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Effects of Drawdown and Structures on Bed-Load Transport in Pool 8 Navigation Channel

by David Abraham and Jon Hendrickson

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes the progress made in using multibeam bathymetric data to determine the effects of a pool drawdown and structures on bed-load transport in the Pool 8 navigation channel. Work was conducted as part of the Monitoring of Completed Navigation Projects (MCNP) program.

BACKGROUND: The channel training structures (wing dams and closing dams) that are currently in place on the Upper Mississippi River were constructed more than 100 years ago to increase flow in the navigation channel and cause scour to occur resulting in a deeper channel. Initially, these structures accomplished this goal as evidenced by the islands and sandbars which formed around them. Construction of the locks and dams, 60 years ago, submerged the training structures, reducing their effectiveness and increasing secondary channel and floodplain conveyance. Both training structure submergence and floodplain conveyance are a function of longitudinal position within the pool, generally increasing from the upstream to the downstream end of the pool.

In cooperation with the U.S. Fish and Wildlife Service (USFWS) and the Departments of Natural Resources from Minnesota and Wisconsin, the U.S. Army Engineer District, St. Paul, executed a drawdown of Pool 8 on the Upper Mississippi River near LaCrosse, WI, during the summers of 2001 and 2002. Water levels were allowed to drop below normal minimum values at lock and dam (L&D) 8 to expose mud flats, promote seed germination, and benefit fish and wildlife. The pool is normally drawn down to an elevation (el) of 630 ft[1] at L&D 8. In 2001, the drawdown was to el 628.5, and thus was 1.5 ft lower than normal. In Pool 8, most of the dredging is done in the middle reach of the pool between river mile (RM) 691 and 688. Figure 1 shows a satellite view of the study area from RM 688 (bottom of figure) to RM 690 (top of figure). This is a reach where the combination of training structure submergence, high floodplain conveyance, and coarse sediment availability results in sediment deposition. By lowering water levels during a drawdown, training structure submergence and floodplain conveyance will be decreased which could result in sediment mobilization and scour in the navigation channel.

However, it was unknown how the flow and sediment movement in the vicinity of these structures might change during such a drawdown. In order to quantify the effects of this water level management on hydrodynamic and sediment transport processes, a monitoring plan was developed. Information derived from a well thought out monitoring plan would allow navigation channel managers to better assess potential costs and/or potential benefits of a water level drawdown. By measuring hydraulic and sediment parameters before, during, and after the drawdown, comparisons can be

[1] All elevations (el) cited herein are in feet referenced to the National Geodetic Vertical Datum (NGVD) (to convert feet to meters, multiply number of feet by 0.3048).

Figure 1. Aerial view of the study reach

made to determine if increased sediment movement occurred. The data collected as part of this monitoring effort were instrumental in answering these questions.

Data Collection: In order to determine the structure/drawdown effect on hydraulic parameters and sediment movement it was necessary to obtain specific bathymetric, hydraulic, and sediment data. The different types of data collected are listed. Portions of these data were also intended for use in eventual verification of three-dimensional (3-D) numerical models.

a. Prior bathymetric surveys in the study reach.

b. Bathymetric surveys before, during, and after the drawdown in the same reach.

c. Velocity fields of the entire cross section upstream, over, and downstream of the most intrusive structures and at the inflow (RM 690) and outflow (RM 688) boundaries of the study reach.

d. Static velocity profiles at several locations along the structures and their cross sections, and at the inflow (RM 690) and outflow (RM 688) boundaries of the study reach.

e. Suspended sediment samples taken concurrently and at the same locations as the static velocity profiles.

f. Bed material load measurements around the most intrusive structures and at the inflow and outflow boundaries of the study reach. These were made with high-resolution multibeam surveys at these cross sections over a space and time scale sufficient to capture any bed form movements. The methodology to accomplish this task is dependent upon the existence of dunes in the reach and their rate of migration.

g. Bed material samples (to obtain bed gradation curves) around the most intrusive structures and at the inflow and outflow boundaries of the study reach.

Methodology: Three methodologies to determine if net sediment movement occurred were used. The first method used detailed bathymetric data taken in the vicinity of RM 689.2. These data were analyzed using a new method for computing the bed-load transport presently called ISSDOT (Integrated-Section Surface Difference Over Time). The second method made use of long-term data collected by the St. Paul District. This data included suspended sediment measurements and bathymetric data. It was analyzed in the form of a sediment budget and through GIS manipulation. The third method used measured sediment and hydraulic data. It was analyzed using sediment transport functions.

Analysis Using ISSDOT: The measurement of suspended sediment fluxes is well established in theory and practice. The measurement of bed material load in large sand bed streams and rivers has been practically nonexistent. The Helley-Smith bed material load sampler has been shown to be somewhat effective in small streams and for gravel and cobble, but not in large sand bed streams. Dutch researchers at the University of Utrecht have also developed a sampler that shows promise for use in large sand bed rivers, but has not been thoroughly tested on rivers like the Mississippi. Thus, until this time, the ability to measure bed-load transport in large sand bed rivers has been elusive. Knowing this, a new method for measuring bed-load transport using multibeam data was developed as a part of this work unit. For more information on this new method (called ISSDOT, (Integrated Section, Surface Difference Over Time)), see Abraham (2002).

Verification of the ISSDOT method is ongoing at this time through flume studies and comparison to any standard techniques that are applicable. The method's validity as a measure of absolute values of transport rates is still in the experimental phase. Also, questions have been raised as to whether a transport rate or gradient of transport is actually being calculated. In Abraham (2002) it was termed as a transport rate. However, when posing the method as a solution of the Exner equation, it becomes clear that the change of volume, and thus the change or gradient of transport, is being measured, and not the transport. So the ordinates of the graphic results presented in Abraham (2002), should be stated as Δq ($q_2 - q_1$), and not as q, where q is the transport of bed material in the sand waves in mass per time per unit width of channel. That being said, it is interesting to note that the Δq approaches q as the time-step, or interval between successive bathymetric plots, gets small. Further analysis is necessary to determine if this is always the case, and if so, to understand why it is so. Preliminary results are encouraging, and after applying the method to several real river examples it is becoming clear that the method can already be used in a relative sense. Because of the repeatability of the measurements and consistency of the method, relative differences between two or more measurement events appear to be able to quantify real changes. However, it is acknowledged that more measurements, experience and statistical analysis must be made in order to prove this statement in a more rigorous sense.

Figure 2 shows the portion of the study area where detailed bathymetric data were collected for trip 2. It was during this trip, 9-10 July 2001 that the water surface was drawn down in Pool 8.

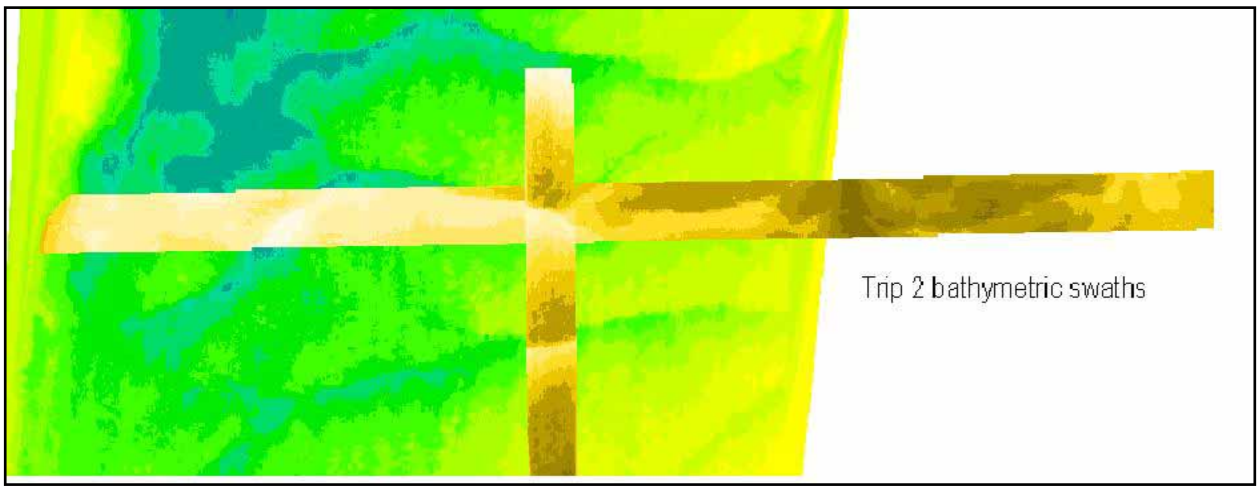

Figure 2. Crosswise and longitudinal swaths of bathymetric data

In this area of the pool, the drawdown resulted in a lowering of the water surface of about 0.9 ft. Four horizontal (cross channel) swaths were taken between 12:14 p.m. on July 9th and 11:46 a.m. on July 10th. The different combinations of time spans between swaths varied from 2.68 to 23.53 hr. The ISSDOT method was applied to these data and the results obtained are shown in Figure 3. Δq decreases with increasing time span because a larger number, as the time span increases, is dividing the quantity of measured material. Whether viewing the data in this manner is the best way to extract transport information, and where to pick a value from such a graph, are questions that are still being grappled with. Additional research, as previously mentioned, is necessary and ongoing to find the answers. For the present, the numbers are being used as an upper and lower bound, with a simple numerical average being a possible and acceptable estimate. (Note: Flume data and field data both show that the calculated Δq approaches q as Δt decreases.) Also shown in Figure 3 are the data from trip 1. Trip 1 data were taken on 26 June 2001, only 2 weeks earlier. However, the flow rate through

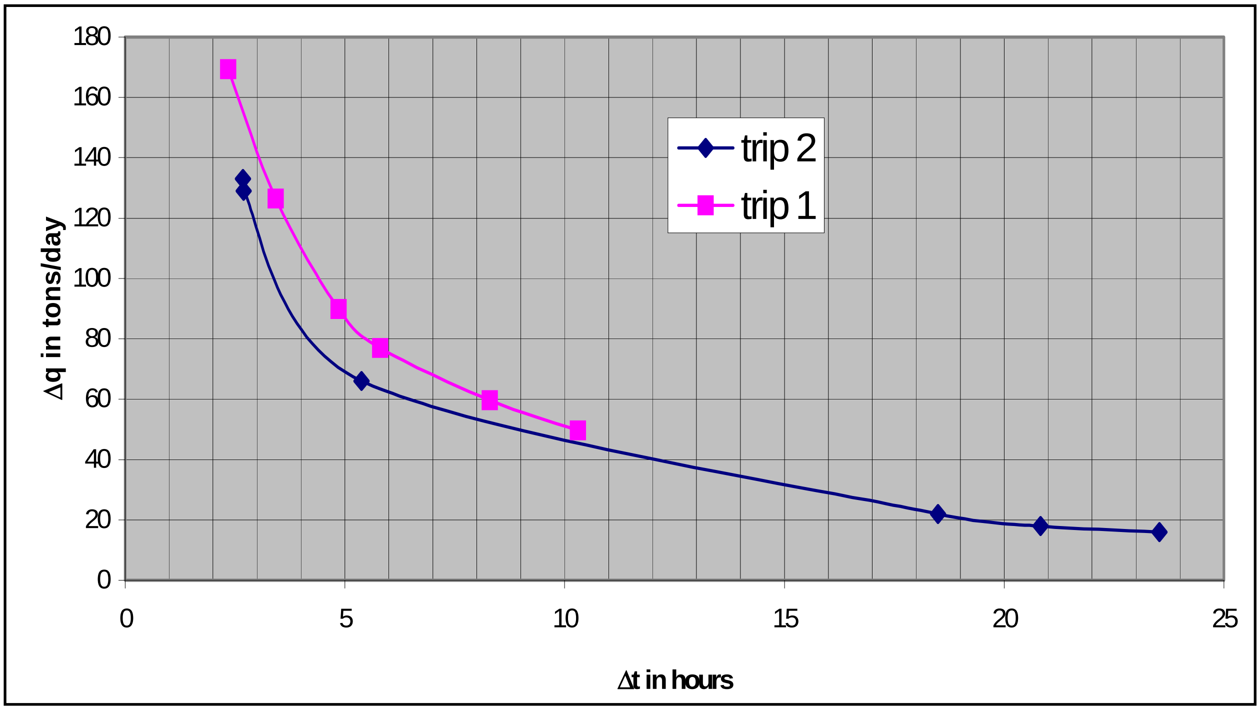

Figure 3. Δq versus Δt as computed using ISSDOT for stated conditions (Tons/day vs. time span between measurement of two sections. Values are average of 30 rows at each Δt)

L&D 8 for trip 1 was about 3,592.6 cu m/sec (97,000 cfs) compared to about 2,185.2 cu m/sec (59,000 cfs) for trip 2. For trip 1 there was no drawdown, yet the flow rate through the dam was about 1.6 times greater than during trip 2. Figure 3 shows that the bed load Δq at the section of river represented by the brown swaths was clearly higher during trip 1. This is what would be expected if there had been no drawdown during trip 2. Since there was a drawdown during trip 2, and the flow rates during trip 1 and trip 2 were so different, nothing definite can be said as to whether or not the drawdown caused any significant increase in sediment mobilization.

From the initiation of the project and in planning the data collection it was realized that in order to say anything about increases or decreases in sediment transport due to the drawdown, it would be necessary to hold as many other variables constant as possible. The most important of these appeared to be flow rate. The river did not cooperate, and in trip 1, 2, and 3, the flow rates through L&D 8 were widely divergent. However, by carefully watching the District Web site during late June of 2002, the trip 4 data were collected at a flow rate through L&D 8 nearly the same as in trip 2. By that time, more analysis of ISSDOT method data had indicated that shorter time intervals between swaths would give results closer to an estimated true bed-load transport rate. So the swaths for trip 4 were taken at about 30-min intervals. Unfortunately, this was not known yet when trip 2 data were obtained. Figure 4 shows a comparison of trip 2 (drawdown) and trip 4 (no drawdown) ISSDOT bed-load Δq computations.

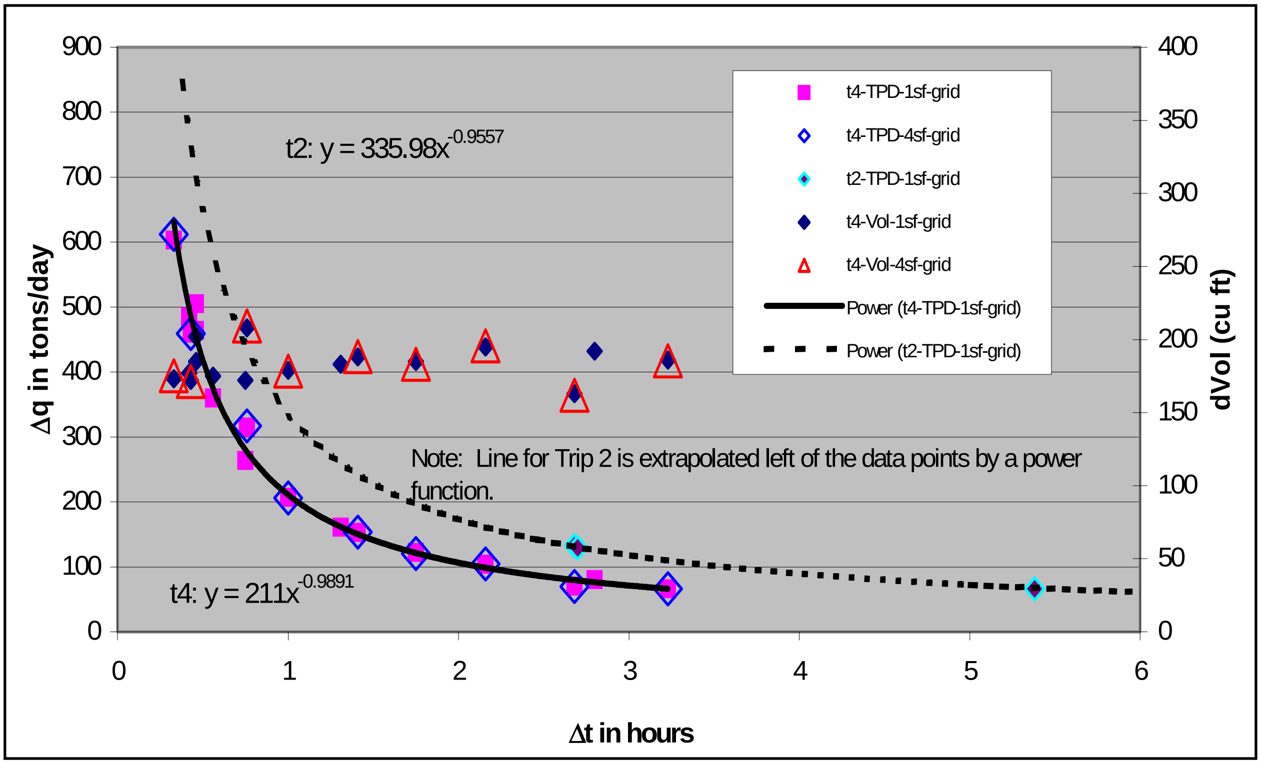

Figure 4. Δ*q* versus Δ*t* computed using ISSDOT for stated conditions change in volume used to compute Δ*q* for each Δ*t* is also shown (Tons/day vs. time span between measurement of two sections. Average of 30 rows at each Δ*t*. Data from trip 4 and 2)

In the legend the first line means trip 4 Δ*q* in tons per day for a 1-sq ft grid.[1] All lines in the legend use this same convention. One- and four-sq ft grids were used for the computations to check the method's spatial sensitivity. For these data and those two grid sizes, there wasn't much difference in the computational results. Considering the plotted values, the two data points for trip 2 data between the 2.5- and 3-hr time spans fall clearly above the data trend for the trip 4 data. Since both data sets were taken at nearly identical flow rates, one could propose that the trip 2 data points do in fact indicate an increase in bed-load mobilization due to the drawdown. However, two data points are insufficient to assert any statistical significance. But, these data taken together with other relevant data and analysis could make a strong case for the increase of bed-load mobilization due to the drawdown. Towards this goal, something needs to be said regarding the ISSDOT method of computing bed-load transport, since it was used to arrive at the data plotted in Figures 3 and 4.

The ISSDOT method is new and still in a development stage. So far, the preliminary results of field tests and a flume study indicate that the method is capable of determining the bed-load transport gradient (Δ*q*) on large sand bed rivers. This is of course subject to certain limitations. As stated earlier, at the present time it cannot be said that the method provides a quantitative value for the true bed-load transport rate of a large river. However, given the way the data are collected and analyzed, it does appear to be able to quantify relative differences of transport gradients at a given location. The reason for this is the quality and repeatability of the collected data, as well as the consistency in

[1] To convert to kilograms per square meter, multiply number of tons by 9,764.856.

the application of the ISSDOT method. To illustrate this, consider the three data collection trips to Pool 8 in which there was no drawdown. These are trips 1, 3, and 4. The data obtained during these trips were taken with a downstream pool elevation at L&D 8 of about el 630.1 to 630.5. However, the flows through L&D 8 were significantly different for the three trips. Trip 1 had a flow of about 3,555.6 cu m/sec (96,000 cfs). Trip 3 was 1,074 cu m/sec (29,000 cfs), and trip 4 was 2,185.2 cu m/sec (59,000 cfs). If the data collection and ISSDOT method are consistent as previously proposed, then this fact should be reflected in increasing transport gradients for increasing flow rates; all other factors being equal.

The data in Figure 5 seem to justify this consideration. Δq for trip 4 falls between that of trip 3 and trip 1. Clearly for the three trips, Δq increases with increasing flow. Since curves were fitted through each data set, it is easy to see the differences. The method appears to be consistent in that, as flow rate increases, Δq increases. It also seems reasonable to allow that for similar flow rates the sand transport should be the same at a given site if all other factors are held constant. In the case of trip 2 and trip 4, the flow rates were indeed the same. One factor was not held constant, that was the drawdown. As stated earlier, it was a reduction of the pool water level at L&D 8 of about 0.5 m (1.5 ft). In the vicinity of the study area near Brownsville, this caused a local drawdown of about 0.3 m (0.9 ft). The data lines for trip 2 and trip 4 seem to indicate clearly that the drawdown did in fact have a net effect of increasing the Δq in the vicinity of the study area. This could be true not only because the cross-sectional area at the study site was reduced, but also because the percentage

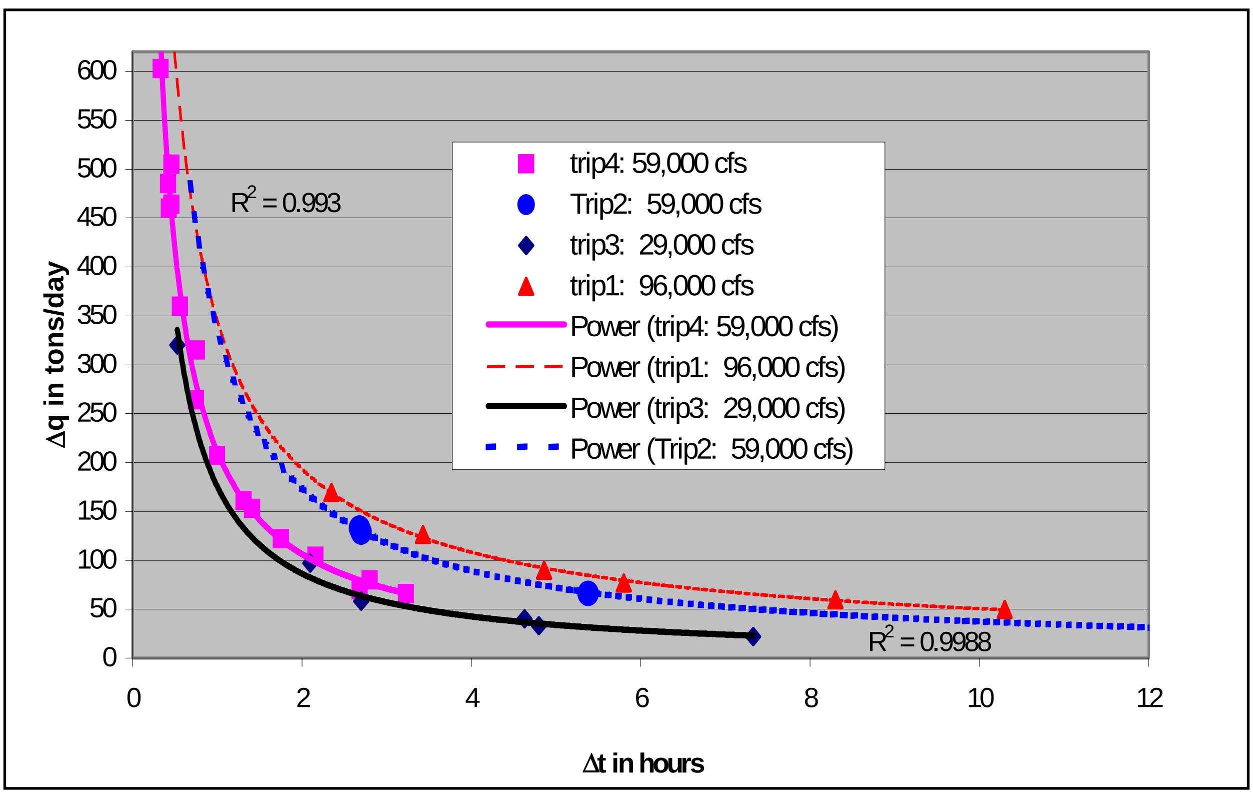

Figure 5. Δq versus Δt computed using ISSDOT for stated conditions (Tons/day vs. time span between measurement of two sections. Average of 30 rows at each Δt. Data from trip 1, 2, 3 and 4)

of total flow through this reach was increased due to the reduction in floodplain and distributary conveyance. Based on the sparse data in Figure 5, the increase would be about 30 percent over normal pool transport.

At this point it might be going a bit too far to say definitively that the drawdown absolutely affected bed-load transport in the study reach. This is because the ISSDOT method is still in development, and the number of data points very minimal. Therefore two other methods of determining if the drawdown caused a net increase in transport will be explored. One is to analyze and compare past historical bathymetric data that the District has collected with recent data collected during the drawdown. Another method is to use standard analytic computations as in sediment transport functions.

Sediment Budget and GIS Analysis:

Sediment budget:

In addition to the measurements made by the U.S. Army Engineer Research and Development Center and used in the ISSDOT computations, St. Paul District personnel have been measuring sediment and hydraulic parameters on the river for years. These data were collected as part of habitat improvement projects and navigation channel maintenance activities. From this data an extensive sand budget was developed. See Hendrickson (2003). This sand budget was developed for Pools 1 through 10 using available information on sediment transport at U.S. Geological Survey (USGS) gauging stations, long-term channel dredging data, studies of sediment deposition, and hydraulic data.

The transport of sand-size sediment was of particular interest because of the expense associated with navigation channel dredging and because sand is the geomorphically dominant sediment size on the Upper Mississippi River. That is to say, that major planform changes on the river are associated with sand deposition in deltas or in natural levees, or sand erosion due to erosion of natural levees and islands. Sand is transported both as bed-load sediment and as suspended sediment depending on local hydraulic conditions, so both modes of transport must be accounted for.

The results of the sand budget are shown in Table 1 of Hendrickson (2003). The table lists data for many locations on the Upper Mississippi River and is four pages long, thus it is not reproduced here. In the column titled "Sand Budget (tons/year)," the value of 201,172 is given for a location at Brownsville, MN. This number represents the estimated bed material load in tons per year at this location, which is the same location of the ISSDOT study area. For this section of river, this would be the sand that moves along the bed in sand waves and the suspended sand of the same size fractions. Because of the small channel slope (due to the pooling effect created by the locks and dams) and medium sand size, it appears that the majority of bed material transport occurs as bed load; that is, as sand moving in the sand waves. If 100 percent of the sand moved in the sand waves, then a mean daily transport rate through this reach would be about 551 tons per day. Even if only 50 percent of the bed material load moved in the sand waves, then the mean daily transport rate would be about 275 tons per day. These fall within the range of values of Δq predicted by ISSDOT for trip 4 as Δt gets small. This would also be the case for trip 2 if its line were extrapolated. Once again, from a research point of view, is it just a coincidence that Δq approaches some estimated value of q as Δt gets small?

GIS analysis:

The information in this section was taken from Hendrickson and Hrdlicka (2003). St. Paul District personnel, using a multitransducer survey boat whose position is tracked using a digital global positioning system, obtained hydrographic surveys of the main channel. Surveys were obtained from L&D 8 at RM 679.2 to L&D 7 at RM 702. Personnel at the St. Paul District Geographic Information Center used ArcView software to create bathymetry models of the main channel between RM 686 and 691 to determine the difference in bathymetry from one year to the next. This was done for the period 1998 to 2003, except that data were not available for the year 2000.

The measurement of hydrodynamic and sediment parameters and the direct measurement of sand wave movement using the ISSDOT method both support the hypothesis of increased sediment transport during the drawdown. However, the GIS computations do not seem to indicate large-scale or long-term changes in main channel bathymetry during the drawdown.

Figure 6 shows that most changes between 2001 and 2002 fell within the range of 0.6 m (2 ft) of deposition to 0.6 m (2 ft) of erosion and probably represent typical bathymetric changes. There were a few areas where as much as 1.8 m (6 ft) of erosion or deposition occurred, but these were small in area and didn’t represent a large-scale trend. It is possible that channel degradation occurred during the actual drawdown, but the channel had filled back in before the surveys that were used in the GIS analysis were taken; however channel maintenance personnel working in this area did not notice this.

Figure 6. Map showing scour and deposition in study area

Figures 7 and 8 show the net main channel volume change and annual dredging between RM 686 and 691 for the years 1999 to 2003. The annual volumetric change for each river mile was obtained by generating difference plots based on surveys for each year. The survey dates were inconsistent from year to year. The 1999 surveys were done throughout the year, 2001 surveys were done in early

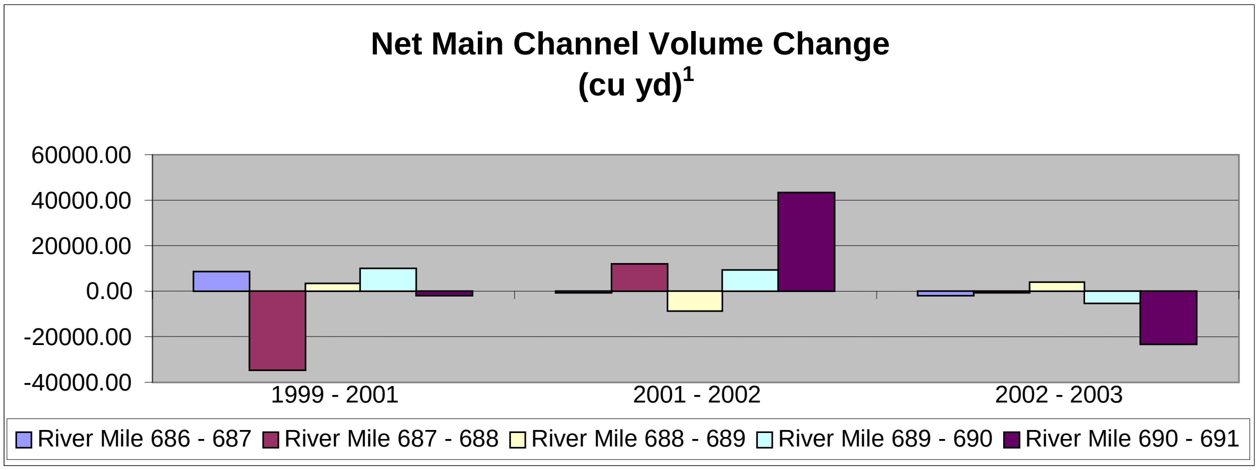

Figure 7. Main channel volume change by year for study area locations

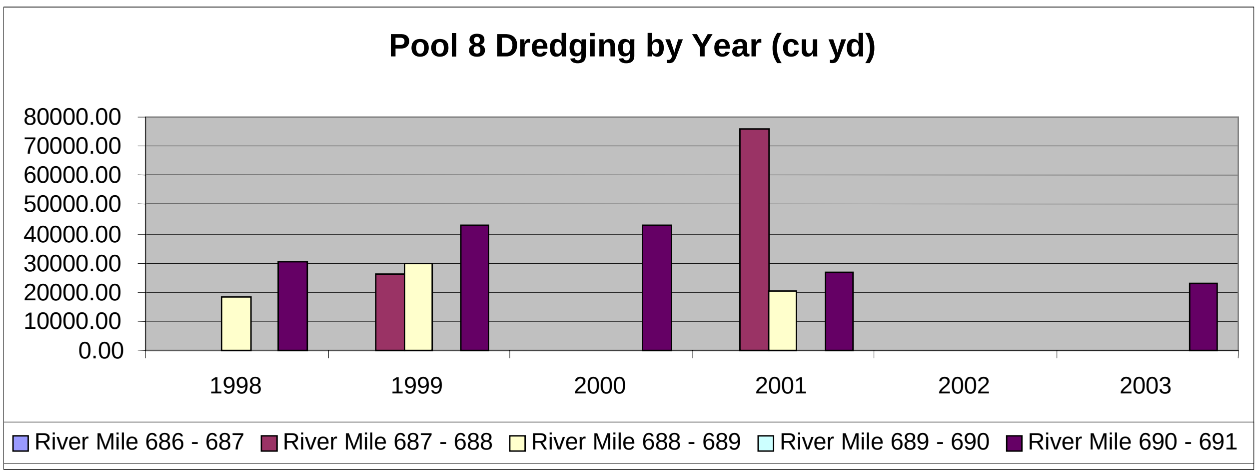

Figure 8. Dredging by year for study area locations

October (well after the large amount of dredging done earlier in the year), 2002 surveys were done in late October, and 2003 surveys were taken from April to June. Because of these inconsistencies, caution should be used in interpreting these results. For instance, surveys done early in the navigation season may show a shallower channel due to the spring floods, while a survey later in the navigation season after dredging was done may show a deeper channel.

1999 to 2001 time period

Figure 8 shows the large amount of channel dredging done in June 2001 prior to the drawdown. 120,000 cu yd were dredged in 2001 and 210,000 cu yd in the other years shown. This dredging activity is partially reflected in the main channel volume changes shown in Figure 7. Between RM 687 and 688, there was a net degradation of about 35,000 cu yd, which is due to the dredging that was done in June 2001. From RM 688 to 689 and RM 690 to 691, about 20,000 and 25,000 cu yd of sand were dredged from each cut in June 2001 (Figure 8). However, both reaches are dredged

[1] To convert cubic yards to cubic meters, multiply by 0.7645549.

at this volume or greater on an annual basis, so the volume change analysis didn't indicate significant change.

2001 to 2002 time period

The volume change analysis also showed that between 2001 and 2002, over 40,000 cu yd of deposition occurred between RM 690 and 691. From RM 687 to 688 and RM 689 to 690 about 10,000 cu yd of deposition occurred in each reach. No dredging was needed in the study reach during this time period.

2002 to 2003 time period

Between 2002 and 2003, over 20,000 cu yd of erosion occurred in the reach between RM 690 and 691. The dredging that was done in this reach, was done after the 2003 survey, so whatever caused the erosion was not related to dredging. No other significant main channel volume changes occurred during this time period.

These are interesting results because this entire reach usually aggrades due to the spring floods and yet there was little change in main channel bathymetry. As previously described, the hydrodynamic conditions in Pool 8 during the drawdown (which occurred in the summers of 2001 and 2002) should have resulted in increased sediment transport, and perhaps this is what kept the channel from aggrading.

The results of this GIS analysis cover time spans of 3 to 4 years and a river length of 8 km (5 miles). Therefore, it cannot be used to say anything definitive as to whether or not the drawdown affected local and temporary transport rates. What it does indicate is that the regular cycles of scour, deposition and dredging may have been shifted towards erosion with less dredging. In the context of the ISSDOT measurements, it allows that there certainly could have been increased transport during the drawdown period, but that such an increase, and the effects from it, was only temporary.

Transport Function Analysis: Analytic transport functions are another way to estimate bed-load transport in large sand-bed rivers. Many functions have been developed for a variety of different river and flume conditions. These functions also compute different types of transport. For instance, some compute only total sediment load, others bed material load, and yet others bed load only. The sediment and hydraulic analysis package SAM, see Thomas et al. (2002),[1] developed at the ERDC Vicksburg, was used to run the transport functions selected for this project. SAM can be accessed at the following Web site. http://chl.wes.army.mil/software/sam/. SAM is a windows based package that allows users to select up to 20 different transport functions. These functions have been programmed to accept the required and necessary hydraulic and sediment input data for each function. When executed with the appropriate data, each selected function will output its computed transport rate. Those functions that require the use of special graphs, for example Einstein's bed-load function, have them analytically programmed into the package. For the Pool 8 study, 17 of the functions were run, although only five of these can be used to compute bed load. Seventeen functions were run because for one, it is very easy to run them once the sediment and hydraulic data

[1] W. A. Thomas, R. R. Copeland, and D. N. McComas. (2002). "SAM hydraulic design package for channels," unpublished report, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

have been entered, and secondly, in further studies, it might be useful to know more about suspended load estimates as well. These functions are listed in Table 1.

Table 1
Transport Function Output Values

Function	TRIP 1 Capacity tons/day	TRIP 1 Concentration ppm	TRIP 2 Capacity tons/day	TRIP 2 Concentration ppm
Toffaleti	1,850	19	268	3
Toffaleti bed load	175		82.5	
Yang	1,490	15	219	2
Einstein (total)	919	9	526	6
Ackers-White	1,958	20	253	3
Colby	4,416	45	2,547	29
MPM (1948)	723	7	188	2
Laursen-Madden	1,998	20	235	3
Laursen-Copeland	3,677	37	852	10
Yang D50	1,352	14	202	2
Ackers-White D50	2,156	22	295	3
Schoklitsch (bed)	121.8	1.25	0	
MPM(1948) D50	973	10	220	2
Einstein bed load	653	7	399	5
Engelund-Hanson	3,096	32	643	7
Van Rijn	2,215	23	215	2
Van Rijn bed load	637.5		126.6	

The five functions used to compute bed load are the following: Toffaleti, Meyer-Peter-Mueller (MPM(1948)), Schoklitsch, Einstein bed load, and Van Rijn bed load. The sediment and hydraulic data used as input to the transport functions are listed in Table 2. These data were not estimated, but consisted of actual field measurements. For each trip, they were collected as closely in time as possible. This included bottom samples for the bed gradations and acoustic data to determine velocity profiles and discharge, as well as to define the site cross section. The discharge measurements at the study site are not the same as the flow through L&D 8. This is because the total flow through the lock and dam includes flow in the main channel, as well as the floodplain and distributaries. A plot of the two cross sections at the time the measurements were made is shown in Figure 9.

Table 2
Input Data for Transport Functions

			Average Sediment Characteristics for Trips 2 and 4			
	Trip 2	Trip 4	% Finer	Grain Size mm	% Finer	Grain Size mm
Flow (cfs)	35,893	31,971	D05	0.18	d50	0.35
Water slope	0.00007	0.00003	D10	0.21	d60	0.44
Water surface	630.38	632.23	D20	0.24	d70	0.78
Cross-section area	15,246	17,485	d30	0.27	d80	1.26
Average channel velocity	2.35	1.83	d40	0.31	d95	1.79

The computed values of bed-load transport, that is, the portion of bed material load estimated or represented as moving in the sand waves, are shown in Figure 10.

Regarding this study, two important results shown in this graph need to be emphasized. The first is that the magnitudes of the transport rates fall within the same range as Δq computed using ISSDOT. For trip 2, when the line in Figure 5 is extrapolated as shown, its highest values are in the range of 600 to 800 tons per day. For Trip 4, the highest values are right at 600 tons per day. The low values

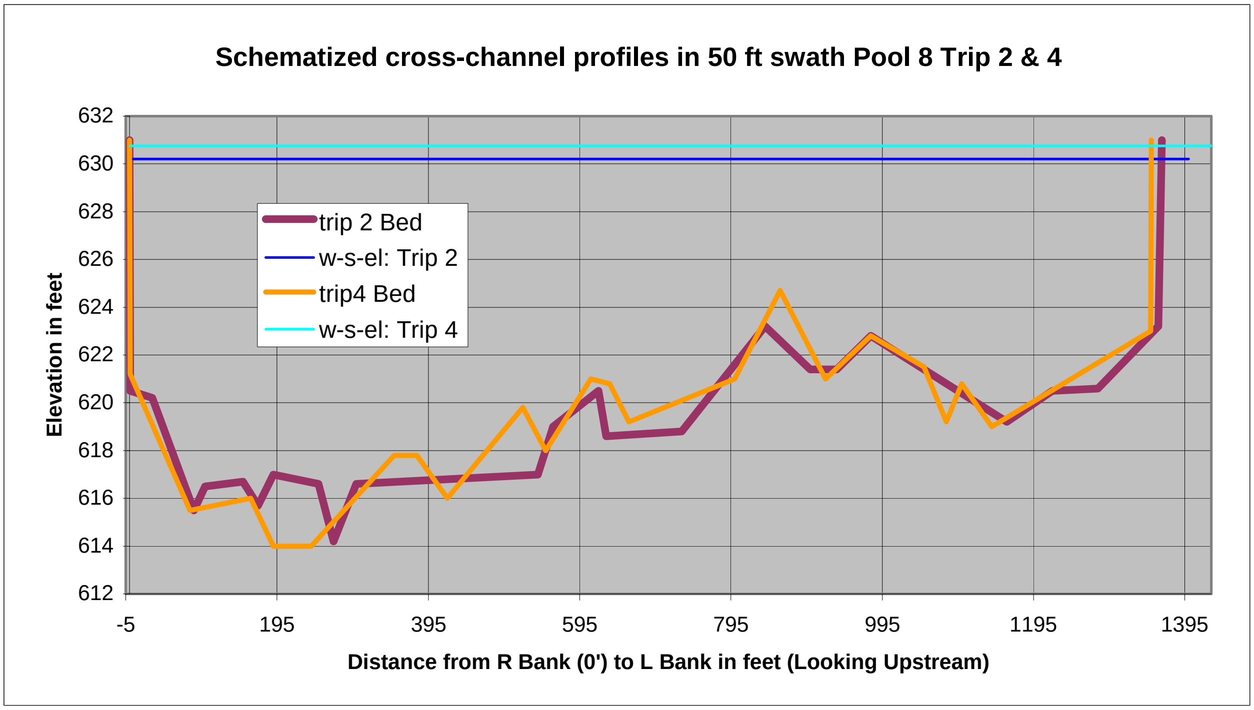

Figure 9. Comparison of channel cross sections in study area for trips 2 and 4

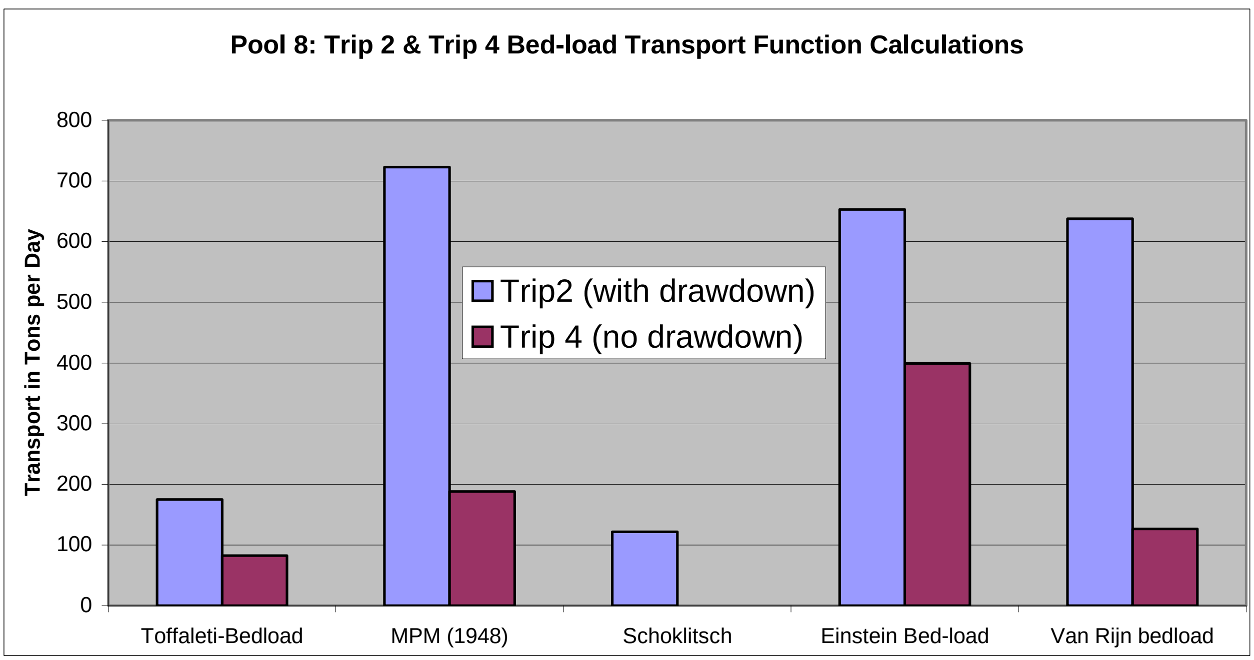

Figure 10. Results of transport function calculations for bed-load transport through study reach

for each trip are near 40 tons per day. If it can be verified and adequately explained that the Δq computed by ISSDOT really does approach the transport rate for small Δt, then these ISSDOT values compare favorably with the transport function computed values. The second result of importance is the consistency of the relative values of transport for trip 2 compared to those for trip 4. All five functions show significantly more transport for the drawdown condition (trip 2) than the normal pool condition (trip 4).

CONCLUSIONS: For the same set of hydraulic and sediment characteristics, both the ISSDOT method of computing bed-load transport gradient and the analytic transport functions computed transport gradients/rates between 40 and 800 tons per day through the study reach. In each method, the lower values corresponded to the normal pool condition, and the higher transport values corresponded to the drawdown conditions. Supporting these data, the sand budget analysis provided an estimate of a mean daily transport rate of bed load between 275 to 550 tons per day. The transport rates for this case would depend on the amount of bed material that could be proven to be in suspension.

Three sets of bed-load transport measurement data have been presented. They were each computed independently of one another. They also were derived using different methods. Yet all three methods produced results that make sense and are within at least an order of magnitude of each other. These data suggest the following conclusions regarding the Pool 8 drawdown of 2001. It appears the observed drawdown did in fact have the effect of increasing the sediment mobilization within the study reach. Additionally, it shows that the original structures as designed, and in conjunction with a drawdown, continue to positively influence sediment movement in the reach. Conversely, as pool levels are increased, the structures will have a diminishing effect in helping to mobilize sediment through the reach. Through further monitoring to establish base transport rates, it might be possible to project sediment movement before, during, and after such events. Equipped with this information, river managers could more efficiently plan their dredging requirements for events such as the Pool 8 drawdown.

POINT OF CONTACT: Questions about this CHETN can be addressed to David D. Abraham (601-634-2846), email: David.D.Abraham@erdc.usace.army.mil.

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