database. The DOE could then consider the representativeness of those experiments to tank wastes to help explain the differences in the modeled behavior versus real waste release testing. The DOE should also evaluate the applicability of the Tank 18 waste release experiments to other tank wastes based, in large part, on waste characterization.

The NRC staff inquired if the DOE evaluated the significant difference in peak dose between modeling using GoldSim (~700 mrem/yr) versus PORFLOW (~500 mrem/yr) in the base-case analysis. The NRC staff indicated that the difference could be due to diffusion (or advection) of radionuclides upwards into the tank grout (prior to significant advective flow downwards out of the bottom of the tank), which is not simulated in the GoldSim model.

The NRC indicated that if infiltration (and flow through the tank) was allowed to increase at 500 years, then the waste release could be significantly greater due to the dominance of advective, downward flow earlier in time, with less time for Pu to be transported up into the overlying grout when the solubility is relatively high. Transport into the overlying grout has been shown to lead to non-intuitive results where higher solubilities can lead to lower releases later in time after significant downward flow occurs through a tank.

The NRC staff commented that the DOE technical analyses (SRR-CWDA-2016-00086) did not consider uncertainty in barriers that delay the timing of release and, therefore, conclusions regarding the impact of the waste release testing results on the PA are not fully supported. The NRC staff explained that, for Pu in Type-IV tanks, there are multiple barriers delaying the timing of the release and potential exposure, including the tank, tank grout, solubility control, basemat, and natural system. Uncertainty in the performance of those key barriers leads to uncertainty in timing of release or transport times. While the DOE studied the impact of changes in solubility control, the DOE did not study the impact of uncertainty for other barriers affecting the timing of waste release and exposure. Therefore, if performance of those other barriers is overly optimistic, then risk-significant releases and exposures could occur much earlier than anticipated. The DOE indicated that it might consider a Tank 18 Pu barrier analysis.

Technical Discussion – General Separations Area (GSA) PORFLOW Model

The DOE briefed the NRC staff on activities related to the GSA PORFLOW model.

The DOE provided the NRC staff with an update on the evolution of the GSA regional groundwater model. The initial regional GSA model was created using the subsurface Flow and Contaminant Transport (FACT) code in the 1990s. That GSA groundwater model was translated to the PORFLOW™ code in 2004. Since 2004, the DOE has collected additional groundwater characterization data and developed new calibration targets using data collected from 2004 – 2014. There is a Rev. 0 and a Rev. 1 of "Groundwater Flow Simulation of the SRS GSA", (SRNL-STI-2017-000080) [ADAMS Accession No. ML1808A308].

The GSA PORFLOW groundwater model was updated from 2016 to 2017 using newly available groundwater characterization data, calibration targets, and hydrostratigraphic unit picks. The GSA PORFLOW groundwater model was calibrated using the Parameter Estimation (PEST) code. Changes to modeled groundwater recharge included consideration of reduced infiltration from the engineered soil covers above the burial grounds at Low Level Radioactive Waste Disposal Facility (LLRWDF) and Old Burial Ground.

When asked by the NRC staff if the new model calibration was better at HTF, the DOE indicated that it was difficult to confirm that because different calibration targets were used. The NRC staff then asked if calibrating the model at HTF was less challenging. The DOE indicated that there was not much change in the calibration process at HTF because it was still very difficult to calibrate the model in the vicinity of HTF. The DOE indicated that HTF sits on a groundwater divide, the flow directions are very sensitive to model parameters, and the geology at HTF is more variable compared to other areas of the GSA.

When asked by the NRC staff if the DOE collected additional data on hydraulic conductivity to constrain the GSA PORFLOW model, the DOE appeared to indicate that no additional hydraulic conductivity data was collected to improve model calibration at HTF. Collection of additional hydraulic conductivity data is important to ensuring that the model is not presenting an acceptable, but inaccurate calibration due to non-uniqueness of the solution in the absence of constraining data on model parameters. Both the DOE contractors and the NRC staff agreed that model calibration at HTF was challenging and problematic.

The DOE originally focused on matching water levels rather than plumes during calibration. (Note: The discussion did not include use of baseflow measurements. However, during the GSA streams tour, the DOE indicated that there were several baseflow measurement stations.) More recently, DOE has considered calibration to contaminant plumes (i.e., transport times). There are separate reports for each of the areas where the DOE conducted some tracer runs with GSA 2018 models in the TFs with continuous and pulse sources.

The DOE explained that they used a layer-cake conductivity field versus a heterogeneous conductivity distribution. In the layer-cake conductivity field, conductivity zones are created as necessary to calibrate the model.

In the mid-1990s, the DOE had hundreds of well-characterized wells in the GSA, with a notable exception that the Z-Area had very few wells that could be used to guide calibration. Additional wells were developed on the GSA from 2004 to 2014; but, there are still relatively few wells in Z-Area. More recent well data from the Saltstone Disposal facility is being considered in the updated GSA PORFLOW model.

When the NRC staff questioned the DOE contactor on the challenge of averaging water level data over different time periods, the SRNL staff indicated that the updated GSA PORFLOW model used data obtained only from 2004 onward. This was partly done to account for the change from operations activities to largely remediation actions across the GSA, where operations resulted in additional water to the subsurface. The post-2003 period also accounts for the placement of large final covers over previous near-surface disposal areas in E-Area.

Previous simulated plume trajectories at Z-Area showed more vertical movement than lateral transport. Subsequently, the DOE made the Z-Area modeled zone above the Tan Clay Confining Zone (TCCZ) more transmissive to enhance modeled lateral transport for consistency with environmental monitoring data.

The NRC staff inquired to DOE as to whether they should wait to review the 2018 GSA PORFLOW model or begin review of the 2016 GSA model while waiting for the new report to be released, the DOE responded that: (1) the draft 2018 report should be available by the end of September 2018; (2) the FTF and HTF modeling results should not be a significant step change between the 2016 and 2018 GSA PORFLOW models; and (3) the NRC could start reviewing the 2016 report now, focused mainly on methodology and then focused on model results after the 2018 minor update has been released. The DOE also indicated it would be useful to start reviewing the 2016 GSA PORFLOW model because there will only be a supplement provided in the 2018 model update, which will be focused primarily on flow and transport in the Z-Area. The DOE may redo the area-specific reports to see if the DOE can match plume trajectories.

The DOE indicated that they had not used electromagnetic borehole flowmeter-derived hydraulic conductivity data obtained in the 1990s to construct the GSA PORFLOW model because that data was collected at too fine a scale to be applied to the model. The DOE will provide a list of SRS reports on GSA electromagnetic borehole flowmeter data.

With respect to the NRC staff inquiries on transport model updates, the DOE indicated that it conducted mesh resolution studies to avoid significant numerical dispersion. The DOE commented that in choosing a longitudinal dispersivity value, a value of 0.1 is the typical/traditional assumption. However, a somewhat lower value has been shown to often be appropriate. The DOE will be looking at dispersivity values of 0.1 and below in sensitivity analyses. The newer versions of the PORFLOW code are capable of modeling anisotropy in transverse dispersivity.

<u>Technical Discussion – *Tank 12 and Tank 16 Grouting* TRR</u>

The NRC staff and the DOE discussed follow-up items reported in the *Tank 12 and Tank 16 Grouting* TRR [Agencywide Documents Access and Management System (ADAMS) Accession No. ML16231A444] issued on September 6, 2016. In particular, the discussion was focused on the TRR Attachment 3, “List of Outstanding References.” This included the clarifications, responses, and paths forward for each action item or question in the following sections of the TRR Attachment 3: (1) Follow-Up Action Items from the May 17, 2016, Teleconference; (2) Follow-Up List of Questions from the May 17, 2016, Teleconference; and (3) Other Follow-Up List of References and Questions from the *Tank12 and Tank 16 Grouting* TRR.

Action Items from the May 17, 2016, Teleconference

- Action Item #1: The DOE clarified that it did not have to pump water from the risers in Tank 5 and Tank 6.

- Action Item #2: The DOE clarified that it performed two pumping campaigns of ~3,800 liters/campaign (1,000 gallons/campaign) due to in-leakage into the Tank 12 annulus from a clay ventilation pipe. From the Tank 12 risers, standing water was pumped out. The DOE removed ~4,542 liters (1,200 gallons) from Tank 12 risers and some risers overflowed with water. The vertical leg of the Tank 12 ventilation duct required some water pumping of ~1,893 liters (~500 gallons). The DOE also clarified that it received permission from SCDHEC to leave installed ventilation running until tank grouting began in the future.

- Action Item #3: With regard to the quantity of Slick Willie used in Tank 18 and Tank 19, the DOE clarified that it would run 1/3 yd of water with ~0.12 liters (4 ounces) Slick Willie added to the water through the hopper each day. The DOE used Slick Willie for 28 days for Tank 18 and for 30 days for Tank 19.

- Action Item #4: With respect to the NRC staff inquiry regarding which of the three grout formulations provided within procurement specification C-SPP-Z-00012 (action referenced CSP-SPP-Z-00012, but it was actually C-SPP-Z-00012) was used for clean cap grout in Tank 16, the DOE indicated that vault clean cap formulation number 1 was used as a low-bleed mix. DOE also clarified the meaning of the word “TEMPER” listed on a batch ticket. DOE clarified that TEMPER is simply water. As the DOE contractor was mixing up a batch, an individual started adding water (e.g., ~7.5 of ~3,028 liters (2 of 800 gallons)), but then stopped. This was done on three batch tickets, and it was not typical.

Follow-up List of Questions from the May 17, 2016, Teleconference

- Question #1: The DOE will gather information regarding the Tank 16 clean cap specification, explicitly whether Daratard or admixtures are used to increase flowability of the grout at a specified water:cement ratio.

- Question #2: The DOE will gather information to explain why compressive strength measurements are not required for the clean cap grout.

- Question #3: The NRC has a DOE report, VSL-14R3330-1, which provides test results for clean cap grout mixed at varying water-to-premix ratios and adding NaOH solution.

- Question #4: The DOE will provide attachments to work orders 01324150-64 and 01337683-33, as well as references related to the transition to use and testing of Grade 120 slag.

- Question #5: The DOE will gather information to clarify the testing of Grade 120 slag.

- Question #6: The DOE clarified that the pump could reduce the water level down to 2 inches, and even lower if ventilation is running.

- Question #7: RECOVER is a hydration stabilizer added to the mix at the batch plant. The volume is determined by the batch plant as an amount needed to delay grout setting, and that volume depends on the ambient temperature, humidity, travel time, operational conditions, and visual observation of previous batches.

Other Follow-up List of References, Questions from the Tank 12 and Tank 16 Grouting TRR

- #1: The DOE indicated that shrinkage testing was inconclusive with respect to the observation of shrinkage or growth and there are now no plans to issue a related report, in contrast to what the DOE had previously indicated during the 2016 TFs OOV.

- #2: The NRC has the latest version of the modeling files associated with SRR-CWDA-2015-00100 (evaluation of impact of clean cap grout in Tank 16).

- #3: The NRC has the most recent version of SRR-CWDA-2012-00051.

- #4: The NRC has VSL-14R3330-1.

- #5: The DOE will gather information regarding the impact of caustic solution on clean cap grout reactivity and flowability.

- #6: The DOE clarified that grout compressive strength increases significantly with time. Hydroxide content of salt waste affects curing time; but, the ultimate compressive strengths of clean cap grout and saltstone should be similar.

- #7: The DOE will provide data and information on Grade 120 tank grout wet chemistry test, flow test, compressive strength test, bleed test, and heat of hydration charted over time.

- #8: The DOE will clarify if the same strategy with respect to disposal of chromate-laden flushwater was used in Tank 12 as was used in Tank 16. The DOE will also provide any related work orders.

- #9: The DOE will provide a copy of SDDR No. 13307 and associated deviation disposition documents.

- #10: The NRC requested clarification from DOE regarding the approach it used for grouting the Tank 12 ventilation duct (see SRR-LWE-2014-00147). The DOE will provide this information.

- #11: With regard to an NRC question about grout drop heights for Tank 12, DOE clarified that they did not drop grout from heights greater than ~1.5 meters (5 feet) knowing that additional investigation was needed. Instead, the DOE drops one ~1.5 meters (5 feet) section of tremie at a time. The DOE will provide reference documents and confirmation to the NRC for the maximum drop height for Tank 12.

The NRC staff will review the final configuration report for Tank 12 to see if any additional information is needed regarding Tank 12 grouting.

<u>Technical Discussion – *Tank 12 Inventory and Special Analysis Document* TRR</u>

The NRC staff and the DOE discussed the *Tank 12 Inventory and Special Analysis Document* TRR [ADAMS Accession No. ML17277B235] issued on January 8, 2018.

The NRC staff reiterated a key finding in previous TRRs: if practical, the DOE should composite within segment versus compositing over the entire tank in order to preserve information on segment variability. The NRC also repeated a previous comment that it appeared inappropriate for the DOE to consider three composites analyzed in triplicate as nine independent samples (in the case that the F-test showed that the random effect did not need to be considered). However, that was only done for a handful of analytes and based on the NRC staff use of nonparametric resampling methods, the NRC staff confirmed that the impact of treating all nine samples as independent was low (i.e., the NRC obtained a similar UCL 95 for the mean for those analytes).

The NRC staff commented that the DOE did not appropriately consider uncertainty in calculating mass fractions from each of the segments (e.g., uncertainty in density measurements was not considered, although found to be variable between segments). Sampling of just three volumes from a triangular distribution representing volume uncertainty to determine mass fractions also appeared to be inappropriate. The NRC indicated that the DOE could consider volume and density uncertainty in a probabilistic analysis conducted to study inventory uncertainty in the Special Analysis Document in lieu of considering volume uncertainty alone in determining mass fractions in the volume proportional compositing scheme.

<u>Technical Discussion – *TFs Environmental Monitoring* TRR</u>

The NRC staff and the DOE discussed the *TFs Environmental Monitoring* TRR [ADAMS Accession No. ML18051B009] issued on April 20, 2018. Note that the Enclosure is undated; but, Final [ADAMS Accession No. ML18051B153].

The NRC staff commented that they performed independent PORFLOW transport modeling to evaluate the groundwater monitoring well network. The NRC staff noted that it is important to use PORFLOW modeling to evaluate vertical well placement, in addition to plan view maps presenting results of particle tracking, which are more useful to inform lateral placement of wells. The NRC staff suggested the DOE to use backwards particle tracking to support environmental monitoring report conclusions regarding the source of contaminant plumes. The SRNL staff responded that it is difficult to pinpoint the exact source from historical releases due to uncertainty in the source and the potential for impact from multiple sources. The SRNL staff commented that there is significant downward flow through the TCCZ, which might explain why radioactivity was detected in a Lower Aquifer Zone well so close to a source. SRNL staff also noted that a background well in the Upper Aquifer Zone above the TCCZ has been dry. The DOE is currently working to identify another location to place a new background well.

Technical Discussion – The DOE and NRC Contractor Research

The DOE and the NRC staff discussed the recent DOE research and the NRC contractor, Center for Nuclear Waste Regulatory Analyses (CNWRA), research that has been conducted or that is still ongoing.

The DOE discussed research in the following documents:

- FY2018 Performance Assessment Maintenance Plan:
  - "Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program – FY2018 Implementation Plan," (SRR-CWDA-2017-00096, Rev. 0) [ADAMS Accession No. ML18067A594]

- Lysimeter Testing:
  - "Fiscal Year (FY) 2017 experimental work provided in Determination of Constituent Concentrations in Field Lysimeter Effluents," (SRRA021685-000008, Rev. 0) [ADAMS Accession No. ML18067A486]

  - "Analysis of Plutonium Soil Concentrations in Field Lysimeter Effluents," (SRRA021685-000009, Rev. 0) [ADAMS Accession No. ML18067A509]

- Revised Geochemical Data Package
  - "Geochemical Data Package for Performance Assessment Calculations Related to the Savannah River Site," (SRNL-STI-2009-00473, Rev. 1) [ADAMS Accession No. ML17047A417]

In SRRA021685, which was an analysis of solids considering the K_d/solubility of Pu, Pu was found to be very immobile in the first lysimeter experiment.

The NRC staff discussed research conducted by the CNWRA, including its survey of drilling companies and its Rn basement model. The CNWRA is conducting a survey of well drilling companies on technologies, behaviors, and practices to inform the inadvertent intruder calculations. Those surveys will be conducted in Idaho and South Carolina. The DOE looked at well-drilling records for three counties in the vicinity of SRS. The DOE went to SCDHEC and the data is in SRNL-STI-2009-00473.

The CNWRA is working on a Rn basemat model, including using the most recent Rn dosimetry for incorporation into BDOSE.

The DOE inquired about their performance in addressing the TFs Monitoring Plan, Rev. 0 monitoring factors priority table and where it should focus its research. The NRC staff went through the prioritization of the monitoring factors listed in the TFs Monitoring Plan, Rev. 0 in Table ES-2 *NRC Prioritization of Monitoring Factors That Support 10 CFR 61.41 and 61.42*. The NRC staff also responded that the *Tank 18 Special Analysis Document* TRR [ADAMS Accession No. ML12240A179] provided what the DOE needs to do with respect to Pu in Tank 18 because it has now been determined that the solubility of Pu is risk-significant. The NRC staff also commented that new information on Pu sorption in the natural system and a more complex model to account for separate Pu species transport is important. The NRC staff indicated that additional information will be provided in the *Waste Release* TRR, which was expected to be issued shortly after the OOV. (The *Waste Release* TRR was issued on September 21, 2018 [ADAMS Accession No. ML18242A259].)

The DOE requested that any publicly available documents of CNWRA Tank Grout research be provided. The NRC staff will consider distributing the CNWRA reports through the WIR ListServ.