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STATE OF UTAH
NATURAL RESOURCES
Oil, Gas & Mining

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August 17, 1983

Mr. Les Boothe
Reclamation Biologist
Kaiser Steel Corporation
Raton Coal Properties
Raton, New Mexico 87740

RE: Sunnyside Mine ACR Response
Sunnyside Mine
ACT/007/007, Folder #2
Carbon County, Utah

Dear Les,

As you know, several questions were raised in the Apparent Completeness Review of the Sunnyside Mine MRP concerning the adequacy and acceptability of Kaiser's vegetation sampling program and of the results presented. As a result of discussions with Kaiser and the consultant reviewing the MRP, the following strategy is suggested.

Kaiser should present a plan for evaluating revegetation success on reclaimed areas based on existing reference areas. The plan should include acceptable methodology to make that comparison. Enclosed is a detailed writeup for an acceptable method for the determination of revegetation success. This is one of several which could be accepted.

If such a plan is presented by Kaiser in their ACR response and found acceptable, much of the vegetation information previously submitted could be considered adequate to address UMC 783.19.

If you have any questions, please feel free to call.

Sincerely,

STEVE COX
RECLAMATION BIOLOGIST

SC/jvb

cc: Lou Hamm, OSM

Aug 8, 83

Dear Steve:

Included is a detailed write up for an acceptable method for the determination of revegetation success. Such methodology should be incorporated into an applicant's reclamation plan (or another method which accomplishes the same end) pursuant to 817.116. This procedure assumes three items:

- 1) That post-mining land use is wildlife habitat;
- 2) That reference areas are to be used and have been approved by the R.A. (The applicant should show evidence of this approval - e.g., letter from UDOGM - in the application);
- 3) That the applicant has developed a monitoring plan which will show evidence supporting the start of the 10-year responsibility period.

If you wish to relay this information to Les Booth of Kaiser, please keep me advised of any changes which you may deem necessary. This also, is only one of the acceptable methods available.

You might pass on that if such a methodology and commitment become a part of the reclamation plan for areas which Kaiser must reclaim, then the requirements of 783.19 are diminished (in my opinion). With this understanding I would be able to accept much of the current vegetation information.

Please keep me posted. Thank you.

Sincerely,

Steve R. Voss

P.S.

You might remind Les (and Kaiser) that 817.116 was reinstated by the OSM - in case they didn't know.

Suggested Procedure

To effect bond release on revegetated areas, the applicant will measure the required variables (herbaceous strata cover and shrub/tree density) once per year in each revegetated community and corresponding reference area, during each of the last two years of the 10-year responsibility period. Measurements will occur during the same month and with the same methodology. In addition to parameter measurement and testing, a discussion will be provided with regard to species composition of the revegetated area with respect to the corresponding reference area and/or the approved post-mining land use. This discussion may include use of a similarity index or other similar method of comparison.

For each revegetated area that has entered the final two years of the responsibility period, the required, parameters for testing are:

- Estimated mean (\bar{x}) cover and density for each post-mining revegetation type and corresponding reference area.
- Variance of the estimated mean (s^2) for cover and density for each post-mining revegetated type and corresponding reference area.

These parameters will be determined using consistent methodology especially between each revegetated type and its corresponding reference area.

Once sampling for these parameters has begun, it will continue on each revegetated type and corresponding reference area until

$$n_i > n_m$$

where n_i = the number of cover or density samples taken from the i^{th} revegetated type or corresponding reference area.

n_m = the minimum number of samples necessary to satisfy required statistical criteria and

$$n_m = (t_{\alpha}^2 s_i^2) / (\Delta \bar{x}_i)^2$$

where t = value from t table (two-tailed) for a given probability level (90% for herbaceous communities, 80% for shrub communities) with $n_i - 1$ degrees of freedom

α = desired probability level (80% or 90%)

s_i^2 = sample variance from the i^{th} revegetated type or corresponding reference area from the samples taken so far

Δ = percent change in the sample mean desired to be detected (10%) and entered into the equation as 0.1.

\bar{x}_i = sample mean from the i^{th} revegetated type or corresponding reference area from the samples taken so far.

Once sampling has satisfied the inequality above ($n_i \geq n_m$) for each variable (cover and density) for each revegetated type and corresponding reference area, testing for revegetation success or failure for that particular year may begin.

The standard testing between individual revegetated areas and corresponding reference areas is recommended and is performed as follows:

First, the status of the following inequality should be determined for both cover and density:

$$\bar{x}_{rv} - C \bar{x}_{rf} \geq 0$$

where: \bar{x}_{rv} = estimated mean cover or density taken from the i^{th} revegetated type

\bar{x}_{rf} = estimated mean taken from the corresponding reference area

C = allowable reduction from the reference area standard for cover ($C = 0.7$) or density ($C = 0.9$). NOTE: This coefficient represents the leniency allowed for a primary post-mining land use of wildlife habitat pursuant to UMC 817.116 (b.3.iv) and UMC 817.117 (c.3.i).

If this inequality fails for any given variable, then the following steps must be taken, otherwise the test has been passed.

In the event of the above failure, the comparison statistic (t'_{α}) is calculated for the failed variable, as follows:

$$t' = \frac{(s_{rf}^2/n_{rf}) t_{\alpha,rf} + (s_{rv}^2/n_{rv}) t_{\alpha,rv}}{(s_{rf}^2/n_{rf}) + (s_{rv}^2/n_{rv})}$$

where: s_{rf}^2 = sample variance for the reference area of the i^{th} revegetated type

n_{rf} = sample size for the reference area of the i^{th} revegetated type

$t_{\alpha,rf}$ = tabular "t" value (two-tailed) for $n_{rf} - 1$ degrees of freedom at the selected level of alpha (α) where $\alpha = 0.05$ for herbaceous cover and 0.10 for shrub density)

s_{rv}^2 = sample variance of the ith revegetated type

n_{rv} = sample size of the ith revegetated type

$t_{\alpha,rv}$ = tabular "t" value (two-tailed) for $n_{rv}-1$ degrees of freedom at the selected level of alpha (herbaceous cover $\alpha = 0.05$, for shrub density $\alpha = 0.10$)

This comparison statistic is then compared with the sample "t" statistic calculated from the data as follows:

$$t' = \frac{(\bar{x}_{rv} - C \bar{x}_{rf})}{\sqrt{(s_{rv}^2/n_{rv}) + (s_{rf}^2/n_{rf})}}$$

and if:

fill in the gaps \sqrt{x}

$$|t'_{\alpha}| \geq |t'|$$

then the test has been successful for the given variable, revegetated type, and year. If this inequality is false, then the test has failed and appropriate measures should be taken (i.e. waiting for the next season's data). When this inequality ($\bar{x}_{rv} - C \bar{x}_{rf} \geq 0$) or the inequality immediately above ($|t'_{\alpha}| \geq |t'|$) is true for the last two years of the responsibility period for both cover and density, then conditions for bond release have been met for the tested revegetated type.