UNITED STATES

NUCLEAR REGULATORY COMMISSION

REGION IV

URANIUM RECOVERY FIELD OFFICE
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DENVER, COLORADO 80225

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Docket No. 40-1162
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MEMORANDUM FOR: Docket No. 40-1162

FROM: Raymond O. Gonzales, Project Manager

SUBJECT: PROPOSED AMENDMENT TO SOURCE MATERIAL LICENSE SUA-56 TO REVISE THE APPROVED DISPOSAL AREA RECLAMATION AND CLOSURE PLAN FOR WESTERN NUCLEAR, INC.'S SPLIT ROCK MILL NEAR JEFFREY CITY, WYOMING

The reclamation and closure plan for Western Nuclear, Inc.'s Split Rock Mill was approved on June 17, 1993, by Amendment No. 68 to Source Material License SUA-56. The backup support for that approval was provided in a Memorandum for Docket File No. 40-1162 dated June 12, 1992. Subsequent to plan approval, Western Nuclear Inc. (WNI) (the licensee) made changes to the radon barrier design and the erosion protection aspects of the approved plan. This memorandum addresses those changes. Revisions were made only to portions of the June 12, 1992, Memorandum, necessary to accommodate a new design. Those sections are appropriately marked by vertical lines in the left margin. All other sections remain unchanged.

BACKGROUND

The Split Rock Mill, which has already been decommissioned, was owned and operated by WNI. It was the first uranium mill to be built in Wyoming. The project is located 2 miles north of Jeffrey City, in Fremont County, Wyoming, at the base of the Granite Mountains. Jeffrey City was established in 1957 by WNI. In 1976, the population of Jeffrey City was estimated to be 2000. In 1988, the population of Jeffrey City was estimated to be 250. The largest population center within 50 miles is the city of Riverton which had an estimated population of 9202 in 1991 according to the Riverton Chamber of Commerce. The land in the vicinity of the site is currently used primarily for livestock grazing and wildlife habitat. Unless the uranium mining industry experiences an unexpected revival, there is no reason to believe that the area will experience a population increase or change in land usage.

Source Material License SUA-56 was issued to WNI in 1957. Milling commenced in 1958, and continued until June 19, 1981, when the mill was placed on

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standby status. The license was amended for possession only and disposal of tailings was terminated by Amendment No. 32 dated August 8, 1986. The decommissioning plan for the mill was approved by Amendment No. 42, April 18, 1988, and was modified by Amendment No. 47, August 18, 1988. Decommissioning began on June 13, 1989, and was completed on September 14, 1989. The unsalvageable material was buried in ten separate burial sites within the restricted area. Review and approval of the Decommissioning Report was documented in a Memorandum for Docket File No. 40-1162 dated July 26, 1990.

Amendment No. 33, August 15, 1986, required the submittal of a reclamation plan for the tailings disposal site (License Condition No. 30(F)). License Condition No. 27 also referenced disposal area reclamation; however, that reference was simply a conceptual plan to reduce the approved embankment crest elevation from 6444 feet msl to 6410 feet msl. By letter dated June 30, 1987, WNI submitted a detailed reclamation plan for the disposal area. NRC review comments on the plan were provided to WNI on October 20, 1987. As a result of those comments and numerous other technical meetings and discussions, WNI submitted Revision No. 2 to the June 30, 1987, Reclamation Plan on March 31, 1989. Revisions to the March 31, 1989, plan and submittal of supportive information were transmitted by licensee letters dated July 12 and November 10, 1989; June 5, 1991; March 12 and April 21, 1992.

On April 21, 1992, WNI submitted a final document entitled "Western Nuclear, Inc. Split Rock Mill, April 1992-Revision No. 3 to the June 30, 1987, Uranium Tailings Reclamation Plan." This submittal contained the drawings and specifications incorporating all revisions to the design. This plan was reviewed and found to be acceptable and the basis for the plan's acceptability was documented in a Memorandum for Docket File 40-1162 dated June 12, 1992. A Notice of Intent to Amend Source Material License SUA-56 was published in the Federal Register (FR) on June 19, 1992. No public comments were received on the FR Notice; however, WNI was advised that before the reclamation plan could be approved, an Environmental Report (ER) would have to be provided. The ER was subsequently provided and on June 4, 1993, an Environmental Assessment was prepared by the NRC. Revision No. 3 to the reclamation plan was finally approved on June 17, 1993, by Amendment No. 68 to Source Material License SUA-56. The amendment however, had stipulations associated with the design's erosion protection.

During the time between when the acceptability of the reclamation plan was documented in a June 12, 1992, Memorandum for Docket File 40-1162 and the time the EA was published on June 4, 1993, WNI proposed a further modification to the plan. That modification was proposed on September 9, 1992, when WNI submitted Revision No. 4 to the 1987 Uranium Tailings Reclamation Plan. Since Revision 3 had already been found acceptable and the EA was being prepared, Revision No. 4 was not reviewed prior to approving the reclamation plan in Amendment No. 68.

Revision No. 5 to the 1987 Uranium Tailings Reclamation Plan was submitted by WNI on October 29, 1993. This revision superseded all previous revisions and not only addressed the erosion protection design but made significant changes to the radon attenuation barrier design. In addition, the plan was expanded to include reclamation of the ground-water corrective action program Winter Storage Ponds located adjacent to the disposal area. A new borrow source, the Cody Shale Borrow Area, was identified as a source for radon barrier material. The Bureau of Land Management issued a "Decision of Record and Finding of No Significant Impact" for the Cody Shale Borrow Area on September 29, 1993. In conjunction, the Wyoming Department of Environmental Quality issued Small Mining Permit No. 694 for the area on October 28, 1993. WNI submitted this information on December 13, 1993. NRC review of Revision 5 resulted in additional information being submitted by the licensee. This additional information was submitted as Addendum A to Revision 5 dated February 7, 1994.

DISCUSSION

The Split Rock tailings disposal area consists of 7.7 million tons of tailings covering 180 acres. Tailings were hydraulically disposed of behind an earthen starter dike which was raised using the upstream construction method. This embankment was breached on April 12, 1977. About 33 feet of the embankment was lost, resulting in the release of about 2 million gallons of tailing liquors. A new embankment was constructed immediately upstream of the old embankment in 1977, using the impounded tailings as foundation. An alternate disposal area located downstream from the old tailings pond was used for storage prior to 1977.

About 5.3 million tons of tailings are located in the old tailings pond and alternate tailings area. The remaining 2.4 million tons are contained within the new tailings area. These tailings will be reclaimed in place as shown on the attached figure. The tailings will be covered with windblown material, a radon barrier which will also reduce infiltration, and a soil/rock erosion protection cover. Flows from upstream drainages will be routed to the north and south of the disposal areas in diversion ditches.

Reclamation activities that have been completed include:

The regrading of the fine and coarse tailings, including the placement of a minimum of 3 feet of coarse tailings over the fine tailings in both the old and new tailings impoundments.

Reshaping of the tailings.

Retrieval and relocation to the tailings of the windblown and contaminated soils outside of the boundaries of the final cover.

Placement of an interim soil cover over the mill site and tailings areas. In addition, borrow material has been placed to reach the desired subgrade configuration.

Preparation of a test pad to determine the feasibility of constructing the proposed radon attenuation barrier.

Review of the proposed reclamation plan in Revision 5 and Addendum A to Revision 5 is discussed below. This discussion is divided into seven sections: structural stability and liquefaction, settlement, surface water hydrology, erosion protection, radon attenuation, construction specifications, and archeology. All references to Reclamation Plan Revisions 3 and 5 and to Addendum A in the discussion below indicate the licensee submittals that contain the commitments or analyses being discussed.

Structural Stability and Liquefaction

The structural stability and liquefaction potential of the existing disposal area, including the foundation, were reviewed as part of the license renewal. It was determined that the structures were designed and constructed in accordance with Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills" (NRC, 1977). The structural stability and liquefaction of the reclaimed facility is therefore not a design concern as the reclaimed configuration flattens the outslopes, eliminates the tailings pool, and minimizes infiltration through the cover system. The addition of the Winter Storage Ponds to the overall reclaimed configuration will not affect the stability of the structure. Therefore, the structural stability of the reclaimed disposal area meets the criteria set forth in 10 CFR 40, Appendix A.

Settlement

The proposed settlement program is summarized in Section 7.2.1 of the specifications (Addendum A to Revision 5). Settlement monuments were installed in 1990 and 1991 during regrading operations at the locations shown on the attached figure and on Figure 4, Drawing No. 91-225-E53 (Addendum A to Revision 5). The monuments consist of a $^{3}/_{4}$-inch diameter riser pipe welded to a 24-inch by 24-inch, $^{1}/_{4}$-inch thick base plate as shown on Figure 10, Drawing No. 91-225-E59 (Addendum A to Revision 5). The monuments were placed on the existing tailings surface so that the riser pipes extended to a minimum of 18 inches above the final elevation of the soil/rock matrix.

The settlement monuments, which the licensee has been monitoring since 1990, will continue to be surveyed for vertical movement quarterly until primary consolidation has occurred. Once this consolidation is complete, the licensee will document the data and provide it to the NRC for review and approval. WNI has committed not to begin placement of the final soil cover until the NRC has reviewed the settlement data and has concluded that primary consolidation has occurred. This commitment provides adequate assurance that differential settlement, if there is any, will not adversely affect the integrity of the cover. The proposed settlement monitoring program is considered to satisfy applicable portions of Criteria 1, 6, and 12 of 10 CFR 40, Appendix A, requiring reclamation designs to control radiological hazards for the design life without active maintenance after reclamation is complete.

To accelerate settlement and assist in the dewatering process, vertical band drains were installed in the disposal area in 1992. (These drains are called wicks because they resemble old oil lamp wicks). Approximately 3250 wicks were installed over an area of about 18.5 acres. Results to date indicate that the rate of change of settlement has increased significantly since the wicks were installed.

Surface Water Hydrology

Hydrologic Description and Conceptual Design

The Split Rock Uranium Mill tailings impoundments are located at the head of a natural drainage area that is bounded on the north, east, and south sides by steep granite outcrops as shown on Figure B.1.2, Appendix B, (Revision 5). The outlet of the drainage area is toward the west where an additional granite outcrop separates the drainage into two valleys. The only perennial stream in the vicinity of the mill site is the Sweetwater River which is located more than a mile south of the site. This river however, poses no threat to the site as the licensee has determined that an extreme flood in Sweetwater River will not reach the mill site. Based on a review of the information provided by the licensee it is agreed that extreme flooding in the Sweetwater River will not affect the site. Flooding in the immediate vicinity of the tailings pile can result from runoff originating on surrounding granite outcrops. This flooding however is limited as the drainage area of the outcrops is less than 1 square mile.

In order to comply with 10 CFR 40 Appendix A, Criterion 6, which requires stability of the tailings for 1000 years to the extent reasonably achievable and in any case for 200 years, the licensee proposes to reclaim the tailings impoundments in place and protect the tailings from flooding and erosion. The design basis events for design of erosion protection include the Probable Maximum Precipitation (PMP) and the Probable Maximum Flood (PMF) events, both of which are considered to have low probabilities of being equaled or exceeded during the 1000-year stabilization period.

As shown on the attached figure, and on Figure 5, Drawing No. 91-225-E54, (Addendum A to Revision 5), the surface of the tailings area will be regraded to drain into a central swale on top of the pile. To protect against erosion, the pile top will be covered with a layer of compacted rock and soil to form a soil/rock matrix, and the swale will be covered with riprap (rock). The heights of the two tailings embankments will be reduced by as much as 30 feet and the slopes, which are about 4H:1V, will be regraded to much flatter configurations of about 10H:1V and 20H:1V. Four rock-lined (riprapped) ditches; the North Diversion Ditch, the South Diversion Ditch, the North Central Diversion Ditch, and the South Central Diversion Ditch, will divert flood flows originating on the granite outcrops around the tailings impoundment. In addition, the riprapped swale on top of the reclaimed tailings piles will drain into the North Diversion Ditch. On the west side of the reclaimed area, riprapped erosion aprons and key trenches will protect the outlets of the diversion ditches against extreme flood and long-term erosion as shown on Figure 9, Drawing No. 91-225-E58, (Addendum A to Revision 5). Key trenches will also be provided in the areas where the soil/rock matrix surfaces transition onto the existing soil as shown on Figure 10, Drawing No. 91-225-E59, (Addendum A to Revision 5).

Flood Determinations

To evaluate the effects of flooding and to determine the need for erosion protection, the licensee analyzed flooding due to Probable Maximum Floods (PMF) from the various drainage areas. A PMF is based on the Probable Maximum Precipitation (PMP) which is defined as the greatest depth of precipitation that is physically possible at a particular geographic location. PMP values were estimated by the licensee using Hydrometeorological Report No. 55A (USDC, 1988), which is the correct reference for estimating PMPs at this location. A 1-hour PMP of 9.2 inches was used as a basis for estimating PMF's for the small drainage areas at the site. The licensee's procedures for estimating the appropriate PMP value for use in calculating design flows were reviewed, and it was concluded that a 1-hour PMP of 9.2 inches is acceptable.

Before the 1-hour PMP value can be used to estimate PMFs, it has to be subdivided into smaller time increments. PMP amounts for durations as small as 2.5 minutes were estimated by the licensee using percentages recommended in HMR-55A. As these percentages are comparable to those recommended in NUREG/CR-4620 (Nelson and others, 1986), it was concluded that PMP values for other durations are also acceptable.

Probable Maximum Flood (PMF) Estimates

PMFs are dependent not only on the magnitude of the PMP but also on the amount of precipitation that is lost by infiltration, surface storage, and evapotranspiration. Other important parameters are the duration and temporal distribution of the PMP and the hydraulic characteristics of the drainage areas. By considering all of these parameters, a PMF can be estimated.

Two procedures were used by the licensee to estimate PMF peak discharges for the site. For the diversion ditches and the pile-top swale, the HEC-1 computer program was used. This program is a widely used and accepted procedure for estimating peak discharges. The program was developed by the U.S. Army Corps of Engineers (COE, 1991a). For the pile top, the licensee used the Rational Method (Chow, 1964). This method is also a widely used procedure for estimating flood peak discharges and it is recommended in the NRC Staff Technical Position on Erosion Protection (NRC, 1990).

Basin characteristics used as input parameters to HEC-1 were determined by using the U.S. Soil Conservation Service Curve Number (CN) Method as described in the U.S. Bureau of Reclamation (USBR, 1977). CN values were estimated by considering each type of material (soil or rock) in each drainage basin. The licensee assumed that the soil moisture at the beginning of the PMP event would be close to saturation. This resulted in conservative PMFs because if the ground is close to saturation, very little of the rainfall can infiltrate into the soil and most will become surface runoff.

Other parameters that affect the magnitude of a PMF estimated using HEC-1 are the lag time and the temporal distribution of rainfall. After rainfall occurs over a drainage area, there is a delay in time before the runoff reaches its maximum peak. This delay is called the lag time. Lag times were estimated by the licensee using a procedure developed by the U.S. Soil Conservation Service (SCS, 1972). This method is considered to be appropriate for estimating lag times for the small drainage areas at the site.

The temporal distribution of rainfall is the sequence in which a storm occurs. For example, in some storms, the largest increments of rainfall occur at the beginning of a storm and taper off as the rainfall continues. In other storms, rainfall begins slowly, increasing in intensity to a peak near the center of the storm duration before it begins to taper off. It has been shown that a rainfall distribution that peaks near the center of the storm duration results in the most conservative (largest) PMF peak discharge. This is the distribution that was used by the licensee.

The Rational Method (Chow, 1964) which was used to estimate PMF peak discharges for the pile top, incorporates a coefficient (C) that represents a multiplier that accounts for any losses to the rainfall. For example, a C = 1.0 indicates 100 percent runoff (no infiltration) and a C = 0.8 indicates that 80 percent of the rainfall results in runoff. The licensee used a C value of 0.8 which indicates that a high percentage of the PMP contributes to the PMF peak discharge. In order to estimate the highest design discharge for the pile top, PMFs were estimated for six locations on the pile top as shown on Figure E.1.1, (Revision 5).

To evaluate the adequacy of the licensee's PMF estimates, independent calculations were performed. Based on these calculations, it is concluded that the licensee's design PMFs for the diversion ditches are conservative and thus acceptable. For the pile top, the PMF estimates were not conservative. However, as discussed below, since the riprap erosion protection proposed by the licensee was, in most cases, larger than required, there were only two locations where the riprap was not adequate. The licensee agreed to adequately oversize the riprap in these locations.

Water Surface Profiles and Flow Velocities

Once PMF peak discharges have been estimated, it is necessary to determine water depths, flow velocities, and shear stresses associated with those discharges. These parameters provide the basis for determining if erosion protection is necessary and if it is, the parameters are used to estimate the required riprap sizes and layer thicknesses needed to provide erosional stability to the reclaimed tailings.

Water surface elevations and flow velocities were estimated by the licensee using two procedures. For the pile top and embankment side slopes, the Manning equation (Chow, 1959) was used. For the diversion ditches and the swale on the pile top, the U.S. Army Corps of Engineers' gradually-varied-flow computer program, HEC-2 (COE, 1991b) was used. Both of these methods are acceptable computational procedures for estimating water surface elevations, flow depths, and flow velocities as recommended in the NRC Staff Technical Position on Erosion Protection (NRC, 1990). To verify the licensee's estimates, independent analyses were performed using HEC-2 and the Manning equation. Based on these independent analyses, it is concluded that the licensee's calculations resulted in conservative design parameters that were used as discussed below to design adequate erosion protection.

Erosion Protection

As discussed above, PMF peak discharges, water surface elevations, and flow velocities were estimated by the licensee for the diversion ditches, the swale and the pile top. Those parameters were then used together with appropriate design methods to determine the shear stresses and the riprap sizes required to resist those stresses. For riprap design purposes, WNI conservatively assumed that the PMF discharge in any particular reach of a ditch would be equal to the discharge at the end of the reach. A summary of riprap requirements is shown in Table 2A (Addendum A to Revision 5).

Riprap Design

In sizing riprap, median stone diameters (D_{50}s) were first estimated using either the Corps of Engineers' Shear Stress Method (COE, 1970) or the Safety Factors Method (Stevens and others, 1976). The Corps' method can be used only in cases where flow depths (y) are large relative to the D_{50} i.e., where the ratio y/D_{50} is greater than about 2. For shallow ditches, the Safety Factors Method was used. The Safety Factors Method was also used to size the rock portion of the soil/rock matrix on the pile top. Eleven riprap sizes (D_{50}s) were estimated for the various applications. To reduce the need for having to produce 11 different riprap sizes, the licensee elected to use larger rock than required in certain areas. This reduced the number of different riprap sizes to four as shown in Tables 2A and C.1.1 (Addendum A to Revision 5). Diversion ditch and swale cross-section design details are shown in Figure 6, Drawing No. 91-225-E55 (Addendum A to Revision 5).

The methods used by the licensee for estimating D_{50}s are those recommended in the NRC Staff Technical Position on Erosion Protection, (NRC, 1990) and are therefore acceptable.

To check the licensee's riprap design, independent analyses were performed. These independent analyses indicated that except for two cases, the D_{50}s proposed by the licensee are adequate and, in several cases, larger than required. The two exceptions are on the pile top. The first is an area where the slope is greater than 9 percent (Segment 3 of Profile 1 shown on Figure E.1.1 (Revision 5)) and the second consists of several small areas south of the South Diversion Ditch (Figure 5, Drawing No. 91-225-E54 (Addendum A to Revision 5)). The staff determined that in these areas, the proposed 2-inch D_{50} riprap proposed is not adequate. For the steep area, a minimum D_{50} of 3 inches is required. For the area south of the South Diversion Ditch, a minimum D_{50} of 4 inches is required. The licensee agreed to use a D_{50} of 3 inches for the area of the pile top where the slope is greater than 9 percent. For the areas south of the South Diversion Ditch, the licensee will use a D_{50} of 6 inches which is larger than required. These design changes were made in Addendum A to Revision 5. Figure 5, Drawing No. 91-225-E54 (Addendum A to Revision 5) shows areas of the pile top where the 2-inch, 3-inch, and 6-inch rock will be placed.

The estimated D_{50}s were then used to design well graded mixtures of rock to resist the shear forces of the PMF peak discharges. The criteria used to determine riprap gradations are from the Surface Mining Water Diversions Design Manual (Simons and others, 1982). The proposed gradations are shown in Table 2A (Addendum A to Revision 5). To verify the adequacy of the licensee's proposed riprap gradations, independent spot checks were made using design methods presented in NUREG/CR-4620 (Nelson and others, 1986). These analyses indicated that the gradations proposed by the licensee are acceptable.

Filter Design

Riprap is used to minimize the potential for erosion of the underlying soil. However, when the soil is of such gradation that there is danger that fines may be washed out through the voids in the riprap, a layer of graded gravel (filter) should be placed beneath the riprap. The gradation of the filter should be coarser than the underlying soil but finer than the riprap. Depending on the size of the riprap, more than one filter layer may be necessary. The licensee proposes to place a filter layer underneath the riprap in the four diversion ditches, the swale, and the key trenches. In areas of the ditches requiring large riprap, the licensee determined that two filter layers are necessary (Table 2B, Addendum A to Revision 5). The design of the filters was based on procedures from the Journal of Geotechnical Engineering (Sherard and others, 1984). This procedure is acceptable for applications where water pressures are not high, such as filters placed under riprap in ditches and swales.

Based on a review of the licensee's filter design calculations, it is concluded that the filters proposed by the licensee will stabilize the riprap layers by preventing the underlying radon barrier soils from washing out into the voids of the riprap.

Apron/Toe Design

The outlets of the four diversion ditches and the areas where the soil/rock matrix transitions to natural ground must be protected from headcuts that can form as a result of scour and subsequently propagate upstream, potentially impinging on the reclaimed tailings.

To minimize the potential for headcutting of the diversion ditches, aprons will be formed at the outlets by flaring out the bottoms of the ditches to greater widths. This design feature will decrease flow depths and velocities so that the aprons may be daylighted onto the natural soil, Figure 9, Drawing No. 91-225-E58 (Addendum A to Revision 5). To determine the required length of the flared aprons, the licensee adapted a method from Barfield and others (1981). At the downstream end of each apron, a cut-off wall will be excavated and filled with riprap as shown on Figure 9, Drawing No. 91-225-E58 (Addendum A to Revision 5). The depths of the cutoff walls will be equal to the expected scour, which the licensee estimated using a method from the Federal Highway Administration (FHA, 1983). This method for estimating scour depth is recommended in the Staff Technical Position on Erosion Protection (NRC, 1990).

The areas where the soil/rock matrix on the pile top transitions onto natural ground will also be provided with rock-filled key trenches as shown in Figure 10, Drawing No. 91-225-E59 (Addendum A to Revision 5). The procedure used for designing toe erosion protection is from the Corps of Engineers (COE, 1970). This procedure is recommended in the Staff Technical Position on Erosion Protection (NRC, 1990)

The rock apron and key trench design calculations were reviewed and independent analyses were performed using procedures from the U.S. Bureau of Reclamation (USBR, 1977) and the Corps of Engineers (COE, 1970). Based on this evaluation, it is concluded that the licensee's rock apron and key trench designs are acceptable for both the diversion ditches and the transition areas between soil/matrix areas and natural ground.

As shown on Figure 5, Drawing No. 91-225-E54 (Addendum A to Revision 5) two storage ponds located about 750 feet downgradient of the outlet of the South Central Diversion Ditch will be reclaimed in place. Flood flows exiting the ditch will pond in a low area between the ditch outlet and the storage ponds. The licensee evaluated the erosion effects of this ponding and concluded that since the top of the reclaimed ponds will be at elevation 6320 feet and the ponding will be at a maximum of 6318 feet, the reclaimed ponds will not be adversely affected. In addition, the apron of the South Central Diversion Ditch will sufficiently dissipate the energy of the flow exiting the ditch such that the flow will not erode the side of the tailings cover which is protected by a soil/rock erosion protection layer.

An independent evaluation of the ponding area downgradient of the South Central Diversion Ditch outlet was performed. To estimate what the maximum ponding elevation will be during a PMF, an independent storage routing analysis was performed using the Corps of Engineers HEC-1 computer program (COE, 1991a). This analysis indicated that the maximum instantaneous ponding elevation would be less that 6316 feet. This elevation is more than 4 feet lower than the storage ponds. Since the water would be ponded, the flow velocity would essentially be zero. To support this analysis, a second independent analysis was performed using the Corps of Engineers HEC-2 computer program (COE, 1991b). Although flood waters would pond to an elevation of about 6314 feet and then spill over a ridge in a northwesterly direction, it was conservatively assumed that the entire flow exiting the South Central Diversion Ditch would remain in the low area against the tailings pile, i.e., no flow would spill over the ridge. The results of this analysis indicated that flow velocities against the reclaimed storage ponds will be nonerosive. On the basis of this independent evaluation, it was concluded that riprap is not required in the ponding area between the outlet of the South Central Diversion Ditch and the storage ponds.

Sediment Considerations

The Staff Position Paper on Erosion Protection (NRC, 1990) recommends that ditches be designed to be self-cleaning in order to prevent sediment from being deposited and reducing the flow capacity of the ditches. In order to assess the ability of the ditches to be self-cleaning, the licensee reasoned that if flow velocities occurring during a 25-year or 50-year flood event were high enough to remove accumulated sediment, the ditches would be self-cleaning.

The licensee first estimated 25-year and 50-year flood events for the diversion ditches using the HEC-1 computer program (COE, 1991a). Rainfall values for 25-year and 50-year events used as input to HEC-1 were obtained from NOAA Atlas 2 (USDC, 1973). Flow velocities were then determined using Manning's equation (Chow, 1959). Next, the licensee examined grain-size distribution data for onsite soils and determined that 99.5 percent on the soils found onsite are smaller than a No. 8 sieve (less than 2.38 mm). Ritter (1978) relates flow velocity to grain size and shows zones where sediment deposition, transportation and erosion will occur. Ritter's relationship shows that a minimum flow velocity of 1.7 ft/sec will erode soil having a grain size of 2.38 mm. Although Ritter's relationship showed that a velocity of 1.7 ft/sec would erode the soil, the licensee conservatively assumed a velocity of 2.5 ft/sec in their analysis. Using this relationship, the licensee determined that flow velocities from both 25-year and 50-year flood events would be high enough, i.e., greater than 2.5 ft/sec, to remove any accumulated sediment in the ditches. Based on this determination, the licensee concluded that the diversion ditches will be self cleaning.

In addition to the 25-year and 50-year flood events considered by the licensee, the staff independently considered the effects of a more frequent flood event. Assuming a flow velocity of 1.7 ft/sec from Ritter, the staff estimated that flow velocities during a 10-year flood event would also be high enough to remove any accumulated sediment in the diversion ditches. Therefore, it is concluded that excessive sediment deposition will not occur in the diversion ditches.

The licensee also considered the potential for clogging of the diversion ditches with sediment from the adjacent granite outcrops. In general, the amount of sediment available for deposition in the diversion ditches is minimal because the areas that contribute runoff to the ditches are solid rock with a minimum amount of soil. There are several locations however, where sedimentation could possibly occur. These are areas where natural gullies exit from the granite outcrops, intercept native soil, and subsequently enter the diversion ditches. The locations of these gullies are shown as "confluences" on Figure 5, Drawing No. 91-225-E54 (Addendum A to Revision 5). In order to provide smooth transitions for flows entering the diversion ditches, the licensee proposes to construct a wide channel at each confluence location as shown on Figure 9, Drawing No. 91-225-E58 (Addendum A to Revision 5). The channels will extend upgradient through native soil to the point of discharge of each natural gully. This design is based on procedures from the Office of Surface Mining (OSM, 1982). The channels will be riprapped with the same size or larger riprap that is being used in the diversion ditches and will extend upgradient to the granite outcrop (Addendum A to Revision 5). Since the flows exiting from the channels will be considerably less than the flows in the diversion ditches, the riprap is more than adequate to protect the confluences of the channels and the diversion ditches.

Based on a review of site topography and on the licensee's analyses and evaluation, it is concluded that sedimentation from the granite outcrops will not affect the ability of the diversion ditches to divert the PMF away from the reclaimed tailings.

Runoff From The Surrounding Rock Outcrops

Since the tailings pile is surrounded by very steep granite outcrops, runoff from these outcrops will enter the diversion ditches in a direction perpendicular to the flow in the diversion ditches. The licensee performed an analysis to assure that these perpendicular flows do not overflow the ditch banks onto the reclaimed tailings. Assuming sheet flow from the granite outcrops, the licensee calculated the size of riprap that would be required in the diversion ditches (Appendix F, March 12, 1992). The results of this analysis indicated that the riprap proposed for the diversion ditches is much larger than required to resist the shear stress of a PMF from the granite outcrops.

Based on a review of the licensee calculations and on independent riprap sizing calculations, it is concluded that the riprap proposed for the diversion ditches is larger than required to resist the shear forces of a PMF on the granite outcrops.

As flows from the rock outcrops merge with flows in the diversion ditches, there is a chance that hydraulic jumps could potentially occur and result in overflows onto the reclaimed tailings pile. An independent analysis was performed using methods from Chow (1959), to assess the effects of any hydraulic jumps that may occur. This analysis showed that the freeboard in the diversion ditches is adequate to contain the increase in flood depths. The analysis also showed that the width of the diversion ditches is greater than the estimated lengths of the jumps. On the basis of this independent analysis, the design of the diversion ditches is adequate to contain any hydraulic jumps that may be caused by flows from the surrounding rock outcrops.

Alternate Design

The steep topography on the south side of the tailings impoundment restricts drainage routes around the tailings and necessitates that the South Diversion Ditch in some areas be placed at the interface between the tailings disposal area and the adjacent granite outcrops. This places portions of the South Diversion Ditch over tailings. At NRC's request, the licensee considered an alternative for routing flood flows completely outside of the reclaimed tailings (Appendix D, Revision 5). This alternative would require that the South Diversion Ditch be located on the steep rock outcrops south of its present location. Locating the diversion ditch in this area is possible but would require drilling and blasting through rock. The problem with this alternative is that because of the steepness of the rock slopes, drainage into the alternate diversion ditch would cascade down rock slopes exceeding 40 feet in height in a nearly free-fall condition. This would disrupt the ditch hydraulics and probably overtop the alternate diversion ditch. The overtopping flow would continue on down the rock slopes onto the reclaimed tailings where erosion would probably occur. This alternative would also add an additional $330,000 to the reclamation cost even if the rock excavated from this alternative ditch was used for erosion protection of other features of the reclamation plan.

Based on a review of the evaluation provided by the licensee for this alternative to the South Diversion Ditch, it is concluded that placing the South Diversion Ditch on the rock outcrops is not feasible because overtopping flows will probably result in erosion of the reclaimed tailings. Therefore, the plan proposed by the licensee for placing a portion of the South Diversion Ditch over tailings is acceptable.

Rock Durability and Gradation

Rock durability is defined as the ability of rock to withstand the forces of weathering. In order to assure that the rock used for erosion protection remains effective for up to 1000 years as required by Criterion 6 of 10 CFR Part 40, Appendix A, potential rock sources must be tested and evaluated to identify acceptable sources of riprap. An acceptable procedure for making this determination is presented in Appendix D of the NRC Staff Technical

Position on Erosion Protection (NRC, 1990). This procedure specifies a minimum score depending on the location where the rock will be placed. Rock scoring 80 percent or greater indicates high quality rock that can be used for any application. Rock scores between 65 and 80 percent indicate less durable rock that can still be used for any application provided that the riprap is appropriately oversized. Rock scoring less than 65 percent cannot be used for critical areas such as diversion ditches, and poorly drained toes and aprons. However, rock scoring between 50 and 65 percent can be used in noncritical areas such as well drained tailings pile tops and side slopes provided it is oversized as recommended in the Staff Technical Paper on Erosion Protection.

As an initial test, the licensee performed a petrographic examination of the proposed rock (ASTM C 295). This examination indicated that the rock could be considered for further physical testing. Rock samples were then tested for Bulk Specific Gravity and Absorption (ASTM C 127), Sodium Sulfate Soundness (ASTM C 88), and Los Angeles Abrasion (ASTM C 535). The results of these tests were then evaluated using procedures recommended in the NRC Staff Technical Position on Erosion Protection. This evaluation indicated that the proposed rock is of very high quality scoring 87.6 and 88 percent, respectively, for the two samples tested. WNI proposes to use rock that will meet the recommendations described in the Staff Technical Position on Erosion Protection. This will allow them to utilize lesser quality rock if it is encountered in the proposed rock source.

Based on a review of the rock durability analysis provided by WNI, and considering the commitment to comply with the Staff Technical Position on Erosion Protection, it is concluded that the rock proposed for erosion protection is acceptable.

Riprap gradations were provided in Table 2A (Addendum A to Revision 5). The information was reviewed, and it was concluded that the gradation requirements meet the criteria recommended by the Corps of Engineers (NUREG/CR-4620, Nelson and others, 1986). Based on this review, it is concluded that the gradations proposed for the riprap are acceptable.

The erosion protection design of the reclamation contributes to meeting the requirements of Criteria 6 and 12 in that the riprap has been sized to provide erosion protection without any maintenance, to the extent reasonably achievable. WNI's determination of the acceptability of the rock source using procedures in the Staff Technical Paper on Erosion Protection contributes to meeting the requirements of Criterion 4 by providing reasonable assurance that the riprap will be dense, sound, and resistant to abrasion, and that the rock will have no other defects which could affect the ability of the riprap to protect the reclaimed tailings from excessive erosion.

<u>Radon Attenuation</u>

For design purposes, the reclamation area was divided into seven areas. As shown on the attached figure, Areas 1A and 1B represent the east and west new tailings areas, respectively, Areas 1C and 2B represent the north and south old tailings areas, respectively, Area 2A represents the alternate tailings area, Area 2C represents the winter storage ponds, and Areas 3A and 3B represent the mill area with and without tailings, respectively. The proposed design of the radon attenuation barrier for each of the seven areas is shown on Figure 10, Drawing No. 91-225-E59 (Addendum A to Revision 5).

Characterization of Materials

The exploration programs for the site were conducted in 1987, 1988, 1989, 1991, and 1993. All pertinent data used in the cover design are contained in Appendix A of Revision 5. Sampling locations are shown on Figure G.1.2 (Revision 5).

The initial exploration program for the tailings consisted of eight test borings; four in the new tailings area, two in the old tailings area, and two in the alternate tailings area. In addition, fourteen surface samples were taken from the new tailings area. Locations of the borings and surface samples are shown on pages A-5 and A-6 (Revision 3). Laboratory testing included in-place moisture and density, specific gravity, radium concentration, emanation coefficient, diffusion coefficient, and laboratory compaction.

Mill soils, which are to be reclaimed in place, were characterized by one composite sample. Additional characterization data were obtained during decommissioning activities and placement of an interim cover over the area. Laboratory testing included specific gravity, radium concentration, and emanation coefficient.

To augment these data, 25 additional borings were drilled in 1993, which resulted in an additional 375 feet of borehole and 431 separated samples. Locations of the 1993 borings are shown on Figure A.5.1 (Revision 5). Laboratory testing included in-place dry density and moisture content, percent passing the No. 200 sieve, and radium concentration. Three composite samples were tested for specific gravity, radon emanation coefficient, radium concentration, and capillary moisture determination.

Windblown tailings, although characterized, were conservatively not included in the model cross sections. This provides the licensee flexibility in the placement of this material in the new tailings area.

The radon attenuation barrier is comprised of an imported clay layer (Cody Shale) and a borrow soil layer placed over the clay. The onsite soil borrow areas are shown on the attached figure and on Figure 3, Drawing No. 91-225-E52 (Addendum A to Revision 5). To obtain representative parameters, 132 samples were taken from the 8 borings and 14 test pits shown on Figure 1 (Addendum A to Revision 5), and composited into 3 representative samples. Gradation tests were performed on all 132 samples. Laboratory testing included gradation, Atterberg limits, specific gravity, laboratory compaction, capillary-moisture relationship, and radon diffusion.

The Cody Shale Borrow Area which is located approximately 7 miles southwest of Jeffrey City, was characterized by 24 borings, sampling 700 feet of the shale deposit located in Sections 6 and 7, Township 28 North, Range 92 West and in Sections 1 and 12, Township 28 North, Range 93 West, (Page A-49, Addendum A to Revision 5). For laboratory determination of in-place moisture content, percent passing the No. 200 sieve (percent fines), and Atterberg Limits, 273 individual specimens were composited into 29 samples. The results were used to further composite four samples representing material with less than 90 percent fines, 90 to 92 percent fines, 92 to 95 percent fines, and more than 95 percent fines. The laboratory testing program for these four samples included laboratory compaction, specific gravity, permeability, double hydrometer, and capillary-moisture relationship. The capillary moisture relationship was determined using Method 26-1 of "Methods of Soil Analysis" (Klute, 1986), extended to 9 days, in lieu of ASTM methodology.

Suitability of the Borrow Materials

Based on the field exploration and laboratory testing programs, the licensee concluded that the proposed borrow areas contain suitable quantities of acceptable material to construct the radon barrier. Testing indicated that the materials are nondispersive. Permeability tests conducted on the Cody Shale composite samples resulted in permeabilities ranging from 1.2×10^{-8} to 9.2×10^{-9} centimeters per second near the average expected placement conditions. These results indicate that the radon barrier material is considered practically impermeable (USBR, 1987). It was concluded that the low permeability of the cover materials coupled with the low annual rainfall and high evaporation rate of the region will serve to prevent significant tailings recharge.

Vegetation intrusion into the radon barrier will be restricted by the soil/rock matrix layer in the final reclamation cover. Although it is recognized that some volunteer plant growth will occur during the design life of the structure, the licensee concluded that it will most likely be shallow rooted grasses whose roots prefer not to enter the dense Cody Shale clay layer.

Indigenous animals to the area are not expected to select the reclaimed disposal area over native terrain. The compacted soil/rock matrix cover will not be conducive to digging or to establishing vegetation to create an acceptable habitat. In addition, the large rocks in the diversion ditches which surround the disposal area should discourage passage onto the disposal area. It is concluded that the reclaimed facility will not provide a desirable habitat and that the diversion ditch system will provide a buffer zone to restrict access.

The effect of freeze/thaw cycles on the radon barrier was also addressed. The licensee concluded that the material will not be susceptible to frost heave as the coarse tailings below it will not support capillary action. Therefore, the ability to transport excess water to the frost line does not exist, and the susceptibility of the cover system to frost heave can be considered low.

The licensee evaluated shrinkage of the radon attenuation barrier and its potential effect on radon attenuation. As this physical process is also dependent on the presence of capillary action, it was concluded that shrinkage effects on the cover soils will not be significant. This conclusion was based on the fact that the long-term moisture content of the soil cover will remain essentially stable over the design life of the structure.

Based on independent evaluations, the licensee's conclusions as to the ability of the proposed borrow materials and amended materials to perform adequately in the cover system are acceptable. It is recognized that repeated freeze/thaw cycles may affect the permeability of the material. The anticipated freeze/thaw cycles may also reduce the density of the material modeled in the radon attenuation design. The attenuation model however, is not sensitive to this parameter, and will therefore have little effect on the ability of the proposed design to meet the radon flux criteria.

Attenuation Modeling Parameters

The modeling of the facility was done using the RADON computer code (NRC, 1989b). The final analyses and supporting data are contained in Appendix G (Revision 5). Addendum A to Revision 5 contains a discussion of each of the parameters that were used in the computer model. Final design depths are shown on Figure 10, Drawing No. 91-225-E59 (Addendum A to Revision 5).

Review of the licensee's input into the model identified several areas of concern, mostly associated with the selection of representative radiological parameters and appropriate estimates of the expected long-term moisture contents. These concerns were adequately addressed in Addendum A to Revision 5. The use of 3 data points to determine the maximum dry density and optimum moisture content for the Cody Shale was not addressed by the licensee in these submittals. Although the use of only 3 data points is not in accordance with ASTM procedures, the resulting density and moisture content determinations are well within the range of values expected for this type of material and are therefore acceptable. The attached table and Table 4 of the Technical Specifications (Addendum A to Revision 5) summarize the parameters used in the modeling process for each area.

Modeling Results

The results of the licensee's modeling are summarized below and in Table G.1.3 (Addendum A to Revision 5). Independent analysis verified that the proposed radon attenuation barrier design will limit releases to the atmosphere to less than 20 pCi/m²sec. Input parameters for the analyses are shown on the attached table. The licensee used the model to optimize the upper layer of Cody Shale (First lift compacted to 90 percent of the laboratory maximum dry density and subsequent lifts to 95 percent) to meet the exit flux standard. The resulting depths of Cody Shale were rounded up to the next highest even inch for design purposes. Therefore, the depths in the following table result in design exit fluxes of less than 20 pCi/m^2sec.

Design Radon Attenuation Barrier Depths

Area[A]	Depth of Cody Shale (inches)	Depth of Soil Borrow (inches)
Area 1A - East New Tailings	33	12
Area 1B - West New Tailings	44	12
Area 1C - Old Tailings	36	12
Area 2A - Alternate Tailings	42	12
Area 2B - Old Tailings	36	12
Area 2C - Winter Storage Ponds	6[B]	12[B]
Area 3A - Mill Area with Tailings	16	12
Area 3B - Mill Area w/out Tailings	6	12

A = Areas are shown on the attached figure.

B = The radon barrier design for the Area 2C will not be considered final until the storage ponds are dismantled and a source term can be confirmed. The proposed cover thickness shown above can be considered to represent a maximum thickness for the purposes of estimating the surety amount. Confirmation of the proposed design will be required by license condition.

Conservatisms in the modeling include the exclusion of windblown cleanup materials and borrow area soils added to the areas to meet grade. The radon attenuation design was based on acceptable input parameters and utilized an acceptable method to evaluate the exit flux. Therefore, it is concluded that the proposed radon attenuation design is acceptable to ensure that the radon emissions at the site will be limited to 20 pCi/m²sec as required by Criterion 6 of 10 CFR 40, Appendix A.

Construction Specifications

The following sections summarize the pertinent sections of the specifications proposed by WNI. All testing shall be done in accordance with ASTM standards unless noted otherwise (Section 1.9 and Section 5.2.1, (Addendum A to Revision 5)).

Material Types

Radon Barrier Layer Material - The Radon Barrier Layer Material will be obtained from the Cody Shale Borrow Area located approximately 7.8 miles southwest of the site. Suitable material will have at least 90 percent passing the number 200 sieve (Section 1.11, Addendum A to Revision 5). Soil classification is not included in the material specification. This material is also referred to as Cody Shale, imported clay, and clay radon barrier material in the support documents and specifications.

Soil - Soil will be all earth material that can be excavated with conventional earthwork excavation equipment. The material shall not contain windblown tailings or affected soil (Section 1.11, Addendum A to Revision 5) .

Borrow Soil Cover Material - The borrow soil cover material shall meet the requirements of soil and no more than 10 percent of the soil volume shall contain particles larger than 6 inches (Section 1.11, Addendum A to Revision 5).

Affected Soils - Soil at depth in the borrow areas which exhibits a gamma radiation survey value greater than 20 μR/hr in areas not affected by shine and greater than 32 μR/hr in areas affected by shine (Section 1.11, Addendum A to Revision 5). This represents a modification of the cleanup criteria, which is addressed under separate licensing action.

Windblown Tailings - Wind transported tailings having gamma radiation survey values similar to the Affected Soils (Section 1.11, Addendum A to Revision 5).

Riprap - Riprap shall consist of sized angular granite obtained from the specified onsite rock source Figure 3, Drawing No. 91-225-E52 (Addendum A to Revision 5) or an alternate rock source approved by the licensee. The riprap shall meet the rock scoring criteria discussed in Appendix D of the Staff Technical Position on Erosion Protection (NRC, 1990) (Section 5.2.1, Addendum A to Revision 5). The riprap material shall be resistant to abrasion and weathering, free from cracks, seams, soils, and other defects that would tend to increase weathering by water and frost action.(Section 5.1.4.1, Addendum A to Revision 5). Riprap shall be well graded and sized as specified for each particular ditch reach or apron as shown in Table 2A of Addendum A to Revision 5.

Filter Material - Filter material shall consist of sized angular granite obtained from the specified onsite source, Figure 3, Drawing No. 91-225-E52 (Addendum A to Revision 5) or an alternate source approved by the licensee. The filter material shall meet the rock scoring criteria discussed in Appendix D of the Staff Technical Position on Erosion Protection (NRC, 1990) (Section 5.2.1, Addendum A to Revision 5). The filter material shall be reasonably free from clay, loam, or deleterious material. The filter material shall be well graded and sized for each particular ditch reach or apron as specified in Table 2B of Addendum A to Revision 5.

Soil/Rock Matrix - The soil/rock matrix shall consist of sized angular granite and soil obtained from the specified onsite borrow sources shown on the attached figure and on Figure 3, Drawing No. 91-225-E52 (Addendum A to Revision 5); soil obtained during excavation of the ditches; or alternate sources approved by the licensee. The soil must be acceptable as specified above. The rock shall meet the scoring criteria discussed in Appendix D of the Staff Technical Position on Erosion Protection (NRC, 1990) (Section 5.2.1, Addendum A to Revision 5). The rock material shall be angular, resistant to abrasion and weathering, and shall be free from cracks, seams, and other defects that would tend to increase weathering by water and frost action. The rock shall be well graded and sized as specified in Table 2C of Addendum A to Revision 5.

Placement

Fill (Below Cover System) - Fill shall be obtained from excavated soil and relocated tailings resulting from diversion ditch construction. If necessary, borrow soil may be used (Section 3.2.7, Addendum A to Revision 5). The maximum loose lift thickness for fill to achieve the desired subgrade shall be 8 inches. Each lift will be compacted by at least one pass of a Caterpillar 815 (or equivalent) smooth drum compactor. Prior to placement of this fill, the existing surface will also be proof rolled with at least one pass of a Caterpillar 815 (or equivalent) (Section 3.2.7, Addendum A to Revision 5).

Radon Barrier Layer - The first 6-inch thick lift of material shall be compacted to 90 percent of the laboratory maximum dry density within minus 2 percent to plus 4 percent of the optimum moisture content. All subsequent 6-inch lifts shall be compacted to 95 percent of the laboratory maximum dry density within minus 2 percent to plus 4 percent of the optimum moisture content (Section 4.2.2.1, Addendum A to Revision 5).

Borrow Soil Layer - The borrow soil layer will be placed in maximum 8-inch loose lifts (Section 4.2.1, Addendum A to Revision 5). Each lift will be compacted using passive means in that compaction will be achieved by construction traffic. (Section 7.2.2, Addendum A to Revision 5).

Riprap - Riprap shall be placed at the locations and grades shown on the reclamation plan drawings. The riprap shall be placed in a manner to prevent segregation and to provide a layer of riprap of the specified thickness. Minimum riprap thicknesses for each particular application shall be as specified in Table 2A of (Addendum A to Revision 5). Hand placing will be required only to the extent necessary to ensure these results. Riprap material which does not meet the quality control requirements discussed below shall be either reworked or removed and replaced as necessary (Section 5.2.3, Addendum A to Revision 5).

Filter Material - Each filter layer will be placed in one lift and tracked in place by three passes of a Caterpillar D-8 bulldozer or equivalent. Minimum filter layer thicknesses for each particular application shall be as specified in Table 2B, Addendum A to Revision 5. Each layer shall be placed in a manner that prevents segregation. Filter material that does not meet the quality control requirements discussed below shall be either reworked or removed and replaced as necessary (Section 5.2.4, Addendum A to Revision 5).

Soil/Rock Matrix - The rock for the soil/rock matrix shall be placed first by end or belly dump trucks or other means in a manner that will minimize degradation and separation of the material. The rock will be spread with a motor grader to achieve the specified thicknesses. Next, the soil for the soil/rock matrix will be placed in a similar manner. The soil will also be spread by a road grader to achieve the desired thickness and then compacted with a vibratory roller/compactor to push the soil into the rock. The soil shall be forced into the rock voids while maintaining a maximum thickness of 2 inches of soil above the rock layer after compaction (Section 5.2.5, Addendum A to Revision 5). Minimum thicknesses for the soil and rock layers shall be as specified in Table 2C, (Addendum A to Revision 5).

Quality Control

The quality control program will be performed by the licensee or its representative. The program is designed to verify that construction activities will meet the intent of the reclamation plan by meeting or exceeding all design criteria.

Table 5 of the specifications (Addendum A to Revision 5) summarizes the quality control program. The program will meet the testing requirements and frequencies for cover material and rock contained in the Staff Technical Position on Testing and Inspection (NRC, 1989a).

The following site specific items are included in the program.

Radon Barrier Layer - Gradation testing (ASTM D 1140) will be performed once for each 1000 cubic yards (cy) of material placed and at least once a day for each day more than 150 cy of material is placed (Section 7.2.3.1, Addendum A to Revision 5). In-place density and moisture testing will be performed once for each 500 cy of material placed, a minimum of two tests will be performed each day more than 150 cy of material is placed, and a minimum of one test per lift and a minimum of one test per full shift of placement (Section 7.2.3.2, Addendum A to Revision 5). Laboratory compaction testing (ASTM C 698) will be performed once for every 15 in-place density and moisture tests performed. Additionally, one-point laboratory compaction tests will be performed at a rate of one test for every 5 in-place density and moisture tests performed (Section 7.2.3.2, Addendum A to Revision 5).

In addition to the testing described above, the Staff Technical Position on Testing and Inspection (NRC, 1989a) requires determination of the plasticity index once per day and also contains requirements for soil classification. As the material specifications for this material do not contain requirements for a minimum plasticity index or an associated classification, there is no reason to include these tests in the quality control program.

Borrow Soil Layer - There are no specific compaction requirements on the borrow soil layer; therefore, there is not a quality control program for the material.

Tolerances - A thickness tolerance specification is not required for the radon barrier layer as the thicknesses shown in Table G.1.3 (Revision 5) and on Figure 10, Drawing No. 91-225-E59 (Addendum A to Revision 5) are minimums. For the borrow soil layer, the thickness tolerance will 8 to 12 inches. Thickness will be measured on a 200-foot grid system (Sections 4.2.2, 4.2.2.1, and 4.2.2.2, (Addendum A to Revision 5).

Nuclear Density Gauge Calibration - During placement of the interim cover, 52 in situ density tests were conducted using both the sand cone apparatus and the nuclear gauge. A strong correlation was determined between the two test procedures and a best-fit equation was developed for dry densities. A 95 percent confidence boundary was determined as shown in Figure 11, Drawing No. 91-225-861 (Addendum A to Revision 5). The dry density specifications are based on these boundaries.

All nuclear gauge dry densities must be corrected by the best-fit equation. Duplicate tests using both the sand cone and the nuclear gauge must be performed once for every tenth in situ test. If the duplicate tests do not fall within the 95 percent confidence boundaries in Figure 11, Drawing No. 91-225-861 (Addendum A to Revision 5), the nuclear gauge results will not be acceptable until the results of an additional 20 consecutive duplicate tests fall within the acceptable boundaries (Section 7.2.6, Addendum A to Revision 5).

Where the nuclear gauge is used to determine moisture content, the oven drying method shall also be conducted as a duplicate test for the first series of ten consecutive tests to confirm that both the sand cone and the nuclear gauge are producing results within ± 1.0 percent moisture. If all ten pairs of test results are within this tolerance, the nuclear gauge may be used for subsequent testing. In addition, after the first series of ten tests, the oven drying method shall be conducted as a duplicate analysis at a frequency of once for every ten nuclear moisture tests. If for any tenth test, the results are not within ± 1 percent moisture, the nuclear gauge will not be used until another ten duplicate tests confirm the results, Section 7.2.6, (Addendum A to Revision 5).

Microwave Calibration - If a microwave oven is used to determine in situ moisture contents, the first series of ten consecutive tests must have duplicate moisture tests using the microwave method and oven-drying method. These results must agree within 1 percent moisture. If all ten pairs are within this tolerance, the microwave method may be used for subsequent testing. Correlations will be verified every tenth test. If the correlation results do not fall within 1 percent moisture, the oven drying method will be used until another ten consecutive duplicate tests confirm that the microwave method produces results within 1 percent moisture of the oven-drying method. (Section 7.2.6, Addendum A to Revision 5)

Rock Durability - As specified in Section 5.2.1, (Addendum A to Revision 5), durability testing of the rock to be used for riprap and filter material, will include the following series of laboratory tests:

1. Bulk Specific gravity
2. Absorption
3. Sodium sulfate soundness
4. L.A. Abrasion

As a minimum, a test series will be performed before use. This will be followed by testing for each additional 10,000 cubic yards of rock from a particular source. More frequent testing may be conducted if it is suspected that the rock has changed substantially from the rock that was previously tested. Any visual change that is noted will be recorded as described under the Records section below (Section 7.2.4.1, Revision 5). The rock will meet the durability requirements defined in Appendix D of the NRC Staff Technical Position on Erosion Protection (Section 5.2.1, Addendum A to Revision 5).

Rock Gradation - Gradation testing of the riprap and filter material will include, as a minimum, an initial test followed by additional testing for each additional 10,000 cubic yards of rock. The testing shall be performed for each riprap and filter size. A minimum of three gradation tests will be required for riprap sizes having less that 30,000 cubic yards (Section 7.2.4.2, Addendum A to Revision 5).

Rock Thickness - For the soil/rock matrix, the thicknesses of both the rock mulch and the overlying soil shall be measured on a 200-foot grid system, Section 7.2.5 (Addendum A to Revision 5). The thickness of the riprap and filter layers in the diversion ditches shall be verified by measuring the thickness in a test section constructed at the initial placement of a specific size riprap. In addition, the riprap layer thickness shall be measured at intervals of 100 linear feet. Layer thickness will be as specified in Tables 2A and 2B of (Addendum A to Revision 5).

Records

Weekly inspection reports shall be maintained that contain the adequacy, progress, details of construction, and decisions. Volumes of materials placed and the number of field and laboratory tests performed on each material shall be summarized weekly. (Section 7.2.7, Addendum A to Revision 5)

In addition, as-built drawings will be prepared at the completion of the project. (Section 1.5, Addendum A to Revision 5)

Archeology

By letter dated December 14, 1987, the Wyoming Department of Environmental Quality identified to WNI that the Oregon Trail variant located on the site should be avoided or that a complete cultural resource inventory be undertaken. Accordingly, WNI was formally requested by NRC in a letter dated May 14, 1991, to document that the requirements of License Condition No. 34 were satisfied. In response, WNI submitted a comprehensive survey of the potential borrow areas at the site. A complete summary of the review is documented by Memorandum for Docket File No. 40-1162 dated June 8, 1992. It was concluded that WNI's proposed avoidance and monitoring program would be adequate. The licensing action in that memorandum should have been included in the issuance of the amendment approving the reclamation plan. It was inadvertently excluded and will therefore be part of the current amendment.

CONCLUSIONS

Appendix A to 10 CFR 40 establishes criteria for the technical, financial, ownership, and long-term site surveillance relating to the siting, operation, decontamination, decommissioning, and reclamation of uranium milling facilities. Each site-specific licensing decision is to be based on the criteria in the Appendix, taking into account the public health and safety and the environment. Decisions as to the ability of the design to meet "reasonably achievable" criteria must take into consideration the state of technology and practice as well as evaluation of the economic cost to resulting benefit.

Review and independent analyses of the revised reclamation plan for the Split Rock Mill disposal area have resolved all issues and open items, and it is concluded that the proposed design is consistent with 10 CFR 40, Appendix A.

Criteria 2, 8, and 11 are not applicable for reclamation and were therefore not considered. Criteria 5, 7, and 13 concern ground-water protection standards. As ground water is being addressed under separate licensing actions, these criteria are also not applicable for reclamation licensing actions. Criteria 9 and 10 require that a financial surety arrangement be established to assure that sufficient funds are available to carry out the decontamination and decommissioning of the facility and the reclamation of the disposal area. By amendment dated October 22, 1993, WNI was required to increase their surety amount to $14,828,282 by License Condition No. 70 of Source Material License SUA-56. The current surety instrument is a performance bond issued by Federal Insurance Company in favor of the State of Wyoming. The licensee is allowed 3 months to submit a proposed revision to the financial surety arrangement if estimated costs in the newly approved plan exceed the amount covered in the existing financial surety. The currently approved surety amount was based on approval of Revision 5 to the reclamation plan and therefore, no revision of the amount is anticipated.

Therefore, it is recommended that Source Material License SUA-56 be amended by modifying License Condition Nos. 27 and 34 to read as follows:

27. The licensee shall reclaim the tailings disposal areas in accordance with the Tables and Figures, and Sections 1 through 5 and Section 7 of their February 7, 1994 repor' titled, "Western Nuclear Inc. Split Rock Mill, Addendum A (February 7, 1994) to Revision 5 to the June 30, 1987 Uranium Tailings Reclamation Plan," with the following exceptions:

    A. If a rock source other than the on-site source is used, durability testing must be performed and the results submitted to the NRC for review and approval prior to placement of materials from the alternate source.

    B. The preliminary radon attenuation barrier design for the Winter Storage Ponds (Area 2C, Figure 4, Drawing No. 91-225-E53 (Addendum A to Revision 5) consists of 6 inches of Cody Shale and 12 inches of Soil Borrow. This design is considered acceptable for estimating the surety amount. However, once the storage ponds are dismantled, the licensee shall confirm the design and obtain NRC approval prior to placing the radon cover on the ponds.

    C. A completion report including as-built drawings, verifying that reclamation of the site has been performed according to the approved reclamation plan shall be provided within 6 months after completion of construction. The report shall also include summaries of results of the quality assurance and control testing to demonstrate that approved specifications were met.

    [Applicable Amendments: 22, 56, 68, 71]

artifact survey of areas of its property, not previously surveyed, performed prior to their disturbance, including borrow areas to be used for reclamation cover. These surveys must be submitted to the NRC and no such disturbance shall occur until the licensee has received authorization from the NRC to proceed.

The licensee is authorized to excavate material from the proposed reclamation borrow areas as designated in the licensee's approved reclamation plan, provided that protection of the cultural resources is managed in accordance with statements and representation contained in the licensee's letter dated March 30, 1992.

[Applicable Amendments: 71]

The proposed licensing action was discussed and agreed to with Ms. S. Baker on March 23, 1994.

Raymond O. Gonzales

Raymond O. Gonzales
Project Manager

Attachments:
1. References
2. Site Plan After Reclamation
3. Radon Attenuation Design Parameters

Case Closed: 04001162990R
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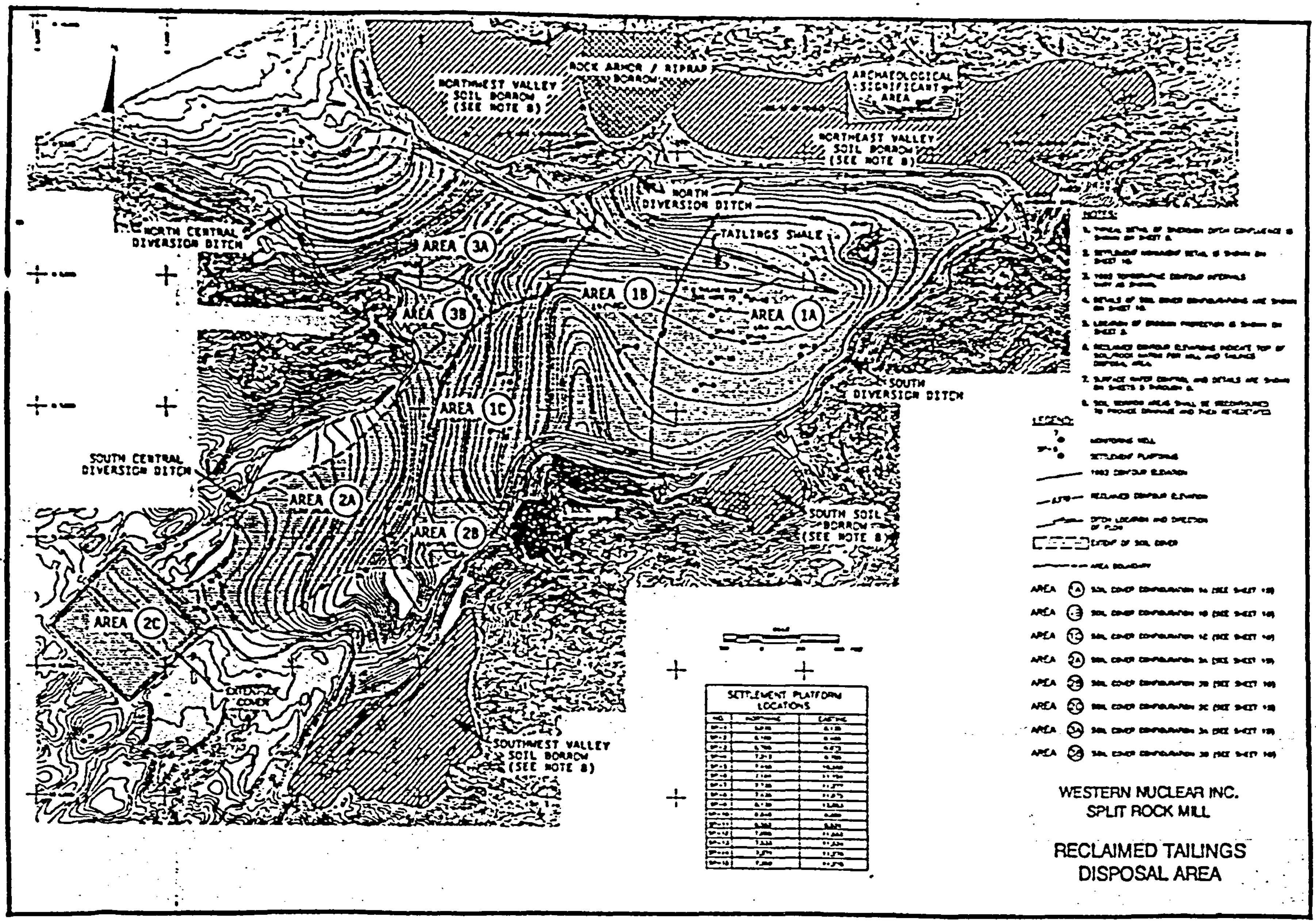

(MODIFIED FROM WNI SUBMITTALS)

RADON ATTENUATION DESIGN PARAMETERS

Material	Porosity	Dry Density (g/cm^3)	Radium Activity (pCi/g)	Emanation Coefficient	Long Term Moisture %	Diffusion Coefficient (Calculated Values) (cm^2/sec)
Area 1A East New Tailings	0.39	1.62	280	0.28	1.5[B]	5.667E-2
Area 1B West New Tailings	0.40[A]	1.55	450	0.37	1.5[B]	5.758E-2
Area 1C Old Tailings	0.39	1.61	341	0.27	6.0[A]	4.239E-2
Area 2A Alternate Tailings	0.38	1.64	448	0.27	6.0[A]	4.977E-2
Area 2B Old Tailings	0.39	1.61	341	0.27	6.0[A]	4.239E-2
Area 2C Winter Storage Ponds	N/A[D]	N/A[D]	N/A[D]	N/A[D]	N/A[D]	N/A[D]
Area 3A Mill Area with Tailings	.38	1.65	88	0.27	6.0[A]	5.027E-2
Area 3B Mill Area w/o Tailings						
Top 1 Foot	0.40[A]	1.57	20.3	0.35[A]	1.5[B]	5.744E-2
Lower 14 Feet	0.40[A]	1.57	5.5	0.35[A]	1.5[B]	5.744E-2
Cody Shale						
@ 90 % Compaction	0.44	1.56	0	0	16.9[B]	7.440E-2
@ 95 % Compaction	0.41	1.65	0	0	16.9[B]	4.068E-2
Borrow Soil	0.40[A]	1.55	1.1	0.35[A]	2.0[C]	5.393E-2

A Default value from RADON computer code.
B Based on 15 Bar Laboratory Testing.
C Less than default value of 6 percent
D Not Applicable as the Radon Barrier design for Area 2C will not be considered final until the ponds are dismantled and a source term can be confirmed.

bcc:
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PDR/DCS
URFO r/f
SJCollins, RIV
DBSpitzberg, RIV
RAScarano, RIV
LLUR Branch, LLWM, 5E2
ROGonzales
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PM:URFO	PM:URFO	DD:URFO	D:URFO:RIV	
ROGonzales/lv	DCWard	EFHawkins	REHall	
03/24/94	03/24/94	03/24/94	03/24/94	