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STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DOE OVERSIGHT DIVISION
761 EMORY VALLEY ROAD
OAK RIDGE, TENNESSEE 37830-7072

February 19, 2013

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DOE FFA Project Manager
P.O. Box 2001
Oak Ridge TN 37831-8540

Dear Mr. Japp

TDEC Comment Letter
Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge, TN
DOE/OR/01-2535&D1
September 2012

The Tennessee Department of Environment and Conservation, DOE Oversight Division has reviewed the above referenced document pursuant to the Federal Facility Agreement for the Oak Ridge Reservation. The following comments are relevant to that review.

General Comments:

The approach to development of a preliminary WAC taken in this document does not address cumulative effects due to the EMWMF and the proposed EMDF, as required by DOE M 435.1-1 (*Radioactive Waste Management Manual*).

TDEC has concerns as to whether the proposed approach is adequate for WAC development or to assure future compliance with the performance objectives required by DOE Order 435.1 and TN Rule 0400-20-11-.16. Below are listed concerns TDEC has with the risk based modeling employed in this document.

1. Sites on the ORR underlain by carbonate rocks fail a key technical requirement for siting facilities for land disposal of radioactive waste in Tennessee [TN Rule 0400-20-11-.17 (1) (b)]. Consequently, sites on the ORR underlain by carbonate rocks should not be candidate sites for CERCLA land disposal of radioactive wastes.
2. Risk modeling is ultimately based on the inventory of contaminant mass or Curies disposed. Using a volume weighted sum of fractions rather than a limit on total mass or curie content (or a mass/Curie weighted SOF) adds an extra and unnecessary step

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between the calculation of risk and waste acceptance. A less complex and more transparent WAC attainment process than that currently used at the EMWMF would be a goal for any new ORR CERCLA disposal facility, although impacts to the conclusions of this RI/FS might not be significant.

3. The list of waste types proposed for the EMDF (section 2.1.2 of the RI/FS) includes a range of demolition material, but it is not apparent that this has been reflected in the choice of solid-liquid partition coefficients used in modeling.
4. The cell design, waste forms, hydrologic setting, and operations proposed for the EMDF is not sufficient to assure that a 1 centimeter per year infiltration rate through the cell represents a plausible worst case.
5. There is little rationale provided for the scenarios used to establish long-term performance of the proposed facility. Other than a proposed three foot thick layer of 4 inch to 12 inch diameter rip-rap in the final cap design, there is nothing to address the performance objective limiting the risk to inadvertent intruders in TN Rule 0400-20-11-.16 (3), or satisfy the similar requirement in Chapter IV, paragraph (P) (2) (h) of DOE M 435.1. The RI should evaluate long term facility performance in accordance with TN Rule 0400-20-11-.16 and DOE Orders, or should provide sufficient justification to demonstrate an equivalent standard of performance under the requirements for formal waiver of ARARS, given in 40 CFR 300.430 (f)(1)(ii)(c)(4).
6. It also appears that the placement of the well (pages F-5 to F-9 of the RI/FS) to establish risks through groundwater pathways does not achieve the stated goal of determining a point of compliance at the point of highest projected dose or concentration beyond a 100 meter buffer zone surrounding the disposed waste, per DOE M 435.1 (P) (2) (b). In order to be consistent with both DOE requirements the withdrawal well should not be far outside the 100 meter buffer. A sensitivity analysis should be performed to show that the dilution factor achieved by the hypothetical location and construction of a withdrawal well is at least typical of worst case scenarios.

A more thorough consideration of all state and federal laws and regulations than that given in Appendix E will be required before establishing a list of ARARs. Some specific examples relative to siting, design, and operations requirements for the proposed facility considered by TDEC to be most significant are discussed below:

1. The discussion in Chapter 3 of Appendix E (pages E-3 and E-4) of this document is not adequate to provide a basis for the waiver of ARARs, specifically TSCA requirement 40 CFR 761.75(b) (3) or TDEC Rule 1200-2-11-.17(1)(h) (now TN 400-20 11-.17(1)(h)). The intent of both of these rules is the long term hydrologic isolation of the disposal facility liner from the water table.
2. Perimeter drains and storm water diversion channels are required to hydrologically isolate the proposed facility from surface water discharge and ground water recharge along Pine Ridge. There is no evaluation of the potential for these constructed features to fail after the closure of the facility. A record of surface water discharge and hydraulic head and water table fluctuations at the proposed site should be done to demonstrate long term performance and compliance with ARARs listed on pages E-38 and E-39 of the RI/FS (now TN Rule 0400-02-11-.17, subparagraphs (e), (f), (g), and (i), as well as the monitoring requirements of TN Rule TN Rule 0400-02-11-.17, paragraph (4).

3. TN Rule 0400-02-11-.17, subparagraph (2)(d). These requirements should be met through proper cap design and void space reduction measures.
4. TN Rule 0400-02-11-.17, subparagraph (2)(f). The requirements would not allow for the current proposal of a low permeability protective layer (modeled in the RI/FS as 1 foot of native soils – hydraulic conductivity of approximately 10^{-6} cm/s on page F-18) above the cell drainage layer and leachate collection system.
5. Wastewater treatment is described in section 6.2.2.7 of the RI/FS. ARARs specific to treatment and discharge of leachate and contaminated storm water cited in this document are listed on pages E-40 and E-60 of the document. Subpart A of 40 CFR 445 for point source discharges of wastewater from landfills subject to the provisions of 40 CFR part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart N–(Landfills) is applicable to wastewater discharges from the proposed facility. TN Rule 1200-04-05-.04 (1) (b), which prohibits the discharge of radioactive waste into waters, should be considered relevant and appropriate.

DOE concluded in 2004 (BJC/OR-1908) that the expenditure of 7 to 10 million dollars on volume reduction technologies would save 60,000 to 90,000 cubic yards of landfill capacity under the assumption that void space reduction of wastes generated from scrapyards and large buildings would translate directly into 1:1 clean fill savings requirements. Experience has shown that clean fill savings are likely to be much more significant, since ratios of over 2 to 1 clean (fill:waste) are required to get proper compaction for a variety of waste materials. Appendix B seems to demonstrate the cost effectiveness of volume reduction methods. There are, however, inconsistencies in discussion of unit cost. In comparing disposal costs for on-site and off-site options, cost per unit volume of on-site disposal was made with a basis that includes clean fill in the total disposed volume. The feasibility of processing equipment, structural steel, piping, and other items requiring a high clean fill to void ratio for off-site disposal while disposing of materials not as suitable for volume reduction such as soil or concrete on-site should be evaluated.

The conceptual design, and presumably, operational costs, of wastewater treatment are based on the assumption that the characteristics of leachate and contaminated storm water will be similar to the characteristics of wastewater currently generated at the EMWMF. The projected waste stream for EMDF disposal is, however, to be generated from somewhat different sources than waste disposed at EMWMF, and may contain contaminants that will be more expensive to treat to water quality standards. Water handling and wastewater treatment options for the proposed facility should be described in greater detail, including costs associated with possible wastewater treatment at the ORNL process waste treatment plant.

Specific Comments:

Page ES-2, RI/FS Approach, Para 3
Risk assessments on individual remedial sites may not be in the scope of this document, but a risk assessment of this new proposed disposal facility on the EMWMF receptor is required. Our preliminary evaluation indicates that the dose from the new facility close to the EMWMF receptor would be cumulative and could approximately double the dose with the same waste acceptance criteria. This situation requires a composite analysis of the two disposal facilities on the EMWMF receptor. Furthermore, a composite analysis should also incrementally include

other sources in Bear Creek Valley, such as S3 ponds, Bear Creek Burial Ground, Bone Yard Burn Yard and so forth, even to consider the Spallation Neutron Source groundwater pathway into spring SS5. It could be that this proposed facility only reduces totaled risk if other sources in Bear Creek Valley are removed, remediated, or consolidated.

Page ES-5, Top of Page,
Waste Control Specialists (WCS) should be included in this discussion or explained why they are not available. Especially since DOE has anticipated capability at the site that may be beneficial. WCS also has rail access. In general, the discussion should include more sorting alternatives for the purpose of disposing non-rad waste in RCRA permitted facilities. "Cradle to cradle" reuse/recycling of metal and other valuable material should also be discussed up front. Please state current and anticipated contract rates for each commercial facility. The discussion, as is, seems to have unsubstantiated cost estimates.

Subsequent pages through about 2-9, including figure 2-2 should include diversion of more debris into non- rad disposal. Some demolition buildings (Table A–2) will not produce all rad waste unless they are mixed with radioactive wastes (dilution). It was not our intent to allow clean waste to be mixed with concentrated rad waste to get higher volume lower activity rad waste (dilution).

Page ES-4
"The estimated total project cost for implementing the Off-site Disposal Alternative is $1.992 billion (B [2012 dollars]) or $1.408B (present worth)."

Is the EMDF cost estimate a fixed price "turn-key" bid where DOE closes the facility upon depletion of the proposed funding cost?

The Off-site Disposal Alternative of $1.992 billion should be based on hard bids from off-site disposal facilities.

Page 5-2, Table 5-1,
Table 5-1 does not evaluate waste classification. Disposal of clean wastes into non-rad RCRA permitted facilities is not mentioned. This infers dilution will be practiced.

Page 5-3, Table 5-1,
Waste Control Specialists (WCS) is a viable alternative that is not listed. Include WCS.

Page 6-15, 6.2.2.4 Disposal Facility
"The geologic buffer could be comprised of compacted native soil or in-situ fine-grained native soil, saprolite, bedrock, or combinations of these geologic materials, depending on measured in situ hydraulic conductivity and layer thickness."

There is some concern with the geologic material used in the buffer. The use of saprolite or bedrock may not be accurately measured in determining hydraulic conductivity. Saprolite and bedrock contains rock pieces that make it difficult to compact and meet the hydraulic conductivity criteria uniformly. The native soils should be sieved before use.

"A lesson learned from the EMWMF construction is that a landfill can be successfully constructed over a tributary in BCV. An underdrain is necessary within the tributary channel to provide a flow path for groundwater immediately below the landfill and prevent upwelling, since tributaries are natural discharge areas for groundwater."

A concern using an underdrain is for physical and chemical weathering of the No. 57 stone (limestone). Eventually the underdrain will fail.

Page 6-28, 6.2.2.7 Leachate/Contact Water Treatment Facility
"The portion of precipitation that falls within an open, active cell potentially coming in contact with the waste materials and collecting on the floor of the cell (referred to as "contact water") would be pumped out of the active cells and stored temporarily in lined basins located near the landfill. While in the basin, the contact water would be sampled and tested to determine whether it is contaminated. If the results of the analytical tests indicate the contact water is free of contamination, it would be released to the storm water detention basin. If contaminated, the contact water could not be released as storm water and would be transferred to the treatment facility via a dedicated piping system."

The term "Contact Water" as used here is a term invented as a matter of convenience for the EMWMF. It has no basis in TN Rules and Regulations. The state's position is that the protective soil layer should be engineered with a permeability such that water entering the active cells will be collected as leachate as much as possible.

Page 6-52, Process Modifications
Volume reduction prior to rail shipment should be a given and not a Process Modification?

Page C-4, First Paragraph, Lines 2-3
From available maps it appears that the proposed EMDF lies in the Anderson County and not the Roane County Census Tract 9801. Please explain this discrepancy.

Page C-20, Figure C-10
Faults that are referred to in the text in section 3.2.3 should be labeled in Figure C-10.

Page C-21, 3.2.2.2.2 Rutledge Limestone
This formation appears to be labeled ***"Friendship Formation"*** in Figures C-9 and C-10 (maps) on pages C-19 and C-20, respectively. As the nomenclature ***"Friendship Formation"*** seems limited to only the Oak Ridge Reservation it is suggested that the designations on the two maps be changed to reflect the commonly accepted formation name Rutledge Limestone.

Page C-21, 3.2.2.2.4 Maryville Limestone,
This formation appears to be labeled ***"Dismal Gap Formation"*** in Figures C-9 and C-10 (maps) on pages C-19 and C-20, respectively. As the nomenclature ***"Dismal Gap Formation"*** seems limited to only the Oak Ridge Reservation it is suggested that the designations on the two maps be changed to reflect the commonly accepted formation name Maryville Limestone.

Page C-22
"...weathers to for a strongly weathered saprolite..."
What is a strongly weathered saprolite? Is it not still a saprolite?

Page C-24
Section 3.2.3 1st sentence, reference to the Whiteoak Mountain thrust fault– the fault needs to be labeled on the figure (C-10)

Page C-25, 3.2.3 Geologic Structure,
Moore (1988) noted the presence of a few high angle faults near ORNL, but tentatively concluded that ". . . groundwater conduits can occur along and near faults ... but that such features are uncommon and may be rare."

Please present data that demonstrates that this is a rare occurrence.

Page C-25
"There is no evidence of active, seismically capable faults in the Valley and Ridge physiographic province or within the rocks under where the ORR is located."

The wording in this document should not be so dismissive about possible seismic hazards nearer to the facility. The USGS estimate that an earthquake as large as magnitude 7.5 (Richter) are possible in the ETSZ (East Tennessee Seismic Zone) and events of magnitude 5 – 6 are possible every 200-300 years. The largest event measured (magnitude 4.6) occurred near Knoxville in 1973.

Page C-25 – C-26
The extensive discussion about fractures in this section, although useful and fascinating, should be taken within the context that it is dissolution along bedding planes that is more important. Although tributary flow must occur along fractures, convergent regional flow occurs along conduits or macrofissures to discharge locations that maybe springs far downgradient or conduits inadvertently intercepted by wells (probably domestic or industrial) at depth.

Page C-26, Third paragraph, last sentence
"Further, they corroborate the notion that the most conductive zone is near the water table."

The nature of flow in carbonates and probably in fractured rocks like shales associated with carbonates is one of vertical tiers of conduits that initially form deep below the water table. Tiers are formed during initial development of a setting/aquifer (Worthington, 1991). There is evidence that there is continuous discharge via conduits from settings/aquifers through many millions of years (Worthington, 2004) despite base level lowering. Lower tiers discharge base flow where higher tiers discharge near the water table. Geologically recent changes to the landscape would not affect flow in deeper tiers, when sea level was 130 m lower than at present during the last glacial maximum, this further deepened flow systems.

Page C-27 3.3 Groundwater, Second paragraph
The quote and reference that follows summarizes the use of the term aquitard in Oak Ridge.

"Contaminant migration through aquitards is often erroneously believed to depend only on bulk hydraulic properties of aquitards, without regard to preferential flowpaths in the aquitard or different contaminant types. Actual rates of contaminant transport through aquitards can be very different from those based on estimates of bulk flow rates. Using a two-dimensional, discrete-fracture model, Harrison, Sudicky, and Cherry (1992) showed even though the volumetric flow rates (i.e., Darcy flux) from an aquitard to an aquifer can be very low, contaminant transport through aquitards may be relatively rapid because of fractures, even very small fractures, if they fully penetrate the aquitard. Basic hydrogeologic techniques designed for aquifers, such as pumping and slug tests, commonly need modification to be appropriate for assessment of low permeability geologic media (Novakowski and Bickerton 1997, Shapiro and Greene 1995, van der Kamp 2001)."

There are also other recent references that show it is not appropriate to describe settings as aquitards simply based upon lithology, where rather than lithological changes, what is observed are sharp changes in hydraulic head profiles in boreholes, not related to lithological changes in stratigraphy (Meyer at al, 2010, 2012).

The use of the term aquitard for lithologies in Oak Ridge should be abandoned, they are shelf sequences and in variably contain both shale and carbonate, by their nature, shales in such sequences are also most commonly discontinuous laterally. In one case an Oak Ridge aquitard has a significant spring that discharges from it, in another an Oak Ridge aquitard is, in an adjacent state a karst preserve, and overall, many domestic wells produce from what are allegedly the aquitards. Use of this term is very misleading and should be discontinued.

Page C-27 3.3.1 Aquifer Characteristics
The use of the term cavities implies that these features are closed. This is theoretically almost impossible to conceive of unless within the framework of the initial deposition of the sediments. Cavities as they are often referred to are simply fragments of sinuous conduits that are intersected by borings.

It is known in carbonates in many locations that most of the flux (> 99%, for Oak Ridge; Davies, 2008) is in conduits with most of the storage in the rock matrix. 94% flux is in conduits regardless of the age of the carbonate rock or the location.

Page C-29 3.3.1.2 Fractures,
"Further, they found that fracture aperture is more important than fracture spacing, and that fractures will dominate flow if apertures approach 1 cm or if gradient is very low so that no preferred pathway develops."

It should be noted that low gradients also can indicate that a preferred pathway has developed.

Page C-30 Section 3.3.2 Hydraulic Conductivity and Results of Tracer Tests,
"Tracer tests offer one means of direct groundwater flow rate measurement, although they require either a large number of sampling points, or knowledge of or good predictions of flow patterns."

Actually the way tracing is done using injected tracers, is that a hydrogeological conceptual model of flow is made and then tested by using injected tracers.

Page C-32 Last paragraph
It has been established that in all measured carbonate aquifers in geological old or relatively young rocks, > 94% of the discharge is in conduits, with only a small fraction in the fractures and an insignificant amount in the rock matrix (Davies, 2008; Worthington et al, 2000a, 2000b). This paragraph sets the case for an equivalent porous medium or a continuum approach. However, in the second to last sentence, beginning "Worthington, (2003, p. 30)......" reference is made to using MODFLOW to simulate flow in carbonates. This is not the complete discussion from the reference, and is misleading. The complete discussion in (Worthington, 1999, incorrectly cited as 2003) does not endorse using MODFLOW as is implied.

Page C-34 Table C-9,
Evans, et al. 1996 applied a particle tracking model and inverse modeling to get an anisotropic ratio of 10:1 for BCV.

Page C-35 Section 3.3.2.2 Results of Tracer Tests,
"Tracer tests are commonly used in fractured and karstic aquifers because they are strongly anisotropic and flow paths are difficult to determine."

Since > 94% of the discharge/flow is in conduits and conduits are known to connect sinking streams and springs, with lengths sometimes of several tens of kilometers, one would know the possible extent of the flow path if the spring was the base flow spring.

Page C-36
"Both of these types of behavior indicate a high degree of longitudinal dispersion, which is typical of systems in which matrix diffusion is dominant."

The reasons for a high value for longitudinal dispersivity in contaminant or tracer transport are also hydraulic complexity and the nature of the release of the substance.

"Matrix diffusion retarded tracer movement by uptake in small blind fractures and pores, and maintained high tracer concentrations by diffusing back into the flowing groundwater in fractures over time."

Velocities in conduits are known to be rapid (geometric mean = 0.022 m/s, n = 3,077) and therefore mostly turbulent (Worthington et al, 2000a, 2000b). How would matrix diffusion work if flow is turbulent?

"It is not the arrival time, but the peak concentration, that is of interest, since this represents the greatest risk."

The determination of an accurate peak concentration is dependent upon sampling frequency to avoid aliasing. Most current sampling done under State, Federal, or any other protocols do not sample often enough, so the values obtained are the minimum that could be passing a monitoring point. If the monitoring location is a well there could be other complications to interpreting the results.

Page C-37
The discussion of the storm-flow zone in the second paragraph implies that this is how recharge works in karst terrane in any climate or landscape. The reference used is for ***"semi-arid karst shrublands...."*** which would not be automatically appropriate for a temperate region like Oak Ridge. There are data from the ORR that refute the general thesis of the storm flow zone that must be cited.

Page C-38 Figure C-13 Conceptual Model of Groundwater Zones in BCV,
This figure lists water flux in the storm flow and vadose zone as 90%, estimates of storm flow were obtained from very steeply sloping sites. It is extremely unlikely that 90% of water flux is retained in storm flow or vadose on the moderately sloping portions of the ORR.
Further this figure shows what is referred to as an aquiclude at >500 ft. BGS. Based on the definition of the aquiclude on page C-43, contaminants are reported from these depths on the ORR (OREIS). Domestic wells emplaced within the Conasauga Group Formations offsite in the area offsite of Melton Valley were reported to be completed at depths that would be within the "aquiclude". The presence of contaminants and the use of this interval for domestic water production suggest that the term aquiclude is inappropriate.

Page C-42 and C-43 3.3.3.2.2 Intermediate and Deep Aquifer Zones,
This discussion and table C-10 suggests that elevated pH in the deeper briny groundwaters of Oak Ridge are normal. Most deep wells (not affected by contamination) encountering brines in the Valley and Ridge are somewhat acidic not caustic as presented in ESD publication 2863. Elevated pH is unlikely to be a normal condition of groundwater beneath the ORR.

Page C-44 3.3.4 Groundwater Contaminants
According to the Final Report End Use Working Group 1998, chemicals of concern at the integrator plane are uranium, nitrate, boron and fluoride. Nitrate and gross alpha in groundwater exceed legal requirements. Boron and fluoride are not included.

Page C-50 3.4.2.4 "Tributary Contaminants"
"Water in NT-3 currently meets ambient water quality criteria (AWQC)."

Is the referred AWQC, ambient water quality criteria, the State of Tennessee General Water Quality Criteria, listed within the TDEC Water Pollution Control document, General Water Quality Criteria, chapter 1200-04-03?

Page C-56 3.6.2 Aquatic Resources,
There is considerably more information relating to species in Bear Creek than is presented for NT-2 and NT-3. The ORNL Biological Monitoring and Abatement Program collect annual samples of macroinvertebrates in NT-3; why is this information not presented?

Page F-16 4.1.1 Conceptual Design of Disposal Facility,
"The waste layer is assumed to consist of contaminated soil, cement stabilized soil-like materials, cement-solidified waste, and debris (rubble)."

Cement rubble and related material has the potential to induce a hyper-alkaline plume in groundwater (See http://www.grimsel.com/gts-phase-v/hpf/hpf-introduction). Hyper-alkaline conditions in and of themselves may pose a risk to end receptors, hyper-alkaline conditions may mobilize inorganics within wastes and country rock so as to cause groundwater to exceed drinking water limits. Hyper-alkaline conditions may alter the absorptive capacity of matrix materials so as to enhance contaminant transport. This model does not seem to address the potential for cement waste material emplaced in the waste cell to alter pH of liquids leaching through the waste cell and to alter basic groundwater geochemistry.

The modeling assumptions are not explicitly spelled out, explain what they are.
What assumptions from the various model types overlap and have compound effects?
What are the assumptions about the waste cell with regards to rapid groundwater flow and transport that should be expected for the terrane beneath the site?
What is the assumption for leachate far down gradient of the cell?

Page F-3 Section 2.1 Fourth paragraph
"Small-scale geologic features, such as fractures and solution features are a major factor in groundwater movement through the formations underlying the BCV."

These features rarely have a major role in groundwater movement because they will only be tributary pathways to major large-scale features. Unfortunately these maybe be missed by drilling, even though the small-scale features may be encountered by drilling.

Page F-5, first paragraph
The majority of flow in only the upper 100 ft. of bedrock is not supported by data. The problem is that if enough deeper wells were not drilled then it is flawed logic that leads to this conclusion, especially when conduits are difficult to intercept when drilling. For example, there are many deep wells in every valley on the ORR that exhibit meteoric water signatures and often contaminants. Would this not be evidence that probably a considerable amount of groundwater circulates much deeper than 100 ft. below the land surface? The true nature of groundwater circulation at depth should be revisited, because it has been inadequately addressed in this document and others. The potential depth of circulation in the carbonates could well in excess of 400m or even deeper (Brahana and Bradley, 1985). For a basin length of 12 kilometers, (approximately from S3 ponds to the Clinch River) the calculated depth of circulation is 170 m below the present water table, circulation along the whole length of the projected basin (~80 km). This is far deeper than the river, which has been claimed to be a barrier to groundwater flow. The 170 m depth is not extreme, in fact, it was predicted in early and recent models constructed in Bear Creek Valley and such a circulation depth has been openly discussed in other documents.

The fact that deep circulation has been predicted and documented on the ORR (Nativ et al., 1997) should mean that caution should be exercised when dealing with eventualities involving accidental waste releases. This would be of particular concern in Bear Creek Valley because it is known that there are sections of Bear Creek that sink into the ground downstream and down gradient of the proposed new waste cell. As of yet there has not been a quantitative assessment made of how much groundwater, tracers, or contaminants flow in shallow, intermediate or deep groundwater zones (deeper than 120 m, 400 ft.) as determined by Bailey and Lee (1991) from both potentiometric and geochemical data. It should be noted that the hydraulic conductivity value used in the digital model constructed by Bailey and Lee (1991) of 3E-10 m/s is extremely low when it is known that contamination and evidence of meteoric water circulation is documented at greater depths (Nativ et al., 1997). Evidence of deep flow in the Cambrian and Ordovician carbonates, that extend across the mid-continent and that underlie the ORR is well known and well documented (Graven et al., 1993; Brahana and Bradley, 1985; Brahana et al., 1986).

In several locations near the proposed site there are losing reaches of Bear Creek. Most models constructed in the past for Bear Creek Valley assumed that groundwater could circulate at various depths below the current water table. These depths were assumed from early investigations. This is a reasonable assumption and follows the documented nature of flow in carbonates worldwide (Worthington, 1991; 2004). The losing reaches of Bear Creek recharge groundwater and thus recharge regional flow paths.

Davies et al. (2012) show that regional groundwater flow in the Valley and Ridge province is related to brine migration and Mississippi Valley type ore emplacement between 380 and 100 Ma, across the US Midcontinent as originally conceived and measured by Graven et al., (1993) and Leech at al., (2001). The issue of regional migration of groundwater and contaminants from the ORR along regional pathways has not been addressed.

Page F-48 Table F-5
The table contains values that require some discussion.

Groundwater zone: horizontal velocity, the value of 14 ft. / y (0.012 m/y) is far too slow for the terrane underlying the proposed facility. The geometric mean groundwater velocity in conduits in carbonates is 1,700 m/day (Worthington et al., 2000a; 2000b). In general between wells, most of which do not often intersect conduits traced velocities are in the range of 100 - 500 m/day. The reviewer understands the modeling limitations with regards to MODFLOW not being compatible with settings with high velocities and aspects of turbulent flow that should be expected even in small-sized openings. Knowledge of the limits of such models should eliminate their choice early on in the design process.

Migration of deep brines and groundwater related to the formation of MVT (Mississippi Valley Type) ore deposits in early Paleozoic sediments (mostly carbonates) over great distances across the mid-continent is a concept that has been discussed for decades and is well accepted (Graven et al., 1993). Modeling and dating show that the deep flow system was in place before the extensive folding and faulting in the Valley and Ridge province. This would mean that any recharge or water associated with the waste cell that was lost to the ground could enter this regionally large flow system.

Page G-8, 4.1 On-Site Disposal Alternative Cost-Estimate Assumptions
"The long-term monitoring and maintenance for the EMDF would continue after closure of the facility. A perpetual care fee of $1M per year for each year of operation of the EMDF would be paid into an escrow account to be used for long-term monitoring and maintenance."

The state has not agreed to the use of a perpetual care fund for long term maintenance post closure of the EMDF.

Questions or comments concerning the contents of this letter should be directed to Curt Myers at the above address or by phone at (865) 481-0995.

Sincerely

Roger B. Petrie, FFA Manager
Environmental Restoration Program

xc: Patricia Halsey, DOE
Jeff Crane, EPA
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