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CONSULTING ENVIRONMENTAL & GEOTECHNICAL ENGINEERS

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Mr. Ray Gonzales
Nuclear Regulatory Commission
730 Simms Street Suite 100
Golden, Colorado 80401

Dear Ray:

Enclosed is the report portion only of the Edgemont Reclamation Evaluation for your review. Your initial review and any comments will be greatly appreciated. If you have any questions or comments, please call either Bob Medlock or me.

Sincerely,

SHEPHERD MILLER, INC.

Barry L. Carlson

Barry L. Carlson
Project Engineer

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EVALUATION OF THE EDGEMONT DISPOSAL SITE RECLAMATION

Submitted By:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared By:
Shepherd Miller, Inc.
Fort Collins, Colorado

September 1, 1992

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APPENDICES

1.0 INTRODUCTION

1.1 Background

TVA completed reclamation of the Edgemont Tailings Disposal Site in November 1989. Reclamation activities included relocating the tailings from the original mill site to a specially constructed disposal basin, placing nine feet of clay soil cover material over the tailings, constructing grass and riprap-lined perimeter drainage channels to control potential erosion, and reseeding all non-riprapped disturbed areas to establish a self-renewing, erosion resistant vegetative cover. NRC modified its procedures for evaluating reclamation plan designs in 1990. NRC consequently requested a retrospective evaluation of the site using the revised and substantially more stringent design criteria. This document is TVA's response to NRC's request.

1.2 Purpose

TVA performed this evaluation primarily in response to NRC's November 7, 1990 letter requesting a comparative analysis of current closure criteria as they relate to long-term site performance. NRC's letter dated August 9, 1991 specifically requests a Criterion 6 (10 CFR 40, Appendix A) assessment of the site using the methodologies suggested in the NRC Staff Technical Position (STP) entitled "Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites" (August 1990). TVA believes that the analyses performed in this assessment fully conform with current NRC rules, regulations and the attendant STP guidelines.

2.0 DESIGN CRITERIA

2.1 Storm Event

The Edgemont site 6-hour Probable Maximum Precipitation (PMP) of 22.5 inches is derived from Hydrometeorological Report (HMR) No. 55A (Hansen, et al, 1988). For reasons discussed below, the 1/2 PMP value of 11.25 inches, or the "design storm event", is the basis for TVA's comparative evaluation.

TVA reevaluated the Edgemont site PMP runoff using the HEC-1 and HEC-2 models developed by the U.S. Army Corps of Engineers. The input assumptions underlying the HEC model analyses are much more stringent than those used in the original Edgemont design analysis. For example, the new time-to-peak and antecedent moisture condition are both substantially more conservative than those used in the original analysis. In light of these assumptions, the current analyses show that, although the vegetated (as-built) cover is stable because the runoff flow is subcritical, full PMP runoff would erode portions of the perimeter diversion channels and erode existing rock protection in many riprapped areas.

TVA therefore evaluated the site using less extreme design criteria, the 1/2 PMP. For design purposes, the NRC considers the 1/2 PMP the appropriate substitute design storm. In selecting this event, TVA noted that for the Edgemont site, the 1/2 PMP is much larger than any event with a statistical or calculated recurrence interval, including the 1,000 year event (Figure 2-1). Hence, this storm was derived pursuant to Criterion 6 and STP Appendix C guidelines. TVA therefore believes that the 1/2 PMP meets NRC criteria for evaluating long-term reclamation stability. TVA also feels that because the site has been fully reclaimed in good faith pursuant to a plan conceived under earlier NRC guidance, the 1/2 PMP is appropriate for use as the retrospective design storm event.

As noted previously, the vegetated as-built cover is stable under full PMP peak flow because the flow is subcritical. One can therefore assume that the vegetated cover is stable under 1/2 PMP

peak flow. This assumption is validated by analysis in Appendix A. Both cover analyses assume a vegetated surface with minimal vegetation densities determined by on-site surveys. However, as described fully in the Section 3.3 runoff analysis, some sections of existing diversion channels areas are unstable under design storm peak flow. Included are portions of the north, southeast, and southwest diversion channels. Figure A.3, Appendix A, shows the relatively small areas that are potentially unstable.

Channel instabilities in the North and Southeast channels can be controlled by adding or modifying channel riprap protection to control runoff velocities. The runoff analysis shows that a 1/2 inch D_{50} riprap will fully stabilize the lower portion of the North channel. To insure stability in the lower Southeast channel, riprap size should be increased from the existing 12-inch D_{50} to a 19-inch D_{50}. As to the Southwest channel, TVA feels that modifying the as-built riprap is not warranted because erosion in this channel could occur only in areas adjacent or parallel to the tailings and therefore could not intrude into, expose or release tailings. Further, TVA is qualified and intends to retain long-term title to the tailings disposal site. TVA will therefore be available to restore the channel in the unlikely event an extreme rainfall event occurs and the site sustains damage.

TVA estimates that constructing these modifications will cost approximately $140,493. Section 3.0 and Appendix D cover these proposed modifications in more detail.

2.2 Full PMP Runoff Analysis

TVA evaluated the Edgemont as-built cover, perimeter channels and downstream dam face for stability under full PMP flows. Assuming a worst-case scenario, the as-built site with an unvegetated surface and Antecedent Moisture Condition (AMC) III, the full PMP runoff would compromise the cover and the perimeter channels. However, the as-built site enjoys a thriving vegetation cover. Under this condition the surface stability analyses show the reclaimed, vegetated cover to be stable. The cover remains stable because peak flows in sensitive areas (the longest and steepest slopes) are subcritical, with low velocities. Velocities and corresponding

flow depths on the longest slope are 2.9 ft/s and 0.9 ft, respectively. Velocities and corresponding depths of flow on the steepest portion are 2.7 ft/s and 0.6 ft, respectively. TVA feels that this demonstration of cover stability is important under the full PMP because the tailings mass integrity is assured even under the most extreme runoff conditions postulated.

Peak flows in the perimeter channels, however, are erosive in two of the vegetated channels and all three of the rock-lined channels. Velocities exceed the permissible velocity in the two grass-lined channels with typical flows greater than 4 ft/s. Velocities in the rock-lined channels range from 8 to 15 ft/s. In each rock-lined channel, required D_{50} exceeds the existing D_{50} in portions of each channel. Although channel erosion would likely be significant, TVA does not consider potential erosion in most channel areas to be critical to tailings stability because 1) it would occur downstream of and parallel to the covered tailings (and therefore would not expose or release tailings), 2) and because of TVA's long-term ownership, which would allow repair of damaged areas if erosion were to occur.

The embankment analysis shows that the rock on the downstream embankment face is not stable under full PMP conditions. However, TVA feels that the downstream dam face instability is of limited concern for several reasons. First, the as-built rock is 4-inch D_{50}. Designing for full PMP flows indicates a need for using 5-inch D_{50} rock. Thus, the existing rock is only slightly undersized for full PMP peak flow. Second, in the event failure of the rock occurs in localized areas, remaining rock would tend to fill the rills or gullies that begin to form. However, if a gully does form, the potential for significant erosion to occur is low because the dam is a thick, compacted earth-filled structure and more-than-sufficient material is present to protect the tailings if erosion occurs. Finally, as noted previously, TVA would have the presence and resources to repair erosion damage that might occur.

2.3 Alternatives Analysis

TVA performed alternative analyses according to Appendix C of the STP to justify a 1/2 PMP design. The cost study considers two alternative designs: 1) a fully riprapped cover, and 2)

a flattened (stable) cover with riprapped side slopes. Both alternatives require enlarged peripheral runoff channels and modified riprap. The incremental cost to effect Alternative 1 is approximately $3,500,000, while Alternative 2 would cost approximately $3,000,000. A detailed description of procedures, calculations, and surface configurations used in the cost analysis is presented in Appendix D. Table 2.1 compares the costs that TVA would incur under the reclamation alternatives described above.

Table 2.1

Description	As-Proposed (1/2 PMP)	Alternative 1 (PMP)	Alternative 2 (PMP)
Southeast channel	58,500	494,370	494,370
Southwest channel	51,300	663,850	663,850
North channel	8,750	188,152	188,152
Surface Modification		1,702,000	1,237,300
Total (w/15% contingency)	$140,493	$3,505,628	$2,971,223

2.4 Discussion

TVA believes that redesign and retrofit of the site to be stable under the revised full PMP flows is not warranted for the following reasons:

- The most critical portion of the reclaimed tailings basin, the as-built tailings cover, is stable under full PMP flows.

- The site is already reclaimed in accordance with a plan designed and constructed in good faith according to pre-1990 NRC design criteria.

- The site enjoys exemplary revegetation success after only two growing seasons.

- Redisturbing the site would produce no tangible benefits for the public, the environment, or TVA's rate payers. Redesigning and modifying the site to be stable under full PMP flows without vegetation credit would cost in excess of $3 million and would provide no commensurate benefits.

- The site can be made stable for a design storm acceptable to the NRC at reasonable cost with minimal disturbance of the revegetated surface and channels.

Beyond the arguments presented above, TVA evaluated the situation for unique circumstances and examined the reclaimed surface for conservative design features. TVA feels that the following observations are highly germane to this evaluation and validate its position on the reasonableness of the proposed 1/2 PMP design.

- TVA is a Federal agency qualified to accept long-term tailings stewardship. Therefore, TVA would have the site access and funds needed to effect repairs in the unlikely event significant erosion occurs. TVA ownership would thus reduce the need for applying the newer and substantially more conservative design criteria at the Edgemont site.

- The Edgemont site was designed and constructed to meet a 2 pCi/m^2-sec radon emanation design standard, whereas the current standard is 20 Pci/m^2-sec. This is significant for two reasons. First, a much thinner cover design would be adequate to control radon emanation. The as-built cover is conservative in this respect by a full order of magnitude. Second, the thick cover will serve as a major physical barrier to potential erosion.

- The site was seeded in the fall of 1989 and enjoys a thriving vegetative cover after only two growing seasons. The reclaimed cover appears stable and exhibits no evidence of rilling. Redisturbing the site would therefore destroy a highly successful revegetation effort and the site would realize no clearly defined benefits. Further, TVA feels that the cover vegetation can only improve as the vegetation matures. This theory is validated by on-site vegetation surveys that show that the vegetation in mature areas that surround the site have higher densities than the site vegetation. Nevertheless, the vegetation values used in the following erosion analyses are minimum values that reflect the lowest observed site vegetation densities.

- Several storm events with statistical and extrapolated recurrence intervals were compared to the design storm to illustrate the conservatism inherent in using the 1/2 PMP as the design event. Figure 2-1 shows a graph of areal 2, 5, 10, 25, 50, and 100-year 24-hour storm events to show the rainfall value trends. The 100-year 24-hour storm event is 4.5 inches (Barfield, 1981). By extrapolating these data (using logarithmic scaling), the 200-year, 500-year and 1,000-year, 24-hour storm events are 4.9 inches, 5.5 inches and 6.0-inches respectively.

  The 6-hour, 1/2 PMP event is nearly double the size of the 1,000-year 24-hour storm event. The design storm thus represents a conservative rainfall for the NRC 200 to 1,000-year period stipulated under Criterion 6 and Appendix C of the STP.

With regard to TVA's willingness to assume long-term responsibility for the reclaimed tailings, TVA recognized the need for periodic inspections of the reclaimed site to verify cover and channel stability in its NRC submittal dated March, 1990. The inspections will focus on evidence of cover cracking, wind or water erosion, structural discontinuity of the embankment, maintenance of vegetation, and evidence of animal intrusions that could affect cover function. TVA will also inspect the entire perimeter fence for integrity.

Contingency inspections will be unscheduled and performed when information has been received indicating that the site integrity has been, or may be, compromised by natural events or unauthorized human activities. An inspection report will be prepared and filed with TVA and the NRC.

If an inspection reveals significant departure from the original as-built condition, the NRC will be notified within 72 hours of such discovery. If significant remedial work is deemed necessary, TVA will develop a plan and schedule to accomplish the required work. The plan and schedule will be provided to NRC prior to initiation of repair activities unless otherwise directed by NRC. If situations are encountered that would expose the public or the environment to contaminated material, if the integrity of the containment basin is jeopardized, or if there is an imminent threat of release of contaminated material, immediate actions will be taken as appropriate and NRC will be notified immediately.

3.0 SITE EVALUATION

3.1 General

The site evaluation is based on criteria set forth in 10 CFR 40, Appendix A Criterion 6 and guidelines presented in the STP. The Edgemont Disposal Site evaluation was divided into three separate areas for assessing the current reclamation. First, the cover surface stability was analyzed to determine if erosive velocities would occur under design storm runoff. Second, the perimeter drainage system was analyzed to determine if erosive velocities would occur, and, if necessary, the required riprap size. Finally, the in-place riprap durability was analyzed to determine if the as-built riprap conforms with STP guidelines.

3.2 Cover Surface Stability

The cover surface stability analysis was performed on two areas shown by analysis to be sensitive in terms of erosion potential. The first area represents the longest cover surface slope, and the second represents the steepest cover surface slope. As the remaining slopes are either flatter or shorter, these two areas provide the most conservative stability calculations. These areas are shown on Figure A.4 in Appendix A. Appendix A also contains detailed slope stability calculations.

Runoff analyses were performed for both areas using 100-foot wide strips oriented parallel to the direction of flow. HEC-1 was used to determine the peak flows for each strip. The peak flows were then multiplied by three to concentrate the flow and obtain conservative discharge values. Manning's equation was then used to determine the depth of flows and corresponding velocities.

Cover stability was determined using Temple's Comparative Shear Stress method (1987) and Chow's Permissible Velocity method (1959). These analyses show the cover to be stable under the design storm event. Detailed results of these analyses, including the HEC-1 outputs, are

provided in Appendix A. These analyses include the site's minimum current established vegetation height and density. A discussion on site vegetation and results of the site vegetation surveys performed for this analysis are provided in Appendix C.

3.3 Perimeter Drainage System Stability

The perimeter drainage system consists of grass-lined and rock-lined channels that circumscribe the tailings impoundment. These channels intercept flow from the cover and surrounding areas and convey it away from the site cover. Three main channels, termed the North, Southwest, and Southeast channels, are shown on Drawing 1.

Stability analyses were performed both on the grass-lined and rock-lined portions of the channels. Vegetation input values reflect the minimum site vegetation values (Appendix C). The resulting HEC-1 discharge was input into HEC-2 to determine corresponding depths and velocities for each channel (Appendix A). For the grass-lined channels, the Comparative Shear Stress and Permissible Velocity methods were used to determine channel stability. For the rock-lined portions, riprap was sized using the U.S. Army Corps of Engineers method (Abt et al, 1988) and compared to existing riprap sizes. Stability analyses are presented in more detail in Appendix A.

The study results indicate that all grass-lined channels are stable under design storm runoff with the exception of one small portion of the North channel. Here the flow exceeds both the permissible velocity and allowable shear stresses. This location is shown on Figure A.3 in Appendix A. Erosion control will be assured by constructing a zone of 1/2 inch D_{50} riprap.

A portion of the 50-10 channel (Figure A.2, Appendix A) is unstable under the Temple calculation, but stable under Chow. This determination was made using minimal vegetation densities (Appendix C). The 50-10 channel is stable under both Temple and Chow assuming average site vegetation densities. Furthermore, both analyses assume full upgradient flow, whereas a significant portion of the 50-10 channel runoff would be intercepted and diverted by

a County road that intersects the drainage area to the West. Therefore, TVA believes that no further action is warranted for this portion of the drainage.

The rock-lined channels are generally stable and have appropriate riprap size, with the exception of portions of the Southwest channel and a small portion of the Southeast channel. As described in Appendix A, the Southwest channel would require larger rock in several locations and the placement of additional rock on the channel sides in the same locations to protect the channel over banks. However, as noted in Section 2.0, fully controlling erosion in the Southwest channel is not critical because erosion would occur downstream from and parallel to the tailings and therefore cannot intrude into and expose or release tailings. Consequently, TVA feels that no additional erosion protection is warranted for the Southwest channel.

Modifications are required to fully meet stability guidelines in the North and Southeast channels. One-half inch D_{50} rock is needed in the North channel. And, 19-inch D_{50} rock, versus the existing 12 inch rock, is necessary for stable conditions in a small, steep portion of the Southeast channel. Locations of these areas and required riprap sizes are presented on Figure A.3 in Appendix A, along with supporting calculations.

3.4 Dam Surface Stability

The surface stability of the dam was analyzed to determine the stable rock size. Procedures followed were similar to those used in the cover surface stability analysis. The analyses were performed using an approximate 100-foot wide strip (width varied between the west side and the east side) oriented parallel to the direction of flow down the dam face. In the initial analysis it was determined that design flow from the tailings cover would overtop the dam, and thus cause additional flow on the dam face. Hence, the resulting maximum peak flow was determined considering both the dam face and the cover surface overflow. Analyses performed to determine maximum peak flow are presented in Appendix A.

This discharge was then used to size the required rock protection, which was determined to be 3.1 inch D_{50}. The downstream face of the dam is currently 4 inch D_{50}, and thus the existing riprap provides conservative protection. Detailed information and calculations are presented in Appendix A.

3.5 Rock Durability

The limestone rock protection installed in the Edgemont perimeter drainage system and on the dam face was analyzed for durability using existing rock durability test data. Hoskins, Western, Sonderegger, Inc., performed laboratory testing on the rock on July 31, 1984. Three tests were performed, including the L. A. Abrasion, Sodium Sulfate Soundness, and Bulk Specific Gravity. Using the existing test results, the scoring criteria and procedures presented in the STP were applied, which resulted in a score of 86.6 percent. Rock with a score above 80 percent is considered adequate for all applications with no oversizing.

The tests which were performed do not meet the required number of tests per current STP guidelines. However, pursuant to discussions with NRC, existing data was determined to be adequate, contingent on demonstrating uniformity of the rock material. TVA consequently contracted a geologist to inspect the site rock. The inspecting geologist performed a visual walk-around inspection of all riprapped areas and confirmed its uniformity. The scoring procedures and results are presented in Appendix B.

4.0 CONCLUSIONS

The reclaimed Edgemont Site as designed conforms with 10 CFR 40 Appendix A Criterion 6 rules and regulations and the STP guidelines, with the exceptions of two small areas. The most critical portion of the reclaimed basin, the vegetated reclamation cover, is stable under full and 1/2 PMP peak flows. Excepting the channel areas noted above, the grass-lined and riprapped perimeter ditches are also stable. Finally, the in-place rock riprap meets NRC durability criteria.

Excessive runoff velocities in unstable portions of the North and Southeast channels will require additional control. Flow in the North channel will be controlled by extending the riprapped area to ensure stability. Southeast channel flows will be controlled by replacing the existing riprap with appropriate gradations of rock in the steep portion of the channel.

5.0 RECOMMENDATION

In light of these findings, TVA recommends NRC closure on the as-built design upon completion of the modifications suggested above for the North and Southeast channels. It is TVA's desire and intent to conduct the proposed construction activities during Fall, 1992 or Spring, 1993. However, the timing for construction of these modifications is dependent on NRC review and concurrence with this recommendation and the attendant construction specifications.

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