Lake Dredging

The Dredging Feasibility Study

Dredging is the removal of accumulated lake bottom sediments ("muck"). The decision to dredge should be based on sufficient study that shows accumulated sediment is having an adverse impact on water quality, recreation, or navigation. This decision process includes defining what you want to use the lake for (such as recreation or water supply) and how you'd like the lake to appear (water quality), and then determining if lake sediment is affecting these factors. If so, the study should compare alternatives to dredging to see if sediment removal is indeed the most cost-effective solution.

The study should identify the sources of the sediment coming into the lake and calculate how much sediment has accumulated. Sediment sources from the watershed (such as from construction sites, eroding streambanks and shorelines, urban and agricultural runoff) should be controlled. Dredging is too expensive to do repeatedly!

Sometimes it is necessary to employ the services of an experienced professional to conduct a dredging feasibility study and help determine if dredging is the most practical alternative. Engineering data and design are almost always needed. The sediment's chemical composition must be tested to determine if contaminants are present. Disposal sites for the dredged sediment must be identified, costs must be calculated, bids must be let . . . as you can see, there are many aspects to the dredging decision. This *Lake Notes* publication is designed to give you the background to help make that decision.

Why Remove Sediments?

Sediments are commonly removed to improve navigation; restore recreational access for leisure boating, swimming, and fishing; or regain lost storage capacity in water supply reservoirs. Dredging also is done to remove nutrient-rich sediments, remove toxic substances, reduce rooted aquatic plant growth, lessen sediment resuspension by winds and waves, and improve fish habitat.

Dredging sometimes can improve water quality by reducing the amount of nutrients available from the sediments, thereby reducing nuisance algae blooms. This can occur through direct removal of nutrient-rich sediments, or by deepening the lake enough to allow thermal stratification to develop and thereby limit nutrient movement from deep-water areas to the upper waters (see the *Lake Notes* fact sheet “Lake Stratification and Mixing”). Dredging in areas of rooted aquatic plants controls their growth through direct removal, and also can limit future regrowth if the new water depths are deeper than sunlight can reach. For lakes that freeze over in the winter, fish survival can be enhanced by removing oxygen-demanding sediments and creating deeper water areas.

Sometimes, however, sediment removal can dig up the unexpected. Dredging too shallow may uncover fertile sediments and provide a perfect place for aquatic plants to grow if the bottom gets enough sunlight. Dredging too deep may expose old arsenic treatments (a herbicide used years ago to treat algae) or nutrient-rich wastes from a forgotten sewage treatment plant. Before dredging begins, you'll need to have sediment cores analyzed by a qualified professional.

Where to Dredge?

Sediments can be removed from either the entire lake basin or just selected spots. Dredging the whole lake increases its average depth, but that can be prohibi-tively expensive—and can (at least temporarily) impact the lake's ecosystem. Dredging just in certain areas ("spot" dredging) is less expensive and less ecologically damaging since only a portion of the lake bed is disturbed. Furthermore, a smaller sediment disposal area is needed. Spot dredging can be beneficial in improving boat and shoreline access, clearing clogged channels or bays, creating hollows for coolwater fishes in the summer and deeper areas for fish in the winter, and forming boat and fish "cruising lanes" through aquatic plant beds.

How Do You Calculate How Much Sediment to Remove?

One method used to determine the accumulated sediment volume involves setting up a grid pattern over the proposed dredging area. At each grid point the water depth and depth to original lake bottom are measured using graduated probing poles. A "contour map" of sediment thickness is created from these measurements. Other methods include the Average End Area Method and Dobson's Prismoidal Formula. Both utilize sediment measurements made along transects across the lake, providing cross-section or profile views.

For small areas you may be able to do the field measurements and calculate the accumulated sediment volume yourself. For big jobs, more sophisticated equipment and/or a consultant may be necessary. Resource agencies and consultants can provide guidance on choosing an approach.

How are Sediments Dredged?

For small jobs of a few to no more than 50 to 100 cubic yards, you may be able to do it yourself using buckets, shovels, small pumps, or small excavating equipment. For big jobs, large earthmoving equipment or hydraulic dredges are needed.

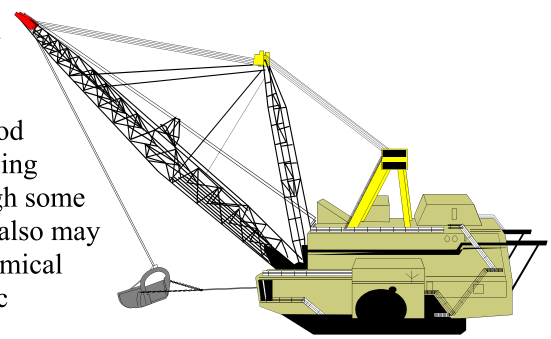
MECHANICAL DREDGING can be done either "in the dry" or "in the wet." Dry mechanical dredging involves either partially or completely draining the lake to expose the sediments to drying or freezing conditions. Conventional earthmoving equipment such as bulldozers, scrapers, backhoes, and draglines are used to remove the sediment. The equipment either works from shore or moves down onto the dewatered lakebed. The sediment may be stockpiled on shore and then hauled away in dump trucks to a disposal location, or directly loaded into awaiting dump trucks.

Wet mechanical dredging does not involve drawing the lake down. Backhoes, draglines, or grab buckets are used to scoop up the sediment. The equipment can either work from shore or a floating barge. Wet mechanical dredging usually causes severe sediment resuspension and turbidity (muddiness).

Mechanical dredging is better at removing hard or rocky material than hydraulic dredges. It is useful for small projects such as dredging bays and shorelines, and for small projects can be less expensive than hydraulic dredging. It may be the only option if land for a sediment disposal basin is not nearby, or if the lake's water volume is too small to allow hydraulic dredging. Mechanical dredging is ineffective at removing watery deposits, is labor intensive, and can disrupt lake usage (if the lake is drawn down).

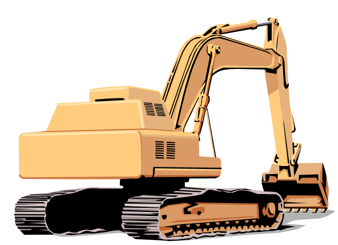
HYDRAULIC DREDGING does not involve drawing down the lake water. The dredging machinery is incorporated onto a floating hull. A cutter with steel blades dislodges the sediments, and a centrifugal pump "sucks up" the muck. This sediment/water mix (called a slurry) is piped to a disposal basin on land where the water is drained off and the sediments are left to dry. Because lake water is removed along with the sediment (hydraulic dredging slurries are commonly 80-90 percent water), this type of dredging requires that enough water volume is maintained in the lake to keep the dredge floating.

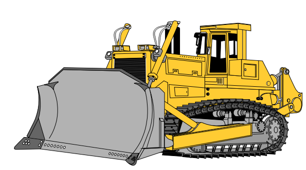
Hydraulic dredging is faster than mechanical dredging, creates less turbidity than wet mechanical dredging, and can effectively remove loose, watery sediments (greater than 70 percent water). It is typically the most cost-effective method for large dredging projects (though some small projects also may be more economical using hydraulic dredging).



Two types of hydraulic dredges are best suited for most Illinois lake sediments: horizontal auger and cutterhead dredges.

A **horizontal auger dredge** utilizes vertical "knives" on a rotating auger to cut and loosen the sediments. The auger is mounted on a boom at the front of the dredge hull. The dredge moves across the lake by a winch attached to a taut cable, and it can cut while moving forward or backward.





These types of dredges work well for soft silts and cause little turbidity. The auger dredge is smaller than a cutterhead dredge and removes sediment in a more concentrated form (less water is removed from the lake). The dredge operator can closely control the auger position and cutting depth. Horizontal auger dredges can remove sediments in up to 20 feet of water (30 feet with extensions), and can remove up to 120 cubic yards of silt per hour.

The **cutterhead dredge** utilizes a rotating "basket" comprised of smooth or toothed blades (depending on the sediment consistency) to dislodge the sediment. The cutter is mounted on a boom ("ladder") at the front of the dredge hull. The ladder also supports the suction pipe. The cutterhead is "swung" through the sediment to cut it as the is dredge stabilized by one of two spuds (vertically mounted pipes located at the rear of the dredge on each side) pushed into the lake bottom. After a swing is completed, the dredge "walks" forward using the spuds. Cutterhead dredges are larger, can dredge deeper (up to 26 feet, or 55 feet with ladder extensions), and have higher production rates (150–350 cubic yards per hour) than horizontal auger dredges. They can cut compacted sediments and some original lake bottom soils, and can work where there is debris and weeds. As with auger dredges, the cutterhead dredge operator can closely control the cutting depth.

Where are the Sediments Put?

Croplands and pasturelands are commonly utilized for land-application of trucked sediments or for siting disposal basins. Landfills are another option for trucked sediments, although landfill fees greatly increase project costs. The closer the disposal site is to the lake, the better. In urban areas where open land is scarce, finding a proper site nearby may be very difficult. Generally, dredging is more cost-effective when the disposal site is located within one mile of the dredging area. However, it is not uncommon to hydraulically pump sediments up to two miles or more, or truck sediments even farther. Dried sediments later may be incorporated into the landscape at the disposal site. Alternatively, the dried sediments may be removed and used as fill or disposed of elsewhere.

For hydraulic dredging projects, a disposal basin must be designed and constructed to hold not only all the dredged sediments once they've dried, but also be large enough to allow the pumped sediment/water slurry enough time to settle out the solids and return relatively clear water to the lake. Also, because lake sediments tend to increase in volume temporarily during hydraulic dredging, a "bulking factor" is added when designing the disposal basin. A 120% bulking factor is typical. For example, if 10,000 cubic yards of sediment were to be dredged, the disposal basin would have to be sized to hold 1.2 times 10,000—or 12,000 cubic yards.

Geology of the disposal site must be considered as well. Some sites may be too porous and could allow nearby lakes or streams, or the groundwater table, to be impacted. Costs increase when the sediments must be trucked far away or the disposal site modified to contain the sediments. If the lake sediments themselves are found to have elevated concentrations of contaminants (e.g., heavy metals, certain pesticides), special handling and disposal will be required. Nutrient-enriched sediments are not considered contaminated and therefore do not require special handling.

Costs

Any costs associated with conducting the dredging feasibility study are separate from actually removing the sediments from the lake. As you've probably heard, dredging can be expensive. However, when coupled with measures to control soil erosion in the watershed, the effectiveness and benefits of dredging can be longer-lived.

Dredging contractors are usually paid on the basis of cubic yards of sediment removed. Dredging costs can vary greatly—from $5 to $15 per cubic yard for hydraulic dredging (including engineering design and construction of the disposal basin), and from $8 to over $30 per cubic yard for mechanical dredging projects (including disposal). It's a good idea to get quotes from several experienced dredging contractors.

As an example, let's calculate how much it might cost to remove 1 acre of sediment 5 feet thick that has clogged a channel. This equals 5 acre-feet or 8,067 cubic yards of sediment. Using a hydraulic dredging cost of $15 per cubic yard for such a relatively small project, this equates to about $121,000.

Costs can be reduced by scaling back your project, pumping or hauling shorter distances, or, if possible, conducting the work during winter when construction equipment tends to be idle.

Permits

Dredging projects, both mechanical and hydraulic, are subject to permitting by the U.S. Army Corps of Engineers, Illinois Department of Natural Resources–Office of Water Resources, and Illinois Environmental Protection Agency. It is best to begin the permitting process as early as possible during your project's planning phase. You can contact Illinois EPA's Division of Water Pollution Control, Permits Section, at 217/782-0610 for more information and to request a permit application.

Lake Notes is a series of publications produced by the Illinois Environmental Protection Agency about issues confronting Illinois' lake resources. The objective of these publications is to provide lake and watershed residents with a greater understanding of environmental cause-and-effect relationships, and actions we all can take to protect our lakes.

Hydraulic auger dredge illustration courtesy of Mudcat Division of Ellicott International. Hydraulic dredging operation illustration courtesy of Tennant's Industrial Dredging. Cover illustration from University of Wisconsin-Extension's *Lake Leaders Handbook*.

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For more information about other publications in this series and to request copies, please contact: Illinois Environmental Protection Agency, DWPC-Lake and Watershed Unit, P.O. Box 19276, Springfield, Illinois, 62794-9276; 217/782-3362.