RECLAMATION CHALLENGES AT USIBELLI COAL MINE IN HEALY, ALASKA[1]

by

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Abstract. Reclamation in a subarctic environment requires a thorough understanding of the effect of subzero temperatures on soil, water and vegetation. Usibelli Coal Mine's Poker Flats mine is located in an area that contains zones of permafrost. The presence of permafrost requires study due to the fact that once it is disturbed it will eventually thaw. The type of material the permafrost is comprised of determines the options you have in stabilizing and maintaining vegetation on it. Once an analysis of soil conditions is conducted, a more detailed study is done to determine what type of water control measures need to be considered given the presence of frozen, ice-rich ground. The water control measures to be implemented are usually untested in the field. This leads to both pleasant and unpleasant results. The water control plan incorporates erosion control measures. Erosion control is one of the most challenging aspects of reclamation in the Healy area, as the Hoseanna (Lignite) Creek drainage has one of the highest rates of natural erosion in the world. One of the key components of maintaining a successful reclamation program in Alaska is to not have any preconceived idea of what is going to happen next. Each project that is designed and implemented usually involves procedures that have never been tried in this particular environment. Because there is little or no precedent for these types of projects, every day is an adventure.

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Introduction

Usibelli Coal Mine, Inc. has been a pioneer in Alaskan reclamation since the spring of 1971. It was then that Usibelli Coal Mine, under the direction of Joseph E. Usibelli, contracted with Canadian agronomist Stanley Weston of Vancouver, British Columbia to act as an advisor in its initial reclamation endeavors. These early experiments included the establishment of grass test plots on mined areas to assess optimum grass and fertilizer combinations. The results of this research led to reclamation of over 650 ha (1600 ac) of mined land in 1972 and 1973 and subsequent reclamation of over 1600 ha (4000 ac) through 1989. Much of the information obtained from this work was later utilized in reclamation projects on the Trans-Alaska Oil Pipeline. To exemplify Usibelli Coal Mine's commitment to reclamation, it should be noted that Usibelli Coal Mine initiated reclamation six years prior to the passage of the Surface Mining Control and Reclamation Act (PL 95-87) by Congress in 1977.

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Usibelli Coal Mine's reclamation activities today center around the mining of coal in the lower Hoseanna (Lignite) Creek Basin located 177 km (110 mi) southwest of Fairbanks and 6 km (4 mi) north of Healy, in an area known as Poker Flats. The Poker Flats site is situated at 149 degrees 57 minutes west latitude and 63 degrees 54 minutes north longitude in the low mountains at the north foot of the Alaska Range.

Poker Flats is located south of Hoseanna (Lignite) Creek with predominantly north-facing slopes underlain by zones of discontinuous permafrost and has numerous natural landslides. Premining slopes range from 1 to 60 degrees in grade. Many of the steeper slopes are the result of erosion of sandstone into the natural "badlands" land form. Elevations at Poker Flats range from 366 m (1200 ft) to 610 m (2000 ft).

Mining at Poker Flats commenced in 1978 utilizing a 25m^3 (33 cy) walking dragline that strips two coal seams using an extended bench on the second pass. Coal production at Usibelli Coal Mine is currently 1.3 Mt/a (1.5 million stpy). Half of the coal produced is used in Alaska by small powerplants located in Healy, Clear and Fairbanks. The remainder is exported to South Korea through the Seward Coal Terminal for use at the 560-megawatt Honam power plant.

The effect of the subarctic climate in association with the physical and chemical properties of the geologic strata involved in mining has a profound effect on reclamation planning and subsequent revegetation. The purpose of this paper is to share some of the reclamation challenges that have arisen at the Usibelli Coal Mine Poker Flats operation.

Climate

Poker Flats climate is classified as Transitional as defined by Searby (1960) and subarctic if forest types are used to differentiate climatic zones. Transitional climates are characterized by significant diurnal and annual temperature variations, low precipitation, low cloudiness, and low humidity. Mean annual temperatures range from -3.9° to 1.7°C (25° to 35°F). Subarctic lands are distinguished by moderate and sparse forests and have from one to four months with monthly mean temperatures greater than 10° C (50°F) and at least one month with a mean temperature of 0°C (32°F) or colder.

Table 1 shows that the mean annual temperature for Poker Flats is 2.6°C (27.4°F). The lowest and highest mean monthly temperatures February, -15.7°C (3.7°F) and July, 12.8°C (55.0°F). With 7 out of 12 months below 0°C (32°F), climatic conditions are favorable for finding permafrost, especially on north-facing slopes and areas with moss vegetative cover.

Table 1. The Monthly Mean Temperatures (1979-1988) in °C

Month	Temperature
January	-14.0
February	-15.7
March	- 8.4
April	- 3.3
May	5.6
June	10.7
July	12.8
August	9.8
September	4.3
October	- 5.3
November	-13.2
December	-14.3
Mean Annual	- 2.6

Precipitation ranges from 38 cm (15 in) to 51 cm (20 in) annually. Most of the moisture is received in the form of rain during May to September. High intensity rainfalls are not uncommon. During one storm on June 18, 1988, Poker Flats received 3.3 cm (1.28 in) in 45 minutes. Snowfall quantities range from 76 cm (30 in) to 152 cm (60 in) per year. Most of this snow never has the opportunity to be utilized by plants. The Healy vicinity is famous for its Chinook winds. These winds are associated with low pressure systems and generally bring temperatures that are above freezing. Wind gusts of 22 m/s (50 mph) to 36 m/s (80 mph) are not uncommon. The above freezing temperatures combined with high winds sublimate the snow, resulting in very little water absorbing into the soil.

Geology

The Poker Flats mining area is located in the lower Hoseanna (Lignite) Creek Basin which makes up a portion of the Nenana Coal Field. The coal-bearing group at Poker Flats is of Tertiary age and is overlain by the Nenana Gravels. Over most of the mine area the Nenana Gravels have been eroded away and replaced by Quaternary outwash gravels. The coal-bearing group is divided into five formations: Healy Creek, Sanctuary, Suntrana, Lignite, and Grubstake (Wahrhaftig et al. 1969). The Healy Creek formation is the oldest unit and is of early Miocene age and the Grubstake is the youngest. Mining at Poker Flats takes place in the Suntrana formation. It contains six coal seams (designated 1-6, with the oldest (lowest) seam being assigned the number 1. Coal seams 6, 4, and 3 are currently being mined. Seam thicknesses average 6.4 m (21 ft) for seams 6 and 4, and 5.2 m (17 ft) for seam 3. On an as received basis, the coal from these three seams has an average heating value of 7800-8000 Btu/lb, 6-8% ash, 25-27% moisture and 0.1 to 0.3% sulfur.

Overburden and partings are typically coarse, pebbly sandstone, grading to fine sandstone and ending with a clay and silt bed. The sandstones are poorly consolidated and composed primarily of quartz, feldspar, and lithics (mostly mica, schist, and plutonic rock fragments).

The limits of mining at Poker Flats are defined by outcrops to the north, and to the south by a fault believed to have several thousand feet of vertical displacement.

Reclamation

Reclamation at Poker Flats can be divided into three phases. They are regrading, drainage control, and revegetation. All three are related and each one is influenced by the presence of permafrost.

Regrading plans were developed for Poker Flats to approximate the premining contours. Recontouring involves the grading of dragline spoils by a bulldozer. Initial reclamation efforts at Poker Flats began on the north-facing slope along the outcrops of 3 and 4 seams. The spoil material in this area is largely composed of ice-rich silt and sandstone. The physical properties of this material restrict the use of bulldozers to the months of December to April. During this time period, surface frost reaches up to 5 m (16 ft) in depth, making it necessary to rip the material in addition to pushing it. Usibelli Coal Mine estimates that this

reduces production efficiency by one-third. Slopes are graded to a maximum slope of 18°(33%).

Upon completion of regrading, the next step is to prepare the planting medium for seeding and to install drainage control in order to minimize erosion. The planting medium utilized for the Poker Flats mine is the Suntrana sandstone. It was selected in lieu of the permafrost soils that predominate the mining area. The physical and chemical properties of the permafrost soils were analyzed, and they were immediately eliminated due to the fact that their thawed angle of repose ranged from 5 to 10 degrees. The best substitute material was determined to be the sandstone overburden and interburden. Table 2 summarized its chemical and physical properties.

Table 2. Suntrana Sandstone Chemical and Physical Properties

Parameter	Average Value (18 Samples)
pH	6.5
Ca	3.18 meq/l
Mg	1.70 meq/l
Na	2.77 meq/l
$N\text{-}NO_3$	1.28 ppm
PO_4	1.17 ppm
K	46 ppm
Organic matter	1.16%
Saturation	29%
Texture	Sandy loam - sand 65%, silt 27%, clay 8%
CEC	7.4 meq/100 g

The sandstone minesoil is prepared for seeding by installing contour furrows. This is accomplished by attaching a modified plow to the ripper teeth of a Caterpillar D-8 dozer and operating on the contour. The benefits of the furrows are as follows:

1. Reduces the velocity of surface water runoff.
2. Conserves moisture by trapping snow.
3. Serves as seed trap during broadcast seeding.
4. Assures a well-prepared seedbed that is not compacted.

In conjunction with the installation of contour furrows, Usibelli Coal Mine constructs a system of terraces and drains designed by Golder Associates (1987). These structures are designed to convey a 10-year, 24-hour rainfall event of 5 cm (2.0 in).

The terraces are spaced vertically every 15 m (50 ft) to 30 m (100 ft) depending on slope steepness. Terraces are designed to be 6 m (20 ft) wide and have a gradient of 2% and a backslope of 10%. Because of the erosive nature of the sandstone and the presence of ice-rich materials, the terraces are lined with a layer of gravel approximately 0.23 m (0.75 ft) in thickness.

The terraces slow into drains that are 6 m (20 ft) in width and trapezoidal in cross-section. The channel lining for the drains consists of rip-rap with a median size of 0.46 m (1.5 ft). Flow from the drains is conveyed to sediment ponds.

It is esimated using the universal soil loss equation that the effect of the furrows and terraces is a reduction in erosion by 700%.

The final step in the reclamation process is the reestablishment of a vegetative cover. The function of this cover is to initially

control erosion and over time, allow the natural reinvasion of native species. The seed mix utilized by Usibelli Coal Mine is illustrated in Table 3.

Table 3. Poker Flats Seed Mix

Common Name	Kg/ ha	Lbs/ Acre
Manchar smooth brome	13.5	12
Scaldis hard fescue	9.0	8
Arctared or boreal red fescue	9.0	8
Nuggest bluegrass	9.0	8
Meadow foxtail	3.4	3
Anik or rhizoma alfalfa	9.0	8
Reed canary grass	2.2	2
Candle rape	2.2	2
Annual ryegrass	4.5	4
Total	61.8	55

Grass species have been chosen because of their ability to withstand the low temperatures, to establish quickly and to adapt to areas with high moisture content such as thawed permafrost materials. To assist in the establishment of the grass seedlings, fertilizer with an analysis of 20-20-10 (N-P-K) is added at a rate of 450 kg/ha (400 lbs/ac).

Seeding is conducted during the time period of May 15 - June 15. During this time of year it is not practical to operate equipment on areas that are composed of thawed permafrost soils. The method used to apply the seed and fertilizer is to broadcast the material using a fixed-wing aircraft. The advantages of aerial application are:

1. There is no damage to the regraded area due to equipment.
2. Steep grades are not a limiting factor.
3. It is cost effective.

After seeding, native shrubs and trees are collected and planted. Species planted include felt leaf willow, balsam poplar, alder and spruce. Sites for planting are chosen based on the moisture requirements of individual species. In soils with high moisture such as thawed permafrost zones, felt leaf willow and balsam poplar are planted. In areas that are drier, alder and spruce are preferred. These plants form the foundation for our postmining land use as wildlife habitat.

Summary and Conclusions

The ultimate test of the reclaimed land is whether it is going to be of benefit to wildlife. The results of over 18 years of reclamation effort by Usibelli Coal Mine, Inc. are encouraging. It is heartening to see wildlife returning to previously mined areas. The challenges of reclaiming land in this subarctic environment are being met. It is important that we understand the climatic and geologic features of the Hoseanna (Lignite) Creek Basin so that more rational environmental regulations are developed to suit this unique area. For Alaska's only producing coal mine to stay competitive, it is vital that we continue to improve reclamation techniques so that both a more effective and a more cost-efficient reclamation program is achieved.

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