Proceedings of the 1st Annual British Columbia Mine Reclamation Symposium in Vernon, BC, 1977.
The Technical and Research Committee on Reclamation

RECLAMATION PROBLEMS AT HIGH ELEVATIONS

KAISER RESOURCES LTD Sparwood B.C.

A.W. Milligan

R.J. Berdusco

February 1, 1977

RECLAMATION PROBLEMS AT HIGH ELEVATIONS

ABSTRACT

Kaiser Resources Limited operates a 4 million ton per year surface coal mine in the southeastern corner of British Columbia.

Since 1969, Kaiser's Environmental Services Department has been responsible for the rehabilitation of some 1400 acres of land disturbed by mining and exploration from valley bottom elevations of 3300 feet to steep mountain terrain at 6900 feet elevation.

Some of the reclamation problems encountered, especially at elevations above 5000 feet, are very steep slopes, dark, highly erodible spoils and the availability of suitable revegetation species.

The use of modified agricultural and forestry techniques has provided an encouraging degree of success in both establishment and maintenance of initial ground cover.

TABLE OF CONTENTS

Location and History

In 1968 Kaiser Resources Ltd. announced its intention to develop extensive coal deposits in the southeast corner of British Columbia. The public reaction to this announcement, because of the fear of wilderness destruction, was responsible for the formulation of provincial regulations controlling reclamation, specifically Section 8 of the Coal Mines Regulation Act and Section 11 of the Mines Regulation Act. Initially this applied, in the case of coal, only to open pit disturbances, but *was* later amended to include disturbances by exploration and underground nines.

At the present time firm regulations have not bean established as to what constitutes an acceptable level of reclamation. This is due to the wide range of climate and topography within the province which create situations that are not easily defined within one set of regulations. Thus each operator has to determine and develop on a site specific basis the reclamation programme which will provide the most successful results.

The property owned by Kaiser Resources Ltd. consists of two separate areas, the larger being in the Crows Nest Coal Field and the second part of the Elk River Coal Field. The Crows Nest Field covers some thirty (30) miles in length and about twelve (12) miles in width near the centre of the basin. This field contains about twelve (12) mineable seams that outcrop within a 2,500 foot stratigraphic sequence primarily along the western slopes of the Rocky Mountains. The second field, a portion of the Elk River Coal Field, is approximately eight (8) miles in length and four (4) miles in width, it contains approximately seven (7) mineable seams that outcrop within 1,500 foot sequence of coal bearing measures. The coal measures in both fields range in thickness from five (5) to fifty (50) feet and vary in elevation from 3,500 feet to 7,000 feet in the Crows Nest Field and from 4,500 feet to 7,000 feet within the Elk River Coal Field.

The overburden on both coalfields is composed mainly of sandstone and carbonaceous shale with some conglomerate and calcareous shales. The pH of this material ranges from 4.2 to 7.8. The coal itself is a low volatile bituminous type with a sulphur content of 0.3 to 0.4 per cent.

The reclamation department was established in 1969 and became fully operational in the spring of 1970. The development of the programme has continued since that time and to date 1,420 acres of disturbed land have been vegetated. Initially the direction of the reclamation programme was based on the Canada Land Inventory, Land Capability Analysis, however practical experience has shown that the best approach to reclamation is to start a natural succession at the primary level of grasses and shrubs rather than attempt to replace, for example a high yield forest with similar material. The agronomic grasses used provide not only initial ground cover but provide a high quality forage to replace the feeding areas alienated by the ongoing mine operations.

When Kaiser Resources Ltd. acquired the property it was fortunate, from a reclamation viewpoint, that several dormant mine sites were also acquired. These areas were available for immediate reclamation and it was on these sites that techniques and species were developed and selected. These sites have proved more informative over the years than would have *a.* series of smaller test plots. All the problems of slope, aspect, and diverse spoil materials can be evaluated on one site. It was possible to study on these areas the use by wildlife. This last being an important factor in an area where major wildlife habitat is being disturbed.

Mining and Exploration Methods

Mining

Presently, approximately 80 per cent of Kaiser's coal production is derived from surface mining and 20 per cent from underground methods, predominantly hydraulic. Although there is some surface disturbance which requires reclamation associated with underground mining, the majority of land disturbance is attributed to surface mining and exploration. These areas will be the basis of discussion in this report.

Kaiser's present approach to surface mining is a shovel and truck method. First the overburden is drilled and blasted and then it is excavated by large shovels, loaded into 200 ton trucks and hauled to dump sites. At the dump, the spoil material is disposed of in benches or terraces, each terrace wrapping around the slope below the preceding one. Where feasible, spoil is backfilled into dormant areas or natural depressions.

As the overburden is removed in roughly 60 foot benches, the coal is exposed. This is then ripped and pushed up for front end loaders which load 100 ton trucks that haul coal from the pits to be processed.

Exploration

Until 1974, Kaiser's coal exploration techniques closely resembled those used by most mining concerns. The general approach was extensive access road construction followed by seam tracing, trenching and test pit and adit sampling. This approach is no longer used at Kaiser.

Since 1974, the exploration approach has changed to one of access construction followed by drilling and more intensive geological mapping. Seam tracing and trenching techniques are no longer used. Adits are still driven but these are carefully located to avoid sedimentation of watercourses. Also adit waste, previously dumped at the most convenient place, is now salvaged for sale or is dumped into natural depressions and resloped to allow revegetation. All access roads and secondary drillsite roads are plotted on sensitivity maps and altered to minimize environmental damage. They are then flagged and inspected prior to construction. All roads that encounter merchantable timber are prelogged before final road building thus salvaging the timber resource and eliminating the fire hazards of roadside slash.

Description of the High Elevation Ecotype

The main mining and exploration areas fall within a biogeoclimatic zone described by Krajina (1965) as the Engelmann spruce-Alpine fir zone at elevations from 4,500 to 7,000 feet. Treeless areas above 6,500 feet are designated as Alpine zone.

For the purpose of discussion, the term "high elevation" in this report will refer to the 5,500 to 7,000 foot range of the Engelmann spruce-Alpine fir zone. This zone is characterized by an overstory of Engelmann spruce, Alpine fir, Lodgepole pine, Alpine larch, and Whitebark pine forests on west to southeast aspects and, usually, grass-shrub communities on south and southeast aspects.

Typically, the slopes of this zone are very steep and the terrain rugged. The "in situ" soils can be described as regosolic, acid brown and brown wooded and usually form a shallow mantle over bedrock or glacial till of varying depths. Typically the pH range is from 5.2 to 7.0. The climate is continental cold, humid (Koppen), characterized by long, cold winters and short, cool, dry summers.

Description of Reclamation Problems

The biogeoclimatic zone described is plagued with a host of reclamation problems. These include the three main areas of: soil, slope and aspect, and species.

Soil Problems

After industrial disturbance, soils in this zone undergo dramatic change in chemical status, color, and structure, all of which frustrate revegetation efforts.

Chemical change is a general raising of pH to the 6.5 to 8.5 range accompanied by a lower nutrient level, especially in available nitrogen. These changes of course bring the pH range beyond the desirable range for tree species and some other native plants.

One other change caused by disturbance is a color change. The incorporation of dark marine shales and coal into the disturbed soil tends to make it much darker than the native soils. This trait decreases the albedo and hence increases heat absorption causing moistures levels, in a soil that already lacks moisture, to decrease. In an environment where available moisture in the growing season is so critical, color change can be a significant factor limiting revegetation of desirable species.

Finally, and certainly not the least important change in soil following disturbance in the Engeltnann spruce-Alpine fir zone is structure. In general terms, large disturbed sites such as overburden dumps or roads are characterized by a reduction in both organic matter and fine particles, mainly due to burying. This reduces moisture retention and decreases cation exchange capacity of the growing medium. However, there are some advantages to an exposed soil that is coarse. This soil is well drained and its potential for erosion is significantly lower than an exposed soil with high fines content. It is also important to note that gravitational sorting takes place in dump construction, with larger particles forming a crude filter at the toe of the dump. The friable nature of the exposed shales also allows soil building to proceed at an accelerated rate, especially when revegetation occurs concurrently.

Slope and Aspect Problems

Most disturbed areas usually end up, in general terms, somewhat steeper than "in situ" soils. These steep slopes present problems for regeneration because of surface creep, erosion, and other related items. Dumping procedures and other practices which disturb large areas of land in mountainous terrain generally tend to make slopes more uniform, that is with fewer microsites and less variation in aspect. Also, drainage patterns tend to be diminished by filling of gulleys and low areas. The significance of these phenomena is that is makes revegetation more difficult especially if the final aspects left after disturbance are south or southwest facing. Mainly because of temperature and related moisture stress, these aspects have been found to be more difficult to reclaim.

Species

The new and markedly different edaphic and induced climatic conditions of the dump slopes have resulted in a new environment for life. Unfortunately, some of the new conditions no longer suit the requirements of some of the previous users. For example, because of the increased pH and lowered organic matter content, most native tree species do not fare well. Paper birch and Black cottonwood are two notable exceptions. As far as native shrubs are concerned, this is an area where great voids exist in the information available on requirement for growth and for seed stratification and propagation methods. Much research and experimentation is required in this area.

The importance of using native grasses and legumes has been emphasized and debated by many authors in range and reclamation research. Although Kaiser has and continues to use agronomic species of both grasses and legumes, recognition is given to the theory that this approach may not be the most suitable in the long run. Presently, both native grasses and legumes collected over the past two years are being tested for viability in germination and growth tests. The use of native species will receive greater emphasis in reclamation work in the years to come, especially at higher elevations.

Reclamation Methods

The most important phase of any reclamation programme must be site preparation. The primary objective of this is to re-establish watershed values on the disturbed sites and at the same time provide favourable conditions for the establishment of vegetation. At Kaiser Resources Ltd. the final disposition of spoil for reclamation is included in the overall mine plan. Because of the natural topography most spoil material is formed into large dumps with long steep slopes. Where this material is mainly fine spoil, a continual creep of this fine surface material prevents vegetation from becoming established. Experiments in the early days of the programme indicated that the maximum angle for successful revegetation on fine material is 28 degrees. In Kaiser's programme, 26 degrees was the slope angle aimed at since it not only resulted in better seedling establishment but facilitated the subsequent operations of seeding, harrowing, and fertilizing. The angle of 26 degrees was aimed at in the smaller inherited pits where the plan was to contour the spoil dumps into the configuration of the surrounding landscape. On the dumps formed by the operating mine this procedure is not feasible due to to their slope lengths and massive size. An operating practice of forming dump terraces in a wrap around fashion as the mine is lowered, greatly facilitates the reclamation plans for this site. The incorporation of these dump roads as terraces when resloping will reduce surface erosion and retain moisture for establishing vegetation. The first areas were resloped using 26 degrees as a maximum slope angle. However, as the work progressed, it was felt that this particular spoil material could be left at a steeper angle. This proposal was based on the fact that the material under the dump was solid, the spoil material itself was coarse and relatively free of fines. It was felt that the underlying and dump material would be stable and the coarse surface material would prevent surface creep, thus the slope angle could be left at 30 degrees.

After a year there was no sign of erosion and vegetation had established successfully. Obviously the steeper angle has to be a factor of the spoil material, but where possible this represents a considerable cost saving in leaving spoil in place.

After resloping the spoil, the standard approach is the sowing of seed and fertilizer by hand using cyclone seeders. This is then harrowed under the surface using very heavy duty harrows which are drawn across the slope. This procedure serves a dual purpose, primarily covering the seed, and secondly the harrows and dozer crossing the slope create a series of small terraces which aid in erosion control and contain surface water for use by vegetation.

The grass species used are all agronomic and the mixture of grasses is the result of test plot and annual vegetation assessments of reclaimed sites over the life of the programme. The aim is to cover the spoil with vegetation as soon as possible to reduce erosion, provide organic material and to provide grazing for wildlife. Ideally, through succession, native species will invade these seeded areas.

Questions have been raised as to their suitability over the long term. To date studies carried out on earlier reclaimed sites at lower elevations up to 5,500 feet indicate that once established agronomic species continue to reproduce and in fact ground cover and plant biomass have been on the increase. At the higher elevations it may be necessary to introduce native grasses to provide a suitable vegetation on a continuing basis. It may also be necessary to include native seeds with the initial seeding.

One optimistic note is that a test plot established in 1971 on Harmer at an elevation of 6,900 feet has shown an increase in certain species over the life of the plot.

On dark spoil the seeds require covering to protect them during germination and the methods that have proved most successful are harrowing or providing a wood fibre mulch using a hydroseeder. This approach stresses the value of an initial cover of grasses. It is felt that once this cover has been achieved then native shrubs and trees which have been grown from seed or cuttings in the greenhouse and nurseries can be planted on site. These seedlings can be held in the nurseries until they are of a suitable size to be field planted. To date approximately 350,000 trees have been planted on reclaimed sites.

The application of fertilizer to established vegetation has been on an annual basis. No definite time limit has been established as to the number of years this may be necessary until the vegetation becomes self-sustaining. Too little is known about the use of added nutrients. A better understanding of the nutrient cycle of these plant communities will allow for a more efficient use of fertilizer. To this end a study was initiated to follow the flow of nutrients through the soil, plant, and detritus compartments of the nutrient cycle. Also being studied are nutrient cycles of adjacent native grasslands to compare the 'stable' communities with the introduced communities.

Exploration

Since 1974, Kaiser Resources Ltd. has employed exploration techniques that differ greatly from the extensive land and water disturbing practices previously used. Once techniques such as seam tracing and trenching were used almost exclusively to provide geological information. The revised technique used at Kaiser eliminates the need for this and with the use of drillhole information and geological mapping, as well as planned access roads and adits, more geological information can be obtained with less unnecessary disturbance. Prior to any exploration disturbance taking place, all exploration proposals are plotted on sensitivity maps and aerial photographs. This enables Environmental Services personnel to evaluate the effects of the proposed work and to request alteration or elimination of undesirable proposals. In the field, all roads, drillsites, and adit sites are flagged and inspected prior to construction. This enables site specific changes to be made to avoid sensitive areas that did not show up on the sensitivity maps or aerial photographs. Once construction has been approved, experienced operators, most of whom have attended a Kaiser sponsored course on Environmental awareness and protective techniques in Exploration, carry out the work. Whenever merchantable timber is encountered, pre-logging of the road right-of-way is carried out. Merchantable timber is decked and later sold to local mills. This technique avoids costly and dangerous slash abatement at a later date and provides a monetary return as well as the utilization of a natural resource.

Apart from pre-logging, supervision and monitoring of proposed and on-going exploration, reclamation of past exploration work is carried out by Kaiser's Environmental Services Department. Some of the work done includes slash abatement using powersaws and a woodchipping machine, ripping and seeding of dormant roads, backfilling of trenches, seam traces, test pits and adits, and re-establishment of watercourses.

Conclusions

High elevation reclamation in the Engelmann spruce-Alpine fir zone appears to be successful by presently used techniques of resloping, seeding, planting, harrowing, and fertilizing. Although the general approach to re-sloping is to aim at a maximum of 26 degrees, recent small scale attempts at 30 degrees have resulted in favourable revegetation levels.

Native trees and shrubs have been used successfully on reclamation projects. However, some sites are not suitable for these plants because of changed soil conditions. On such sites, agronomic species of grass and legumes are the only species used. The use of native species of grass and legumes is being investigated at Kaiser. Present research on the subject in general indicates that it may be necessary to use native species more extensively at high elevations either in initial seeding or in supplementary seedings. This is expected to ensure longevity of desirable species.

The techniques presently being used in the exploration-reclamation section, that is pre-planning of disturbances on sensitivity maps, monitoring and supervision of exploration work, resloping, terracing, ripping and seeding, and watercourse restoration are resulting in a more orderly and less damaging exploration program. Recent innovations widely used include the use of a woodchipping machine for slash abatement, pre-logging of exploration roads, terracing, and salvage of adit waste.

Most fundamental to the Reclamation program in general is pre-planning. The experience at Kaiser indicates that the most effective and productive approach to reclamation is with research programmes complementing the ongoing field programmes, not substituting for them.