Dredged Material: Its Potential for Ice Control Sand Replacement

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Every year the St. Paul District of the Corps of Engineers dredges huge volumes of sediment from the Mississippi, St. Croix, and Minnesota rivers in Minnesota. That dredged material is deposited in established corps upland disposal sites. The corps makes the material available for public and private use at no cost. A study was conducted to analyze the acceptability of the material and the cost benefits for the Minnesota Department of Transportation (Mn/DOT) and the corps, with Mn/DOT's use of the dredged material as road ice control sand. The findings were as follows: (a) Mn/DOT could realize considerable savings through the use of dredged material as ice control sand; the savings would be significant even with the purchase or lease of a portable screener; (b) field tests demonstrated that the material was of the same or better quality as commercially supplied sand and that it is effective for ice control; and (c) this use of the dredged material helps retard the rate of filling of corps disposal sites, which helps reduce corps operations costs.

Every year the St. Paul District of the U.S. Army Corps of Engineers dredges huge volumes of sediment from the Mississippi, Minnesota, and St. Croix rivers in Minnesota. Most of the dredged material is deposited in upland disposal sites where it is available for any beneficial use. The Minnesota Department of Transportation (Mn/DOT) buys thousands of yards of sand each year for ice control on the roads in the same areas where the corps deposits the dredged material. If the dredged material from the river could be used for ice control purposes it would produce a twofold benefit: Mn/DOT's maintenance costs would go down and the corps would fill its costly disposal sites at a reduced rate.

Environmental protection regulations in Minnesota place restrictive parameters on dredged material disposal site locations. In each pool of the river in the St. Paul District of the corps, there are at the most only one or two approved primary and one or two secondary sites. The restricted number of disposal sites in each pool forces the corps to transport the dredged material considerable distances, which adds to dredging costs.

Transportation of the dredge material becomes even more costly with the need to move to the secondary sites. Reducing the rate of filling the primary sites by using the material would help control Corps of Engineers' costs. That becomes more important with each renewed effort to charge channel maintenance costs to commercial navigation users of the river.

The use of dredged material as ice control sand is an established practice with some of the Minnesota and Wisconsin river city and county road agencies. Those organizations use roller sanders, which spread the sand by gravity over a single highway lane. Mn/DOT uses sanding trucks, which pour the sand on a rapidly revolving disc to create coverage of two or three lanes. The revolving disc also creates fairly high velocity projection of pebbles or pieces of wood or metal that might be in the sand. For that reason it was assumed that a screening machine would be necessary for removing the larger pebbles and other potential projectiles from the dredged material.

The study's main areas of concern, then, were to determine if the material was usable and if the savings realized by its use would cover the cost of a screening machine.

Eight existing Corps of Engineers disposal sites were sampled to determine if the dredged material they contained would meet Mn/DOT standards for ice control sand. The locations of the sites are shown in Figure 1. Samples of dredged material were taken from the sites and sieve analyses were made of the samples. The results were compared with the results of sieve tests of commercially supplied road sand in the three Mn/DOT districts that border the rivers. In most instances the results showed that the dredged material not only satisfied Mn/DOT specification requirements but was of the same or better quality as purchased sand. Only one location on the Mississippi contained material that was unusable. Sand from Disposal Location 8, at Brownsville, proved to be either too fine or too silty. Table 1 presents the results of the sieve tests. The table shows Mn/DOT requirements and the percentages of the material that passed through each size screen.

The existing corps disposal sites provide a potential supply for truck stations in Mn/DOT's Maintenance Districts 5 and 6, as shown in Figure 1. At present, there are no functioning sites in Mn/DOT District 9. However, planned dredging will require a site near Lock and Dam 2, in Hastings, which could supply truck stations in that district. Sand quality in the Hastings area, as determined from random samples of older dredgings, appears to be acceptable.

All of the corps' disposal sites would provide continuous supplies of dredged material well in excess of Mn/DOT's needs. Mn/DOT's needs in the river districts would average about 40,000 yd^3 annually and the corps dredges an average of 900,000 yd^3 of materials each year. However, dredging volumes do fluctuate and surpluses from one year might be usable in following years. All of the beneficial users, including Mn/DOT, will probably not strain the supplies available from the corps.

The study's second phase involved determination of size requirements and the relative benefits of leasing or purchasing a portable screener. It was determined that a portable screener was most acceptable. None of the three Mn/DOT districts would need a screener for more than a few weeks each year to allow time to screen a winter's supply. Portability would

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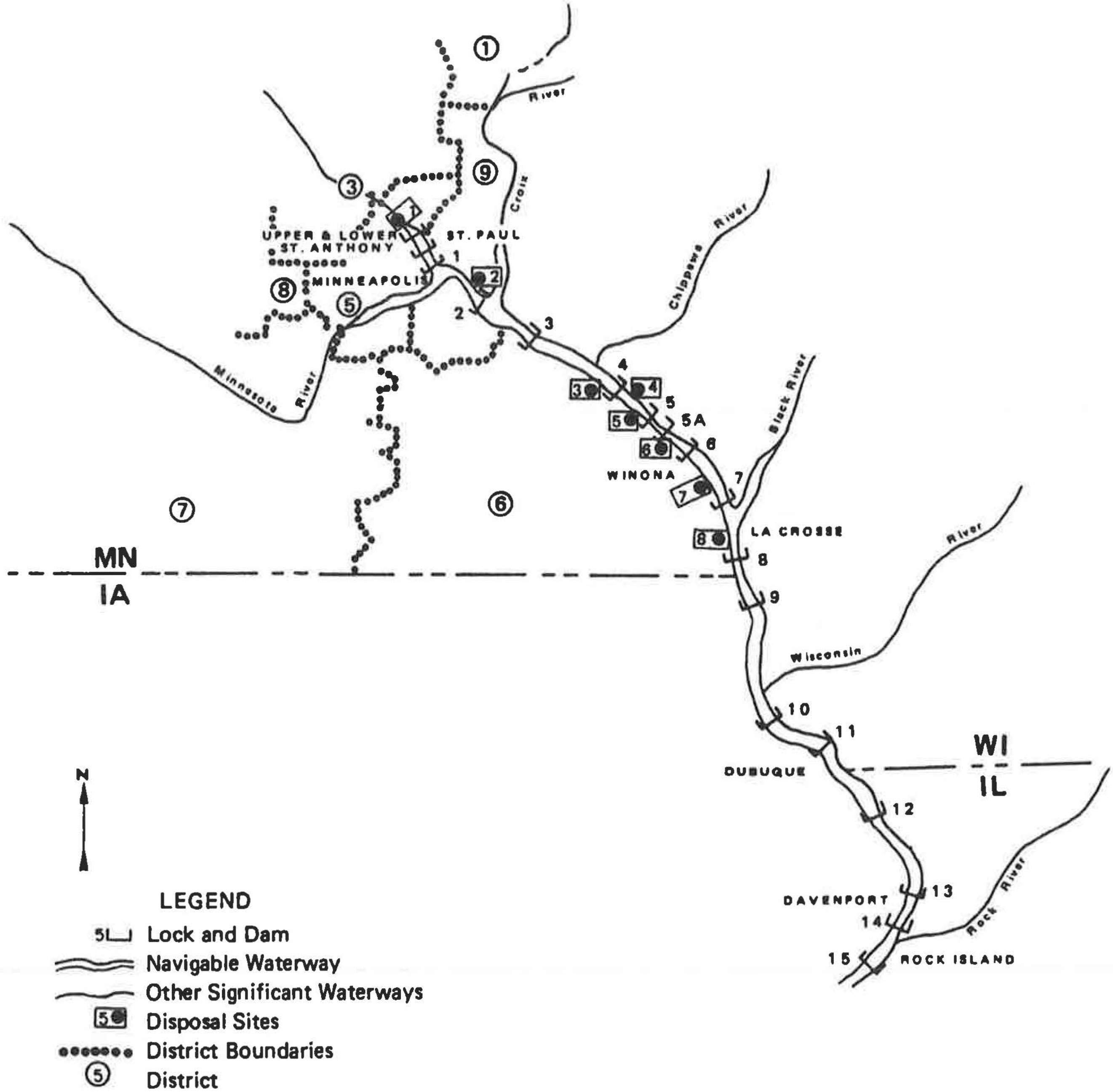

FIGURE 1 Upper Mississippi River.

allow use by each river district, in turn, and even allow movement to Duluth should tests of dredged material in that harbor prove the material usable for ice control purposes.

Results of the screener analysis showed that Mn/DOT could most effectively use a screener with a capacity of 100 tons per hour. Analysis showed that leasing would cost $20,340/year for the anticipated 10-year life of the machine, and purchase of the machine would cost $9,340 for each of the 10 years, including anticipated maintenance. The analysis of screener needs and costs included a determination of the numbers and sizes of screens needed, volumes of material that would be screened, and the number of probable screener operating days in each of the districts.

The final study analysis included a review of truck, material, and labor costs for existing sanding operations and a determination of changes in those costs that would result from the use of dredged material. That analysis demonstrates the potential for substantial savings for Mn/DOT's ice control program in the three districts.

Fixed costs were determined from operating records in each district. A fixed cost multiplier (dollars per load-mile) was calculated separately for each of the three districts because of their operational differences.

One of the variables that changed from district to district was truck size, which made significant differences in fixed costs. At present, District 6 uses both 6- and 12-ton trucks. An average of 9 tons was used in computing the initial fixed costs and operating costs with the addition of a screener. In

TABLE 1 SIEVE TEST RESULTS—PERCENTAGE OF DREDGED MATERIAL PASSING EACH SCREEN

Screen Size	Comm'l Supplier					Corps of Engineers Disposal Sites								Mn/DOT
	A	B	C	D	E	1	2	3	4	5	6	7	8	Standards
1/2"						100	100	100	100	100	100	100		100
3/8"						99	99	100	100	100	99	100		100
#4	100	100	100	100	100	98	99	98	99	99	96	100		95-100
#10	27	90	89	85	82	95	97	96	96	97	92	100		
#20	8	71	60	60	57	86	87	84	77	82	78	97	100	
#40	2	37	50	22	26	40	37	51	35	31	38	76	97	
#80	1	5				1	2	2	1	1	2	3	23	
#100	1	4	3	5	4	1	1	1	0.4	0.5	1	2	16	
#200	0.4	1.6	1.1	1.7	1.5	0.3	0.4	0.5	0.2	0.3	0.7	0.4	5.1	3.0 maximum

Districts 5 and 9, 12-ton trucks are currently in use, so all computations for these districts were based on 12-ton truck use.

For the purpose of costs determination, an average operational day of 6 hr, to allow for necessary nonoperating functions, was used in each district. To compute the dollars per load-mile factor, the number of loads per day one truck would carry was needed. This was determined by using an average of 0.1 hr (6 min) for loading and weighing and 0.083 hr (5 min) for unloading. Screening added 0.1 hr (6 min) to a 9-ton load and 0.133 hr (8 min) for a 12-ton load. There was no significant difference in loading, weighing, and unloading times between the two truck sizes. Travel time was developed for each travel pattern and added to the handling time to produce total load time. This was divided into the 6-hr workday to get loads per day, which in turn was used to produce dollars per load-mile.

In reviewing the results of the analysis, District 6 could save $35,371/year (purchase screen), or $26,232/year (lease screen), using 12-ton trucks for moving the dredged material. Combining Districts 5 and 6, a savings of $49,225/year (purchase) or $38,805/year (lease) could be realized. If all three districts were involved there could be a $84,813/year (purchase) or $73,669/year (lease) savings. Savings for the three districts in total are based on the assumption that the new disposal site near Hastings will have usable dredged material, as would appear to be the case from samples of residue from previous dredging in the area. Because only one screener would be leased or purchased for use in the three districts, the relatively small differences between leasing and purchasing in Districts 5 and 9 by themselves are shown only for comparison.

A field test was made of the ice control effectiveness of dredged material. The material was screened with a small screener currently in use for District 6 maintenance activities. The machine has limited capacity but was able to supply enough sand for a single crew's use during the field test, which ran through the winter of 1985 to 1986.

For the field tests the screened dredged material was mixed with salt and rice rock. The most acceptable mix was 75 percent dredged sand, 10 percent salt, and 15 percent rice rock. Rice rock, which is residue from a local concrete mixing plant operation, was added to enhance the average grain size of the mix. It is the size of rice grains. The 10 percent salt element keeps the storage piles from freezing.

An unexpected finding of the field tests was that the dredged material mixture tended to cake less around the augers in the truck boxes than does commercially supplied sand. This is probably because of the smaller percentage of fines in the river sand, as is shown on Table 1. This pleased the maintenance workers who spent less time with the truck stopped while they worked to free the augers in bad weather.

A side benefit, which was not fully evaluated in this study, was the production of pea rock from the screening process. Pea rock is required in the bituminous patching mix used by Mn/DOT maintenance workers. It has become increasingly costly to purchase pea rock and cheaper substitutes do not have the same properties. Although the quantity of pea rock obtained from the screening would probably not be large, it is a welcome and unexpected windfall.

A final indication of the effectiveness of dredged material as ice control sand was the response of the local aggregate suppliers in District 6. They dropped their prices from $2.60 to $1.00/yd for the 1986 to 1987 season. Because of this dramatic reduction in District 6 costs, Mn/DOT has delayed acquisition of a screener. Even with free sand, the costs of processing and handling exceed the $1.00/yd commercial price. Without the inclusion of District 6, the program—including the purchase or lease of a screener—would not be effective in Districts 5 and 9.

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