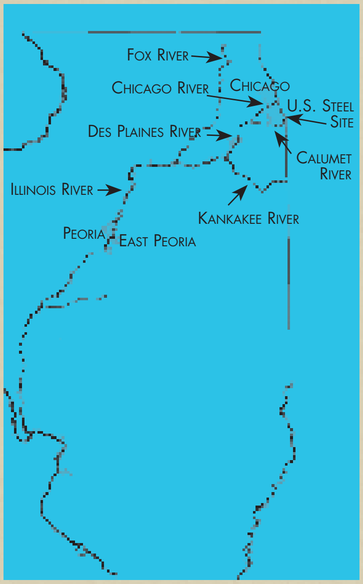
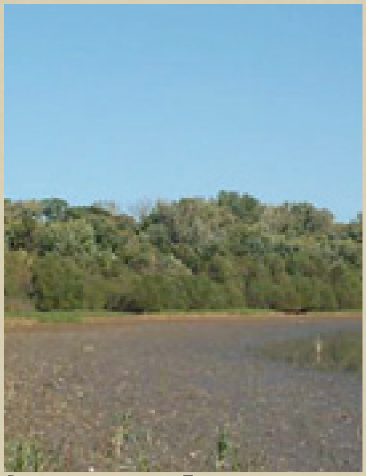
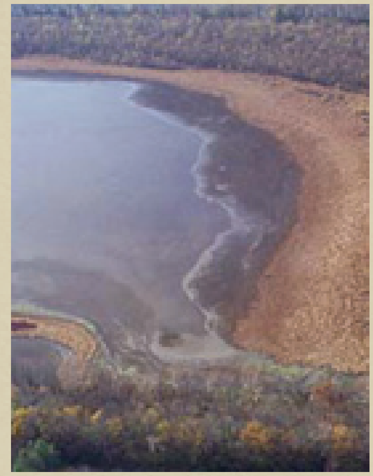
# RETURNING THE SOIL TO THE LAND

## *The Mud to Parks Project*

by John C. Marlin and Robert G. Darmody





*Previous page, top:* The development of East Peoria's Riverfront Park, from the deposition, drying, and vegetating of sediment in spring and summer of 2000, to the finished park in 2004. *Previous page, bottom:* An aerial view of the U.S. Steel South Works site on Lake Michigan before sediment was placed along the waterfront for a park. *Above:* Both ground level and aerial views of an Illinois River backwater show sediment deposition.

Giant floating cranes digging in Lower Peoria Lake, northbound barges filled with mud, and mining trucks pouring 20-ton mud pies onto Chicago slag fields are part of an ambitious pilot project to return displaced soil to the land. The mud, soil eroded from farm fields and stream banks, was choking the life from Illinois River backwaters, and the slag fields had no topsoil. The "Mud to Parks" project highlights a rare opportunity to simultaneously generate environmental, recreational, and economic benefits in two distinct areas of the state.

Large-scale beneficial use of sediment is an attractive option for restoring aquatic habitat along the Illinois River, which is filling with soil at an alarming rate. The Illinois State Water Survey determined that by 1985 over 70% of backwater storage capacity was gone and today few areas outside the main channel exceed 18 inches in depth. The Peoria lakes alone contain enough sediment to cover a football field to a depth of 10½ miles. Some 60,000 acres of water that once supported the nation's second largest fishery are now too shallow for even small recreational boats.

Restoration efforts must take into account the altered hydrology of the watershed and the presence of navigation dams and levees. Thus, a variety of concepts and methods are likely to be used. These include large agricultural levee districts that are converted to wetlands and are relatively isolated from the river. Another method constructs low, frequently overtopped levees, which are favored by waterfowl advocates. A third method involves periodically removing sediment from portions of connected backwaters and side channels to restore a variety of depths. Connectivity is especially important to

The weathering process begins with the placement of wet sediment that soon dries and cracks into polygons. Further weathering by wetting, drying,

Rough, graded sediment dries at the U.S. Steel South Works site along Lake Michigan.

fish adapted to moving onto floodplains during high water for feeding, spawning, and finding shelter. The deep-water pockets also provide habitat away from the main channel for overwintering fish.

Removing enough sediment to restore even minimal amounts of aquatic habitat is daunting. It must be excavated from the water and moved to a placement site or transfer location. The availability of land for placement, distance from the dredge site to the area, and public perceptions all factor into a project's feasibility.

## Is Illinois River Sediment Topsoil?

Dredged material was traditionally considered "spoil" and was "disposed of" often in confined disposal sites. Sediment from urban and industrial areas is often heavily contaminated and warrants such caution. However, the increasing use of dredging to restore capacity at water supply reservoirs and revitalize aquatic habitat caused the U.S. Army Corps of Engineers (USACE) and others to reexamine sediment quality. There is a growing recognition that sediment derived primarily from rural, freshwater areas has potential beneficial uses including fill, landscaping soil, soil amendments, or as topsoil at strip mines, old industrial sites, and other areas.

Illinois River sediment is largely derived from Illinois topsoils, which are among the best in the world. Sediment from most locations has physical and chemical properties, including texture, favorable for optimal plant growth. Silt-sized particles are the most common in the Peoria lakes reach of the river where most of our work centers. There, the silty texture of the sediment provides good soil moisture storage for plants. The sediment also has organic matter content similar to productive Illinois agricultural topsoils.

Favorable chemical properties of Illinois River sediment include high calcium content and consequently an elevated pH. This encourages growth of most farm and garden crops. Micronutrients such as zinc are also plentiful. The unfavorable chemical constituents often found in sediment from marine and estuarine environments are essentially absent.

These favorable properties of Illinois River dredged material emerge only after the material undergoes dewatering and soil formation processes known as weathering. When initially applied to the land, sediment is wet and in the form

and freezing and thawing break down the polygons into smaller aggregates.

Within a year, the developing soil structure allows good root penetration.

Sediments alone or mixed with biosolids and/or compost support lush greenhouse vegetation.

Grasses sown on wet sediment grow best in the drying cracks and help soil structure formation and control erosion.

Sandy soil in adjacent research plots amended with sediment show more vigorous growth of corn and soybeans.

Corn yields are dramatically increased when sandy soil is amended with sediment.

of a runny to thick paste simply described as "mud." During weathering it hardens and cracks, forming blocklike polygons, and assumes the appearance of cracked concrete. However, this material quickly breaks down with wetting and drying, freezing and thawing, or tillage, to form granular soil structure. We have found that sediment applied in the fall that freezes while still very wet forms a thin layered soil structure by the following spring.

Several field and greenhouse demonstrations show that plants grow readily in weathered sediment. In one experiment, sediment was applied to sandy topsoil in layers 3-, 6-, and 12-inches deep in large research plots. We grew corn in the sediment and untreated sand plots with identical fertilizer and irrigation inputs. Corn yields were as much as four times greater in sediment plots. This demonstrated that sandy soils could be improved for crop growth by the addition of sediment. We have also successfully grown prairie plants and turf grasses in sediment without tillage, fertilizer, or irrigation.

Because sediment from more industrial areas is often contaminated with toxic materials, we conducted greenhouse experiments to determine if plants grown in Illinois River sediment from the study area accumulated any toxic materials. While analyses of sediment shows that some industrial-related chemicals are elevated as compared to pristine topsoils, our results indicate that toxic industrial metals such as mercury, lead, and cadmium are not a serious problem in the river reach we studied. Plants, including legumes, grasses, and vegetables, grew well in sediment and did not accumulate metals at levels that would cause concern for human consumption. However, because there are no firm standards for most chemicals in topsoil, it is important to consider the risks associated with soil from any source.

The results of all the field and greenhouse studies that we have conducted on sediment are consistent. Sediment from the portions of the Illinois River we have researched makes excellent topsoil after dewatering and weathering.

## Moving Mud

Traditional dredging methods were generally designed for digging deep channels or adding volume to reservoirs. The variety of depths and relatively shallow wetland expanses for ecological restoration will require some innovation. Moving the material far enough for beneficial use or upland placement is another problem.

A variety of dredging equipment exists that is based on two basic concepts. Hydraulic dredging typically mixes sediment with up to 90% water and pumps it through a pipe that can be several miles long. The main drawback is the need for large settling and drying ponds to cope with the water. Mechanical dredging generally uses an excavator or crane to pick up sediment with little extra water and place it on an adjacent shore or vehicle. The method chosen depends on distance, handling options, and the anticipated use.

The City of Chicago and the Chicago Park District expressed interest in using river sediment at the 573-acre U.S. Steel South Works redevelopment site on Chicago's south side. About 100 acres bordering Lake Michigan will become part of the lakefront park system, but is covered with steel-mill slag devoid of topsoil. Moving reclaimed soil by barge directly to the site was attractive compared to taking it from suburban construction sites, an option that would require thousands of large trucks moving over congested urban highways and through neighborhoods. Lieutenant Governor Quinn called meetings of interested agencies in June of 2003 to determine if a project was possible. Sampling, risk assessment, and permitting preceded signing agreements in April of 2004. Chicago received a $1.4 million Illinois Department of Commerce and Economic Opportunity grant to obtain reclaimed topsoil.

The Fon du Lac Park District's Spindler Marina access channel at East Peoria was the sediment source. The channel extends about 1,000 yards from shore to the navigation channel and needed dredging to restore depth for recreational boats. The district had participated in several demonstration projects. Additionally, the sediment in the area had been tested for contaminants and could be excavated to the 11-foot depth needed to load hopper barges.

### Bipartisan Action Addresses River Issues

The past 25 years saw increasing public concern over the declining health of the river and its floodplain. Governors Thompson, Edgar, Ryan, and Blagojevich all encouraged restoration efforts. The legislature created the Illinois River Coordinating Council to promote integrated management. Pat Quinn (above left) is the third lieutenant governor to head the council while Congressman Ray LaHood (above right) of East Peoria champions the bipartisan effort in Washington. The Illinois Department of Natural Resources and the U.S. Army Corps of Engineers are the lead agencies in developing strategies that include emphasis on floodplain restoration, upland erosion control, and backwater rehabilitation.

Midwest Foundation, a company in Tremont, IL, that builds bridges and navigation structures, excavated the sediment. Most of the material was removed with a clamshell bucket designed to minimize turbidity. The bucket brought up $5^{1}/_{2}$ cubic yards of mud weighing about 7 tons with each swing, and dropped it into barges, each of which held 1,500 tons of mud. Once the barges were filled, three companies, each with a specific function, relayed them 168 miles to Chicago.

ARTCO Fleeting of Peoria, an ADM subsidiary, was the prime contractor. It provided barges and handled fleeting, which is similar to a railroad switchyard operation. Individual barges were towed 5 miles to a staging area.




*From left to right:* Dredging techniques mix progressively less water with the sediment. Shown are the discharges from a hydraulic dredge, a slurry pump, a concrete pump, and a clamshell bucket.

Loading barge on Lower Peoria Lake in April

Discharging from clamshell bucket

Loaded barge with towboat

Dumping sediment at U.S. Steel South Works site

Bulldozing wet sediment

Reclaimed topsoil drying on slag field

Loaded mud barges were combined with others into groups of 15 and taken to Lemont by Illinois Marine Towing. In the narrow man-made Cal-Sag Channel between Lemont and Chicago, Holly Marine used towboats with telescoping pilothouses that lower to pass under bridges.

Upon arrival, the mud in some barges had dried and cracked. In others, varying amounts of free water, mostly from rainfall, was present in shallow pools on top of the sediment. Excess water was pumped onto a field to prevent it from mixing with the mud during unloading, which would make it more difficult to handle.

Beemsterboer, Inc., which has considerable experience handling steel-mill slag and wet soils, unloaded and placed the mud. A large crane with a tight-closing bucket lifted 10-cubic-yard dollops of mud from barges to mining trucks with minimal spillage. The plan was to spread the material about a foot thick so that it would dry rapidly and could then be pushed into piles 6 to 8 feet high after a week or two, freeing up the space for more mud. About 15 acres would be covered south of the slip and an additional 20 acres on the north.

On the first day, a bulldozer pushed up a 2-foot-high dike of slag to contain the wet mud. However, it was soon apparent that this was unnecessary because the material formed stationary cohesive piles about 2½ feet deep and 20 feet across when poured from the trucks. The depth could be increased by dumping loads over each other, or decreased by dumping from moving trucks. A bulldozer had no difficulty spreading it immediately after dumping.

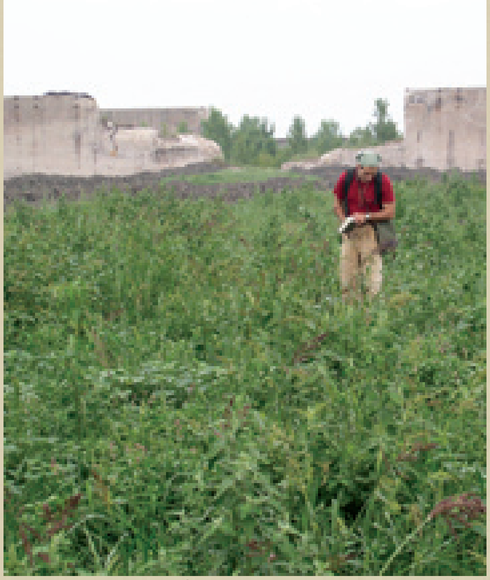
After drying for a week, the top 8 inches of material was pushed into piles, which supported a person's weight within a day. A delay in availability of the north field necessitated


Barges awaiting unloading in Chicago


Offloading barge onto truck in Chicago


Removing the last of the sediment from barge


Emerging vegetation in June


Lush vegetation growing in July


Sunflowers growing in September

placing material deeper on the south field and piling it with a higher moisture content than planned. Erosion was not a problem because the cracks in the drying sediment collected rainwater. The process continued until the 68th barge was unloaded in July. In mid-September a low-ground-pressure bulldozer spread the soil on the southern field to a depth of 2 to 4 feet, and it was seeded with rye grass. The grass was well established by December.

Grass and alfalfa were planted on portions of the fields at various times. Rye grass was planted in April and germinated within 10 days. Seeds grew best in cracks where roots found moisture after drying crusted the top. Volunteer weeds on the bulldozed piles grew up to 6 feet tall by September. The Illinois Natural History Survey identified 79 species of vascular plants in the southern sediment piles. Seventeen of them were wetland species. The others either were on site initially and were mixed in with the sediment, or were in the sediment seed bank. On the undozed northern field, seeded grass and sunflowers grew well as did thousands of volunteer cottonwood seedlings.

## Moving to the Future

The soil in our rivers and lakes is a valuable, though out-of-place, resource. The Mud to Parks project clearly demonstrates the technical feasibility of transporting river sediment long distances for use as soil in a variety of potential applications. The ability of this type of project to provide benefits in two or more geographic areas raises the potential for cost savings and sharing across projects. We believe this concept merits consideration as the social, economic, and environmental costs and benefits of the way we currently use soil and water resources are evaluated.



## Sediment-Handling Demonstrations

The Illinois Department of Natural Resources' Waste Management and Research Center is working with the other Illinois Scientific Surveys, several companies, and the USACE to find innovative ways to restore shallow backwaters. The goal is to develop equipment that will operate in about 2 feet of water and excavate material with little added water. The thick sediment must then be transported over distances for island building or other beneficial uses. Without such equipment, restoration to reasonable depths in most backwaters will be extremely difficult or impossible.

Small-scale demonstrations show that conveyor belts and concrete pumps are both capable of moving sediment. As shown in photos (below right), truck-mounted booms are able to place the material at various elevations and thicknesses. The basic equipment can be adapted to float on shallow water. The dry dredge was used in Upper Peoria Lake to build a test island held in place by geotextile tubes filled with mud (below left). This small prototype operates in 2 feet of water and can push material hundreds of yards with an onboard concrete pump. When funds become available, equipment will be adapted for pilot projects in backwaters.

A variety of companies joined in this effort, often donating the use of equipment and expertise. In addition to those mentioned elsewhere, Caterpillar Inc., Kress Corporation, N.E. Finch Company, Brennan Marine, Anderson Engineering, Geotec Associates, Cochran and Wilkins, Roberts and Schaefer Company, Seneca Petroleum, CF Industries, DRE International Inc., Patrick Engineering, Arrow Terminals, Putzmeister, Inc., and many others provided assistance.

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*Additional information about this project is available at www.wmrc.uiuc.edu under "Illinois River Project." Other useful Web sites include: http://ilrdss.sws.uiuc.edu/ and http://www.mvr.usace.army.mil/Products/Projects.asp.*