ABOVE THE COAL MINES:
THE EVOLUTION OF MINE RECLAMATION IN THE UNITED STATES

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ABSTRACT

Prior to 1977, there was no federal law in the United States that regulated the surface mining aspect of the coal industry. Individual states were responsible for their own regulations and laws. After World War II, most states enacted more stringent post-mining reclamation requirements. By 1965, mine operators were expected to act on their own to restore the land that they mined. The Surface Mining Control and Reclamation Act of 1977 (SMACRA) established permitting guidelines for existing as well as future mining activities. The purpose of SMCRA is to ensure that coal mining is conducted in an environmentally-responsible manner and that the land is progressively reclaimed during the mining process. In the late 1970s and early 1980s, coal-mining states developed their own programs consistent with SMCRA and were given the primary responsibility to regulate surface coal mining on lands with the federal Office of Surface Mining providing jurisdiction. This paper presents a photographic history of coal mine reclamation as it was practiced from the 1940s to the present day and suggests that through observation of past mine reclamation practices we can develop strategies for future land rehabilitation.

KEY WORDS

Approximate Original Contour (AOC); Abandoned Mined Land (AML); dragline; high wall; overburden; spoil.

HISTORY OF COAL MINE RECLAMATION REGULATIONS IN THE UNITED STATES

Reclamation is the final part in the life cycle of the surface coal mining process; but in fact, the rehabilitation process really begins with preparation and planning prior to a mine being permitted and before the first ground disturbing activity is started. Prior to 1977, there was no federal law that regulated the surface mining aspect of the coal industry. Each state was responsible for its own regulation and laws and enforcement was variable. After World War II, most states began to enact more stringent - if in some cases, voluntary – post-mining reclamation requirements and by 1965, most mine operators were expected to act on their own to restore the land that they mined.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) established permitting guidelines for existing as well as future mining activities and also established a trust fund to finance the reclamation of abandoned mined lands (AML). The purpose of SMCRA is to ensure that coal mining is conducted in an environmentally-responsible manner and that the land is progressively reinstated or reclaimed during the mining process. In the late 1970s and early 1980s, most coal-mining states developed their own programs consistent with SMCRA and were given the primary responsibility to regulate surface coal mining on lands within their jurisdiction with the federal Office of Surface Mining (OSM) providing jurisdiction.

GROUND EFFECT

The Indiana coal mine reclamation regulations that followed the implementation of Public Law 95-87 (SMCRA) were drafted in 1978. As Peabody Coal Company's Reclamation Supervisor for Sycamore Mining Complex, the author helped design and implement several cost-effective reclamation approaches – unique at the time - that resulted in sustainable land use and benefits to wildlife and recreation. Working within current mining regulations and by studying past reclamation approaches, the author developed some principles that supported Peabody's approach to mine reclamation design and implementation:

- One can learn what works by observing the examples of past reclamation in the coal fields (or the lack thereof);
- It's possible to extract the good approaches and eliminate the poor practices through proper planning and implementation;
- One should look at the physical and biological resources available to determine what rehabilitation nature would achieve in our absence and "set the table" for that succession; and,
- We should always look beyond our own life span in terms of our rehabilitation goals.

EXAMPLES OF POST-MINE RECLAMATION

In May of 2013, the author and former Peabody Coal Company Engineer and Mine Superintendent, Don Wile conducted a ground and aerial tour of the coal fields of Southwestern Indiana to document the current condition of land reclaimed from the 1940s to present day. Beyond documentation, one of the intentions of the survey was to evaluate whether or not the varying forms of rehabilitation practiced over the last fifty years have resulted in better land uses and overall environmental improvement. The following narrative and supporting photos are the author's observations and resulting interpretation of past mine reclamation that helped to form some of the reclamation methods that are currently practiced in modern strip mine rehabilitation.

<u>1940s - When we do nothing:</u>

Coal that outcropped at or near the surface was relatively easily mined with what would be considered today as small excavators. Removal of the soil and consolidated material (rock) above the coal was side-cast, resulting in low hillocks (Figure 1) or corrugated banks of overburden (Figure 2) that were left to re-vegetate over time through natural succession. Neither topsoil nor subsoil was segregated from the excavated rock which in many cases was acidic, producing impoundments of low pH which have taken a number of years to neutralize. Indeed, many of these impoundments remain highly acidic decades after mining and the ultimate land use of these areas is limited to wildlife habitat.

<u>1950s - When we plant trees:</u>

The difference between mining and reclamation practices of the 1950s when compared to the 1940s is primarily one of re-forestation. Following mining, many of the spoils were planted with wood and shrub species adapted to the somewhat acidic overburden/spoil conditions. This meant that coniferous species such as white, red and Scotch pine predominate, making these areas easily recognizable from the air (Figure 3). The rough topography does not appear to have been a factor in the re-vegetation of these areas

and it has been suggested that trees – both hardwoods and coniferous - established better on non-topsoiled land than in topsoil itself, probably due to compaction and weed competition. In Indiana, much of this land has been sold to private individuals and groups that use it for recreational purposes (Figure 4).

1960s - Islands in the Stream:

Coal mining companies began grading or "striking off" the tops of overburden/spoil banks in the 1960s to improve access for reforestation and also to improve the land's post-mining value. Areas so-reclaimed are prime spots for homes due to their highly forested acreage and adjacent water impoundments (Figure 5). Many of these areas have produced merchantable timber harvest (Figure 6) and provide "islands" of wildlife habitat in agricultural areas where fencerows and other zones of interspersion have been removed or plowed under due to expansion of agricultural lands. As such, these lands represent a net gain for resource diversity.

1970s - Rangeland:

This beginning of this decade saw reclamation where land was graded back to its approximate original contour (AOC). However, topsoil was not segregated and reapplied, at least not at the quantities or depth required to diversify the land use into anything other than "rangeland". These areas are characterized by poor soil conditions, primarily herbaceous growth of fescue with a few volunteer native red cedars and locust trees (Figure 7). Furthermore, the present land uses are not consistent with previous utilization. Unless managed intensively, grazing and hay production is poor. However, this "in-between" land is a source of recreation in the form of hunting and fishing and is typically interspersed with large impoundments (Figure 8)

1980s - Land of Many Uses:

With the passing of SMACRA (1977) and the implementation of the Indiana state regulations that followed, pre-mining surveys were used to establish the ultimate land use capabilities of areas that were subject to strip mining (Figure 9). Topsoil horizons were identified, segregated, stockpiled or hauled back for ultimate re-application on cast overburden graded to AOC (Figure 10). As a result, many alternative land uses were developed as part of post-mining reclamation planning, including re-establishment of prime agricultural ground (Figures 11 and 12). An opportunity was also presented whereby mine operators had the potential to save money on reclamation through minimized grading and topsoil replacement based on ultimate land use for wildlife and recreational purposes: e.g., grading to AOC and topsoil application might not need to be conducted if the area in question was to be flooded for wildlife habitat (Figures 13 and 14).

Reclamation is the final part in the life cycle of the surface coal mining process. There is no such thing as serendipitous mine reclamation; it has to be planned before the first ground disturbing activity is started on the area to be reclaimed. In order for innovative reinstatement techniques – those that differ from the standard specifications - to be approved by a regulatory agency there must be: 1) site analysis that characterizes the land use and resources of the area; 2) protection of resources such as environmental sensitive perimeter areas 3) progressive reinstatement of disturbed areas must be accomplished in phase with disturbance activities – in other words, one cannot wait until an area is mined out before beginning reclamation; 4) planning must include dedicated features as part of post-mining reclamation, such as lakes, wetlands, upland forest, etc.; 5) the land use(s) must be self-perpetuating, self-reliant and require little long term maintenance; and finally, 6) public and regulatory acceptance for ultimate land use must be acquired during the planning stages.

PHOTOS OF MINE RECLAMATION: 1940S THROUGH PRESENT DAY

Figure 1. Ground view of 1940s-type post mining land characteristics, including piles of overburden (spoil) from truck-shovel operation, water-filled pit, and volunteer vegetation.

Figure 2. Aerial view of 1940s-type post mining land characteristics, including linear overburden (spoil) piles from small dragline operation, water-filled final cut pit, and volunteer vegetation.

Figure 3. Strip mined areas from the 1950s have been developed as private recreation areas due to their fish and wildlife habitat.


Figure 4. An area mined in the 1950s south of Linton, Indiana where hardwoods and coniferous trees were planted following the cessation of mining.

Figure 5. Former Peabody Coal Company superintendent Don Wile standing at the edge of a re-forested area of 1960s reclamation where the tops of the spoil have been graded.

Figure 6. Don Wile's property of re-forested mined land showing the final cut lake and location of his home (arrow).

Figure 7. Area of typical 1970s reclamation (rangeland) with herbaceous growth and volunteer locust trees covering graded spoil.

Figure 8. Rangeland-type land use following 1970s mine reclamation showing volunteer red cedar and final cut impoundments of varying water quality.

Figure 9. Typical mining operation in 2013 at Bear Run Mine near Pleasantville, Indiana. Arrows indicate removal of vegetation and topsoil ahead of the pit for later use in final reclamation.

Figure 10. Dragline removing overburden from above coal seam at Bear Run Mine while end dump trucks haul topsoil for placement on top of graded cast overburden.

Figure 11. Current practice preserving topsoil and its placement on graded cast overburden has resulted in more acres of prime agricultural land in Indiana as a post-mining land use.

Figure 12. Prime agricultural land as a result of identification and preservation of topsoil has greater value that other forms of reclamation..

Figure 13. Dugger Mine as seen from the air. Pre-planning for wetland and wildlife habitat development can result in recreational opportunities in the post-mining environment and save operators on grading costs.

Figure 14. Peabody's former Dugger Mine is now part of the State of Indiana's Fish and Wildlife inventory, supporting a number of resident and migratory waterfowl while providing recreational opportunities in the form of an active warm-water fisheries that attracts year-round recreational users.

DIRECT RE-VEGETATION OF ABANDONED MINE REFUSE AREAS

Abandoned mine sites are often acidic due to the presence of pyrite. When this mineral form of sulfur is disturbed and exposed to air it oxidizes creating sulfuric acid. In 1978 SMCRA established a trust fund to finance the reclamation of abandoned mined lands (AML). A common practice under the AML program is to spread thick layers of overburden and soil to cover over areas of "gob" or waste materials produced by coal processing operations (Figure 15). Unfortunately, material used for this cover has to come from somewhere and that generally means that it is borrowed from surrounding areas where it has in many cases, already been stabilized by time and vegetation. The process of covering ten acres of gob or slurry can thus yield twenty acres of additional reclamation needs as the older borrow areas are again exposed to oxidation and the cover soil eventually turns acidic. In addition, the process of moving material can be very expensive. Clearly some alternative approaches have been warranted.

In the 1980s, Drs. William Klimstra and Jack Nawrot of the Southern Illinois University Cooperative Wildlife Research Laboratory (Carbondale) recognized the limitations of this "cut and cover" approach and pioneered direct re-vegetation methods through the development of wetlands[1]. Their methodologies not only addressed acid soils reclamation[2], but created wildlife habitat in the process

Figure 15. Gob pile covered with overburden/spoil cap near Sullivan, Indiana illustrating that acidic water can still leach for years from areas where pyritic materials are exposed to oxidation.

Beginning in 1980, the author and co-workers attempted direct re-vegetation of dry coal slurry sites at Peabody Coal Company's Sycamore Mine (Jasonville, Indiana) and at the Tecumseh Mine (Lynnville, Indiana). The slurry was treated with application of lime to neutralize acidity before seeding and mulching adapted species. Warm season prairie grasses, such as the broom sedge were established under a mulch blanket as pioneering species. Over the last twenty years, these areas have successfully re-vegetated through a combination of inter-plantation of woody and shrub species and natural, vegetation "creep" of pioneering species found on the perimeter of the impoundments (Figure 16).

Figure 16. A slurry pond near Jasonville, Indiana that after initial re-vegetation with herbaceous vegetation was inter-planted with acid tolerant woody species with great success. Photo was taken in May 2013 nearly thirty years after first application of lime. The coniferous and hardwoods are nearly twenty feet tall.

SUMMARY OF LEARNINGS

We can learn about the potential paths to take strip mine reclamation for ultimate land uses by observing the efforts of those that went before us, extracting the good and avoiding the bad examples. We should first see what's ahead of the mine to understand what should be planned for behind it and utilize the resources available to us. These resources include soil, water, geological, zoological, botanical, human and historical assets to set the table for what Nature would do in our absence. In other words, if an area to be mined is a bottomland habitat, we need to plan mine restoration to achieve that land use objective. But if the affected area is prime agricultural land, we need to reclaim for that purpose. We should look beyond our own lifespan, maintaining at all times a 100-year viewpoint in our regulations, post-mine planning, progressive reinstatement and long term monitoring of our efforts.

REFERENCES

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