NRRI minerals processing experts from the Coleraine laboratory moved a bench-scale operation up to pilot-scale in Duluth late last summer. Using proven minerals processing techniques, they demonstrated that material dredged from the St. Louis Harbor can be reclaimed for alternative uses instead of being stored in the near-capacity Erie Pier confined disposal facility.
What a difference a few months make! The announced closing of LTV Mining, Minnesota’s second largest taconite plant, signaled the start of a period of cutbacks by other taconite companies. Paper companies have been announcing disappointing earnings, and now other manufacturers and businesses in general are experiencing a significant downturn. Once again, despite considerable efforts to diversify, our region will be reminded that well over one half of its economy is based on natural resources.

Global economic and political forces that are beyond the scope of NRRI are at work. Nonetheless, NRRI is making an important contribution to the State of Minnesota’s economic response team that has been assembled to address the impact of the LTV closing. In this regard time has been our ally. The Institute has been able to systematically assemble a highly qualified team of professionals and the research infrastructure, in terms of laboratories and pilot facilities, to support them. Further, these individuals have a successful track record of helping to create new jobs and of improving processes and products. This is important in that the experience has given them a strong sense of what is likely to work or not to work as we address the future.

Clearly, we need to redouble efforts to assist our existing iron ore and forest product companies to improve processing costs and product quality. At the same time we need to assist them to responsibly deal with environmental and resource management issues such as mercury emissions and sustainable wood fiber supplies. We need to continue our support to non-ferrous mineral exploration interests, particularly the several projects focused on copper/nickel and the associated precious metals palladium and platinum.

Although the investment climate in the steel industry and energy costs are currently not favorable, extensive $150 to $500 million research efforts to develop new iron making technologies have been ongoing in Japan, Australia and Europe. NRRI has been following these developments and evaluating how they might be adapted to Minnesota iron ores. Scientists from four of these companies visited the Institute during the past year and, while here, presented seminars to introduce local, state and industry leaders to their technologies. NRRI has been working with IRRRB consultant Larry Lehtinen, as part of the LTV response effort, to consider options for the Iron Range. Current focus is on one of these new technologies, iron “nuggets” developed by Kobe Steel.

An important part of the LTV response effort centers around NRRI’s work to help start and expand regional secondary wood product companies. NRRI scientists have ongoing efforts with area companies and entrepreneurs, and they believe that there are enough wood product companies in the area to constitute an industry cluster. Individual companies in the cluster would each do their part in a progression of manufacturing steps required to produce value added end products. Focus is on a Japanese precision modular housing concept and on the possibility of manufacturing ready to assemble cabinetry for sale in retail chains like Home Depot.

On one final bright note, I would like to take the opportunity to congratulate NRRI’s Center for Water and Environment Director, Jerry Niemi and his colleagues for their recent award of a $6 million grant from the U.S. Environmental Protection Agency to study bioindicators as monitors of the health of the Great Lakes basin (refer to article on page five in this issue). This highly competitive award is the largest in UMD history. One EPA official indicated to me that the award is the result of an outstanding proposal that was head and shoulders better than other submissions.

Michael J. Lalich
Director
NRRI IS MAKING AN IMPORTANT CONTRIBUTION TO THE STATE OF MINNESOTA’S ECONOMIC RESPONSE TEAM THAT HAS BEEN ASSEMBLED TO ADDRESS THE IMPACT OF THE LTV CLOSING

Michael J. Lalich
Using a proven minerals processing technique, researchers have demonstrated that material dredged from the St. Louis Harbor can be reclaimed for alternative uses and not stored indefinitely in the Erie Pier confined disposal facility.

Built in 1979, the 86-acre site is rapidly approaching capacity. The cost of building a new disposal facility, if property could be located, is estimated to exceed $30 million. Extending the life of the current facility is wiser both economically and environmentally.

In a recent project sponsored by the U.S. Army Corps of Engineers (USACE), NRRI researchers built a pilot-scale processing facility that separates dredged sediments into what’s usable and non-usable. Technicians from NRRI’s Coleraine laboratory processed harbor sediment consisting of sand, silt, clay, boulders and other waste over a two-month trial period from late July through late September, 2000.

“Our main purpose was to recover any clean sand or silt that could be used for other purposes,” noted NRRI project coordinator Blair Benner. “The ratio of usable to non-usable product was directly related to the quality of the dredged material. Sandy material is easier to separate than clay.”

During the initial steps, technicians used grizzly screens to separate debris from sediment and then used hydrocyclones to separate out the sandy material. Later, the belt press squeezed water from the silt-clay overflow and the wastewater was pumped back into the disposal facility. Technicians sampled the sand, silt and water throughout the entire process for chemical and size analysis.

The reclaimed materials, mostly sand and silt-clay combination, have a marketable value and can be used as construction fill and topsoil. The remaining debris, such as rock, wood and other natural material, was taken to a local landfill. If metals or toxic materials were present, researchers expect that they remained with the fine material, as was the case with previous chemical analysis from Erie Pier and other Great Lakes harbor sediments. Test results will be reported in the near future.

In addition, the Minnesota Department of Natural Resources is experimenting with using recovered material for Iron Range mineland reclamation projects.

According to the Army Corps, the St. Louis Harbor site is an ideal place for a pilot-scale experiment because contaminant levels are very low. The results of this study will be used to determine how efficiently the processor separated the material and how cost effective these techniques are for the confined disposal facility application. It is hoped that the pilot-scale experiment could be scaled up for application to other confined disposal facilities.

“We would expect that the results of studies done on Duluth sediments would be applicable to work with similar types of sediments at harbors throughout the Great Lakes,” noted Jim Galloway of the U.S. Army Corps of Engineers.

The pilot facility was designed and custom-built by engineers and technicians at NRRI’s Coleraine laboratory. This project is an on-going effort to use minerals processing techniques to remediate dredge material. It was initially conceived and tested in 1991 with a grant from the U.S. Environmental Protection Agency to investigate methods of remediating materials dredged from “areas of concern” within the Great Lakes system.

The U.S. Army Corps of Engineers maintains 17 miles of dredged channels throughout the St. Louis Harbor. The Duluth-Superior port is the busiest of all Great Lakes ports, moving over 40 million metric tons and 1,100 vessels annually.
The drainage basin of Lake Superior encompasses 49,300 square miles, two countries, three states, one Canadian providence, 15 counties and numerous townships and tribal organizations. What happens in one section of the vast basin can have ripple effects across the entire basin. That’s why scientists gathered land use information and other relevant data and translated it into usable formats for state and federal agencies, local governments, interest groups and citizens.

Information collection formed the backbone of the project. NRRI researchers compiled data ranging from physical features like roads, governmental jurisdictions, forest communities and vegetation to technical maps of hydrology and topography. They also added historical elements such as population and precipitation trends.

“No one has developed a seamless map of the entire basin before,” noted NRRI researcher George Host. “Including both the U.S. and Canadian sides was a huge undertaking. However, now that all the data has been accumulated and synchronized, making additions and queries to the computerized databases replaces days and weeks of legwork.”

Once the information was collected and pieced together, the team molded it into formats suitable for various end-users. Based on the extensive databases, researchers developed a land use primer in compact disc format—a training tool for citizens who volunteer on various land use and planning committees. These grassroots decision-makers will use the education tool as they develop strategies for sustainable development on a regional level as it relates to the entire basin.

Land use professionals will also be able to use the data to evaluate large-scale management strategies. They could, for example, use predictive models to test the consequences of different planning options on the hydrology of a watershed. One pilot project was implemented to do just that (www.nrri.umn.edu/lsgis).

The largest stakeholders—citizens and visitors in the Lake Superior basin—will learn more about habitat and other natural resource issues via public kiosks. These interactive displays have been installed at the Northern Great Lakes Visitor Center near Ashland, Wisc. and Watersmeet Visitor Center for the Ottawa National Forest, Mich. Future locations will likely include the Great Lakes Aquarium in Duluth and Canadian sites.

As the economy of the entire basin shifts from primary dependence on minerals and timber to additional use of the natural resources for recreation and tourism, the emphasis on the lake and surrounding area will also change. This comprehensive project addresses those changes.

“If our task is to manage an ecosystem at the scale of the Lake Superior watershed, we really need to have this kind of seamless geographic data,” said Pat Collins, Lake Superior habitat coordinator for the Minnesota Department of Natural Resources.

NRRI’s Host, Lucinda Johnson and Carl Richards, former NRRI aquatics biologist and current Minnesota Sea Grant director, led the project. NRRI computer and geographical information systems specialists Gerry Sjerven and Mark White contributed to the project, which was funded by the U.S. Environmental Protection Agency and managed by Collins.
Focus on Boreal Owls

As its name implies, the boreal owl resides in northern forests. It prefers to nest in older trees with suitable cavities, primarily old aspen. These owls are also known to be secondary cavity nesters—usually claiming a nest that was first built and then vacated by another bird such as a woodpecker or flicker.

NRRI avian researchers Jerry Niemi and Tim Jones along with graduate student Lisa Belmonte are taking a closer look at boreal owls. Studying this rare bird’s basic ecology will give insight about how it reacts to forest management.

“The boreal owl has been the subject of several lawsuits regarding logging practices in northern Minnesota. We know very little about the breeding biology of the species, especially critical nest site and foraging details,” noted Niemi. “We also do not know how important the forests of northern Minnesota are to the species because it has a highly variable population with higher abundances in Canada.”

By using radio collars to track owls during the breeding season, researchers can determine the birds’ home range and movement patterns for eating and roosting. In addition, they will assess the long- and near-term changes in the birds’ breeding habitat.

The U.S. Fish and Wildlife Service lists the boreal owl as a species of concern. This project is funded jointly by the USDA Forest Service and the Minnesota Department of Natural Resources.

Great Lakes Ecosystems
National Project Centered at NRRI

NRRI was recently awarded a $6 million grant from the U.S. Environmental Protection Agency to identify, evaluate and recommend a portfolio of multi-scaled environmental indicators for the Great Lakes basin. Jerry Niemi, biologist professor and center director at NRRI, will lead the extensive collaborative effort.

This is the largest single research grant ever awarded to UMD. In addition to more than 15 researchers and technicians at NRRI, the project will include experts from the University of Minnesota Twin Cities and Duluth campuses, Minnesota Sea Grant, University of Wisconsin–Green Bay and – Madison, Cornell University (New York), University of Windsor–Canada, John Carroll University (Ohio), University of Michigan and U.S. Environmental Protection Agency—Mid-Continent Ecology Division in Duluth and Grosse Ile, Mich.

The project is one of only four awarded nationally. Parallel projects are underway in the country’s other primary coastal regions—the Atlantic, Pacific and Gulf coasts.

“At the end of the four year period, we will provide guidance to the Environmental Protection Agency on what indicators are their best bets for future monitoring efforts,” said Niemi. “This is a wonderful opportunity to critically examine which indicators can be used to determine the health of the Great Lakes coastal and near shore regions. We applaud the Environmental Protection Agency for requesting this study.”

The spring issue of NRRI NOW will feature a comprehensive story on the multi-faceted project and its objectives.
NRRI forest products researchers are taking a new look at maple—literally. While the outer sections of a maple log are traditionally used for cabinetry, flooring, furniture and veneers, the inner sections are bypassed because of coloring or other physical defects. These sections, which are currently made into transportation pallets and crates, have excellent structural characteristics and prompted industry to ask for help developing alternative, higher-value uses.

“An excellent interdisciplinary team was brought together to look at the entire need—to demonstrate high-value structural components from low-quality hardwood lumber—as a way to add value to the resource,” noted NRRI wood engineer Brian Brashaw. “In this case, the upgraded products are roof trusses, floor trusses and prefabricated I-joists.”

While the project focuses on developing the technical basis, researchers covered the entire process from lumber selection and yield, to manufacturing and testing, to product demonstration.

Headed by Bob Ross of the USDA Forest Products Laboratory, the research team (see sidebar for listing) shortened kiln-drying time by 75 percent. While this reduction does cause some minor cracking, it does not affect the structural properties of the maple and lowers the cost of bringing the resource to market.

Industry collaborators Kylmala Truss and Superior Wood Systems made trusses and I-joists of both spruce-pine-fir and southern yellow pine, the currently-used components, and of experimental maple variations. Using the test wall in NRRI’s mechanical test laboratory, researchers looked at maple’s strength, durability and load-bearing characteristics. Twenty-four feet trusses and standard-sized I-joists were tested.

Research to date shows that hard maple trusses are 24 percent stronger and 10 percent stiffer than equivalent spruce-pine-fir trusses. The maple I-joists also demonstrated properties equivalent to the currently used combination of spruce-pine-fir.

Yield analysis indicates that maple is a healthy, wealthy resource. Researchers estimate that over 100 million board feet of red and sugar maple are available in Minnesota, Wisconsin, Michigan and the New England states. Based on the current market, Brashaw estimates that the value of these low-grade hardwoods could increase by 100 percent if they are made into trusses or I-joists.

According to project leader Ross, this is a valuable project for the USDA Forest Products Laboratory, which focuses on adding value to under utilized hardwood resources in the Great Lakes and New England States. “We believe that this project has substantial implications for forest management and exciting potential for using hardwood lumber as structural components in residential and light commercial construction,” he said.

In future steps toward commercialization, researchers will demonstrate these I-joists and trusses during the 2001 construction season. Researchers will then pass the entire technology package on to industry, which can then pursue a certified lumber grade stamp from the American Lumber Standards Committee.
Minnesota has a history rich in minerals prospecting. Despite the lack of gold rush-like fanfare, NRRI geologists spend weeks at a time in the field, working their way across the forests and fields of northern Minnesota. Armed with pick and hammer like prospectors of old while using the latest in technological advancements, they meticulously plot, map, test and document billions of years of rock formations in their quest for rich mineral deposits.

Similar to investigators compiling a case, geologists gather evidence from a variety of sources. Starting in the field, they use machetes to hack narrow forest trails while noting outcrops on field-drafted maps. These trained investigators search for other clues to what lies beneath the surface using documented information such as geochemical and geophysical data along with professional intuition.

As they walk miles on mapped grids, they sometimes seek what is known in the industry as “biogeochemical indicators.” For example, science has proven that balsam fir trees indicate gold mineralization and large leaf asters may grow in areas where nickel is present. Submitted as circumstantial evidence, these indicators add more substance to the case.

Aerial photos, geological data, historic data, geographic information systems and maps from a variety of sources also point geologists in the right direction.

Once a promising outcrop is sited, researchers peel back the moss carpet like detectives unearthing a clue. They then use rock hammers to extract a core sample that is about two inches in diameter and six- to eight-inches deep. All samples are carefully bagged, documented and sent to the lab for chemical analysis. They also use a hand-held global positioning system to lock in the coordinates of each outcrop and drill core site.

In the laboratory, technicians log, test and characterize the samples. The scientists then compare their findings with known data from other geographic areas. For example, areas of Canada may already be mined for certain minerals. How does the information from northern Minnesota compare to what’s documented? How does it differ? Historical information and database comparisons give even more clues about an area’s geological make-up.

Packaged in the form of technical reports, physical evidence and extensive databases, these clues are accessible to prospectors of the future.

The NRRI geological team of Steve Hauck, John Heine, Julie Oreskovich, Rich Patelke, Dean Peterson, Mark Severson and Larry Zanko collectively compile nearly 125 years of prospecting and mineral exploration experience. They work closely with the Minnesota Geological Survey and the Minnesota Department of Natural Resources Minerals Division to present evidence of Minnesota’s rich geology.
Business Expansion

Setting a Path for Growth

Pop culture of the late-90s saw skate-boarding, in-line skating and trick bike riding emerge as growing sports. In stride with that trend, TrueRide, Inc., a Duluth-based business began designing, manufacturing and installing complete skating parks across the country. Based on strong sales and a proven product, the established business is poised for expansion and growth. In a current project with NRRI forest products engineers and business consultants, they hope to look at three varying but related aspects of the company.

First, TrueRide officials want to refine the look and manufacturing of their product to help differentiate it in an increasingly competitive marketplace. NRRI’s Brian Brashaw, Bob Vatalaro and Dave Halverson are working with TrueRide to incorporate alternative materials, starting with the prototype stage and moving into production. The testing phase will ensure that TrueRide maintains its current high standards.

Second, as the ramps are re-designed, they will evaluate and streamline the entire manufacturing process so that more of the skate parks are produced in the factory instead of on-site—a costly and time-consuming practice. With improved appearance and lower-cost manufacturing, TrueRide expects higher sales and an additional share of the market.

“We see working with NRRI as an important step in becoming a long-lasting, sustained business,” noted company chief executive officer, Greg Benson. “We are a small business and we simply don’t have the resources in-house to accomplish the goals the market has set for our company.”

Third and hand-in-hand with the manufacturing modifications, Kathy Forslund of the NRRI business group is helping TrueRide develop a long-term business plan. Company officials will closely examine each segment of TrueRide’s operations as they project the next several years in terms of sales, production, physical expansion and financing.

“With a strong business plan, we can secure funding to upgrade our tooling for advanced and more efficient production,” said Benson. “This will create a better, more productive work environment both at our facility in Duluth and in the field.”

The business plan will also better position TrueRide to seek financing alternatives and estimate future personnel growth and physical storage expansions.

TrueRide currently employs six full-time and eight seasonally at their plant north of Duluth. The company posted $1.2 million in gross sales this year. With technical and business assistance from NRRI, TrueRide will readily meet growing skatepark demands worldwide.
For over 12 years, NRRI staff has been helping businesses through a crucial commercialization step—the testing phase. With capabilities as varied as the clients, the NRRI mechanical testing laboratory equipment tests strength, durability, wearing and weathering.

Northern Contours, a manufacturer of cabinet and furniture components, works with NRRI researchers on quality control issues. Using accelerated aging methods, they determine if a membrane-pressed cabinet door will separate at finished seams or if the veneer on a wood door will crack due to heat or humidity. Similar tests are run on sample products for Van Technologies, a Duluth-based coatings company. For example, a cabinet door coated with a Van Technologies product was cycled three times from 120 degrees and 70 percent relative humidity to –10 degrees Fahrenheit. These hot-cold crack tests follow the Kitchen Cabinet Manufacturers Association guidelines, a vital quality and marketing factor for clients.

“The testing performed by NRRI provided an independent, third party evaluation of our line of wood finishes,” noted Larry Van Isgehem, company president. “The results enabled Van Technologies to instill customer confidence in the quality of our product line.”

NRRI researchers also conduct abrasion tests to determine how a product or finish will hold up over time. Flooring samples coated by Van Technologies undergo repetitive cycles to imitate high traffic areas or furniture being dragged across the floor.

“Our clients use the testing data and results in many ways. To some, it ensures that the products performed as designed, yet for others it is a critical component during the development of a new product,” said Brian Brashaw, NRRI wood engineer. “Performance testing is an important part of any new product introduction and the use of our facilities offers a competitive advantage to our clients.”

The lab’s test wall applies up to 50,000 pounds of pressure on many different types of wood samples. In the past, four-by-eight-foot wall sections, wood I-joist and building trusses have been tested at NRRI, the only public-use lab in the state. (See page 6 for more information about a current project.)

The testing facilities also include a chemical laboratory for specialized experiments. NRRI’s coatings specialist Victor Krause attempts to stain or fade kitchen and bath cabinet doors with household items such as tea, orange juice, wax crayons and chemicals like iodine, ammonia and nail polish remover. The documented results from these stain resistance tests give clients such as Northern Contours a competitive advantage and a comfort level that their product can withstand tough kitchen, bath and office environments.

Researchers also look at wear and tear on hardwood truck flooring for several Minnesota-based clients. Using a machine fabricated at NRRI, a 12,500-pound load is repeatedly driven over an eight-feet by 10-feet piece of hardwood truck flooring, simulating repeated loading and unloading of freight. This dynamic truck testing technique demonstrates long-term performance and load capability.

All testing equipment in the lab is calibrated with ASTM standards annually and the staff regularly attends seminars and workshops covering testing methods and standards to ensure they are well-versed in the industry’s testing requirements and methods.
NRRI researchers are continuing to examine amphibian communities and the landscape in which they reside. Through three separate projects, scientists are looking beyond individual sites to gain a better perspective on the health of wetlands and amphibian communities.

**Amphibians as indicators**

Because amphibians share similar developmental pathways with other vertebrate species, use similar processes for detoxifying and eliminating pollution from their bodies, and have complex life histories that can include both an aquatic and terrestrial phase, they are valuable as indicators for a wide range of environmental conditions.

The field collection studying the use of amphibians as environmental indicators of wetland conditions has been completed. At 64 sites (including 13 watersheds in three states), researchers gathered data on the frog community, water quality, sediments and vegetation, landscape information, and other environmental variables. Field collection of species was based on frog breeding calls and field observations. The second and third years of this study changed in scope to include more intensive analyses and more detailed wetland and frog health assessments at 36 sites in central Minnesota and Wisconsin.

In addition to visual observations at field sites, satellite imagery and aerial photography were used to characterize the landscape surrounding each wetland. Parasite and frog health data are being assembled by NRRI’s partners at the U.S. Geological Survey National Wildlife Health Center and the University of Illinois Veterinary School. NRRI researchers are analyzing the frog-wetland and frog-landscape data. Together the partners will analyze health data in the context of the wetland and landscape data.

“This study is unique in that we are looking at a wide spectrum of health issues in amphibians, not just malformations, and are analyzing this information in the context of the entire landscape, rather than on a site-by-site basis,” said Lucinda Johnson, principal investigator for the project. “As we look at the overall picture, we hope to include information that may have been overlooked in research conducted with a narrower focus. To our knowledge, ours is the only truly randomized study that examines the occurrence of frog malformations across a large region.”

**UV study**

UV-B radiation has increased in recent decades due to decreased ozone in the atmosphere and is associated with increased incidences of skin cancer. In early spring, when some tadpoles first develop, potential exposure to UV-B radiation is greatest and protective vegetation is not yet developed. Preliminary lab studies at the Environmental Protection Agency indicate that tadpoles exposed to ambient light with high-intensity UV-B radiation show both increased mortality rates and malformations.

NRRI’s data collection measuring UV-B in amphibian breeding ponds is now complete. From spring through fall, 10-12 wetlands were studied over two summers to measure UV light levels in ponds used by amphibians.

Light (including UV radiation) penetrates to different depths in the water column depending on water clarity. Researchers are developing models to predict the rate of UV light extinction in the water column using simple water chemistry parameters. They also are developing economical techniques to measure the amount of UV light received over time.

“This is a critical part of the risk assessment process for determining the true exposure...
The leopard frogs are emphasized in the frog health component of the indicator study because they are commonly found at most of the field sites. All studies look at the whole amphibian “community.”

Wood frogs and blue-spotted salamanders were picked for the vernal pool project because they both: 1) characteristically use vernal pools (ephemeral wetlands) for breeding, and 2) disperse into woodland habitat after breeding, and 3) are commonly found in the study area.

Forest fragmentation

Another research project funded by the U.S. Environmental Protection Agency studies the effects of forest fragmentation on vernal pool habitats (small pools that dry over the summer) and their amphibian communities. Emphasized in this study are the commonly found wood frogs and blue-spotted salamanders chosen because they both use vernal pools for breeding and then disperse into woodland habitat.

NRRI’s Cathy Johnson is a co-principal investigator on the $770,000 project. Overall, habitat structure and other environmental variables (light, water chemistry) will be examined to quantify the effects of forest fragmentation on vernal pools. Sites in Grand Rapids, Duluth and Wrenshall are being studied. Local breeding populations are being studied at eight fragmented and unfragmented sites near Wrenshall.

“We visit the sites daily to individually mark captured frogs and salamanders leaving or entering each pond,” said C. Johnson. “Recapture of marked individuals will give us information about habitat use, interpond movement and the effect of fragmentation on those phenomena.”

After three years of data collection, research partners at the University of Colorado will create a computer model to predict results of landscape changes on the persistence of wood frog and blue-spotted salamander metapopulations (groups of separate breeding populations connected by the migration of a few individuals living in the same area).
David Lonsdale, executive director of the Great Lakes Aquarium, and NRRI geologists Steve Hauck and Mark Severson along with UMD geology professor emeritus John Green examined thin section mineral slides at the newly opened Great Lakes Aquarium. Hauck and Green were instrumental in acquiring the thin sections while Severson wrote the exhibit descriptions. In addition to their roles as economic geologists, the minerals experts often contribute their time and skills to community organizations such as the Aquarium.

Retraction
Sharp-eyed readers already spotted the fact that this bird was incorrectly identified as a Black-capped Chickadee on the last issue and is actually a Mountain Chickadee. All errors rest solely with the editorial staff. We apologize for the confusion. –Ed.