Dredging and the Great Lakes

Great Lakes Dredging Team

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Great Lakes

Dredging Team

Acknowledgements

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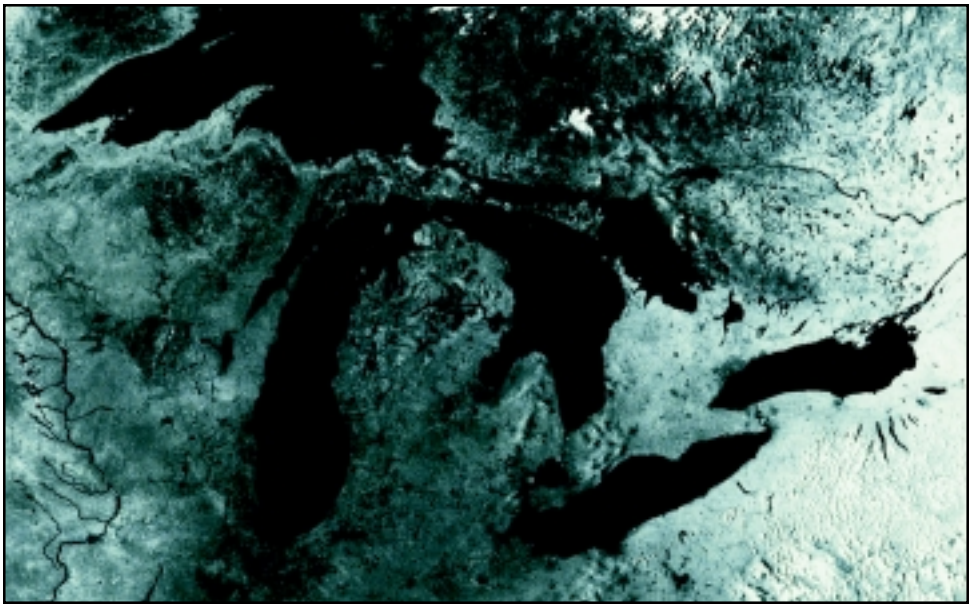

Figure 1: Satellite image of the Great Lakes basin

The Great Lakes - A Resource for the Future

For the Great Lakes region, water was not just important, it was the most important factor guiding settlement and establishing the economy. The natural water routes and canals channeled territorial expansion and with it came the underpinnings for economic development including water dependent transportation and industrial operations. From this water genesis, the Great Lakes economy was created.

The magnitude and grandeur of the Great Lakes is not easy to convey. The Great Lakes are also the foundation of a diverse and unique basinwide ecosystem. Management and protection of the Great Lakes is a high priority for the federal, provincial and state governments in the region.

The five Great Lakes along with their connecting waters comprise the largest system of fresh surface water on earth, containing 5,400 cubic miles of water and covering 94,250 square miles.

The Role of Dredging in the Great Lakes

Dredging usually involves the periodic removal of accumulated bottom sediments from waterways to maintain adequate depth for safe and efficient vessel operations. Dredging is also done to enlarge or deepen a navigation channel or for the purposes of waterfront construction, utilities placement and environmental remediation. Concern over environmental effects of dredging and disposal of dredged material (contaminated or otherwise), the increasing unavailability of suitable disposal sites and dredging's role in supporting waterborne commerce have combined to raise public interest in dredging and disposal of the material.

The U.S. Army Corps of Engineers is authorized to maintain 131 navigation-related projects, nearly all of them commercial and recreational harbors and navigation channels. Many of these projects require periodic dredging. For other commercial and recreational harbors, some are privately owned and maintained or state and local jurisdictions have responsibility.

For more than 150 years, dredging for navigation purposes has taken place in the Great Lakes.

Early efforts aimed at improving U.S. harbors, such as the construction of piers and breakwaters and limited dredging, were often undertaken by private and local interests with some federal involvement. As vessel size and draft increased over time, harbor sediments needed to be regularly removed and adja-

Figure 2: Hydraulic pipeline dredge

cent shore lands modified to widen harbor areas and also to accommodate waterfront development. Eventually, connecting channels became a top priority with incremental depth improvements as well as new locks at Sault Ste. Marie, Michigan. The River and Harbor Act of 1892 authorized a minimum 20-foot navigation depth in connecting channels and gradually major commercial harbors also were dredged. Vessel drafts and navigation depth continued to increase and in 1956, legislation coincident with planning and construction of the St. Lawrence Seaway, set the stage for current vessel drafts. U.S. regulations for maintaining Great Lakes navigation channels provide for vessel drafts of 25.5 feet below low water datum. Commercial navigation drafts usually range between 26 and 28 feet depending on water levels and route. The Seaway has recently increased permissible vessel draft to 26 feet, 3 inches.

Figure 3: A 1,000-foot lake freighter passing through the Poe Lock at Sault Ste. Marie, MI Credit: Albert G. Ballert

Great Lakes Commercial Navigation

The Great Lakes and their outlet to the Atlantic Ocean, the St. Lawrence River, are major components of a vast intermodal transportation system linking the heartland of North America with ports and markets throughout the world. The completion of the St. Lawrence Seaway in 1959 allows vessels up to 740 feet in length, 78 feet wide to travel 2,300 miles/3,700 kilometers from the Gulf of St. Lawrence to the lakehead ports of Duluth-Superior and Thunder Bay on Lake Superior. This transportation system, unlike any other in the world, includes three segments where a total of 16 navigation locks raise vessels 600 feet from sea level. Waterborne commerce throughout the system includes overseas vessel operations (salties) and U.S. and Canadian

shipping using lake freighters (lakers). Dredging to provide adequate depth for safe and efficient vessel passage has a direct effect on the bottom line of commercial operations and potential ripple effects on local communities and regional economies. Even slight decreases in available depth significantly reduces a vessel's carrying capacity. For example, the workhorse vessel of the Great Lakes fleet, the 1,000-footer, loses 270 tons of cargo for each inch reduction in draft. For a vessel sized to fit the St. Lawrence Seaway, the loss of an inch of draft translates into a 100-ton cargo reduction.

Commercial navigation on the Great Lakes has steadily improved through larger, more maneuverable and efficient vessels, better crew training and modern port facilities. The principal cargoes moved on the Great Lakes are bulk commodities – iron ore/taconite, coal, grain, limestone, salt and petroleum products. Great Lakes shipping handles an average of 180 million tons annually in domestic, cross-lake and overseas trade. Much of this commodity movement is connected to raw material supply for steel mills and coal-fired power plants. These facilities and commodities help support a diversified regional economy with a strong manufacturing base. The relatively low-cost water transport option helps maintain competitive alternatives for shippers and compares favorably with other transportation modes with less fuel use, pollutant emissions and more safety with fewer accidents.

The largest Great Lakes vessels can carry nearly 70,000 tons of bulk cargo or the equivalant of 700 rail hopper cars.

Figure 5: Recreational boating on the Great Lakes

Recreational Boating

Recreational boating is a growing activity in the Great Lakes region. According to the National Marine Manufacturer's Association, there are more than 4 million recreational boats in the Great Lakes states. This number represents an increase of more than 700,000 boats in the past decade. All but one of the Great Lakes states are among the top 11 nationally in numbers; Michigan is number one. Surveys indicate that nearly a third of Michigan's "boat days" are tied to the Great Lakes, even though less than a fifth of the boats are dedicated to exclusive Great Lakes use.

Recreational boating is also a major industry in the region represented by boat manufacturers and retailers, marina operators and marine business suppliers.

Boating also has a direct connection to sport fishing and the several billion dollars of regional economic impact it accounts for. Retail boat/trailer, outboard motor and marine accessories sales for the Great Lakes states amount to $2-3 billion annually depending on the state of the economy. Marina development and related facilities on the Great Lakes have been increasing, keeping pace with moderate growth in boat usage and accelerating interest in residential shore developments. The amenities of the coastal zone are attracting more seasonal home development. Some of these new properties have slips or boat houses/garages integrated with the property.

About a million U.S. and Canadian recreational boats are on the Great Lakes at some point during the boating season.

Sedimentation

Much of Great Lakes dredging is undertaken in response to sedimentation processes in tributary rivers and streams. In addition to agricultural practices, construction activity and the relative imperviousness of developed land contribute to sediment loads and transport dynamics. Also littoral drift, a natural process of sand and sediment movement along the shore, contributes to some sedimentation in navigation channels exposed to or near the open lake. Siltation levels are high for many Great Lakes harbors, particularly those that contain river flows and areas where the basin has substantial agricultural activity. A good example of the sediment-dredging connection is the largest tributary of Lake Erie, the Maumee River.

With its 6,600 square mile--predominately agricultural watershed, the transport of huge quantities of silt and clay sediment cause shoaling (sediment buildup) in parts of the river. It is estimated that the mean annual sediment load for the Maumee River is more than 1.1 million tons, representing about 10 percent of annual gross erosion in the Maumee watershed. In addition to the physical movement of sediment, sediment-produced turbidity reduces light penetration, which affects aquatic plant growth. Agricultural runoff is also a primary source of phosphorus loading for streams and rivers and especially for lakes.

As a result of all this flowing soil, Toledo Harbor at the mouth of the Maumee, has large dredging needs. The high volume of sediment, if allowed to build up, would in the short term substantially affect commercial vessel drafts and in the long run threaten the port's existence. The port handles an average of 15 million tons of cargo a year, including coal, iron ore, grain and various general cargoes, and its activities generate more than $500 million in economic activity annually with more than 500 dependent jobs. In 1995 the Corps of Engineers and the U.S. Department of Agriculture's Natural Resources Conservation Service entered into a partnership for a two-year demonstration project to address the Toledo dredging issue. This was the first time in the Great Lakes that Corps dredging funds were directed to upland soil conservation measures.

In recent years, the Corps of Engineers has moved an annual average of 800,000 cubic yards of sediment in the Maumee River at the Port of Toledo and about 200,000 cubic yards in the outer harbor in Lake Erie making it the largest regular dredging project on the Great Lakes.

The Toledo Harbor Project entailed a program of grants to 22 basin counties for sediment projects that addressed vegetative cover, conservation tillage, structural controls such as sod-lined waterways and numerous information and education activities. The results of the demonstration program are encouraging. The goal for the agricultural component was a 130,000 cubic yard reduction in sediment at Toledo Harbor and half of this target has been achieved. Farmers in the Maumee basin have been increasing their use of conservation tillage practices (crop residue kept on cropland surfaces) from near 30 percent in 1991 to a 60 percent rate in the late 1990s.

Great Lakes Dredging Activities

The Corps of Engineers annually spends approximately $20 million for maintenance dredging at federally authorized Great Lakes harbors and channels. On average, about 4 million cubic yards of sediments are dredged from 35 federal navigation projects each year. In recent years private dredging contractors have done all the dredging work. These projects have been authorized by Congress with specific project limits for widths, lengths and depths. Congress authorized the Corps to maintain these projects for safe navigation use, but this does not necessarily require that all parts of the harbor or channels be maintained at authorized dimensions. Some Great Lakes harbors that were authorized in the 19th century no longer have vessel use requiring commercial navigation depths, and therefore they are not maintained at originally authorized depths.

Dredging needs are typically determined by Corps of Engineers district offices through ongoing communication with commercial and recreational navigation users and local or state agencies responsible for harbor or port facilities. The district offices at Buffalo, New York; Detroit, Michigan; and Chicago, Illinois, collect depth data for many harbors and channels on an annual basis, and long-term trends for shoaling are determined from this data, previous dredging records and information supplied by harbor users.

Funds for maintenance dredging and dredged material management at federal navigation projects are part of the Corps of Engineers annual Operations

and Maintenance budget. This budget is initially prepared at the project level by the district and contains numerous items of required work such as surveys, sampling and testing, environmental compliance, design plans and specifications, dredging contracts, etc. It generally takes about 12-14 months from the initial stages of budget development to when the president releases his budget to Congress. When combined with the Congressional appropriations process, it can take 20-22 months for a dredging project's funding process to run its course. It is recognized that work required at a project can change from the time it is scheduled to when funds are actually received. Unforseen emergencies, equipment failure or unanticipated changed conditions occur from time to time. Congress recognizes the need for flexibility and has given the Corps of Engineers limited budget reprogramming authority to account for these situations.

The Federal Standard, established by regulation in 1988 (33 CFR 209, 335-338), is a benchmark for determining the level of federal funding that will be allocated for the disposal of dredged material from the maintenance of authorized federal channels. The Federal Standard is defined as the least costly disposal alternative which is engineeringly sound and satisfies applicable federal environmental regulations. In 1993, the Corps of Engineers initiated a program for the development of long-term plans for managing channel maintenance projects. Districts were directed to establish a Dredged Material Management Plan (DMMP) process for all deep-draft navigation projects. Through a preliminary assessment, an economic analysis of the federal interest in maintaining the navigation project is undertaken. Also evaluated is whether the project's dredged material management option(s), consistent with the Federal Standard, are available for the next 20 years. For those projects where such managmeent options are not available, a detailed DMMP is to be prepared which evaluates management options, addresses environmental compliance and defines federal and non-federal cost sharing responsibilities.

Dredging Equipment

Mechanical and hydraulic types of dredges are used on the Great Lakes. Mechanical dredges employ a crane and bucket and are effective with hard-packed materials or debris. Once the material is removed from the bottom, it is placed in a barge and then transported to a disposal site.

The two types of hydraulic dredges that operate on the Great Lakes are the cutterhead pipeline dredge and the self-propelled hopper dredge. Dredges that use pipelines have powerful engines that suction sediments and pump the slurry directly to disposal sites. They are capable of operating continuously and are very efficient on a quantity-moved-over-time basis. The hopper dredges have on-board storage capacity along with the ability to bottom-release material directly. This kind of dredge is used less often than the pipeline dredge.

Figure 7: Mechanical dredging using a crane and barge

Figure 8: "Clamshell" type bucket

Figure 9: Hydraulic dredging with a pipline.

Figure 10: The cutterhead of a hydraulic dredge

Figure 11: Self-propelled hopper dredge

Environmental Dredging

In the Great Lakes basin, environmental dredging is done to ensue protection of human health, welfare and the environment and to improve environmental conditions of the Great Lakes and their tributaries.

To address the ecological and human health risks that contaminants in sediments pose, the U.S. Environmental Protection Agency (U.S. EPA) published its *Contaminated Sediment Management Strategy*. The Strategy is a U.S. EPA work plan describing actions the Agency believes are needed to bring about consideration and reduction of risks posed by contaminated sediments. The remediation section of the Strategy discusses several federal laws which U.S. EPA may use to require contaminated sediment remediation by parties responsible for the pollution. These laws include the Comprehensive Environmental Response, Compensation, and Liability Act (known as Superfund), the Resource Conservation and Recovery Act, the Clean Water Act (CWA), the Toxic Substances Control Act, and the Oil Pollution Act. Sediment remediation is accomplished through environmental dredging or other management options such as inplace capping. States may also require environmental dredging for various purposes.

Environmental dredging is also done to improve environmental conditions where contaminated sediments threaten ecological functions and/or impair people's use and enjoyment of associated natural resources. Provisions under several federal Water Resources Development acts authorize the U.S. Army Corps of Engineers to work with U.S. EPA, the Great Lakes states and local governments to clean up contaminated sediments in certain areas around the Great Lakes. These include areas near federal navigation channels and Great Lakes Areas of Concern (AOCs). The AOCs are degraded geographic areas within the Great Lakes basin as defined by the U.S.-Canada Great Lakes Water Quality Agreement. In addition, provisions under Superfund and the CWA authorize U.S. EPA to work with agencies that represent federal, state and tribal natural resource trustees (e.g., U.S. Fish and Wildlife Service in the Department of Interior and National Oceanic and Atmospheric Administration in the Department of Commerce) to address the restoration of natural resources (fish, wildlife, habitat, sediments and waterways) that have been impacted by contamination. In certain situations restoration can be accomplished through dredging.

Environmental Windows

Environmental windows are time constraints placed on dredging or dredged material operations to protect biological resources or their habitats from detrimental effects. Such windows can include, among other factors, effects of resuspended sediments on fish and shellfish resources, sedimentation effects on sensitive resources and habitat, entrainment of aquatic organisms by hydraulic dredges and disruption during bird nesting times. The technical issues underlying requests for and compliance with windows are complex, as are the implications of windows for conduct of dredging in a cost effective manner. Windows complicate dredging contracts in many ways that can increase costs on a per cubic yard basis. Achieving a balance between adequate resource protection and cost effective dredging operations is a continuing challenge.

Disposal

Where to place dredged material is a question in search of answers. The selection of disposal sites is a lengthy process involving land use, environmental and natural resource concerns. The appropriate disposal of material dredged from navigation projects is a nationwide issue but has important implications for the use, management and protection of waters in the Great Lakes basin. The disposal of dredged material whether on land or in water is subject to environmental review and regulation. Confinement of contaminated dredged

material determined to pose an unacceptable risk to the environment is a federal policy and is recognized as necessary by state and local governments.

Under current dredged material evaluation procedures, about half of the material removed each year is considered polluted or otherwise not suitable for open water disposal and placed in confined disposal facilities(CDFs). Since the 1960s, the Corps has constructed 40 CDFs around the Great Lakes. Many CDFs were built at full federal expense but since 1996, a non-federal cost share is required. Of the total number of U.S. Great Lakes CDFs, 14 were constructed on land and 26 were built as in-water facilities with many at near shore locations. The CDFs built in the water average 112 acres in size, whereas the upland sites are considerably smaller, averaging 35 acres. The size and design of a CDF is site-specific, depending on the location, the type of sediment and nature of contaminants, potential amount of material and how the facility will be used or function once it is full or no longer receiving dredged material. Dikes for in-water CDFs are usually constructed in layers with heavy, protective stone on the outside and progressively smaller stones to sand on the inside. Some CDFs incorporate liners or steel sheet pile in the dike walls. As dredged material is pumped or placed in a CDF, the sediments fall to the bottom and the accompanying water evaporates or percolates through the walls or into the ground. When permeability is reduced over time because of sediment sealing, a variety of water-release mechanisms, including overflow weirs and filter cells are used.

Figure 12: Saginaw Bay Confined Disposal Facility

The amount of dredged material placed in Great Lakes confined disposal facilities averages around 2 million cubic yards per year and would fill 400,000 standard dump trucks.

Great Lakes ecosystem health depends, among other things, on the elimination of contaminants or, where necessary, a high level of isolation of contaminants. CDFs are built to keep the material from contaminating the surrounding environment. Contaminants often bind with fine sediments such as silt and clay. If this form of pollution is confined to the CDF and fish, wildlife and habitat are not impacted by the contaminated sediments in the CDF, then CDFs are presumed to be effective. Long-term use of CDFs is the principal means of resolving the overall problem of disposal of contaminated sediments derived from dredging for navigation purposes. But other strategies exist. Remediation or cleanup of polluted material from a CDF or elsewhere is technologically feasible through various means, but is relatively expensive compared with placement and storage in a CDF. Sediment reduction at the source offers much promise as a means to both reduce polluted sediment transport and, where possible, lessen navigation-related dredging requirements.

Beneficial Use of Dredged Material

Figure 13: Pointe Mouille Confined Disposal Facility in Michigan

In the past there was extensive use of dredged and excavated material for the purpose of waterfront land expansion to accommodate developing shoreside industry and urban areas. Such "beneficial uses" of dredged material are now much reduced for various reasons. The fact that existing confined disposal facilities have been filling up coupled with public and governmental scrutiny of open water disposal has created interest in other management options. Productive uses of dredged material include beach/nearshore nourishment, habitat restoration, landscaping, amendments to agricultural soils, road construction fill, strip mine restoration, temporary cover for landfills and many others.

Beneficial use is the general term that describes alternatives for managing dredged material by focusing on its value as a resource and not as a waste.

Beneficial use has potential for providing a low-cost solution for the management of dredged material that is environmentally responsible and publicly acceptable. With proper testing and governmental guidelines for dredged material use, the business community will be able to create new uses and expand its involvement in this part of the dredging process.

The Pointe Mouille Confined Disposal Facility is a 700-acre diked area in Lake Erie designed to contain contaminated dredged material from the Detroit and Rouge rivers. Its beneficial use is linked to its role in providing and protecting different kinds of wildlife habitat. Pointe Mouille is near the mouth of the Huron River, an area with extensive wetlands. Dams on the river have reduced sediment flow and as a consequence, a natural barrier island that protected back barrier marshes was destroyed by wind and wave action. The CDF with its long crescent shape was designed to protect the fragile wetlands as a substitute for the barrier island. The CDF with its internal diking system along with the nearby Pointe Mouille State Game Area is managed as productive waterfowl habitat.

Figure14: Beach nourishment at Grand Haven, Michigan

Beach/littoral nourishment involves the placement of dredged material directly onto a beach or into the shallow water. Beach nourishment is typically discharged by pipeline from a hydraulic dredge. Suitable dredged material is typically a fine sand, and may only stay on the beach for a limited time before being eroded into the littoral drift. Littoral nourishment involves a discharge to nearshore shallow areas and is typically done with bottom dump scows when a mechanical dredge is used. Beach and littoral nourishment are used for approximately 10 to 15 percent of Great Lakes dredged material.

Figure 15: Construction fill being loaded at the Erie Pier Confined Disposal Facility in Duluth, Minnesota

At the Erie Pier Confined Disposal Facility in Duluth Harbor, the Corps of Engineers has used the process of "soil washing" to separate sediment particles by size and make some of the material available for use. Contaminants often associate with particular sediment types – usually finer grain sizes. In a sloping part of the CDF, water is pumped over the dredged material allowing the coarser or cleaner material to settle out. This material is then excavated and used as construction fill. An average of 20 to 25 percent of the dredged material placed in Erie Pier each year is removed, thereby expanding capacity and extending the CDF's useful life.

The 1987-1988 construction of the 72-acre North Point Marina on the Illinois shore of Lake Michigan required the hydraulic dredging of approximately 1.5 million cubic yards of gravelly sand. This sediment was dispersed to the downdrift (south) side of the marina basin to form a feeder beach for downdrift nourishment. As of 1999, most of the available sand and gravel has been eroded from this initial nourishment area. Downdrift beaches are still benefitting as the stream of nourishment sediment continues in southward transit along the shore.

Figure 16: Dredged material from an Illinois marina construction project is being used for long-term beach nourishment. Credit: Illinois State Geological Survey

A Citizen's Role in the Dredging Process

Dredging and management of dredged material involves a substantial amount of planning and a commitment of adequate funding. Public involvement in and support for the dredging decision process is therefore very important. An active and informed public helps ensure that local expertise and knowledge is made available in the process. This also promotes sound regulatory and financial decisions regarding dredging and the management of dredged material. People who want to be involved in the public policy process need to inform themselves about the issues and pursue opportunities to convey their views and concerns. With respect to Great Lakes dredging, experience has shown that individuals or groups with a local presence and stake in an issue can provide a very effective means to advise government officials and influence policy.

Information is often the critical link in how effective citizen participation and influence can be in the dredging process.

Much of the information about dredging is contained in scientific literature and is not readily available to the general public. Public opinions and impressions of dredging and dredged material management are too often based on misunderstanding and misinformation. Efforts to educate and inform the public about dredging issues have been few and generally focused at a limited audience. Government agencies with dredging decision responsibility as well as the private sector involved in dredging activities can be responsive to citizen information needs. The Great Lakes Dredging Team and the National Dredging Team have established public outreach and education goals to advance these objectives.

Great Lakes Dredging Team

In 1993, the Department of Transportation's Maritime Administration initiated the Interagency Working Group on the Dredging Process to evaluate problems and delays encountered with dredging the nation's ports. The working group held public hearings at several locations, including Chicago, to obtain input and released a report of its findings in December 1994. One of 18 recommendations was that National and Regional Dredging Teams be established to "provide a mechanism for timely resolution of conflicts by involving all agencies and maximizing interagency coordination." The Great Lakes Dredging Team was formed in 1996 in response to that recommendation.

The Great Lakes Dredging Team is composed of representatives (and alternates) from the following:

Federal Agencies

U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish & Wildlife Service
Maritime Administration
Natural Resources Conservation Service
National Oceanic & Atmospheric Administration

States/Interstate Agency

State of Illinois
State of Indiana
State of Michigan
State of Minnesota
State of New York
State of Ohio
Commonwealth of Pennsylvania
State of Wisconsin
Great Lakes Commission

The Great Lakes Dredging Team is co-chaired by a federal and a state representative. The state chair also leads the state caucus whose membership is the Great Lakes states and the Great Lakes Commission. The full Dredging Team meets twice per year; issue-specific work groups can meet at other times.

For further information, please consult the Great Lakes Dredging Team web site: *www.glc.org/projects/dredging* or call the Great Lakes Commission at 734-665-9135.

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