

STATE OF
COLORADO

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Hayden Gulch SL3 Application

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To: "Ridley - DNR, Hunter" <hunter.ridley@state.co.us>

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Hunter,

In response to your second adequacy letter for SL3, HGT has complied the attached Sediment demonstration using RUSLE. After we discussed the SEDCAD option I decided that a RUSLE demonstration was easier to compare and understand. I did use the SEDCAD program to derive a few values as noted in the report but overall I think this demonstration gives a good representation of the topsoil piles. Please review and let me know if you have any questions.

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SL3 RUSLE Demonstration.pdf
410K

SL3 RUSLE Demonstration

Pursuant to Rule 4.15.10, HGLO has demonstrated the sediment contributions to the surface post-mining and reclamation activities by the use of RUSLE, Revised Universal Soil Loss Equation for the topsoil piles with in the SL3 associated areas. This bond release represents the areas that are to be released under the post mining land use of industrial/ commercial for the transition of the Tie-Across Haulroad to Routt County as a public county road.

The Revised Universal Soil Loss Equation is used to predict and compare the gross annual erosion per acre on the reclaimed and vegetated parcels and compare them to the undisturbed reference areas. For this demonstration HGLO is using the reference areas from the nearby Yoast Mine.

The RUSLE equation and variables are as follows:

$$A = R K L S C P$$

Where A = Gross erosion per acre per year

R = Erosivity of rainfall and runoff

K = Soil Erodibility

LS = Hillslope-length and gradient

C = Cover management

P = Support Practice

R Factor, Erosivity of Rainfall and Runoff

The R Factor quantifies the effect of raindrop impacts and reflects the amount and rate of runoff associated with annual precipitation. The value used for this factor was obtained from the EPA Rainfall Erosivity Factor Calculator. The calculator accounts for the mine location and disturbance dates to relate back to historic rainfall data. For this demonstration a R Factor of 15 was used.

K Factor, Soil Erodibility

The K Factor indicates the relative susceptibility of surface soil to water erosion. Values can vary from 0.0 to 0.70. The higher value indicates higher erosion susceptibility. For this demonstration K values from tables within SEDCAD4 program were utilized. A value of 0.32 was used based on the soil texture that was reported for the area from the USDA NRCS Web Soil Survey interactive site.

Soil Erodibility Factor K

Typical Topsoil K Values	
Texture	Estimated K Value
Clay, clay loam, loam, silty clay	0.32
Fine sandy loam, loamy very fine sand, sandy loam	0.24
Loamy fine sand, loamy sand	0.17
Sand	0.15
Silt loam, silty clay loam, very fine sandy loam	0.37

K Factor: 0.32

OK

LS Factor, Hillslope-Length and Gradient

The LS Factor is the slope length factor representing the effect of the slope length on erosion relative to the slope steepness. This value represents how erodible the particular slope length and steepness is relative to a 72.6 ft long and 9% steep slope unit plot. These values were unique to each topsoil pile and were determined using the USDA NRCS Table LS-2 – “LS” Values for Rangeland and Other Consolidation Soil Conditions (attached to the back of this report). Based on the topography of the topsoil piles, a slope gradient value of 20% was used for the topsoil piles and slope lengths varied by the size of the topsoil piles.

C Factor, Cover Management

The C Factor represents the effects of plants, soil cover, soil biomass, and soil distributing activities of erosion. The C factor accounts for all surface cover including non-plant material. From on the ground inspections, it was estimated that the ground cover on the topsoil piles is close to 80% and the canopy cover is around 60%. Using these estimates with tables from SEDCAD4 and value of 0.011 was obtained and used for this demonstration.

C Factors

C Factor Table: Permanent Pasture, Rangeland, Idle Land, etc. % Ground Cover: 80% ground cover

C Factors for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland									
Vegetal Canopy			Cover that Contacts the Surface						
Type and Height of Raised Canopy	Canopy Cover (%)	Type	0% Ground Cover	20% Ground Cover	40% Ground Cover	60% Ground Cover	80% Ground Cover	95-100% Ground Cover	
Canopy of tall weeds or short brush (0.5m fall ht)	25	Grass	0.360	0.170	0.090	0.038	0.012	0.003	
		Weeds	0.360	0.200	0.130	0.082	0.041	0.011	
	50	Grass	0.260	0.130	0.070	0.035	0.012	0.003	
		Weeds	0.260	0.160	0.110	0.075	0.039	0.011	
▶	75	Grass	0.170	0.100	0.060	0.031	0.011	0.003	
		Weeds	0.170	0.120	0.090	0.067	0.038	0.011	
Appreciable brush or bushes (2m fall ht)	25	Grass	0.400	0.180	0.090	0.040	0.013	0.003	

C Factor: 0.0110 OK

P Factor, Support Practice

The P factor reflects the impact of support practices on the annual average erosion rate. A conservative value of 1 indicates that there is no consideration for deposition whereas a value of 0 indicates that no sediment left the slope. In our scenario we know that sediment leave the slope but hope that our practices help reduce the sediment leaving so we assumed a value of 0.9.

HGLO RUSLE Calculations

SL3 HGLO Bond Release RUSLE Variables and Calculations

Topsoil Pile	Acres	R	K	Length of Segment	Slope Gradient	LS	C	P	A	% Area	Weighted
A	2.5	15	0.32	100	20	3.22	0.011	0.9	0.153	0.226	0.035
B	1.77	15	0.32	140	20	3.72	0.011	0.9	0.177	0.160	0.028
C	2.12	15	0.32	60	20	2.56	0.011	0.9	0.122	0.192	0.023
D	1.48	15	0.32	80	20	2.92	0.011	0.9	0.139	0.134	0.019
E	1.33	15	0.32	50	20	2.37	0.011	0.9	0.113	0.120	0.014
F	1.15	15	0.32	75	20	2.84	0.011	0.9	0.135	0.104	0.014
G	0.7	15	0.32	70	20	2.75	0.011	0.9	0.131	0.063	0.008

11.05

AVG
Tons/Acre/Year **0.141**

The Divisions RUSLE Calculations for Reference Areas

Area	A	R	K	LS	C	P	% Area	Weighted
Aspen	0.119627	30	0.24	16.61	0.001	1	0.244	0.029189
Steep Mnt. Brush	0.1433	30	0.2	3.98	0.006	1	0.24	0.034392
Mnt. Brush	0.602464	30	0.32	20.92	0.003	1	0.489	0.294605
Sagebrush	0.460269	30	0.37	41.51	0.003	1	0.027	0.012427
Tons/acre/year weighted								0.370613

The above table shows a RUSLE Demonstration performed on the reference areas around the Yoast Mine site by DRMS for the Yoast SL7. The Yoast Mine is nearby the TAHR and contributes to some of the same drainages as the TAHR. As Demonstrated by this comparison the topsoil piles show that they contribute less sediment than the nearby reference areas therefore the vegetated topsoil piles have met the obligations of rule 4.15.10

Table LS-2 - "LS" Values for Rangeland and Other Consolidated Soil Conditions

% Slope	Horizontal Slope Length (ft)														
	< 3	6	9	12	15	25	50	75	100	150	200	250	300	400	600
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.5	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
1.0	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16
2.0	0.20	0.20	0.20	0.20	0.20	0.21	0.23	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.33
3.0	0.26	0.26	0.26	0.26	0.26	0.29	0.33	0.36	0.38	0.40	0.43	0.44	0.46	0.48	0.52
4.0	0.33	0.33	0.33	0.33	0.33	0.36	0.43	0.46	0.50	0.54	0.58	0.61	0.63	0.67	0.74
5.0	0.38	0.38	0.38	0.38	0.38	0.44	0.52	0.57	0.62	0.68	0.73	0.78	0.81	0.87	0.97
6.0	0.44	0.44	0.44	0.44	0.44	0.50	0.61	0.68	0.74	0.83	0.90	0.95	1.00	1.08	1.21
8.0	0.54	0.54	0.54	0.54	0.54	0.64	0.79	0.90	0.99	1.12	1.23	1.32	1.40	1.53	1.74
10.0	0.60	0.63	0.65	0.66	0.68	0.81	1.03	1.19	1.31	1.51	1.67	1.80	1.92	2.13	2.45
12.0	0.61	0.70	0.75	0.80	0.83	1.01	1.31	1.52	1.69	1.97	2.20	2.39	2.56	2.85	3.32
14.0	0.63	0.76	0.85	0.92	0.98	1.20	1.58	1.85	2.08	2.44	2.73	2.99	3.21	3.60	4.23
16.0	0.65	0.82	0.94	1.04	1.12	1.38	1.85	2.18	2.46	2.91	3.28	3.60	3.88	4.37	5.17
20.0	0.68	0.93	1.11	1.26	1.39	1.74	2.37	2.84	3.22	3.85	4.38	4.83	5.24	5.95	7.13
25.0	0.73	1.05	1.30	1.51	1.70	2.17	3.00	3.63	4.16	5.03	5.76	6.39	6.96	7.97	9.65
30.0	0.77	1.16	1.48	1.75	2.00	2.57	3.60	4.40	5.06	6.18	7.11	7.94	8.68	9.99	12.19
40.0	0.85	1.36	1.79	2.17	2.53	3.30	4.73	5.84	6.78	8.37	9.71	10.91	11.99	13.92	17.19
50.0	0.92	1.52	2.06	2.54	3.00	3.95	5.74	7.14	8.33	10.37	12.11	13.65	15.06	17.59	21.88

This table displays the "LS" values for topographic factors for land with a low ratio of rill to interrill erosion such as for rangeland and other consolidated soil conditions with cover (applicable to thawing soil where both interrill and rill erosion are significant).