



## **Techniques used for Reclamation of Mined Lands in England**

Karen Javurek

### **Introduction**

Reclaiming mined lands in England represents complex socio-cultural, economic, and, ecological challenges (Clove, 1996). The ecological challenges to ecological reclamation are the focus of this paper. In the following, I discuss the history and effects of mining in England and techniques used in reclaiming mine lands using forest regeneration.

### **History**

The history of mining in England is long and varied. Coal is mined in the forest of Dean, precious metals are mined in west Wales, and deposits are worked in Devon, Dorset, and Cornwall (ECCI web site). The areas of Devon, Cornwall, and Dorset are where the most intensive mining and therefore degradation is taking place. Mining in these areas began during the 1770's with the highest production occurring at the beginning of this century (ECCI web site).

The wealth and power resulting from activities during war and post-war times depended heavily on the exploitation of natural resources (Linehan, 1976). Due to the desire for increased profits and pressure from the international markets, the mining industry explored cheaper and faster methods for mineral extraction (Clove, 1996). Deep surface mining was slowly phased out, and by the early 1990's was completely taken out of production. Surface mining became the ideal method for exploitation (Linehan, 1976).

There are many severe side effects from mining. At mining sites near Devon, Dorset, and Cornwall, for example, every one ton of china clay extracted produces seven to eight tons of waste (ECCI website). Large piles of mixed soil and larger debris were not leveled off as is now required, leaving the landscapes in mining areas forever changed. In addition, their huge pits were created that were sometimes used for holding water that is needed for the mining processes. Because of these and many other mining practices, severe soil erosion, nutrient loss, sedimentation, and water contamination (depending on the site), are characteristic environmental impacts at mine sites.

In recent times, the government has placed an increased importance on funding for various programs supporting restoration and reclamation projects of many pieces of previously mined lands. For example, it is supporting a program through the Countryside Commission that is restoring all types of lands (including mining) into Community Forests that spread throughout England (Countryside web site). The emphasis of these projects is sustainability and education. This is a positive focus; however, the ecological reclamation must remain a priority as well.

## **Techniques for Mining Reclamation: A Case Study**

It is common for project organizers to conduct a site survey, outlining the goals and expectations (Kerr, 1996). Characteristics such as previous mining practices, the length of time since its' abandonment, and an inventory of tree species surrounding the site may be included in determining reclamation techniques (Hodge, 1996). Many techniques used for reclaiming mines in England are borrowed from common silvicultural practices used in forest management. The most commonly used techniques include site preparation, soil remediation, monitoring, and maintenance.

A case study took place in 1994 at a site near Desford Lakes within the English National Forest in central England (Kerr, 1996). The English National Forest consists of 194 square miles of newly planted trees on many different types of land, including the derelict mine lands of Desford Lakes (Kerr, 1996). Desford was historically a deep shaft mining site started in 1900. It continued through the 1970's when it was realized that the resource was nearly depleted; the mine closed in 1984 (Kerr, 1996). Part of the spoil was 'coal washed', a process that increases the rate of recovery but results in little spoil structure (Kerr, 1996). At Desford Lakes, the following techniques were implemented.

### Site Preparation

At most sites, the soils are severely compacted and displaced because they were mixed up, and moved into huge piles during mining activities (Jobling, 1980). Compaction slows percolation of rainfall, increases runoff, and makes establishment of seedlings difficult. It is well accepted that without some form of tilling, vegetation is difficult to accomplish (Jobling, 1980). Reclamation must include attempts to rebuild the soil with earth moving machines, such as cultivators, soil rippers, and box scrapers (Jobling, 1980). Heavy graders are then used to flatten soil surfaces for various reasons including the creation of a more aesthetically appealing landscape and restoring the historical landscape of the area. Soil ripping was used to mix the colliery spoil and soil in order to restore soil stability. A three-winged tine ripper was used that reached a depth of 50 cm and placed 115 cm between rows. Ripping was also implemented along the contours at steeper slopes (Kerr, 1996).

### Soil Remediation

Another requirement of reclamation projects is re-establishing the balance of nutrients within the soils. Most recent abandoned mining sites are neutral (pH= 7.0) or alkaline (pH= >7.0) (Jobling, 1980). When iron pyrite particles react with air and water, soils become acidic. This is a common concern for reclamation workers. Liming and adding organic materials can equalize the pH of the soils. Through soil analysis, the project in Desford Lakes determined that the minimum amount of limestone they had to add to the area was 12 tons per hectare (Kerr, 1996). The limestone was applied after the ripping, which incorporated it into the soil to encourage healthy establishment of seedlings. Other liming applications can reach up to 100 tons per hectare in very extreme areas (Jobling, 1980). Chemical herbicides can also be used to add nutrients to soils to balance the nitrogen phosphorus ratio. Timing is important for all of these methods to prevent run off and allow applications to penetrate the soil. Finding a realistic balance for soil nutrition

depends partly upon the plants to be used. Different species can thrive on different soil types. Integrating these can make for a more successful reclamation.

### Plant Establishment

Relieving soil compaction and planning for proper soil acidity are important precursors to plant establishment on mined soils (Jobling, 1980). Important factors for establishment of plants include proper spacing, stock quality, and species type. Natural colonization or hydro seeding are also options for seeding. Many sites owned by local authorities are immediately sown with grasses to give the site an attractive look in the shortest possible time and to stabilize the soil in order to prevent further erosion (Jobling, 1980). Introducing grasses can create competition for tree species and in response, clover and other legumes may be planted, which lessen the degree of competition. Poor planting techniques and stock quality account for a large portion of the death and slow growth among seedlings (Jobling, 1980). Many features can be considered when planning layout of reclamation, such as soil quality, topography, and ethics. The seedlings at the Desford Lakes site were densely planted at 4500 stems per hectare (approximately 1.5 X 1.5m spacing) (Kerr, 1996). A portion of the planting was planned in plots of native species and non-native species. The survival rate (for the first year) was higher for the native species (Kerr, 1996). The prevailing species at this site were as follows: Native: *Euonymus europaeus* (spindle), *Crataegus monogyna* (hawthorn), *Quercus robur* (english oak), *Acer saccharinum* (silver maple), and *Fraxinus excelsior* (ash).

Non-native: *Cupressocyparis leylandii* ('Leighton Green', Leyland cypress), *Fraxinus pennsylvanica* (green ash), *Populus alba* (white polar), *Pinus nigra var. martima* (Corsican pine), and *Catalpa speciosa* (western catalpa) (Kerr, 1996). The species used in this study are representative of most reclamations in England.

### Monitoring/ Maintenance

The Desford Lakes restoration project recognizes the importance of monitoring programs. Project organizers have created educational programs and are actively monitoring the site (Kerr, 1996). The monitoring process is the only method for assessing success or failure; it is the learning process by which future restoration efforts can benefit.

The Desford Lakes site experienced a drought in the summer of 1995, losing 30% of the planting which they replanted the following year. Although the basic plant establishment guidelines used were acceptable, the condition of the site before planting may have exacerbated the effects of the drought. The plant loss has lead to future recommendations. The ideal sequence of events would have been: to apply limestone directly into the surface of the colliery spoil, rip to 50 cm to mix in the limestone and relieve the compaction, and apply herbicides or plant a cover crop which was less moisture demanding.

### **Conclusions**

As shown above, the reclamation efforts in England offer many challenges. Analyzing ecological techniques used for reclamations of mined lands provides the opportunity to learn from the

process. Careful planning and prioritizing are vital to the process. The techniques presented in this paper for reclamations share many principles with silviculture, but must be adapted for previously mined sites, the specific ecosystem of the site, and individual project objectives. More emphasis could be placed on implementing restrictions to prevent further waste. Creating policies and techniques for decreasing the waste are essential. Although a mixture of non-native and native species is typically used for reclamation, there should be research into the use of native species tolerant of mine spoil conditions.

An history of exploitation of natural resources is present in England. In reaction, practices and techniques have been developed that make up the extensive programs underway to reclaim lands that have been altered as a result of mining. There are needed improvements and alternative techniques, but the techniques outlined in this report are improving the negative ecological effects of mining.

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