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Badger State Pioneers Mine Reclamation Techniques

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DESPITE the image of its university mascot, Wisconsin's "Badgers" were not named for the ferocious burrowing weasel of the prairies. Rather, the state's nickname refers to its infamous miners who burrowed underground in the lead-zinc mines during the 1800s and early 1900s. In fact, the state's seal even shows a neat pile of lead ingots at the feet of a miner.

The storied tradition of mining in Wisconsin has led to a parallel evolution in mine reclamation techniques, beginning in 1974 with the passage by the Wisconsin legislature of a landmark revision to its metallic mining code. That year, strict new mine planning and operation requirements were established in response to the discovery of numerous metallic sulfide mine deposits in the Canadian Shield bedrock of the northern highland areas of Wisconsin.

Prior to reclamation, the Fambeau Mining Co. replaced six million tons of spoil that it had removed from the 360-foot deep pit during mining. Once the surface was recontoured to replicate its original condition, Applied Ecological Services planted the site into over 10 different ecological communities.

The new mine reclamation standards of 1974 were updated in 1978, and several times since, in order to protect ground and surface water quality through proper construction of mining waste containment areas and long-term management requirements. One of these requirements was the use of native vegetation species for reclamation.

The net effect of the regulatory changes was to force the innovation of many new reclamation techniques. Early applications of these techniques were implemented in the late 1970s at the Jackson County Iron Mine near Black River Falls, at two large groups of abandoned sites in the southwest lead-zinc district and in the underground red ore iron mining districts of northern Wisconsin.

Innovative techniques, such as using wetlands for biofiltration, were a large part of the Flambeau mine reclamation design completed in 1998 by AES.

Although more mining activity was anticipated, the Jackson County mine was the only active metallic mine in Wisconsin at the time. However, several orphaned lead-zinc mine and smelter sites had existed for years as acute sources of acid mine drainage and heavy metal pollution. Tailings piles at several sites were serious sources of dust and air

particulates which, in drier parts of the year, spread metallic pollutants off-site to adjacent farms and streams.

After repeated attempts to revegetate these sites with traditional reclamation strategies, Applied Ecological Services of Brodhead, Wisconsin, was brought in to develop new techniques to stabilize many of these tailings piles. Using both hydroseeding and new native species seed drilling techniques, AES was able to successfully stabilize four of these sites with initial plantings of the more aggressive agronomic species, followed by a diversification using native prairie species.

Several experimental native species plantings were only qualified successes, but these provided a great deal of experimental data experience. For example, AES discovered that on these dry sites, warm season grasses grew well, but forbs required the presence of the native grasses to survive.

"Regulatory agencies were motivating the use of native plants in reclamation, and we learned that this initially appeared in conflict with quick stabilization," said Steven Apfelbaum, AES research and consulting ecologist. "However, our study provided the basis for a reclamation approach that involves a layered planting, and this has subsequently worked well on dozens of project sites. Initial layers ameliorate and stabilize inhospitable, soil-less site conditions, and follow-up layers provide long-term native plant cover and structure.

Discovering and perfecting this technique has saved thousands of dollars on many of our projects," Apfelbaum said. "Direct planting of natives may cost many times that of a typical 'highway grass' mix, but this layered approach has brought most native plantings to a comparable level. And it has saved considerable funds by reducing the need for long-term management, including fertilizing and weed control or mowing, that is often needed on sites planted with highway mixes."

Jackson County Iron Mine

Major successes with native species were realized at the Jackson County Iron Mine where AES began experimentation with native prairie species in 1977, and with live-staking brushy species on tailings in 1980. This mine closed temporarily in 1983, and permanently in 1986. Between 1984 and 1988, AES restored the site's 312 acre tailings basin to a dry prairie community by seeding directly into the tailings. Nearly 620 acres of the waste rock dumps were shaped and hydroseeded with native species between 1985 and 1990. And in 1991-1992, another 43 acres were covered with sandy soils and restored to prairie on what had been the mine's operating plant site.

In all, 1,340 acres were restored to native prairies, making the former mine site the largest prairie restoration in the state of Wisconsin. The restoration created a planting that allowed for gap phase invasion by native plants from the surrounding pine/oak barrens.

In fact, the restoration has proven to be so attractive that the site has been transferred to county ownership and developed into the highly popular Lake Wazee recreational area. The park now features a 114-acre, 385-foot deep lake on the site of the old mine pit, with a productive trout fishery, a premier scuba diver training site, swimming beaches, and hiking trails and wildlife areas on the restored mine. Lake Wazee has become one of the most popular regional parks in central Wisconsin, and fills a need for high quality, water-based recreation in an area of the state with few natural lakes.

Flambeau Mine Reclamation

With a company commitment to protect the environment and following a rigorous permitting process, Flambeau Mining Co. was issued eleven permits in 1991 to begin construction and ultimately

operation in 1993 of an open pit copper mine near Ladysmith, Wisconsin. The site, containing a small but relatively rich copper and precious metal deposit, was located near the edge of the Flambeau River, a popular fishing and canoeing stream. This proximity to the Flambeau River and concerns regarding groundwater protection had resulted in intense scrutiny of the project by the company, regulators, and environmental groups for nearly 20 years.

Once permitted, the mineral deposit was mined in slightly over four years, and in 1997, AES was retained to refine the general reclamation plans that had been developed prior to Flambeau receiving its permits. Detailed reclamation plans and specifications were approved by the Wisconsin Department of Natural Resources in 1998, and AES finished installation of the surface reclamation plan in the spring of 1999.

At the Flambeau Mine, unlike all previous surface mines in Wisconsin, the waste rock excavated to reach the ore deposits was not disposed of in mining dumps. Rather, the waste rock was temporarily stockpiled within the 181-acre mine site in engineered areas that included impervious plastic liners and water treatment systems to minimize impacts to the environment. The waste rock was mixed with limestone and returned to the 34-acre open pit during closure of the mine. Limestone treatment buffers the groundwater, creating a neutral environment. During 1997-98, over five million cubic yards of stockpiled waste rock and soils, and over 35,000 tons of limestone, were backfilled into the 220-foot deep pit.

Last summer, AES replanted the site in various zones. The surface was restored to the gently rolling topography that existed before mining. Five small wetlands that existed previous to mining were replaced with a single 8.5-acre wetland. Watercourses and drainage were reestablished, meandered and live-staked with woody vegetation to mimic the original drainage of the site.

Upland areas were restored to a mixture of open grasslands, savannas and tree copses. One 32-acre area containing the mine office buildings and infrastructure was reserved for future industrial development. This area was restored to a mowed grassland, with a separate stormwater management system built into a naturalized landscape.

Most of the 181-acre mine site was restored to native mesic prairies, woodland, savannas, wetlands and watercourses. Many innovative techniques, such as meandering watercourses, stream stabilizations with local rock, live stakes, and wetland biofilters, were designed and built for effective, high quality management of stormwater runoff. Initial monitoring indicates that the surface water quality appears to be exceeding expectations.

The goal of producing a site dominated by locally derived native plant communities is well on its way to becoming an achievement.

Conclusions

Over the past 25-year evolution of mine reclamation in Wisconsin, the learning curve has been steep. However, the challenging opportunity to develop and test new reclamation strategies dominated by native species has brought its rewards. The Jackson County Iron Mine is now a valued recreational public park. The lead-zinc tailings piles in southwestern Wisconsin no longer pose a public health threat to local residents. And the Flambeau mine, conducted under the most restrictive mine reclamation code in the world, is well on its way to becoming one of the most successful mine closures ever undertaken.

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The conclusion, according to Apfelbaum, is that the partnership of ecological science with regulatory accountability and ethical business practices can create win-win solutions that offer unprecedented ecological, economic and cultural benefits within the mining enterprise. ***L&W***

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