

NRRI Now

NATURAL RESOURCES RESEARCH INSTITUTE



Winter 2004



President Bruininks

VISITS

NRRI rolled out the red carpet when University of Minnesota President Robert Bruininks came to discuss economic development issues with UMD Chancellor Kathryn Martin, NRRI Director Michael Lalich and local community leaders.

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University of Minnesota President Bob Bruininks recently chose to focus on the University's role in economic development during a visit at UMD. A key part of his visit was a discussion, held at NRRI, with a representative group of local and regional business leaders and economic development professionals. Anchored by the pool of talented graduates provided by the University, there is no question but that the University plays a crucial role in enhancing Minnesota's economy. On this day, however, President Bruininks wanted to highlight and emphasize the key role played by the University's research and outreach programs. These resources can and do have an important impact on the economy, particularly when used in partnership with the private sector. In addition, President Bruininks wanted to learn from the group how these resources might be better deployed.

At the meeting, UMD Chancellor Kathryn Martin highlighted NRRI and the Center for Economic Development as the key UMD programs charged with helping the regional economy. As such, I was provided an opportunity to give a brief overview of NRRI and a perspective on regional economic development efforts to start the group discussion. I indicated that, in my experience at NRRI, finding the right private sector partner or partners is a prerequisite for a successful project or initiative.

The esteem in which meeting participants held NRRI was apparent and very gratifying to me. This was highlighted by a number of anecdotal examples participants offered regarding Institute collaborations with them. Of note were NRRI's participation in the Blandin Foundation Vital Forests/Vital Communities Initiative, the active research and technology development role of NRRI in support of the minerals industry, and the Institute's engagement in assisting with area small company start-ups in the forest products industry.

... President Bruininks wanted to highlight and emphasize the key role played by the University's research and outreach programs.

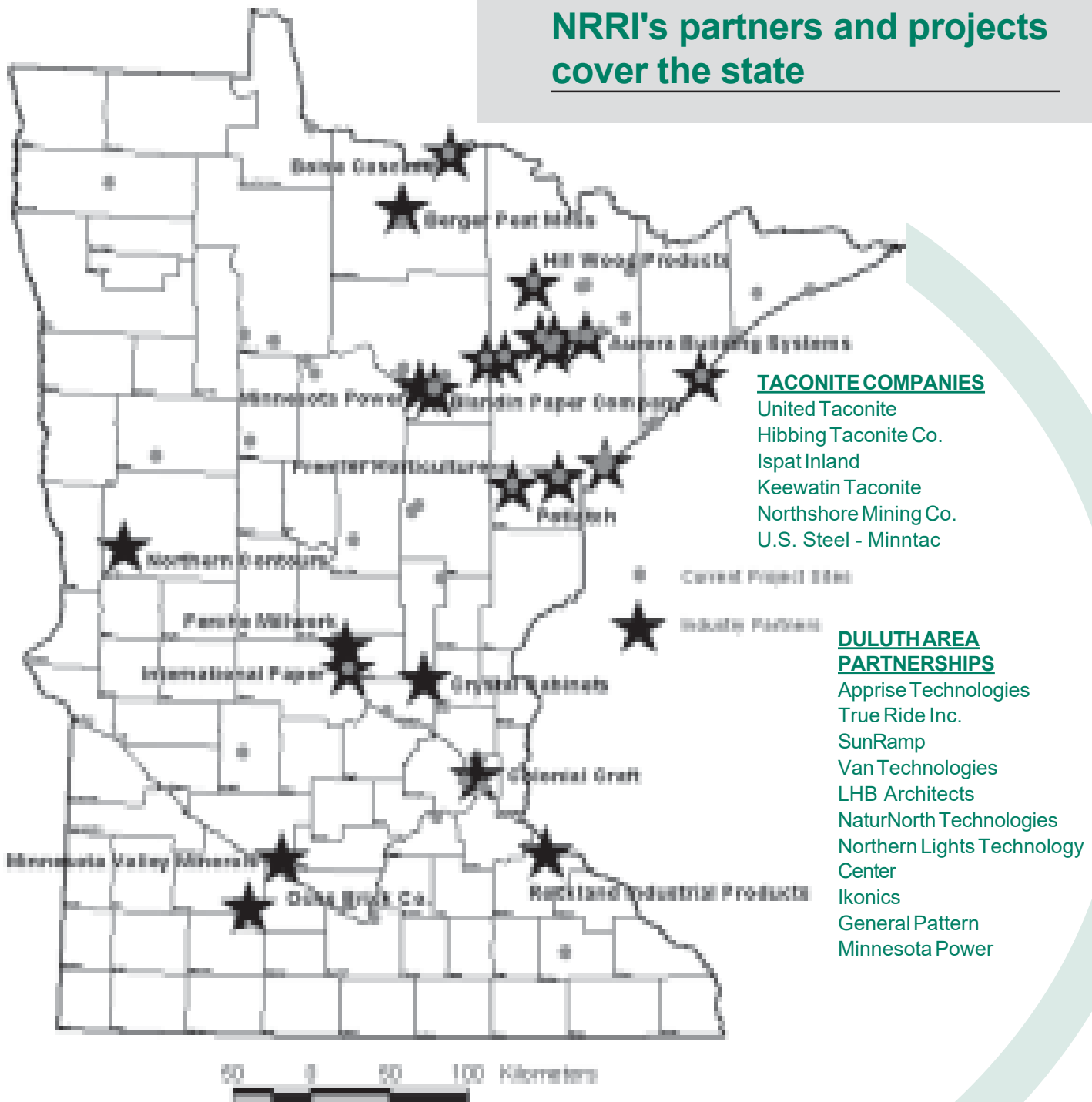
The conversation included a discussion of availability of financial resources by NRRI and other University units to support economic development initiatives. President Bruininks identified with the notion that much of the University's research and outreach funding, by its nature, had to be targeted to specific objectives outlined in grants or contracts and lacked the flexibility required to offer a targeted and timely response to an economic opportunity or challenge. From NRRI's perspective, the Institute is still suffering from the loss of Minnesota Technology monies that were designed to allow timely response to assist companies with their product and process

development and business start-up and expansions on a matching basis. However, grants from the National Science Foundation, U.S. Department of Agriculture, and the U.S. Department of Commerce's Economic Development Agency, have given NRRI financial ability to continue these efforts on a significant basis.

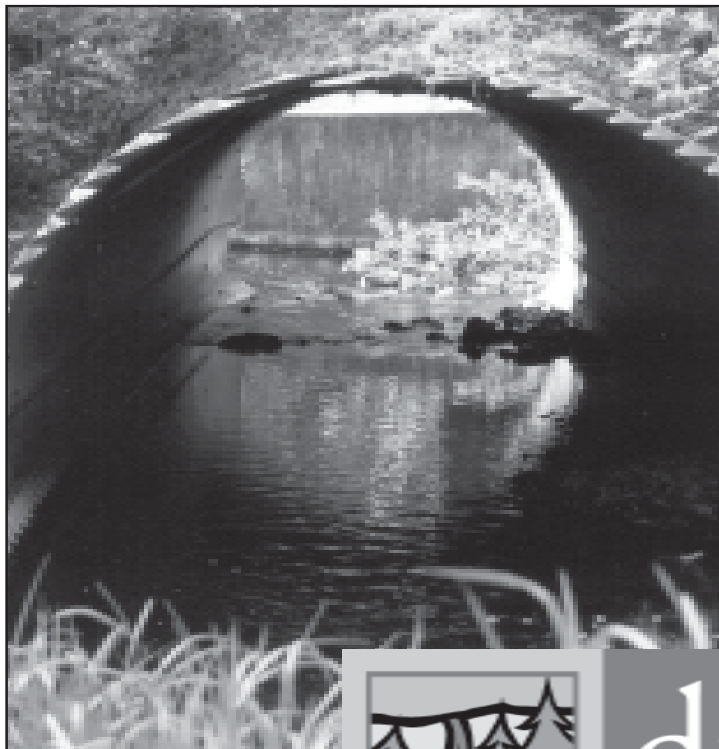
Buoyed by the discussion and comments of local leaders, President Bruininks asked me about the Area Partnership for Economic Expansion (APEX), a business and industry led initiative to assist the region in promoting economic growth of existing businesses and to attract new businesses. At a social function that evening, he pulled me aside and indicated that the University should be doing what it can to support such an excellent economic development effort. He expressed willingness on behalf of the University to financially support an additional APEX Board seat for a three year period. Consequently, I have joined Chancellor Martin on the APEX Board. In my mind, this is just an excellent opportunity to foster partnerships with the private sector to enhance the regional economy.

Michael J. Lalich

NRRI's partners and projects cover the state



NRRI outreach encompasses both private sector and public partnerships throughout Minnesota. These stars represent many of NRRI's industry partners while the dots show many of our research project sites, but certainly not all! Many of our projects cover broad expanses of land and water, such as coordinating the environmental indicators project of the entire Great Lakes Basin.



DuluthStreams.org
leads the way in
watershed education

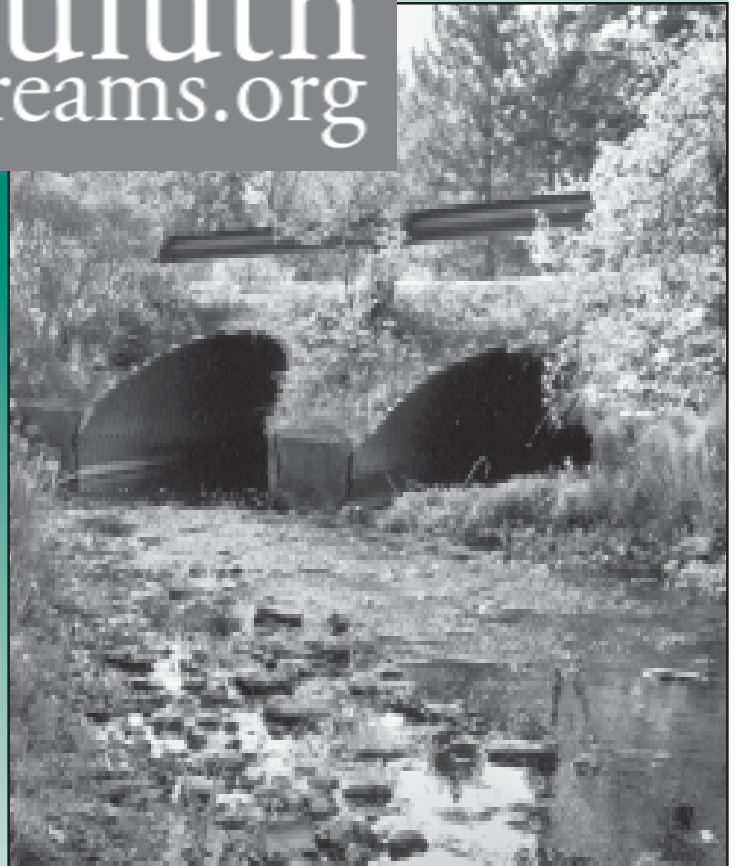


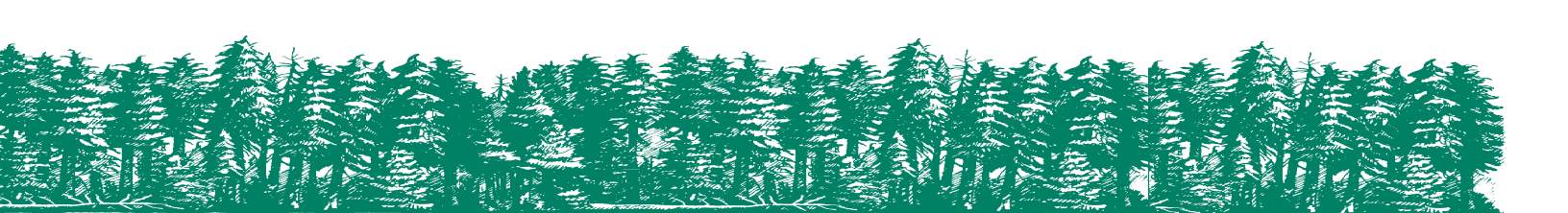
duluth
streams.org

There's a heavy responsibility resting on the shoulders of everyone who lives in a watershed. Unfortunately, many people don't know what their responsibilities are, or even that they DO live in a watershed. Researchers hope that knowledge will lead to understanding, with a good dose of sympathy for the waterways we live near.

Streams in Duluth have a particularly difficult urban life. The entire city is one big, fast-moving watershed that feeds into one of the most valuable fresh water resources on the planet—Lake Superior. This city on a hill is streaked with 42 streams that wind through town and discharge into the great lake. And everyone in Duluth lives within 10 minutes of one of its 12 especially sensitive trout streams.

Researchers at NRRI have teamed up with University of Minnesota Sea Grant Program, UMD Education, the City of Duluth and other area agencies to package the information so it's easy to access and understand. *DuluthStreams.org* is a





unique Web site that shows what can be done to help citizens understand their role in water pollution.

The Web site is loaded with facts about the Duluth environment, citizen involvement opportunities and stormwater issues. Pictures and land use data related to all 42 of Duluth's streams are available with the quick sweep of a computer cursor over a map. The Web site has unique computerized technology that monitors four Duluth streams, downloading "real time" data to the site. Teachers, students, scientists and citizens can keep watch over changes in the streams' temperature, turbidity and water chemistry through the seasons. A special graphing tool, developed at NRRI, animates and colorizes the data, giving viewers a peek at the "pulse" of three of the streams.

To keep residents informed on how their urban streams are faring, the City of Duluth is using *DuluthStreams.org* as the backbone of their public awareness campaign, kicking off this spring. The Web site is also growing to include surrounding communities.

"One of the funny things about living here is that living is so good people don't see the problem," said Marnie Lonsdale, Duluth's Stormwater Coordinator. "We have a wealth of natural characteristics right in town that haven't been damaged, and we want to keep it that way."

But development and bad habits are having an impact on water quality. Long term monitoring of Miller Creek, which runs through Duluth's heavily developed mall shopping district, shows signs of heat stress from pavement run-off, as well as, deteriorated plant and animal life due to excess sediment and contaminants during heavy rains. Bad habits carried over from a less environmentally educated time still haunt Duluth's waterways, too. Residents can still be seen sweeping spring salt and gravel from their yards into the streets and down the storm drains, fertilizing lawns near creeks and dumping toxic chemicals down storm drains. After a rain, those pollutants quickly impact down-stream organisms in the creeks and then reach Lake Superior or the harbor within minutes.

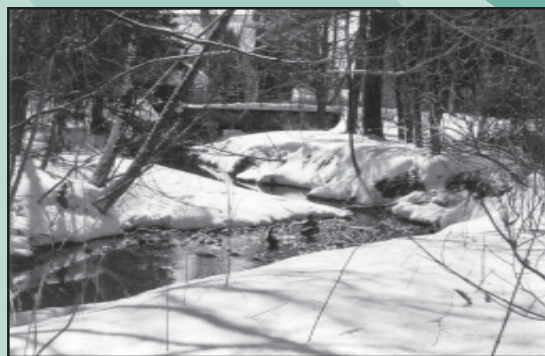
NRRI's technical expertise, with the University of Minnesota Sea Grant's outreach expertise and the City of Duluth's stormwater program knowledge, work together to bring a depth of information through *DuluthStreams.org* to the public. The team's skills in planning, designing and editing the

site to make the information accessible is at the center of what it's all about. They hope the Web site will become a model for what can be done across Minnesota.

"We're better off than most cities that are faced with the enormous cost of fixing their 'broken' streams," explained Carl Richards, Sea Grant director. "We know how important the natural resources are to the people who live here. Our goal is to help everyone understand their responsibility in keeping the streams healthy."

BRINGING IT ALL TOGETHER

A partnership between the City of Duluth, UMD's NRRI and Department of Education, University of Minnesota Sea Grant Program, the Western Lake Superior Sanitary District and the Minnesota Pollution Control Agency was formed to increase public understanding of streams and the impacts of watershed land use and stormwater runoff. The creation of *DuluthStreams.org* was made possible by funding from EPA's EMPACT program (Environmental Monitoring for Public Access and Community Tracking). *DuluthStreams* is a spin-off from the *Water On the Web* (*waterontheweb.org*) basic science and water science curriculum project, and *Lake Access* (*lakeaccess.org*), another EMPACT funded project focused on Lake Minnetonka and urban lake issues in the Minneapolis metro area. The University's Principal Investigator team for the three projects includes Rich Axler and George Host (NRRI), Cindy Hagley and Carl Richards (Sea Grant) and Bruce Munson (Sea Grant and UMD-Education).



Minnesota *Industry*

Mapping down under

NRRI geologists map plans for deep physics lab in Northern Minnesota

While there is plenty of interest in what lies beyond our solar system, the truth is scientists still don't know what makes up 99 percent of the universe. Part of the problem is that much of the mass deep in space can't be seen; yet it's that unseen "dark matter" of the universe that holds the key to studying its origin and evolution.

This is the world of astrophysics, a complicated science that involves neutrinos, supernovas, spontaneous decay of matter and the origin of elements. It's science on the leading edge of new knowledge sought by physicists around the world, but ironically, it's difficult science to do anywhere *on* this world. It requires a science laboratory that's deep, deep underground to avoid interference by cosmic radiation that descends to earth naturally from the sky.

Right now, the federal government is seeking proposals for a place to build just such a laboratory. NRRI geologist Dean Peterson and colleagues recently completed a report containing the geological mapping to prove that Soudan, Minnesota has an outstanding site, just a mile east of the old Soudan mine.

The proposed National Underground Science and Engineering Lab (NUSEL) would be 8,200 feet underground and connected to the existing Soudan physics lab owned by the University of Minnesota that is now in the mine 2,400 feet below the surface. Peterson's task was to map the geology of the proposed site to

find an area of solid, homogeneous rock to build the new lab.

"We did some very detailed mapping and found an area of very strong rock near the mix of rocks around the Soudan mine site," said Peterson. "It's the perfect place for the underground lab."

The ability to connect the new lab to the existing physics lab also lends to the site's appeal: a neutrino beam from the Fermi National Accelerator Lab in Chicago is expected to be transmitted to Soudan in late 2004. Neutrino transmission through the earth is an essential part of research in high-energy physics to learn how the universe is made and how it works.

But digging down 8,200 feet to build high tech laboratories and underground roads big enough for semi trucks is no small feat. University of Minnesota physics professor Marvin Marshak, proposed the Soudan site for the new national lab knowing what it would take to make it work.

"No one's been down that deep there before at Soudan, so the question arises, 'What is the quality of the rock down there?'" explained Marshak. "The best we can do right away to answer that is what Dean and his colleagues have done—make use of their knowledge of the geology of northern Minnesota and map what we know."

This type of lab is not new. Deep underground research had been taking

place in an old gold mine in Lead, South Dakota, but underground water is slowly filling that space. Other states are vying for the opportunity to house the new multi-million dollar facility, but Peterson's Soudan investigation report, sent in October to the National Science Foundation (NSF), the Department of Energy and Minnesota legislators, details many advantages of the Soudan site. It is an excellent location for geological and seismological research, and overall responsibility for the lab by the University of Minnesota.

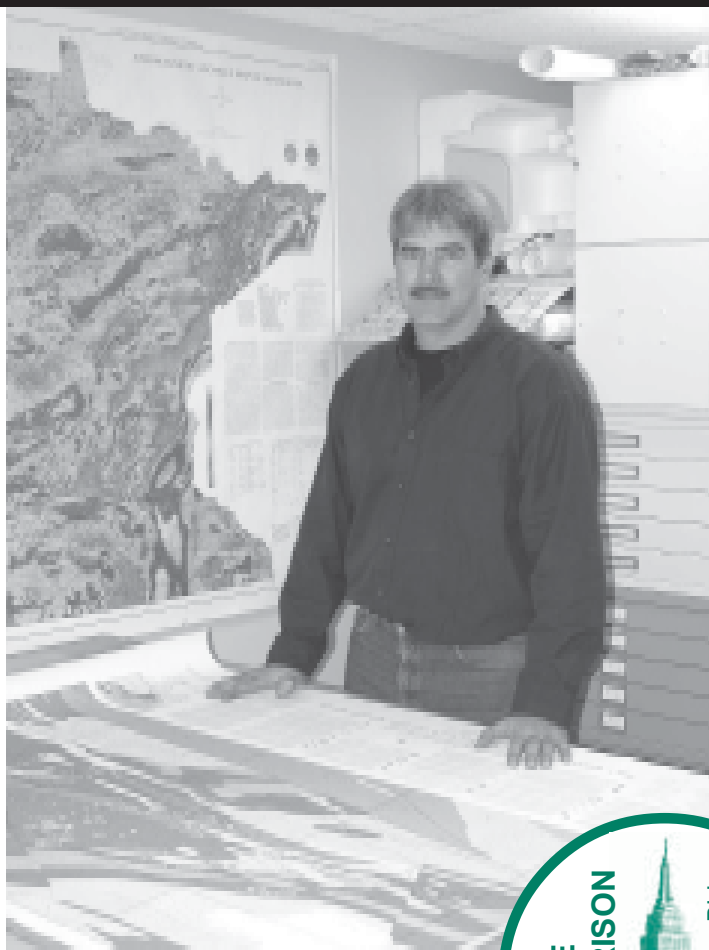
"This could be an amazing facility for basic research in many disciplines—physics, geology and hydro-energy. We have a good location for this, and it would draw hundreds of high-paying jobs to an area that really needs it," said Peterson. "If this goes, it would bring a truly high-tech sector to Minnesota with many, many possibilities for jobs in support services, too."

Now that the report is completed, the next step will be for the NSF and the Department of Energy to decide that the Soudan site is worth further investigation by drilling core samples to verify the mapping Peterson has done.

"Frontier research like this has the potential to retain and attract a high quality workforce for northern Minnesota," said Marshak. "In the interim, we'll propose upgrades to the Soudan facilities and keep developing the science program. That's very important to me and to Minnesota."

Mapping down

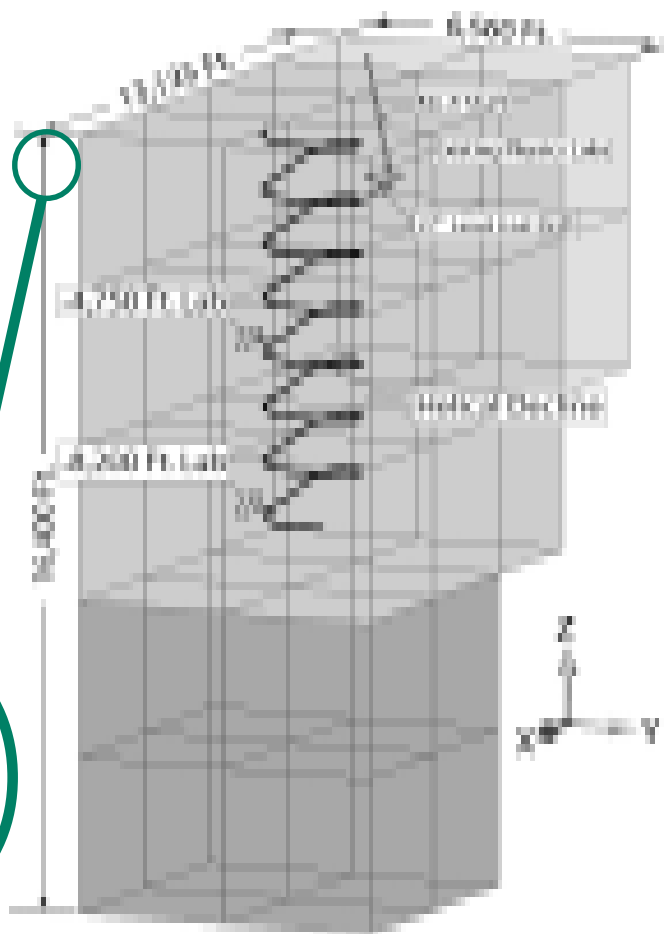
under



NRRI geologist Dean Peterson hopes his detailed geology maps will lead to further investigation of the Sudan site for an underground lab.

SIZE COMPARISON

Empire State Bldg
1453 feet =



-  - 4 km³ Accessed from the Sudan Mine
-  - 18 km³ Accessed from the Helical Decline
-  - 8 km³ Accessed from Deep Drilling for the Microbial Life Experiment

View in the Southwest at 345°
Looking Down 10°

Terms:

Dark Matter – Less than 90 percent of the matter contained in the universe is not visible to us on Earth.

Neutrinos – An abundant, fundamental particle thought to have zero mass, or a very miniscule amount. Neutrinos interact very little with ordinary matter.

Astrophysics - The branch of astronomy concerned with the physical and chemical properties of celestial bodies.

Accelerator - A scientific instrument that increases the kinetic (motion of matter) energy of charged particles.

Partnerships *in Action*

Forest Management Northern Minnesota Style

With about 55,000 acres of Norway pine stands to keep watch over, land managers at Potlatch decided they need a little help. They want to know if they're using the best management techniques to get the highest value possible from their investment. Boise Paper Solutions also wants to increase the productivity of their 170,000 acres of aspen trees. What is the best way and the best time to thin the tree stands? How should they fertilize for the best productivity of the stands?

Both companies came to Bill Berguson, program director in NRRI's Forestry Group, for the answers.

"You may think that we'd already have that kind of information for species we've been growing for a long time," said Potlatch Timberlands Manager Tom Murn, "but we really don't have the kind of detail we need. With NRRI's help, we're gaining valuable insight on how to optimize the management of our Norway pine stands."

Minnesota's forest products industry has taken a downturn over the past couple of years. Machine shutdowns and reductions in investments in the local industry have resulted in a loss of 1,000 jobs. It has become serious enough that Governor Tim Pawlenty established an Advisory Task Force on the Competitiveness of Minnesota's Primary Forest Products Industry to evaluate the industry's competitiveness.

Potlatch has an especially large investment in Norway pine, primarily used for saw timber. At harvest, these pine stands can be

twice as valuable as aspen, which is used for pulpwood. NRRI research is helping Potlatch managers understand the growth history of the stands and how it relates to product value. This allows them to make well-informed decisions on the best time to either thin the stand or clear-cut harvest.

Boise is taking a hard look at the effectiveness of both thinning and fertilization on aspen growth.

"We need to be able to get more wood from our stands in a shorter amount of time," explained Boise Area Forester Craig Halla. "Bill (Berguson) and his team have been doing work on aspen longer than anyone else in the state and we always get good research from them that we can really

work with. The skill set at NRRI is a perfect match for us."

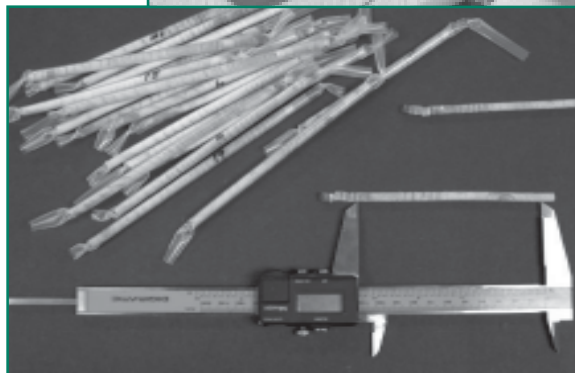
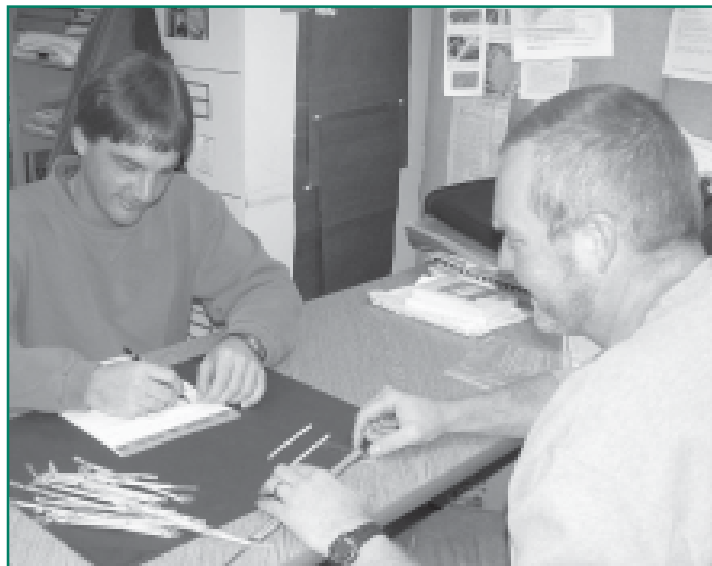
Boise's aspen stands are being studied for their response to mechanical strip thinning and fertilization. The project will try to reduce the time between rotations of aspen crops to get the pulpwood to paper mills faster. They've also asked Berguson's team to do research on the fertilization of Red Pine and to re-measure plots that Boise established five or six years ago.

With heavy hits in the forest products industry overall, the companies appreciate being able to tap the skills and knowledge available at NRRI that is specific to their industry. The synergy

between NRRI and the forest products industry allows them to solve problems faster and get more in depth answers than what they could do separately given the same resources.

"It's not unusual to have a stand worth \$2,000 in product value," said Berguson. "Our unique expertise, I think, is taking the detailed biology and growth rates, and then crunching out the numbers that land

managers can make sense out of and use. This detail allows the industries to establish some very clear guidelines for managing their resources."



NRRI forestry researchers Craig Maly and Dan Buchman analyze tree core samples for the Minnesota forest products industry.

Opening a can of (exotic) worms

Research grows into outreach for citizen scientists

Gardeners covet earthworms for their composting abilities. Anglers dangle them on their hooks. Kids giggle as they wiggle around in their hands. But many people don't realize that these worms are really exotic invaders in Minnesota's woods.

NRRI scientist and U of M graduate student Cindy Hale has done extensive research on the effect of these non-native leaf litter munchers on forest plants. And in the process she's blurring the line between scientists and non-scientists, getting everyone involved.

"Looking at worms and how they affect the forest is a great way to understand how nutrients cycle through the ecosystem," Hale explained. "Because worms are not native to the forests here, they speed up the natural nutrient cycle by eating the duff layer that would otherwise decay over many years. We're seeing the forest floor disappear where worms have invaded."

Hale's worm research is attention grabbing because it brings to light new revelations about something very familiar that people think they already know something about. Gardeners and anglers have long been fans of earthworms and night crawlers. But earthworms have only been on the North American continent for a couple hundred years when they hitchhiked over on boats from Europe. The forests, however, have been evolving over some 10,000 years with nature's slow nutrient cycling of bacteria and fungi.

"How the forests will adapt to these worms is anyone's guess at this point," said Hale. "That's what makes this research so interesting. When we started this project five years ago there was almost no research on earthworms in Minnesota."

That leaves the door wide open for everyone to participate, and Hale has pushed her worm research project outward to include "citizen scientists"

from the elementary level through college and into the professional sectors. The model can then be used by other groups doing research that would also benefit from having citizen scientists gather data—like monitoring of dragonflies, butterflies, and water quality projects.

"People seem to think that all the important science has been done already, but the truth is, we know almost nothing," said Hale. "There's so much out there to discover, but you don't realize that until you're involved in it."

Having students collect data on interesting critters in their communities adds to the database of knowledge and, as Hale has seen with worm research, it's not hard to get their attention. While some of the techniques are slow and meticulous, students of all ages squeal in delight as earthworms rocket out of the ground when confronted with a little mustard-tainted water. Excitement surrounding her research with worms has generated a series of Train the Educator workshops, a Minnesota Worm Watch website (www.nrri.umn.edu/worms), and "Contain Those Crawlers" posters about stopping the spread of invasive worms.

But even more help is needed. This spring Hale will train members of the Minnesota Conservation Corps so they can collect data in remote targeted areas. The hope is to get continued funding to keep the project going and growing. The research project thus far has been supported by the Northeast Regional Sustainable Development Partnership through the University of Minnesota Extension Service and a Department of Natural Resources Environmental Partnerships grant. Hale has also relied on graduate students from the University of Minnesota Duluth Environmental Science Program who helped create the curriculum materials and host citizen scientist workshops.

drawing Wall Street Journal



WORMS TAKE ON THE WORLD

While the earthworms help spread science knowledge, the worms themselves are spreading and research on their impact continues beyond Minnesota.

NRRI received funding from the Cooperative Ecosystems Studies Unit, a collaborative effort between the federal government and the university, for Hale to start worm research projects in the Pictured Rocks National Park in Michigan and in Voyageurs National Park near the Canadian border in Minnesota. These projects will study the effect of worms beyond the Sugar Maple forests by looking at forests with combinations of Beech-Maple, Beech-Oak, Aspen-Birch, and Spruce-Fir. She's also bringing her expertise to France in 2004 for the International Colloquium on Soil Zoology and Ecology. Hale and her research will join an international team of scientists from Russia, Germany, Puerto Rico, South America, New Zealand and Australia. The result will be a series of papers on the dynamics of earthworm invasions globally to be published in the *Journal of Biological Invasions*.



NRRI Research Update

Research pushes technology—Technology pushes research

When a University research lab is involved with the newest technologies, be prepared for anything to happen. NRRI is gearing up to push the envelope of what can be done with state-of-the-art rapid prototyping technologies in their new Northern Lights Technology Center—and they're finding the possibilities are endless.

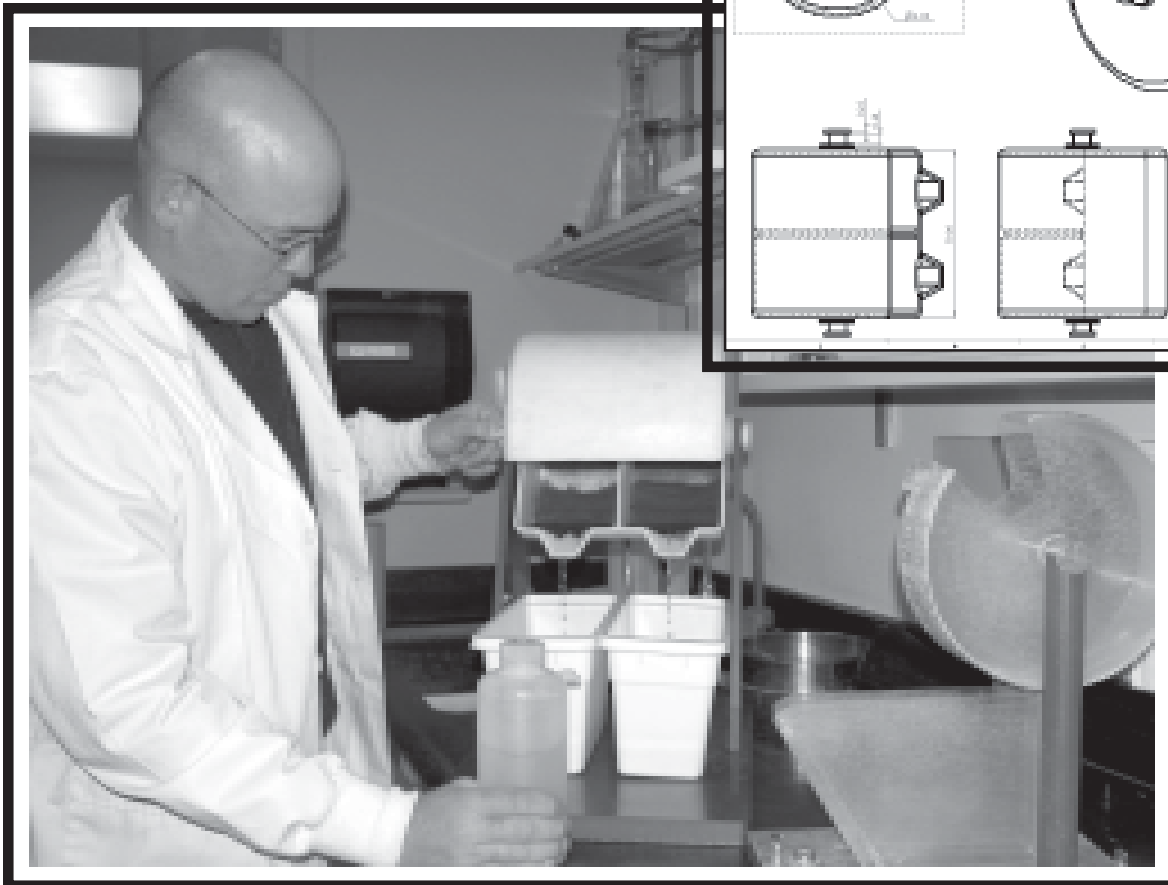
"There are two ways to use this equipment," explained Applied Research Center Director Don Fosnacht. "One is to use them for purely mechanical or architectural designing, using standard materials. The other is to evaluate the effectiveness of new materials in the machines. That's where we'll find out what these machines can really do."

The center is home to four of the newest machines for making three-dimensional renditions from any type of computer-driven design program—from computer drawings of small machine parts (or even of the entire machine!), to a CT scan of a body part. This technology is the only one of its kind

in the northland and is unique in the University of Minnesota system. And because of the limitless possibilities, researchers in many areas of study are finding creative uses for this center.

NRRI geologists wanted a more effective way to show non-geologists the mineral deposits they've mapped on the Duluth Complex along Lake Superior. Combining the expertise in NRRI's Geological Information Systems lab with the center's Z Corp 3-D Inkjet Printer produced a functional tabletop model of moveable mineral deposit layers, just as they lay in the ground.

Biologists in NRRI's Center for Water and the Environment needed a sediment sample splitter to make their



NRRI biologist Dan Breneman demonstrates the lab's new sample splitter, made to his specifications with rapid prototype technology.

lab work more efficient. By explaining their needs to Chief Design Engineer Steve Kossett, a CAD drawing was made to the biologist's specifications and within days they had a sample splitter that fit their needs. Making this item was also a learning experience for Kossett. Because it needs to hold wet lake sediments, he experimented with different coating materials over the porous plastic to make the splitter watertight.

"A splitter the size we needed wasn't available from the biological supply companies," said NRRI biologist Dan Breneman. "Steve was able to modify the dimension of an existing device to meet our needs. This very simple tool can save us a lot of time and money in the lab."

NRRI's Coleraine Minerals Research Lab has an exciting new linear hearth furnace, with capabilities that can be difficult to describe. A model of the system, made with the center's Vanguard Selective Laser Sintering machine, allows the "furnace" to go on the road for presentations.

The Coleraine lab also needed a unique form for its new research in iron nugget production. Dave Englund, a program director at Coleraine, designed a special mold to shape the concentrate before it goes into the furnace.

"We had the capabilities with this rapid prototype technology to do it, and do it quickly," said Englund. "It worked out very well for us."

Fosnacht admits that the center is still in the learning curve of how to use the rapid prototyping technology most efficiently.

"We're still learning about what we can do, and it's very exciting," said Fosnacht. "I know we can help other areas further their research by providing useful tools, but we're also conducting our own research on how far we can take this technology."

Thinking futuristically—yet realistically—Fosnacht's team is working with the University of Minnesota Biosystems



NRRI Center Director Don Fosnacht explains the limitless possibilities of rapid prototyping to UMD engineering students.

Engineering Department to use a biodegradable plastic in the center's fused deposition modeling machine. Coupled with the precision technology of rapid prototyping, perhaps this biodegradable plastic will be used for medical applications beyond dissolving sutures.

"Soon we'll be able to push this idea further. Maybe it can be a matrix that grows a new organ in the body," said Fosnacht. "Once we fully understand the capabilities of these systems, the possibilities are limitless. And that's what research is all about."

The Northern Lights Technology Center opened in May 2003 under a cooperative agreement with General Pattern Corporation of Blaine, Minn. The unique relationship has helped move the new center into the forefront of creating useful designs and models for a variety of clients.



Local lynx joins NRRI study

A local Canada lynx made a visit to the NRRI offices recently. A commercial trapper caught the cat and called a DNR Conservation Officer, who contacted NRRI. Lynx researchers Ron Moen and Chris Burdett brought the cat to the Lake Superior Zoo to make sure he wasn't injured. The lynx was fitted with a GPS collar and released near his capture site. His movements will be tracked along with nine other collared lynx in the study.

The big cats are part of an ongoing study to understand how well this threatened species is doing in Northern Minnesota. The public is welcome to follow the trail of the Canada lynx in Minnesota with NRRI and the U.S. Forest Service through a new Web site developed at NRRI:

www.nrri.umn.edu/lynx



LYNX



NRRI

Check us out: www.nrri.umn.edu

The Natural Resources Research Institute was established by the Minnesota Legislature in 1983 to foster economic development of Minnesota's natural resources in an environmentally sound manner to promote private sector employment.

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