REQUEST FOR ADDITIONAL INFORMATION
NASA PLUM BROOK

1. **Comment:** It is not clear how ALARA is going to be addressed for the residual radioactivity in the Plum Brook.

Basis: The radiological criteria for unrestricted use in 10 CFR 20.1402 includes a requirement that the residual radioactivity has been reduced to levels that are as low as is reasonably achievable (ALARA).

Path Forward: Describe how the ALARA requirement will be satisfied.

2. **Comment:** More information is needed to confirm that Cs-137 and Co-60 are the only radionuclides of Plum Brook Reactor Facility (PBRF) origin present at levels above background in the Plum Brook.

Basis: The radiochemical analysis performed for two ditch samples and three Plum Brook sediment samples is described on pages 3 and 4 of the National Aeronautics and Space Administration (NASA) Technical Basis Document (TBD) titled "Radiological Characterization of Plum Brook Sediments", PBRF-TBD-08-005, Revision 1. Because only Cs-137 and Co-60 were present at levels above background, it was concluded that these were the only radionuclides of PBRF origin present in the Plum Brook. More information is needed about the representativeness of these samples and the basis for concluding that other radionuclides are not present in the Plum Brook based on the other radionuclides not being present in these samples.

Path Forward: Provide additional information about the ditch and Plum Brook sediment samples discussed above and provide justification for concluding that the fact that other radionuclides were not found in these samples indicates that other radionuclides of PBRF origin are not present anywhere in Plum Brook.

3. **Comment:** The basis for the assumed areas for the localized areas of elevated activity is not provided.

Basis: The size of the localized areas of elevated activity is an important parameter in determining the dose a person receives from the areas of elevated activity.

Path Forward: Provide justification for the values used for the area of the contaminated zone parameter in the RESRAD calculations for the localized areas of elevated activity in the NASA TBD titled "Revised Dose Assessment for Plum Brook Sediments", PBRF-TBD-08-006, Revision 0.

Enclosure

4. **Comment:** Additional justification is needed for some of the assumptions used in the Brook-Side Resident scenario.

Basis: The Brook-Side Resident scenario considers a receptor living in a house. This resident is modeled as spending ¼ of their indoor time above the contaminated zone. A local area of elevated concentration is assumed to be located outside the residence. The Brook-Side Resident is assumed to be a different person than the Suburban Gardener. The U.S. Nuclear Regulatory Commission (NRC) staff needs additional justification for these assumptions.

The footprint of the house in the resident scenario is assumed to be partially located over the contaminated zone. This assumption is accounted for in the RESRAD modeling by dividing the indoor occupancy time by 4. However, it may not be appropriate to account for a reduced area of the contaminated zone by adjusting the occupancy time. For example, the direct radiation dose to a receptor which is located near the contaminated zone may not be much less than the dose to a receptor which is directly above the contaminated zone. In addition, a receptor may not spend the same amount of time in all portions of their house, so their dose may not be directly proportional to the fraction of the footprint that is located over the contaminated zone. NRC staff recognizes that mixing of contaminated sediments with clean soil would likely occur if sediments were moved from Plum Brook to the site of the house and that the dose assessment initially submitted by NASA does not take credit for this mixing. However, it is not clear that the selected scenario is conservative compared to a scenario in which the exposure times were longer and the concentrations were lower.

Additional justification is also needed to support the assumption that the local area of elevated contamination is not located directly under the residence. Because the receptor spends more time indoors than outdoors, the dose from a hot spot located under the residence would be higher than the dose from a hot spot located elsewhere on the property even though the residence would provide some shielding.

The basis for the Suburban Gardener and Brook-Side Resident being two different scenarios is also needed. It is likely that the Suburban Gardener would live in the vicinity of their garden, so the same receptor could receive a dose both while in their house and from consuming plant foods grown on contaminated soils. In addition, if a garden in which the higher concentration sediments were used as topsoil was located near the house, the resident of the house would likely receive an external radiation dose from the radionuclides in the garden while they are inside.

Path Forward: Provide additional justification for the following assumptions used in the dose assessment:
i. the resident only spends ¼ of their time over the contaminated zone.
ii. the local area of elevated contamination is not located under the house.
iii. the resident does not also have a garden in which plants are grown for consumption.

Alternatively, a revised dose assessment that does not include these assumptions could be provided.

5. **Comment:** Additional justification is needed for the assumption that the gardener would not garden on and consume plants from a local area of elevated concentration.

Basis: The Suburban Gardener scenario includes the dose from the consumption of plant products that have been grown in soil containing Cs-137 and Co-60 at concentrations equal to the average concentration in Section 1 of the Plum Brook. However, there are areas of the Plum Brook that have concentrations of these radionuclides that are much higher than the average amount. Though some mixing with clean soil would be likely to occur when removing sediments from the Plum Brook and placing them in a garden, it is possible that a garden that has soil that has been supplemented with sediment from the brook could have concentrations of radionuclides that are higher than the average concentration in the Plum Brook.

Path Forward: Provide justification for turning the plant ingestion pathway off for the calculation of dose from elevated areas in the garden scenario or provide a revised dose assessment that includes this pathway.

6. **Comment:** It is unclear how the concentration of Cs-137 used for the Country Club Maintenance Worker scenario was derived.

Basis: The footnotes to Table 17 in PBRF-TBD-08-005 state that the concentrations used for the Country Club Maintenance Scenario are based on data presented in Table 11. However, Table 17 lists a value of 1.38 pCi/g for the single layer average concentration, but this value does not appear in Table 11.

Path Forward: Provide an explanation of how the value of 1.38 pCi/g of Cs-137 was derived for the source term for the Country Club Maintenance Worker.

7. **Comment:** It is not clear what thickness is assumed for the contaminated zone in the elevated local area calculation for the Country Club worker.

Basis: Appendix B of PBRF-TBD-08-006 states that a contaminated zone thickness of 6 inches is used in the RESRAD calculation for the elevated local area for Cs-137 for the Country Club Worker scenario (File 02100903). However, this RESRAD calculation seems to have been run with a 3 inch thickness for the contaminated zone.

Path Forward: Clarify which value is the correct contaminated zone thickness for this scenario and provide revised RESRAD calculations if necessary.

8. **Comment:** The configuration of contamination assumed in the conceptual model in RESRAD for the calculation of dose from the aquatic food pathway is significantly different than the configuration of residual radioactivity present in the Plum Brook.

Basis: The conceptual model used by RESRAD to calculate the concentration of radionuclides in surface water assumes that the contamination is present in soil. The radionuclides are modeled as leaching into the groundwater and being transported to a

surface water body. However, the radionuclides at the Plum Brook are already present in the sediments in the stream. This difference in configuration of the radionuclides may be significant enough that the conceptual model in RESRAD does not adequately calculate the concentration in the surface water.

Path Forward: Provide justification that the way that RESRAD models the fish pathway is conservative for modeling the aquatic food pathway dose from the radionuclides present in the Plum Brook, or use an alternative model for calculating the aquatic food pathway dose. One possible alternative approach would be to perform calculations similar to those described in Regulatory Guide 1.109.

9. **Comment:** Additional justification is needed for the assumed location of the fish in the Recreationist scenario.

Basis: The dose to a recreationist who fishes in the Plum Brook is calculated based on the concentration of radionuclides present in the sediment in the Plum Brook Estuary (stream Section 4). The concentration of radionuclides in the sediment in this section is lower than the concentrations seen upstream. Additional information is needed to confirm that fish that could be consumed by humans are not present in the upstream segments of the Plum Brook.

Path Forward: Provide additional information about the fish located in the Plum Brook and provide justification for the assumption that the fish are only located in stream Section 4. Alternatively, provide a revised dose assessment that considers the concentration of radionuclides observed in the other stream sections.

10. **Comment**: Staff cannot determine from PBRF-TBD-08-005 if NASA evaluated and identified any other liquid effluent discharge point(s) from the PBRF to the environment other than the primary liquid discharge point from PBRF to Pentolite Ditch and Plum Brook. If any other liquid effluent discharge point(s) are identified on site, please identify what streams or impoundments were used for these liquid effluent discharge points.

Basis: NASA states in Section 4.1 Plum Brook Overview, "The portion of Plum Brook impacted by radionuclides of PBRF origin lies between the confluence of Plum Brook with Pentolite Ditch and its terminus in Sandusky Bay. It is divided into four sections for characterization purposes, denoted as Sections 1 through 4. Section 1, lies between Pentolite Road, in the northern portion of the NASA Plum Brook Facility, and US Rt. 2. This portion of the stream was further divided into five subsections for characterization. These are identified as Sections A – E. They are shown in Figure 3."

Path Forward: Provide justification that any other liquid effluent discharge point(s) have been evaluated by NASA.

11. **Comment**: Staff notes that Section 2 had a significantly lower number of sample results for Cs-137 as compared with sample results for Cs-137 for other Sections.

Basis: NASA states in PBRF-TBD-08-005 Section 5.3, Lower Meander - Section 2, that there were 16 sample results from all depths at the three locations. Whereas, in Table 8 for Section 1 for all locations there were 358 sample results, Table 11 for Section 3 for all locations there were 485 sample results, and Table 14 for Section 4, there were 292 sample results.

In addition, the sample results from stream Section 1 were used in calculating the dose to a Brook-Side Resident located in Section 2. However, it is unclear how it is known that the concentrations in this section are less than or equal to the concentrations in Section 1. Although the data do show that the average concentrations tend to be lower further downstream, there are areas of elevated concentration along the stream where sediments have deposited. The areas in Section 2 that were not sampled are significant in size and it is possible that areas of elevated concentration could have been missed.

Path Forward: Provide justification for the difference in the number of samples and sample results for Cs-137 in Section 2 when compared to the number of samples and sample results in the other sections. Also, provide justification for the use of Section 1 concentrations when modeling the dose from sediments located in Section 2.

12. **Comment**: It is the staff's understanding that the duration of liquid discharge from PBRF to the Pentolite Ditch occurred between 1963 to 1973. During this period, heavy rains and flooding have occurred and have transported the contaminants downstream. The staff also notes that the sampling from Section 1 was initiated in 2005. Staff cannot determine the basis for why activity concentrations from Section 1 sample results would be conservative for Section 2.

Basis: NASA states in PBRF-TBD-08-005 Section 5.3, Lower Meander - Section 2, that the use of Section 1 sample results for establishing source term activity concentrations for an exposure scenario set in Section 2 provides additional conservatism.

Path Forward: Provide justification for why Section 1 sample results would be conservative for Section 2.

13. **Comment:** The extend/boundary of frequently flooded area in the meandering stream section and the flood plain section of the Plum Brook, since the release of Cs-137 in 1963, was not adequately shown on the map(s) along with the locations of sediment/soil samples.

Basis: During major flood events**,** Cs-137 contaminated sediment is re-suspended from the stream bed, transported by rising flood water over the banks, and deposited onto the surrounding low land areas. The flood in July of 1969, believed to be the largest in recent history, may have set the broadest flood boundary for the contaminated sediment from Plum Brook.

Path Forward: Based on the available historical aerial photos and/or other local hydrologic maps (e.g., 100-year flood map), define the floodplain extent/boundary for

areas along Plum Brook during which significant flooding has occurred after 1963. Also, include figures with topographical data of the floodplain, which identifies low-lying areas that have a greater potential for fine-grain sediment deposition to establish if the impacted sediment/soil in the flooded areas/plain of Plum Brook are adequately characterized.

14. **Comment:** The morphological elements of Plum Brook should be accurately characterized to explain sediment erosion and deposition after the known release in 1968.

Basis: With a better understanding of the morphology of Plum Brook, sub-environments that have a greater potential to accumulate fine grained sediments (clays associated with Cs-137 adsorption) that have not undergone erosion since their initial deposition can be identified and sampled. A better understanding of the morphology will also aid in the understanding of sediments that have undergone re-suspension and re-deposition.

Path Forward: Provide references to other characterization reports that identify the most likely locations of initial deposition and re-deposition of contaminated sediments after 1963 throughout Plum Brook, or provide figures that identify the most likely locations for initial deposition and re-deposition throughout Plum Brook. The figures should also include all sampled locations for comparison.

15. **Comment:** The initial scoping survey was conducted in 2005, with scan survey points primarily located at stream roadway over-crossing of the Plum Brook to avoid entering private property and due to safety access concerns.

Basis: The design of the subsequent Phase I and II sediment and soil characterization was based on the results of the initial scoping survey results. The approach to selecting the initial scan locations (stream roadway over-crossing) may potentially increase the chance of missing the highest contaminated sediments.

Path Forward: Provide a justification, for example based on the site conceptual model, that the initial scoping does not compromise the full characterization of the sediment along Plum Brook.

16. **Comment:** Based on the Characterization Report for Plum Brook Sediment in East Sandusky Bay, it appears that sediment samples were not collected along and west of the previous stream channel after Plum Brook entered the Sandusky Bay, and the extent of sediment with Cs137 was not defined to the west of the stream channel

Basis: Stream maps and areal photos of Plum Brook indicated water previously flowed through Sandusky Bay to the North, then turned west upon reaching the Cedar point bar (Figure 4), and the sediment samples collected were primarily located to the northeast along the current flow channel (Figure 4 and Figure 12).

Path Forward: Provide an explanation or justification that there is no need for additional sediment sampling along the previous stream channel to the west within the bay.

17. **Comment:** In assessing the residual radioactivity and demonstrating that the stream bed and banks of Plum Brook between Plum Brook Station boundary and Sandusky Bay meet the radiological criteria for unrestricted use, NASA should also assess any dose contribution from any radionuclides of PBRF origin in groundwater that may result in potential exposure through drinking water.

Basis: Transport of any radionuclides of PBRF origin in groundwater may result in potential exposure through drinking water.

Path Forward: Provide information describing the assessment of any groundwater contamination impacts including potential dose contribution from all pathways (including groundwater) to offsite receptors consistent with the release criteria.