1. Waste disposed in a new Environmental Management Disposal Facility (EMDF) will not be like waste disposed in EMWMF. K-25 (ETTP), Y-12, and ORNL (X-10) have different waste profiles both in radionuclides present and their abundance (inventory). K-25 (ETTP) has been the major focus for many years and is the source of most of the waste disposed in the Environmental Management Waste Management Facility (EMWMF). The EMDF Performance Assessment[i] and EMWMF/EMDF Composite Analysis[ii] show that waste disposed in EMWMF is not indicative of future waste proposed to be disposed at EMDF. DOE proposes to dispose a significantly greater inventory of radionuclides at EMDF than EMWMF.[iii] Further, average leachate activity concentrations projected in the EMDF Performance Assessment at landfill closure are significantly greater than maximum leachate and contact water activity concentrations measured at EMWMF from October 2015 through June 2021.[iv] During disposal of wastes from specific areas, radionuclides[v] and Clean Water Act Pollutants[vi] in contact water and leachate will be a function of what was disposed in the past and what is being disposed at the time. The EMDF Performance Assessment is also useful in identifying radionuclide inventory that DOE anticipates disposing in the landfill from the various remedial areas. The greater the number of curies of a radionuclide from an area, the greater the inventory of that radionuclide disposed in the EMDF landfill from that area.[vii]
2. The Environmental Management Waste Management Facility (EMWMF) has not always been operated in compliance with federal law. The EMWMF Record of Decision (ROD) did not authorize discharge of landfill wastewater (e.g., contact water) to surface water as part of the remedial action. An EMWMF contractor had an unauthorized release of contact water containing radionuclides to Bear Creek during 2002 to avert a failure of the ponds and pled guilty in federal court to unlawfully discharging EMWMF refuse (e.g., contact water containing radionuclides) into a waterway without a permit.[viii]
3. The EMWMF ROD was not amended to (1) authorize discharge of contact water with radionuclides and Clean Water Act pollutants to Bear Creek and (2) establish legally compliant and protective discharge criteria.[ix] Yet since 2003, the Department of Energy (DOE) has routinely discharge EMWMF contact water containing radionuclides and other pollutants to Bear Creek surface water.[x] For example, during FY 2020, DOE reported discharging 17,635,000 gallons of contact water to Bear Creek.[xi]
4. Even though EMWMF has released contact water to Bear Creek since 2003, fish samples from Bear Creek and lower East Fork Poplar Creek were not analyzed to evaluate levels of radionuclides in fish that people may eat until after U.S. Environmental Protection Agency (EPA) Administrator Wheeler's December 31, 2020, final dispute decision.[xii] Analyzing fish for radionuclides in the Poplar Creek embayment where it is documented that people fish and some people consume fish caught[xiii] was also not done from 2003 through 2019.[xiv] The frequency of radionuclide analysis and radionuclides to be analyzed in future fish sampling is unclear.
5. The focus of the ORR cleanup during much of the EMWMF operational period has been K-25 (ETTP) instead of ORNL (X-10). If ORNL waste instead of K-25 waste had primarily been disposed in EMWMF, then without treating all EMWMF discharges of radionuclides to surface water, radionuclides in discharges to surface water over the past 18 years would likely have been significantly different.[xv]
6. In 2003, there was an "Engineering Feasibility Plan for Groundwater Suppression" at EMWMF[xvi] that did not include evaluation of applicable or relevant and appropriate requirements (ARARs) listed in the EMWMF ROD as criteria for remedy evaluation and selection. Installation of the underdrain under EMWMF landfill Cell 3 created a landfill inconsistent with at least two ARARs listed in the EMWMF ROD[xvii]. This feasibility study

specifies the underdrain will increase contaminant dilution to the hypothetical groundwater user. A 2010 addendum to the EMWMF Remedial Design Report clarifies that the underdrain will collect a significant fraction of leachate and direct it to Bear Creek.[xviii]

7. EMWMF discharges landfill wastewater (i.e., contact water) into Bear Creek. Bear Creek and downstream surfaces waters are included on the 303(d) list of impaired and threated waters for polychlorinated biphenyls (PCBs). Analysis and reporting of PCBs in EMWMF wastewater discharges to surface water are insufficient[xix] to determine whether recreational use water quality criteria are exceeded or whether there is a correlation between EMWMF discharges and levels of PCBs in fish in Bear Creek.[xx].
8. The Environmental Management Disposal Facility (EMDF) is proposed to be authorized for disposal of Toxic Substance Control Act (TSCA) waste including PCBs. If laboratory method detection limits and reporting limits for PCBs at a future EMDF are consistent with those used at EMWMF and are greater than the recreational use water quality criteria, pursuant to Tennessee Rule 0400-40-03-.06(2)(a)[xxi] discharge of wastewater from a future EMDF cannot be authorized to surface water listed on the 303(d) list for PCBs.
9. Bear Creek is also listed on the 303(d) list of impaired and threated waters for mercury. EPA Comment 104 on the EMDF D1 ROD states *"In order to meet the CWA requirements and be consistent with the NCP, the discharge must meet the most stringent of either the [Technology Based Effluent Limits (TBEL)] (which has yet to be determined), a [Water Quality Based Effluent Limit (WQBEL)], or an antidegradation-based limit."*
10. Tennessee antidegradation regulations[xxii] specify that new or increased discharges of unavailable parameters, such as mercury, shall not be authorized if the discharge would cause measurable degradation of surface water for mercury. Bear Creek is included on the 303(d) list for mercury and a 95% UCL mercury concentration of 5.17 ng/L (ppt) with a median of 3.3 ng/L (ppt) can be calculated in Bear Creek surface water near the proposed EMDF. [xxiii]
11. Tennessee antidegradation rules also require that discharges of bioaccumulative parameters, such as mercury, will not be authorized if they cause additional loading of the unavailable parameter (e.g., mercury). Neither the FFS for Water Management[xxiv] nor the EMDF D1 ROD include loading analysis that verifies proposed discharge criteria do not increase mercury loading to Bear Creek. Loading calculations using mercury concentrations obtained with EPA method 1631 or 1631E and flow data in OREIS suggest loading of mercury to Bear Creek from EMWMF has been minimal. A competent mercury loading analysis is needed.
12. Beginning with the EMWMF discharge sample collected on August 27, 2019, laboratory analysis for mercury changed from a method with a reported laboratory detection limit of 0.2 to 1 ng/L (ppt) to a method with a detection limit of 67 ng/L and a DOE reporting limit of 200 ng/L.[xxv] This change in analytical methodology with corresponding increased method detection limits and reporting limits complicates analysis of loading of mercury released to Bear Creek from EMWMF.
13. It is likely EMWMF Waste Acceptance Criteria (WAC) does not protect future groundwater users. The East Bear Creek Valley (EBCV) Site is adjacent to EMWMF. In the D4 version of the EMDF Remedial Investigation and Feasibility Study (RI/FS)[xxvi], the hypothetical or modeled groundwater point of compliance well was moved to a location near the projected highest concentration beyond a 100-meter buffer zone[xxvii] surrounding the waste consistent with requirements in DOE G 435.1-1[xxviii]. The EMDF D4 RI/FS substituted preliminary administrative limits that do not comply with the CERCLA carcinogenic risk range or relevant and appropriate requirements for 28 of the 32 radionuclides evaluated.[xxix] TDEC's May 16, 2016, comment letter includes WAC calculated using methodology DOE presented in the EMDF D4 RI/FS consistent with the CERCLA carcinogenic risk range and remedial action objectives presented in the EMDF D4 RI/FS. Preliminary administrative limits were

based on a 500 mrem/year EDE where the ARAR (TDEC Rule 0400-20-11-.16(2) and equivalent 10 CFR § 61.41) is roughly equivalent to 10 mrem/year EDE. Both WAC limits presented in TDEC's comment letter and dividing EMDF D4 RI/FS preliminary administrative limits by 50 give order of magnitude WAC limits based on methodology in the EMDF D4 RI/FS. When comparing these WAC levels with the EMWMF WAC, there are striking differences. For example, EMWMF carcinogenic WAC for Uranium-238 is 1,200 pCi/g and D4 EMDF carcinogenic WAC for Uranium-238 based on 10 mrem/year EDE[xxx] and $1X10^{-4}$ cancer risk[xxxi] is on the order of 55 to 63 pCi/g. EMWMF WAC for plutonium-239 is 720 pCi/g and the D4 EMDF carcinogenic WAC based on 10 mrem/year EDE and $1X10^{-4}$ cancer risk is 19 to 42 pCi/g. Further, the EMWMF WAC includes a shorter list of radionuclides.[xxxii]

14. The D5 version of the EMDF RI/FS includes a placeholder WAC. EMDF D5 RI/FS[xxxiii] Figure 6-91[xxxiv] shows the WAC and WAC compliance Plan will incorporate the EMDF Performance Assessment and would be verified and appropriately documented under CERCLA before the EMDF ROD. The EMDF Performance Assessment deferred the WAC to the Federal Facility Agreement (FFA) parties. Deferring the WAC to CERCLA should cause the exposure point concentration to evaluate the impact on human health from future groundwater use to be in the core/center of the plume as terms exposure point concentration, core/center of the plume, and contaminant plume are defined in OSWER Directive 9283.1-42 "Determining Groundwater Exposure Point Concentrations." The proposed WAC in the EMDF D1 ROD are not based on protection of human health from groundwater use and are not based on protection of future generations that may consume fish caught downstream. The EMDF D1 ROD WAC do include protection from inadvertent intrusion at a 100 mrem/year EDE which is an order of magnitude greater than both the cancer risk allowed by CERCLA and a relevant and appropriate requirement. The footnote includes a table comparing the EMDF D1 ROD WAC with the EMDF D4 RI/FS WAC corrected from a 500 mrem/year dose to a 10 mrem/year dose to be consistent with relevant and appropriate requirement 10 CFR § 61.41.[xxxv] The 2018 Proposed Plan[xxxvi] states: "*The purpose of WAC is to allow the disposal of only those wastes that could be protectively managed within the facility and ensure protection of human health and the environment. Wastes that do not meet the WAC will require offsite disposal or receive treatment. The final WAC will be attached to the Record of Decision (ROD) prior to signature and will be one of many factors used by DOE to assure protection of human health and the environment.*" It has not been demonstrated that the EMDF D1 ROD WAC achieves the WAC purpose stated in the Proposed Plan.
15. The EMDF D1 ROD includes an ARAR waiver or exemption from TSCA 40 CFR 761.75(b)(3), relating to hydrologic conditions, including waiving or exempting "*There shall be no hydraulic connection between the site and standing or flowing surface water.*" Without laboratory method detection limits capable of measuring release of PCBs to surface water at the recreational use water quality criteria, it has not been demonstrated protective of human health to waive or exempt this requirement. Isolation of the site from surface water is needed during landfill operations, closure, and post closure to protect human health and the environment from PCB pollution. Installation of the underdrain at EMWMF was also inconsistent with this requirement.
16. The EMDF D1 ROD includes an ARAR waiver or exemption to TDEC 0400-20-11-.17(1)(h): *"The hydrogeologic unit used for disposal shall not discharge groundwater to the surface within the disposal site."* The ROD justification includes discussion that *"Limiting the acceptance of radionuclides during operations and limiting the final inventory of those*

contaminants allowed at closure of the facility will also provide a significant measure of protectiveness. Determination of these limits for the proposed site take into account site-specific conditions and consider failure scenarios and their outcomes, to ultimately set limits that ensure human and environmental protectiveness are met per RAOs." This discussion sounds good, but the expressed methodology was apparently not used in determining what may be disposed. Failure scenarios other than having inadvertent intrusion are not included. WAC included in the EMDF D1 ROD were not based on protecting future groundwater use and were not based on protecting future surface water use. Further, even though the EMDF D1 ROD WAC is based on inadvertent intrusion, it used risk criteria of 100 mrem/year EDE which is a cancer risk about 10 times greater than cancer risk levels allowed by CERCLA. If the ARAR is waved and, in the future, someone builds a farm pond on one of the tributaries with groundwater discharging to surface water adjacent to EMDF, heaven help them. Installation of the underdrain at EMWMF was also inconsistent with this requirement.

17. Cost analyses for EMDF are incomplete. Costs presented for the remedial action are based on what may be theoretically disposed onsite without knowing WAC that protect future groundwater and surface water uses and associated volumes of waste that would be accepted in EMDF. WAC[xxxvii] appears to maximize waste disposal in the future landfill instead of identifying what wastes may be disposed while also protecting human health and the environment. Even the hybrid alternative with the combination of onsite and offsite disposal assumed all wastes that could theoretically be disposed onsite are disposed onsite and after the landfill is filled, wastes are disposed offsite[xxxviii]. The unapproved EMDF RI/FS drafts did not estimate overall cost of disposal, where wastes that meet protective WAC are segregated and disposed onsite and a significant amount of waste do not meet WAC requirements and are disposed offsite. Landfill operations have an annual cost, and the length of landfill operation affects the overall cost. Whether the landfill operates until 2045 or 2070 influences the cost evaluation.[xxxix] It is undetermined whether operating a landfill with a protective WAC and legally compliant and protective discharge criteria is more cost effective than offsite disposal.
18. The State Acceptance section in the EMDF Proposed Plan[xl] includes a list of items and data gaps that need resolved.

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[i] Performance Assessment for the Environmental Management Disposal Facility at the Y-12 National Security Complex, Oak Ridge, Tennessee (UCOR-5094/R2)

[ii] Composite Analysis for the Environmental Management Waste Management Facility and the Environmental Management Disposal Facility, Oak Ridge, Tennessee (UCOR-5095/R2)

[iii]

Radionuclide Inventory Identified for Disposal in EMDF is Significantly Greater than Radiological Inventory Disposed at EMWMF			
	EMDF/EMWMF Composite Analysis Table B.1		EMDF Performance Assessment Table B.6
Isotope Name	Reported EMWMF Activity at FY 19 (Curies)	Composite Analysis Estimated Waste Inventory Activity at EMWMF Closure (Curies)	EMDF Estimated Waste Inventory Activity at closure (Curies decayed to 2047)
Am-241	20.2	25.5	**152**
C-14^	2.77	3.5	**7.43**
Cm-244	-----	-----	**326**
Cs-137	-----	-----	**3040**
Eu-152	-----	-----	**74**
Eu-154	-----	-----	**16.7**

H-3^	12.1	15.3	28.8
I-129^	0.00115	0.00145	1.05
K-40	-----	-----	8.46
Ni-63	-----	-----	1740
Np-237	1.4	1.77	0.837
Pb-210	-----	-----	9.5
Pu-238	-----	-----	242
Pu-239/240	14	18	310
Pu-241	-----	-----	525
Pu-242	-----	-----	0.445
Ra-226	-----	-----	2.07
Sr-90	-----	-----	496
Tc-99^	170	215	7.23
Th-229	-----	-----	14.7
Th-230	-----	-----	4.94
Th-232	-----	-----	9.07
Th-234*	-----	-----	-----
U-232	-----	-----	26.3
U-233/234	433	547	1727
U-235/236	42	53	125.2
U-238	258	326	983

^Radionuclides that EMDF PA Table G.9 adjusts for activity loss due to leaching during the 25-year operational period.
*Th-234 is in secular equilibrium with U-238.

[iv] Comparison of projected leachate activity concentration at EMDF and maximum measured leachate and contact water concentrations in EMWMF from October 2015 through June 2021 show EMDF will have orders of magnitude more radionuclides in leachate than EMWMF. EMDF Performance Assessment Table C.5 at T=0 gives the projected average leachate activity concentration for several selected radionuclides including all waste and clean fill.

Comparison of Maximum Measured Activity Concentration in EMWMF Leachate and Contact Water for the period of October 2015 to June 2021 with the Average Leachate Activity Concentration Projected in EMDF at Closure.			
	Maximum Activity Concentration Measured from October 2015 through June 2021 and Reported in OREIS Data		EMDF Projected Leachate Activity Concentrations at EMDF Landfill Closure
Isotope Name	EMWMF Leachate (pCi/L) Activity concentration >1 rounded to a whole number	EMWMF Contact Water (pCi/L) Activity concentration >1 rounded to a whole number	EMDF Performance Assessment Table C.5. at T=0 (pCi/L)
Am-241	0.708	0.245	29
C-14	20	22	2,450
Cm-244	Undetected at 0.473	Undetected at 0.201	6,230
Cs-137	5	Undetected at 5.89	787
Eu-152	14	16	1,420
Eu-154	9	6	321
H-3	10300	4,790	21,000
I-129	3	2	158
K-40	65	67	215
Ni-63	65	53	673
Np-237	Undetected at 0.207	0.685	16
Pb-210	2	0.987	73
Pu-238	Undetected at 0.457	Undetected at 0.458	4,640
Pu-239/240	Undetected at 0.235	Undetected at 0.364	5,950
Pu-241	Undetected at 47.5	Undetected at 18.6	10,100

Pu-242	Undetected at 0.476	Undetected at 0.286	9
Ra-226	1	1	0.5
Sr-90 / radioactive strontium	44 (Sr-90)	8 (radioactive strontium - total)	12,600 (Sr-90)
Tc-99	2120	28,500	2,690
Th-229	Undetected at 0.503	Undetected at 0.241	4
Th-230	2	0.586	1
Th-232	0.201	0.361	2
Th-234*	28	41	
U-232	0.455	Undetected at 0.263	404
U-233/234	2200	676	26,650
U-235/236	226	48	1,926
U-238	100	41	15,100

*Th-234 should be in secular equilibrium with U-238. Therefore, leachate activity concentration in EMDF should be the same as U-238 leachate concentration.

[v] The following table from the EMDF Performance Assessment gives an indication of levels of radionuclides that DOE anticipates disposed from major cleanup areas. The EMDF Performance Assessment page B-20 states *"Activity concentrations are adjusted for radiological decay to the assumed year of EMDF closure (2047) based on radioisotope half-life and the year of data collection."*

Table B.5. Arithmetic average activity concentrations for EMDF waste streams

	EMDF waste stream average activity concentration (pCi/g)					
Radioisotope	ORNL D&D	ORNL RA	Y-12 D&D Alpha-4 and Alpha-5	Y-12 D&D Biology	Y-12 D&D Remaining Facilities	Y-12 RA
Ac-227	3.88E-02					
Am-241	2.10E+02	6.14E+02	1.61E-02	1.82E-01	5.96E-02	6.86E-01
Am-243	2.73E+00	3.95E+01				
C-14	8.53E+00	2.55E+01		4.18E+01		
Cf-249	1.44E-05					
Cf-250	9.82E-05					
Cf-251	2.79E-06					
Cf-252	1.74E-06					
Cm-243	5.18E+00	5.65E-01				
Cm-244	1.67E+03	1.40E+01	3.93E-03			
Cm-245	5.08E-01					
Cm-246	2.11E+00					
Cm-247	1.38E-01					
Cm-248	7.43E-03					
Co-60	2.18E-01	4.38E-02	6.47E-03			7.98E-04
Cs-134	2.79E-08	1.21E-07				
Cs-137	2.11E+03	1.46E+04	1.99E-01	1.32E-01	4.68E-02	5.40E+00
Eu-152	3.73E+02	8.08E+00				
Eu-154	8.49E+01	1.39E+00				
Eu-155	8.87E-02	7.95E-04				
Fe-55		1.28E-05				
H-3	1.30E+02	1.97E+01		2.23E+00		
I-129	4.92E+00	5.18E-01				
K-40	5.53E+00	1.90E+01		2.23E+01		6.33E+00
Mo-100	5.58E-05					
Na-22	1.08E-05	1.45E-07				
Nb-94	2.16E-01					
Ni-59	4.04E+01					
Ni-63	6.02E+02	8.97E+03		1.72E+00		
Np-237	4.59E-01	2.81E+00	4.90E-02	2.15E-01		4.32E-01
Pa-231	3.17E+00					
Pb-210	4.68E+01	2.26E+00				
Pm-146	1.17E-03					
Pm-147	2.83E-03	9.38E-05				
Pu-238	7.37E+02	5.46E+02	1.84E-01		3.95E-01	8.77E-03
Pu-239	2.37E+02	5.76E+02			7.62E-02	5.93E-01
Pu-240	3.51E+02	5.08E+02	6.77E-02	1.80E-01		
Pu-241	6.87E+01	2.83E+03				
Pu-242	1.83E-01	2.27E+00				
Pu-244	4.89E-02					
Ra-226	2.92E+00	3.92E+00		9.97E-01		1.45E+00

Table B.5. Arithmetic average activity concentrations for EMDF waste streams (cont.)

	EMDF waste stream average activity concentration (pCi/g)					
Radioisotope	ORNL D&D	ORNL RA	Y-12 D&D Alpha-4 and Alpha-5	Y-12 D&D Biology	Y-12 D&D Remaining Facilities	Y-12 RA
Ra-228	6.54E-03	1.39E-02			1.71E-01	2.68E-03
Re-187	2.27E-05					
Sb-125	4.02E-07					
Sr-90	2.16E+03	4.15E+02		1.75E+00	1.66E-01	
Tc-99	1.32E+01	3.94E+00	1.08E+00	4.06E+01	7.78E-01	4.61E+00
Th-228	1.16E-06	1.88E-09	5.93E-07	1.27E-05	1.58E-05	
Th-229	1.73E+00	7.96E+01			4.71E-02	
Th-230	1.70E+00	2.11E+01	4.32E-01		7.85E-02	1.37E+00
Th-232	1.19E+00	9.36E+00	3.74E-01	7.96E-01	6.54E-01	1.31E+01
U-232	8.34E-01	1.45E+02				
U-233	2.65E+02	2.92E+02		9.65E+01	1.10E+00	
U-234	1.11E+01	1.51E+02	9.10E+00	8.33E+01	5.23E+03	1.56E+01
U-235	4.20E-01	2.34E+00	7.47E-01	7.18E+00	3.16E+02	1.11E+01
U-236	2.65E-01	1.08E+00	3.80E-01	4.23E+00	7.47E+01	2.26E-01
U-238	6.79E+00	2.92E+01	3.43E+01	3.40E+02	2.91E+03	1.51E+02

D&D = deactivation and decommissioning
EMDF = Environmental Management Disposal Facility
ORNL = Oak Ridge National Laboratory
RA = remedial action
Y-12 = Y-12 National Security Complex

[vi] *Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2664&D2) APPENDIX E. Mercury Concentration in Environmental Management Disposal Facility Leachate includes:
"Untreated soils and debris that pass TCLP will be disposed of in the landfill. Although mercury has naturally high Kds, the amount of mercury-contaminated waste soil and debris expected to be disposed is large enough to result in significant "as-disposed" soil mercury concentrations that may result in measurable mercury concentrations in the leachate (see Fig. E.3). "As-generated" soil/debris mercury concentrations must be adjusted to account for the addition of soil fill, necessary for landfill stability, and the inclusion of other wastes in the landfill resulting in an "as-disposed" mercury concentration. The assumed volume of mercury-contaminated debris and soil to be disposed that will not require treatment to meet LDRs is approximately 300,000 CY. This material will be disposed along with the mercurycontaining debris and soil within the first three cells resulting in a final as-disposed volume of approximately 1.25M CY. Consequently, the as-generated mercury concentrations would be reduced by a factor of about four. Assuming the resulting, as-disposed concentration is in the range of 0.03 to 0.25 mg/kg (equivalent to an as-generated waste mercury concentrations corresponding to 0.1 to ~1 mg/kg), leachate concentrations could exceed the 51 ppt ambient water quality criteria (AWQC) for mercury depending on the Kd exhibited (see Fig. E.3). As noted in the Alpha-5 characterization results, mercury concentrations are highly variable, and 95% of debris samples exhibiting mercury concentrations up to 151 mg/kg may pass TCLP. Taking this as an upper bound of the as-generated mercury concentration and assuming the Kds for contaminated debris would be the same as soil, a leachate mercury concentration in the range of 10,000 (highest Kd) to 90,000 ppt (lowest Kd) might be possible. With the uncertainty in volumes of soil/debris to be disposed, and the variability in as-generated mercury concentrations, predictions are highly uncertain. It is expected that leachate concentrations will vary widely for reasons such as variability in rainfall, sequencing of waste volumes, operations procedures, etc."

Table B.6. Total EMDF waste radionuclide inventory (Ci decayed to 2047)

Waste mass (g)	ORNL D&D 1.94E+11	ORNL RA 1.81E+11	Y-12 D&D Alpha-4 and Alpha-5 1.37E+11	Y-12 D&D Biology 2.81E+10	Y-12 D&D Remaining Facilities 3.03E+11	Y-12 RA 5.26E+11	EMDF Waste Total Inventory (Ci) 1.37E+12	EMDF waste average activity concentration (pCi/g)
Radio-isotope	EMDF activity by waste stream (Ci)							
Ac-227	7.54E-03						7.54E-03	5.50E-03
Am-241	4.09E+01	1.11E+02	2.20E-03	5.11E-03	1.80E-02	3.61E-01	1.52E+02	1.11E+02
Am-243	5.30E-01	7.12E+00					7.65E+00	5.59E+00
Ba-133	Refer to Attachment B.3 for basis of inventory estimate						4.14E+00	3.02E+00
Be-10	Refer to Attachment B.3 for basis of inventory estimate						6.52E-05	4.76E-05
C-14	1.66E+00	4.60E+00		1.17E+00			7.43E+00	5.43E+00
Ca-41	Refer to Attachment B.3 for basis of inventory estimate						1.09E-01	7.92E-02
Cf-249	2.80E-06						2.80E-06	2.05E-06
Cf-250	1.91E-05						1.91E-05	1.39E-05
Cf-251	5.42E-07						5.42E-07	3.96E-07
Cf-252	3.37E-07						3.37E-07	2.46E-07
Cm-243	1.01E+00	1.02E-01					1.11E+00	8.10E-01
Cm-244	3.23E+02	2.53E+00	5.39E-04				3.26E+02	2.38E+02
Cm-245	9.87E-02						9.87E-02	7.21E-02
Cm-246	4.10E-01						4.10E-01	2.99E-01
Cm-247	2.68E-02						2.68E-02	1.96E-02
Cm-248	1.44E-03						1.44E-03	1.05E-03
Co-60	4.23E-02	7.90E-03	8.87E-04			4.20E-04	5.15E-02	3.76E-02
Cs-134	5.41E-09	2.19E-08					2.73E-08	1.99E-08
Cs-137	4.11E+02	2.63E+03	2.73E-02	3.71E-03	1.42E-02	2.84E+00	3.04E+03	2.22E+03
Eu-152	7.25E+01	1.46E+00					7.40E+01	5.40E+01
Eu-154	1.65E+01	2.52E-01					1.67E+01	1.22E+01
Eu-155	1.72E-02	1.44E-04					1.74E-02	1.27E-02
Fe-55		2.31E-06					2.31E-06	1.68E-06
H-3	2.52E+01	3.56E+00		6.25E-02			2.88E+01	2.10E+01
I-129	9.56E-01	9.35E-02					1.05E+00	7.66E-01
K-40	1.07E+00	3.43E+00		6.27E-01		3.33E+00	8.46E+00	6.18E+00
Mo-100	1.08E-05						1.08E-05	7.92E-06
Mo-93	Refer to Attachment B.3 for basis of inventory estimate						1.00E+00	7.30E-01

Table B.6. Total EMDF radionuclide inventory (Ci decayed to 2047) (cont.)

Waste mass (g)	ORNL D&D 1.94E+11	ORNL RA 1.81E+11	Y-12 D&D Alpha-4 and Alpha-5 1.37E+11	Y-12 D&D Biology 2.81E+10	Y-12 D&D Remaining Facilities 3.03E+11	Y-12 RA 5.26E+11	EMDF Waste Total Inventory (Ci) 1.37E+12	EMDF waste average activity concentration (pCi/g)
Radio-isotope	EMDF activity by waste stream (Ci)							
Na-22	2.09E-06	2.63E-08					2.12E-06	1.55E-06
Nb-93m	Refer to Attachment B.3 for basis of inventory estimate						6.01E-01	4.39E-01
Nb-94	4.20E-02						4.20E-02	3.07E-02
Ni-59	7.84E+00						7.84E+00	5.73E+00
Ni-63	1.17E+02	1.62E+03		4.84E-02			1.74E+03	1.27E+03
Np-237	8.92E-02	5.08E-01	6.72E-03	6.04E-03		2.27E-01	8.37E-01	6.12E-01
Pa-231	6.15E-01						6.15E-01	4.49E-01
Pb-210	9.09E+00	4.08E-01					9.50E+00	6.93E+00
Pm-146	2.28E-04						2.28E-04	1.66E-04
Pm-147	5.49E-04	1.69E-05					5.66E-04	4.13E-04
Pu-238	1.43E+02	9.86E+01	2.52E-02		1.20E-01	4.62E-03	2.42E+02	1.77E+02
Pu-239	4.61E+01	1.04E+02			2.31E-02	3.12E-01	1.50E+02	1.10E+02
Pu-240	6.81E+01	9.18E+01	9.29E-03	5.07E-03			1.60E+02	1.17E+02
Pu-241	1.33E+01	5.12E+02					5.25E+02	3.83E+02
Pu-242	3.55E-02	4.10E-01					4.45E-01	3.25E-01
Pu-244	9.49E-03						9.49E-03	6.93E-03
Ra-226	5.68E-01	7.08E-01		2.80E-02		7.63E-01	2.07E+00	1.51E+00
Ra-228	1.27E-03	2.52E-03			5.17E-02	1.41E-03	5.69E-02	4.15E-02
Re-187	4.40E-06						4.40E-06	3.21E-06
Sb-125	7.82E-08						7.82E-08	5.71E-08
Sr-90	4.21E+02	7.50E+01		4.93E-02	5.02E-02		4.96E+02	3.62E+02
Tc-99	2.57E+00	7.11E-01	1.48E-01	1.14E+00	2.36E-01	2.43E+00	7.23E+00	5.28E+00
Th-228	2.25E-07	3.40E-10	8.14E-08	3.58E-07	4.78E-06		5.45E-06	3.98E-06
Th-229	3.36E-01	1.44E+01			1.43E-02		1.47E+01	1.08E+01
Th-230	3.30E-01	3.81E+00	5.92E-02		2.38E-02	7.20E-01	4.94E+00	3.61E+00
Th-232	2.32E-01	1.69E+00	5.14E-02	2.24E-02	1.98E-01	6.87E+00	9.07E+00	6.62E+00
U-232	1.62E-01	2.61E+01					2.63E+01	1.92E+01
U-233	5.15E+01	5.27E+01		2.71E+00	3.33E-01		1.07E+02	7.83E+01
U-234	2.15E+00	2.72E+01	1.25E+00	2.34E+00	1.58E+03	8.24E+00	1.62E+03	1.19E+03
U-235	8.15E-02	4.23E-01	1.02E-01	2.02E-01	9.57E+01	5.84E+00	1.02E+02	7.47E+01
U-236	5.14E-02	1.95E-01	5.22E-02	1.19E-01	2.26E+01	1.19E-01	2.32E+01	1.69E+01
U-238	1.32E+00	5.27E+00	4.71E+00	9.56E+00	8.83E+02	7.92E+01	9.83E+02	7.18E+02

D&D = deactivation and decommissioning
EMDF = Environmental Management Disposal Facility
ORNL = Oak Ridge National Laboratory
RA = remedial action
Y-12 = Y-12 National Security Complex

[viii] This is documented in the EPA Office of the Inspector General, May 2007 Semiannual Report to Congress (EPA-350-R-07-002).

[ix] The EMWMF ROD has not been amended to authorize wastewater discharge to surface water, establish enforceable applicable or relevant and appropriate requirements (ARARs) for discharge of radionuclides and Clean Water Act (CWA) pollutants, and establish discharge criteria that are overall protective of human health and the environment. The *Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee (*DOE/OR/01-2664&D1) (DOE/OR/01-2664&D2) and (DOE/OR/01-2664&D3) (Focus Feasibility Study or FFS for Water Management) was to address this failure and provide basis for both an EMWMF ROD amendment and future discharge from a new Environmental Management Disposal Facility (EMDF) landfill. EMDF is a proposed new landfill for disposal of toxic (e.g., PCBs), hazardous (e.g., mercury), and radioactive waste in Bear Creek Valley on the DOE Oak Ridge Reservation. Dispute over this focus feasibility study for water management is the subject of EPA Administrator Wheeler's December 31, 2020, final dispute decision. The D3 version of the FFS for Water Management issued by DOE after the EPA Administrator's dispute decision did not comply with the dispute resolution decision. See EPA letter from Mr. Carl R. Froede Jr. to Mr. Roger B. Petrie dated July 22, 2021, and TDEC letter from Mr. Randy C. Young to Mr. Roger Petrie dated July 23, 2021.

[x] Oak Ridge Environmental Information System (OREIS) data

[xi] Fiscal Year 2021 Phased Construction Completion Report for the Oak Ridge Reservation Environmental Management Waste Management Facility (DOE/OR/01-2880&D2)

[xii] Oak Ridge Environmental Information System (OREIS) data.

[xiii] Joanna Burger & Kym Rouse Campbell (2008) Fishing and consumption patterns of anglers adjacent to the Oak Ridge Reservation, Tennessee: higher income anglers ate more fish and are more at risk, Journal of Risk Research, 11:3, 335-350, DOI: 10.1080/13669870701795560

[xiv] Oak Ridge Environmental Information System (OREIS) data.

[xv] See: endnote iv on *Comparison of Maximum Measured Activity Concentration in EMWMF Leachate and Contact Water for the period of October 2015 to June 2021 with the Average Leachate Activity Concentration Projected in EMDF at Closure.*

[xvi] Engineering Feasibility Plan for Groundwater Suppression at the Environmental Management Waste Management Facility, Oak Ridge Tennessee (BJC/OR-1478/R1)

[xvii] 40 CFR 761.75(b)(3) on EMWMF ROD page 2-73

TDEC 1200-2-11-.17(1)(h) EMWMF ROD page 2-74. (TDEC rule 1200-2-11-.17(1)(h) renumbered to TDEC 0400-20-11-.17(1)(h) after the EMWMF ROD was issued.)

[xviii] Addendum to Remedial Design Report for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge Tennessee, Volume 3, Appendix A (continued, Appendix B, (DOE/OR/01-1873/V3&D2/A6/R1)

Analysis of the Performance of Cells 1-6, with Underdrain, of the EMWMF, OR, TN

CONCLUSION

For the approved list of WAC constituents (Revised Table A.1: Analytic WAC Limits, http://bechteljacobs.org/webindex.html#3) assumed to be in the EMWMF at the maximum allowable concentrations (and having a finite WAC value) the risks and doses to the receptor will not exceed the current WAC criteria for all the constituents currently with approved WAC, if the EMWMF is configured with 6 cells, as depicted in Figure 1. The risk and dose criteria for all such constituents are satisfied. Several factors cause the risks and doses calculated for Cells 1 through 6 to be lower than those that formed the basis for the approved WAC. These include the fact that the underdrain beneath Cell 3 will collect a significant fraction of the leachate and direct it into Bear Creek via the remnant of NT-4. This will significantly decrease the concentrations of constituents in the well water. The analyses that led to the development of the WAC in the attainment plan (DOE 2001a), in which it was projected that the concentrations in the well water and the creek would be approximately the same, demonstrated that the vast majority of the total risk and dose to the receptor for most of the constituents came from drinking well water. Any major reduction in concentrations in the groundwater at the well, such as those achieved by the presence of the underdrain, greatly reduces projected risks and doses. Therefore, as shown in the calculation package supporting this assessment (JEG 2010b), the expansion of the EMWMF from 4 to 6 cells, will not exceed the current WAC criteria for any of the constituents currently with approved WAC.

[xix] EMWMF discharges landfill wastewater (i.e., contact water) into Bear Creek. Bear Creek and downstream are included on the 303(d) list of impaired and threated waters for PCBs and other pollutants. Bear Creek is designated for recreational use and promulgated water quality criteria for total PCBs in surface water designated for recreational use is 0.00064 ug/L. PCBs are a bioaccumulative carcinogenic pollutant. PCB-1260 is measured in fish harvested from Bear Creek. EMWMF discharges to Bear Creek surface water during February 2003 utilized a detection limit for PCB-1260 of about 2 times the water quality criteria at 0.00125 ug/L. OREIS data shows that since March 2003 detection limits for PCB-1260 in EMWMF landfill wastewater discharges ranged from 0.0311 to 0.532 ug/L with reporting limits ranging from 0.0317 to 0.61ug/L.

[xx] 2021 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Site Oak Ridge, Tennessee Data and Evaluations (DOE/OR/01-2869&D1) (2021 RER)

BCK 9.9 is located near the Bear Creek Burial Grounds and is the first fish sampling location downstream of EMWMF. (See 2021 RER Figure 4.2 for fish sampling locations.)

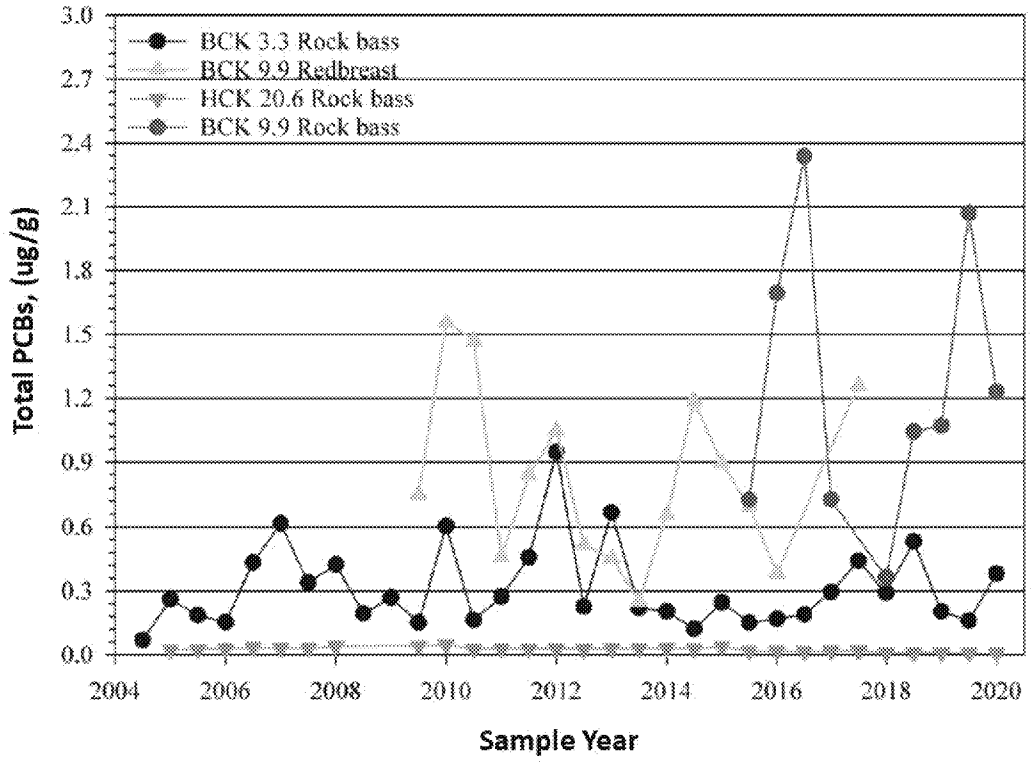

Figure 4.17. Mean concentrations of PCBs in rock bass from BCK 3.3, redbreast sunfish from BCK 9.9, rock bass from BCK 9.9, and rock bass from the Hinds Creek reference site (HCK 20.6), 2004 – 2020.

[xxi] EPA Administrator Wheeler's December 31, 2020, final dispute decision (Page 11) specifies Tennessee antidegradation rules remain legally applicable to Clean Water Act pollutants. PCBs are a CWA pollutant. TDEC Rule 0400-40-03-.06(2)(a) specifies "*Nor will discharges be authorized in such waters … that have criteria below current method detection levels.*"

[xxii] TDEC Rule 0400-40-03-.06(2)(a)

In waters with unavailable parameters, new or increased discharges that would cause measurable degradation of the parameter that is unavailable shall not be authorized. Nor will discharges be authorized in such waters if they cause additional loadings of unavailable parameters that are bioaccumulative or that have criteria below current method detection levels.

[xxiii] OREIS data of mercury in surface water at Bear Creek sampling stations BCK 9.2 and BCK 07.87 with mercury analysis performed by EPA method 1631 or 1631E from 2009 through 2020 were evaluated using ProUCL 5.1. This evaluation yielded a mercury concentration 95% UCL of 5.17 ng/L (ppt) and a median mercury concentration of 3.3 ng/L (ppt).

[xxiv] *Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee (*DOE/OR/01-2664&D1) (DOE/OR/01-2664&D2) and (DOE/OR/01-2664&D3)

[xxv] OREIS data

[xxvi] *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal Oak Ridge, Tennessee (DOE/OR/01-2535&D4)*

[xxvii] The D1 through D3 versions of the EMDF RI/FS located the EMDF groundwater point of compliance essentially outside groundwater contamination projected to originate at EMDF.

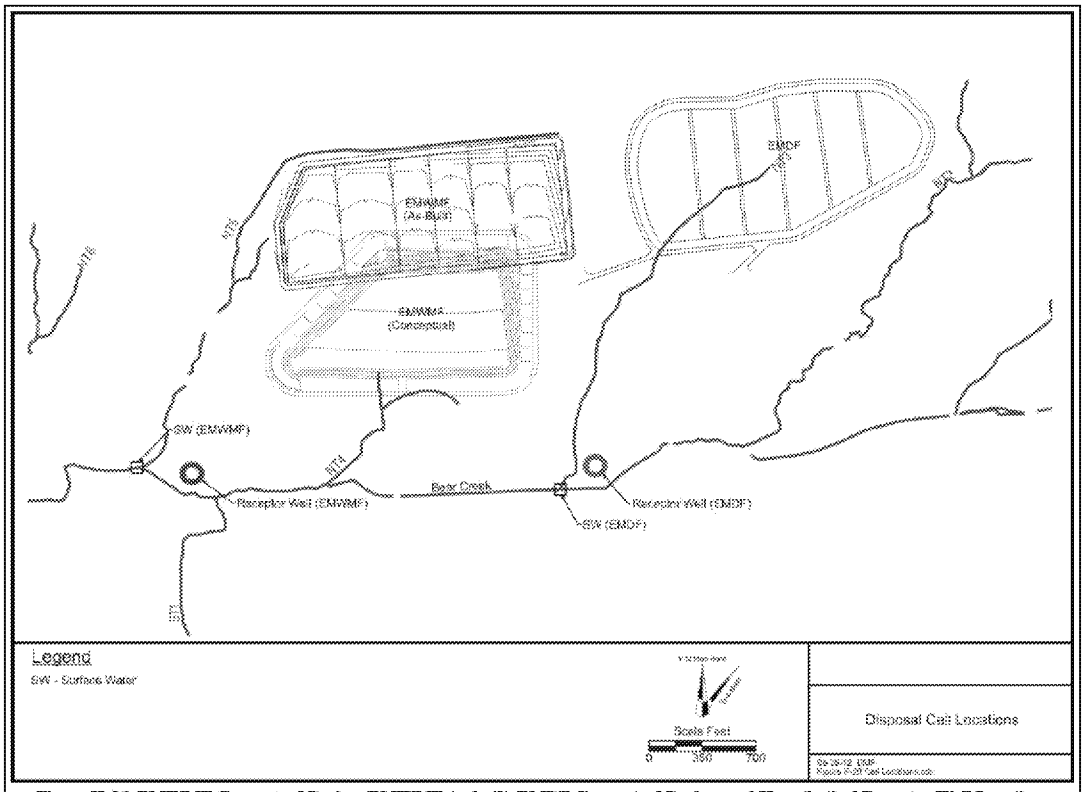

Figure H-26. EMWMF Conceptual Design, EMWMF As-built, EMDF Conceptual Design, and Hypothetical Receptor Well Locations

EMDF D3 RI/FS

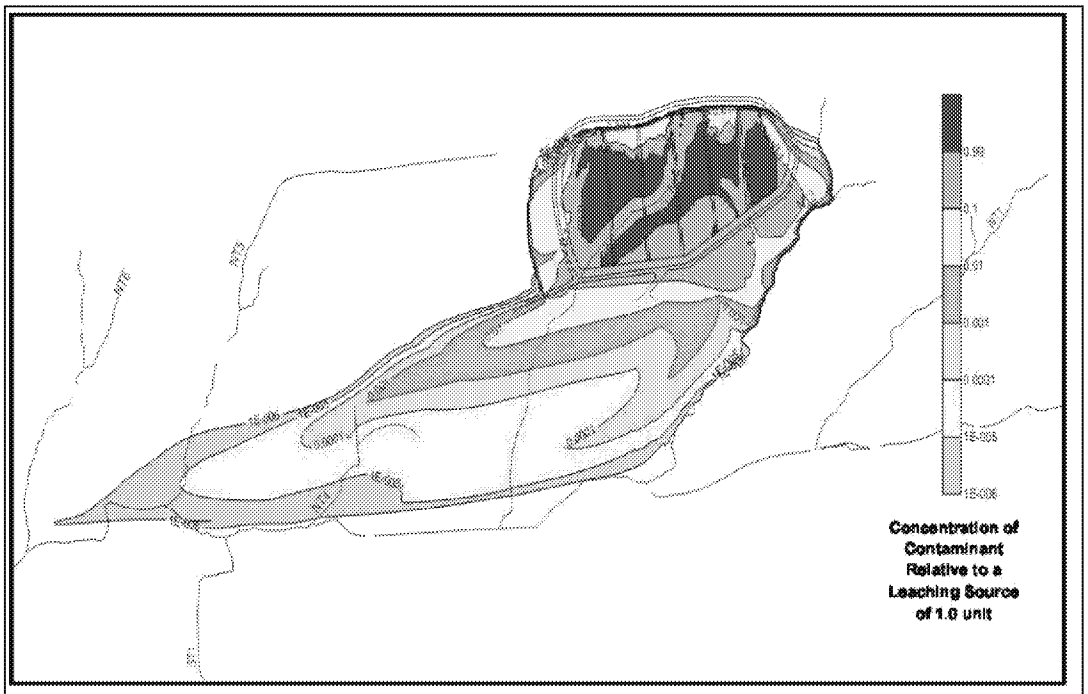

Figure H-16. MT3D Model Predicted Plume of Maximum Contaminant Concentration in All Model Layers for EMDF

EMDF D3 RI/FS

In the D4 EMDF RI/FS, the groundwater point of compliance was moved to a location near the projected highest concentration beyond a 100-meter buffer zone surrounding the waste consistent with DOE G 435.1-1.

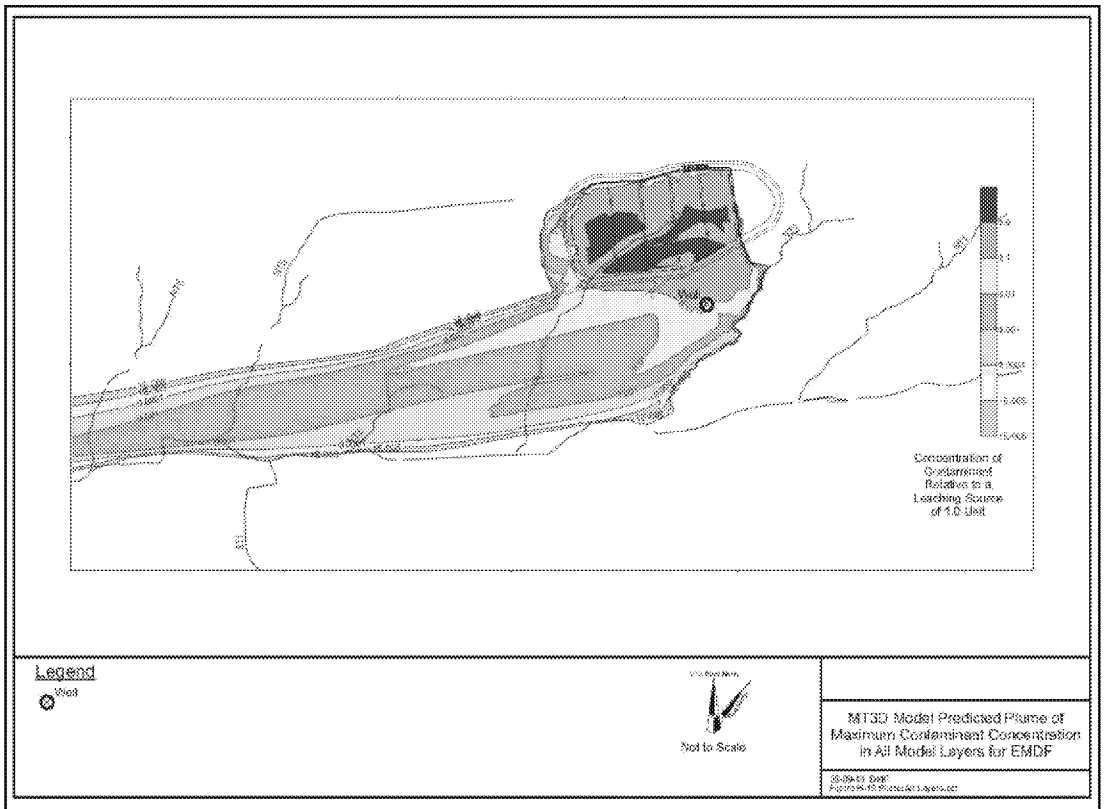

Figure H-16. MT3D Model Predicted Plume of Maximum Contaminant Concentration in All Model Layers for EMDF

EMDF D4 RI/FS

[xxviii] DOE G 435.1-1 was cancelled January 12, 2021.

[xxix] The D4 RI/FS, page H-17, states *"For radioisotopes predicted to peak after 2,000-years post-closure, preliminary administrative limits based on modeling exposures at 100 m have been assigned, considering DOE, International Commission on Radiological Protection, and proposed Nuclear Regulatory Commission exposure limit guidelines."* The EPA National Remedy Review Board's April 4, 2017 recommendations on EMDF *(EPA National Remedy Review Board Recommendations for the Oak Ridge Reservation Environmental Management Disposal Facility and Waste Management for the Disposal of Comprehensive Environmental Response, Compensation and Liability Act Waste, April 4, 2017 from Amy R. Legare to Franklin E. Hill)* states that a dose limit of 500 mrem/year and a hazard index of 3 post-2000 years would not be considered protective of human health for CERCLA cleanup purposes. D4 RI/FS Table H-13 includes carcinogenic WAC where 28 of the 32 radionuclides were assigned preliminary administrative limit based on risk greater than the CERCLA risk range and inconsistent with relevant and appropriate requirement TDEC Rule 0400-20-11-.16(2) and 10 CFR § 61.41 Protection of the general population from releases of radioactivity. TDEC commented on the preliminary administrative limits in its May 16, 2016, comment letter. DOE's response to TDEC's May 16, 2016, comments on the D4 EMDF RI/FS are included in the D5 EMDF RI/FS. DOE's full response to TDEC Comment 9: *"As noted in the D4 RIFS response to comment reviews and informal dispute resolution meetings, modeling of radionuclide fate and transport will not be presented in the D5 RI/FS. Rather, a placeholder range (low to high) of analytic Waste Acceptance Criteria limits for radionuclides will be presented, along with placeholder (total) inventory limits. The previous radionuclide fate and transport modeling (included in the D4 RI/FS) that was completed for the East Bear Creek Valley site will be removed from the revised document. Modeling to determine CBCV Site radionuclide Analytic WAC that meet Remedial Action Objectives will be performed and results documented in the CERCLA WAC Compliance Plan and the final ROD. Discussion of specific*

elements of this path forward is included in the D5 RIFS Sections3.2, 6.2.3, and 7.2.2.1 This comment dealing with modeling and/or preliminary WAC will be considered in moving forward with modeling and WAC development through the CERCLA process."

[xxx] Relevant and Appropriate requirement TDEC Rule 0400-20-11-.16(2) and 10 CFR § 61.41

[xxxi] High end of the 10^{-4} to 10^{-6} CERCLA risk range used by TDEC in the TDEC May 16, 2016, letter to DOE.

[xxxii] Based on the proximity of the EBCV site and EMWMF, it is likely that to protect future groundwater use, EMWMF WAC should be similar to the D4 EMDF WAC adjusted to 10 mrem/year instead of 500 mem/year. WAC values to protect groundwater from Table 1 of TDEC's May 16, 2016, comment letter on the D4 EMDF Remedial Investigation and Feasibility Study (RI/FS) are shown below. WAC from the D4 RI/FS shown below are adjusted so preliminary administrative limits are based on 10 mrem/year effective dose equivalents (EDE) instead of 500 mrem/year EDE. This conversion was accomplished by dividing the preliminary administrative limit by 50. EPA has determined that 10 mrem/yr EDE is within the CERCLA cancer risk range and is roughly equivalent to dose requirements in relevant and appropriate requirements TDEC Rule 0400-20-11-.16(2) and 10 CFR § 61.41. (See page 7 of EPA Administrator Wheeler's December 31, 2020, final dispute decision. 10 CFR § 61.41 was identified as a relevant and appropriate requirement in Administrator Wheeler's December 31, 2020, final dispute decision and should be ARARs for radionuclides disposed in EMWMF and a future EMDF. TDEC Rule 0400-20-11-.16(2) is the TDEC equivalent to 10 CFR § 61.41.) Source screening concentrations from the EMDF Performance Assessment for the Environmental Management Disposal Facility at the Y-12 National Security Complex, Oak Ridge, Tennessee (UCOR-5094/R2) (Performance Assessment or PA) are also included. This gives the EMDF Performance Assessment high-end screening level of radionuclides in wastes proposed to be disposed in a future EMDF. Comparing EMWMF WAC with D4 RI/FS WAC adjusted to 10 mrem/year, WAC from Table 1 of TDEC's May 16, 2016, comment letter, and the screening source concentrations indicates the list of radionuclides in the EMWMF WAC is incomplete. This is a problem because radionuclides without WAC may be disposed at unlimited amounts and are not tracked or used in determining whether overall landfill WAC is exceeded. Using a limited list of radionuclides may make a landfill seem protective when it is not. EMWMF WAC levels of certain radionuclides (e.g., I-129, uranium isotopes, and plutonium isotopes) are also significantly greater than WAC based on EMDF D4 RI/FS methodology.

Comparison of EMWMF Waste Acceptance Criteria (WAC) with EMDF D4 RI/FS WAC^						
Isotope	EMWMF Analytic WAC	EMDF D4 RI/FS Analytical WAC	TDEC May 16, 2016, letter to DOE	TDEC May 16, 2016, letter to DOE	EMDF PA Table G.18 Screening Source Concentration^^ (pCi/g)	Half-life (years)
	D2 Table F-10 Carcinogenic (pCi/g)	Table H-13 Carcinogenic WAC / Preliminary Administrative WAC Limits were divided by 50 to convert 500 mrem/yr. dose to 10 mrem/yr. dose^^^	Page 13, Table 1 /Target Risk Level	Page 13, Table 1 / Calculated WAC based on Target Risk Level using D4 RI/FS methodology (pCi/g)	pCi/g (Rounded to whole number if > 1)	ORNL RAIS
Ac-227					48,900	21.772
Am-241	2.00E+21	2.92E+13	1.00E-04	6.92E+13	2,300	432.2
Am-243		95	1.00E-04	225	23	7370
Ba-133					27	10.52
Be-10					716,000	1510000
C-14	165	69	1.00E-04	69	627,000	5700
Ca-41					4,110,000	102000
Cd-113m					111,000	14.1
Cf-249		6.60E+15	1.00E-04	2.25E+16	0.0004	351
Cf-250					0.0170	13.08
Cf-251		1.44E+07	1.00E-04	4.88E+07	0.0001	900

Cl-36		3	1.00E-05	3	1	301000
Cm-243					44	29.1
Cm-244					526,000	18.1
Cm-245		70	1.00E-04	172	98	8500
Cm-246		264	1.00E-04	665	2	4760
Cm-247		12	1.00E-04	29	24	15600000
Cm-248		3	1.00E-04	7	23	3.48E+05
Co-60					1,930,000	5.2713
Cs-135					2,460,000	2300000
Cs-137					382,000,000	30.1671
Eu-152					584,000	13.537
Eu-154					785,000	8.593
H-3	150,000	3.80E+19	1.00E-05	3.80E+19	4,840,000	12.32
I-129	13	2	1.00E-04	2	486,000	15700000
K-40		274	1.00E-04	85	57	1251000000
Mo-93					4,990	4000
Nb-93m					3,000	16.13
Nb-94		22,800	1.00E-04	6,170	190,000	20300
Ni-59		1.47E+10	1.00E-04	4.19E+09	1,550,000	101000
Ni-63					10,300,000	100.1
Np-237	320	21	1.00E-04	46	56	2144000
Pa-231		2,620	1.00E-04	13,400	3	32760
Pb-210					448	22.2
Pd-107					3,340,000	6500000
Pm-146					0.124	5.53
Pu-238					7,150	87.7
Pu-239	720	19	1.00E-04	42	185,000	24110
Pu-240	5,800	97	1.00E-04	222	8,440	6564
Pu-241					283,000	14.35
Pu-242		10	1.00E-04	23	50	375000
Pu-244		10	1.00E-04	20	11	80000000
Ra-226					14	1600
Ra-228					3	5.75
Re-187		172,200	1.00E-04	32,700	0.00194	41200000000
Se-79		35,800	1.00E-04	18,500	2,470,000	295000
Si-32		5.28E+12	1.00E-04	1.02E+12	Not Included	132
Sm-151					5,750,000	90
Sn-121m					64	43.9
Sn-126		1,874	1.00E-04	421	1,890,000	230000
Sr-90					393,000,000	28.79
Tc-99	172	46	1.00E-04	46	1,350,000	211100
Th-229					3,480	7340
Th-230					148	75380
Th-232					2,670,000	14050000000
Th-234					Same as U-238	
U-232					843,000	68.9
U-233	1,700	65	1.00E-04	57	549,000	159200
U-234	1,700	65	1.00E-04	55	1,670	245500
U-235	1,500	61	1.00E-04	51	2,570	704000000
U-236	1,700	61	1.00E-04	53	487	23420000
U-238	1,200	63	1.00E-04	55	2,070,000,000	4468000000
Zr-93		2,640	1.00E-04	3,330	556,000	1530000

^Except for Th-234 which should be in secular equilibrium with U-238 and therefore have the same activity as U-238, radionuclides with half-lives less than 5 years are not included in the above table.
^^For radionuclide screening in the EMDF Performance Assessment (PA). Per the PA, these are bounding activity concentration estimates (screening source concentrations) that include all maximum and upper confidence limit (UCL) data values as inputs to the screening model without corrections for radioactive decay or adjustments for addition of clean fill.
^^^EMDF D4 RI/FS Preliminary WAC limits divided by 50 are shown in bolded red font

[xxxiii] Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal Oak Ridge, Tennessee (DOE/OR/01-2535&D5)
[xxxiv]

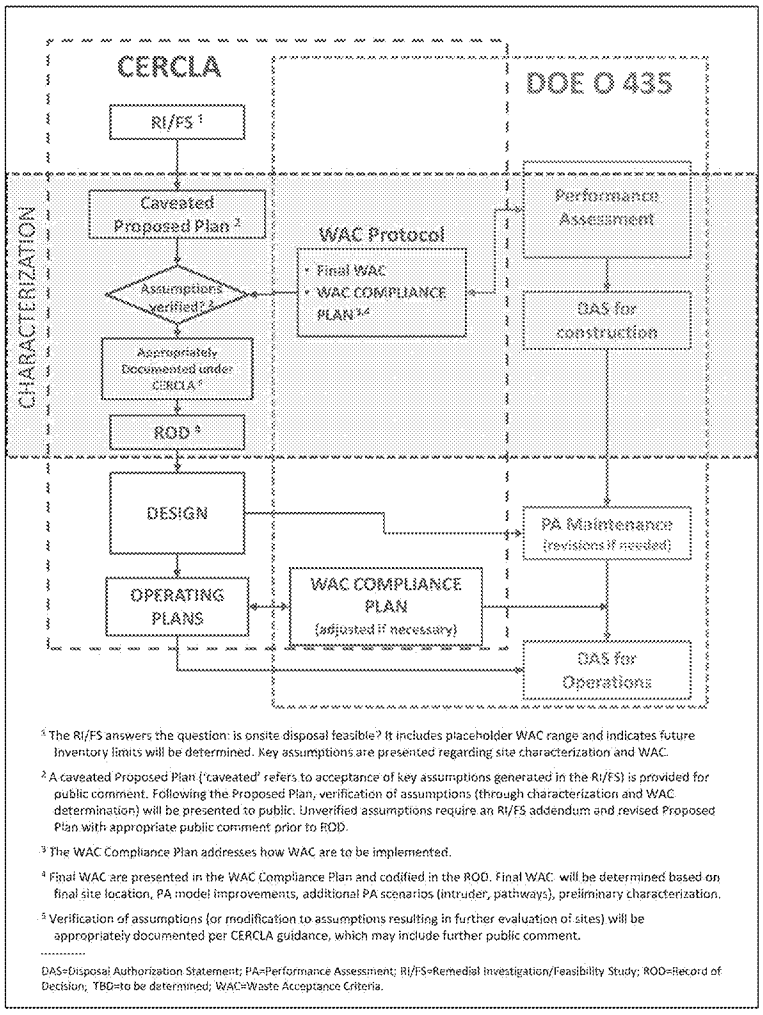

Figure 6-31. CERCLA and DOE O 435 Progression and Interaction for On-site Disposal Alternatives

[xxxv]

Comparison of EMDF D1 ROD WAC based on NRC Class C limits and Inadvertent Intrusion scenario at a 100 mrem/year dose with EMDF D4 RI/FS WAC corrected from a 500 mrem/year dose to a 10 mrem/year dose. The 500 mrem/year dose was converted to a 10 mrem dose consistent with relevant and appropriate requirement 10 CFR § 61.41 by dividing by 50. The EMDF D4 RI/FS used a groundwater point of compliance at a location near the projected highest concentration beyond a 100-meter buffer zone surrounding the waste. The EMDF D1 ROD WAC did not include protection of groundwater as criteria in WAC development. Neither the EMDF D1 ROD nor the EMDF RI/FS included protection of future surface water use in WAC development.

Comparison of EMDF D1 Record of Decision (ROD) Waste Acceptance Criteria (WAC) with EMDF D4 RI/FS WAC corrected from a 500 mrem/year dose to a 10 mrem/year dose.						
Isotope	EMDF D1 ROD WAC (pCi/g)	EMDF D4 RI/FS EBCV Site WAC at Criteria (pCi/g)	EMDF D4 RI/FS Criteria	WAC to Protect Downstream	EMDF PA Table G.18 Screening Source Concentration (pCi/g)	Half-life (years)
	If value >1, rounded to a whole number	Rounded to a whole number	10 CFR § 61.41 ARAR or ELCR Level identified	Recreational Uses	If value >1, rounded to a whole number	ORNL RAIS
Ac-227	1,300,000	NI		NE	48,900	21.772
Am-241	100,000	2.92E+13	10 CFR § 61.41	NE	2,300	432.2
Am-243	100,000	95	10 CFR § 61.41	NE	23	7370
Ba-133	55,000,000	NI		NE	27	10.52
Be-10	6,000,000	NI		NE	716,000	1510000
C-14	31,000	69	1.00E-04	NE	627,000	5700
Ca-41	2,300,000	NI		NE	4,110,000	102000
Cd-113m	NI	NI		NE	111,000	14.1
Cf-249	79,000	6.60E+15	10 CFR § 61.41	NE	0.0004	351
Cf-250	100,000	NI		NE	0.02	13.08
Cf-251	100,000	1.44E+07	10 CFR § 61.41	NE	0.0001	900
Cl-36	NI	3	1.00E-05	NE	1	301000
Cm-243	100,000	NI		NE	44	29.1
Cm-244	100,000	NI		NE	526,000	18.1
Cm-245	100,000	70	10 CFR § 61.41	NE	98	8500
Cm-246	100,000	264	10 CFR § 61.41	NE	2	4760
Cm-247	68,000	12	10 CFR § 61.41	NE	24	15600000
Cm-248	16,000	3	10 CFR § 61.41	NE	23	3.48E+05
Co-60	4,700,000,000	NI		NE	1,930,000	5.2713
Cs-135	NI	NI		NE	2,460,000	2300000
Cs-137	230,000	NI		NE	382,000,000	30.1671
Eu-152	3,600,000	NI		NE	584,000	13.537
Eu-154	63,000,000	NI		NE	785,000	8.593
H-3	570,000,000	3.80E+19	1.00E-05	NE	4,840,000	12.32
I-129	6,100	2	1.00E-04	NE	486,000	15700000
K-40	18,000	274	10 CFR § 61.41	NE	57	1251000000
Mo-93	55,000	NI		NE	4,990	4000
Nb-93m	16,000,000,000	NI		NE	3,000	16.13
Nb-94	16,000	22,800	10 CFR § 61.41	NE	190,000	20300
Ni-59	76,000,000	1.47E+10	10 CFR § 61.41	NE	1,550,000	101000
Ni-63	64,000,000	NI		NE	10,300,000	100.1
Np-237	100,000	21	10 CFR § 61.41	NE	56	2144000
Pa-231	41,000	2,620	10 CFR § 61.41	NE	3	32760
Pb-210	21,000	NI		NE	448	22.2
Pd-107	NI	NI		NE	3,340,000	6500000
Pm-146	9,600,000,000	NI		NE	0.1240	5.53
Pu-238	100,000	NI		NE	7,150	87.7
Pu-239	100,000	19	10 CFR § 61.41	NE	185,000	24110
Pu-240	100,000	97	10 CFR § 61.41	NE	8,440	6564
Pu-241	3,500,000	NI		NE	283,000	14.35
Pu-242	100,000	10	10 CFR § 61.41	NE	50	375000
Pu-244	63,000	10	10 CFR § 61.41	NE	11	80000000

Ra-226	880	NI		NE	14	1600
Ra-228	720,000,000	NI		NE	3	5.75
Re-187	NI	172,200	10 CFR § 61.41	NE	0.002	4.12E+10
Se-79	NI	35,800	10 CFR § 61.41	NE	2,470,000	295000
Sm-151	NI	NI		NE	5,750,000	90
Sn-121m	NI	NI		NE	64	43.9
Sn-126	NI	1,874	10 CFR § 61.41	NE	1,890,000	230000
Sr-90	350,000	NI		NE	393,000,000	28.79
Tc-99	48,000	46	1.00E-04	NE	1,350,000	211100
Th-229	63,000	NI		NE	3,480	7340
Th-230	2,400	NI		NE	148	75380
Th-232	4,800	NI		NE	2,670,000	1.405E+10
Th-234^				NE		
U-232	12,000	NI		NE	843,000	68.9
U-233	39,000	65	10 CFR § 61.41	NE	549,000	159200
U-234	39,000	65	10 CFR § 61.41	NE	1,670	245500
U-235	35,000	61	10 CFR § 61.41	NE	2,570	704000000
U-236	45,000	61	10 CFR § 61.41	NE	487	23420000
U-238	41,000	63	10 CFR § 61.41	NE	2,070,000,000	4468000000
Zr-93	NI	2,640	10 CFR § 61.41	NE		1530000

NI means not included. Radionuclides labeled NI have an unlimited WAC
NE means not evaluated.
^Th-234 is in secular equilibrium with U-238

[xxxvi] Proposed Plan for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Waste (DOE/OR/01-2695&D2)
[xxxvii] The EMDF D1 ROD bases WAC for radionuclides on the lesser of NCR Class C limits (EMDF Administrative WAC Table 2-4) and Inadvertent Intrusion from the EMDF Performance Assessment at a 100 mrem/year EDE. 100 mrem/year EDE is greater than the CERCLA risk range.
[xxxviii] *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal Oak Ridge, Tennessee (DOE/OR/01-2535&D5)*, Section 6.4, Hybrid Disposal Alternative.
[xxxix] DOE May 10, 2019 Response to High Level Cost Evaluation Questions: Follow-up to TDEC Request (November 29, 2018) for Backup Information Used in the Development of the Cost Estimates for Comparison of Disposal Alternatives Associated with ORR CERCLA Waste Disposal
[xl] Proposed Plan for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Waste, September 2018 (DOE/OR/01-2695&D2/R1) includes the following State Acceptance:

STATE ACCEPTANCE The State of Tennessee recognizes the importance of selecting a waste disposal option to support environmental cleanup and building demolition on the Oak Ridge Reservation (ORR) by the U.S. Department of Energy. The State also supports identification of Central Bear Creek Valley Site 7c as the most promising disposal location on the ORR. A key reason the State supports evaluation of Site 7c is its potential to provide a reasonable disposal capacity without relying on underdrains for collecting and discharging groundwater under the facility. DOE is collecting information at the site to evaluate this assumption.

To be clear, the State would not support a disposal facility that has a drainage feature (underdrain) to suppress the water table. In addition, current information about conditions at the site indicates the proposed landfill would need limits on the types and volumes of waste to protect human health and the environment. Waste exceeding onsite disposal limits would need to be disposed of offsite.

The State did not approve the remedial investigation/feasibility study report that serves as the primary basis for this Proposed Plan. The State documented concerns about protecting human health and the environment

throughout the CERCLA process leading to this Proposed Plan. On May 22, 2017, DOE initiated a formal dispute under the Federal Facility Agreement for the Oak Ridge Reservation to move the CERCLA process forward to this Proposed Plan. The State, EPA and DOE signed a Dispute Resolution Agreement on December 7, 2017. As part of the Dispute Resolution Agreement, the three parties agreed to give their best efforts to work jointly to issue this Proposed Plan identifying Central Bear Creek Valley Site 7c as the preferred location for EMDF. The Dispute Resolution Agreement outlines a general path for meeting CERCLA requirements.

It is the State's opinion that outstanding issues should be resolved before a ROD selects onsite disposal as the preferred alternative. Until then, the State is unable to approve the preferred alternative. To be clear, a preferred alternative is not the same as a preferred location. The preferred alternative presented in this Proposed Plan includes assumptions about the volumes and types of waste, as well as natural conditions at Central Bear Creek Valley Site 7c.

The following discussion summarizes the State's key concerns.

1) Site characterization (detailed description) – During March and April, 2018, DOE collected data on hydrologic conditions underlying the proposed Central Bear Creek Valley Site 7c disposal site during the "wet" season (winter/spring), consistent with the attached Field Sampling Plan. DOE submitted a "Pre-published Technical Memorandum #1" summarizing the data. Preliminary review of Technical Memorandum #1 indicates the conceptual design of the EMDF presented in the draft RI/FS reports and this Proposed Plan may need revision to accommodate the new information on site hydrology.

DOE will collect additional data before the ROD to characterize conditions during the "dry" season (summer/fall). DOE will place the data in the Administrative Record. If this information changes understanding of the site's suitability, the new information would be documented consistent with the NCP at 40 CFR 300.430(f)(3)(ii), including possible issuance of a revised Proposed Plan. Provided the FFA parties determine the EMDF can be built, operated, and closed in a manner that is protective of human health and the environment and complies with ARARs, a ROD for the EMDF would be signed consistent with CERCLA and the NCP.

2) ARAR identification – CERCLA requires the ROD to include a final list of ARARs. It is the State's position that, at a minimum, ARARs will include State and Federal statutes, rules, and regulations identified in RI/FS Appendix G attached to the Dispute Resolution Agreement. As stated in this Proposed Plan, DOE may request CERCLA waivers and/or exemptions under the State radioactive waste disposal rules and waivers under the Toxic Substances Control Act (TSCA) for the following requirements, as allowed by the regulations.
- The hydrogeologic unit used for disposal shall not discharge ground water to the surface within the disposal site. [TDEC 0400-20-11-.17(1)(h)]
- The landfill site shall be located in an area of low to moderate relief to minimize erosion and to help prevent landslides or slumping. [TSCA 40 CFR 761.75(b)(5)]
- The bottom of the landfill shall be above the historical high groundwater.... There shall be no hydraulic connection between the site and standing or flowing surface water.... The bottom of the landfill liner system or natural in-place soil barrier shall be at least fifty feet from the historical high water table. [TSCA 40 CFR 761.75(b)(3)]

The State intends to review exemption and waiver requests pursuant to statutory and regulatory requirements and the State's site-specific understanding, including characterization data, projections of waste proposed for disposal (i.e., volumes, types, and characteristics), and the conceptual dimensions for a waste disposal unit at Central Bear Creek Valley Site 7c.

3) Waste acceptance criteria –TDEC wants to make sure that the proposed landfill would be sufficiently protective for Tennessee residents. One way to protect human health over the long term is to limit what may be placed in the landfill. Limits are determined through modeling various scenarios that represent where and how people may be exposed to materials released from the landfill in the future. Even though the landfill would be engineered and constructed to specific standards, it would still be affected by natural processes such as erosion, settling, and root penetration over time. Given that some radionuclides to be placed in the landfill would remain dangerous for

thousands of years and longer, analytical WAC will be developed to limit what can go into the landfill.

The Dispute Resolution Agreement provides for the State's independent verification of DOE modeling. State acceptance of the preferred alternative relies heavily on the State's ability to complete the independent verification based on information provided by DOE. The State will consider site-specific data, assumptions, and exposure scenarios in evaluating whether the WAC support an onsite disposal alternative that meets CERCLA requirements, remedial action objectives in this Proposed Plan, and performance objectives in Tennessee radiological health rule 0400-20-11-.16. The State will evaluate potential toxic effects of uranium in addition to potential cancer risk.

4) DOE assessments – DOE Orders require an assessment of the performance of the proposed disposal facility for radionuclides. This includes the Performance Assessment (PA), Composite Analysis (CA), and Preliminary Disposal Authorization Statement (PDAS). The State contends these DOE documents should be in the Administrative Record because the State will rely on them when evaluating the protectiveness of the preferred alternative during remedy selection under CERCLA

5) Mercury disposal – Mercury contamination at the Y-12 National Security Complex (Y12) is currently the greatest known environmental risk on the ORR (DOE 2017b). DOE plans to demolish parts of Y-12, including the West End Mercury Area (WEMA) buildings. The State is concerned about disposal of mercury-containing waste from that effort because of its potential release into Bear Creek and threat to people who eat fish caught downstream.

Fish in Bear Creek and downstream in East Fork Poplar Creek already contain mercury. Both streams are posted by the State to prevent fish consumption. The State is concerned that disposal of large volumes of mercury-contaminated waste in EMDF could further degrade Bear Creek, East Fork Poplar Creek, Poplar Creek and the Clinch River. Therefore, the State expects that DOE will limit or manage mercury disposal to provide reasonable assurance that the amount of mercury released in the future will not violate the intent of the Tennessee Water Quality Control Act (TWQA) or adversely impact people fishing and eating fish downstream.

6) Use of underdrains – Tennessee operational practice does not allow drainage features to permanently suppress the water table to mitigate springs or streams at proposed landfill sites. This is consistent with Tennessee rules [for example, TDEC Rules 0400-11-01-.04(3), 0400-11-01- .04(4)(a)(2), 0400-20-11-.16(5), and 0400- 20-11-.17(1)(h)]. It is the State's position that selecting a disposal alternative that requires an underdrain would require (1) exemptions or waivers from Tennessee Division of Radiological Health and TSCA requirements and (2) a convincing demonstration that use of underdrain(s) would protect human health and the environment.

7) Discharge limits – Consistent with the Dispute Resolution Agreement, it is the State's position that discharge limits for disposal of facility wastewater should be consistent with CERCLA and established in the ROD. The State considers it important for a future onsite disposal facility to protect downstream surface water users who eat fish and comply with the Tennessee Water Quality Control Act and regulations.

CERCLA requires DOE, as the lead agency, to provide an opportunity for local governments and members of the public to offer input to help ensure selection of the most acceptable alternative. CERCLA also requires DOE to incorporate meaningful citizen input into making the decision. After DOE collects additional data, the State may request another public meeting if evaluation of the data changes the State's understanding of conditions at the Central Bear Creek Valley Site 7c.