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STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF REMEDIATION - DOE OVERSIGHT OFFICE
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OAK RIDGE, TN 37830

August 6, 2015

Mr. John Michael Japp
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&D3
March 2015

The Tennessee Department of Environment and Conservation (TDEC), DOE Oversight Office has reviewed the above referenced document pursuant to the Federal Facility Agreement for the Oak Ridge Reservation (ORR). TDEC had extensive comments on the proposed Environmental Management Disposal Facility (EMDF) Remedial Investigation/Feasibility Study (RI/FS). Some of the issues of greatest concern are summarized below. A complete list of comments with more specific detail is attached.

TDEC sees no benefit in DOE submitting a proposed plan for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) waste disposal or proceeding with Phase 2 of the site characterization, prior to tri-party agreement on the EMDF RI/FS. We therefore look forward to discussing and resolving these issues as expeditiously as possible.

In addition, because operations at ORR will continue into the foreseeable future, TDEC believes that DOE should increase its waste minimization and segregation practices to preserve capacity at the existing EMWMF disposal facility, which will possibly reduce the footprint and impact of the proposed EMDF.

Summary of Concerns:

DOE does not provide, either in this RI/FS or in CERCLA documentation that authorizes clean-up actions on the ORR, a comprehensive analysis of the reduction in risk that would be achieved through onsite disposal, including the potential for environmental releases during the CERCLA action and during transport to the disposal site. To authorize onsite disposal of waste generated by onsite CERLCA actions, reduction in risk due to consolidation of waste and isolation of contamination should be used as a tool to screen candidate waste streams for onsite disposal.

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1. <u>Lack of consensus regarding which laws are applicable and/or relevant and appropriate (ARARs)</u>
   Until DOE, EPA and TDEC agree which laws are ARARs, there is no way to determine if the proposed site, facility design and associated waste acceptance criteria (WAC) will meet CERCLA remedial action goals. It is TDEC's position that the substantive requirements of TDEC 0400-20-11, *Licensing Requirements for Land Disposal of Radioactive Waste,* are relevant and appropriate to the management and disposal of Low Level Radioactive Waste (LLRW). Therefore, the TDEC rules require inclusion as ARARS in the RI/FS for the EMDF and subsequent CERCLA documentation.

   While TDEC agrees DOE Orders are not ARARs as defined in CERCLA, the orders nevertheless represent DOE's regulatory responsibilities under the Atomic Energy Act, as well as its obligation to maintain EMDF in perpetuity. Consequently, the DOE Orders must be considered (TBC) in Records of Decision and associated CERCLA documentation to the extent that they form a basis for a more stringent requirement than the TDEC rules. The expectation is that the more restrictive requirement will apply, as is typical of the CERCLA process.

2. <u>Site characteristics</u>
   The proposed location conflicts with siting criteria for the Toxic Substances and Control Act (TSCA), Solid Waste and LLRW and associated guidance issued by the EPA and NRC. It is TDEC's expectation that the EMDF location will meet the siting requirements of all pertinent regulations, unless officially waived. The basis for waivers of siting requirements must be founded on a robust facility design and WAC that restricts the contaminant loading of any substances that are likely to persist past the expected life of the engineered features.

   To overcome limitations of the EMDF site, DOE proposes various engineered barriers, but fails to provide substantive technical justification of their equivalency over time in the risk assessment and funding for their maintenance and monitoring beyond 100 years. All engineered barriers will be affected by natural processes over the course of time and these phenomena need to be evaluated in the risk and performance assessments and taken into account developing the WAC.

   In addition, the proposed EMDF is not the only future source of releases of contaminants into Bear Creek Valley. Releases and future releases from all sources, including and not limited to; EMDF, EMWMF, and Bear Creek Burial Grounds should be evaluated together for cumulative impact. The EMDF preliminary WAC must be modified, so EMDF will not cause or contribute to an unacceptable risk or violation of ARARs (including water quality criteria).

3. Weaknesses in the model used as the basis for assessment of risk and preliminary WAC
   Modeling used for the risk assessment and to establish preliminary WAC fails to incorporate fundamental requirements of DOE Order 435.1-1 and NRC guidance. To approve a LLRW disposal facility, TDEC requires reasonable assurance the facility can meet the performance objectives in TDEC 0400-20-11-16 over the compliance period. As DOE is obligated to abide by DOE Order, it is TDEC's position that DOE should complete the performance assessment and associated composite analysis required by DOE Order 435.1-1 and obtain a Disposal Authorization Statement (DAS) prior to finalizing the RI/FS. The DAS should be based on a full review and recommendation by DOE's LLW Disposal Facility Federal Review Group.

   In this RI/FS, the preliminary WAC fails to limit the loading of toxic substances in a protective manner. For example, more mercury would be allowed in the facility than was lost to the environment at Y-12. The strategy offered in this document leaves only the facility design as a single line of defense against future releases of contamination.

4. Mercury
   DOE has proposed that TDEC and EPA waive provisions of 40 CFR 268 to allow treatment of mercury contaminated demolition debris to land disposal restrictions (LDR) within the EMDF disposal cells. Since mercury does not degrade over time, it presents a long-term hazard similar to that of long-lived radionuclides and its disposal in unlimited amounts inside EMDF raises similar concerns relative to the limitations presented by the EMDF location and viability of the proposed engineered controls over the course of hundreds and thousands of years. In addition to satisfying the statutory criteria, any ARAR waivers requested by DOE must also demonstrate that the remedy will be protective of the public health and environment over the duration of the hazard. Furthermore, it is an expectation that these limitations and corresponding waivers will be taken into consideration with subsequent modeling and WAC development.

   TDEC does not support disposal of a principal threat waste, like debris saturated with elemental mercury, in a facility that does not meet all the requirements of a RCRA Subtitle C facility. Based on information provided to date, TDEC is not convinced that a waiver to place mercury in the disposal cell prior to treatment is appropriate; and macro encapsulation at the point of generation should be considered.

Questions or comments regarding the contents of this letter should be directed to Howard Crabtree at the above address or by phone at (865) 220-6571.

Sincerely

Randy Young
Acting FFA Manager

Enclosure

xc Shari Meghreblian, TDEC
Patricia Halsey, DOE
Jeff Crane, EPA
Jason Darby, DOE

ATTACHMENT A

Document Name: *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal Oak Ridge, Tennessee Operations Plan, Oak Ridge, Tennessee* (DOE/OR/01-2535&D3)

General Comments

In *Remedial Investigation/Feasibility Study* [RI/FS] *for Comprehensive Environmental Response, Compensation, and Liability Act* [CERCLA] *Oak Ridge Reservation* [ORR] *Waste Disposal, Oak Ridge, Tennessee* (DOE/OR/01-2535&D1), the Department of Energy (DOE) recommended a second on-site waste disposal facility for the disposal of CERCLA waste on the ORR. As proposed, the Environmental Management Disposal Facility (EMDF) would primarily be a Low Level Radioactive Waste (LLRW) Disposal Facility, but also authorized under CERCLA to dispose of hazardous and chemical wastes regulated under the Resource Conservation and Recovery Act (RCRA) and the Toxic Substances Control Act (TSCA). The Tennessee Department of Environment and Conservation (TDEC) and the U.S. Environmental Protection Agency (EPA) submitted comments on the D1 RI/FS in early 2013 that were not resolved in the D2 revision and that document was elevated to informal dispute. By agreement of parties to the Federal Facility Agreement (FFA), a D3 RI/FS was to be submitted by DOE addressing associated issues. The D3 RI/FS was received April 2, 2015. However, major issues identified in comments on previous documents and subsequent technical sessions remain unresolved in the D3 RI/FS. At this juncture, TDEC sees no benefit in DOE submitting a proposed plan for CERCLA waste disposal or proceeding with phase 2 of the site characterization prior to the resolution of the outstanding issues.

1. Subsequent to the D2 RI/FS, DOE has taken the position that state regulations governing the disposal of LLRW are not relevant and appropriate to the disposal of DOE radioactive wastes; therefore the state rules should not be considered Applicable or Relevant and Appropriate Requirements (ARARs) for the EMDF. While DOE states it is obligated to abide by DOE Orders, it is also DOE's position that the orders should not be cited as requirements or to be considered guidance (TBC) in Records of Decision and other CERCLA agreements. As a consequence, TDEC rules regulating LLRW were removed as ARARS from the D3 RI/FS, as were DOE Orders listed as TBC. TDEC strongly disagrees with DOE's position and EPA has indicated they disagree as well.

It is TDEC's position that the substantive requirements of TDEC 0400-20-11, Licensing Requirements for Land Disposal of Radioactive Waste, are relevant and appropriate to the management and disposal of LLRW authorized by the FFA under CERCLA and, in fact, intrinsic to the CERCLA process. While TDEC agrees DOE Orders are not ARARs as defined in CERCLA, the orders nevertheless represent DOE's regulatory responsibilities under the Atomic Energy Act, as well as its obligation to maintain the facility in perpetuity. Consequently the orders require consideration in Records of Decision and associated CERCLA documentation to the extent that they form a basis for a more stringent requirement than the TDEC rules. The expectation is that the more restrictive requirement will apply, as is typical of the CERCLA process. The above does not preclude DOE from pursuing the EMDF under its own authority, subject to state oversight as provided by the Tennessee Oversight Agreement.

2. There is currently no consensus between DOE, EPA and TDEC regarding which laws are applicable and/or relevant and appropriate. Until agreement is reached on ARARs, there will be no way to determine if a given proposed site, facility design, and associated waste acceptance criteria will meet CERCLA remedial action goals. If agreement cannot be reached on ARARs, DOE should use the remaining capacity at EMWMF judiciously and, if EMWMF capacity is inadequate to accommodate all waste streams generated by CERCLA actions that are necessitated by imminent risk to human health and the environment, pursue disposal options outside of CERCLA for those waste streams. These options could include on-site disposal of radioactive waste under DOE authority, on-site facilities permitted for mixed waste, and off-site disposal.

3. The proposed location for the EMDF conflicts with siting criteria for TSCA, Solid Waste, and LLRW disposal facilities and associated guidance issued by the EPA and NRC. More specifically, the EMDF, as proposed, would be located approximately 650 yards from the nearest DOE boundary and over steep slopes (>30%), shallow watertable, zones of upwelling groundwater, wetlands, seeps, springs, a stream, and complex geohydrology. While not a natural feature, the extensive underdrain system proposed to collect groundwater beneath the facility and discharge it local streams, provides a direct and rapid pathway for the dispersion of contaminants to Bear Creek and via Bear Creek to Poplar Creek and the Clinch River: a condition the siting requirements specifically attempt to avoid.

While the siting requirements for LLRW disposal facilities tend to be the most restrictive, the location proposed for the EMDF also fails to meet siting requirements for TSCA and Solid Waste disposal facilities. For example, the TSCA rules require: the bottom of the landfill liner to be greater than 50 feet from the historical high water table; there be no hydraulic connection between the site and standing or flowing surface water; and the landfill be located in an area of low to moderate relief. The TDEC Solid Waste Rules require subtitle D landfills to be located at least 200 feet from the normal boundaries of springs and streams. As the TDEC rules regulating LLRW facilities have been removed from consideration in the D3 RI/FS, a discussion of the these requirements relative to the proposed EMDF location is provided in Attachment A.

While there may be no site on the ORR that will meet all the siting requirements, it seems likely there are better location(s) that could accommodate the bulk of the waste, if more rigorous sequencing, segregation, recycling, and size reduction of waste were practiced. A Site-Wide Radioactive Waste Management Program as required by DOE Order M 435.1-1 would be expected to facilitate such an effort. In any case, it is TDEC's expectation that the EMDF meet all pertinent regulations, unless officially waived and the waiver appropriately documented.

4. To overcome limitations of the location proposed for the EMDF, DOE proposes various engineered barriers,[1] but fails to provide substantial technical justification of their equivalency over time in the risk assessment and funding for their maintenance and monitoring beyond 100 years. Due to the long-term hazards presented by uranium and other long-lived radioisotopes, NRC's view has been that engineered barriers (e.g., cap components, drains) can improve performance, but are expected to degrade over time and become ineffective. Consequently, State and NRC LLRW regulations rely heavily on the natural characteristics of a site to isolate wastes in the long-term and, thereby, protect the public health and environment. As stated in TDEC Rule 0400-11-.17(1)(a): *The primary emphasis in disposal site suitability is given to isolation of wastes, a matter having long-term impacts and to disposal site features that ensure that the long-term performance objectives of Rule 0400-20-11-.16 are met, as opposed to short-term convenience or benefits.* In this context, NRC's Performance Assessment Working Group in NUREG 1573 recommends any credit given for engineered barriers in performance assessments be specified and technically justified on a case-by-case basis. For periods over 500 years, NUREG 1573 advises it is unreasonable to assume any physical engineered barrier can be designed to function long enough to influence the eventual release of long-lived radionuclides.[2]

While the risk assessment in the RI/FS assumes some engineered components degrade (synthetics), others retain their initial functionality indefinitely. For example, clay components in the cap are assumed to retain the same hydraulic conductivity for a million years and, thereby, their ability to restrict water infiltration into the waste to 0.43 inches/year. This despite the degradation of the geomembrane and drainage layer; challenges presented by the location; the potential for differential settlement of the cap; no funds allocated for maintenance past 100 years; and evidence that the hydraulic conductivity of compacted and amended clays can increase over relatively short periods. It is also unclear how the underdrain could be repaired, if it clogged or otherwise failed over the course of time and at what expense, given it would be covered by 2.5 million cubic yards of waste (a large proportion of which would have been created by adding clean soils to fill void space). All engineered barriers are subject to long-term degradation and are apt to require maintenance to remain protective of human health and the environment over the course of time. This needs to be reflected in the EMDF risk and performance assessments and taken into account in the cost analysis.

5. This RI/FS maintains that many toxic, hazardous, and radioactive substances can be disposed in the proposed EMDF with no limits on concentration or restrictions on chemical form. The analysis is based on a risk assessment that uses limited exposure pathways for a resident located where the calculated future risk is minimal in comparison with that computed for a resident at many alternate locations in Bear Creek Valley. The risk assessment relies on assumptions of homogeneity

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[1] As defined in NUREG 1573 an "*Engineered barrier is a man-made structure or devise designed to improve the land disposal facility's ability to meet the performance objectives of 10 CFR Part 61 described in Subpart C, meaning the ability to isolate and contain waste, to retard and minimize possible release of radionuclides to the environment.*"

[2] U.S. Nuclear Regulatory Commission. NUREG- 1573: *A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities: Recommendations of NRC's Performance Assessment Working Group.* October 2000. (http://pbadupws.nrc.gov/docs/ML0037/ML003770778.pd (Last visited 07/06/2015)

and equilibria that result in best case scenarios for transport of most hazardous substances in ground water. The model does not incorporate degradation of key barrier layers in the facility, even over geologic time frames, resulting in unrealistic estimates of infiltration rates over thousands of years. The risk assessment does not consider other sources of contamination in Bear Creek Valley. The risk assessment presented in this document is therefore unusable to establish waste acceptance criteria that would protect human health and the environment. To the extent possible, the methodology described in "*Performance Assessment for the Class L-II Disposal Facility*" (ORNL, 1997, ORNL/TM-13401) should be used as a template for development of a credible WAC. TDEC recognizes this document as a competent radiological performance assessment for a Bear Creek Valley site.

6. TDEC acknowledges that there are very few, if any, preferable sites on the Oak Ridge Reservation to dispose of radioactive, hazardous, and toxic waste than the site selected in this RI/FS. TDEC does not believe that there is a site on the Oak Ridge Reservation that would accommodate a contiguous land-based waste disposal facility of the size DOE has proposed and meet TDEC rules that would apply to either a permitted radioactive waste disposal facility or a new commercial hazardous waste landfill. Likewise, we have not located an area with the requisite footprint that could be permitted under toxic waste rules. The basis for waivers of siting requirements must be founded on both a robust facility design and waste acceptance criteria that restricts the contaminant loading of any substances that are likely to persist past the expected life of the engineered features. As opposed to a good site, which has intrinsic characteristics that will provide a buffer to attenuate a future release and sufficient time to implement a corrective action, if necessary, the protectiveness of design and restrictions on waste inventory rely on human implementation and are subject to human error. In this RI/FS, the proposed waste acceptance criteria hardly limit the loading of toxic substances at all. More mercury would be allowed in the facility than was lost to the environment at Y-12, and an amount of depleted uranium comparable to that disposed in Bear Creek Burial grounds could be accepted. The strategy offered in this document leaves only the facility design as a single line of defense against future releases of contamination. This approach seems inconsistent with the approach DOE typically takes toward worker health and safety, nuclear criticality, compliance with environmental permits or any number of other issues that might involve risk to human health and the environment, where multiple lines of defense are preferred. TDEC does not think this strategy toward waste disposal is acceptable.

7. As opposed to the EMWMF, where DOE Orders are listed in the Record of Decision as "To Be Considered" guidance for on-site disposal of CERCLA generated waste, this RI/FS does not include DOE Order requirements. As DOE states it is obligated to abide by its orders, it is TDEC's position that DOE demonstrate that the proposed facility will comply with the requirements of DOE Order M 435.1-1 by completing a performance assessment, composite analysis, preliminary closure plan, and preliminary monitoring plan for the proposed facility. Based on a full review by DOE's Low-Level Waste Disposal Facility Federal Review Group, DOE should secure a disposal authorization statement, prior to decisions under CERCLA. TDEC anticipates that such a

demonstration of compliance with the requirements of DOE Orders will prevent inconsistencies with the regulatory approach under CERCLA and address inadequacies in site selection and characterization and fate and transport modeling that remain problematic in this RI/FS.

8. The approach to waste disposal of future generated CERCLA waste mirrors the approach taken almost twenty years ago to authorize waste disposal at the EMWMF. Despite doubts that the EMWMF will ultimately afford long term protection of human health and the environment, TDEC does believe that the EMWMF has provided risk reduction in the near term. The facility provides isolation of contaminants that were migrating freely into the environment, both offsite and onsite near ORR boundaries. The EMWMF has also allowed for timely demolition of deteriorating structures that contained significant inventories of radioactive material and has provided a cost effective disposal option that has facilitated brownfield development.

However, the Oak Ridge Reservation does not offer a potential disposal site that provides better intrinsic isolation of contamination from the environment or property boundaries than many of the areas where contaminated facilities or environmental media are currently located. This leads to questions about the degree of risk reduction that can be achieved by consolidation of contaminants in a single disposal facility on the ORR, particularly for contaminants that persist in the environment for centuries and millennia.

At present, few areas remaining on the ORR are scheduled for clean-up to free release status, which leads to further questions about the degree of risk reduction that may be realized by relocation of contamination, even in the short term. DOE does not provide, either in this RI/FS or in CERCLA documentation that authorizes clean-up actions on the ORR, a comprehensive analysis of the reduction in risk that would be achieved through on-site disposal, including the potential for environmental releases during the CERCLA action and during transport to the disposal site.

Consequently, TDEC suggests that attempting to build a facility that will meet all CERCLA goals and still accommodate all waste expected to eventually be generated from the demolition of legacy buildings and soil removal actions may be misguided. To justify the use of CERCLA to authorize on-site disposal of waste generated by on-site CERCLA actions, reduction in risk due to consolidation of waste and isolation of contamination should be used as a tool to screen candidate waste streams for on-site disposal. If, based on projected land-use, no significant reduction in either short term or long term risk can be clearly demonstrated for a CERCLA action that relocates the contamination to an on-site disposal facility, the waste generated by the proposed activity should not be a candidate for on-site disposal of CERCLA waste.

9. Shallow groundwater and steep slopes are part of a formula for structural instability. An inadvertent intruder will not adequately evaluate this threat and the risk to future resident farmer(s) in event of structural failure needs to be evaluated. Further, Appendix H does not include an inadvertent intruder scenario and states it will be performed as part of DOE order compliance. The

EMWMF intruder scenario assumes the intruder will not come in contact with material in steel boxes and considering steel deteriorates in the ground over time, this does not seem protective. An intruder scenario should also be included for EPA and TDEC review.

10. There are a number of uncertainties that complicate the evaluation of the cost of various alternatives that are discussed in the document. Are there any total operating costs per cubic yard of waste disposed at EMWMF? If not then it's difficult to perform an objective evaluation for off-site disposal, transportation, volume reduction, etc.? With respect to the cost of volume reduction, the longer the delays on implementing the use of volume reduction equipment, then the lower the cost benefit analysis becomes for the use of volume reduction equipment.

11. Based on the information submitted in this document, TDEC does not agree that a waiver for placement of mercury in the disposal cell prior to treatment is appropriate. Thermal mercury treatment or macro encapsulation at the point of generation should be considered.

Specific Comments

1. **Page ES1, Paragraph 3:** ..." *The EMWMF RI/FS (DOE 1998) was the first document in the CERCLA process that led to the construction and operation of EMWMF. As a follow-on to that process, this RI/FS utilizes relevant information from the EMWMF RI/FS with revisions and updates to describe and analyze current conditions."*

The EMWMF RI/FS discussed in paragraph 3 of this page did not anticipate a number of problems encountered during the construction and operation phases of EMWMF. Due to inadequate facilities to handle water at the EMWMF, as well as sloppy practices during the implementation of removal actions and during transport of waste to the facility, environmental releases of contaminants that had previously been isolated from the environment occurred. Groundwater levels beneath the EMWMF footprint proved higher than predicted and intruded into the facility buffer despite the installation of an underdrain system. The approach to waste characterization and waste acceptance was project specific and not readily amenable to regulatory audit.

After approval of the EMWMF RI/FS, Proposed Plan, and Record of Decision, TDEC staff had the opportunity to review a number of groundwater studies done in Bear Creek Valley and to conduct a tracer test in the Maynardville Limestone adjacent to the EMWMF. Additional insight into the hydrogeology of Bear Creek Valley has raised additional concerns about the validity of fate and transport modeling used in the 1998 RI/FS, which was questioned in comment submitted by TDEC in a letter prior to RI/FS approval.

Consequently, when scoping for an additional CERCLA waste disposal facility began, TDEC requested that the new facility have technically defensible waste acceptance criteria (WAC) that would allow easier verification of WAC attainment and that the facility not be built over a "blue-line" stream, thus avoiding many problems with groundwater levels below the facility as well as a direct connection of the site to surface water. The regulatory framework that was used to authorize the EMWMF is used as a template for the EMDF, but key issues which were not satisfactorily resolved for the EMWMF during the past decade of operations have not been addressed in any revision of the document now under review.

2. <u>**Page ES1, Paragraph 3**</u>:" *As a follow-on to that process, this RI/FS utilizes relevant information from the EMWMF RI/FS with revisions and updates to describe and analyze current conditions. Consistent with the EMWMF RI/FS, this RI/FS analyzes three alternatives: "*

Despite some analysis of combined off-site and on-site disposal options (see comments on section 5.4), the three alternatives presented in this document do not provide the flexibility needed to evaluate optimum waste disposal options for future waste generated by CERCLA actions in Oak Ridge. There is little justification for this choice of alternatives, other than consistency with the EMWMF RI/FS, and a no-action alternative does not provide a baseline risk that can serve as a comparison for risk reduction. The choice of alternatives seems to reflect the assumption that another waste disposal facility similar to the EMWMF can be legally sited under CERCLA on the Oak Ridge Reservation (ORR) without significantly more stringent restrictions on waste acceptance than those in place for the current facility. Reassessment of performance modeling and an evaluation of the attainment of applicable or relevant and appropriate requirements (ARARs) at EMWMF are overdue, and should be completed before the FFA parties consider authorization of a similar waste disposal facility. Suggestions for additional remedial alternatives are given in comments on page ES3.

3. <u>**Page ES1, Paragraph 4**</u>: "*Unlike a typical remediation project, the purpose of this RI/FS is not to evaluate alternatives for cleaning up a contaminated site. The purpose of this RI/FS is to develop, screen, and evaluate the alternatives for waste disposal against CERCLA criteria designed to address statutory requirements and feasibility. The RI/FS provides support for an informed selection decision about disposal of CERCLA waste.*"

A better discussion of how this RI/FS is consistent with the purpose of the remedy selection process (40 CFR 300.430 (a)(1)) is needed. A baseline risk assessment is not performed, and little is presented in the way of argument that provides information on the actual reduction of risk to human health and the environment by the various alternatives considered. A reader well-acquainted with legacy contamination in Oak Ridge might heuristically infer some significant degree of short-term risk reduction for the on-site disposal alternative and considerable long-term risk reduction for the off-site option, as discussed in Chapter 3. However, the use of CERCLA to authorize waste disposal as proposed in this RI/FS is justified primarily by the largely unstated assumption that consolidation of waste generated by demolition of contaminated facilities into an engineered disposal facility will lead to substantial risk reduction.

In cases where buildings are contaminated with hazardous materials that are mobile but not persistent in the environment, a qualitative argument is adequate support for this assumption. To make the case more generally, as is implied in this document, would require a more facility specific comparison of alternatives. The rationale behind the general assumption that consolidation will necessarily lead to risk reduction is undercut further in Oak Ridge by:

(1) no current proposed plans for consolidation of significant quantities of contaminated environmental media associated with, or proximal to, the ORR facilities that will generate the bulk of candidate waste streams,
(2) the lack of sites on the ORR with geologic and hydrologic characteristics appropriate for long-term isolation of contamination, and
(3) no location on the ORR that is not close to property boundaries, leaving little buffer area between the disposal facility and the public, a problem exacerbated by ongoing plans to release additional properties currently held by the federal government.

4. **<u>Page ES2, Paragraph 1</u>**: *"The remedial action objectives (RAOs) for alternatives evaluated in this RI/FS are:*

- *Prevent direct or indirect exposure of a human receptor to future-generated CERCLA waste that exceeds a human health risk of 10-4 to 10-6 Excess Lifetime Cancer Risk (ELCR) or Hazard Index (HI) of 1 to 3.*
- *Prevent releases of future-generated CERCLA waste, or waste constituents that exceed a human health risk of 10-4 to 10-6 ELCR or an HI of 1 to 3, or that do not meet applicable or relevant and appropriate requirements (ARARs) for environmental media. This is accomplished through compliance with chemical specific ARARs, maximum concentration limits in waters that are current or potential sources of drinking water considering site-specific background levels, or risk based levels for chemicals without ARARs.*
- *Prevent ecological exposure to future-generated CERCLA waste.*
- *Facilitate timely cleanup of ORR and associated facilities"*

The data and analyses presented in this document are not sufficient to assure that the remedial action objectives (RAOs) listed in bullets 2 and 3 on this page and stated again in Chapter 4 will be met. Human exposure levels may be kept acceptably low, but this is contingent on institutional controls and development of protective waste acceptance limits. Future impacts to water resources cannot be evaluated with the approach used in this document, which is to assess risk to a hypothetical resident using groundwater and surface water pathways. The receptor is placed at a distance 460 meters from the facility oblique to the direction of flow paths that would originate from the facility. Maximum concentration limits in waters that are current or potential sources of drinking water are evaluated only at this location. Despite the inevitability of future releases from the proposed facility to both surface water and groundwater, the requirements of neither the Safe Drinking Water Act nor the Clean Water Act (e.g., general water quality criteria, as given in chapter 0400-40-03 of Tennessee Rules) are listed as chemical specific ARARs. In addition, this RI/FS predicts (see tables H-6 and H-7) that peak concentrations in Bear Creek of a number of contaminants of principle concern will, using limits imposed by the pre-WAC established by the risk assessment in Appendix H, exceed either ambient water quality criteria or derived concentration standards that implement *DOE Order (O) 458.1, Radiation Protection of the Public and the Environment*. While TDEC challenges many of the assumptions used in the risk analysis, TDEC does agree with the RI/FS that the preferred alternative will not protect water resources. More detailed comments on evaluation of impacts to water quality can be found in comments on Appendices E, G, and H.

The fourth bullet is very general and does not necessarily imply reduction of risk to either human health or the environment. While not inconsistent with the goals of CERCLA, an evaluation of risk reduction specific to the generation and disposal of each candidate waste stream would be necessary to show that this was an appropriate objective in every case where CERCLA waste might be generated.

5. <u>Page ES2, Paragraph 3 et seq</u>: "*WASTE VOLUMES AND CHARACTERIZATION*"

The RI/FS appears to have done a good job of establishing an upper bound for the potential volume of waste to be disposed on-site. However, as stated above, the preferred alternative fails to protect water resources. To form an adequate basis for an alternative that is consistent with all the goals of CERCLA, an estimate should be established for the most probable and minimum waste volumes to be disposed on-site consistent with a more defensible set of waste acceptance criteria and aggressive waste minimization and volume reduction efforts. An attempt to better quantify the uncertainty in waste volume estimate would also be helpful. More detailed discussion of waste volume estimates can be found in comments on Appendices A and B.

6. <u>Page ES3, Paragraph 4:</u> *"Demolition of several large facilities at the Y-12 National Security Complex will result in large volumes of mercury-contaminated debris. This debris is assumed to be treated and disposed by macroencapsulation within EMDF, as part of the On-site Disposal Alternative, or transported off-site for compliant treatment/disposal in the Off-site Disposal Alternative."*

This requires waiver of Land Disposal Restriction rules, which has not been granted at this time. This RI/FS does not present sufficient information to evaluate the merits of such a waiver. Thus, a more appropriate evaluation of alternatives would include an alternative with on-site disposal and another with off-site disposal for this candidate waste.

7. <u>Page ES3, Paragraph 4</u>: "*Remedial Alternatives*"

As stated in other comments, TDEC does not agree that this document establishes either a technical or regulatory basis for on-site disposal. In conjunction with establishing this basis, other alternatives should be evaluated and carried forward. These include (1) an on-site low level radioactive waste (LLRW) disposal facility authorized under DOE Orders, with off-site disposition of TSCA and RCRA mixed waste, (2) on-site disposal of mixed TSCA/LLRW waste authorized and off-site disposition of RCRA mixed waste, (3) disposal at smaller sites and at sites further west in Bear Creek Valley, and (4) alternatives that consider aggressive steps toward waste minimization and volume reduction. Several of these alternatives were considered in this RI/FS, but were eliminated in preliminary screening due to costs. Given that this document does not provide evidence that the preferred alternative can meet other goals of CERCLA, cost alone is not an adequate reason for eliminating alternatives.

8. **Page ES4, Paragraph 2**: *"By design, the analytic WAC of a new facility would ensure risk to future receptors would not exceed risk criteria (10-5 ELCR or an HI of 1 in the first 1,000 years and maximum concentration limits in current or potential drinking water). This RI/FS provides results of fate and transport analysis which demonstrate that analytic preliminary waste acceptance criteria (PreWAC) for the proposed EMDF would meet applicable risk and dose criteria and be protective."*

The fate and transport analysis presented in this document is flawed in many respects. The limitations of the models used to predict fate and transport, and the consequent potential for underestimation of future contamination levels in ground water and surface water will be addressed in comments on Appendix H. More generally, as noted in Chapter 3 of this document with respect to long term risk posed by the proposed facility, there is currently considerable uncertainty in any estimate of values for a number of parameters that control future risk. Typical ways to minimize impacts of this uncertainty for fate and transport of contaminants in water would be to construct scenarios that assured safe drinking water limits and ambient water quality criteria were evaluated at all locations potentially impacted by releases from the facility, and to assume conservative values for key parameters controlling contaminant migration. In the analysis presented here, risk and drinking water limits are evaluated with respect to a resident at one location in Bear Creek Valley 460 meters from the facility boundary and generally away from areas that would be more contaminated by releases from the facility. In the application of the models, some parameters key to estimating the future release and migration of radioactive and hazardous constituents have been assigned values that would be considered conservative, as listed on page 82 of Appendix H, but other assumptions and estimates of parameter values lead to lack of conservatism. This appears to result in inconsistent levels of conservatism, or lack thereof, for different radioactive and hazardous constituents. If future waste disposal is to be authorized under CERCLA, modeling must be revisited to establish the veracity of the claim made for the analytic pre-WAC and to establish a defensible approach that can be used to develop final waste acceptance criteria.

In the CERCLA decision process for authorization of a new on-site disposal facility, TDEC sees two potential roles for assessment of risk to a future resident. An assessment of risk to a receptor drinking from a groundwater source adjacent to the proposed landfill could set limits for waste acceptance that would prevent any further degradation of groundwater in Bear Creek Valley due to future releases from the proposed facility. In addition, an analysis of risk to a resident at some location in Bear Creek Valley that integrates risks from all existing and proposed sources of contamination in the valley would allow an evaluation of the incremental risk that the proposed landfill might add to the risk from the aggregate of sources in the valley. This approach would be consistent with DOE's requirements for performance assessment and composite analysis, which serve similar functions in evaluating the feasibility of radioactive waste disposal at a site.

The analysis presented in this RI/FS evaluates risk to a future resident due to contamination from the proposed facility only, but does so at a location where groundwater and surface water are impacted by other sources of contamination in Bear Creek Valley. The risk assessment neglects these additional impacts, and thus serves only as an inadvertent source of confusion rather than as a tool for responsible decision making.

9. <u>**Page ES-5, Volume Reduction, Paragraph 2, 1st Sentence:**</u> Is a detailed analysis of the claim "*For the On-site Disposal Alternative, VR processing of suitable waste debris was determined to be a net expense; that is, the construction and operation of a VR facility cost more to implement than the savings it would achieve through reducing volume and conserving air space in the EMDF (e.g., building a smaller facility)*" available for review? Also, would not volume reduction be considered a best management practice, as it would ultimately reduce the size of the landfill?

10. <u>**Page ES5, Paragraph 4:**</u> "*Key assumptions regarding responsibilities of the waste generators are common to both the On- and Off-site Disposal Alternatives. The waste generators are considered to be responsible for removal of waste during cleanup actions; waste characterization and treatment as necessary to meet disposal facility WAC; and local transport to the EMDF (On-site Disposal Alternative) or the ETTP transfer facility (Off-site Disposal Alternative).*"

In some cases, this assumption may result in significant errors in total cost comparisons. For example, the K-25 building, which contributed a large volume of waste to the EMWMF, had characterization costs that were of the same order as the disposal costs. Costs for characterization for on-site disposal were driven by the mobility of key contaminants in water and an attempt by the FFA parties to minimize the potential impacts on both EMWMF operations and concentrations of radioactive constituents in ongoing releases of wastewater to Bear Creek, as well as possible impacts from future releases at the facility.

Characterization costs were presumably much higher than characterization costs would have been for off-site disposal at a facility in an arid environment. A more holistic approach to cost comparison between off-site and on-site is needed. For example, total cost comparisons that include generator costs for classes of waste with similar contaminants of concern in similar media originating from similar remedial actions would offer more insight than the limited cost analysis performed here.

11. <u>**Page ES5, Paragraph 6:**</u> "*Thus VR is included as part of the Off-site Disposal Alternative for Option 1 only (primarily disposal at NNSS). Option 2, Energy Solutions disposal, uses transport containers that are limited by weight rather than volume, thus VR is not cost effective for Option 2.*"

This would seem to assume that almost all waste generated in future CERCLA actions on the ORR will be sufficiently dense to be weight limited in transport containers. This statement may be true, but needs more justification, as potential waste types listed in Section 2.1.2 of this document includes waste with highly variable densities (e.g. structural steel versus personal protective equipment).

12. **Page ES6, Paragraph 1**: "In the CERCLA process, alternatives for remedial action are *assessed against nine evaluation criteria, which include two threshold criteria, five primary balancing criteria, and two modifying criteria. All three alternatives evaluated would meet the two threshold criteria of overall protection of human health and the environment and compliance with ARARs".*

TDEC disagrees with the ARAR selection in Appendix G. TDEC also thinks the approach to fate and transport modeling in Appendix H should be revisited. However, the modeling results do suggest that, if the only limits on waste acceptance were determined by fate and transport modeling to the hypothetical receptor identified in section 2.3 of Appendix H, the proposed facility would likely contaminate groundwater above safe drinking water limits over much of the area within a few hundred meters of the waste. These topics will be addressed in more detail in comments on Appendices G and H.

13. **Page ES6, Paragraph 1**: "*For the On-site Disposal Alternative, two waivers would be requested:*

1. A waiver of one hydrologic condition ARAR would be requested on the basis of equivalent protectiveness provided by the landfill design.

2. A waiver from Land Disposal Restrictions prohibition on placement of untreated waste in the landfill for the purpose of treatment would be requested (as an interim measure)."

The information presented in support of the waiver of a TSCA rule 40 CFR 761.75(b)(3) in this document (pages 9 and 10 of Appendix G) is not adequate grounds for a waiver based on equivalent performance as specified in 40 CFR Part 300.430(f)(1)(ii)(C). The portion of the argument relevant to the water table has merit, but the underdrain does not prevent a direct hydraulic connection to surface water, as groundwater from the site can flow directly under gravitational forces through the drain into a tributary to Bear Creek. Limits on waste acceptance determined by the expected life of design features, the anticipated degradation rate of toxic substances in the landfill, and a technically defensible approach to fate and transport would also be necessary to achieve an equivalent protectiveness.

The argument for the waiver from land disposal restrictions is also incomplete. As with other chemical species that have relatively high affinity for adsorption to soils, fate and transport modeling of mercury migration through the vadose zone yields travel times to the water table that are thousands to millions of years. Failures in the landfill design that would result in preferential migration pathways into the environment are likely before the times calculated by the model for contaminants to enter either groundwater or surface water. In addition to modeling fate and transport with more realistic estimates of travel times, details on the final waste form are needed to evaluate realistic scenarios of elemental mercury in equipment or concrete debris that could be inadvertently disposed of in the waste cell. These scenarios should be examined, and the costs of characterization and treatment necessary to prevent elemental mercury in debris from entering the proposed facility should be included in the assessment of cost.

Based on our review of the regulatory foundation for the preferred alternative (see comments on Appendix G), a number of additional waivers may be required to provide a proper legal framework for on-site disposal of CERCLA waste. This document is itself inconsistent on the issue, with other potential rules that may require waivers listed on page 32 of Appendix D.

14. **Page ES7, Paragraph 3:** *"The Off-site Disposal Alternative (Option 2) estimated cost for disposal of the projected volume of CERCLA waste is $824/yd3 (FY 2012 dollars) or $986/yd3 (Present Worth). This is approximately two times the estimated cost for disposing of the waste in the On-site Disposal Alternative ($399/yd3 [FY 2012 dollars] or $447/yd3 [Present Worth])."*

Discussion of cost is contingent on volume estimates and the assumption of on-site disposal in a large, contiguous landfill near the current disposal facility. Since such a facility may not be possible due to siting criteria, the cost estimates are premature. In any case, total cost estimates for on-site disposal versus off-site disposal should be emphasized rather than unit cost.

15. **Page ES8, Paragraph 3:** ***"PREFERRED ALTERNATIVE"***

As stated in the comments above, TDEC does not agree that the preferred alternative will necessarily meet the threshold criteria required for a selected remedy under 40 CFR Part 300.430(f)(1)(i)(A). Consequently, TDEC suggest that the following steps should be taken to work toward authorization of on-site waste disposal under the FFA.

1. Establish an agreement between the FFA parties on which rules are applicable or relevant and appropriate requirements (ARARs).
2. Select a site or sites that can either (1) meet all siting requirements specified in ARARs or (2) be cost effectively modified in such a way that any siting requirements that are not met can be waived.
3. Should ARAR compliance indicate significant limitations on volumes that can be legally and cost effectively disposed on-site, have a commitment by DOE to immediately implement aggressive waste minimization practices, including size reduction of debris and sequencing of soils and debris disposal to minimize use of clean soils as structural fill at the on-site facility currently in use.
4. Obtain disposal authorization from DOE for the proposed site(s).
5. Incorporating restrictions imposed by ARARs and the requirements of DOE Orders with information from site characterization studies and design plans, complete a valid risk assessment for the site(s) which can be used to set limits on waste acceptance for the proposed disposal facility or facilities that will protect human health and the environment.

6. Obtain sufficiently detailed information on characteristics of candidate waste streams for a comparison with waste acceptance criteria. Obtain sufficiently precise volume estimates to make cost comparisons between any potentially feasible alternatives that would include various combinations of on-site and off-site disposal consistent with waste acceptance criteria.
7. At this stage, a valid feasibility study could be written and a preferred alternative selected by the FFA parties. The comparison of alternatives should incorporate a comparison of long and short term risks, life cycle and contingency costs, and equity considerations.

16. Page ES9, Paragraph 1 et seq: "*SITE SELECTION AND CHARACTERISTICS*"

As stated elsewhere, TDEC has not seen evidence that any site on the ORR with sufficient footprint to place a contiguous 2 million cubic yard facility for near surface disposal of radioactive, hazardous, and toxic wastes can meet the threshold criteria under CERCLA, protection of human health and the environment and compliance with ARARs. Attachment B provided with these comments, shows candidate areas on the ORR for radioactive and hazardous waste disposal using current property boundaries. Areas underlain by geologic units prone to dissolution and development of karst features or having slopes in excess of 25% have been color coded. Using only these two criteria, potential candidate sites are restricted primarily to Melton Valley and Bear Creek Valley. Sites in Melton Valley and Bear Creek Valley not already filled with legacy waste are dissected by streams and have high water tables. Large sites are unlikely to meet TDEC Division of Radiological Health (DRH) rule 0400-20-11-.17 (1), *Technical Requirements for Land Disposal Facilities*, which specify site suitability requirements for land disposal of radioactive waste, siting criteria under TSCA rules 40 CFR 761.75(b)(3) and (5), or criteria under TN Rule 0400-12-02-.03 (2), *Siting Criteria for New Commercial Hazardous Waste Management Facilities.* In this RI/FS, only the TSCA criteria are considered to be ARARs, but TDEC rules are arguably both relevant and appropriate, and are more or less consistent with the requirements under TSCA. Attachment A evaluates the site chosen in this RI/FS against TDEC DRH rules.

Site suitability requirements may be waived under CERCLA, but such a demonstration would require limits on waste acceptance as well as engineered features to isolate waste, enhance stability of the landfill, and minimize site erosion. The role of engineering features serves primarily to prevent a significant release. These are mostly barriers that prevent something (usually water) from going somewhere and that route it somewhere else. The site attributes, on the other hand, primarily serve two different, but related, functions. The first is to minimize the long term effort required to maintain the barriers. Requirements for low to moderate slope are of this nature. Buttresses can be constructed, and are proposed for EMDF, but they will never be as cheap or as effective as flat ground. The second is to mitigate the impacts, in the eventuality of a release. This requires a buffer zone around the facility that provides attenuation of the release until it can be detected and evaluated and, if necessary, prevented from spreading by corrective actions. Due to the presence of streams and rapidly migrating shallow groundwater, sites on the ORR will not provide opportunities to effectively mitigate a release of contaminants. Costs for construction of a buffer comparable to that offered by a site that meets the siting criteria in state and federal rules is likely to be prohibitive.

17. **Page 2-4, Paragraph 1**: *"Material types may consist of various forms of soil and debris. Soil includes soil, sediment, and sludge. Debris includes a mixture of various forms of construction and demolition debris, including, but not limited to, the following:*

- *Reinforced concrete, block, brick, and shield walls*
- *Thick plate steel, structural steel, large piping, heavy tanks, and bridge cranes*
- *Glove boxes, fume hoods, ventilation ductwork, small piping, and conduit*
- *Insulation, floor tiles, siding materials, and transite*
- *Small buildings, small cooling towers, wood framing, and interior and exterior finishes*
- *Asphalt shingles, low-slope built-up roofs, vapor barrier, insulation, roof vents, flashing, and felt*
- *Containers, furniture, trash, and personal protective equipment (PPE)."*

Some of the waste types defined as debris may contain significant internal contamination. Based on experience at the EMWMF, proper characterization of equipment and other materials that may hold substantial contamination can significantly increase the overall cost of on-site disposal. Another concern is that deposits of contamination held inside equipment may leach at rates that are significantly faster or slower than predicted rates that assume leaching from soil-like materials or rubblized concrete. Consequently, some material types may need to be considered on a case-to-case basis to evaluate their long-term performance in a landfill.

18. **Page 2-5, Paragraph 4**: **"*2.2 RI/FS WASTE VOLUME ESTIMATES*"**
"The waste volume estimates included in this RI/FS are limited to future CERCLA waste that will be generated from facility D&D and environmental restoration activities on the ORR. Development of waste volume estimates for this RI/FS relies on waste disposal practices and experiences on the ORR to date and reasonable assumptions about planned future D&D and remedial action activities."

A number of factors might influence the actual volume of waste disposed in a future on-site facility, including waste acceptance restrictions, more aggressive volume reduction, and other disposal practices that are different from those of the recent past. Assessment of the feasibility and cost associated with combined on-site and off-site scenarios evaluated in section 5.4 of the RI/FS indicates that costs associated with on-site disposal are significantly lower than off-site disposal only if at least half of the candidate waste considered in Table 2-2 of this RI/FS is suitable for disposal on-site, and then, only if a single large landfill can be used.

19. **Page 2-9, Paragraph 1**: *"A straight 25% uncertainty on waste volumes is assumed in this document."*
The assumption of an additional 25% waste volume may create a bias that makes the unit cost of on-site disposal appear cheaper than unit cost estimates based on more realistic assumptions.

20. **Page 2-9, Paragraph 2:** *"Establish total fill needed using a multiplication factor of 2.26 applied to the as-disposed debris volume. The factor 2.26 is based on a field-determined ratio of total fill density to as-disposed debris density."*

This statement implies that about 5/4 the volume of the as disposed debris volume will need to be added as structural fill. As the densities of soil and debris may differ significantly, it is unclear how the volume ratio can be simply extracted from a field determined density ratio. This factor has also changed significantly over time. Better justification should be given for this number.

21. **Page 2-10, Paragraph 2:** *" Previous waste volume estimates required a facility size of 2.5 M yd3 and as this is only a conceptual design, the difference between 2.2 and 2.5 M yd3 will allow for final design changes (e.g., slope recalculations, cut/fill changes, height of waste, etc.); the conceptual design has not been modified. As explained in Table 2-4, the additional 25% volume uncertainty adds approximately the volume of one cell (Cell 5) to the projected disposal capacity without uncertainty. The additional 15% capacity is approximately equivalent to the size of cell 6, and as discussed, this contingency in capacity will accommodate final design changes. Establish total fill needed using a multiplication factor of 2.26 applied to the as-disposed debris volume. The factor 2.26 is based on a field-determined ratio of total fill density to as-disposed debris density."*

The conceptual design for the landfill accommodates 2.5 million cubic yards when the projected waste volume needed for waste disposal is estimated to be about 2/3 of that capacity. As stated in other comments, TDEC currently has seen no evidence that a 2.5 million cubic yard facility can be compliantly sited on the ORR. Better information on the waste volume and characteristics of candidate waste streams will be necessary to provide for more realistic cost estimates of compliant alternatives, such as the combined on and off-site disposal alternatives discussed in section 5.4 of the RI/FS.

22. **Page 2-10, Table 2.3:** From this table it is obvious that the amount of clean fill planned for use nearly equals the combined total of debris + waste soil. Wouldn't further volume reduction of debris be environmentally judicious?

23. **Page 2-14, Paragraph 1:** *"2.3 RI/FS WASTE CHARACTERIZATION"*
"This section discusses characterization of future generated CERCLA waste streams. Because detailed characterization data do not exist for many of the individual D&D and remediation projects, characterization of future waste streams is based on available data for waste disposed at EMWMF to establish contaminants of potential concern (COPCs) and estimate contaminant concentrations. This methodology relies on the assumption that available data for waste disposed at EMWMF approximately represent the waste characteristics of future waste streams."

The assumption that waste characteristics of the waste streams that are candidates for future on-site disposal will be sufficiently similar to the waste characteristics of waste disposed at the EMWMF to allow accurate estimates of on-site waste volumes is not well supported by either data or process knowledge. This is only likely to be true if essentially all candidate waste will be acceptable at the proposed facility.

24. **Page 2-14, Paragraph 1:** *"Use of characterization data for waste disposed at EMWMF is limited in the RI/FS to serving as a basis for the transportation risk and natural phenomena risk calculations."*

Note that the waste inventory that was not accepted for disposal at EMWMF and was consequently shipped off-site included much of the material that would drive exposure risk. Risks due to non-exposure related transportation accidents may increase proportionally with the volume shipped off-site, but exposure risks are unlikely to do so.

25. **Page 3-3, Table 3.1:** It would be helpful if Document numbers were included for any documents in this table that currently lack them (e.g. Hot Garden).

26. **Page 3-8, Paragraph 1:** *"No changes are expected to the pre-WAC/risk evaluation through the Proposed Plan and ROD processes."*

In comments submitted on the 1998 EMWMF RI/FS, TDEC expressed concerns that pre-WAC development was based on modeling that did not have adequate foundations in either science or regulations. A decision was made at that time to approve the RI/FS and address waste acceptance uncertainties at a later date. Administrative limits that prevented acceptance of radioactive waste deemed by the Nuclear Regulatory Commission and Tennessee Division of Radiological Health to be unsuitable for shallow land disposal were negotiated after the EMWMF Record of Decision, but improved performance modeling of the site was never initiated. Other than the administrative limits, waste acceptance limits established in the EMWMF RI/FS were never altered. Additional information on groundwater flow in Bear Creek Valley and changes to the size and scope of the waste disposal operations at the EMWMF have since increased concerns over the protectiveness of the EMWMF WAC, and efforts have been made by the FFA parties to limit waste with high concentrations of radionuclides to disposal in more suitable facilities offsite. Consequently, TDEC asked DOE to revisit performance modeling and WAC development prior to submitting CERCLA documentation for a new CERCLA waste disposal facility. DOE has not addressed this concern, and the D3 RI/FS again postpones any changes to the modeling until after key regulatory decisions have been made, stating, at the top of page 3-8, "No changes are expected to the pre-WAC/risk evaluation through the Proposed Plan and ROD processes." In more detailed comments on pre-WAC development in Appendix H, some preconditions necessary for development of a credible pre-WAC are given and some constraints on modeling parameters are suggested.

27. **Page 6-6, Paragraph 2, Line 9:** *"An acoustic bat survey conducted by ORNL personnel did not detect any listed bats, such as the endangered Gray or Indiana bats."*

It is strongly recommended that a new bat acoustic survey be conducted at the proposed EMDF site. Although the previous ORNL survey did not detect the federally endangered Indiana or Gray bats, this study may have been completed prior to the recent listing of the Northern Long-eared bat as a federally threatened species. Accordingly, acoustic survey information is needed to determine if the Northern Long-eared bat is present onsite or not present. If an acoustic survey detects threatened and endangered bat species at the EMDF proposed site, then DOE may need to enter into a section 7 consultation with the US Fish and Wildlife Service to address the threatened and endangered species at this site.

28. **Page 6-20, Floor of Landfill, 1st Bullet, Lines 3-5:** *"The purpose of geotextile as separator layers is to provide a filter that restricts finer particles of a material on one side of the textile from traveling through to the other side in order to reduce the potential for clogging."*

Either the reader is misunderstanding something or there is a problem with this statement. It seems that, if a layer restricts the passage of small particles, enough of these particles would accumulate to cause water movement through these to be slowed and then stopped.

29. **Page 6-21, Facility Underdrain discussion:** Are there any case studies or solid examples that the proposed underdrain would function as described? Strong evidence that the underdrain would be successful is needed.

30. **Page 6-39, Facility Underdrain discussion:** The arguments made here for a forested landfill cover may not prove valid. Although initially one may be able to establish the desired mix of vegetation, there are no guarantees that these conditions will remain stagnant over time. Establishment of a climax forest does not mean that conditions will remain the same over time. The collapse of individual trees will open that area for a new succession. The vegetation growing in such a disturbed site may not fit the desired type for the climax-forested landfill.

Additionally, disturbances, such as those that have already historically occurred at the site could be an extremely important factor in what the eventual climax forest cover looks like. The downburst that seriously impacted the forest cover at the site in the past couple of years could tremendously change any man-made plans for a final vegetative cover.

31. **Page 6-55, Last Paragraph, Lines 4-6:** Can materials bound for Energy Solutions in Clive, Utah not be shipped all the way via rail? Is it being indicated here that the material is being trucked from Kingman, Arizona to Clive, Utah.

32. **Page 7-7, Paragraph 2, Line 9:** *"There are currently no identified federal- or state-listed threatened and endangered species in the proposed EMDF site area."*

This sentence should be struck until the presence/non-presence of the federally-threatened Northern Long-eared bat at the proposed EMDF site can be determined.

33. **Page 7-9, Paragraph 2:** What guarantees are there that the landfill design will not leak for a 100 years much less 200, 1000 or several 1000's years? Are there currently any landfills that have never leaked?

34. **Page 7-10, Paragraph 2:** "*Survival of an engineered landfill structure for thousands of years is not unreasonable since, for example, many British earthen hill forts more than 2,000 years old are remain essentially intact. Native American mounds in the Ohio and Tennessee River valleys, many of which are more than 1,000 years old, have also survived with little erosion, as have similar structures built by pre-Columbian civilizations in the much wetter climates of Central and South America. Detailed design calculations will be conducted, in part, to assess the capability of the landfill design to protect from long-term geomorphic and seismic stresses. If final design efforts identify areas needing improvement, these would be incorporated into the final design.*"

The concern is not whether a relic of the EDMF will remain after 1,000 or more years, but whether engineered barriers can be relied upon to contain radioactive and hazardous contaminants for the period. Prior to approving a LLRW disposal facility, TDEC requires reasonable assurance the facility will meet the performance objectives of TDEC 0400-20-11-.16 for the compliance period and beyond. Any time credit for engineered barriers needs to be justified on case by case basis.

35. **Page 7-10, 2nd Last Paragraph, Last 2 lines:** Why is erosion caused by wind throw considered unlikely, since a large portion of the area being considered for EMDF has seen considerable wind throw (from a downburst) in recent history?

36. **Page 7-18, 7.2.2.6 Implementability (On-site) (top of page, first paragraph, 5th line):** "*Should releases to groundwater go undetected, groundwater in the immediate vicinity of EMDF could be contaminated and minor releases to Bear Creek could occur. The actual risk of exposure from such a release would be low.*"

The discharge to Bear Creek down-valley from the proposed facility footprint will join that of the creek only until that discharge is known to sink into the bed of the creek (TDEC, 2001) near the western limit of the current EMWMF. This has the potential to impact groundwater many kilometers away from the sinking point. This is not addressed in the document.

37. **Page 7-29, Last Paragraph, Lines 1-3**: DOE states "The No Action Alternative may not be supportive of timely remediation of ORR sites due to lack of a coordinated disposal strategy and could result in actions that are less protective and less costly than either of the action alternatives." Is this statement correct?

38. **Page 7-32, Table 7-4, Implementability, On-site Disposal Alternative Column, Lines 2-4:** Perhaps some examples or case studies of successfully engineered landfills and evidence that they have been protective of the environment can be provided here or elsewhere in the document.

39. **Page B-6, 1. Introduction:** "*Volume reduction (VR) almost always requires additional effort to characterize or process the waste in a manner that reduces volume and cost. Therefore, it is necessary to evaluate VR methods to determine if the additional effort is beneficial.*"

The longer the delays on implementing the use of volume reduction equipment, then the lower the cost benefit analysis becomes for the use of volume reduction equipment with each delay. Volume reduction and the associated savings for off-site and onsite disposal was well documented at BNFL's Three Building D&D Project.

40. **Page B-12.5. Volume Reduction Methods and Benefits:** "*Volume reduction methods evaluated in this report include recycling, project sequencing, improved segregation, and physical size reduction. Advantages and disadvantages are discussed along with cost data collected from various sources.*"

Are there any total operating costs of waste disposed per cubic yard at EMWMF to compare to costs of off-site disposal to use a basis for the overall cost of the proposed EMDF? If not, then it's difficult to perform an objective evaluation for off-site disposal, transportation, volume reduction, etc.? Since the proposed EMDF is based on the same operating costs as EMWMF, then EMWMF's total (100%) operating costs should be made available for off-site disposal options.

41. **Page B-22, Size Reduction of Equipment and Structural Steel, Paragraph 2, Lines 8-9:** Here it is stated that "*It is assumed that shearing operations will reduce the void volume of equipment and heavy steel components by 50%, doubling the bulk density.*" However, on page B-20 under the discussion for the Shearing Machines on Lines 15-18 it is stated that "*Discussions with former BNFL operations supervisors indicated the typical net weight of the sheared material loaded into a 25 ft3 intermodal container was 52,500 lb. giving a bulk density of 2,100 lb. per yd3. This is triple the bulk density normally experienced for large equipment disposed at the EMWMF (per CARAR density data).*" What is the reason for this discrepancy? The difference between a doubling and tripling of the bulk density is quite significant.

42. **Page B-22, Size Reduction of Equipment and Structural Steel, Paragraph 2:** It appears that the discussion here is saying that after use of the supercompactor, the same ratio of clean fill material will be required as without the use of size reduction methods. Somehow, this doesn't seem right.

43. **Page B-22, Last Paragraph:** First, based on comments 41 & 42 above, the cost savings calculated here is questionable. Second, reduced landfill space utilized, smaller size for final landfill, reduced S&M costs after closure, reduced likelihood of waste components leaching (i.e., less exposed surface area, less leaching of components) and other considerations should be evaluated before making the final decision on size reduction.

44. **<u>Page B-30, Cost Effectiveness of Size Reduction:</u>** Cost should not always be the ultimate decision factor in determining the benefits of size reduction.

45. **<u>Page B-34, Size Reduction Evaluation Conclusions for the On-site Disposal Alternative:</u>** It is clear that the only factor being considered in whether or not size reduction should be implemented is cost. There is some question as to whether the cost differential may be being artificially inflated. Cost should not be allowed to outweigh all the other benefits of size reduction (i.e., environmental, local economy, etc.).

46. **<u>Page B-43 & Page B-44 7. LESSONS LEARNED</u>**: Interesting that although the waste operations at both Weldon Springs and Fernald involved volume reduction, none of the lessons learned involve the benefits emanating from that volume reduction.

47. **<u>Page B-44, 8. Summary:</u>** It is quite clear from this summary that the only factor given consideration in this analysis is cost. Although, these "costs" for size reduction have been shown to be greater than not size reducing, in terms of the money being spent in Oak Ridge on CERCLA activities the differences are not excessive. More consideration needs to be given to environmental, NEPA, long term monitoring and maintenance, and possibility of landfill failure where size reduction benefits far outweigh the alternative.

48. **<u>Page B-44, 8. Summary:</u>** *"The results of this study indicate that volume reduction methods must be evaluated on a case by case basis and are not always cost effective for disposal of CERCLA waste.*

Case by case studies should include building reuse/reindustrialization vs. total building disposal to determine the method and equipment used to generate the waste and thus the associated waste size and costs at the point of generation. This must be taken into account for any case by case comparisons for volume reduction. Reindustrialization requires that the structure of the building be protected and D&D equipment such as large track hoes with shears cannot be used. Many of the volume reduction compacter shear comparisons are built upon false comparisons where the intended reuse of the facilities is mixed with total disposal of facilities thus impacting the associated costs, size and equipment used for point of generation.

49. **<u>Page B-53, 1st Row:</u>** *"Feed preparation requirements: Used hand-held plasma cutters and air-arc (arc gouge) cutters to prepare materials for 26' feed box. This was the slow step of the process. The shear operators spent a lot of time in stand-by waiting for material to process. Air-arc cutters were much faster than the plasma cutters, but were much louder due to the use of compressed air, and also emitted a large shower of sparks during operation. This was acceptable for cutting converter vessels because sparks were contained within the vessel. Feed box was 26 ft. long and throat width was 5 ft., allowing cut width of 2-5 ft. Longer boxes are available, up to 40 ft."*

This statement is not applicable to the comparison. For BNFL's Three Building D&D Project, K-33 and K-31 were preparation for a final status survey for reindustrialization of the buildings where the integrity of the building structure was to be maintained, thus hand-held plasma cutters and air-arc (arc gouge) cutters were used. This resulted in manual removal of waste material to protect the building structure, not to prepare material for the feed box. Additionally the logistics of moving material east-west without the benefit of the north-south bridge cranes caused higher costs; this would also not be required with the current mode of demolition for a reindustrialization. A 26' feed box would take less preparation with both methods simply do to the fact it's larger than a dump truck. A compactor shear would perform the sizing to minimize the amount of soil brought in, thus reducing operating costs and maximizing the use of space for the intended purpose of waste disposal.

50. <u>**Page B-53, 3rd Row:**</u> "*Number of operators: To operate the shear requires one person at the controls, one person to provide feed, and 3 persons to manage the product which involves moving the intermodals into place, distributing the product in the intermodal, and managing the filled intermodal. Intermodals were frequently punctured during loading due to the size, weight, and shape of the metal pieces. The intermodals were placed on a stand after filling and patched as necessary. Placing flat sheets of metal (waste material) in the bottom of the intermodals prior to loading helped reduce punctures.*"

With the current mode of demolition consisting track hoes, shears and dump trucks for size reduction the beds of dump trucks have also been punctured; this should also be noted for the onsite disposal option with or without volume reduction. Compactor shears are more efficient at reducing the size/weight of material thus reducing the risk of punctures. Punctures happened several times with LATA Sharp during the removal of K-33 building debris. As a corrective action LATA Sharp also used segregated waste material to protect the bottom of dump trucks. It can potentially be assumed this is still an ongoing problem with onsite disposal? How many personnel does it take to load a dump truck including the truck driver, the equipment operator and the Rad Tech?

Compacted and sheared material is not restricted to intermodals for transport; dump trucks and various other containers may also be used. BNFL used intermodals loaded on articulated rail cars for offsite shipment of compacted and sheared waste. Each rail car was designed to hold eight intermodals; however only six intermodals were carried on each car due to the fact the compactor shear was so efficient at volume reduction that the addition of more than six intermodals would exceed the weight limit of one rail car. This efficiency would also be effective with onsite disposal and save waste disposal space.

51. <u>**Page B-53, Last Row:**</u> "*Support equipment: Track hoes used to rake/distribute material within intermodals. Intermodals did not have full-open lids, making it difficult to distribute material in the container. System included 4 air-cooled oil coolers mounted on roof about 85 ft. above the shear.*"

Track hoes are currently used for most loading and distributing of bulk waste for onsite and offsite disposal, especially for loading waste into dump trucks. This should be listed for all bulk waste loading, not just the compactor shear option.

52. **Page B-58, Table B-22, Row 6, "Operating Hours:"** Why are the estimated operating hours for the excavator twice that of the Crusher and Shredder combined?

53. **Page C-4, Paragraph 3, Line 3:** This discussion seems to exclude treated mercury wastes from the risk assessment. Treatment standards do not protect all water pathways. Treated mercury must be included in the risk assessment. An assessment to ecological and human health risk through fish consumption is most critical. The risk assessment must evaluate the treated mixed waste matrix through the same time scale that its constituent waste radionuclides require. Recognize that Bear Creek is already listed by the state as an impaired stream. Impaired streams are protected more than ones that are not impaired.

54. **Page C-5, Paragraph 2, Line 4:** Mercury transport is sensitive to small changes in its partition coefficient (Kd) as when waste is in high pH conditions. The predominant Y-12 waste matrix is concrete and concrete has a high pH (good concrete is pH 9-12.5). Furthermore, mercury migrates out of concrete even without water as a transport agent. The discussion acknowledges some of these difficulties, but does not address the long term effectiveness of the treatment method to protect human health and the environment. Macro encapsulation and flowable fill do nothing to mitigate the fact that the source matrix itself is not treated and is a high pH source that mobilizes mercury. Over time mercury will initially exit the waste disposal facility in a high pH condition through holes and cracks in the encapsulation materials. During this breakthrough single digit Kds best describe mercury waste properties as if in a soil-water solution, not a soil matrix. One way to investigate this is to set up an outdoor test facility similar to the Hill Cut Test Facility at SWSA 6. The test could be run with different treatment technologies and different conditions to test the viability of various treatment methods over the years before WEMA starts. As it is, the state has small confidence that in-cell macro-encapsulation can perform over the long term as required by CERCLA.

55. **3. Page C-6, Thermal and Chemical:** This brief acknowledgement of thermal separation and retort as an option for WEMA waste treatment is the one the state recognizes as protecting human health and the environment. It is a way to recover and separate mercury from the biosphere. The process also purifies mercury to reduce the chance of it being radiologically contaminated when compared to IAEA standards.

56. **Page D-16, 3.2.5 Proposed SWSA 7 Site (1st paragraph this subsection, last sentence):** *"Groundwater occurs in fractures, and drainage is radial, making monitoring more difficult. There is no karst at this site."*

It would seem that if it is known that groundwater drainage is radial, then monitoring could be more straightforward. So, how is it known that drainage is radial?

57. Page D-30, 4.3.2.1 Sensitive Habitats, Paragraph 2: A number of factors besides contamination are likely particularly in the headwaters of Bear Creek. Being a headwater stream (especially BCK 12.3), and having limited habitat a diverse fish community would not be expected regardless of any contaminants.

58. Page E-1 et seq. General comments on hydrogeology relevant to the discussion in Appendix E:

- **Monitoring Wells, Macrofissures, Fissures, Fractures. Channels and Conduits.** It has been published for several decades that there is a low probability of intersecting flow features in the subsurface by drilling boreholes. In the gypsum karst of Ukraine, there are caves systems that comprise the densest conduit networks known on the planet. These are also walking sized passages. The probability of intersecting a conduit in that setting whilst drilling is only 17% (Alexander Klimchouk, personal communication). It should therefore be prudent that during any drilling program that this low probability should be considered after the site investigation has been completed.

  The way that many problems such as inaccurate groundwater velocities and inaccurate flow vectors are shown is that hydrogeological data from boreholes are significantly different from the results of injected tracer tests done at a given site. It should also be noted that data from boreholes mostly represent flow in small fractures and subsidiary channels and fissures and that these do not carry most of the groundwater flux (Worthington et al., 2000). Although a conduit is often conceptualized as a relatively large, walking-sized opening, for groundwater velocity of 0.001 m.s-1 at the onset of turbulent flow, a diameter of only a few millimeters is needed (Quinlan et al., 1997). With this in mind, groundwater and contaminants may migrate at about 90 m/day (0.001 m/s) in tiny openings not discernible from drilling or from many other site investigation techniques, except tracing.

- **Hydrogeology, (statistics of finding features remotely).** There are only 5 well clusters being used to evaluate this site. The statistics of finding openings of a certain width in the subsurface are discussed by (Benson and La Fountain, 1987). If a site of 1 acre is being evaluated and an elliptical object (or opening) of 23 meters in diameter is being sought, it would require that at least 10 3-cm drill holes be used to have a 90% probability of finding the object. If the object is 7 meters in diameter, 100 drill holes would be needed, and for a 2.3 meter size 1,000 drill holes would be needed. The point is that 2.3 meters is a very large feature. For an object of 0.25 m it would require more than 80,000 borings. The message is clear, drilling as a method of site evaluation is severely limited. In fact, as many professional have acknowledged the only way to understand groundwater flow and transport in fractured rocks is by tracing and the best way to evaluate transport initially is by injected tracing and analysis of the recovery curve and the inferred hydraulic components.

- **Groundwater Basin Boundaries.** It is known that topographically-based groundwater basin (catchment) boundaries rarely are consistent with topographic basin boundaries. This is particularly true in carbonate terrains and is also true in fractured-rock terrains involving clastic rocks.

- **Lithology.** Care should be exercised when making big distinguishing statements about differences between carbonate, shale, and clastic sequences that are close to each other either stratigraphically or geographically. This is particularly true in East Tennessee, where the Nolichucky Shale becomes progressively more of a carbonate rock the further northeast away from the Oak Ridge area. It does not take much carbonate cement or some small amount of calcite in fractures, some very small, to be removed to make a groundwater pathway, and eventually breakdown the rock thus enlarging the pathway. Examples of this are known where conduits or channels 70 cm high form along a shale bed, where the bed that has been removed is shale and the roof and floor are relatively pure limestone.

  It is not safe to assume any lithology such as a clay bed or shale is necessarily impermeable, fractures are present especially in geologically older rocks, and where there has been crustal deformation (such as the Valley and Ridge province). These older rocks are not only heavily fractured but many of the fractures are filled with readily soluble minerals such as calcite. Calcite is the most abundant fracture-filling mineral because the components of calcium and the bicarbonate and carbonate ions are common in most waters and it therefore does not exclude filling fractures.

- **Potentiometric Maps: Assumptions.** The principal assumption made when constructing a potentiometric map is that the site approximates a porous medium. This is not the case for fractured rocks and carbonates because there is convergent flow to channels and conduits. The fundamental assumptions about porous media, function of wells, and validity of potentiometric maps were discussed in comments on the first draft of the RI/FS. These assumptions also apply to any numerical modeling that is performed using porous-media based modeling codes. This means that the fundamental assumptions problem really puts everything in a state of uncertainty. In fact, there is no case that this reviewer has experienced where the assumptions have been tested and not shown to be violated.

59. **<u>Page E-15, 2.1 LOCATION AND SETTING, Paragraph 1, Line 4:</u>** Here the expected area permanently occupied by the EMDF is listed as 60-70 acres. In Table D-5 on page D-38 the approximate footprint for the facility is given as 50 acres.

60. Page E-41 2.3.3 Ground Water Flow (first paragraph in this subsection): *"...several lines of evidence converge to indicate that flow systems on the ORR are local, not regional."*

The Valley and Ridge province in the Oak Ridge area is characterized by folded and faulted Lower Paleozoic sedimentary rocks that unfortunately have a history that predates DOE Operations in the area. Garven et al., (1993) explain the formation of Pb-Zn deposits in the carbonates as being a result of brine migration across the US Midcontinent, mostly in rocks of the Knox Group. This is regional flow of brines driven by physiographic uplift of the Appalachian Mountains and the flow of brines was driven by meteoric waters. A brine (Appalachian type, when plotted) occurs offsite of the ORR, but there are carbonates beneath it with contaminants and fresher water showing that they are certainly not a lower barrier to the groundwater setting.

The local flow we see today in any region (in carbonates) is a result of the landscape and geomorphological changes. Just because there is local flow does not mean there is not still active regional flow that is most likely to be deep. This is particularly the case for East Tennessee and the whole mid-continent area. The hydraulic gradients of the shallow profiles are too steep for regional flow, geochemical and isotopic data suggest that the total mass of contaminants is not contained within and does not discharge through the local discharge points.

The reference is made to conduits, but there is no definition of a conduit provided. In fact, this was done by Quinlan et al., (1996) where the criteria used were, the minimum velocity for turbulent flow, which resulted in openings of only a few millimeters.

In addition there is reference to flow nets based upon water table head measurements. Is it appropriate to draw flow nets, presumably through several different hydrostratigraphic units, that likely have different hydraulic conductivity values? Also, this hydrogeology must be investigated and properly defined in 3D. Lots of evidence exists in BCV that shows, gradients are downward from the surface, and at depth there are flatter gradients toward the southwest. The simplest explanation for this is recharge and a permeable zone at depth that is influenced by the regional flow in the Valley and Ridge.

61. Page E-41 *2.3.3* Ground Water Flow (first paragraph in this subsection, 5th line): *"....and interconnected cavity conduits in the Maynardville Limestone."*

What are "cavity conduits?" I think comments were made in previous versions that talk about cavities, and how it is conceptually more difficult to form a cavity, which is probably a conduit albeit small, that a borehole has intersected.

62. Page E-41 *2.3.3* Ground Water Flow (first paragraph in this subsection, 8th line): *"Flow on the flanks of Pine Ridge occurs mainly in fractures, with little contribution by open conduits."*

Quinlan et al., (1996) show that for a velocity of 0.001 m/s a conduit a few millimeters in diameter can sustain turbulent flow. Please explain how it is known that conduits this small are not involved.

63. **Page E-44 *2.3.3.2.1* Shallow Aquifer Zone (3rd paragraph):** *"Vertical gradients are generally upward and flow toward the reduced hydraulic head in the Maynardville Limestone (Dreier et al. 1993). The nitrate plume from the S-3 Ponds (DOE 1997) and chlorinated volatile organic compound (VOC) contaminant plumes from the Boneyard/Burnyard (BY/BY) and BCBG areas (DOE 1997; BNI 1984) have been reported to extend down-dip in the Maynardville and Nolichucky formations, but these are density-driven flows, and not the result of downward vertical ground water flows."*

This is an interesting description since in Bear Creek Valley it is known that parts of the creek immediately downstream of the proposed facility sink into its own bed, which would mean, after the water entered the ground, downward (in places vertical) flows.

64. **Page E-46, Figure E-15:** The potentiometric contours, although dashed, where there are few data, have been estimated and drawn so they closely mimic topography. Should this be expected in a fractured rock with such steep dip? The dip is steeper than the slope of Pine Ridge or the slopes of the stream channels.

It is often not the case that the water table configuration mimics the topography. For example, it does not appear to in Melton Valley (Webster, 1996). Since the potentiometric surface has been estimated and is inferred to mimic topography, if it actually does not the actual flow system would be significantly different (Haitjema and Mitchell-Bruker, 2005). This could have a significant impact on groundwater movement (and managing groundwater discharges) underneath the proposed facility. . Has it been established that it is appropriate to draw the potentiometric surface to mimic the topography?

65. **Page E-47 2.3.3.2.2 Intermediate and Deep Aquifer Zones, (last paragraph):** The deeper wells in carbonates in Bear Creek Valley (the ultimate fate of under drain water) show: a relatively flat hydraulic gradient toward the southwest, and, a zone of higher hydraulic conductivity at depth. This strongly suggests a deep system is present and flow is to the southwest along the strike. Uranium-series data and a signature from S-3 Ponds (in picket wells) support this conceptual model.

66. **Page E-50, *2.3.3.3* Aquiclude (top of page):** The name aquiclude is used here because: "*the extremely high salinity of this water indicates little or no ground water movement occurs*"
It is not correct to imply that the existence of brines at moderate depth means no ground water movement associated with them.

A single huge contradiction to this is brine *migration* that resulted in the formation of the Mississippi Valley type Pb-Zn deposits (Garven et al., 1993). These brines were driven at depth across the US

Midcontinent, beginning about 400 million years ago, from the uplifted Appalachians to Missouri and beyond and from the uplifted Ouachita uplift to the Michigan basin and beyond. During this time the whole of the US mid-continent was characterized by carbonate rocks formed in relatively shallow seas. The results of this topographically driven brine migration was formation of the largest strata-bound Pb-Zn ore deposits on Earth (Garven et al., 1993). Again, *brine migration in the subsurface* caused this.

The fact there is a brine, does not mean there is no ground water circulation near or beneath it. TDEC has documented, in an offsite well, continuous groundwater discharge (fresher groundwater) including continuous discharge of BTEX compounds, from a thin carbonate bed, nearly 200 m below the water table, and also beneath and decoupled from an Appalachian brine.

There are also other examples of brines in contact with fresh water, near the surface and deep beneath the water table, decoupled and moving independently of each other at velocities of kilometers per day (Beddows, 2004; Lindgren et al, 2004).

There is also incorrect reference use. Note also that referring to Nativ et al., (1997) as a "report" is not appropriate, it is an independently peer-reviewed paper in a scientific journal.

Also, if this paper, Nativ et al., (1997), is to be discussed, the paper, plus any comments made, plus the *responses by the original authors to those comments* also have to be discussed. *This did not happen,* so it appears that the comments successfully refute the original paper. This is hardly the case, because the original authors respond to the comments, and successfully defend their original position. This must be correctly referenced and correctly stated in the document.

The Nativ et al (1997) reference provides evidence of deep circulation of meteoric water, which is what the evidence from the geology, contaminant and geological history support. In terms of how strong this evidence is, the original authors point out that the stable isotope data show a meteoric water signature at depth. This shows that meteoric water circulates deep beneath the ORR and for it to retain this signature, it must have a substantial volume and be connected to recharge and discharge. The response must be reflected in the document. The way the Nativ et al., (1997) reference is misused and misquoted casts doubt on this document and anything that is written in it.

67. <u>Page E-66, 2.6.2.2 Aquatic Resource Monitoring in Bear Creek, Paragraph 1, Lines 2-4:</u> The statement "*The stream habitats of upper Bear Creek and its tributaries are used infrequently by aquatic biota because of headwater contamination originating from waste disposal sites near the Y-12 Plant (Southworth, et al. 1992)*" is not quite accurate. Despite its inadequacies BCK 12.34 supports small populations of the intolerant to pollution benthic taxa of Pycnopsyche luculenta, Chimarra sp., Neophylax spp. (perhaps 2 species), Optioservus sp., Rheopelopia sp. and Psilotreta sp.

Also, although portions of Bear Creek go dry in the summer, portions of the stream support a rather healthy community of benthic macroinvertebrates. Intermittent streams in the Cumberland Plateau region of Tennessee often support a very healthy fauna. In dry periods much of the benthic fauna may migrate to the hyporheic zone of the stream.

68. <u>**Page E-67, Paragraph 2, Lines 1-3:**</u> The statement "*Benthic fauna appear to be more sensitive to contaminants than the fish communities; species intolerant of pollution (mayflies, stoneflies, and caddisflies) are absent in the upper reaches of Bear Creek and are increasingly more common downstream.*" is not accurate. See comment 65 above.

69. <u>**Page E-67, Paragraph 3, Lines 3-7:**</u> Regarding the statement "*Fish surveys near the headwaters demonstrate a stressed condition without a stable, resident fish population (Southworth, et al. 1992). A weir located in the creek near Highway 95 acts as a barrier to movement, preventing redistribution of fish species from the lower portions of Bear Creek.*", headwater streams typically don't support very diverse fish fauna. Also, wasn't the weir removed a number of years ago?

70. <u>**Page E-68, Paragraph 1, Lines 1-3:**</u> Regarding the statement, "*The number of species at BCK 12.4 and NT-3 fish communities is below that of a comparable reference stream (Mill Branch kilometer 1.6), particularly during dry seasons. This has been attributed (DOE 2012) to the greater proportion of stream flow that is provided by contaminated ground water.*" Mill Branch 1.6 is a much larger water body than either BCK 12.4 or NT-3. Regardless of other factors, one would expect the fish fauna to differ considerably.

71. <u>**Page E-69, Paragraph 3, Lines 6-9:**</u> Regarding the statement "*These results indicate that conditions in NT-3 become less suitable for invertebrate species that normally inhabit small headwater streams as summer progresses, probably due to poor in-stream habitat quality and poorly developed riparian zone (Peterson, et al. 2009).*", even in pristine headwater streams there is a distinct difference between spring and fall fauna. The majority of the benthic macroinvertebrate fauna emerge as adults in the early to late spring. If there are to be existing populations of these species the following year, they would have to be present in the fall as either eggs or early instar larvae which would be much more difficult to collect and identify.

72. <u>**Page E-69, Paragraph 5:**</u> Regarding the aquatic life stream survey, a more extensive survey with more specific identifications would be warranted.

73. <u>**Page E-70, 2.6.3.1 Terrestrial Flora, Paragraph 1, Lines 7-8:**</u> *Magnolia grandiflora* is mentioned here as part of the understory in the forests of the Oak Ridge Reservation. Although 2 species of magnolia are listed in Kitchings and Mann 1976, neither of them was this species. No mention of *Magnolia grandiflora* was found in the cited document.

74. **Page E-71, Paragraph 2:** Along with the whitetail deer, Elk are also occasionally sighted on the Oak Ridge Reservation. See: ORNL/TM-2011/323, *Environmental Survey Report for ORNL: Small Mammal Abundance and Distribution Survey Oak Ridge National Environmental Research Park 2009–2010*, Neil R. Giffen, R. Scott Reasor, Claire A. Campbell. Date Published: September 2011.

75. **Page E-71, 2.6.3.3 Avifauna, Paragraph 1, Lines 2-4:**
"*Colantes auratus*" should be "*Colaptes auratus*".
"*Centurus carolinus*" should be "*Melanerpes carolinus*".
"*Dendrocopos villosus*" should be "*Picoides villosus*".
"*D. pubescens*" should be "*P. pubescens*".

76. **Page E-71, 2.6.3.3 Avifauna, Paragraph 2, Paragraph 3, Lines 1-4, 1:**
"*Oporonis formosus*" should be "*Geothlypis formosa*".
"*Dendroica pinus*" should be "*Setophaga pinus*".
"*Seirus aurocapillus*" should be "*Seirus aurocapilla*".
"*Parus cardinensis*" should be "*Poecile carolinensis* ".
"*Parus bicolor" should be "Baeolophus bicolor"*.
"*Buteo lineatus*" should be "*Buteo jamaicensis*"

77. **Page E-71, 2.6.4 Results of Recent Surveys at the EMDF Site, Paragraph 1 and Page E-72 :**
"*Carpus caroliniana*" should be "*Carpinus caroliniana*".
"*C. pallida*" (sand hickory) does not appear to occur on the Oak Ridge Reservation.
"*Q. prinus*" (chestnut oak) is not the currently accepted name. Should be "*Q. montana*".

Also, the name "*Q. prinus*" is used twice in paragraph 3 on page E-72.

78. **Appendix E – Attachment A., Section 7.2.3.3 Horizontal and Vertical Ground Water Gradients, Page 73, Paragraph 2.** "*It should be noted that the relatively large open hole intervals in the deep wells (and large screened interval in GW-968[I]) result in a composite hydraulic head distributed across the entire interval in each of the deep wells.*"

There is a transmissive-weighted average of the hydraulic head from the different flow zones in open hole intervals (LeBorgne, 2005). Essentially, the head from the fracture with the greatest yield will control the head in a borehole. Therefore, the uncertainty may not be so undefined.

79. **Appendix E – Attachment A., North-South Cross Section Through Phase 1 Well Clusters.** It is pretty evident that the model predicted water table [Post Construction, Steady-State Ground Water Flow Conditions] is wrong. There are no engineering changes that would affect the water levels in the Rome formation or upgradient of the proposed EMDF facility, thus this formation will continue to be a source of water above the proposed landfill after construction.

80. **Exhibit A.9, Packer Test Documentation, Packer Test Summary Sheet and Table 14 Hydraulic Conductivity Data from Packer Tests, Page 85.** The packer test data looks like a modified Lugeon test for conductivity. No real description was given in the Appendix E for test

methodology. However, with a lugeon test there are usually 5 test stages which help determine the lugeon value and its interpretation. If using limited information (which it appears was done), then there should be reporting of the lower and higher conductivity values during the test, rather than representative values.

81. <u>**Page G-5, Paragraph 2:**</u> *"The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Section 121(d) (see United States [U.S.] Code Title 42, Chapter 103, Section 9621{d}), as amended, specifies that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more stringent state environmental laws and regulations that are applicable or relevant and appropriate to the hazardous substances or particular circumstances at a site, or obtain a waiver under 40 Code of Federal Regulations (CFR) 300.430 (f)(1)(i)(B) and (C)."*

The list of applicable or relevant and appropriate requirements (ARARs) in Appendix G is not complete. If CERCLA is to provide the legal authority for on-site disposal of radioactive, hazardous, and toxic waste on the Oak Ridge Reservation, DOE, EPA, and TDEC should jointly compile a more extensive list ARARs. For example, federal and state rules that implement portions of the Clean Water Act and Safe Drinking Water Act such as water quality criteria that would continue to regulate releases of contaminants to groundwater and surface water from the facility after closure are not listed as chemical specific ARARs in Table G-1. Other examples, discussed on pages G-7 through G-9 of this appendix, are the substantive portions of TDEC Rule 0400-20-11, *Licensing Requirements for Land Disposal of Radioactive Waste.* See comments on pages G-8 and G-9.

82. <u>**Page G-6, Paragraph 6:**</u> *"The On-site Disposal Alternative would comply with all ARARs with the exception of the following two requirements for which waivers would be requested..."*

As stated in comments on page G-5, TDEC does not agree that all requirements that are applicable or relevant and appropriate for on-site disposal of CERCLA generated waste in Oak Ridge have been properly identified. Likewise, TDEC does not agree that only two waivers of such requirements would be necessary to legally authorize disposal of radioactive, hazardous, and toxic waste on the Oak Ridge Reservation under CERCLA. One example could be substantive portions of Tennessee Rule 0400-12-02-.03, *Siting Criteria for New Commercial Hazardous Waste Management Facilities*, which are arguably relevant and appropriate. Specifically, part 1 of subparagraph (2) (e) of this rule might require a waiver. TDEC also believes that waivers of some requirements based an equivalent standard of performance (40 CFR 300.430 (f) (ii) (c) (4)) may not be possible, or at least not economically feasible, for the preferred alternative. Examples might include specific siting criteria for radioactive, hazardous, and toxic waste disposal facilities from TDEC rule 0400-20-11-.17, TDEC rule 0400-12-02-.03, and 40 CFR 761.75[b], respectively. In one form or another, these requirements all prescribe that the site provide sufficient buffer to mitigate the impacts of a release from the facility and to implement corrective actions, if needed, to further restrict migration of contaminants. A site constructed over an underdrain that discharges to a stream is unlikely to provide such a buffer.

83. Page G-7, Paragraph 4 et seq: "3. ROLE OF NUCLEAR REGULATORY COMMISSION REGULATIONS AND DOE ORDERS"

In summary, this section proposes that NRC low-level waste regulations, and more specifically, their analogue in Tennessee Rule 0400-20-11, which contains the licensing requirements for land disposal of radioactive waste, should not be listed as ARARs. The RI/FS argues that these rules are not applicable due to an exemption under the Atomic Energy Act and not appropriate because all requirements of Chapter 0400-20-11 relevant to radioactive waste disposal on DOE facilities have been incorporated into DOE Orders and hence, are redundant. However, the requirements of DOE Orders are not identical to TDEC rules, as acknowledged on page G-8, with TDEC rules offering more prescriptive regulation of site selection and DOE Orders prescribing more detailed guidance for performance assessment. The lines of authority and accountability for enforcement of the requirements written into a Record of Decision (ROD) by the three parties of the Federal Facilities Act (FFA) also differ substantially from those that enforce DOE Orders. If TDEC is to be, jointly with EPA and DOE, responsible for enforcement of the requirements of the ROD, then the ROD should incorporate TDEC rules that state personnel have the experience and training to properly enforce. Disposal of radioactive waste under the authority of DOE Orders could provide an equivalent level of protectiveness to public health and the environment, but it will not provide an equivalent means for TDEC to enforce regulations that assure protection of public health and the environment.

84. <u>Page G-8, Paragraph 4, Last Sentence:</u> *"Conversely, 10 CFR 61 requirements that are not incorporated into DOE O 435.1-1 do not meet the "appropriateness" criteria and, as such, are not regarded as "relevant and appropriate" for DOE environmental restoration sites."*

This is simply a conclusion and not an argument. This text does not provide enough of the background on the process of development of the DOE Order to allow evaluation of this position. Clearly, the state LLW disposal standards are not applicable, but in almost an equally clear fashion they are "relevant and appropriate" in general. Any decisions on specific provisions not being "appropriate" should be made a much higher level of detail.

85. <u>Page G-8, Paragraph 5:</u> *"An example of this process is site selection for a new low-level radioactive waste disposal facility. As discussed in DOE Guide (G) 435.1-1, initial site selection for a new DOE low-level waste (LLW) disposal facility accepting only DOE waste is limited to the DOE reservation, focusing on identifying the best site within the reservation. This is different from the way sites are selected for commercial NRC-licensed LLW disposal facilities, which are selected from large geographic areas where ownership of the land may be under private or public control. Site selection processes for commercial facilities are directed toward identifying sites that meet geographic suitability requirements, considering seismic, hydrogeological, archaeological, and other physical conditions."*

These requirements are to protect health, safety and the environment and are designed to minimize releases to the environment and to mitigate impacts in the event of a release. All these requirements are about managing environmental risk.

86. <u>**Page G-8, Paragraph 5:**</u> *"While relevant, the suitability criteria are not appropriate since they are not well-suited to the site given the type of facility regulated by the state (a commercial, licensed LLW disposal facility) and the type of facility contemplated by the DOE CERCLA action (a non-commercial, non-licensed LLW disposal facility located on DOE property accepting only DOE waste)."*

Refer to the previous comment as well. It is unclear why the performance objectives for a DOE site would be different than minimizing the potential for releases and mitigating the impact in the event of any releases. Both public and private wastes are radioactive. Any argument of this nature should involve a comparison of isotopes and characteristics (such as alpha, beta, gamma particles; half-lives, curies, etc.) The commercial/public distinction is irrelevant in and of itself to environment risk.

87. <u>**Page G-8, Paragraph 5:**</u> *"This can lead to DOE sites being selected that are located adjacent to or within land previously contaminated."*

The statement referring to site selection on site and in areas of prior disposal leads to the comment that an option not considered would be a site with better hydrogeology that would actually be located in the general area of the Bear Creek Burial Grounds where there have been releases of uranium measured entering the Clinch River. All or parts of this area such as around the S-3 ponds having a remedy not meeting goals in the interim ROD for Bear Creek Valley should be part of the on-site options if this policy were really being applied carefully.

88. <u>**Page G-8, Paragraph 5:**</u> *"DOE G 435.1-1 states that "[i]t is not intended that the 435.1 criteria be used as exclusionary conditions to eliminate a site from being considered, but instead provide a measure of evaluation of the site's contribution to performance of the disposal facility. Use of existing facilities on DOE reservations should be considered to the extent practical." (see DOE G 435.1-1, Chapter IV, pp.123–124)."*

While Tennessee could accept this argument about 435.1 criteria not being exclusionary in general, many of the specific sites screened in the RI/FS and the ones with the larger capacity are located in areas where there are concerns about depth to water table, karst and perhaps highly-developed karst with conduit flow and very rapid transport in which releases would migrate rapidly and not attenuate. Tennessee would submit that DOE's performance objectives should be to confine the wastes in long-term performance and not just delay the releases or allow the releases to occur gradually because of slow failure of areas of engineering systems that cannot be expected to compensate for a bad site.

89. <u>**Page G-9, Paragraph 1:**</u> *"Since DOE is specifically exempted from NRC regulations and the TDEC rule equivalents, and has equivalent requirements in its internal orders, it is, per EPA's own language, inappropriate and unnecessary to cite these as relevant and appropriate requirements."*

DOE is free to use its internal guidance and develop a site strictly for LLW free from the use of these ARARs, but a lot of material is mixed waste and subject to RCRA jurisdiction and Tennessee is an authorized state having its own hazardous waste program of equivalent stringency. And the DOE Orders themselves should themselves be identified as To Be Considered (TBC). So, in addition to state LLW disposal rules including siting criteria, the DOE Order should either be identified in a table as TBC or could be placed in narrative and could control in circumstances in which the DOE order would be more stringent and more protective of the environment.

90. <u>**Page G-9, Paragraph 2**</u>: *"CERCLA Section 121(d)(4) allows for waivers of ARARs under certain circumstances for CERCLA actions.*

It must be said here that it appears that the obvious reason for the arguments about not identifying state LLW rules as "relevant and appropriate" in the previous section is to take shortcuts for waivers of ARARS without adequate factual support and justification.

91. <u>**Page G-9, Paragraph 2**</u>: *"For this On-site Alternative, waivers for two requirements will be requested, as follows:*

- *A hydrologic conditions requirement under TSCA specifies that there be no hydraulic connection between the site and standing or flowing surface water and the bottom of the landfill liner system or natural in-place soil barrier of a chemical waste landfill must be at least 50 ft. above the historical high water table (40 CFR 761.75[b][3]). Construction of a disposal facility at the EMDF site evaluated under the On-site Disposal Alternative would not meet this TSCA requirement.*
- *The RCRA LDRs (40 CFR 268 et seq.) prohibit the placement of untreated hazardous waste in land disposal units. DOE proposes to treat characteristic mercury-contaminated demolition debris by macroencapsulation in specially constructed forms within EMDF cells. Debris would be treated within a short time after placement, and any stormwater or other liquids would be collected and treated so that no contaminants exit the forms. A waiver will be requested to allow this operational approach to be implemented, as an interim action. Once treatment of the waste forms is completed, all applicable and relevant and appropriate requirements will have been met."*

The argument made for the waiver of the depth to water table required by 40 CFR 761.75[b][3] is not unreasonable, but has proven not to be true in the case of the EMWMF, where water levels have been and may continue to be near the top of the buffer in some areas under the facility. The argument for waiving the requirement that there shall be no hydraulic connection between the site and standing or flowing surface water would only be valid if the water from the proposed underdrain were permanently prevented from entering NT-3, the discharge point for the underdrain and a tributary to Bear Creek, or any other surface waters, prior to treatment.

While the Demolition and Decontamination (D & D) of the West End Mercury Area buildings is not within the scope of this RI/FS, some of the characterization has been referenced in this draft RI/FS. There are concerns that some mercury that can be recovered as free mercury would then need to be subject to recovery as free mercury and treated by RMERC. Although there is precedent for this approach in Hanford, http://pdw.hanford.gov/arpir/pdf.cfm?accession=0090734, the documentation is at much greater level of detail. Specifically, the level of detail in this draft report is inadequate for the state to evaluate either the basis for macro encapsulation effectively under RCRA or the larger issue of whether the proposed off-site cell treatment is protective under CERCA 121(a). The methods used to characterize and demolish the buildings that will generate waste containing mercury at concentrations above LDR, the method of transportation to the disposal facility, and the placement of debris in the facility may all impact the effectiveness of various encapsulation technologies.

92. **Page G-10, Paragraph 5**: "*The waiver for temporary placement of untreated wastes within one or more landfill cells is justified on the basis that it is an interim action that is a part of a total remedial action that will achieve the LDR requirements at completion, as allowed under CERCLA section 121(d)(4)(A) and 40 CFR 300.430(f)(1)(ii)(C)(1). An April 24, 1991 memorandum from the EPA Office of General Counsel (L. Starfield) to S. Golian, Chief, EPA Remedial Guidance Section, and L. Boornazian, Chief, EPA CERCLA Compliance Division, concurred with a very similar approach at the Wasatch Chemical Superfund site (accessed at www.epa.gov/superfund/policy/remedy/pdfs/memo42491-s.pdf). This waiver request is limited to temporary placement for treatment, and does not affect other aspects of LDR compliance.*

Refer to earlier comments about lack of detail in evaluation of this proposal and, more specifically, how it would be equivalent to a CAMU. The website for the ROD is: http://www.epa.gov/superfund/sites/rods/fulltext/r0891048.pdf

And this ROD is not nearly as relevant as the Hanford example discussed above. Here we reiterate our previous concerns regarding both the CAMU- equivalency for placement and the high concentration mercury waste sometimes in free elemental form. Even if an ARAR waiver were granted, concerns remain about the in cell approach for macro encapsulation and protectiveness for the debris waste streams from the WEMA and the concentrations of mercury in this debris. Protectiveness of the remedy is one of two threshold criteria that must be satisfied and cannot be waived like an ARAR, see CERCLA 121(d)(1), 42 USC 9621(d)(1):

'*Remedial actions selected under this section or otherwise required or agreed to by the President under this chapter shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further release at a minimum which assures protection of human health and the environment. Such remedial actions shall be relevant and appropriate under the circumstances presented by the release or threatened release of such substance, pollutant, or contaminant. It must be said here that it appears that the obvious reason for the arguments about not identifying state LLW rules as "relevant and appropriate" in the previous section is to take shortcuts for waivers of ARARS without adequate factual support and justification.*'

93. **Page H-8, Paragraph 1**: "*The purpose of this Appendix is to develop preliminary analytic concentration limits for contaminants of potential concern (COPCs), referred to as Preliminary Waste Acceptance Criteria (PreWAC), which would meet the applicable risk and dose criteria*

specified in the remedial action objectives (RAOs), using fate and transport analysis based on a resident farmer scenario for the proposed Environmental Management Disposal Facility (EMDF)."

TDEC does not agree that the resident farmer scenario used in this document is adequate to provide a basis for demonstrating that the preliminary WAC computed here for the proposed facility will protect human health and the environment. The resident farmer scenario does not consider groundwater impacts except at the point of water extraction 460 meters from and oblique to flow paths from the proposed disposal facility. Impacts to surface water quality are not considered except in the context of their contribution to human health risk via livestock watering and plant irrigation.

94. **Page H-8, Paragraph 1:** *"This analysis provides the basis for demonstrating that the proposed EMDF conceptual design and site would be protective of human health and the environment and be a viable disposal option for most future Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) waste."*

Because sites on the Oak Ridge Reservation offer little in the way of environmental buffer to attenuate releases of hazardous or radioactive material, robust facility design and restrictive waste acceptance criteria are the only avenues available for effective protection of human health and the environment in Tennessee. Consequently, a detailed site characterization, detailed design, and final waste acceptance criteria are necessary to show that CERCLA remedial action objectives will be met, and should be completed prior to seeking regulatory agreement for authorization to dispose of future CERCLA generated waste on the ORR.

95. **Page H-8, Paragraph 3:** *"A negotiated waste acceptance criteria (WAC) attainment process was developed for the EMWMF(DOE/OR/01-1909&D3), which involves the designation of four separate types of WAC requirements (DOE 2001a) to define and limit acceptable wastes. Similar tri-party negotiations would result in a WAC attainment process for this proposed on-site facility to be documented in a primary Federal Facility Agreement (FFA) document, the WAC Attainment Plan (see Section 1.2 for more information)."*

Based on experience at the EMWMF, TDEC does not believe that a negotiated WAC is the best way to protect human health and the environment. TDEC was concerned with the validity of fate and transport modeling to establish analytic WAC for the EMWMF, so negotiations between FFA parties were used for the EMWMF as a means to establish protective WAC. Based on current information, TDEC is not convinced that the resulting WAC will be protective in the long term. WAC should be derived from a credible risk assessment that is consistent with whatever WAC limitations may ultimately be imposed by the requirements of DOE Orders. DOE should obtain a Disposal Authorization Statement for any new radioactive waste disposal facility on the Oak Ridge Reservation prior to finalizing the CERCLA risk assessment and establishing waste acceptance criteria.

96. **<u>Page H-9, Paragraph 5</u>:** *"The sum of fractions (SOFs) calculation method is applied to each waste lot to account for the presence of multiple contaminants. To consider incorporation of that waste lot into the entire EMWMF landfill, a volume-based weighting factor is applied to the SOF of each waste lot for all waste lots already in the landfill, waste lots proposed for acceptance in the landfill, and some forecasted future waste lots to determine a "landfill-wide" SOF. This method is referred to as the volume-weighted sum of fractions (VWSF), which allows an evaluation of the acceptance of a waste lot into the disposal facility as a whole."*

TDEC has requested repeatedly that the approach used at the EMWMF to establish waste acceptance criteria (WAC) and implement WAC attainment be changed for any proposed facility for land disposal of CERCLA waste. When waste density is highly variable, as has been the case at EMWMF, the volume weighted sum of fractions method discussed here creates a disconnect between the measure of radioactive or hazardous material in the facility and the actual mass or Curie content in the waste, which is the quantity that drives risk. If the less dense material is cleaner than the more dense material, the facility may be loaded with more contamination than the risk assessment based directly on mass or activity would allow. TDEC experience at the EMWMF has also shown that having no fixed limits (other than administrative WAC) that exclude waste from the facility complicates auditing and validation of compliance with WAC.

97. **<u>Page H-14, Paragraph 2</u>:** *"An inadvertent intruder (e.g., someone digging through the final cap and being directly exposed to the waste after landfill closure) will be examined as part of the DOE O 435.1 compliance."*

Risk assessment under CERCLA should include sufficient exposure scenarios to be compatible with those mandated under DOE Orders and those prescribed by Tennessee rules for disposal of radioactive waste."

98. **<u>Page H-14, Paragraph 3</u>:** *"In accordance with current practices in Tennessee, the upper, more active weathered bedrock part of the unconfined aquifer (nominally a 30–50 ft. stratum between the water table and competent bedrock) would not be used for domestic water supplies."*

What is the basis for this statement? A variety of practices are used in the state. See Tennessee Rule 1200-4-9-.10, Well Construction Standards, for information on compliant well completion in Tennessee."

99. **<u>Page H-16, Paragraph 1</u>:** *"A further key assumption in the resident scenario development and risk evaluation is the location of the hypothetical receptor. As this is the location at which the proposed alternative must meet the CERCLA defined risk criteria (e.g., 10-4 to 10-6 Excess Lifetime Cancer Risk [ELCR]), it is appropriate to look to CERCLA guidance on placement of the future hypothetical receptor. Per EPA's Risk Assessment Guidance for Superfund Volume I Human Health Evaluation manual (Part A) [EPA 1989], this placement or location is the "exposure point."*

TDEC performed a limited analysis of the sensitivity of the pre-WAC to the receptor location. The goal was to compare the pre-WAC proposed in the RI/FS to a pre-WAC generated if the pathway analysis included a scenario with the receptor using ground water that was much less diluted by clean recharge. The advection-dispersion equation solved by PATHRAE in the saturated zone can be expressed in terms of dimensionless variables, and the analytical solution will depend only on the Peclet number, a Courant number, and time constants that are representative of the time for radioactive decay, the time for release from the source, and the time required for solute to advect to the point where the Peclet number is unity. The latter quantity is a measure of the strength of dispersion. When the time for release of a contaminant from the model boundary into the model domain, which is controlled in PATHRAE by either the release rate from the source or the migration time through the vadose zone, is large enough, and when the time for decay is large compared to the travel time in the saturated zone, the peak concentration will be comparable to that calculated assuming a permanent continuous source. In that case, differences in dilution would account for most of the concentration differences that would result from modeling to a different location of the hypothetical receptor. Consequently, the sensitivity analysis was restricted to examples with long-lived radionuclides. Relocating the receptor closer to the source could have much greater impacts on groundwater concentrations of isotopes with shorter half-lives.

Pre-WAC for Tc-99, with a half- life substantially longer than the time to peak concentration, is listed as 69,300 pCi/g. If the receptor were assumed to be either immediately downgradient of the facility or near the facility underdrain that is shown in the conceptual design, the dilution factor would be near 0.1, as shown in Figures H-16 and H-17. The proposed underdrain, like the underdrain at the EMWMF, would presumably be able to supply several gallons per minute of water continuously even under drought conditions, and might be a usable water supply even when individual wells were dry. Then Tc-99 at peak concentration should be more or less determined by a ratio of the dilution factor estimated at the new receptor location to that calculated for Bear Creek, or 0.1/.00254. This would result in a concentration in the underdrain or near the facility of slightly less than 40 micro Curies per liter. Since the effective uptake comes primarily from the drinking water pathway, the relocation of the receptor would result in an excess cancer risk of about 2.4E+0 due to Tc-99 exposure The pre-WAC for technetium 99 calculated using the methodology outline on page H-70 would then be about 25 pCi/g.

Another example is U-238. The pre-WAC in Appendix H, Table H-8 includes a pre-WAC of 103,000 pCi/g. With an order of magnitude dilution, then a pre-WAC of 33 pCi/g is calculated. There is about a 4 order of magnitude difference in 33 and 103,000. Therefore, a WAC of 103,000 pCi/g proposed for U-238 in the RI/FS could pose an excess lifetime cancer risk of 3 in 10.

100. **<u>Page H-16, Paragraph 1</u>:**"*This is the point where MEI contact with the highest contaminant concentration is made "if the site is currently used, if access to the site under current conditions is not restricted or otherwise limited (e.g., by distance), or if contact is possible under an alternate future land use." In this case, the proposed EMDF site is within Zone 3 of Bear Creek with a future* *land use designation of "DOE-controlled Industrial Use," access is restricted by DOE, and for the foreseeable future will be under DOE control as described in the BCV Phase I ROD (DOE 2000). This future land use designation has been supported and approved by public stakeholders in the End Use Working Group (documented in the Final Report of the Oak Ridge Reservation End Use Working Group, July 1998). Accordingly, the nearest possible exposure point for a future hypothetical resident, and point of highest expected concentration based on ground water and surface water flows, would be the intersection of the "DOE-controlled Industrial Use" Zone 3 boundary with Bear Creek shown in Figure H-3, approximately 1.5 miles to the west of the EMDF.*

As stated in comments on Appendix G, water quality rules are not listed as chemical specific ARARs. The risk assessment performed here does use MCLs at the receptor location as an end point for modeling, but does not look at ground water protection more generally, and does not include protection of surface water quality or ecological risk. For the proposed EMDF to meet criteria specified in CERCLA Section 121 (d)(1), future releases from EMDF must assure protection of human health and the environment. In addition to evaluating the risk levels required by CERCLA, we interpret this to mean that future releases cannot cause pollution that violates stream classified uses in Bear Creek or downstream.

Bear Creek is a tributary to East Fork Poplar Creek, Poplar Creek and the Clinch River. By evaluating risk for a single, hypothetical receptor, the EMDF RI/FS does not consider the designated uses of Bear Creek, East Fork Poplar Creek, Poplar Creek, and the Clinch River and it does not evaluate the impact of the calculated pre-WAC allowed releases on these surface water uses. The Clinch River, Poplar Creek, East Fork Poplar Creek, and Bear Creek are all classified for fish and aquatic life and recreational use. The Clinch River downstream is also classified for domestic water supply. Certain radioactive, hazardous, and TSCA pollutants pose or may pose a threat to human health through ingestion and/or recreational use (e.g. fishing consumption), or a threat to aquatic life or other ecological risk. These potential pathways are not modeled in the risk assessment and need to be evaluated and included in the development of the pre-WAC. In fact, the pre-WAC should be made to constrain the cumulative impact from any proposed new sources and any existing sources, such as the Bear Creek Burial Grounds and S-3 ponds secondary sources and plume so that the potentially impacted streams or ecosystems will not suffer further degradation.

TDEC did some limited modeling with the RESRAD code to evaluate WAC sensitivity to water quality driven endpoints, and pathways that might incorporate the effects of progeny. RESRAD modeling based on a source concentration of 103,000 pCi/g uranium-238, the pre-WAC concentration specified in Table H-8 of this Appendix, identified polonium-210 as a progeny and fish consumption as a potentially significant exposure pathway. While a more realistic fate and transport analysis than can be achieved with RESRAD might not reveal an actual risk to a recreational user of Bear Creek, TDEC cannot accept a risk assessment that makes no attempt to incorporate water quality criteria, cumulative effects, and a more detailed analysis of the effects of progeny resulting from radioactive decay. For a number of the contaminants of potential concern modeled in Appendix

H, peak concentrations in Bear Creek listed in Tables H-6 and H-7 (pages H-64 through H-69) are above DOE derived concentration standards that limit releases to surface water or ambient water quality criteria.

Specifically, any new or expanded discharge to Bear Creek must comply with the Antidegradation Statement of the Tennessee Water Quality Control Act and rules, meaning that no measurable loading is authorized for the parameters causing the stream to be impaired. For now, these parameters include mercury, cadmium, nitrates, and PCBs. Likewise, under Tennessee rule 0400-40-03-.07, groundwater is classified as general use groundwater. Therefore, except for naturally occurring levels, general use ground water: (a) shall not contain constituents that exceed those levels specified in subparagraphs (1)(j) and (k) of Rule 0400-40-03-.03; and (b) shall contain no other constituents at levels and conditions which pose an unreasonable risk to the public health or the environment.

101. **Page H-16, Paragraph 2**: "*Ultimately, a much more conservative approach is preferred, and the receptor location was selected based in part on historical records (prior to DOE's land ownership) that indicate several homes were located along Bear Creek in the general area being considered (Tennessee Valley Authority Maps and Surveys Division Quadrangle map 1935, 1941, see Appendix E, Figure E-5 and Section 2.1).*"

The implication here is that the receptor location is quite conservative with respect to locations outside of the zone 3 boundary. However, TDEC dye tracing results indicate that groundwater and surface water travel times from the approximate location of the hypothetical receptor to the zone 3 boundary are on the order of only a day. This allows very little additional time for decay or degradation of radioactive or hazardous substances and little opportunity for mass transfer processes to remove solutes from the water. Reasonable dilution factors at hypothetical locations for a receptor along the dominant groundwater flow paths outside the zone 3 boundary in Bear Creek Valley can be estimated from the hydrologic balance over the watershed. Using the optimistic assumption that only 1 centimeter of water infiltrates through the landfill annually, the hydrologic balance still gives dilution of only 10^3 to 10^4, less than the 10^5 determined for the groundwater extraction well. Even though the RI/FS uses less dilution for the surface water pathways, the receptor location used in the RI/FS thus represents more or less a best case scenario rather than a more conservative approach. If modeled with realistic groundwater travel times in the karstic Maynardville limestone, most locations downgradient of the facility outside of zone 3 would yield higher risk than that at the chosen location. The water well location in this RI/FS does not lie along the primary groundwater flow paths that emanate from the landfill footprint, and most of the recharge to the well and the creek is derived from water not impacted by the facility. Perhaps the only less conservative locations would be either upgradient of the proposed facility itself , uphill from the dominant flow paths down Bear Creek Valley, or at the Clinch River.

102. **Page H-18, Paragraph 1**: "*DOE performed this analysis of the proposed low-level waste disposal facility using a performance-based approach with little to no reliance on long-term* *maintenance and the man-made components of the landfill (i.e., geosynthetics) for a performance period of 1,000 years beginning at closure of the landfill."*

TDEC agrees that long-term performance of the proposed facility should be based on characteristics of the landfill and the site that do not require substantial long-term maintenance. However, the conceptual model used to provide the basis for inputs to the fate and transport model should not assume that either the amended clay barrier layer in the cap or the clay liner will last indefinitely. Note that differential settling of the cap sufficient to create concave upward surfaces at the interface of the drainage layer with the barrier layer that could pool, on average, about 1 centimeter of water over only 10 percent of the barrier surface for one rainfall each month might double the projected infiltration rate. While it may be reasonable to suppose that the geosynthetic materials in the cap and liner will greatly restrict infiltration for decades, or even centuries, performance modeling should allow for degradation of clay layers prior to the one thousand year time frame of the model (or 1 million years in the case of modeling to peak). The time period for which infiltration rates can be assumed to be only one centimeter annually is one of many details in the fate and transport model that needs to be revisited and agreed upon by all FFA parties prior to approval of this RI/FS.

103. **<u>Page H-18, Paragraph 1</u>:** *"Isotopes that peak beyond 1,000 years are modeled under the recognition that the modeling results for these much greater time lengths have a higher degree of uncertainty."*

While TDEC generally agrees that there is a higher degree of uncertainty over time, this would seem to be cause for more conservative assumptions that account for the probable deterioration of all the landfill components over time, not just geosynthetic materials. The only changes made in the modeling in this RI/FS would seem to be a higher target for risk.

104. **<u>Page H-20, Paragraph 1</u>:** *"An overview of the models used, conceptual design and site features provided, and major calculations performed are as follows:"*

The description of the models does not include a summary of the equations used or any analytical or numerical techniques used to solve the equations, nor does it address all the consequences of uncertainties in key parameters that are inputs to the models. A description of the key equations and a more detailed sensitivity analysis to certain model inputs should be provided. In the case, of HELP, MT3D, and MODFLOW/MODPATH, the codes and manuals are readily available for download from government web sites. To our knowledge, this is not the case for the latest versions of PATHRAE HAZ and PATHRAE RAD. A more detailed summary of the PATHRAE model is necessary.

105. **<u>Page H-25, Paragraph 1</u>:** *"The waste layer is assumed to consist of contaminated soil, cement-stabilized soil-like materials, cement-solidified waste, and debris (rubble). These wastes are assumed to be placed in lifts to minimize void spaces within the waste layer. Void spaces are filled with soil or soil-like material to provide structural strength and reduce settling due to waste* *compaction. For modeling purposes, all waste is conservatively assumed to be soil-like (see Section 4.4 of this Appendix)."*

The assumption of soil-like waste may lead to conservatism for many waste forms that may have contamination confined in the interior of inert material. However, definition of the waste types in Section 2.1.2 of the RI/FS includes tanks, piping, glove boxes, and ventilation ductwork. There are no proposed requirements that material having sorptive properties similar to that of soil be used as structural fill around such debris. At the EMWMF, limestone gravel has historically been used around irregular objects rather than soil-like material. Under circumstances where the waste may corrode over time and contain unfilled voids, release rates from the waste may exceed those based on the assumption of equilibria between leachate and a soil-like material. Since the radioactive isotope or chemical is assumed to be adsorbed, this lack of conservatism will be exacerbated when the true chemical form is highly soluble, as in the case of uranyl fluoride deposits in compressors used in the gaseous diffusion process.

106. **Page H-26, Paragraph 6:** "*7. Performance Scenario – The performance of the conceptual design (cover and liner specifically) was assumed to change over time. Three stages were defined as follows:*

A. Stage 1: The best case, short-term performance of the cover/liner systems is assumed. All layers fully function. This stage is assumed to continue through the first 100 years following closure of the landfill. The composite barrier (the compacted and amended clay layers and geosynthetic layers) in conjunction with the overlying lateral drainage layer serve to divert infiltrating water away from the underlying waste and transport the water to the perimeter drainage system, thus minimizing infiltration into the waste. This is a very conservative assumption, supported by research that indicates the service life of HDPE geomembranes exceed 500 years and may reach over 1,000 years at temperatures of 20° C as expected in the case of the EMDF (depth below ground surface ensures temperate conditions); based on the thickness of the proposed geomembrane (40 mil) (antioxidant depletion lifetime in the membrane is extended with thickness); humid environment/moderate rainfall; and protected (depth under overburden) location of the geomembranes. (Benson 2014, Rowe et al. 2009, Needham et al. 2006, Mueller and Jakob 2003, Bonaparte, et al. 2002; Hsuan 2002; Koerner et al. 2001; Giroud 1984)

B. Stage 2: Gradual failure of the cover/liner systems is assumed. This period is assumed to last for 100 years, extending from year 100 following closure, through year 200 following closure. A linearly increasing infiltration rate is assumed between Stage 1 and Stage 3 results.

C. Stage 3: The worst case, long-term performance of the cover/liner systems is assumed. It is assumed that all geosynthetic materials degrade and are ineffective at 200 years and beyond. Layers are assumed to be degraded and no longer function (i.e., Layers 5, 11, 12, 13, 14, and 15 are removed from the model). Erosion of the cover is assumed to occur resulting in a decreased thickness of the top soil/rock layer. Layer 1 thickness is reduced by 20%."

A key component of the Appendix H risk assessment and determination of the pre-WAC (pre-Waste Acceptance Criteria) is how much leachate exits the landfill and enters groundwater or the underdrain after engineering controls fail in a few hundred years. DOE modeled this through the HELP model.

DOE's presentation of their HELP modeling shows that, worst case, DOE expects about 0.42 to 0.43 inches of water per year to percolate through the waste and enter groundwater or the underdrain. DOE used this to model whether the peak concentration of pollution for a specific contaminant impacts a receptor living near Bear Creek during the first million years after engineering controls fail. This modeling helps determine which constituents need waste acceptance criteria (WAC). Waste assumed to be placed in EMDF was modeled as a soil-like material and consequently differential settling or differential compaction was not mentioned in Appendix H. Modeling the 50 foot thick waste layer as a soil-like material is inconsistent with many of the materials needing disposal. Further, based on experience with EMWMF, DOE will not perform size reduction of the waste placed in EMDF. Lack of size reduction could result in long term differential compaction/differential settling that disturbs cap drainage layers and causes ponding or micro-fractures in cap layers. Differential compaction/ differential settling could result in DOE's predicted volume of leachate entering groundwater or the underdrain being low by an order or more. If sensitivity analyses were run to evaluate differential compaction and settling, it was not referenced in the RI/FS Appendix H. DOE's worst case scenario (Table H-2) did not assume differential compaction.

DOE's worst case scenario did assume the top 48 inch soil layer (Table H-1) erodes 20% or 9.6 inches. However, Table H-2 includes a thickness of 5 feet (60 inches) instead of 38.4 inches.

Tennessee Department of Environment and Conservation's Division of Solid Waste Management estimates that a fully closed, grassed, well-maintained landfill should have erosion on the order of two (2) tons of soil per acre per year. Assuming about 120 pounds per cubic foot and that the landfill is completely grassed and well-maintained for the first 100 years after closure (Stage 1, RI/FS page H-26) there may be about 0.233 millimeters (mm) erosion per year or about 0.92 inches erosion in the first 100 years after closure.

As opposed to the 1 millimeter erosion per century input to PATHRAE in attachment B of Appendix H, The DOE code RESRAD assumes a default erosion rate of about 1 mm per year. If a 1 mm per year erosion rate is assumed for stages 2 and 3 (Stage 2 and 3, RI/FS page H-26) after maintenance is discontinued, then about 4 inches erosion per 100 years may be expected assuming erosional rills, farming, fires, etc. do not cause an increased erosion rate. Under this scenario, it would take on the order of 240 to 350 years to erode 9.6 inches and it only takes about 1300 years for the initial 48 inch top soil layer to entirely erode away. If the 48 inch soil cover essentially erodes away in the first 1300 years, the clay layer will degrade significantly as an effective hydraulic barrier during the first 1300 years after closure. A more credible "worst case" scenario would allow infiltration rates to increase by an order of magnitude during the first few hundred years, and allow the infiltration rate to increase to the same recharge rate as that assumed for the surrounding area by 1000 years. These increased infiltration rates would not only provide some conservatism, they would reduce the time to peak concentration at a receptor location and allow development of WAC without modeling for time periods that might require consideration of climate change and other long term phenomena.

107. **<u>Page H-28, Paragraph 1</u>:** "*Clay layers in the final cover system are below 8 ft. of overburden. The clay layers are assumed to retain their hydraulic conductivity parameters based on the depth below ground surface, which ensures there is no direct exposure to freeze-thaw conditions and no desiccation; no cracking/tunneling due to roots or burrowing animals/insects; little temperature or moisture variation; and the layers are subjected to high pressures (approximately 60 kPa). Research has actually shown decreasing hydraulic conductivities with increased confining stress as is associated with significant overburden pressures (Boynton and Daniel 1985; Albrecht and Benson, 2001).*"

This discussion seems to assume that moisture content in the clay liner will not vary significantly even after the geomembrane is degraded. The geomembrane will, at some point, degrade sufficiently at discrete locations to allow significant wetting and drying in the amended clay layer below, leading to desiccation cracks. While the overburden pressure may help to close desiccation cracks, 8 feet of soil and rock overburden (reduced to about 7 feet for stage 3) does not correspond to 60 kPa of effective stress. In fact, Albrecht and Benson, cited above, state in the summary, "Tests at various effective stresses show that an effective stress of at least 60 kPa was needed to close desiccation cracks so that hydraulic conductivity is < 10-7 cm/s. This effective stress is higher than that found in most cover applications, suggesting that desiccation damage to covers will be permanent."

108. **<u>Page H-36, Paragraph 2</u>:** "*Six distinct hydraulic conductivity zones were used in the UBCV Model to represent the eight geologic units that exist in BCV (Knox Dolomite, Maynardville Limestone, Nolichucky Shale, Maryville-Rogersville-Rutledge formations, Pumpkin Valley shale, and Rome shale/sandstone). Anisotropy ratios (Ky versus Kx [Kz]) of 5:1 (for weathered bedrock zone) and 10:1 (for fractured bedrock zone) were used to represent the preferred fracture/bedding orientation of the geologic units. In this case, Ky represents the conductivity parallel to strike, Kx is the horizontal conductivity perpendicular to strike, and Kz represents the vertical hydraulic conductivity.*"

Anisotropy values significantly higher than those used here may be necessary to properly simulate groundwater flow paths. Evidence from tracer studies and contaminant migration pathways on the ORR demonstrate that heterogeneity in the subsurface is on a very small scale with respect to hydraulic conductivity perpendicular to bedding (centimeters to decimeters for permeable fracture zones that seem to provide the most transmissive zones in shale rich formations and generally smaller for discrete continuous fractures in carbonate units). Hydraulic conductivity may be much less variable over considerable distance parallel to bedding, creating the effect of stratabound flow.

Based on the variability of hydraulic test results on the ORR, the magnitude of local hydraulic conductivity variations is likely to be quite large, particularly in the direction perpendicular to bedding. This heterogeneity is on a scale smaller than the dimensions used for model discretization, and unlikely to be captured by grouping of model cells into only a few zones for purposes of assigning distinct hydraulic conductivities to the subsurface. Consequently, prediction of local hydraulic head values as well as flow direction at specific locations with MODFLOW is questionable. TDEC staff supposes that insufficient data may be available for a more refined model calibration, but cautions that the model results have limited value when used for the purposes of prediction of local flow direction and hydraulic head.

109. **<u>Page H-41, Paragraph 1</u>:** *"New ground water monitoring wells installed under Phase I characterization efforts, within the proposed EMDF area, have been used in UBCV Model calibration, and well head values were in general agreement with the model-predicted values."*

What were the actual and predicted values of hydraulic head for the wells installed under the Phase I characterization effort? Were the hydraulic head residuals greater or less than those determined in the regional flow model calibration?

110. **<u>Page H-41, Paragraph 3</u>:** *"The water balance conducted for the calibrated current condition UBCV Model compared observed and predicted ground water discharge rates. Ground water sinks (drains cells in the model) discharge to Bear Creek directly and to surface drainage features that also flow into Bear Creek eventually. The model predicted ground water discharge above the Bear Creek/NT-3 junction is 0.31 ft3 per second (cfs). For comparison, the average flow rate measured at the junction location is 0.55 cfs (Appendix E, Section 2.4.3.1), which includes both base flow (ground water discharge) and surface water runoff. The water balance error for the UBCV Model was about 0.34% and is within the typically accepted limit of 1% (EPA 1996).CERCLA process that led to the construction and operation of EMWMF.As a follow-on to that process, this RI/FS utilizes relevant information from the EMWMF RI/FS with revisions and updates to describe and analyze current conditions."*

TDEC agrees that the recharge rates and hydraulic conductivity values in the calibrated MODFLOW are reasonable for the purposes of computing Darcy flux and a water balance. Consequently, the general relationship between overall dilution computed using MODFLOW results and the steady state MT3D model as a function of distance from the facility footprint (see Figures H-16 and H-17) yields useful information, even if the specific location of any given plume isopleth may not be accurate due underestimation of anisotropy or the scale of heterogeneity in the subsurface.

111. **<u>Page H-48, Paragraph 1</u>: 4.3.2 MT3D Model Assumptions.**
"Assumptions made in running the MT3D code are as follows:

1. *Changes in the concentration field will not measurably affect the flow field.*
2. *Transport is modeled as three dimensional and transient until a steady state condition is reached.*
3. *Only advection is considered; other processes (dispersion and retardation) were not assumed. This is a conservative assumption because other processes will reduce the*

contaminant peak concentrations, as dispersion and retardation terms represent the contaminant spreading in the environment, thus flattening the peak.

4. *The MOC solution method, best for advection only, was used for the simulation to minimize the potential error from numerical dispersion.*
5. *The well pumping rate is 240 gallon/day, based on its use by a family of four.*
6. *The well is cased to 70 ft. Water is drawn from model Layers 5–8, corresponding to 70–150 ft below ground surface.*
7. *The well was assumed to be located nearby on the BCV floor between the EMDF and Bear Creek (see Section 2.4), at a distance of 460 m from the edge of the landfill. This location is also consistent with topographical and geological features, lithostratigraphic and hydrogeological data, and ground water modeling results*
8. *The landfill is represented by a uniform, constant leaching source (assigned a unit leach rate of 1.0), which is assumed for the duration of the simulation. This represents a conservative approach as in reality the source will be depleted as leaching proceeds. The code is run for a single, non-specific contaminant source.*
9. *Steady state is reached at peak leaching, based on a constant, non-depleting contaminant source."*

TDEC believes these modeling assumptions provide a reasonable basis for deriving some measure of dilution at various locations in the model domain. Estimation of dilution otherwise may be problematic. Incorporation of dilution effects directly into the differential formulation of the mass balance adds an additional term to the conventional advection/dispersion equation solved analytically in PATHRAE. However, since contaminant transport is being modeled separately but in parallel with the dilution calculations, the claims of conservatism in assumption statements 3 and 8 above are not valid. The attenuation of the peak concentration due to the finite nature of the source and mass transfer processes such as dispersion and adsorption is accounted for in PATHRAE.

112. <u>Page H-49, Paragraph 1</u>:"*This calculated average ratio of the concentration at the well relative to leachate concentration from the cell, 0.000015, equals the DF_{well}*"

A reasonable bound on dilution factors can be deduced from a water balance over all of zone 3 in Bear Creek Valley. Assuming about half of precipitation is lost to evapotranspiration and 1 centimeter infiltration annually over the 10 to 20 acre footprint of the waste, the resulting bulk dilution factor for the entire upper Bear Creek watershed lies between 0.001 and 0.0001. A more realistic dilution factor near the integration point below the confluence of Bear Creek with NT-8 (where the bulk of groundwater and surface water have already been mixed along the karst pathways) would employ an order of magnitude higher infiltration, based on some expectation of cap degradation, and the dilution factor would be between 0.01 and 0.001. Anything less than this average (for example, the DF_{well} derived in this Appendix needs some extraordinary justification, and is clearly not conservative, as it is less concentrated than the average value leaving the zone of restricted use. To be somewhat consistent with RCRA LDRs (which typically use a total dilution/attenuation factor of .01 between leachate concentrations and drinking water MCLs), it is hard to justify using a DF less than 0.01. On the other hand, there is some justification for using a dilution factor less than 1, since water infiltrating through the waste will be diluted to some degree even under the facility footprint with groundwater recharge upgradient of the facility.

113. Page H-49, Footnote:" *[2]This assumption is necessary, since the exact contaminant concentrations and placement within the landfill will not be known until after the landfill begins operation. An assumption that contaminants are uniformly distributed is conservative because it allows leaching to be modeled in all the formations underlying the landfill, for the entire footprint."*

While the assumption that contaminants are uniformly distributed in the land fill may facilitate computation of the leachate concentrations, it may not always be conservative. The release rate into infiltration will depend locally on the infiltration rate, the concentration of the contaminant in the waste, and the rate at which the contaminant is transferred between solid and liquid phases. If most of the water infiltrates along pathways that are initially cleaner or have slower release rates, the assumptions of uniformity will be lead to conservative values of contaminant concentration in leachate. The opposite situation might occur in a few cases in the EMWMF, where infiltration rates through clean fill may be substantially less than through contaminated demolition debris.

114. Page H-54, Paragraph 1:"*The contaminant concentration in the landfill is depleted by two mechanisms: (1) decay (for radioactive contaminants; no degradation of hazardous COPCs (chemical compounds) is accounted for as they are all assumed to degrade well within 1,000 years; USGS 2006) and (2) leaching via solid-liquid partitioning."*

The reference cited here pertains only to volatile organic compounds, not to pesticides, PCBs, dioxins and furans, or other chemical compounds that are more chemically inert and typically biodegrade to other hazardous chemicals. Reported half-lives of most of these more persistent compounds in soils are reported to be less than 100 years, but the degradation rates under the conditions that may exist in a CERCLA waste landfill, expected to be dryer with less microbial activity, are uncertain. A more conservative approach, that allows modeling of chemicals known to degrade slowly past 1000 years, would add credibility to the risk assessment.

115. Page H-54, Paragraph 1: *"Transport of the contaminant is modeled assuming migration through the vadose zone by soil-water equilibrium partitioning followed by migration in the saturated zone also via soil-water partitioning (with an added level of conservatism introduced by decreasing the partition coefficient by a factor of 10), and a receptor (MEI) exposure to that contaminant via discharge of ground water to surface water."*

The PATHRAE code assumes a homogeneous, one-dimensional flow field and chemical equilibria between the fluid and solid phases. For the purposes of modeling solute transport from the fluid phase to the solid phase, the assumption of chemical equilibria allows for the maximum possible transfer of material to the solid phase and may thus create a bias toward long residence times for contaminants. Unrealistically long travel times could lead to lack of conservatism for radionuclides that decay significantly during transport. This is particularly true when contaminants move through very heterogeneous media such as the fractured rock aquifers in Oak Ridge, simulated by the saturated zone in PATHRAE. In such cases, equilibrium is rarely achieved.

It is also likely that the assumption of homogeneity will lead to underestimation of peak values of contaminants at the receptor location. Heterogeneity in hydraulic properties typically causes an increase in first arrival times and a shorter time to peak concentrations. For contaminants that will undergo significant decay over the mean time of travel to the receptor, these effects may substantially decrease the computed risk. In addition to the heterogeneity in the aquifer, there is likely to be substantial heterogeneity in the vadose zone, except in engineered materials that have not undergone significant degradation. The effects of dispersion in the vadose zone should be incorporated into the model, as well as use effective porosity and partition coefficients. Tracing studies in very similar Oak Ridge hydrogeologic settings indicate that, to conservatively simulate reactive solute transport with the advection dispersion equation used in PATHRAE, assumed effective porosities should be at least an order of magnitude less than the total porosity, and effective partition coefficients should be near zero.

116. **Page H-59, Table 5:** "*Table H-5. Parameters for Use in PATHRAE Modeling and PreWAC Calculations.*"

TDEC has found potential discrepancies between tables summarizing model inputs and the model input files in Attachment B. An example would be a vertical groundwater velocity of 0.025 meters per year (from page 16 of attachment B), a 1centimeter per year infiltration rate, and a porosity in the vadose zone of 0.25 (from Table 5 of Appendix H), implying an effective porosity greater than the total porosity.

117. **Page H-60, Paragraph 3:** "*The PATHRAE model also determines the equivalent annual water consumption per year for the creek water for each nuclide based on the surface water exposure routes (via crops and livestock), as stated in Section 2.3. PATHRAE uses EU factors (defined in Section 4.4.1) to represent and quantify the annual amount of nuclide (in terms of water volume) consumed by an individual from all pathways (EU includes the volume of well water ingested as well as volume ingested via surface water pathway) (EPA 1987).*"

The document does not state whether the PATHRAE library of parameters such as uptake factors and slope factors used to compute the EU factors has been updated over the past twenty years, and TDEC has not yet been able to get detailed information about the PATHRAE codes. Have changes to the risk analyses for all of the pathways analyzed in the RI/FS since the version of PATHRAE used in the analysis been considered?

118. **Page H-62, Paragraph 5:** "*Sensitivity model runs were conducted for mercury, since mercury-contaminated debris will be in a macroencapsulated form(s) within the landfill. The controlling release mechanism of mercury in the macro-form (e.g., the Kd in the waste) and potential localized placement within the cells were analyzed.*"

Appendix H assumes that mercury contaminated debris that fails TCLP will be macroencapsulated within the landfill. This material includes demolition debris from the Y-12 West End Mercury Area. It is anticipated some of this building material will be impregnated or saturated with elemental mercury. Section 4.4.3.3 of Appendix H assumes this building material will contain about 625 mg/kg of mercury, but provides little detail on the chemical form. The sensitivity analysis was restricted to changing the partition coefficient of the waste, the waste volume, and, in a final analysis, the partition coefficient of mercury during transport in the vadose zone.

PATHRAE model inputs gleaned from Attachment B to this Appendix yield a vertical groundwater velocity of 2.5 centimeters per year and a vadose zone thickness of 7 meters, resulting in a groundwater travel time of 280 years. Since PATHRAE solves the transport equation with constant coefficients and the assumption of linear partitioning between liquid and solid phases, the groundwater velocity cannot be increased over time as the barrier layers in the facility degrade. In the model, solute transport will be retarded with respect to the groundwater velocity by a factor equal to unity plus the product of the bulk density of the vadose zone times the soil-water partition coefficient divided by the porosity. Using the values for density and porosity and the units and nomenclature of Appendix H, this is 1+6.4*Kd, so the conclusion that transport through the vadose zone controls the time to peak can be generalized. Using the methodology inherent in PATHRAE, any COPC with an assumed partition coefficient greater than 0.4 ml/g will have a travel time through the vadose zone of greater than 1000 years. Likewise, any COPC with Kd > 560 will have a vadose zone travel time of greater than a million years. Note that the time span for which the model must maintain constant infiltration rates, effective partition coefficients and hydraulic parameters in the subsurface will encompass geological changes that are not addressed in the design. These would include the known, small but relevant climate changes that are documented on cycles during the last few thousand years caused by variation of solar activity, and significantly larger climate change variation on a scale of tens of thousands of years to hundred thousand years, caused by the variations of the Earth's axis wobble during the planet's orbit around the Sun that is well documented over the past two million years.

119. <u>**Page H-63, Paragraph 3:**</u> "*A Kd of 580 ml/g is a reasonable assumption for the vadose zone, as discussed in Section 4.4.2.3. These results do indicate, however, that Kd in the vadose zone is the controlling factor.*"

The partition coefficient of 580 ml/g is a reasonable soil-mercury equilibrium partition coefficient. However, as the geosynthetic liner is ultimately breached and the clay liner begins to degrade, the changes to the hydraulic properties of the liner will not be uniform, and flow through the liner and buffer will not be uniform. The vadose zone beneath the engineered features will have hydraulic properties with significant spatial variation, so after the liner begins to degrade, the assumption that equilibria between the soil and water is achieved everywhere seems unlikely. At this point, flow through the vadose zone should be along preferential paths without enough loss to mass transfer processes to reach equilibrium throughout vadose zone. The sensitivity analysis and implied conclusion that disposal of mercury at concentrations of 625 ppm and higher will not pose a significant risk to human health or the environment is contingent upon slow uniform migration of water through the vadose zone for millennia.

The conclusion that mercury can be disposed without limitations on concentration or chemical form is also based on the use of drinking water standards as endpoints for the risk assessment rather than ambient water quality criteria. As noted in other comments, the proposed facility is anticipated to have an extensive underdrain system. The underdrain will provide a direct pathway for future mercury polluted leachate to flow to Bear Creek. The promulgated recreational water quality standard for mercury is 51 ng/L (ppt), resulting from bioaccumulation effects in fish. The allowable TCLP mercury concentration is to 0.2 mg/L (200,000 ppt) in leachate. Concentrations of leachate at the allowable TCLP limit are about 4 orders of magnitude greater than the applicable water quality criteria and so ambient water quality criteria in surface water are likely to control the mercury pre-WAC rather than Maximum Contaminant Levels in ground water. The primary risk from eating fish containing methylmercury include teratogenic (neurodevelopmental effects), mutagenic, or neuro and immunotoxicities, rather than an excess cancer risk

Finally, the modeled macro-forms assumed in Appendix H measure 30 feet by 30 feet by 10 feet. It is expected that uncovered macro-forms will contain water due to precipitation. DOE proposed direct dumping large demolition debris into these macro-forms. Dump trucks cannot run on large debris, so it is anticipated smaller material will also be dumped to make a surface that allows dump trucks to fill the cells. Given the potential for elemental mercury to accumulate in certain areas of the macro-form, possibility of inundation of debris, and landfill logistics, TDEC is not convinced that flowable fill can be added in such a way as to assure effective in-cell macroencapsulation.

120. **<u>Page H-71, Paragraph 2</u>:** "*Radioactive decay chains in which decay products (daughters) have PreWAC limits were analyzed for cases where the parent isotope may require either establishment of a PreWAC limit (if no limit was determined by the fate-transport modeling of that isotope), or a more stringent limit (if the isotope has an initial fate-transport calculated PreWAC limit). The analysis thus assures that decay of a parent will not result in a daughter concentration exceeding its PreWAC limit. Several decay paths were determined to require this analysis including the following parent - daughter pairs:*"

This evaluation of radionuclide progeny addresses only parent-daughter pairs and is incomplete, potentially contributing to inflated pre-WAC values for uranium and transuranic radionuclides. An evaluation of non-cancer toxicity of radionuclides, their progeny, and hazardous substances is also required to evaluate compliance with RAOs and should be included in Appendix H.

121. **<u>Page H-72, Table 8:</u>** Adjustments to the pre-WAC have expanded the list of radionuclides that have WAC lower than the specific activity of the isotope. However, pre-WAC values for Am-

. 241, Am-243, Cf-249, Cf-250, Cf-251, Cm-244, Cm-245, Cm-246, Cm-247, Cs-137, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, and Sr-90 all exceed Class C NRC limits at a soil bulk density of 1.6. Since these are limits that are imposed on near surface disposal under even the most favorable siting conditions, the modeling effort in this Appendix appears to give results that are not consistent with an approach that is used widely across the nation.

122. **Page H-83, Paragraph 1:** "*Table H-11 compares the analytic PreWAC developed for EMDF with the EMWMF analytic WAC. As shown in the table, the analytic PreWAC for EMDF are generally 10 to 100 times higher than the analytic WAC for EMWMF. However, many more isotopes are assigned PreWAC for the proposed EMDF compared to the EMWMF analytic WAC.*"

This states the Pre-WAC for EMDF is generally 10 to 100 times higher than the analytic WAC for EMWMF and the higher pre-WAC is based on the distance from the disposal cell to the receptor location, contributing to a smaller dilution factor and increased attenuation due to decay and dispersion modeled in PATHRAE. Another contributing factor to the higher pre-WAC is the underdrain system, which, in the MT3D model, reduces the source of contaminated leachate with respect to clean recharge. A third factor, not mentioned in this discussion, is the use of a 10^{-4} excess lifetime cancer risk to compute any non-adjusted pre-WAC values of radionuclides.

123. **Page H-83, Paragraph 7:** "*A hydraulic break will be created by excavating and filling the major existing stream channels within the landfill footprint with highly conductive gravel/cobble sized material. A thinner blanket drain would extend beyond this trench drain to conduct high water seepage to the trench drain. These backfilled existing channels would behave hydraulically as underdrains to allow shallow ground water to move laterally to discharge to surface water outside the landfill. The underdrain system should also help maintain a lower water table under much of the landfill. The underdrain system would act as a preferred migration pathway for contaminant movement under some conditions.*"

TDEC agrees that the underdrain will lower concentrations of COPCs in some locations in groundwater at the expense of surface water. If modeling scenarios were expanded to assure protection of surface water quality, pre-WAC values for some COPCs might be limited by ambient water quality criteria rather than risk to a hypothetical receptor or MCLs in ground water. More realistic scenarios might also look at cumulative effects of all sources on surface water, and would include a more realistic way to incorporate the mixing between surface water and ground water in any carbonate rock formations.

With the underdrain at EMWMF, a flow path to carry groundwater and leachate (once engineering controls fail) has already been constructed and is documented to have sufficient flow to be utilized as a future residential water supply. In addition, the MWMF conceptual design and as-built locations shown in EMDF RI/FS, Figure H-26, are not the same and the footprint has expanded significant since the risk evaluation performed for the EMWMF in 1998. The next five year review should revisit the EMWMF risk assessment incorporating relevant potential scenarios and make a determination as to whether groundwater and surface water were evaluated and protected consistent with CERCLA requirements. The updated evaluation should include analysis of what has been put in EMWMF to date and what is proposed to be put in the landfill until closure including constituents for which there is a WAC, constituents for which no WAC was developed, and ingrowth progeny.

Editorial Comments

1. **Page X, "UEPC:** "*Upper East Fort Poplar:*" Upper East Fort Poplar Creek should be Upper East Fork Poplar Creek

2. **Page ES-2, Last Paragraph, Line 1:** Should *as generated* be placed in quotes as it is in the first line of the paragraph above (i.e., "as generated")?

3. **Page 2-1 & 2-2, First Paragraph, Line 5 (Page 2-1), Line 1 (Page 2-2):** Since the PCCR for 2014 is included in the references as DOE 2014, should it be cited appropriately here?

4. **Page 2-8, First Paragraph, Line 2:** See comment Page 2-1 & 2-2, First Paragraph, Line 5 (Page 2-1), Line 1 (Page 2-2): above.

5. **Page 2-9, Second Bullet, Line 2:** The 2013 PCCR is included in the references. Should it be cited appropriately here?

6. **Page 2-9, Last Paragraph, Line 2:** Which PCCR is being spoken of here, 2013?

7. **Page 2-11, Paragraph 2, Lines 1- 2:** Should "Figure 2-3" here be "Figure 2-3[a]"?

8. **Page 2-17, Table 2.6, Middle Table, Row 1:** Should "F-59" be "Fe-59"?

9. **Page 3-3, Table 3.1, Column 4, Row 1:** Should "Record of Decisions for Interim Actions in Bethel Valley, Oak Ridge, Tennessee" be "Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee"?

10. **Page 5-6, 6th column, 2nd last row, Line 6:** Should "...to implement of stockpiling..." be "...to implement if stockpiling..."?

11. **Page 5-9, Engineered Disposal Cell, Paragraph 4, Line 5:** MLLW is not included in the list of Acronyms.

12. **Page 6-4, Paragraph 2, Line 11:** "DuVall 1996" should be "DuVall & Souza 1996".

13. **Page 6-4, Paragraph 3, Line 4:** Although included in the references for a couple of the appendices, DOE 1997 is not included in the Chapter 8 references.

14. **Page 6-20, 2nd bullet from bottom of page, Line 11:** Should the guidance from Savannah River National Laboratory (i.e., SRNL 2014) be included in the references?

15. **Page 6-20, 2nd bullet from bottom of page, Lines 13-14:** Should "that may be present or develop of time in the primary geomembrane liner." Be something like "that may be present or develop in time in the primary geomembrane liner." or, "that may be present or develop over time in the primary geomembrane liner."?

16. **Page 6-29, Paragraph 1, Lines 1-2:** This document is included in the references as UCOR 2015 and should be cited here accordingly.

17. **Page 6-37, Paragraph 3, Line 9:** Should "...the ground water ground water table during seasonal..." be "the ground water table during seasonal..."?

18. **Page 6-54, Characterization and Treatment, Line 4:** Should "...documents for each of the off-site disposal facilities provides..." be "...documents for each of the off-site disposal facilities provide..."?

19. **Page 7-23, Last Paragraph, Line 2:** Should "...fctors that minimize long-term risk to human..." be "...factors that minimize long-term risk to human..."?

20. **Page 7-26, 4th Paragraph, Line 6:** TDEC 2008 is not included in the References.

21. **Page 7-35, Paragraph 2, Line 11:** Should "PWAC" be "PreWAC"?

22. **Page 8-1, References:** The following references were not cited in this portion of the document: Benson, 2014; BJC 2002; BJC 2006.

23. **Page 8-1 References, (7th reference):** The reference *Benson 2014* has no initial and seems incomplete.

24. **Page 8-2, References:** The following references were not cited in this portion of the document: DOE 2008a; DOE 2008b; DOE 2008c.

25. **Page 8-3, References:** The following references were not cited in this portion of the document: DOE 2009a; DOE 2010a; DOE 2011a; DOE 2011d; DOE 2013.

26. **Page 8-4, References:** The following reference was not cited in this portion of the document: Needham, et al. 2006.

27. **Page 8-5, References:** The following references were not cited in this portion of the document: Rodriguez et al. 1992; Rowe et al. 2009. Also, if the Rodriguez et al. 1992 reference is used, all authors need to be listed in the references.

28. **Page A-10, Table A-1, Footnote a:** Should "...volume of classified waste other than for East Tennessee Technology Parl (ETTP)." be "volume of classified waste other than for East Tennessee Technology Park (ETTP)."?

29. **Page A-52, References:** DOE 2013 is not cited in this appendix.

30. **Page B-7, Approach, Paragraph 2, Line 6:** The CARARs are included in the references. Should they be cited appropriately here?

31. **Page B-8, Waste Materials, Paragraph 1, Line 7:** RCRA and TSCA are not included in the list of Acronyms.

32. **Page B-24, Last Paragraph, Last Line:** ROM is not included in the list of Acronyms.

33. **Page B-39, Table B-16. Total Life-cycle Costs for Off-Site Alternative Size Reduction Facility:** Would it perhaps be clearer to label this table as being for the "Off-Site Disposal Alternative"?

34. **Page B-41, Paragraph 1, Line 2:** Should "...in a \$960 per yd^3..." be "...in \$960 per yd^3..." or "...in a \$960 per yd^3 cost..."?

35. **Page B-46, Paragraph 1, Line 2:** DOE 2009b, DOE 2010, and DOE 2012b are not cited in this section of the RI/FS.

36. **Page C-7, 3.3 Macroencapsulation Techniques, Paragraph 1, Line 9:** In the References the Chattopadhyay paper is listed as 2003.

37. **Page C-10, 4.2 MACROENCAPSULATION AT THE GENERATOR / DEMOLITION SITE, Paragraph 1, Lines 5-6:** Should "While is it technically possible to transport very large loads with specialized equipment,..." be "While it is technically possible to transport very large loads with specialized equipment,..."?

38. **Page C-12, Table C-1, Row 1, Column 3, Second entry, Line 3:** Should "...use of fewer, larger container.s (-)" be "...use of fewer, larger containers. (-)"?

39. **Page C-16, References:** DOE 1998 is not cited in this section of the RI/FS.

40. **Page C-18, References, 1st Reference, 9th Reference:** Should "McBeath 1983" be "McBeath, I 1983"? Should "Siry 2007" be "Siry, G.W. & L.T. Reid 2007"?

41. **Page D-7, Paragraph 3, Lines 12-13:** BJC 2002 and BJC 2006 are not included in the list of References for this section of the RI/FS.

42. **Page D-8, 2. Preliminary Screening, Paragraph 1, Line 3:** The Reference included here as "DOE 2008a" is in the References as "DOE 2008".

43. **<u>Page D-13, 3.2.1 EBCV Option 2, Paragraph 2, Line 2:</u>** "DOE 2008b" is not included in the References for this section of the RI/FS.

44. **<u>Page D-17, 4.1.1 Physical Characteristics, Paragraph 1, Line 2:</u>** "Wooded, undisturbed terrain is west, northwest and north east of the site, and on the southeast by Hembree Marsh." is not a coherent sentence.

45. **<u>Page D-19, 4.1.2.1 Sensitive Habitats, Paragraph 1, Line 2:</u>** "Pounds, et al. 1993" is not included in the References for this section of the RI?FS.

46. **<u>Page D-19, 4.1.2.1 Sensitive Habitats, Paragraph 2, Line5:</u>** "TDEC 2008" is not listed in the References for this section of the RI/FS.

47. **<u>Page D-22, 4.2.1 Physical Characteristics, Paragraph 2, Line 3:</u>** "Walker and Saylor 1988" is not included in the References for this section of the RI/FS.

48. **<u>Page D-23, 4.2.1.1 Topography, Paragraph 1, Line 1:</u>** "The WBCV site lies squarely on a spur ridge of extending from Pine Ridge." is not a coherent sentence.

49. **<u>Page D-25, Paragraph 2, Line 5:</u>** Should "NT-5" be "NT-15"?

50. **<u>Page D-25, 4.2.1.4 Ground Water, Paragraph 1, Line 7:</u>** "Moore 1988" is not included in the References for this section of the RI/FS.

51. **<u>Page D-26, 4.2.2.1 Sensitive Habitats, Last Paragraph, Line 6:</u>** "Baranski 2009" is not included in the References for this section of the RI/FS.

52. **<u>Page D-28, 4.2.3.2 Historical Resources, Paragraph 2, Lines 6-7:</u>** Should "Currier Cemetery is located west of the WBCV site and cemetery contains…" be "Currier Cemetery is located west of the WBCV site and contains…"?

53. **<u>Page D-29, 4.3.1.2 Surface Water, Paragraph 1, Line 5:</u>** "Robinson and Mitchell 1996" is not included in the References for this section of the RI/FS. Is it possible that "Robinson and Johnson 1996" was the intended citation?

54. **<u>Page D-30, Paragraph 2, Line 1:</u>** Should "…just below the Haul Row indicate…" be "…just below the Haul Road indicate…"?

55. **<u>Page D-31, Paragraph 1, Line 3:</u>** "Duvall 1998" is not included in the References for this section of the RI/FS.

56. **<u>Page D-35, 4.4.2.2 Implementability, Paragraph 2, Line 6:</u>** Should "…along NT-15 and it east tributary…" be "…along NT-15 and its east tributary…"?

57. **Page D-40, References, reference #5, reference #14:** "DOE 2000" is not cited in this section of the RI/FS. "Lietzke, D.A. et al." should list all authors in the References.

58. **Page D-41, References, reference #1, reference #3:** "ORNL 2002" and "Parr 2011a" are not cited in this section of the RI/FS.

59. **Page E-7, Acronyms:** "USGS" is defined here as U.S. Geographic Services; it should be U.S. Geological Survey.

60. **Page E-11, Footnote 1:** The hyperlink here does not appear to work.

61. **Page E-14, Fig. E-4, source:** The hyperlink here redirects you to the new web page.

62. **Page E-14, Footnote 2:** The hyperlink given here does not work.

63. **Page E-17, 2.1.2 Limited Site Characterization, Paragraph 2, Line 3:** Should "...and summarize below." be ""...and are summarized below."?

64. **Page E-24, Paragraph 1, Line 5:** "Driese 2002" isn't included in the list of References for this section of the RI/FS.

65. **Page E-24, Paragraph 2, Lines 1& 5:** "Driese 2001" is not included in the list of References for this section of the RI/FS.

66. **Page E-25, 2.2.3 Geologic Structure, Paragraph 4, Line 5:** Should "(Lemiszski 2000)" be "(Lemizski 2000)"?

67. **Page E-25, 2.2.3 Geologic Structure, Last Paragraph, Line 2:** Should "...the formation complex systems of fractures..." be "...the formation complex of systems of fractures..."?

68. **Page E-26, Paragraph 1, Line 1:** Should "...and occur in all of the lithologies..." be "...and occurs in all of the lithologies..."

69. **Page E-26, 2nd LastParagraph, Lines 7-8:** Should "...favors the formation bedding plane fractures." Be "...favors the formation of bedding plane fractures."?

70. **Page E-28 Figure E-11:**
The discussion of Figure E-11, says: *"On the right, the GW-968 stereonet...."* the part of the figure that shows GW-968 is on the left.

71. **Page E-28, Paragraph 1, Line 1:** Here it is stated "On the right, the GW-968 stereonet exhibits a tight grouping of planes...". The graph for GW-968 is on the left of the figure.

72. **Page E-28, 2.2.4 Seismicity, Paragraph 1, Line 2:** Should "Oak Ridge area lies in..." be "The Oak Ridge area lies in..."?

73. **<u>Page E-29, Paragraph 3, Line 1:</u>** "Hatcher, et al (2012)" should be "Hatcher, et al. (2012)" and is not included in the References for this section of the RI/FS.

74. **<u>Page E-31, 2.3. 1 Aquifer Characteristics, Paragraph 1, Line 7:</u>** "Worthington 2007" is not included in the list of References for this section of the RI/FS.

75. **<u>Page E-31, 2.3. 2.3.1.1 Matrix pores, Paragraph 1, Lines 3-4:</u>** Should "There are conflicting interpretation regarding…" be ""There are conflicting interpretations regarding…"?

76. **<u>Page E-33, Paragraph 3, Line 2:</u>** Should "…acoustic televiewer logs from all deep and…" be "…acoustic televiewer logs from all deep wells, and…"?

77. **<u>Page E-36, Table E-6:</u>** "Golder Associates 1989" has to be 1989a, b or c. Which is it?

78. **<u>Page E-39, 2.3.2.2 Results of tracer tests, Paragraph 3, Lines 2-3:</u>** Should "Well GW-734, at the eastern edge of the Y-12 Plant Site in UEFPC Valley, has a large cavity in the Maynardville Limestone, was therefore added to the monitoring program." be "Well GW-734, at the eastern edge of the Y-12 Plant Site in UEFPC Valley, has a large cavity in the Maynardville Limestone, and was therefore added to the monitoring program."?

79. **<u>Page E-43, 2.3.3.2.1 Shallow Aquifer Zone, Paragraph 2, Line 1:</u>** Should "The water table is 36 ft (<1-2 m) deep near perennial stream channels…" be "The water table is 3-6 ft (<1-2 m) deep near perennial stream channels…"

80. **<u>Page E-43, 2.3.3.2.1 Shallow Aquifer Zone, Paragraph 3, Lines 5-6:</u>** Should "Schreiber (1995) reported that in shallow wells, the ground water gradient averaged south-southwest, but flow direction average west to west-southwest…" be "Schreiber (1995) reported that in shallow wells, the ground water gradient averaged south-southwest, but flow direction averaged west to west-southwest…"?

81. **<u>Page E-50, 2.3.3.3 Aquiclude, Paragraph 3, Lines 6-9:</u>** "Moline, et al. (1998) refute this interpretation, noting that the persistence of brine over geologic time provides a strong indication that deep ground water circulation is minimal, and that deep rocks exhibit very low hydraulic conductivity values, on the order of 10-7 to 10-9 cm/s, which suggests either absence of numerous permeable fractures." appears to be an incomplete sentence.

82. **<u>Page E-50, 2.3.3.3 Aquiclude, Paragraph 5, Lines 10-11:</u>** Should "This analogous to the fresh water sea water boundary that develops in coastal aquifers." be "This is analogous to the fresh water sea water boundary that develops in coastal aquifers."?

83. **<u>Page E-54, 2.4.2 Northern Tributaries of Bear Creek, Paragraph 3, Line 3:</u>** "TDEC 2011" is not included in the list of References for this section of the RI/FS.

84. **<u>Page E-54, 2.4.2 Northern Tributaries of Bear Creek, Paragraph 4, Line 1:</u>** "NT-3a above the from the headwater spring is a wet weather conveyance." is not a coherent sentence.

85. **Page E-56, 2.4.2.1 Stream Flow Characteristics, Paragraph 6, Lines 9-11:** In "A storm that dropped 1.35 in (3.44 cm) of rain on December 6, 2014 resulted in maximum flow rates of 2.95 cfs at SWG-1, 0.45 cfs at SWG-2, and 0.99 cfs at SWG-1." two different flow rates are reported for the same storm at SWG-1.

86. **Page E-66, 2.6.2.1 Wetlands, Paragraph 3, Line 4:** "Baranski 2009" is not included in the list of References for this section.

87. **Page E-67, Paragraph 1, Line 1:** The proper term for "dragon flies" is "dragonflies".

88. **Page E-67, Paragraph 4, Line 6:** "(Petersen, et al. 2009)" should be "(Peterson, et al. 2009)".

89. **Page E-67, Paragraph 5, Line 3:** Should "...increased in 2011..." be "...increased in FY 2011..."?

90. **Page E-68, Paragraph 3, Line 5:** Please note the citation "Peterson, et al. (2009)" (here spelled correctly) is included in the References of this section as Petersen, M.J., etc.

91. **Page E-69, Paragraph 3, Lines 1-3:** Should "Peterson, et al. (2009) reported that evidence that the macroinvertebrate community in NT-3 is degraded relative to nearby reference sites, and that no major changes occurred over the period from 2004 through 2008." be "Peterson, et al. (2009) reported evidence that the macroinvertebrate community in NT-3 is degraded relative to nearby reference sites, and that no major changes occurred over the period from 2004 through 2008."?

92. **Page E-70, 2.6.3.1 Terrestrial Flora, Paragraph 2, Line 1:** "(*Liquidambar styracifulia*)" should be "(*Liquidambar styraciflua*)".

93. **Page E-72, 2.6.5 Terrestrial Status Species, Paragraph 1, Line 1:** "Mitchell, et al. 1996" is not included in the references for this section of the RI/FS.

94. **Page E-73, 2.6.5 Terrestrial Status Species, Paragraph 1, Line 7:** The full genus name of "*A. cooperii*" (i.e. *Accipiter*) should probably be used here.

95. **Page E-74, 2.7 CULTURAL RESOURCES, Paragraph 1, Line 2:** "DuVall 1996" should be "DuVall and Souza 1996".

96. **Page E-74, 2.7 CULTURAL RESOURCES, Paragraph 2, Line 3:** "DuVall 1996" should be "DuVall and Souza 1996".

97. **Page E-77, References:** The references on this page are not in alphabetical order.

98. **Page E-77, References:** "Bureau of the Census 2010" was not cited in this section of the RI/FS. "CDM 1994" was not cited in this section of the RI/FS. "Collins 2015" was not cited in this section of the RI/FS.

99. **Page E-78, References:** "Cunningham and Pounds 1991" was not cited in this section of the RI/FS. "DOE 1998" and "DOE 2008b" were not cited in this section of the RI/FS.

100. **Page E-79, References:** "EPRI 2008", "Golder Associates 1989a" and Goldstrand, et al. 1995 are not cited in this section of the RI/FS.

101. **Page E-80, References:** "Huff and Frederick 1984" is not cited in this section of the RI/FS.

102. **Page E-81, References:** "McKay, et al. 2005", Moneymaker 1941, and Nativ and Hunley 1993 not cited in this section of the RI/FS.

103. **Page E-82, References:** "Pounds, et al. 1993 and "Pounds 1998" are not cited in this section of the RI/FS.

104. **Page E-83, References:** "Shevnell 1994" is not cited in this section of the RI/FS.

105. **Page E-84, References:** "TDEC 2008" is not cited in this section of the RI/FS. "USGS 2013b" and "USGS 2013c" are not cited in this section of the RI/FS. "Walker and Saylor 1988" are not cited in this section of the RI/FS.

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Worthington, S.R.H., Davies, G.J., and Ford, D.C., 2000. *Matrix, Fracture and Channel Components of Storage and Flow in a Paleozoic Llimestone Aquifer,* (in) Wicks, C.M., and Sasowsky, I.D., (eds) *Groundwater Flow and Contaminant Transport in Carbonate Aquifers*, Balkema, Rotterdam, p. 113-

ATTACHMENT A: TDEC 0400-20-11-.17(1) siting requirements for LLRW Disposal Facilities relevant to the location proposed Environmental Management Disposal Facility (EMDF)

It is generally accepted that even the best landfills can be expected to fail over time; most in relative short periods when compared to the longevity of the hazards presented by uranium isotopes and other long-lived radionuclides (millions of years). The NRC's view has been that engineered barriers[3] (e.g., cap components, drains, etc.) can improve performance, but are expected to degrade over time and become ineffective. In this context, NRC's Performance Assessment Working Group in NUREG 1573 recommends any credit given for engineered barriers in performance assessments be specified and technically justified on a case-by-case basis. For periods over 500 years, NUREG 1573 advises it is unreasonable to assume any engineered barrier (such as a cap or concrete vault) can be designed to function long enough to influence the eventual release of long-lived radionuclides.[4] As a consequence, TDEC LLRW regulations and associated NRC guidance emphasize the need for disposal sites to meet minimum technical requirements related to the geologic, hydrologic, and demographic characteristics of a site deemed necessary to provide *reasonable assurance* of long-term protectiveness and tend to view administrative requirements, institutional controls, and engineered barriers as enhancements whose effectiveness decreases with increasing time after closure. As stated in TDEC Rule 0400-11-.17(1)(a):

"*The primary emphasis in disposal site suitability is given to isolation of wastes, a matter having long-term impacts and to disposal site features that ensure that the long-term performance objectives of Rule 0400-20-11-.16 are met, as opposed to short-term convenience or benefits.*"[5]

The rule goes on to specify ten minimum site characteristics required for low level radioactive waste disposal with guidance provided in the NRC's Regulatory Guide 4.19 and NUREG 0902, along with numerous other publications addressing associated issues. The EMDF D2 RI/FS acknowledges a waiver will be needed for one of the requirements (TDEC 0400-20-11-.17(1)(h)), but it never *clearly* establishes compliance with other criteria and, in some cases, it is not clear that it could given the limitations of the site. Examples are provided below based primarily on the guidance in Regulatory Guide 4.19 and NUREG 0902, both of which are also recommended as guidance in DOE Order G 435.1-1, *Implementation Guide for use with DOE Order M 435.1-1*. Contrary to previous versions of the RI/FS, DOE has taken the position in the latest version of the RI/FS that TDEC rules regulating the disposal of radioactive waste are not relevant and appropriate to the disposal of DOE radioactive wastes; therefore, they should not be considered as ARARs for the proposed EMDF.

TDEC 0400-20-11-.17(1)(c). Within the region where the facility is to be located, a disposal site *should* be selected so that projected population growth and future developments are not likely to affect the ability of the disposal facility to meet the performance objective of Rule 0400-20-11-.16.

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[3] *As defined in NUREG 1573 an "Engineered barrier is a man-made structure or devise designed to improve the land disposal facility's ability to meet the performance objectives of 10 CFR Part 61 described in Subpart C, meaning the ability to isolate and contain waste, to retard and minimize possible release of radionuclides to the environment."*

[4] U.S. Nuclear Regulatory Commission. NUREG- 1573: *A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities: Recommendations of NRC's Performance Assessment Working Group. October 2000.* http://pbadupws.nrc.gov/docs/ML0037/ML003770778.pdf (Last visited 07/24/2015).

[5] State of Tennessee. *Rules of the Tennessee Department of Environment and Conservation Division of Radiological Health Chapter 0400-20-11 Licensing Requirements for Land Disposal of Radioactive Waste. May 2012.* *http://www.state.tn.us/sos//rules/0400/0400-20/0400-20-11.20120522.pdf (Last visited 07/24/2015).*

As explained in NRC's NUREG-0902[6]: "*Disposal sites should be located in areas which have low population density and limited population growth potential. <u>Disposal sites should be at least two kilometers from the property limits of the closest population centers</u>.*"

The population density in the immediate vicinity of the Oak Ridge Reservation is reported to be one of the highest of any of the sites in the DOE complex, with more than 815,000 people in the counties immediately surrounding Oak Ridge.[7] The EMDF would lie in Anderson County (population within the corporate boundary of the city of Oak Ridge (population ~ 29,330), approximately 650 yards (~ 0.6 kilometers) from the nearest reservation boundary and property limits (Figure 1). The closest resident is currently located approximately 1.35 kilometers (km) to the north. At approximately 1.5 km to the northeast is Groves Park Commons, a relatively new and developing subdivision planned for 300 homes and townhouses upon completion.[8] At approximately 2.1 km is the Scarboro Community and beyond Scarboro the center of the city. The Scarboro Community was established during the Manhattan Era to house African-American workers and remains a predominately minority community. Due to Scarboro's proximity to the Y-12 Plant, environmental justice has been an issue in the past resulting in various environmental and epidemiological studies, including DOE's *Scarboro Community Environmental Study*[9] and the CDC/ATSDR's *Scarboro Community Health Investigation*.[10]

Figure 1: Approximate distances from the proposed EMDF to the nearest private property limits, resident, subdivision, Scarboro Community, and center of Oak Ridge. Tennessee (1 km = 0.62 miles)

[6] U.S. Nuclear Regulatory Commission. *NUREG-0902: Site Suitability, Selection and Characterization.* July 1986. http://pbadupws.nrc.gov/docs/ML0530/ML053010325.pdf (Last visited 07/24/2015).

[7] Oak Ridge Site Specific Advisory Board. *Balancing Environmental Management Challenges with the Complexity of the Oak Ridge Reservation. Oak Ridge TN. December 2012.* http://www.oakridge.doe.gov/em/ssab/Documents/EMChallengesandComplexity.pdf *(Last visited* 07/24/2015).

[8] *Groves Park Commons, a Traditional Neighborhood Development, Receives the Outstanding Planning Award for a Green Development*. Retrieved from http://www.pr.com/press-release/107141 (Last visited 07/24/2015).)

[9] U.S. Department of Energy. *Scarboro Community Environmental Study*. U.S. DOE. September 22, 1998.

[10] ATSDR (Website). *Oak Ridge Reservation: Compendium of Public Health Activities at the U.S. Department of Energy.* http://www.atsdr.cdc.gov/hac/oakridge/phact/c_5.html (Last visited 07/24/2015).

TDEC 0400-20-11-.17(1)(b): The disposal site shall be capable of being characterized, modeled, analyzed and monitored.

As explained in NUREG 0902: "*The first requirement implies that the proposed site should be geologically and hydrologically simple. Since site characterization investigations can only sample a small fraction of the surface area or subsurface volume of the disposal site, site characteristics must be such that these limited investigations can adequately define the site characteristics spatially across the disposal site. Site conditions should be such that well-documented analytical solutions or computer codes are available and applicable for modeling site performance. As a minimum, the modeling of site characteristics, such as infiltration or ground-water flow, should be able to reproduce natural steady-state conditions and perturbed conditions, such as responses to precipitation or stresses introduced by pumping during site characterization investigations.*

Since most modeling tends to homogenize the hydrogeological units and average the hydrologic properties for such units, the site characteristics should vary within a sufficiently narrow range so that the input to the modeling is representative of the hydrogeologic units and the assumptions underlying the modeling are valid. For example, the hydrogeologic unit used for disposal should not have continuous permeable or impermeable anomalies such as faults or fracture zones, sand lenses, weathered horizons, or karstic features that provide preferential pathways for or barriers to ground-water flow." [11]

As described in the RI/FS, the proposed site for the EMDF is topographically, geologically and hydrologically complex, with steep slopes (>30%), deep ravines, zones of upwelling groundwater, numerous springs & seeps, wetlands, two spring fed streams, and preferential groundwater flow in the fractured shales of the Conasauga Group that drain to the mature karst network of the Maynard Limestone. The stream to be partially covered by the EMDF, North Tributary (NT)-3, drains to Bear Creek, which is typically considered a surface expression of the karst hydrology of the Maynardville Formation, with gaining and losing reaches common (Figure 2). The intimate relationship between surface and ground waters in the valley is evidenced by a losing reach of Bear Creek immediately downstream of NT-3, where Bear Creek as whole descends into the solutionally enlarged cavities of the Maynardville during base flow conditions, then re-emerges further downstream in a series of springs and seeps. While the network of cavities in the Maynardville Formation remains poorly understood, legacy contaminants are found in both the shallow interval and at depth.

As NT-3 flows southwesterly underneath cells 1 through 3, NT-2 drains the eastern cells (5 & 6), and the proposed underdrain is designed specifically to capture groundwater beneath the cells and deliver it to these streams, any contaminants released from the facility would be expected to disperse rapidly to both surface and ground waters and be transported downstream by way of Bear Creek to Poplar Creek and the Clinch River.

[11] Ibid, U.S. Nuclear Regulatory Commission. *NUREG-0902: Site Suitability, Selection and Characterization*. July 1986. http://pbadupws.nrc.gov/docs/ML0530/ML053010325.pdf (Last visited 07/24/2015).

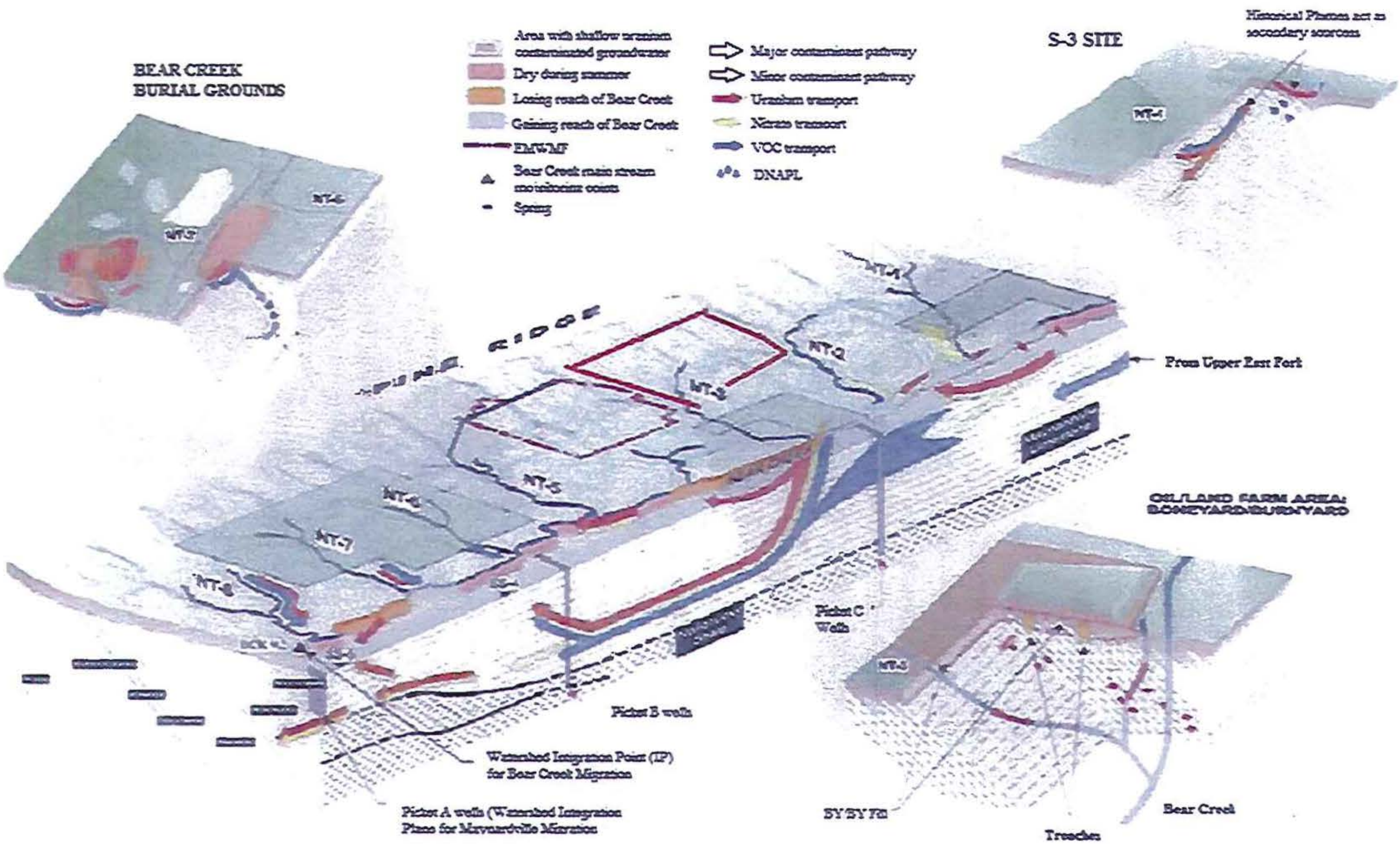

Figure 2: Conceptual model for contaminant migration in Bear Creek.

(Basemap reproduced from *Focused Feasibility Study for the Bear Creek Burial Grounds at the Y-12 National Security Complex, Oak Ridge Tennessee* (DOE, 2008).[12]

[12] Argonne National Laboratory. *Focused Feasibility Study for the Bear Creek Burial Grounds at the Y-12 National Security Complex, Oak Ridge Tennessee*. September 2008. http://www.oro.doe.gov/PAODOEIC/Uploads/F.0601.029.0558.pdf (Last visited 07/24/2015).

Complicating the hydrology further is the abundant rainfall of the region, which varies significantly both seasonally and annually. Over the last fourteen years the annual average rainfall measured on the ORR has ranged from 73.7 inches in 2003 to 36.6 inches in 2007 (Figure 3). The nature, rate, and direction of groundwater flow vary in response to climatological conditions both temporally and spatially with annual cyclic variations resulting from seasonal changes and short-term variations in response to individual storm events.[13]

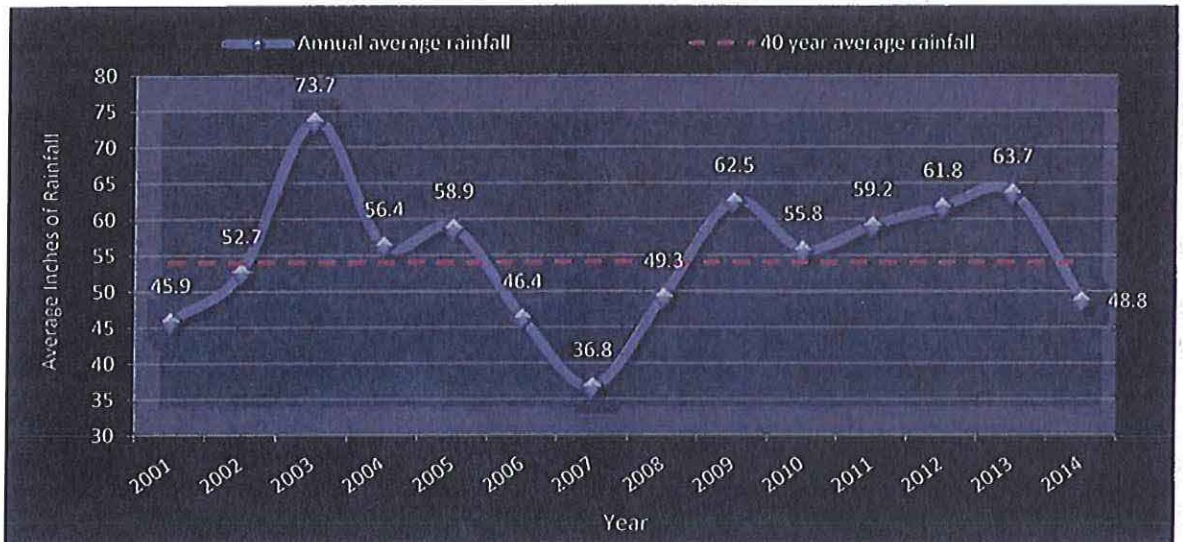

Figure 3: Annual average rainfall on the Oak Ridge Reservation (2001-2014).[14]

Historically, such complexities have limited the usefulness of conventional groundwater modeling in the valley. For example, the Environmental Management Waste Management Facility (EMWMF) model (amended for use in the EMDF RI/FS) was found to have underestimated groundwater levels in wells in the vicinity of the EMWMF, as well as the effect of filling the channel of NT-4.[15] In the twelve months following the opening of the EMWMF, it rained 77 inches, including a storm reported to have a 67-year recurrence interval.[16] During the year, the waste cells flooded, containment berm(s) were washed out (Figure 4), seeps developed in the cell 2 berm (Figure 5), and the operator was penalized $300,000 in fine and restitution for pumping waste water known to have exceeded the allowable limits to Bear Creek.[17] Groundwater was subsequently found to have risen through the required ten foot geologic buffer below the facility to levels near and / or above the liner, necessitating the construction of the EMWMF underdrain: a mitigative measure necessary to protect

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[13] P.D. Moss, S.R. Pack, K.P. Catlett, D.G. Adler, C.S. Haase, S.P. Kucera. *Characterization to support Watershed-Scale Decision making for the Bear Creek Watershed at the Oak Ridge Reservation. Oak Ridge, Tennessee.* Science Applications International Corporation, Oak Ridge Tenn., U.S. Department of Energy, Oak Ridge Tenn., and Bechtel Jacobs Company, LLC, Oak Ridge Tenn., WM Conference, February 28 - March 4, 1999. http://www.wmsym.org/archives/1999/70/70-3.pdf (Last visited 07/24/2015).

[14] URS/CH2M Oak Ridge LLC. 2014 *Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee Data and Evaluations.* (DOE/OR/01-2640&D2). September 2014. http://www.oakridge.doe.gov/External/LinkClick.aspx?fileticket=mwiYV6jgf7o%3d&tabid=325&mid=1118 (Last visited 07/24/2015).

[15] J. Williams, J. Patterson, R.D. George (Bechtel Jacobs Company LLC), J.M, Japp (Oak Ridge Operations, U.S. Department of Energy Oak Ridge). *Environmental Management Waste Management Facility DOE-EM's first on-Line privatized Disposal Facility*. WM'04 Conference, February 29. Tucson AZ. March 4, 2004. http://www.wmsym.org/archives/2004/pdfs/4537.pdf (Last visited *07/24/2015*).

[16] *Ibid.*

[17] U.S. Environmental Protection Agency Office of Inspector General. *Waste Management Contractor Pleads Guilty.* 2007. http://www.epa.gov/oig/reports/OI_documents/2007/20061220-DFS.pdf *(Last visited 07/24/2015).*

the liner. The underdrain was an attempt to re-establish the drainage previously provided by the channel of the NT-4 tributary of Bear Creek, which had been filled to accommodate construction of the facility.[18] While the underdrain lowered the water table, its effectiveness in the long-term is unknown and presently suspect based on more recent water level measurements that indicate incursions into the ten-foot buffer zone required beneath the facility.

Figure 4: Flooded Cell 2 and repaired EMWMF berms.

[18] *Ibid.* Williams et al, 2004. *Environmental Management Waste Management Facility DOE-EM's first on-Line privatized Disposal Facility* http://www.wmsym.org/archives/2004/pdfs/4537.pdf (Last visited 07/24/2015).

Figure 5: Cell 2 seep.

TDEC 0400-20-11-.17(1)(k). The disposal site must not be located where nearby facilities or activities could impact the ability of the site to meet the performance objectives of Rule 0400-20-11-.16 or mask the environmental monitoring program.

The EMWMF and seven legacy disposal sites are located immediately adjacent to or in close proximity to the proposed EMDF location (Figure 6): the EMWMF immediately to the west; the Oil Land Farm (OLF) and Sanitary Landfill 1 to the southwest along the western bank of NT-3; and Boneyard/Burnyard (BY/BY), the Hazardous Chemical Disposal Area (HCDA), and the Unit 6 Landfill immediately to the south along the eastern bank of NT-3. Approximately 3,000 feet further east are the S-3 ponds and approximately 4,000 feet to the west are the Bear Creek Burial Grounds.

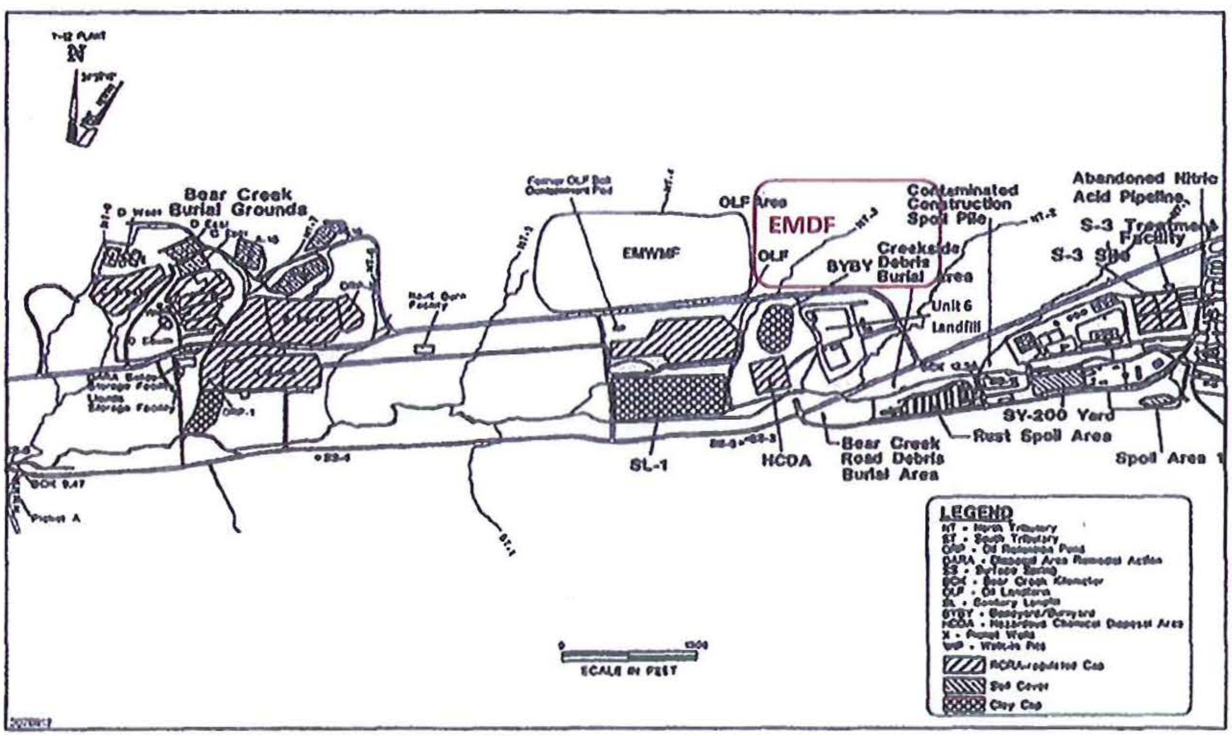
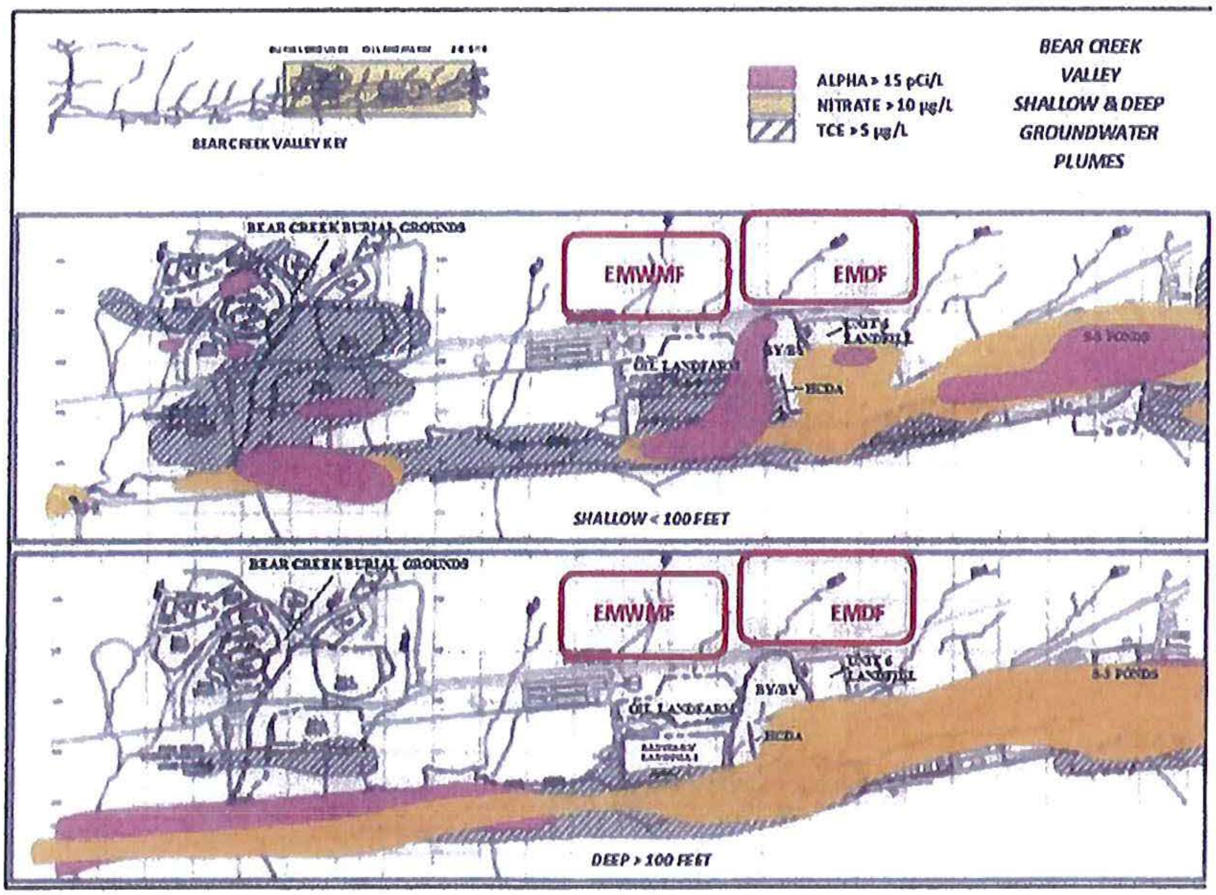


Figure 6: Location of primary waste disposal areas in Bear Creek Watershed. (Basemap from *Focused Feasibility Study for the Bear Creek Burial Grounds at the Y-12 National Security Complex, Oak Ridge Tennessee.*[19]

Releases from the legacy disposal sites have formed a comingled plume containing multiple contaminants that extends from the S-3 Ponds to the east down the valley parallel to Bear Creek past the Bear Creek Burial Grounds. The plume passes directly in front of the proposed EMDF site and contaminants are evident in NT-2, NT-3, and Bear Creek below the site (Figure 7). The 2014 Remediation Effectiveness Report (RER)[20] indicates the uranium concentrations have been rising in NT-3 in recent years, although the exact source of the contamination is uncertain. In 2013, the flux of uranium in the stream was approximately five times the goal in the ROD for Phase 1 Activities in Bear Creek Valley and comprised approximately16% of the total uranium flux at the Bear Creek integration point (which was ~ 3.6 times the goal set in the ROD). Releases from the legacy disposal sites have the potential of masking any releases from the EMDF. Alternately, any releases from the EMDF would contribute to exceedances of the goals set in the ROD for NT-3 and the Bear Creek Integration Point. It should also be noted that while the concentrations of total mercury in NT-3 reported in the RER were below AWQC, methylmercury concentrations were higher than any other location monitored on or off the ORR.



[19] *Ibid.* Argonne National Laboratory, 2008. *FFS for the Bear Creek Burial Grounds.* http://www.oro.doe.gov/PAODOEIC/Uploads/F.0601.029.0558.pdf (Last visited 07/24/2015).

[20] Ibid. URS/CH2M Oak Ridge LLC. 2014. *2014 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee Data and Evaluations.* (DOE/OR/01-2640&D2). September 2014. http://www.oakridge.doe.gov/External/LinkClick.aspx?fileticket=mwiYV6jgf7o=&tabid=325&mid=1118 (Last visited 07/24/2015)

*(BY/BY (Boneyard/Burnyard), HCDA (Hazardous Materials Disposal Area).

Figure 7: Extent of groundwater contamination in Bear Creek Valley. Basemap reproduced from *Characterization to support Watershed-Scale Decision making for the Bear Creek Watershed at the Oak Ridge Reservation, Oak Ridge, Tennessee* (Moss et al, 1999).[21]

TDEC 0400-20-11-.17(1e): The disposal site must be generally well drained and free of areas of flooding or frequent ponding. Waste disposal *shall not* take place in a 100-year flood plain or wetland, as defined in Presidential Executive Order 11988, "Floodplain Management Guidelines."

The footprint of the EMDF would cover a number of wetlands, zones, of upwelling groundwater, and draws & ravines containing seeps and springs (Figure 8). According to the RI/FS there are six wetlands in the NT-3 drainage. Five wetlands are included in Reference Area (RA)-5, the Quillwort Temporary Pond wetland. RAs are defined as primarily terrestrial areas that contain special habitats or features and that also may serve as reference or control areas for research, monitoring, remediation, or characterization activities. A small emergent wetland occurs farther upstream on NT-3 from RA-5.

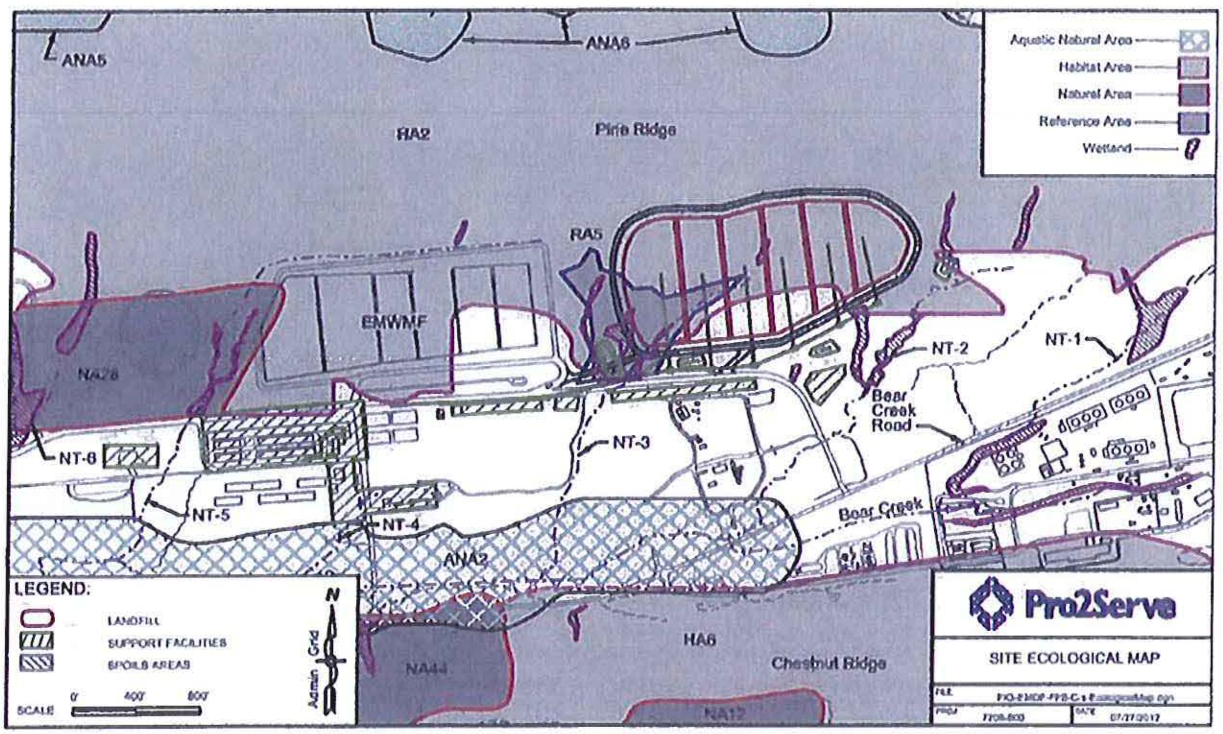


Figure 8: Streams, Wetlands, and Reference Areas in Vicinity of the proposed EMDF. (Reproduced form D2 RI/FS Figure C-17)

TDEC 0400-20-11-.17(1)(f). Upstream drainage areas must be minimized to decrease the amount of run-off which could erode or inundate waste disposal units.

[21] *Ibid.* Moss et al, 1999. http://www.wmsym.org/archives/1999/70/70-3.pdf (Last visited 07/24/2015).

As explained in Regulatory Guide 4.19[22]: "*A waste disposal site should not be located in an area where the natural ground slope is steep. Runoff from intense local precipitation may cause damage to the waste disposal unit or to diversion channels constructed to divert overland flow around the site. Intense rainfall could be a determining factor in the stability of the site. Even though the upstream drainage areas may be minimized, steep slopes could produce high water velocities that could be difficult to mitigate.*"

As described in the RI/FS, the EMDF would be constructed over steep slopes on Pine Ridge (>30%), which increase significantly above the facility as they approach the crest of ridge. The slope of Pine Ridge has necessarily been incorporated into the preliminary design of the EMDF, resulting in slopes of 25% and 33% on the cap and floor of the waste cells respectively (Figure 9). To hold the waste in place, the RI/FS proposes to construct a clean fill dyke around the perimeter of the landfill to provide lateral containment of the waste. While Regulatory Guide 4.19 leaves some room for regulatory discretion, 40 CFR 761.75 (b)(5) of the rules governing chemical landfills is more definitive: "*The landfill site shall be located in an area of low to moderate relief to minimize erosion and to help prevent landslides or slumping.*" This TSCA requirement is included as an ARAR in the RI/FS but not addressed otherwise.

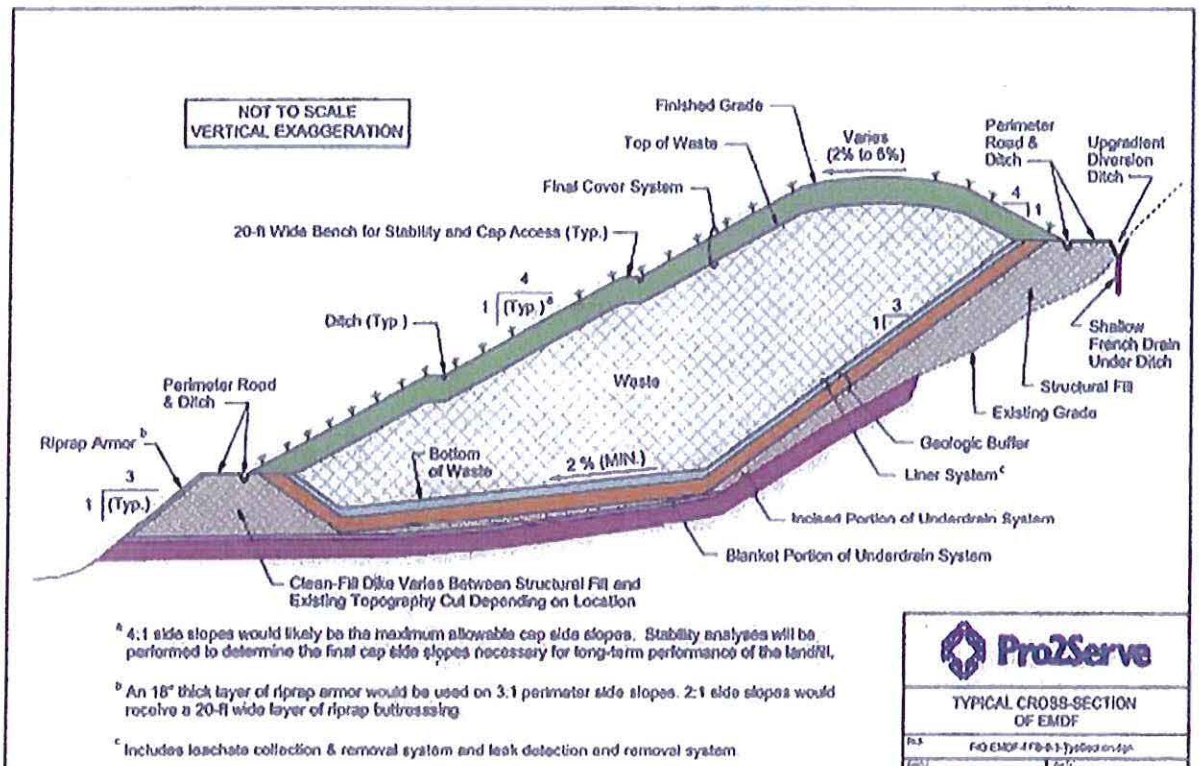


Figure 9: Typical cross section of EMDF. (Reproduced from Figure 6-2 of the D3 RI/FS)

Regulatory Guide 4.19 goes on to state: "*Sites should not be located in areas where extensive hydraulic design features will be needed to provide flood protection or erosion protection for the*

[22] U.S. Nuclear Regulatory Commission 1988, Regulatory Guide 4.19: *Guidance for Selecting Sites for Near-Surface Disposal of Low Level Radioactive Waste* August 1988 http://pbadupws.nrc.gov/docs/ML0037/ML003739520.pdf (Last visited 11/13/2014).

site. The NRC staff considers that natural conditions of the site, by virtue of typography, elevation, and location, should provide the principal contribution to site stability. While some minor hydraulic engineering designs will usually be necessary, ***<u>extensive hydraulic designs should be avoided because (1) they may lose their effectiveness over time without maintenance and (2) they may not provide an adequate degree of confidence in predicting their long-term performance or in meeting the long-term stability requirements of § 61.44."</u>***

To control storm water from the steep slopes above the facility and capture uncontaminated groundwater to help lower the water table and minimize underflow towards the liner, the RI/FS proposes a geomembrane lined rip raped ditch with an underlying French drain (comprised of gravel wrapped geotextile filter fabric) extending ten feet below the surface to collect groundwater and discharge it the ground surface down gradient of the facility. To maintain the water table below the base of the landfill liner system, a portion of the NT-3 tributary would be filled and an extensive underdrain system constructed to provide a flow path for groundwater immediately below the landfill within the portion of NT-3 to be filled and beneath the landfill locations where there are wetlands, draws, and ravines containing springs and seeps, with the intent to intercept potentially upwelling groundwater and prevent it from rising into the geologic buffer (Figure 10). It is unclear how the underdrain would be maintained or repaired should it fail (e.g., clog) over the course of hundreds of years, considering it would be covered by 2.5 million yards of radioactive and hazardous waste, much of which would have been created by mixing clean soils with debris to maintain the soil to debris ratio.

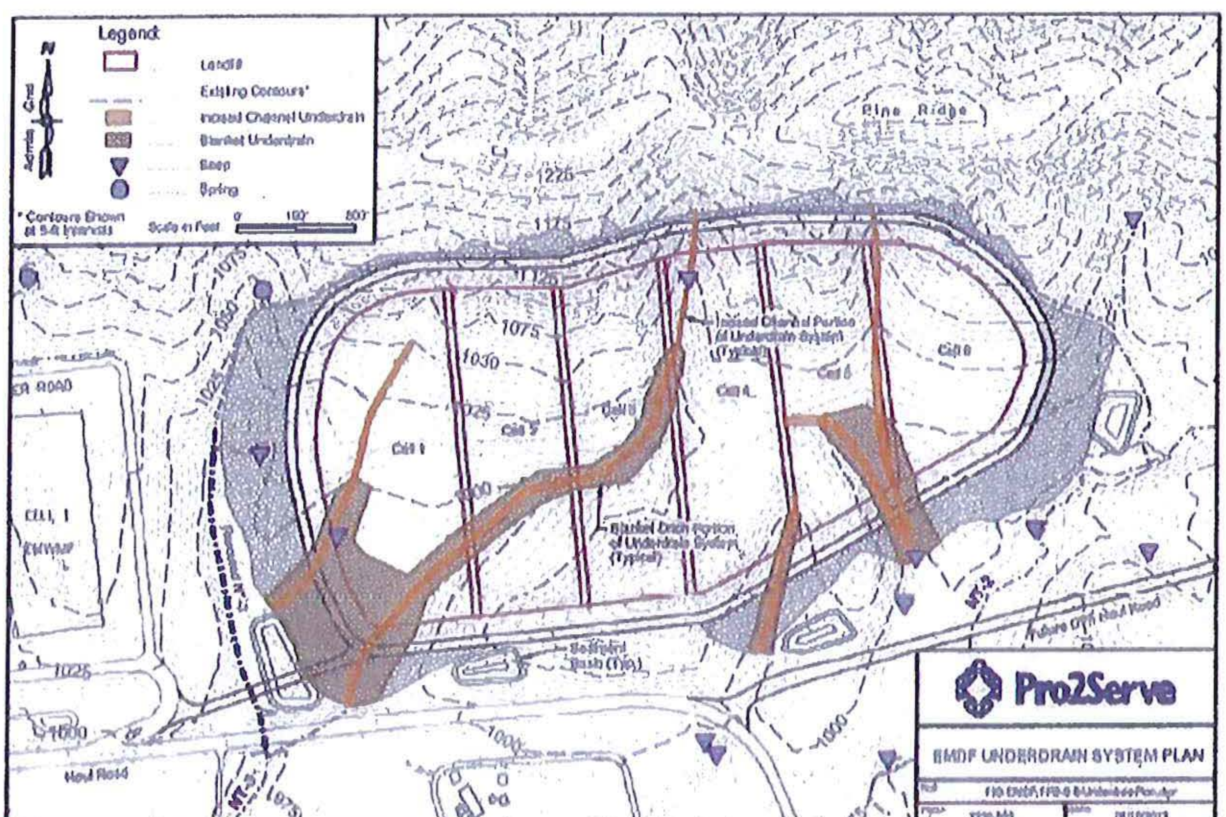


Figure 10: EMDF Underdrain System. (Reproduced from Figure 6- 8 of the D2 RI/FS)

TDEC 0400-20-11-.17(1)(h). The hydrogeologic unit used for disposal *shall not* discharge ground water to the surface within the disposal site.

NUREG-0902 states: "*Surface-water features sustained by ground-water discharge, such as perennial and ephemeral streams, springs, seeps, swamps, marshes, and bogs, should not be present at the proposed disposal site. This requirement will result in a travel time for most dissolved radionuclides at least equal to the travel time of the ground water from the disposal area to the site boundary.*"

According to the RI/FS, the EMDF would cover an area of upwelling groundwater, where groundwater is discharged to the surface in numerous seeps and springs, wetlands, and a spring fed stream. While the proposed underdrain is not an actual site feature, it is specifically designed to collect groundwater beneath the facility and deliver it to local streams: thereby, creating a direct and rapid pathway for contaminants released through the liner of the facility to Bear Creek, Poplár Creek, and the Clinch River. A condition the regulations specifically attempt to avoid.

TDEC 0400-20-11-.17(1)(g). The disposal site must provide sufficient depth to the water table that ground water intrusion, perennial or otherwise, onto waste will not occur. The Department will consider an exception to this requirement to allow disposal below the watertable if it can be conclusively shown that disposal site characteristics will result in molecular diffusion being the predominant means of radionuclide movement and the rate of movement will result in the performance objectives of Rule 0400-20-11-.16 being met. In no case will waste disposal be permitted in the zone of fluctuation of the water table.

As described in the RI/FS and noted above, the footprint of the EMDF will cover an area with a high water table, upwelling groundwater, seeps and springs, wetlands, and a spring fed stream that will be partially filled. While the RI/FS proposes an extensive underdrain system to lower the water table, its service life is uncertain, as are any mitigative measures that could be taken to lower the water levels should the underdrain fail over the course of a thousand years (given it will be located beneath the liner and many of tons of radioactive and hazardous waste). As noted in the RI/FS: "*Landfill construction, operation, and long-term performance depend on maintaining the water table below the base of the landfill liner system.*"

TDEC 0400-20-11-.17(1) (j) Areas must be avoided where surface geologic processes such as mass wasting, erosion, slumping, landsliding or weathering occur with such frequency and extent to affect the ability of the disposal site to meet the performance objectives of Rule 0400-20-11-.16, or may preclude defensible modeling and prediction of long-term impacts.

As stated in 40 CFR 761.75(b)(5), the landfill site shall be located in an area of low to moderate relief to minimize erosion and to help prevent landslides or slumping. The EMDF lies over steep slopes.

TDEC 0400-20-11-.17(1)(i). Areas must be avoided where tectonic processes such as faulting, folding, seismic activity or volcanism may occur with such frequency and extent to affect the ability of the disposal site to meet the performance objectives of Rule 0400-20-11-.16, or may

preclude defensible modeling and prediction of long-term impacts.

As proposed, the EMDF lies over steep slopes (>30%), the White Oak Mountain thrust sheet, and complex geology of the folded, fractured, and faulted shales of the Conasauga Group and within the East Tennessee Seismic Zone (ETSZ). The ETSZ is the second most active seismic zone east of the Rocky Mountains. While historical earthquakes with a magnitude greater than 5 have not been recorded, researchers from the University of Tennessee have used hypothetical and theoretical relationships that suggest the ETSZ may be capable of generating an infrequent quake of approximately 7.5.[23] Figure 11 taken from *Large Earthquake Paleoseismology in the East Tennessee Seismic Zone: Results of an 18-Month Pilot Study* (Hatcher, 2012) shows the ETSZ earthquakes from 1966 through 2003, with several larger historic earthquakes superimposed on a digital elevation model of the region. While the likely hood of a large earthquake over the course of thousands of years is unknown, smaller earthquakes may be a concern, where the facility sets on steep slopes and relies on earthen dykes laterally and around the perimeter of the landfill to provide containment of the waste and stability. As previously noted, 40 CFR 761.75 (b)(5) provides: "*The landfill site shall be located in an area of low to moderate relief to minimize erosion and to help prevent landslides or slumping.*"

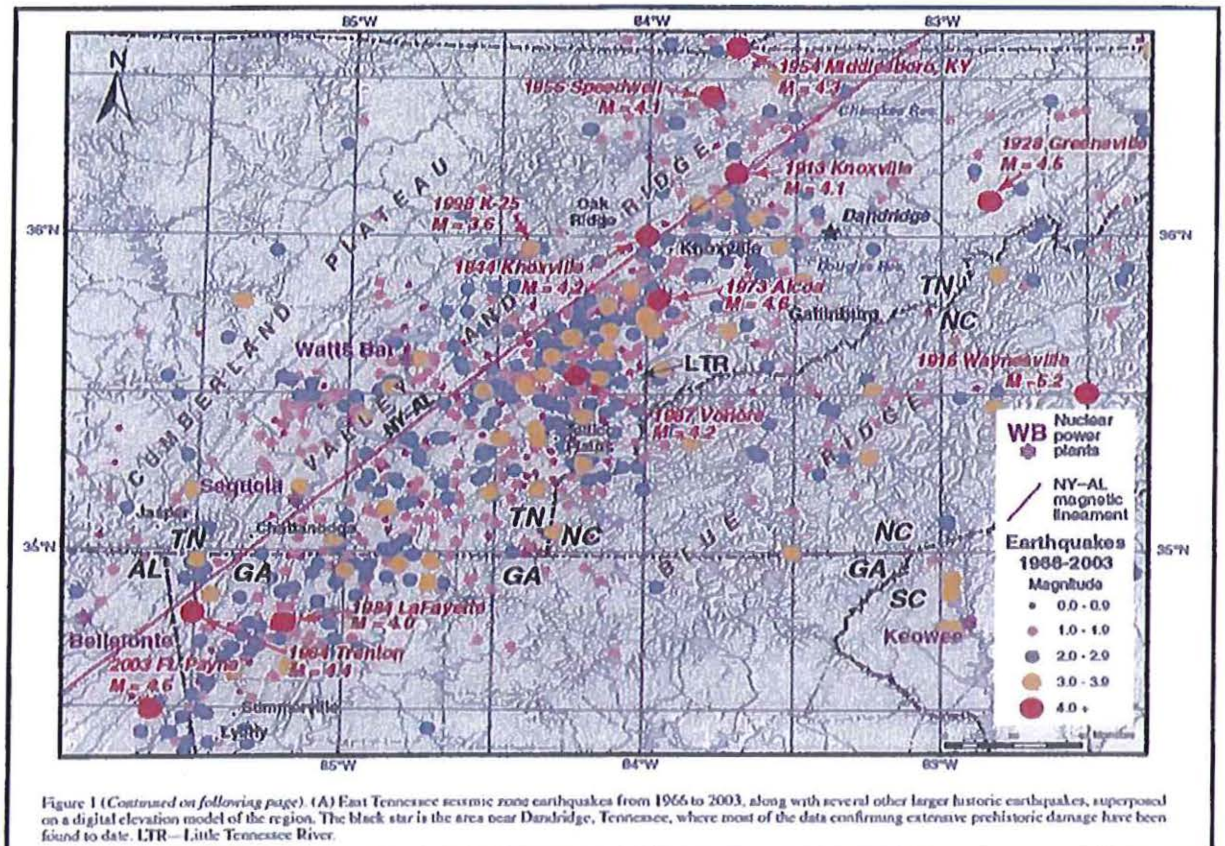


Figure 1 (*Continued on following page*). (A) East Tennessee seismic zone earthquakes from 1966 to 2003, along with several other larger historic earthquakes, superposed on a digital elevation model of the region. The black star is the area near Dandridge, Tennessee, where most of the data confirming extensive prehistoric damage have been found to date. LTR—Little Tennessee River.

[23] Robert Hatcher Jr., James D. Vaughn, Stephen F. Obermeier. *Large Earthquake Paleoseismology in the East Tennessee Seismic Zone: Results of an 18-Month Pilot Study*. 2013 Geologic Society of America. Accepted June 15, 2012. http://specialpapers.gsapubs.org/content/493/111.abstract (Last visited *11/13/2014*).

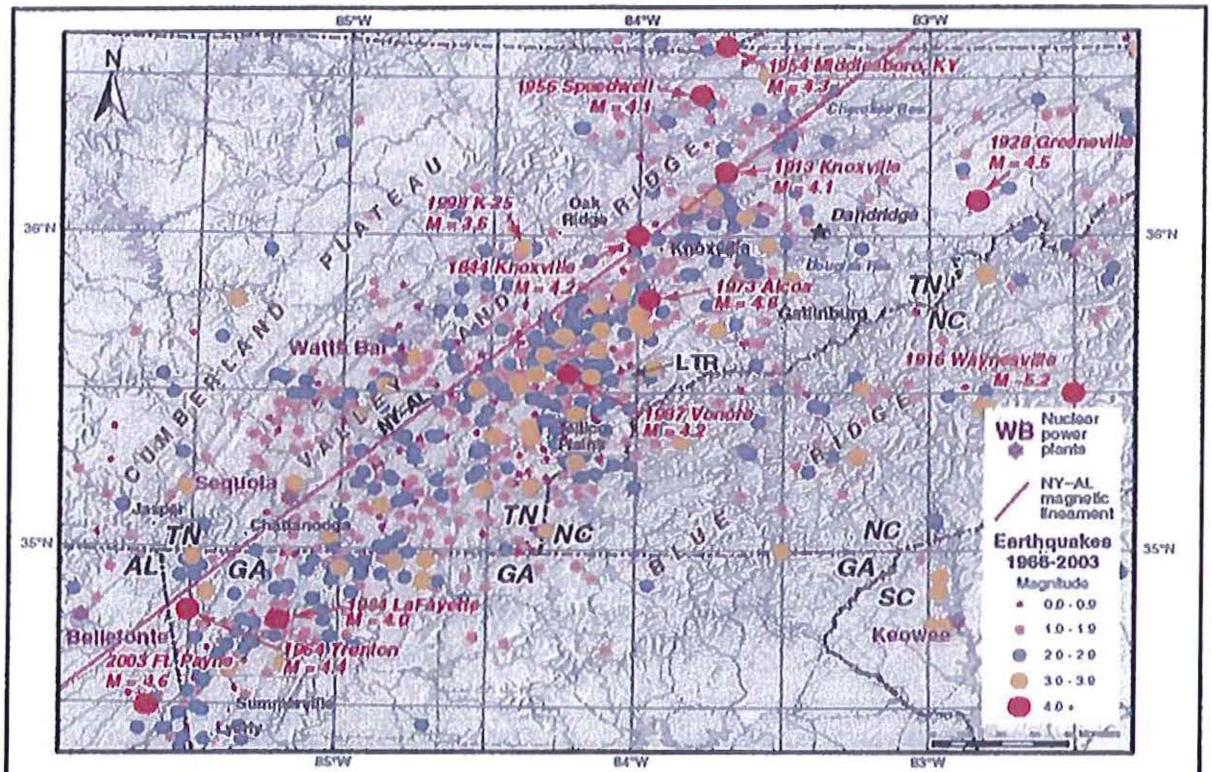
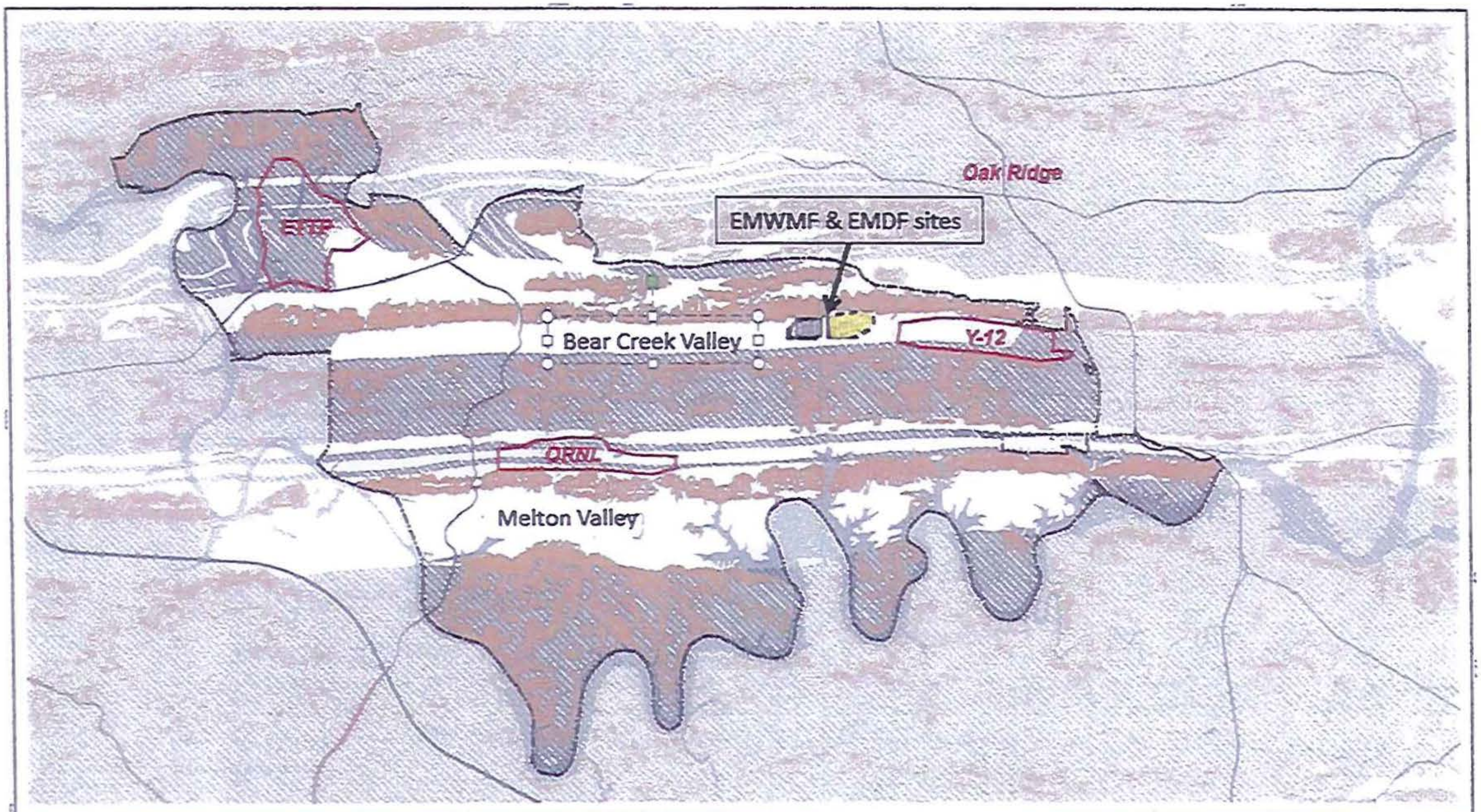


Figure 1 (*Continued on following page*). (A) East Tennessee seismic zone earthquakes from 1966 to 2003, along with several other larger historic earthquakes, superposed on a digital elevation model of the region. The black star is the area near Dandridge, Tennessee, where most of the data confirming extensive prehistoric damage have been found to date. LTR—Little Tennessee River.

Figure 11: ETSZ earthquakes from 1966 through 2003 with several other larger historic earthquakes superimposed on a digital elevation model of the region. (Reproduced from *Large Earthquake Paleoseismology in the East Tennessee Seismic Zone: Results of an 18-Month Pilot Study*. Hatcher et al, 2012[24])

[24] *Ibid.* Hatcher et al, 2012. *Large Earthquake Paleoseismology in the East Tennessee Seismic Zone: Results of an 18-Month Pilot Study*. http://specialpapers.gsapubs.org/content/493/111.abstract (Last visited -8/05/2015).

Attachment B. Steep slopes (in orange) and karst development in carbonate rocks (hatched in gray) eliminate candidate radioactive waste disposal sites on much of the Oak Ridge Reservation, especially sites for large disposal facilities such as the proposed EMDF.



Preliminary Geologic Map of the Oak Ridge, Tennessee Area