

# The Environment



250,000  
acres

## Bringing Back the Forest

Over 250,000 acres of land in Kentucky have been impacted by surface mining, and another 1.6 million acres have been slated for coal extraction. Most of the land mined since 1978 has been heavily compacted, making it unsuitable for deep growth of any kind.

"The ground is so compressed that water can no longer percolate into and through it," explains Don Graves, an extension professor in the UK Department of Forestry. "It was all re-vegetated with tall fescue

## Fiber Optics in Service to the Environment

When most people think about fiber optics, they think of telephone or cable service. One UK researcher has taken fiber optics beyond communications to produce highly sensitive environmental monitoring tools.

Since 1995, Sylvia Daunert, a professor of chemistry, has been working on NSF-funded research to produce fiber optic sensors that use bacteria genetically engineered to glow in the presence of very low—but still dangerous—levels of toxic substances. This bioluminescence is created by altering the same proteins that make fireflies and jellyfish glow.

She has studied the toxic substances arsenic and antimony, a chemical used in matches. "We've used various proteins that can emit different colors," Daunert says, "and now we can detect many toxic substances at the same time just by looking at which color—red, green or blue—is emitted." The bacteria Daunert and her colleagues use is a non-toxic strain of *E. coli*, which is widely used in biotechnology.

Daunert creates her bioluminescent bacteria by using natural bacterial genes that recognize small amounts of toxic substances. "We

trick the bacteria by hooking up the gene that recognizes a toxic compound to what we call the reporter gene—the one that generates the bioluminescent signal," she says. "So as the toxic compound enters the cell, it is recognized by the gene."

The advantage of using these optic fibers for environmental monitoring lies in their ability to act as remote sensors. "You can place a fiber at a polluted site, just leave the fiber there, and monitor what is happening from miles away."



and sericea lespedeza [a noxious weed], both of which only serve as undesirable ground cover."

Now, backed by grants totaling nearly \$5.5 million from the U.S. Forest Service and the Department of Energy, UK researchers are taking the lead in a project to reclaim 3,000 acres in areas around Prestonsburg, Hazard and Madisonville, Kentucky. UK is partnering with experts from state government and industry in this six-year project.

The researchers are using novel deep ripping methods to produce loose material so that tree roots can

easily penetrate the earth and water can percolate into the soil rather than run off, carrying sediment into the streams. "This work will result in high-value hardwood timber that can be used to manufacture furniture, hardwood floors, and decorative furnishings," says Graves, who is heading up UK's part in this project, which will end in 2008. "It will also increase wildlife habitat.

"What we hope is to replace a fescue desert with a total forest community," Graves adds.



**4.6**  
million tons  
of ash

## Putting Mountains of Ash to Work

When coal burns to generate electricity, it leaves ash behind. Coal-burning utilities have traditionally stored this ash in ponds or have simply created mountains of the stuff near the utility site.

Mountains? What exactly is the magnitude of this problem?

In 2002, 4.6 million tons of ash were produced in Kentucky, of which only half a million tons were utilized, mostly in concrete, so 4.1 million tons were stored. In addition, 6.1 million tons of scrubber by-products were generated and 1.2 million tons were used, mostly to make wallboard for home construction. Scrubbers remove sulfur and nitrogen compounds resulting from coal combustion before the air is released. Putting this stored ash to use has been a longtime concern for electric utilities.

This is where expertise at UK's Center for Applied Energy Research (CAER) comes in. CAER researchers Tom Robl and Jack Groppo are heading up a project on advanced coal-ash processing to improve the quality of fly ash from burned coal. The higher-quality ash improves the durability and strength of the concrete. The result is that coal-burning utilities can become more economical, since fly ash becomes a marketable product rather than a nuisance to be disposed of. The technology was first tested in Ghent, Kentucky, at the Ghent Station power plant.

In addition, developments in ash-processing technology at CAER—specifically, a new approach that takes raw land-filled ash in a slurry form and separates it in a four-step process—have the potential to generate high-quality products, serving existing markets such as concrete, and new markets such as filler.

UK has three patents on aspects of the process with one patent pending. “This process can turn mountains of coal ash into commercially competitive products, including some that will greatly reduce greenhouse gas emissions and create new jobs for Kentuckians,” says Robl.