GEOTECHNICAL REVIEW OF HMC URANIUM MILL LICENSE RENEWAL APPLICATION

by

Karen Agogino, P.E.

Project Manager
W. John Smith, II, Ph.D.
ROY F. WESTON, INC.
Albuquerque, New Mexico 87108

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Project Officer

Felix R. Miera, Jr.
Uranium Licensing Section
Radiation Protection Bureau
Environmental Improvement Division
State of New Mexico
Santa Fe, New Mexico 87504

SECTION 1

INTRODUCTION

s consultant to the New Mexico Environmental Improvement Division, EID), ROY F. WESTON, INC. has prepared the following comments on ertain geotechnical aspects of the Uranium Mill License Renewal pplication by Homestake Mining Corporation. At the request of the ID, the review and comments were not restricted to current State of ew Mexico regulations, but address as well issues that would need to e resolved if the license renewal were subject to current Federal egulations (UMTRCA Title II).

SECTION 2

COMMENTS

.1 The Modified Universal Soil Loss Equation (MUSLE)

imons, Li and Associates (1982) evaluated the Universal Soil Loss quation, (USLE), and pointed out important limitations to its use in he arid regions of the west. The data base used in developing the SLE was collected east of the Rocky Mountains. Significant errors an be introduced when applying it to the western areas, primarily ecause of the R-factor. Many arid regions receive a large percentage f rainfall in the form of high-intensity, short-duration thunder-torms. This is not the case in the central and eastern United tates, where the effect of this type of rainfall cannot be totally ncorporated.

modified equation, based on the USLE is presented in the National ooperative Highway Research Program Report 221 (1980), reference 2, or predicting soil loss due to water erosion on highway construction ites, and for determining the effectiveness of various erosion ontrol measures. R-factors for areas west of the 104° west longitude o the Pacific are presented in Report 221 and were determined by ischmeier and Smith (1978), reference 12. The modified universal oil loss equation (MUSLE) is:

$$A = R \cdot K \cdot LS \cdot VM \quad . . . . . . (2\text{-}1)$$

n which:

A = computed amount of soil loss per unit area for the time interval represented by factor R, generally expressed as tons per acre.

R = rainfall factor
K = soil erodibility factor in tons per acre per year per unit of R
LS = topographic factor (length and steepness of slope) (dimensionless)
VM = erosion control factor (vegetative and mechanical measures) (dimensionless)

The MUSLE is more applicable to the arid regions of the west and should be used for the Homestake Milling site rather than the USLE.

2.2 Design Floods and Erosion Protection

Design floods should be prepared using both the 6 hour general storm PMP (probable maximum precipitation) and the 1-mile^2 PMP. The more critical of the two inflow design floods should be used in the design of the tailings retention system. The PMP and resulting PMF should be determined using Hydrometeorological Report No. 55, reference 3.

2.2.1 In determining the peak PMF flow, the following methods and assumptions should be used:

- For small, steep, ungaged watersheds, where adequate stream flow data is lacking, the stream hydraulics method (Ref. 13) should be used to compute the time of concentration of flood flows, unless it can be documented that other methods would be applicable for the watershed under analysis. The upland method or curve number method (Ref. 14) may be used for the area extending from a defined channel to the watershed ridge.

- The soils over the watershed area should be assumed to be saturated. Use of infiltration losses and runoff coefficients which reduce surface runoff should be fully justified and carefully documented.

- The time distribution and arrangement of the PMP rainfall increments should be developed in accordance with Hydrometeorological Report No. 55, reference 3.

2.2.2 In determining the water surface profiles and flow velocities, the following methods and assumptions should be used:

- The flow profiles should be computed using a standard step flow computation model, such as reference 12. Particular care should be exercised in determining the starting water surface elevations for use in these models; in general, to obtain realistic starting elevations, profile calculations should be performed upstream and/or downstream of the diversion channel proper. In addition, careful consideration should be given to developing both subcritical and supercritical flow profiles; that is, the model may have to be run in both upstream and downstream directions for certain channel slopes and configurations. This will help determine the location, length, and magnitude of hydraulic jumps. If possible, however, subcritical flow should be avoided. The flow profiles and cross sections should be provided for review. In particular for the Homestake site, more cross sections are needed especially in the areas between cross section A and B as shown in Figure C9-9 of the "Environmental Improvement Division Uranium Mill License Renewal Application Environmental Report - Homestake Milling Operation". these cross sections should provide justification for the limits of the flood protection berm.

- The Manning's "n" value selected should be carefully justified and documented. Guidance for the selection of appropriate "n" values may be found in References 1 and 13. A higher "n" value should be used for determining channel capacity than the "n" value used for determining channel flow velocities.

- Judgement and experience should be utilized in the interpretation of results of flow profiles. Studies performed to demonstrate the sensitivity of flow profiles to variations in input parameters (such as "n" values, loss coefficients, and starting elevations) are often helpful in assessing the validity of computed results and should be submitted.

2.2.3 Erosion protection for channels and channel side slopes should be designed in accordance with Reference 11 to determine the size and thickness required and References 5 and 6 to determine the necessary gradations. Velocities used to determine the size of erosion protection may be taken from the water surface profile computations. Specifications for placement, quality control, and durability should be provided for staff review.

2.2.4 The design of a protection cover system over radon barriers for uranium mill tailings piles should be as follows:

- In the design of radon barriers, it is extremely important that the integrity of the barrier be maintained for the design life of the facility (1000 years). In order to protect against potentially destructive forces such as wind and water erosion, plant intrusion, etc., a rock cover is needed. The design criteria for the stability of the tailings piles due to erosive forces resulting from rainfall runoff across the top and down the sides of the stabilized embankment are based on the runoff from the localized Probable Maximum Precipitation (PMP). For flow occurring as a result of rainfall on the watershed above the stabilized embankment, the pile should be designed to resist the runoff from the Probable Maximum Flood (PMF) as a result of the PMP. The design method which is most applicable to the design of a rock blanket for erosion protection is the "Riprap Design with Safety Factors Method" developed for the Wyoming State Highway Department by Stevens et al. (1976), reference 8.

Information needed to design the riprap by the Safety Factors Method are:

- The angle of repose of rock to be used.
- The specific gravity of rock to be used.
- The slope of the bed or sideslope over which the rock will be placed.
- The velocity of flow over the rock to be used.
- The depth of flow over the rock to be used

The angle of repose of a rock is dependent on the angularity and diameter of the rock and routinely varies from about 32 degrees to 42 degrees, with most naturally occurring rocks falling in the range of 34 to 37 degrees. This factor has a small effect on the final mean rock size and wherever data is not available a conservative estimate of 35 degrees should be assumed.

The specific gravity of a rock is dependent on the mineralogy of the rock and can vary from 2.5 to 2.8. Where data is not available a conservative estimate of 2.60 should be assumed.

The slope of the bed, side, and topslope will vary and will be part of the design. Typically, the topslope should be 2 to 5 percent and the sideslope should be 20 percent or less. The bedslope will be dependent on the topography.

Generally on slopes steeper than 10 percent and/or if the flow is small, the Safety Factors Method is not accurate and the Stephenson's Method (1979), reference 7, should be used. The input parameters for this method are the following:

- o Quantity of flow (cfs)(Q)
- o Angle of slope (0)
- o Constant (C)(varies from .22 to .27)
- o Specific gravity of rock to be used (G_s)
- o Angle of repose of rock to be used (0)
- o Porosity of rock fill (related to density)(p)

This formulation is based on the work originally done by Olivier (1967), reference 4.

When this method is used, the D_{50} size rock is conservative and includes a safety factor on the order of 1.2 to 1.8.

o When designing the cover system, one must evaluate the need for a filter layer between the radon barrier and the erosion protection layer.

It is recommended that the following equation be used as the criteria for all filters. This criteria can be relaxed in some instances for a clay with a high plasticity or if there are fairly low flow gradients.

$$\frac{D_{15}\text{filter}}{D_{85}\text{soil}} < 5 \text{----Stability Criterion} \quad (1)$$

The following requirements for graded filter should also be met:

- o The filter material should pass the 3-inch sieve for minimizing particle segregation and bridging during placement. Smaller maximum particle sizes may be specified if practical. Also, filters must not have more than 5 percent minus the No. 200 mesh sieve, to prevent excessive movement of fines in the filter.

- o The gradiation curves of the filter and base material should be approximately parallel in the range of the finer sizes, because the stability and proper function of protective filters depends upon skewness of the gradation curve of the filter towards the fines, giving support to the fines in the base material. Additionally, the material should be reasonably well graded throughout the in-place layer thickness.

- o The minimum thickness of the layer should be 6 inches in order to facilitate ease of construction during placement.

When a rock blanket is to be used over a filter, the rock used should be essentially equidimensional, well-graded in size, with a maximum size equal to about one-tenth of the blanket thickness. The rock blanket should also meet the filter criteria of equation 1 so that the filter material does not migrate through the voids in the rock. The thickness of the rock layer should not be less than the spherical diameter of the upper limit of D_{100} rock or less than 1.5 times the spherical diameter of the upper limit of D_{50} rock, whichever is greater.

When a rock blanket is to be used on a sideslope and flow will be horizontal to the slope, scour at the toe will most likely occur. To prevent the scour, which could cause failure of the rock blanket, it is recommended that a shallow trench be excavated at the toe of the slope and that the trench be backfilled with the same rock blanket material. As a rule of thumb, the depth of the trench should be at least two times the thickness of the blanket and the width of the trench should be twice the depth.

2.3 Lobo Canyon Drainage Channels

More information is needed on the channels surrounding the Homestake site. Of particular concern is the channel which terminates at the berm north of the mill and is the master drainage of Lobo Canyon. A flood analysis for a PMP event should be performed for this and any other channels which may have potential impacts on the site.

2.4 Maximum Credible Earthquake

The stabilized embankment should be designed to withstand a Maximum Credible Earthquake (MCE). However, it is not necessary to determine factors of safety under seismic loading of the construction or immediate end of construction phases since the possibility of an earthquake, especially an MCE, occurring during the relatively short construction period is essentially zero.

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