Attachment 3

List of Concerns
Design

Section 3.1.4
Demonstrate that the disposal facility is designed to complement and improve, where appropriate, the ability of the disposal site's natural characteristics to assure that the performance objectives of 30 TAC §336.723 will be met.

1. Comment: The caliche layer present on-site has yet to be fully characterized, for example regarding potential impacts of erosion. There is no data found on the specific gravity, absorption, freeze-thaw weight loss, gradation, or densities of the caliche soil. Please see detailed erosion comments in Attachment 2. Due to the incompleteness and unresolved issues associated with site characterization, other topics in the application remain incomplete.

The design of the cover for erosion and infiltration remain incomplete. Recent field observations have indicated that the caliche layer may not be as stable as described in the application. Furthermore, these observations extend to the caliche spoils site, where mostly unconsolidated caliche rocks are intermingled with few rocks greater than 1.5 feet in diameter and even fewer caliche rocks greater than 3 feet in diameter. The application states that the design of the cover will incorporate a "bio-intrusion barrier" made up of caliche cobbles between 1.5 feet and 3.0 feet in diameter. Given the field observations stated above, this design may require revision in order to account for these factors or other sources of caliche cobble must be provided for in relevant reports of the application. Characterization should also extend to design of erosion in the berms and ditches, as previously requested in Section 3.6.4, Comment 3. Additionally, there are no permeability tests or test pads of this caliche layer to determine the hydraulic conductivity of this layer to be used in the infiltration models, HELP and VS2Di.

Another unresolved issue is construction material to be used for the cover embankment. The application relies on material for embankment being readily available on-site to construct the bio-intrusion barrier. Given the scarcity of data on the caliche material, it is unclear what will be done if the larger, more erosion resistant rocks called for in the proposed design are not available on-site.

Requested Action: Please fully characterize the caliche layer and provide related site-specific data on specific gravity, absorption, freeze-thaw, weight loss, gradation, densities, and erosion. Please provide permeability tests or test pads of the caliche layer and determine hydraulic conductivity. Please describe the size, quantity, and availability of caliche rocks on-site. If characterization and subsequent analysis indicates insufficient local material will be available for the embankments, please indicate plans for acquiring additional material and incorporate the use of off-site material for the embankments in relevant reports of the application.

2. Comment: TCEQ rule at 30 TAC §336.723 makes reference to 30 TAC §336.727, which requires that the facilities be "sited, designed, used, operated, and closed to achieve long-term stability of the disposal site. . . ." While the Applicant has made comments about long-term stability, it is still unclear whether a determination can be made when differential settlement and stream morphology have yet to be adequately addressed. Also, pedogenesis and climate change have not been discussed in relation to long-term stability of the cover. For reference, the U.S. Department of Energy's "Growing a 1,000-Year Landfill Cover" by Jody Waugh, provides methods to determine long-term stability. This publication recommends monitoring, modeling, and analog studies to produce credible long-term performance projections.

Requested Action: Please provide an analysis of long-term stability of the engineered cover in relation to the issues noted above, including differential settlement, stream morphology, pedogenesis, increased infiltration, and climate change.

Section 3.4
Describe the design features of the land disposal facility and the disposal units. For near-surface disposal, the description shall include those design features related to structural stability of backfill and wastes. [30 TAC §336.707 (4)].

1. Comment: This comment is based on the TCEQ staff review of Volume 8C, Appendix 3.4-1 "Evaluation of Structural Stability of Disposal Units By Numerical Modeling" and Appendix 5.4.4, Volume 9B "Comparison of Compacted Clay Containment Structure to One Made of Reinforced Concrete."

Appendix 3.4-1 describes the applicant's effort, via numerical simulation using the FLAC geomechanics computer code, to demonstrate satisfaction of the performance objective of §336.727 (Stability of Disposal Site After Closure) and the Equivalency Demonstration required under §336.730(b)(1). Appendix 5.4-4 describes the applicant's efforts to satisfy all the performance objectives of §336.723 (Performance Objectives), including qualitative analyses, intended to be complementary to the quantitative analyses described in Appendix 3.4-1, in meeting the performance objective of §336.727(Stability of Disposal Site After Closure).

After a review of the these two Appendices, TCEQ staff has concluded that neither demonstration provided in the application is satisfactory to demonstrate compliance with performance objectives. Reasons supporting this conclusion are as follows:

- In Appendix 3.4-1, the applicant's description and justification of a set of principles and procedures characterizing an appropriate Equivalency Demonstration are incomplete. The Appendix does not fully describe the processes modeled during the static and dynamic simulations of the geomechanical behavior of the proposed disposal units during construction and operation or after closure of the proposed facility. For example, the applicant does not make clear how realistic estimates of the in-situ moisture contents, and uncertainties in these moisture contents, were used in modeling the effective stresses in all subsurface materials. Appendix 3.4-1 also does not describe how the construction and operation of the proposed disposal units might interact with, or otherwise change, the location of the water table or the subsurface system of fractures in the hosting in-situ clay materials. Also, it appears that due to elevated shearing stresses, the concrete liner designed by the applicant for comparison with the proposed clay liner, may not itself be structurally stable which would not provide a justifiable basis for an equivalency demonstration. In previous comments and based on TCEQ rules, the TCEQ has required that the proposed clay liner must be demonstrated to be technologically equivalent or superior to a concrete liner that itself meets all the performance objectives of §336.727. The applicant notes large shear stresses occurring in the bottom right hand corner of the concrete barrier as designed by the applicant. The applicant states that the "large shear stress spike could be alleviated by placing a construction joint at that location. This would allow small differential displacements to take place without jeopardizing the structural integrity of the reinforced concrete in the cover." Again, this seems to be an indication that the concrete-barrier utilized in the applicant's equivalency demonstration, *as designed and analyzed by FLAC,* has undergone structural failure. While the applicant has suggested changes in design that might preclude the simulated failure of the shotcrete liner, they have not in fact incorporated such design changes into the simulations and then demonstrated, via computation, that the shotcrete liner indeed will exhibit long-term structural stability.

- The applicant states that "except for small differences within the range of analysis accuracy, the analysis results for both designs were essentially identical." However, in Appendix 3.4-1 the applicant does not explicitly discuss the "range of analysis accuracy", or mention any quantitative assessments of such accuracy applicable to the modeling results presented in the Appendix. This issue may be relevant in that the "equivalent maximum shearing stresses (in the shotcrete liner) of 194 and 208 psi are less than the ultimate shear strength of 212 psi for f_c'= 5000 psi concrete. This seems to indicate that the FLAC simulations suggest that the shotcrete liner used in the equivalency demonstration by the applicant is close to *failure*, or perhaps if the "range of analysis accuracy" is taken into account the FLAC simulations suggest that the shotcrete liner, as designed, may experience failure due to excessive shear stress. To consider a specific example: Figure 5-16 shows a maximum axial strain in the performance cover, in the absence of a shotcrete barrier, to be 0.5%, and a maximum axial strain in that same cover, with the shotcrete liner present to be 0.3%. Does the statement in Section 8.4 quoted above imply that the difference of 0.2% in these axial strains to be entirely within the "range of analysis accuracy"? If so, does this statement also imply that the maximal axial strains could just as well be 0.7% and 0.1%, respectively (computed value plus or minus 0.2%)?

- Figure 5-12 (Lateral Pressures Acting on Canisters) indicates that the maximum lateral earth pressures acting on the canisters when the shotcrete liner is present is more than 10 percent less than when the shotcrete liner is not present. Similarly, Figure 5-11 shows that the maximum vertical stress at the midheight of a canister in the bottom row of canisters when the shotcrete liner is utilized is *less* than the maximum vertical stress in a canister when the shotcrete liner is not present. Other paragraphs in Section 5 illustrate measures relative to which it could be argued that the clay liner proposed by the applicant is *not equivalent or superior* to the shotcrete liner that the applicant has designed by the purpose of making an equivalency demonstration. Furthermore, in Section 5.0 the applicant compares only the maximum value of the parameter of interest (e.g., maximum vertical stress in bottom row canister) with the shotcrete liner present and not present. A more complete equivalency argument would be based upon a point-by-point comparison of the parameter of interest. For instance, in Figure 5-11 the *complete* locus of vertical stresses in the canisters in the top, middle, and bottom row with the shotcrete liner present could be overlaid on the complete locus of stresses for these same canister row with the shotcrete liner not present. From the information supplied by the applicant, it is not even clear if the maximum values made available (and in this case only in the bottom row) even occur in the same spatial location.

- According to Figure 5-16 (Performance Cover Axial Stresses and Axial Strains), the performance cover will have lower minimum axial stress, lower maximum axial stress, and a lower maximum axial strain (40 percent lower) with the wrap-around shotcrete liner present than when it is not present. This may be an indication that the clay liner, without shotcrete liner, is not technological equivalent or superior to an engineered system incorporating the shotcrete liner.

- The studies outlined in Appendix 5.4-4 do not demonstrate how a subset of the red clay properties are technically equivalent or superior to reinforced concrete, such as: 1) shrinkage; 2) thermal permeability; 3) diffusion coefficients; 4) density (with regard to ability to attenuate radiation fields); 5) freeze/ thaw durability; 6) resistance to the chemical properties and chemical constituents of radioactive waste; 7) resistance to erosion; 8) resistance to biodegradation; 9) leach resistance; and 10) resistance to variations in pH of the leachate to be formed within the trenches.

- The studies outlined in Appendix 5.4-4 have not demonstrated how physical properties (such as the ones listed above) can be achieved and sustained for the red bed materials for 500 years (expected life of engineering features to provide protection for "short lived" radionuclides). Also, these studies do not demonstrate how the quality of the liner materials (whether red bed clay or reinforced concrete) or their desired properties can be achieved and sustained (e.g., how will construction processes control crack formation in an engineered clay liner?)

- These studies also do not demonstrate how the homogeneity of red clay can be made equivalent or superior to that of reinforced concrete for 500 years or, alternatively, how reinforced concrete is more heterogenous than red clay. Nor has there been a description of the processes envisioned to prepare red bed clay materials for use as a barrier medium with properties superior to reinforced concrete.

- Furthermore, the Applicant has not provided sufficient data indicating what percentages or contents of hazardous chemicals will be in the mixed waste planned for disposal at the site, or what the pH ranges in the wastes and the leachates will be, so that an evaluation of the behavior of a clay layer, relative to characteristics can be completed.

- The authorship of both Appendix 3.4-1 and Appendix 5.4-4 is unknown and neither of these documents are signed, or sealed by a professional engineer.

Requested Action: Please complete the demonstrations showing that any proposed concrete liner used for comparison of equivalency will satisfy all the performance objectives of §336.727 (Performance Objectives). Specifically, demonstrate that all canisterized waste will be placed in a disposal trench protected by a barrier made of reinforced concrete or of materials equivalent or superior to reinforced concrete, as required by 30 TAC §336.730(b)(1). Please address the adequacy of the concrete liner designed by the applicant, for comparison with the proposed clay liner, for providing structurally stable. Please specifically address elevated shearing stresses associated with the designed concrete. Please explain why suggested changes in design that might preclude the simulated failure of the shotcrete were not submitted by the applicant as part of the basis of design. Please incorporate a point-by-point comparison of the parameters of interest for the equivalency demonstration. Please explain what factors effect the "range of analysis accuracy" for comparison of the two designs. Is the model mesh size for the "shotcrete" proposed in the concrete liner designed by the applicant one of these factors?

Please describe the processes modeled during the static and dynamic simulations of the geomechanical behavior of the proposed disposal units during construction and operation or after closure of the proposed facility. Please demonstrate that estimates of in-situ moisture contents were used in modeling the effective stresses in all subsurface materials and ensure that uncertainties in these moisture contents are described. Please describe how the construction and operation of the proposed disposal units might interact with, or otherwise change, the location of the water table or the subsurface system of fractures in the hosting in-situ clay materials.

Please demonstrate how the red bed clay is technically equivalent or superior to reinforced concrete with respect to the following properties: 1) shrinkage; 2) thermal permeability; 3) diffusion coefficients; 4) density (with regard to ability to attenuate radiation fields); 5) freeze/thaw durability; 6) resistance to the chemical properties and chemical constituents of radioactive waste; 7) resistance to erosion; 8) resistance to biodegradation; 9) leach resistance; and 10) resistance to variations in pH of the leachate to be formed within the trenches. Please demonstrate how physical properties (such as the ones listed above) can be achieved and sustained for the red bed materials for 500 years.

Please demonstrate how the quality of the liner materials (whether red bed clay or reinforced concrete) or their desired properties can be achieved and sustained. Please demonstrate how the homogeneity of red clay can be made equivalent or superior to that of reinforced concrete for 500 years or, alternatively, how reinforced concrete is more heterogenous than red clay. Please describe the processes proposed to prepare red bed clay materials for use as a barrier medium with properties superior to reinforced concrete. Please provide data indicating what percentages or contents of hazardous chemicals will be in the mixed waste planned for disposal at the site, what the pH ranges in the wastes and the leachates will be, and provide an evaluation of the behavior of a clay layer, relative to characteristics of the wastes disposed.

If the Applicant wishes to submit a proposal for materials other than reinforced concrete, ensure that any document containing claims or studies pertaining to the equivalency or superiority of materials over reinforced concrete are signed and sealed by the engineer or supervisor making such claim.

2. Comment: There is still uncertainty regarding the location of the water table relative to the proposed disposal units. It remains a possibility that the water table might be above the base or bottom of the proposed disposal units, particularly the FWF disposal unit.

Requested Action: Please provide the precise location of the water table and its variable depth across the proposed site.

Section 3.6

3.6.1 Describe those design features related to infiltration of water, contact of wastes with standing water, and disposal site drainage. [30 TAC §§336.707(4) and 305.54(f)]

3.6.2 Demonstrate that the disposal site is designed to minimize the contact of water with

waste during storage, the contact of standing water with waste during disposal, and the contact of percolating or standing water with wastes after disposal. [30 TAC §336.729(f)]

1. Comment: Federal rule at 10 CFR §61.7(b)(2) and TCEQ rules at 30 TAC §336.707(4) and (5) require a disposal unit design which will minimize contact of water with waste, and when related to pathway analysis, will assure that the performance objectives of 30 TAC §336.724 and §336.727 are being met. NUREG/CR-5453 has identified several of these pathways, one of which involve "bathtubbing." This guidance describes three conditions which will produce bathtubbing: infiltration of water into the disposal unit, a cover that is more permeable than the liner, and dissolution of water into the waste. The application discusses infiltration of water into the disposal unit, but does not refer to the permeability of the cover relative to the liner or mention the possibility of water dissolving the waste.

It is unclear based on the information submitted by the applicant whether bathtubbing is a credible scenario after closure. Given the uncertainty of the location of the water table, it is still possible that the water table could encroach upon the disposal units and contact waste. This would then make a determination on bathtubbing incomplete until the issue of the water table has been resolved. Similarly, a determination of bathtubbing is also dependent on the result of the concrete equivalency demonstration.

Requested Action: Please provide consideration of possible "bathtubbing" on the proposed site and justification of why this effect will not impact the long-term performance of the site. If the application is revised with respect to the location and depth of the water table, please revise the analysis on bathtubbing accordingly.

2. Comment: The applicant provided results of a 2-D infiltration model, but did not provide the model input files. Thus, it is unclear how an evaluation of the infiltration model could be performed without this information. Also, Figure 7 in Appendix 3.6.2 indicates potential problems with the modelling; however, this cannot be assessed without knowing its inputs.

Regarding comments in Attachment 2 – Confidential (Cost Estimates), please include the bulk waste matrix as an input layer in the model. This would determine the amount of infiltration of water through the waste and provide a volume and time history of the leachate being produced at the site starting from the initial placement of bulk waste in the trench.

The modelling of the clay and caliche layers also appears to be problematic. The application states in Appendix 7.1.1, among others, that the red bed clay (performance cover) will have a permeability of 10^{-7} cm/sec. However, a permeability of 10^{-9} cm/sec was used under normal conditions and a permeability of 10^{-8} cm/sec was used as a "high conductivity" parameter rather the permeability stated in this section. Furthermore, there is no data to support the conclusion that an engineered clay layer can approach, much less retain such an impermeable layer of 10^{-8} cm/sec. Carrying out test pads of the clay and caliche layers with the results submitted would be an acceptable demonstration in determining permeability of their respective layers. Given these statements, modelling the clay at a higher permeability, and using an even higher permeability for sensitivity and degradation of clay in time would be appropriate.

In response to climatic variations, Scanlon et al[1], recommend using a weather generator, such as USCLIMATE or GEM to account for long range climatology at the site.

Requested Action: Please provide the model input files for the 2-D infiltration model. Please include the bulk waste matrix as an input layer in the model. Please justify the selection of permeability input for the model and provide data and analysis to support the conclusion that the engineered clay layer can approach a permeability of 10^{-8} cm/sec. Please demonstrate that rainfall rates used in permeability analysis are conservative and account for long range climatology at the site.

3. Comment: The responses to various inquiries on management of storm water within the facility have resulted in new comments. There is no discussion of why design for 100-yr storm event during operations is not applicable. Given the probability of 76% chance of the 25-yr storm being exceeded during the 35 years of operations, it would be prudent to design the tanks to a higher design standard.

Conversely, it appears that the leachate pumps have too high a conveyance capacity (200 and 250 gal/min, respectively). The likely result is that fine gravel and clay deposits from the drainage system will be sucked into the pump.

It is unclear whether leaving uncontainerized bulk waste open to the elements (wind, rain) meets the criteria of 30 TAC§336.729(f) (minimizing contact of water with waste.)

Requested Action: Please incorporate the 100-yr storm event into facility design features or explain why design for the 100-yr storm event during operations is not applicable. Please justify the conveyance capacity of the leachate pumps and demonstrate that their operation will be compatible with the proposed design of the disposal units. Please demonstrate that the

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[1]Scanlon, B. R., Reedy, R. C., Keese, K. E., Dwyer, S. F. (2005) "Evaluation of Evapotranspirative Cover for Waste Containment in Arid/Semiarid Regions." Vadoze Zone Journal, Vol. 4, pp. 55-71

uncontainerized bulk waste will have minimized contact with water by providing specific plans, procedures, calculations, analyses, drawings, and cost estimates.

4. Comment: The connection between the FWF sidewall liner system and the cover system (the 60-mil HDPE membrane) is not described. Once connected, these two membranes should serve as a self-contained unit which will completely enclose and seal the waste in the trench from external moisture. There is no indication that the sidewall and cover membranes are connected, creating a potential for water penetration into the disposal unit along this connection, both through the leachate detection/collection layer and along the leachate riser pipes.

Requested Action: Please demonstrate that the completed liner system will be self-contained and will completely enclose and seal the waste in the trench from external moisture. Please describe in detail how this will be accomplished, specially include how the two membranes are connected. Please demonstrate that water from the cover drainage system cannot reach the leak detection-collection layers either via the connection or along the leachate riser pipes.

Section 3.6.4
Demonstrate that surface features direct surface water drainage away from disposal units at velocities and gradients which will not result in erosion that will require ongoing active maintenance. [30 TAC §336.729(e)]

1. Comment: Criteria provided in the application for erosion protection correctly state that the design basis is the Probable Maximum Precipitation (PMP). However, calculations contained in Appendix 3.0-3.14 indicate a design using the 100-yr storm event.

Requested Action: Please revise calculations to use the PMP to design erosion protection of the cover.

2. Comment: Volume 8A, Appendices 3.0-3.2 and 3.0-3.3 state that the diversion ditches will be constructed from the natural caliche found at the site. (Also, see Section 3.1.4 comment 1.) However, there does not appear to be any erosion calculations indicating that the side slopes have been taken into account for the design of on-site diversion ditches. NUREG-1623 recommends using a rip-rap for design of armoring the side slopes. Please note that a discussion of using natural materials for channel armoring is found in NUREG-1623, Appendix D, Section 7.

Requested Action: Please provide a demonstration of the performance of the natural caliche. Please submit data to demonstrate that the natural caliche can withstand the erosional forces for the side slopes of the ditches. Please follow the procedures in Appendix D to demonstrate how the natural caliche can be used as channel armoring for the side slopes. Please consider the use of rip-rap for channel armoring as an alternative to this demonstration for the side slopes, channel bottom and outlet; and updating cost estimates accordingly.

3. Comment: Certain appendices, for example Appendix 3.0-3.2 (berm design), have not been updated to reflect the latest revision to a two-unit federal facility design.

Requested Action: Please update all appendices, drawings, and calculations to account for any and all design revisions.

Section 3.7.1
Describe the design basis natural events or phenomena and their relationship to the principal design criteria. [30 TAC §336.707(2)]

1. Comment: Please provide the information previously requested. This response is substantially complete, however the Applicant has cited the F2 classification of two recorded wind speeds as the basis for using a wind gust speed of 160 mph despite the caveat on the use of the Fujita Scale.

Requested Action: Please respond regarding use of the F2 Scale and provide justification for the use of corresponding wind speeds.