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October 1993

US Army Corps
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Waterways Experiment
Station

Flood Control Channels Research Program

Modified Laursen Method for Estimating Bed-Material Sediment Load

by Edward B. Madden
Consulting Engineer

Approved For Public Release; Distribution Is Unlimited

Prepared for Headquarters, U.S. Army Corps of Engineers

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10109 McCree Road
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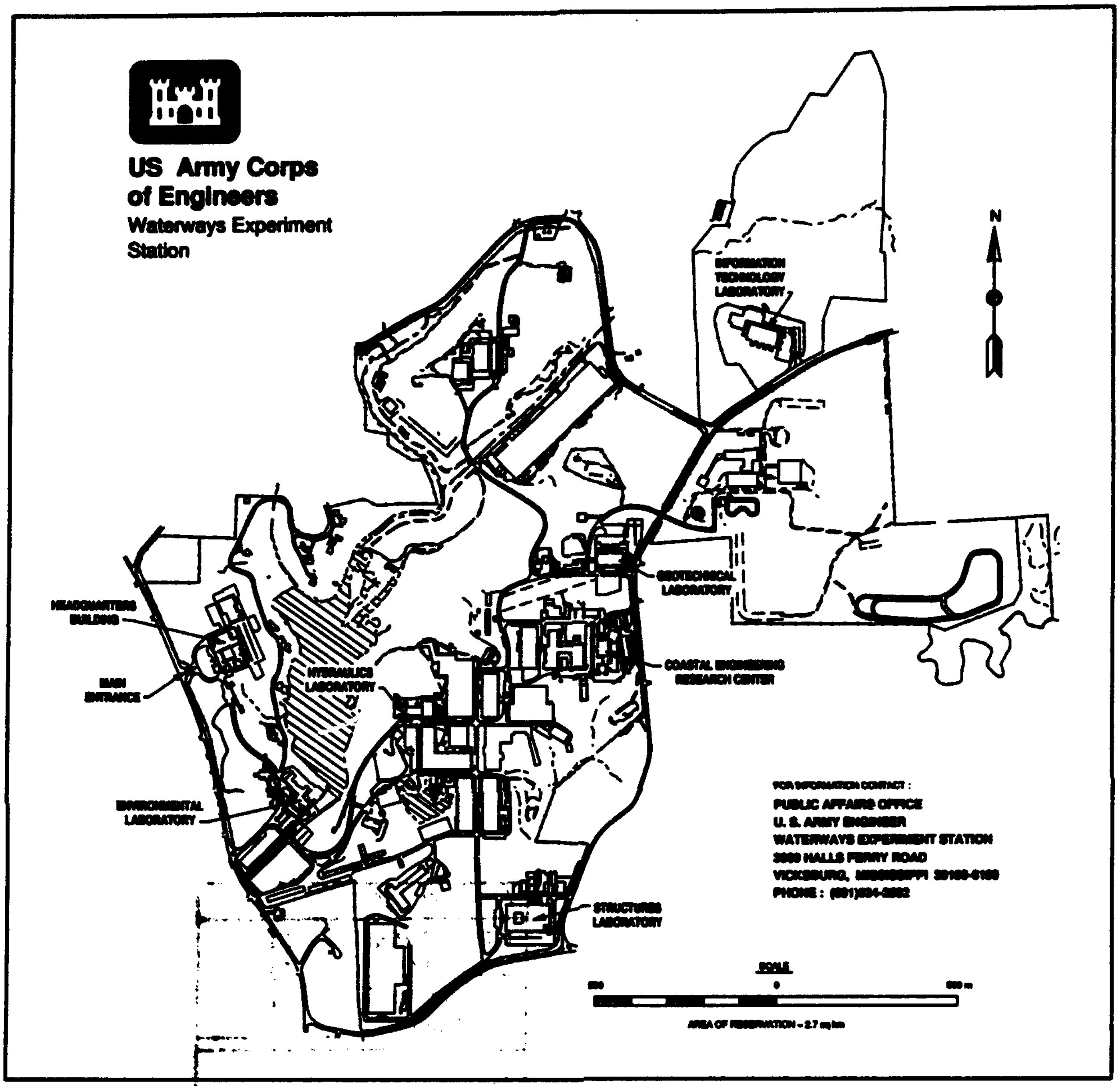

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Preface

The investigation reported herein was conducted for the U.S. Army Engineer Waterways Experiment Station (WES) by Edward B. Madden under Contract DACW39-85-M3699. It documents a modification to coefficients in the Laursen Transport Function using data from streams and rivers. To better fit observations, a new expression involving Froude number of the flow was added to the calculations.

The study, conducted during the period 1984 to 1985, was under the general supervision of Messrs. F. A. Herrmann, Jr., Chief of the Hydraulics Laboratory, WES; R. A. Sager, Assistant Chief of the Hydraulics Laboratory; Mr. M. B. Boyd, Chief of the Waterways Division, Hydraulics Laboratory; and under the direct supervision of Mr. W. A. Thomas, Research Hydraulic Engineer, Waterways Division, who was the Contracting Officer's Representative. This report was prepared by Mr. Madden as part of the contract, and was reviewed by Mr. Thomas.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

Conversion Factors, Non-SI to SI Units of Measure

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic meters
Fahrenheit degrees	5/9	Celsius degrees or kelvins[1]
feet	0.3048	metres
tons (2,000 pounds, mass)	907.1847	kilograms

[1] To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

1 Introduction

During planning studies for the Arkansas River navigation channel, which were carried out during the late 1950's and on into 1960, it was considered desirable to express the relation between stream and channel characteristics, discharge, and bed-material sediment load in generalized terms such that the effects of changes in the various parameters involved could be evaluated. A functional relationship developed by Emmett M. Laursen (1968) was used as a framework for developing a generalized working curve for use in the Arkansas River channel design studies. Laursen's relationship was adopted because it is expressed in terms which permit separating readily the effects of the various parameters which are generally considered to govern the relation between the bed-material load, the hydraulic characteristics of the streamflow, and the characteristics of the material of which the streambed is composed. In addition, being empirical, the Laursen relation is susceptible of being adjusted to fit Arkansas River sediment load observations.

2 Laursen Procedure

Using the results of a number of flume tests from various sources Laursen developed a functional relation curve between the expressions $\sqrt{\tau o/\rho}/w$ and $c/((d/D)^{7/6}\,((\tau o'/\tau c)-1))$, where $\sqrt{\tau o/\rho}$ is the shear velocity at the streambed in feet per second, and the second group of parameters is referred to as $f(\sqrt{\tau o/\rho}/w)$; τo is the boundary shear or tractive force in pounds per square foot, $\tau o'$ is the boundary shear associated with the sediment particles in the streambed, τc is the critical tractive force for beginning of movement of the sediment particles, ρ is the mass density of the fluid (1.94 for water), w is the fall velocity of the sediment particles in water in feet per second, c is the concentration of sediment in percent by weight, d is the diameter of the sediment particle (mean diameter of each fractional size range in feet, D is the depth of flow in feet, and f means "function of."

Laursen's functional relation curve is shown in Figure 1. In attempting to reproduce sediment load versus discharge rating curves which had been developed for gaging stations on the lower Arkansas River from numerous sediment measurements that had been made over a period of many years, it was discovered that the rating curves calculated from Laursen's relation resulted in loads considerably smaller than the curves developed from the long-term measurements. However, the curves did parallel each other. It was also noted that the data point values of $f(\sqrt{\tau o/\rho}/w)$ calculated from Missouri River data by D. C. Bondurant (1968) plotted considerably higher than Laursen's functional relation. For these reasons, a new relationship curve was developed for use in the Arkansas River planning studies, using Laursen's parameters but based on Arkansas River data. Two versions of the modified relationship were developed at different times. Both versions are shown on Figure 1 for comparison with Laursen's original curve.

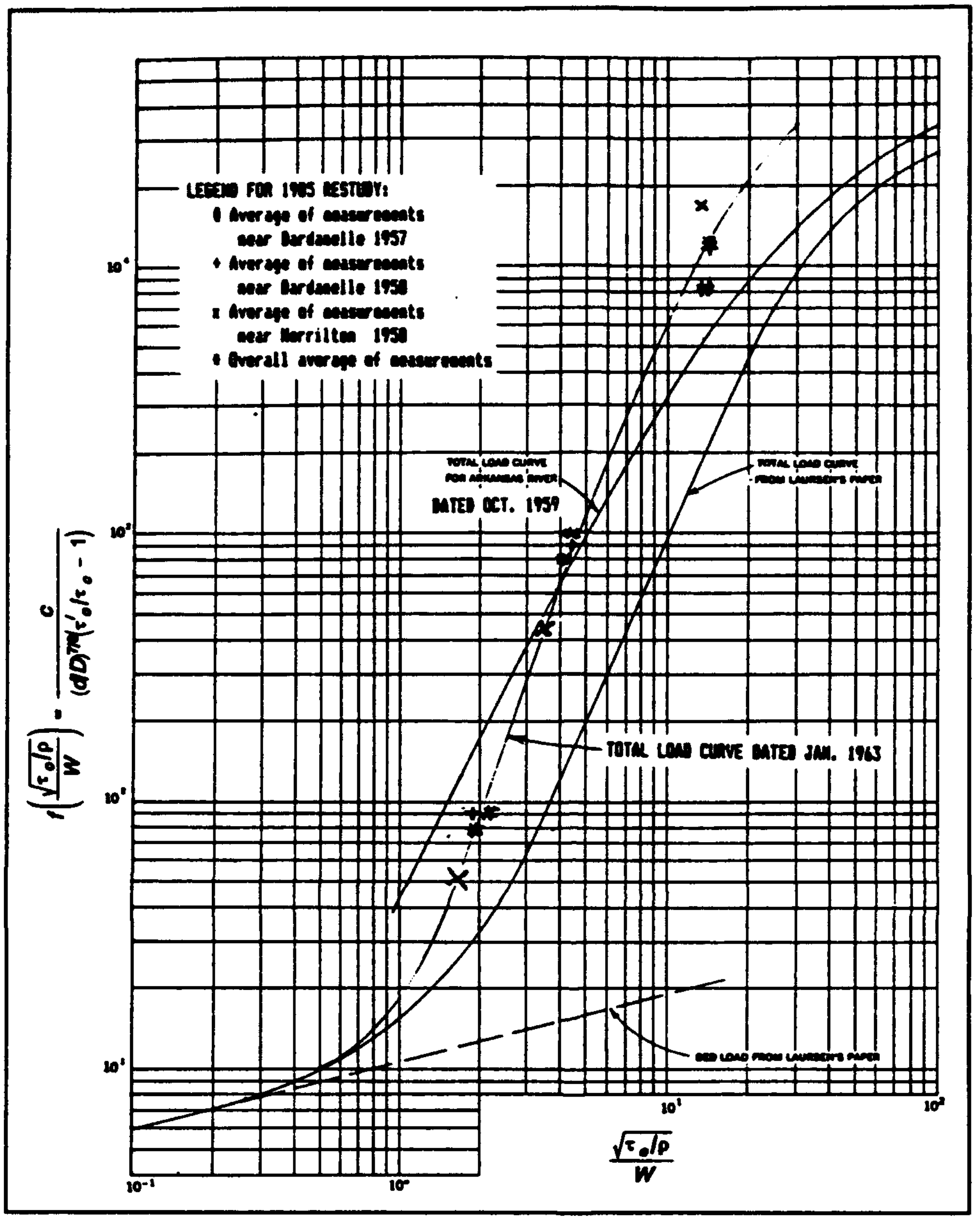

Figure 1. Relation for sediment load, Laursen method

3 Arkansas River Data

Three sets of special measurements were made on the Arkansas River as follows:

Near Dardanelle, Arkansas, in June-July 1957,
Near Dardanelle, Arkansas, in April 1958, and
Near Morrilton, Arkansas, in April 1958.

In each set, the measurements were made on four separate ranges and at five verticals on each range, resulting in 20 measuring locations in each set and a total of 60 locations for the three sets.

The observations at each vertical consisted of the sounded depth, the mean velocity in the vertical, and a depth-integrated suspended sediment sample. Bed-material samples were also obtained at each vertical with a revolving-bucket type sampler during the 1958 measurements at both Dardanelle and Morrilton. Attempts to obtain bed-material samples with a drag-bucket sampler at Dardanelle during the 1957 observations were unsuccessful. The water temperature was measured on each day of the observations. Water surface elevations also were obtained at each range. The total river discharges during the observations were approximately 178,000 cfs[1] at Dardanelle in 1957, 121,000 cfs at Dardanelle in 1958, and 97,000 cfs at Morrilton in 1958.

[1] A table of factors for converting non-SI units of measure to SI units is found on page v.

4 Development of Modified Laursen Functional Relationship

The sediment size classification used in this study is presented in the following tabulation:

Sediment-size Class	Size Range in mm	Geometric Mean for in mm	Size Class in feet
Coarse Silt	0.031 - 0.0625	0.044	0.000142
Very Fine Sand	0.0625 - 0.125	0.088	0.000285
Fine Sand	0.125 - 0.250	0.177	0.000580
Medium Sand	0.250 - 0.500	0.353	0.001158
Coarse Sand	0.500 - 1.00	0.707	0.00232
Very Coarse Sand	1.00 - 2.00	1.414	0.00464
Very Fine Gravel	2.00 - 4.00	2.828	0.00928

Sediment fall velocities as a function of grain size and water temperature are shown in Figure 2.

The procedure for developing the desired functional relationship consists essentially of calculating values of $\sqrt{\tau_o/\rho}/w$, $(d/D)^{7/6}$, and $((\tau'_o/\tau_c)-1)$ for each data point, based on the observed information on flow and bed-material characteristics and then solving for $f(\sqrt{\tau_o/\rho}/w)$ using the equation:

$$f\left(\sqrt{\tau_o/\rho}/w\right) = (c/P_s)/\left\{P_b(d/D)^{7/6}\ [(\tau_o/\tau_c)-1]\right\} \tag{1}$$

where P_s is the fraction of suspended material of the size class represented by d, P_b is the fraction of bed material of the size class represented by d, and the other symbols are as previously defined.

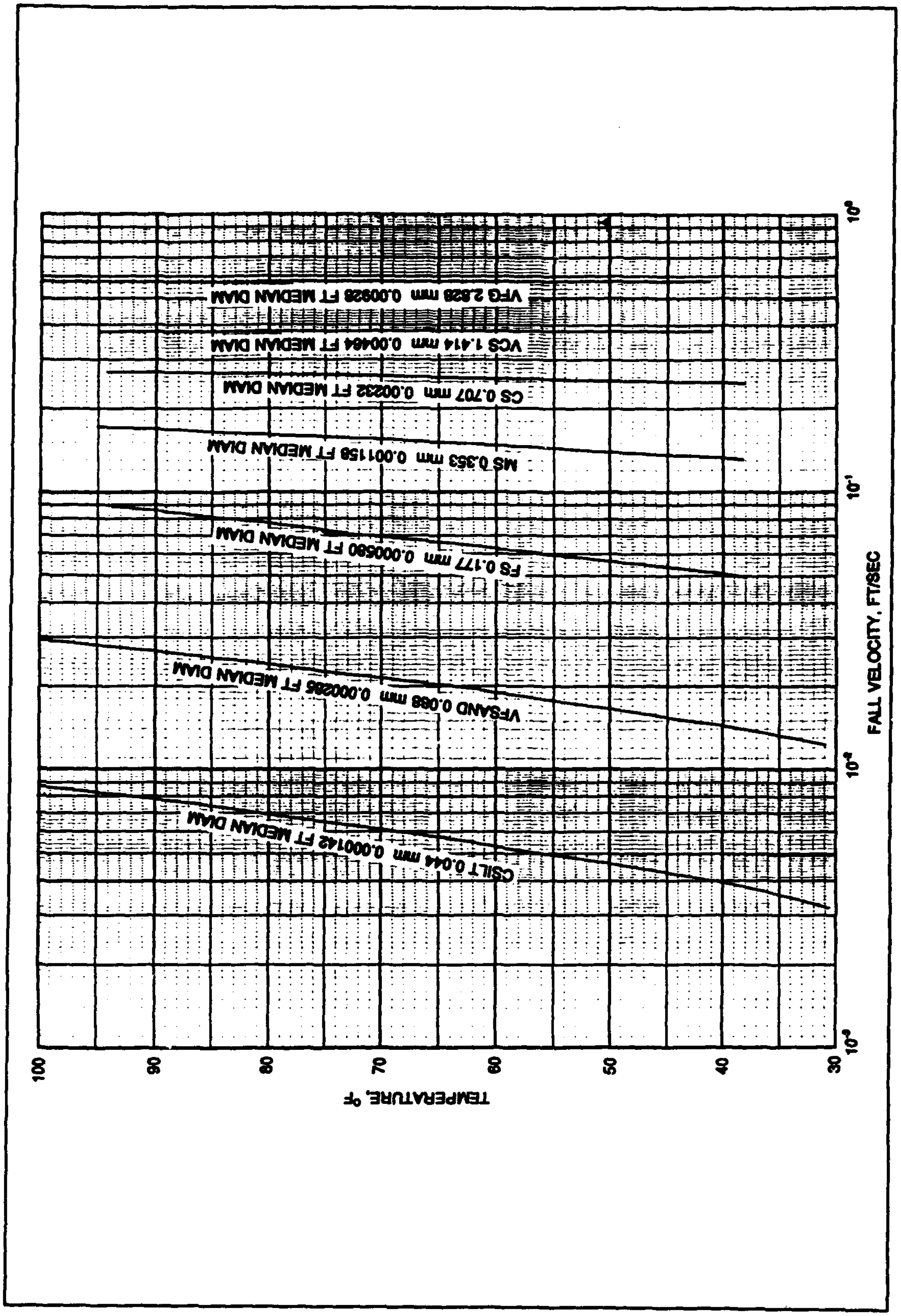

Figure 2. Sediment fall velocity

Additional pertinent equations are as follows:

$$\tau_o = \gamma DS = 28.25n^2V^2/D^{1/3} \qquad (2)$$

$$\tau_o' = (V^2/30d_m/D)^{1/3} \qquad (3)$$

$$\tau_c = 4d \qquad \textit{in general,} \qquad (4a)$$

$$\textit{but } \tau_c > 4d \textit{ for particles less than } .088mm \textit{ in size} \qquad (4b)$$

$$q_s = 27qc \qquad \textit{or } Q_s = 27Qc \qquad (5)$$

In these equations γ is the specific weight of the fluid in pounds per cubic foot (62.4 for water), S is the energy gradient in feet per foot, n is the Manning roughness coefficient, V is the mean velocity in feet per second, d_m is the median size of the sediment mixture in the streambed in feet (considered representation of the grain roughness of the bed), q is the discharge per foot width in cubic feet per second per foot, Q is the total discharge in the stream cross section in cubic feet per second, q_s is the sediment load in tons per day per foot width, and Q_s is the total sediment load in the channel cross section in tons per day. These and other symbols are summarized in a list of symbols, Appendix A.

The procedure described above was applied to each sediment size class in the suspended and bed material samples at each observation location. These calculations resulted in values of $f(\sqrt{\tau_o/\rho/w})$ for the suspended sediment corresponding to each value of $(\sqrt{\tau_o/\rho/w})$. Values of $f(\sqrt{\tau_o/\rho/w})$ for bed load were calculated from the equation.

$$f(\sqrt{\tau_o/\rho}\ /w)_b = 10.7378\ (\sqrt{\tau_o/\rho}\ /w)^{0.25301} \qquad (6)$$

which was deduced from Laursen's curve labelled "Bed load" in Figure 1. The bed-load values were added to the suspended-load values to obtain values of $f(\sqrt{\tau_o/\rho/w})$ applicable to the total load. Plotting of the resulting values of $f(\sqrt{\tau_o/\rho/w})$ versus corresponding values of $\sqrt{\tau_o/\rho/w}$ served as the basis for developing the functional relationship curve. As the many points were widely scattered, group averaging was employed to aid in plotting the curve. The points fell into groups according to sediment-size class. Accordingly, the group averaging was performed on a size-class basis.

The latest, 1985, implementation of the procedure described above is illustrated in detail by Table 1. In the interest of simplifying computer printouts, the symbols *To, To'*, *X*, *Y*, and *Y'* have been substituted for τ_o, τ'_o, $\sqrt{\tau_o/\rho}/w$, $f(\sqrt{\tau_o/\rho}/w)$ for suspended load, and $f(\sqrt{\tau_o/\rho}/w)$ for total load, respectively. The results of computations for all of the special Arkansas River observations at Dardanelle and Morrilton in 1957 and 1958 are included in Appendix B of this report as Tables B-1 through B-12. The computation of group averages of data points is included as Table B-13.

At the time of the Arkansas River project planning studies, the results of laboratory analyses of the bed-sediment samples had not been completed. Because of this, it was necessary to use the results of bed-material samples obtained previously during relatively low river flows. The resulting modified functional relationship curve in Figure 1 is labelled "Curve dated October 1959." The application of that relationship curve to the Arkansas River project planning studies is described in Madden (1964).

The relationship curve was revised in 1963 utilizing the results of the bed-material samples that were obtained at the time of the special observations in 1958. The 1958 samples at Dardanelle were assumed to be applicable to the 1957 observations at Dardanelle in the absence of actual bed-samples at that time. The 1963 modified relationship curve is labelled "Curve dated Jan. 1963" in Figure 1. A more detailed "working-curve" version of the 1963 curve is included as Figure 3 of this report. Copies of this curve were distributed to attendees at a course in Sediment Problems in Hydraulic Engineering that was held at the US Army Engineer Waterways Experiment Station in Vicksburg, MS, May 18-22, 1970.

The group-averaged data points computed in the latest (1985) study agree very closely with the 1963 relationship curve. Consequently, further revision of that curve is considered not warranted.

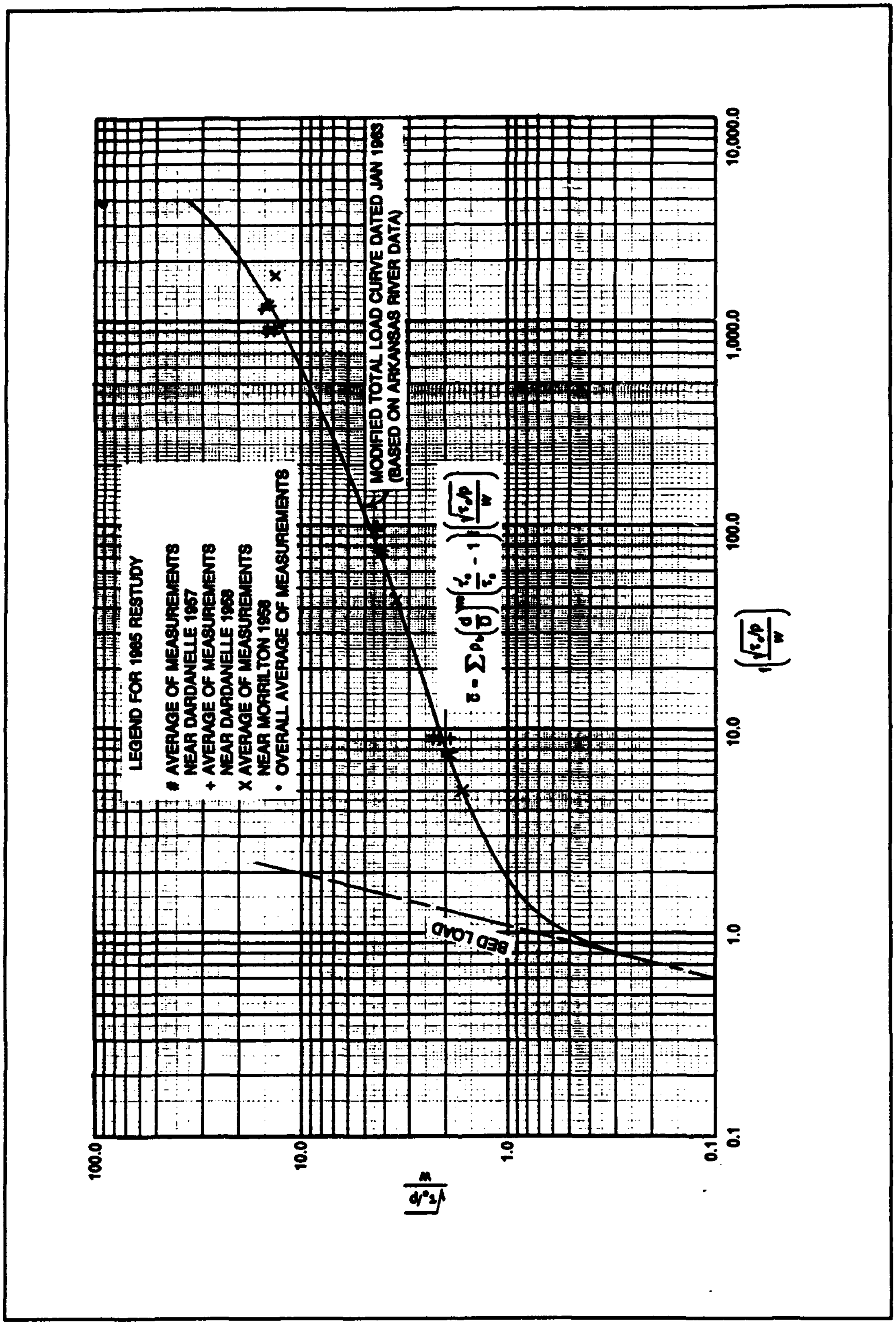

Figure 3. Modified relationship for sediment load, working curve

5 Application of Modified Laursen Functional Relationship

Calculation of the bed-material sediment concentration follows a reverse process to that described above. Data requirements include the flow depth or hydraulic radius, D or R; the velocity, V; the energy gradient, S; or a Manning n value; a grain-size distribution for the bed material, P_b; and an observed or estimated water temperature, *TDF*. The parameters $\sqrt{\tau_o/\rho}/w$, $(d/D)7/6$, and $((\tau'_o/\tau_c)-1)$ are first computed from the known information as before. For each value of $\sqrt{\tau_o/\rho}/w$, a corresponding value of $f(\sqrt{\tau_o/\rho}/w)$ is then read from the functional relationship curve. The sediment concentration is then calculated by means of the equation:

$$c = P_b(d/D)^{7/6} \quad ((\tau_o'/\tau_c)-1)f(\sqrt{\tau_o/\rho}\,/w) \tag{7}$$

The sediment load is calculated from Equation 5.

The calculations are carried out for each grain-size class, and the resulting incremental loads are then summed to obtain the combined load for all sizes. For total load, Equation 7 is modified as follows:

$$\bar{C} = \Sigma P_b(d/D)^{7/6} \quad ((\tau_o'/\tau_c)-1)f(\sqrt{\tau_o/\rho}\,/w) \tag{7a}$$

where $\bar{C}$ is the total bed-material concentration and $\sum$ represents summation.

As a test of the procedure, it has been applied to the following locations at which observed sediment concentration data are available for comparison with computed values:

RIVERS:
Atchafalaya River at Simmesport, Louisiana
Mississippi River at Tarbert Landing, Louisiana

Mississippi River at St. Louis, Missouri
Red River at Alexandria, Louisiana
Rio Grande near Bernalillo, New Mexico
Middle Loup River at Dunning, Nebraska
Niobrara River near Cody, Nebraska
Arkansas River at Dardanelle and Morrilton, Arkansas

FLUME TESTS:

Simons and Richardson,	0.19mm sand,	Colorado State University
" " "	0.27mm sand	" " "
" " "	0.45mm sand	" " "
" " "	0.93mm sand	" " "
Toch,	0.04mm sand,	Iowa Institute of Hydraulic Research

The information on all of the rivers except the Arkansas was obtained from a paper by Toffaleti (1968). Information on the flume tests by Simons and Richardson was obtained from Guy, Simons, and Richardson (1966). Information on the flume tests by Toch was obtained from Laursen (1968).

Calculation of the bed-material sediment load is demonstrated in detail in Table 2. Calculations for all of the locations listed above are included in Appendix C as Tables Nos. C-1 through C-27. Critical tractive force values of 4d were assumed for all computations except for the Toch flume tests, for which a value of 5d was used because of the small size of the bed material. The tables include computations of ratios of computed load to observed load. A wide variation in the ratios can be noted. In an investigation to determine whether or not some additional parameters should be included in the procedure, the ratios were plotted against values of the Froude number, $F_r = V/\sqrt{gD}$, where g is the gravitational acceleration. The Froude number is considered to be one of the factors governing the presence of ripples, dunes, antidunes, plane bed, or intermediate transitions. (See Albertson, Simons, and Richardson (1958) and a relationship of dune wave steepness versus Froude number presented in Vanoni (1975) from a study by Kennedy (1963).) Variations in these bed-regime features affect the bed roughness and turbulence, which, in turn, affect the flow-sediment interaction.

The plot of the computed-to-observed load ratios versus Froude numbers on log-log graph paper is shown in Figure 4. A definite correlation can be observed. A representative straight-line curve has been drawn in an approximately median position among the points. Most of the points lie within enveloping curves drawn at positions giving ratio values from one-half to two times the median curve values. This degree of correlation is considered good for field sediment data. Almost all of the points are within a range of one-third to 3 times the median values. This is considered acceptable.

Two of the points diverge widely from the others. An examination of the basic information on these points revealed that sediment transport was very small, consisting entirely or almost entirely of bed-load movement with little

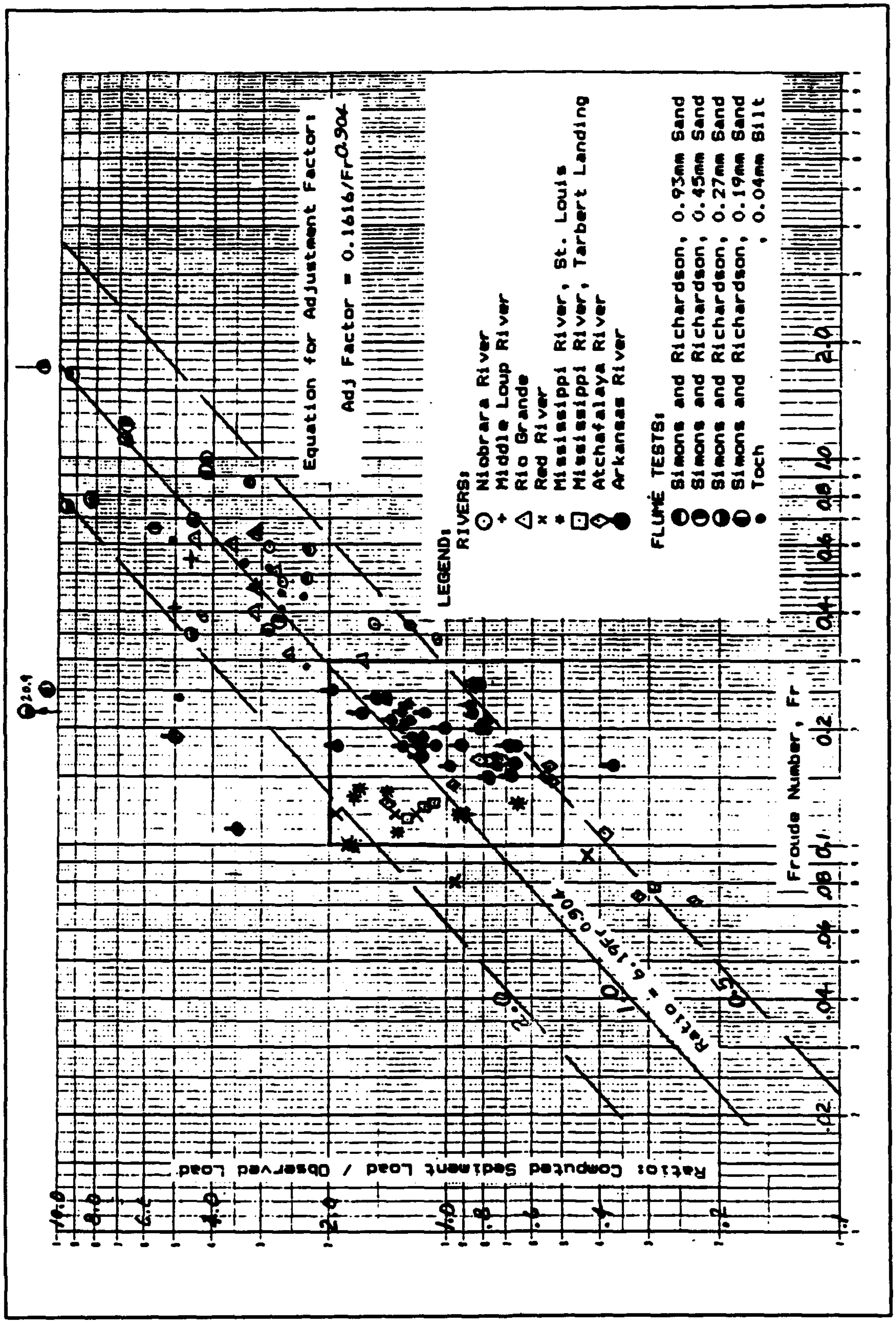

Figure 4. Modified Laursen method, error analysis

or no suspended load. The bed configuration was in the ripple regime. Also, it was noted that the grain-associated tractive force, τ'_o, for the median-size was only 1.4 and 1.5 times the computed critical tractive force, τ_c. This suggests the possibility of a "hiding effect," in which the smaller particles are partially sheltered when movement of the median size is marginal, or that the assumed value of 4d does not define the critical tractive force with sufficient accuracy under near-threshold conditions.

The following equation was deduced for the median curve of relationship between the ratio of computed to observed sediment load and the Froude number:

$$Ratio = 6.19F_r^{0.904} \tag{8}$$

An adjustment factor for adjustment of the computed load can be computed from the inverse of the latter equation:

$$Adj.\ Factor = 0.1616/F_r^{0.904} \tag{9}$$

Equation 9 was applied to each initially computed load or concentration in Tables 2 and B-1 through B-27 to obtain adjusted values of computed load or concentration. Although the adjustment was performed as a separate operation in the tables for illustrative purposes, it should be noted that Equation 9 can be incorporated into Equations 7 and 7a, resulting in the equations:

$$c = P_b(d/D)^{7/6}\ ((\tau'_o/\tau_c)-1)f(\sqrt{\tau_o/\rho}\ /w)(0.1616/F_r^{0.904}) \tag{10}$$

$$and\ \ \bar{C} = \Sigma P_b(d/D)^{7/6}\ ((\tau'_o/\tau_c)-1)f(\sqrt{\tau_o/\rho}\ /w)(0.1616/F_r^{0.904}) \tag{10a}$$

As indicated previously, the bed-material load is computed by means of the equation:

$$q_s = 27q\bar{C} \qquad or \qquad Q_s = 27Q\bar{C} \tag{11}$$

A plot of all values of adjusted computed loads or concentrations versus observed loads or concentrations, shown in Figure 5, indicates acceptable results, comparable to results of other sediment load computation procedures.

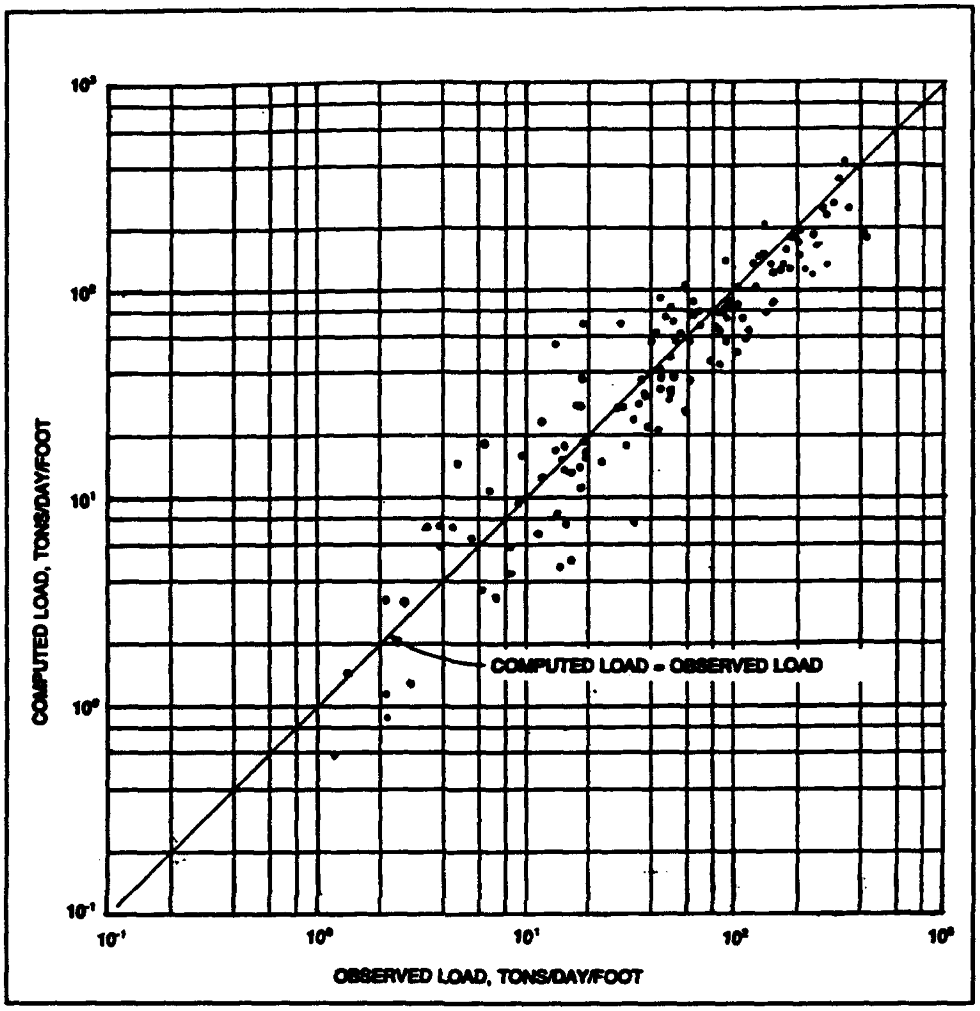

Figure 5. Comparison of results

6 Range of Applicability

The modified Laursen procedure has been applied to sediments ranging in size from coarse silt (noncohesive) to very fine gravel, flow depths ranging from 0.25 to 54 feet, velocities from 0.85 to 7.7 feet per second, energy gradients from 0.00001 to 0.1, temperatures from 36 to 90 degrees Fahrenheit, and Froude numbers from 0.07 to 1.7. It is concluded that the results, with adjustments for Froude number effects, are satisfactory throughout these ranges in variables except when the grain-associated tractive force for the median size of the bed-material mixture is less than about two times the critical tractive force. Within this same restriction, satisfactory results can be obtained without the Froude number adjustment when the Froude number is within the range from 0.10 to 0.30 (see boxed area in Figure 4.) This range of Froude numbers is characteristic of large alluvial rivers.

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TABLE NO. 1

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
DARDANELLE RANGES
June-July 1957

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Ps	Pb	do	Tc	To'	n	To	w	c	X	Y	Y for Bed Load	Y' for Total Load	Ave. of X each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	17	19	20	21	22	23
										.001213			.029									
3	6-27-57	76F																				
			420	26.80	5.23							.0320931		.2171565		.173						
						VFS	.000285	.1	.033		.00114				.024	.0173	13.94	12087.28	20.91	12108.19	12.72	8862.47
						FS	.00058	.03	.136		.00232				.077	.00519	4.35	812.18	15.57	827.76	3.96	1297.69
						MS	.001158	.02	.57		.00463				.155	.00346	2.16	124.62	13.05	137.66	1.97	94.71
			820	19.50	4.63							.0283128		.1892191		.212						
						VFS	.000285	.11	.033		.00114				.024	.02332	13.01	12972.98	20.55	12993.53		
						FS	.00058	.07	.136		.00232				.077	.01404	4.06	1860.25	15.30	1875.55		
						MS	.001158	.02	.57		.00463				.155	.00424	2.01	123.98	12.82	136.80		
			1220	14.80	4.58							.0303722		.2029823		.188						
						VFS	.000285	.13	.033		.00114				.024	.02444	13.48	9161.16	20.74	9181.90		
						FS	.00058	.07	.136		.00232				.077	.01316	4.20	1108.01	15.44	1123.85		
						MS	.001158	.01	.57		.00463				.155	.00188	2.09	36.66	12.93	49.59		
			1620	14.40	3.42							.0170909		.1142210		.19						
						VFS	.000285	.06	.033		.00114				.024	.0114	10.11	7584.89	19.28	7604.17		
						FS	.00058	.06	.136		.00232				.077	.0114	3.15	1765.52	14.36	1779.87		
						MS	.001158	.01	.57		.00463				.155	.0019	1.57	74.13	12.03	86.16		
			2020	9.80	4.14							.0284724		.1902858		.194						
						VFS	.000285	.05	.033		.00114				.024	.0097	13.05	2403.97	20.57	2424.54		
						FS	.00058	.08	.136		.00232				.077	.01552	4.07	866.40	15.31	881.80		
						MS	.001158	.02	.57		.00463				.155	.00308	2.02	50.50	12.83	63.33		

TABLE NO. 2

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	Q	V	R	W	S	TDF	Bed Composition			w	I	V'	c	Bed-Material Sediment Load Tons Per Day		Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft	
							Size Class	Geom. Mean Size, ft.	Pb				%	Computed	Observed					Computed	Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Atchafalaya R., Simmesport, La. April 12, 1962	501000	6.28	40.3	1651	.0000472	59	VFS	.000205	.049	.019	14.35	13000	.0133964	181212.53			.16	154139.05			
							FS	.00058	.717	.064	6.32	800	.0130095	176519.93				150167.01			
							MS	.001150	.23	.144	1.92	76	.0004107	5555.04				4726.00			
							CS	.00232	.002	.257	1.08	21.7	.0000009	12.08				10.08			
							VCS	.00464	0	.385	.72	12.7	0	.00				.00			
							Median	.000636													
							Total							363301.09	677000	.54		309063.35	.46	107.29	410.05
Atchafalaya R., Simmesport, La. May 24, 1961	444000	5.68	44.6	1562	.0000465	70	VFS	.000205	.076	.022	12.00	9000	.0110723	142325.13			.15	130452.70			
							FS	.00058	.771	.072	3.67	500	.0071609	85044.84				78683.91			
							MS	.001150	.149	.154	1.71	54	.0001507	1806.19				1655.32			
							CS	.00232	.002	.261	1.01	19	.0000006	7.40				6.70			
							VCS	.00464	0	.385	.69	12	0	.00				.00			
							Median	.00059													
							Total							229983.56	437000	.53		210799.00	.48	134.95	280.35
Atchafalaya R., Simmesport, La. March 18, 1963	301000	4.91	45.5	1353	.0000390	30	VFS	.000205	.165	.0160	14.33	12700	.0274009	222719.54			.13	229916.03			
							FS	.00058	.612	.0505	4.12	700	.0028003	47700.86				49533.04			
							MS	.001150	.184	.1375	1.75	59	.0001034	1165.71				1203.38			
							CS	.00232	.023	.2525	.95	17	.0000039	31.43				32.65			
							VCS	.00464	0	.385	.63	12	0	.00				.00			
							Median	.00056													
							Total							271670.11	192300	1.41		280404.06	1.46	207.31	142.15
Atchafalaya R., Simmesport, La. December 14, 1964	176000	4.49	30.6	1270	.0000276	46	VFS	.000205	.262	.0177	9.31	5250	.0222939	105940.40			.14	99304.64			
							FS	.00058	.404	.0565	2.92	360	.0017502	8321.09				7800.25			
							MS	.001150	.015	.1355	1.22	27	.0000062	29.34				27.50			
							CS	.00232	.002	.2525	.65	12	.0000002	1.06				.99			
							VCS	.00464	0	.385	.43	9	0	.00				.00			
							Median	.000330													
							Total							114291.31	119000	.96		107133.39	.90	84.36	94.02
Atchafalaya R., Simmesport, La. August 13, 1964	43700	1.92	22.1	1030	.0000113	86	VFS	.000205	.362	.0268	3.34	300	.0004307	508.20			.07	886.31			
							FS	.00058	.312	.0016	1.10	22	.0000004	9.91				17.28			
							MS	.001150	.037	.1624	.35	11	-.000002	-1.77				.00			
							CS	.00232	0	.2606	.33	8	0	.00				.00			
							VCS	.00464	0	.385	.22	7	0	.00				.00			
							Median	.000305													
							Total							516.34	2260	.23		903.39	.40	.00	2.19

Appendix A
List of Symbols

c	sediment concentration of each grain size class, percent by weight
$\bar{C}$	total sediment concentration of all grain size classes, percent by weight
d	diameter of sediment particle (geometric mean of size class; $d = \sqrt{d_i * d_{i+1}}$ where i represents the lower bound and $i+1$ the upper bound of the size class), ft
d_m	median size of bed material, ft (i.e., D_{50})
D	depth of flow in a vertical, ft
$f(\;)$	function of variable inclosed in the parentheses
F_r	Froude Number, $V/\sqrt{gD}$
g	gravitational acceleration, ft/sec/sec
n	roughness coefficient in Manning flow formula
P_b	fraction of bed material of diameter d, % by weight
P_s	fraction of suspended material of diameter d
q	flow per unit width, VD or Q/W, cfs/ft
q_s	sediment load per unit width, tons/day/ft
Q	total rate of flow in a cross section, cfs
Q_s	total bed material sediment discharge, tons/day

R	hydraulic radius of a channel cross section, ft
S	energy gradient, ft/ft
Tc	substitute symbol for τ_c, critical tractive force for beginning of sediment movement, lb/sq ft
To'	substitute symbol for τ_c, boundary shear or tractive force associated with sediment particles, lb/sq ft
TDF	temperature of water, degrees Fahrenheit
V	velocity of flow, ft/sec
w	fall velocity of sediment particle of size (or size class) d, ft/sec
W	surface width of channel cross section, ft
X	equivalent to $\sqrt{\tau_o/\rho}/w$ (*also* = $\sqrt{gDS}/w$ *or* $\sqrt{gRS}/w$), dimensionless
Y	function of X or $f(X)$ for suspended sediment concentration
Y'	$f(X)$ for total concentration including bed load
γ	specific weight of water, lb/cu ft
ρ	mass density of fluid, 1.94 for water, slugs/cu ft
τ_o	boundary shear or tractive force ($=\gamma DS$), lb/sq ft
$\sqrt{\tau_o/\rho}$	boundary shear velocity U_* (also = $\sqrt{gDS}$), *ft*/sec
Σ	sum

Appendix B
Development of Modified Laursen Sediment Relationship Based on Arkansas River Data

DARSD1

TABLE NO. B-1

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
DARDANELLE RANGES
June-July 1957

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Ps	Pb	dm	Tc	To'	n	To	w	c	X	Y	Y for Bed Load	Y' for Total Load	Ave. of X each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	17	19	20	21	22	23
										.001213			.029									
3	6-27-57	76F																				
			420	26.00	5.23							.0324931		.2171565		.173						
						VFS	.000205	.1	.033		.00114				.024	.0173	13.94	12087.28	20.91	12108.19	12.72	8862.47
						FS	.00058	.03	.136		.00232				.077	.00519	4.35	812.10	15.57	827.76	3.96	1297.69
						MS	.001150	.02	.57		.00463				.155	.00346	2.16	120.62	13.05	137.66	1.97	94.71
			820	19.50	4.63							.0283128		.1892191		.212						
						VFS	.000205	.11	.033		.00114				.024	.02332	13.01	12972.98	20.55	12993.53		
						FS	.00058	.07	.136		.00232				.077	.01004	4.06	1060.25	15.30	1075.55		
						MS	.001150	.02	.57		.00463				.153	.00424	2.01	123.98	12.02	136.00		
			1220	14.00	4.50							.0303722		.2029823		.188						
						VFS	.000205	.13	.033		.00114				.024	.02444	13.08	9161.16	20.74	9181.90		
						FS	.00058	.07	.136		.00232				.077	.01316	4.20	1108.01	15.44	1123.45		
						MS	.001150	.01	.57		.00463				.155	.00188	2.09	36.66	12.93	49.59		
			1620	14.40	3.42							.0170909		.1142210		.19						
						VFS	.000205	.06	.033		.00114				.024	.0114	10.11	7584.89	19.28	7604.17		
						FS	.00058	.06	.136		.00232				.077	.0114	3.15	1765.52	14.36	1779.87		
						MS	.001150	.01	.57		.00463				.155	.0019	1.57	74.13	12.03	86.16		
			2020	9.00	4.14							.0284724		.1902850		.194						
						VFS	.000205	.05	.033		.00114				.024	.0097	13.05	2403.97	20.57	2424.54		
						FS	.00058	.08	.136		.00232				.077	.01552	4.07	866.40	15.31	881.80		
						MS	.001150	.02	.57		.00463				.153	.00388	2.02	50.50	12.83	63.33		

TABLE NO. B-2

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
DARDANELLE RANGES
June-July 1957

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Ps	Pb	do	Tc	To'	a	To	w	c	X	Y	Y for Bed Load	Y' for Total Load	Ave. of X each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
										.001213			.029									
7	6-28-57	76F																				
			500	20.60	4.63							.0277996		.1857093		.212						
						VFS	.000285	.04	.033		.00114				.024	.00848	12.89	5126.16	20.50	5146.67	15.40	8513.61
						FS	.00058	.025	.136		.00232				.077	.0053	4.02	722.57	15.27	737.83	4.02	634.38
						MS	.001158	.005	.57		.00463				.155	.00106	2.00	33.78	12.79	46.57	2.00	76.64
			700	21.70	5.23							.0340617		.2329868		.239						
						VFS	.000285	.095	.033		.00114				.024	.022705	14.44	11529.75	21.10	11550.85		
						FS	.00058	.02	.136		.00232				.077	.00478	4.50	542.18	15.71	557.89		
						MS	.001158	.005	.57		.00463				.155	.001195	2.24	31.01	13.16	44.17		
			900	25.20	6.10							.0451109		.3015370		.245						
						VFS	.000285	.09	.033		.00114				.024	.02205	16.43	10222.02	21.80	10243.82		
						FS	.00058	.03	.136		.00232				.077	.00735	5.12	754.70	16.23	770.93		
						MS	.001158	.02	.57		.00463				.155	.0049	2.54	113.03	13.60	126.63		
			1300	22.20	6.71							.0569499		.3806056		.226						
						VFS	.000285	.09	.033		.00114				.024	.02034	18.46	6409.00	22.45	6431.45		
						FS	.00058	.025	.136		.00232				.077	.00565	5.75	392.02	16.72	408.74		
						MS	.001158	.025	.57		.00463				.155	.00565	2.86	87.00	14.01	101.00		
			1500	21.50	5.49							.0385328		.2575212		.225						
						VFS	.000285	.09	.033		.00114				.024	.02025	15.18	9173.89	21.37	9195.26		
						FS	.00058	.03	.136		.00232				.077	.00675	4.73	680.62	15.91	696.53		
						MS	.001158	.01	.57		.00463				.155	.00225	2.35	51.50	13.33	64.83		

TABLE NO. B-3

BARS03

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
DARDANELLE RANGES
June-July 1957

Range No.	Date	Water temp.	Station on range	B	V	Sediment size class	d	Ps	Pb	da	Tc	Td	n	To	w	c	I	Y	Y for Bed Load	Y' for Total Load	Ave. of I each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
										.001213			.029									
10	7-1-57	79F																				
			300	26.60	6.33							.0477177		.3109050		.241						
						VFS	.000285	.13	.033		.00114				.025	.03133	16.22	14606.62	21.73	14628.35	13.97	5057.83
						FS	.00058	.03	.136		.00232				.078	.00723	5.20	705.45	16.29	761.74	4.40	679.33
						MS	.001158	.01	.57		.00463				.159	.00241	2.55	55.64	13.61	69.25	2.20	74.81
			700	17.20	5.23							.0376690		.2517532		.202						
						VFS	.000285	.1	.033		.00114				.025	.0302	14.41	7220.37	21.09	7241.46		
						FS	.00058	.008	.136		.00232				.078	.017776	4.62	1415.30	15.81	1431.11		
						MS	.001158	.022	.57		.00463				.159	.004444	2.27	80.46	13.21	93.66		
			1100	10.70	4.78							.0368604		.2463442		.199						
						VFS	.000285	.08	.033		.00114				.025	.01592	14.25	3344.07	21.03	3365.90		
						FS	.00058	.06	.136		.00232				.078	.01194	4.57	359.21	15.77	374.98		
						MS	.001158	.02	.57		.00463				.159	.00398	2.24	42.46	13.17	55.63		
			1700	13.00	4.40							.0292700		.1956164		.176						
						VFS	.000285	.05	.033		.00114				.025	.0088	12.70	2946.58	20.43	2967.01		
						FS	.00058	.03	.136		.00232				.078	.00520	4.07	397.76	15.32	413.08		
						MS	.001158	.03	.57		.00463				.159	.00520	2.00	92.46	12.79	105.26		
			2300	8.00	3.92							.0273133		.1825394		.174						
						VFS	.000285	.03	.033		.00114				.025	.00522	12.27	1066.16	20.25	1086.41		
						FS	.00058	.025	.136		.00232				.078	.00435	3.93	200.35	15.18	215.73		
						MS	.001158	.02	.57		.00463				.159	.00348	1.93	37.57	12.68	50.25		

TABLE NO. B-4

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
DARDANELLE RANGES
June-July 1957

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Ps	Pb	do	Tc	To'	n	To	w	c	I	Y	Y for Bed Load	Y' for Total Load	Ave. of I each size	Ave of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
										.001213			.029									
14	7-2-57	80F																				
			240	30.69	7.08							.0527274		.3523859		.216						
						VFS	.000205	.1	.033		.00114				.025	.0216	17.05	10438.92	22.01	10460.93	13.98	9382.39
						FS	.00058	.06	.136		.00232				.078	.01296	5.46	1858.14	16.50	1874.64	4.08	1304.11
						MS	.001150	.02	.57		.00463				.16	.00432	2.66	137.96	13.76	151.72	2.10	113.87
			440	31.00	7.56							.0646770		.4322525		.228						
						VFS	.000205	.12	.033		.00114				.025	.02736	18.80	11179.21	22.58	11201.79		
						FS	.00058	.05	.136		.00232				.078	.0110	6.05	1023.02	16.93	1039.96		
						MS	.001150	.01	.57		.00463				.16	.00228	2.95	45.16	14.12	59.28		
			640	20.50	5.49							.0391095		.2616422		.19						
						VFS	.000205	.07	.033		.00114				.025	.0133	14.69	5607.18	21.19	5628.38		
						FS	.00058	.05	.136		.00232				.078	.0095	4.71	890.96	15.89	906.85		
						MS	.001150	.02	.57		.00463				.16	.0038	2.30	80.81	13.25	94.06		
			840	20.00	3.80							.0197160		.1317654		.185						
						VFS	.000205	.07	.033		.00114				.025	.01295	10.42	10854.02	19.43	10873.46		
						FS	.00058	.05	.136		.00232				.078	.00925	3.34	1784.47	14.57	1799.04		
						MS	.001150	.02	.57		.00463				.16	.0037	1.63	174.93	12.15	187.08		
			1240	11.50	3.01							.0142692		.0953633		.169						
						VFS	.000205	.045	.033		.00114				.025	.007605	8.07	4728.76	18.65	4747.41		
						FS	.00058	.035	.136		.00232				.078	.005915	2.04	871.06	13.99	885.04		
						MS	.001150	.01	.57		.00463				.16	.00169	1.39	65.57	11.66	77.23		

TABLE NO. B-5

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
DARDANELLE RANGES
April 1958

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Ps	Pb	dm	Tc	Tc'	n	To	w	c	X	Y	Y for Bed Load	Y' for Total Load	Ave. of X each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
										.001213			.027									
Bridge	4-1-58	55F																				
			410	21.00	4.58							.0270286		.1565003		.25						
						VFS	.000285	.07	.033		.00114				.0175	.0175	16.23	11140.99	21.74	11162.73	15.89	14334.68
						FS	.00058	.03	.136		.00232				.061	.0075	4.66	1070.33	15.85	1094.18	4.36	1379.78
						MS	.001150	.01	.57		.00463				.14	.0025	2.03	84.27	12.84	97.12	1.99	133.94
			610	22.70	3.50							.0379795		.2200203		.224						
						VFS	.000285	.14	.033		.00114				.0175	.03136	19.24	15363.77	22.69	15386.46		
						FS	.00058	.06	.136		.00232				.061	.01344	5.52	1046.24	16.54	1082.78		
						MS	.001150	.025	.57		.00463				.14	.0056	2.41	138.84	13.41	152.25		
			850	24.00	4.26							.0223656		.1293671		.217						
						VFS	.000285	.13	.033		.00114				.0175	.02021	14.77	25597.30	21.22	25618.52		
						FS	.00058	.025	.136		.00232				.061	.005425	4.24	1123.31	15.47	1138.90		
						MS	.001150	.015	.57		.00463				.14	.003255	1.05	161.93	12.54	174.47		
			1130	19.00	4.38							.0255501		.1400618		.206						
						VFS	.000285	.11	.033		.00114				.0175	.02266	15.79	13609.17	21.58	13630.75		
						FS	.00058	.04	.136		.00232				.061	.00824	4.53	1120.87	15.74	1136.60		
						MS	.001150	.008	.57		.00463				.14	.001648	1.97	82.90	12.75	85.66		
			1390	17.20	3.66							.0104481		.1060723		.194						
						VFS	.000285	.04	.033		.00114				.0175	.00776	13.41	5854.20	20.71	5874.91		
						FS	.00058	.06	.136		.00232				.061	.01164	3.85	2031.28	15.10	2046.38		
						MS	.001150	.02	.57		.00463				.14	.00388	1.68	167.96	12.24	180.28		

TABLE NO. B-6

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
DARDANELLE RANGES
April 1958

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Ps	Pb	dm	Tc	To'	n	To	w	c	X	Y	Y for Bed Load	Y' for Total Load	Ave. of X each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
										.001213			.027									
3	4-1-58	55F																				
			230	26.20	5.94							.0422317		.2046537		.213						
						VFS	.000285	.17	.033		.00114				.0175	.03621	20.29	10000.31	23.00	10023.30	15.59	9614.00
						FS	.00058	.03	.136		.00232				.061	.00639	5.82	736.27	16.77	753.04	4.67	656.33
						MS	.001150	.01	.57		.00463				.14	.00213	2.34	55.37	13.59	68.95	1.95	47.01
			620	19.50	4.21							.0234091		.1356122		.199						
						VFS	.000285	.1	.033		.00114				.0175	.0199	15.11	13508.15	21.34	13529.49		
						FS	.00058	.02	.136		.00232				.061	.00398	4.33	614.91	15.56	630.47		
						MS	.001150	.005	.57		.00463				.14	.000995	1.09	36.69	12.61	49.30		
			1010	14.00	4.74							.0331395		.1919010		.33						
						VFS	.000285	.005	.033		.00114				.0175	.02085	17.90	9002.10	22.30	9024.40		
						FS	.00058	.01	.136		.00232				.061	.0033	5.16	237.02	16.26	253.28		
						MS	.001150	.003	.57		.00463				.14	.00099	2.25	16.34	13.18	29.52		
			1400	9.00	3.28							.0183865		.1065155		.182						
						VFS	.000285	.06	.033		.00114				.0175	.01092	13.39	3883.30	20.70	3904.00		
						FS	.00058	.03	.136		.00232				.061	.00546	3.04	449.27	15.09	464.36		
						MS	.001150	.01	.57		.00463				.14	.00182	1.67	37.17	12.23	49.41		
			1700	5.00	2.48							.0127863		.0740729		.174						
						VFS	.000285	.06	.033		.00114				.0175	.01044	11.17	2769.38	19.77	2789.15		
						FS	.00058	.015	.136		.00232				.061	.00261	3.20	166.06	14.42	180.47		
						MS	.001150	.01	.57		.00463				.14	.00174	1.40	30.19	11.60	41.80		

TABLE NO. B-7

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
DARDANELLE RANGES
April 1958

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Ps	Pb	dm	Tc	To'	n	To	w	c	X	Y	Y for Bed Load	Y' for Total Load	Ave of X each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
										.001213			.027									
8	4-1-58	55F																				
			290	11.30	3.72							.0217940		.1262600		.17						
						VFS	.000205	.08	.033		.00114				.0175	.0136	14.30	5375.32	21.15	5396.00	14.91	11109.53
						FS	.00050	.035	.136		.00232				.061	.00935	4.10	804.85	15.42	860.25	4.20	944.96
						MS	.001150	.01	.57		.00463				.14	.0017	1.02	37.04	12.50	49.54	1.03	90.[illegible]4
			690	16.30	4.16							.0241652		.1399925		.239						
						VFS	.000205	.13	.033		.00114				.0175	.03107	15.35	16705.73	21.43	16807.16		
						FS	.00050	.06	.136		.00232				.061	.01434	4.00	1760.11	15.62	1773.74		
						MS	.001150	.015	.57		.00463				.14	.003305	1.92	104.30	12.66	117.24		
			1100	17.00	3.92							.0212449		.1230746		.207						
						VFS	.000205	.13	.033		.00114				.0175	.02691	14.39	17200.13	21.08	17261.22		
						FS	.00050	.03	.136		.00232				.061	.00621	6.13	911.05	15.37	926.40		
						MS	.001150	.025	.57		.00463				.155	.003175	1.62	183.79	12.14	195.93		
			1500	12.00	4.30							.0314435		.1821562		.109						
						VFS	.000205	.1	.033		.00114				.0175	.0909	17.31	5350.01	22.16	5372.97		
						FS	.00050	.025	.136		.00232				.061	.004725	5.02	300.02	16.15	316.18		
						MS	.001150	.000	.57		.00463				.14	.001512	2.19	22.16	13.09	35.25		
			1900	12.60	3.30							.0166360		.0963793		.152						
						VFS	.000205	.12	.033		.00114				.0175	.01020	12.74	10689.40	20.44	10709.84		
						FS	.00050	.04	.136		.00232				.061	.00600	3.65	831.33	14.90	846.23		
						MS	.001150	.000	.57		.00463				.14	.001216	1.59	42.14	12.08	54.21		

TABLE NO. B-8

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
DARDANELLE RANGES
April 1950

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Ps	Pb	da	Tc	To'	n	To	w	c	E	Y	Y for Bed Load	Y' for Total Load	Ave. of E each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
										.001213			.027									
13	4-2-50	55F																				
			330	25.00	5.05							.0361115		.2091987		.201						
						VFS	.000285	.12	.033		.00114				.0175	.02412	18.76	13931.52	22.55	13954.07	14.73	10776.09
						FS	.00058	.05	.136		.00232				.061	.01005	5.38	1294.91	16.44	1311.35	4.23	774.38
						MS	.001158	.02	.57		.00463				.14	.00402	2.35	118.16	13.32	131.49	1.81	90.57
			710	19.00	4.96							.0327751		.1898700		.202						
						VFS	.000285	.2	.033		.00114				.0175	.0404	17.88	10728.20	22.27	10750.47		
						FS	.00058	.05	.136		.00232				.061	.0101	5.13	1048.31	16.24	1064.55		
						MS	.001158	.02	.57		.00463				.14	.00404	2.23	96.44	13.16	109.60		
			1100	13.20	3.76							.0212659		.1231961		.17						
						VFS	.000285	.13	.033		.00114				.0175	.0221	14.40	10528.00	21.09	10549.09		
						FS	.00058	.035	.136		.00232				.061	.00975	4.13	649.06	15.37	664.44		
						MS	.001158	.015	.57		.00463				.155	.00255	1.63	67.33	12.14	79.47		
			1400	6.00	2.64							.0136330		.0709096		.164						
						VFS	.000285	.12	.033		.00114				.0175	.01968	11.53	6019.16	19.93	6039.09		
						FS	.00058	.035	.136		.00232				.061	.00574	3.31	417.88	14.53	432.41		
						MS	.001158	.02	.57		.00463				.14	.00328	1.44	63.77	11.78	75.55		
			1840	5.30	2.49							.0126417		.0732351		.159						
						VFS	.000285	.1	.033		.00114				.0175	.0159	11.10	4571.18	19.74	4590.93		
						FS	.00058	.035	.136		.00232				.061	.005565	3.19	384.28	14.00	398.28		
						MS	.001158	.015	.57		.00463				.14	.002385	1.39	45.10	11.67	56.76		

TABLE NO. B-9

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
MORRILTON RANGES
April 1958

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Pb	do	Tc	To'	n	To	w	c	X	Y	Y for Bed Load	Y' for Total Load	Av. of X each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
									.001213			.024									
5	4-7-58	55F																			
			360	13.00	3.31						.0165443		.0758190								
						VFS	.000205	.03		.00114				.0175	.02793	11.30	18761.31	19.83	18781.14	12.12	19018.08
						FS	.00058	.2185		.00232				.061	.00082	3.24	782.46	14.46	796.92	3.08	589.20
						MS	.001158	.4965		.00463				.14	.00147	1.41	61.02	11.72	72.73	1.51	83.22
			810	20.80	4.24						.0232306		.1063498								
						VFS	.000205	.03		.00114				.0175	.00554	13.38	36945.97	20.70	36966.67		
						FS	.00058	.2185		.00232				.061	.00028	3.04	865.52	15.09	880.61		
						MS	.001158	.4965		.00463				.14	.00207	1.67	95.35	12.23	107.58		
			1110	19.30	3.83						.0194407		.0889835								
						VFS	.000205	.03		.00114				.0175	.03300	12.24	30415.27	20.24	30435.50		
						FS	.00058	.2185		.00232				.061	.0077	3.51	901.21	14.75	915.96		
						MS	.001158	.4965		.00463				.14	.00154	1.53	81.68	11.96	93.63		
			1300	13.80	3.58						.0189950		.0869435								
						VFS	.000205	.03		.00114				.0175	.0072	12.10	4479.54	20.18	4499.68		
						FS	.00058	.2185		.00232				.061	.0020	3.07	195.00	14.71	209.71		
						MS	.001158	.4965		.00463				.14	.0024	1.51	88.74	11.92	100.66		
			1700	8.70	3.17						.0173691		.0795035								
						VFS	.000205	.03		.00114				.0175	.01098	11.57	4387.44	19.95	4407.39		
						FS	.00058	.2185		.00232				.061	.00244	3.32	128.24	14.55	142.78		
						MS	.001158	.4965		.00463				.14	.00122	1.45	29.69	11.79	41.48		

TABLE NO. B-10

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
MORRILTON RANGES
April 1950

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Pb	dm	Tc	To'	n	To	w	c	I	Y	Y for Bed Load	Y' for Total Load	Ave. of I each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
									.001213			.024									
7	4-7-50	55F																			
			1300	2.40	2.70						.0193563		.0085995								
						VFS	.000205	.03		.00114				.0175	.00672	12.21	532.46	20.22	552.60	12.94	13643.96
						FS	.00050	.2105		.00232				.061	.00160	3.50	17.36	14.75	32.11	3.71	201.00
						MS	.001150	.4965		.00463				.14	.00056	1.53	2.62	11.95	14.57	1.62	82.74
			1600	9.00	3.20						.0178719		.0810030								
						VFS	.000205	.03		.00114				.0175	.01672	11.73	7445.93	20.02	7465.95		
						FS	.00050	.2105		.00232				.061	.00076	3.37	44.41	14.60	59.01		
						MS	.001150	.4965		.00463				.14	.00076	1.47	20.45	11.83	32.28		
			1960	23.50	4.59						.0261470		.1196061								
						VFS	.000205	.03		.00114				.0175	.03828	14.19	31642.70	21.01	31663.71		
						FS	.00050	.2105		.00232				.061	.00696	4.07	736.45	15.32	751.77		
						MS	.001150	.4965		.00463				.14	.00174	1.77	79.92	12.41	92.34		
			2260	23.50	5.32						.0351263		.1607035								
						VFS	.000205	.03		.00114				.0175	.03255	16.45	19798.10	21.01	19819.91		
						FS	.00050	.2105		.00232				.061	.0031	4.72	238.24	15.90	254.14		
						MS	.001150	.4965		.00463				.14	.00155	2.06	50.23	12.09	63.12		
			2540	26.00	3.32						.0132267		.0605424								
						VFS	.000205	.03		.00114				.0175	.00452	10.09	8698.25	19.27	8717.52		
						FS	.00050	.2105		.00232				.061	.00113	2.90	293.92	14.05	307.97		
						MS	.001150	.4965		.00463				.14	0	1.26	.00	11.39	11.39		

TABLE NO. B-11

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
MORRILTON RANGES
April 1958

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Pb	dm	Tc	To´	n	To	m	c	I	Y	Y for Bed Load	Y' for Total Load	Ave. of I each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
									.001213			.024									
11	4-?-58	55F																			
			370	14.00	3.42						.0169355		.0775106								
						VFS	.000205	.03		.00114				.0175	.0203	11.42	21595.19	19.09	21615.00	12.63	19640.07
						FS	.00058	.2105		.00232				.061	.0058	3.28	583.39	14.50	597.09	3.62	423.02
						MS	.001158	.9965		.00463				.14	0	1.43	.00	11.75	11.75	1.58	23.74
			640	19.00	4.32						.0205233		.1122501								
						VFS	.000205	.03		.00114				.0175	.03	13.75	21716.32	20.04	21737.36		
						FS	.00058	.2105		.00232				.061	.006	3.94	557.09	15.19	573.08		
						MS	.001158	.9965		.00463				.14	0	1.72	.00	12.31	12.31		
			920	20.70	3.03						.0109921		.0069324								
						VFS	.000205	.03		.00114				.0175	.033	12.10	32954.99	20.18	32975.16		
						FS	.00058	.2105		.00232				.061	.00471	3.47	616.20	14.71	628.99		
						MS	.001158	.9965		.00463				.14	0	1.31	.00	11.92	11.92		
			1220	15.00	3.35						.0178540		.0017232								
						VFS	.000205	.03		.00114				.0175	.0228	11.73	17745.34	20.02	17765.36		
						FS	.00058	.2105		.00232				.061	.00720	3.36	232.07	14.60	247.47		
						MS	.001158	.9965		.00463				.14	.00076	1.47	35.75	11.83	47.57		
			1500	16.70	4.33						.0260757		.1193561								
						VFS	.000205	.03		.00114				.0175	.00735	14.17	4090.40	-21.00	4111.41		
						FS	.00058	.2105		.00232				.061	.000735	4.07	52.37	15.31	67.68		
						MS	.001158	.9965		.00463				.14	.000735	1.77	22.76	12.41	35.15		

TABLE NO. B-12

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA
MORRILTON RANGES
April 1958

Range No.	Date	Water temp.	Station on range	D	V	Sediment size class	d	Pb	da	Tc	To'	n	To	w	c	X	Y	Y for Bed load	Y' for Total load	Ave. of X each size	Ave. of Y' each size
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
									.001213			.024									
24	4-?-58	55F																			
			240	25.30	4.14						.0207552		.0950024								
						VFS	.000285	.03		.00114				.0175	.0143	12.65	16425.00	20.40	16445.00	15.40	14113.26
						FS	.00058	.2185		.00232				.061	.0024	3.63	357.75	14.88	372.62	4.04	505.02
						MS	.001158	.4965		.00463				.14	0	1.58	.00	12.06	12.06	1.94	65.23
			450	19.00	4.25						.0237350		.1006418								
						VFS	.000285	.03		.00114				.0175	.0195	13.52	14600.21	20.75	14620.96		
						FS	.00058	.2185		.00232				.061	.0039	3.00	375.98	15.13	391.11		
						MS	.001158	.4965		.00463				.14	.0026	1.69	110.14	12.26	122.40		
			660	16.00	4.82						.0322471		.1476042								
						VFS	.000285	.03		.00114				.0175	.0417	15.76	10732.80	21.57	10754.37		
						FS	.00058	.2185		.00232				.061	.0209	4.52	1190.27	15.73	1206.00		
						MS	.001158	.4965		.00463				.14	.0017	1.97	41.13	12.75	53.88		
			880	16.00	5.01						.0468542		.2144652								
						VFS	.000285	.03		.00114				.0175	.0481	19.00	14703.47	22.62	14726.08		
						FS	.00058	.2185		.00232				.061	.00996	5.45	381.18	16.49	397.67		
						MS	.001158	.4965		.00463				.14	.00167	2.37	26.43	13.36	39.79		
			1090	10.50	4.66						.0352539		.1613476								
						VFS	.000285	.03		.00114				.0175	.0253	16.48	5989.27	21.82	6011.09		
						FS	.00058	.2185		.00232				.061	.00474	4.73	141.76	15.91	157.67		
						MS	.001158	.4965		.00463				.14	.00158	2.06	19.92	12.09	32.81		

TABLE NO. B-13

DEVELOPMENT OF MODIFIED LAURSEN SEDIMENT RELATIONSHIP
BASED ON ARKANSAS RIVER DATA

Computation of Group Averages of Data Points

			Sediment Size Class					
			Very Fine Sand		Fine Sand		Medium Sand	
Location	Date	Range	Ave. X	Ave. Y'	Ave. X	Ave. Y'	Ave. X	Ave. Y'
Dardanelle	June-July 1957	3	12.72	8862.07	3.96	1297.69	1.97	94.71
"	"	7	15.48	8513.61	4.02	634.38	2.40	76.64
"	"	10	13.97	5857.83	4.40	679.33	2.20	74.81
"	"	14	13.98	9302.39	4.48	1301.11	2.18	113.07
Dardanelle	June-July 1957	Average	14.04	8134.00	4.44	978.13	2.19	90.01
Dardanelle	April 1958	Bridge	15.09	14334.60	4.56	1379.70	1.99	133.94
"	"	3	15.59	9614.00	4.47	456.33	1.95	47.81
"	"	8	14.91	11109.53	4.20	944.96	1.83	90.44
"	"	13	14.73	10776.09	4.23	774.28	1.81	90.57
Dardanelle	April 1958	Average	15.28	11458.80	4.39	888.04	1.90	90.69
Morrilton	April 1958	5	12.12	19018.08	2.48	509.20	1.31	73.22
"	"	7	12.94	13643.96	3.71	201.00	1.62	42.74
"	"	11	12.63	19640.87	3.62	423.02	1.58	23.74
"	"	24	15.48	14113.26	4.44	505.02	1.94	65.23
Morrilton	April 1958	Average	13.29	16604.04	3.56	437.39	1.66	51.23
OVERALL AVERAGE			14.20	12065.64	4.13	760.12	1.92	77.31

Appendix C
Modified Laursen Method Sediment Load Calculations

TABLE NO. C-1

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	Q	V	R	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	V'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Atchafalaya R., Simmesport, La. April 12, 1962	501000	6.20	40.3	1651	.0000492	59	VFS	.000285	.049	.019	14.55	13000	.0133964	181212.53			.16	154159.05			
							FS	.00058	.717	.066	4.32	800	.0130495	176519.93				150167.01			
							MS	.001150	.23	.144	1.92	76	.0004107	5555.84				4726.00			
							CS	.00232	.002	.237	1.08	21.7	.0000009	12.80				10.88			
							VCS	.00464	0	.385	.72	12.7	0	.00				.00			
							Median	.000656													
							Total							363301.09	677000	.54		309063.35	.46	187.20	410.05
Atchafalaya R., Simmesport, La. May 24, 1961	444000	5.68	46.6	1562	.0000465	70	VFS	.000285	.076	.022	12.00	9000	.0110723	142325.13			.15	120452.78			
							FS	.00058	.771	.072	3.67	300	.0071609	85044.04				78683.91			
							MS	.001150	.109	.154	1.71	54	.0001507	1886.19				1655.52			
							CS	.00232	.002	.261	1.01	19	.0000006	7.00				6.70			
							VCS	.00464	0	.385	.69	12	0	.00				.00			
							Median	.00059													
							Total							229983.56	437900	.53		210799.00	.80	134.95	280.35
Atchafalaya R., Simmesport, La. March 18, 1963	301000	4.91	45.3	1353	.0000390	50	VFS	.000285	.163	.0160	14.33	12700	.0274049	222719.54			.13	229916.03			
							FS	.00058	.612	.0585	4.12	700	.0020003	47788.06				49333.01			
							MS	.001150	.180	.1375	1.75	59	.0001434	1165.71				1203.30			
							CS	.00232	.023	.2525	.95	17	.0000039	31.03				32.03			
							VCS	.00464	0	.385	.63	12	0	.00				.00			
							Median	.00056													
							Total							271674.11	192300	1.41		280484.06	1.46	207.31	142.13
Atchafalaya R., Simmesport, La. December 14, 1964	176000	4.49	30.6	1270	.0000276	46	VFS	.000285	.262	.0177	9.31	5250	.0222939	105940.40			.14	99304.64			
							FS	.00058	.404	.0565	2.92	260	.0017512	8321.09				7800.25			
							MS	.001150	.015	.1335	1.22	27	.0000062	29.34				27.50			
							CS	.00232	.002	.2325	.65	12	.0000002	1.06				.99			
							VCS	.00464	0	.385	.43	9	0	.00				.00			
							Median	.000320													
							Total							114291.31	119900	.96		107133.39	.90	84.36	94.02
Atchafalaya R., Simmesport, La. August 13, 1964	43700	1.92	22.1	1030	.0000113	86	VFS	.000285	.562	.0268	3.34	380	.0004307	500.20			.07	886.31			
							FS	.00058	.312	.0816	1.10	22	.0000004	9.91				17.20			
							MS	.001156	.037	.1624	.55	11	-.000002	-1.77				.00			
							CS	.00232	0	.2686	.33	8	0	.00				.00			
							VCS	.00464	0	.385	.23	7	0	.00				.00			
							Median	.000305													
							Total							516.34	2260	.23		903.59	.40	.00	2.19

TABLE NO. C-2

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location Date	Q	V	D	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	V'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Atchafalaya River, Simmesport, Louisiana																					
April 20, 1965	429000	6.35	45.10	1500	.0000505	62	VFS	.000205	.035	.02	13.53	11000	.0101415	117460.74			.17	95916.04			
							FS	.00050	.407	.066	4.10	690	.0092703	107470.47				87752.95			
							MS	.001150	.407	.147	1.84	60	.0007966	9226.90				7534.04			
							CS	.00232	.025	.250	1.05	21	.0000144	166.31				135.79			
							VCS	.00464	.001	.385	.70	12.5	.0000002	2.83				2.34			
							Median	.000707													
							Total							234335.25	324500	.72		191341.94	.59	127.56	216.33
Atchafalaya River, Simmesport, Louisiana																					
April 7, 1965	361000	5.62	43.40	1400	.0000443	54	VFS	.000205	.032	.017	14.63	13200	.0082070	88701.49			.15	72391.54			
							FS	.00050	.701	.06	4.14	700	.0103205	100633.36				90181.59			
							MS	.001150	.265	.14	1.78	61	.0003444	3357.31				3000.62			
							CS	.00232	.001	.254	.90	18.3	.0000003	3.34				2.99			
							VCS	.00464	0	.385	.65	12	0	.00				.00			
							Median	.000656													
							Total							184775.50	333500	.55		165304.75	.50	118.27	238.21
Atchafalaya River, Simmesport, Louisiana																					
February 19, 1965	290000	5.02	38.20	1340	.0000385	40	VFS	.000205	.1	.016	13.59	11500	.0256474	206520.20			.17	169261.10			
							FS	.00050	.592	.058	3.75	530	.0075021	60361.92				49471.78			
							MS	.001150	.018	.136	1.60	46	.0000200	160.95				131.91			
							CS	.00232	.001	.25	.87	15.4	.0000003	2.61				2.14			
							VCS	.00464	0	.385	.56	10.6	0	.00				.00			
							Median	.000442													
							Total							267045.76	325000	.82		218866.93	.67	163.33	242.54
Atchafalaya River, Simmesport, Louisiana																					
May 19, 1964	96400	3.12	27.00	1130	.000019	77	VFS	.000205	.151	.024	6.35	1400	.0022510	5850.92			.11	7212.25			
							FS	.00050	.632	.076	1.69	52	.0003341	869.51				1070.35			
							MS	.001150	.15	.159	.81	14	.0000155	40.46				49.80			
							CS	.00232	0	.263	.49	10	0	.00				.00			
							VCS	.00464	0	.385	.33	8.4	0	.00				.00			
							Median	.000558													
							Total							6760.89	17300	.39		8332.40	.48	7.37	15.31
Atchafalaya River, Simmesport, Louisiana																					
September 18, 1964	44600	1.97	21.70	1040	.0000100	79	VFS	.000205	.301	.0247	3.52	440	.0005950	716.09			.07	1210.83			
							FS	.00050	.332	.077	1.13	23.5	.0000128	15.65				26.11			
							MS	.001150	.028	.16	.54	10.4	0	.00				.00			
							CS	.00232	0	.264	.33	8.4	0	.00				.00			
							VCS	.00464	0	.385	.23	7.4	0	.00				.00			
							Median	.000312													
							Total							731.94	2260	.32		1236.94	.55	1.19	2.17

TABLE NO. C-3

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location Date	Q	V	R	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	Y'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Mississippi R., Tarbert Ldg., Louisiana																					
May 13, 1964	1010000	5.19	53.00	3440	.0000302	70	VFS	.000285	.071	.0222	11.50	9600	.0095352	262004.20			.12	278122.04			
							FS	.00058	.283	.0715	3.60	385	.0016270	44720.99				47457.62			
							MS	.001150	.564	.154	1.67	52	.0004309	12063.65				12801.87			
							CS	.00232	.070	.261	.99	19	.0000109	519.70				551.50			
							VCS	.00464	.002	.385	.67	12	.0000001	3.47				3.68			
							Median	.00102													
							Total							319312.01	270000	1.15		338936.67	1.22	93.11	76.37
Mississippi R., Tarbert Ldg., Louisiana																					
May 3, 1965	850000	5.00	47.00	3620	.0000345	64	VFS	.000285	.097	.0206	11.05	13000	.0166153	384910.90			.13	398965.30			
							FS	.00058	.615	.0673	3.54	440	.0037301	87060.58				90239.50			
							MS	.001150	.263	.149	1.50	45	.0001599	3703.27				3838.49			
							CS	.00232	.021	.26	.91	16.3	.0000036	83.08				86.11			
							VCS	.00464	0	.385	.61	11.3	0	.00				.00			
							Median	.000623													
							Total							475757.82	443500	1.07		493129.40	1.11	136.22	123.07
Mississippi R., Tarbert Ldg., Louisiana																					
March 24, 1965	615000	4.19	41.20	3560	.0000332	46	VFS	.000285	.079	.0162	12.95	10500	.0099274	160004.94			.12	180126.79			
							FS	.00058	.467	.0565	3.71	520	.0030093	49839.00				56007.99			
							MS	.001150	.425	.1355	1.55	44	.0002136	3507.11				4048.73			
							CS	.00232	.026	.2305	.84	15	.0000028	47.30				53.99			
							VCS	.00464	0	.385	.54	10.4	0	.00				.00			
							Median	.000735													
							Total							218279.15	173500	1.26		209147.09	1.04	69.99	66.74
Mississippi R., Tarbert Ldg., Louisiana																					
June 2, 1965	373000	3.73	30.20	3310	.0000365	77	VFS	.000285	.141	.0241	7.01	3500	.0066041	66510.03			.12	73285.44			
							FS	.00058	.607	.0762	2.47	160	.0010002	14907.02				16425.60			
							MS	.001150	.235	.159	1.10	25	.0000601	686.12				756.01			
							CS	.00232	.013	.2632	.72	12.7	.0000008	8.46				9.32			
							VCS	.00464	0	.385	.49	10	0	.00				.00			
							Median	.000558													
							Total							82111.63	97700	.84		90476.38	.93	27.33	29.52
Mississippi R., Tarbert Ldg., Louisiana																					
August 6, 1964	180000	2.32	27.00	3000	.0000199	87	VFS	.000285	.054	.0271	4.85	1100	.0003080	1932.82			.08	3109.99			
							FS	.00058	.313	.0822	1.60	46	.0000777	394.26				634.38			
							MS	.001150	.59	.163	.81	14	.0000169	85.88				138.19			
							CS	.00232	.04	.269	.49	10	-.000003	-13.69				.00			
							VCS	.00464	0	.385	.34	11.4	0	.00				.00			
							Median	.000919													
							Total							2399.27	8300	.29		3882.56	.47	1.29	2.77

TABLE NO. C-4

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location Date	Q	V	R	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	ω	X	Y'.	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Mississippi R., St. Louis, Missouri April 8, 1963	278000	4.56	34.40	1676	.0000603	50	VFS	.000285	.04	.01675	15.86	15000	.0137468	103103.41			.13	103141.05			
							FS	.00058	.37	.0585	4.54	930	.0006139	64458.97				64641.95			
							MS	.001150	.07	.1373	1.96	78	.0001347	1011.16				1010.94			
							CS	.00232	.35	.2525	1.05	21	.0001567	1176.31				1176.06			
							VCS	.00464	.14	.385	.69	12.3	.0000166	124.53				124.50			
							Median	.00167													
							Total							170151.37	90100	1.73		170114.40	1.73	101.50	58.53
Mississippi R., St. Louis, Missouri April 21, 1961	226000	4.37	31.00	1640	.0000055	52	VFS	.000285	.015	.01705	17.24	17200	.0061614	37396.59			.14	36539.00			
							FS	.00058	.295	.0595	4.94	1130	.0000525	51576.80				50126.14			
							MS	.001150	.27	.1385	2.12	102	.0004911	4217.14				4090.52			
							CS	.00232	.255	.2535	1.16	24.5	.0001207	785.14				763.06			
							VCS	.00464	.075	.385	.76	13.3	.0000061	37.31				36.26			
							Median	.00128													
							Total							94213.05	66000	1.43		91563.06	1.39	55.83	40.24
Mississippi R., St. Louis, Missouri July 14, 1953	180000	3.92	29.50	1625	.0000647	79	VFS	.000285	.01	.0247	10.04	6300	.0010017	5090.46			.13	5730.30			
							FS	.00058	.50	.0774	3.21	330	.0054056	17090.10				18253.08			
							MS	.001150	.12	.1596	1.55	44	.0000877	444.91				464.33			
							CS	.00232	.17	.2640	.96	17.2	.0000307	156.01				162.82			
							VCS	.00464	.09	.385	.64	11.6	0	.00				.00			
							Median	.000787													
							Total							23301.48	36600	..64		24610.90	.67	15.15	22.52
Mississippi R., St. Louis, Missouri April 19, 1954	130000	3.42	25.50	1501	.000072	60	VFS	.000285	.01	.01925	12.62	10200	.0016502	6178.35			.12	6021.21			
							FS	.00058	.50	.0645	3.77	500	.0051210	19083.79				21069.46			
							MS	.001150	.33	.145	1.60	52	.0002414	899.35				993.15			
							CS	.00232	.06	.2375	.94	17.2	.0000063	23.30				26.03			
							VCS	.00464	.02	.385	.63	11.4	0	.00				.00			
							Median	.000787													
							Total							26185.28	29500	.89		28909.86	.98	18.29	18.66
Mississippi R., St. Louis, Missouri August 27, 1958	102000	2.89	22.00	1550	.0000773	77	VFS	.000285	.04	.0241	9.00	6000	.0040004	11259.36			.11	13760.71			
							FS	.00058	.13	.0762	3.12	310	.0006034	1802.06				2300.17			
							MS	.001150	.36	.1500	1.50	40	.0002038	561.17				685.03			
							CS	.00232	.32	.2632	.90	16.2	.0000253	69.61				85.07			
							VCS	.00464	.1	.385	.62	11.4	0	.00				.00			
							Median	.00154													
							Total							13772.19	10200	1.35		16831.70	1.65	10.06	6.50

TABLE NO. C-5

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location Date	Q	V	R	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	Y'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Mississippi R., St. Louis, Missouri																					
April 8, 1959	207000	4.00	35.20	1700	.0001131	51	VFS	.000285	.01	.017	21.05	21000	.0053128	41169.05			.14	38704.22			
							FS	.00058	.15	.0545	6.57	2320	.0090457	73194.91				60812.68			
							MS	.001150	.44	.130	2.99	300	.0021795	16000.05				15077.69			
							CS	.00232	.26	.26	1.30	33.5	.0002113	1637.60				1539.36			
							VCS	.00464	.05	.305	.93	17	.0000105	81.05				76.57			
							Median	.00141													
							Total							132971.06	80300	1.66		123010.69	1.56	73.54	47.24
Mississippi R., St. Louis, Missouri																					
July 11, 1962	173000	3.71	29.20	1997	.0000465	82	VFS	.000285	.03	.025	8.36	4000	.0023961	11192.00			.12	12208.03			
							FS	.00058	.08	.0795	2.63	182	.0003031	1415.62				1543.75			
							MS	.001150	.31	.161	1.30	29.5	.0001002	841.59				917.76			
							CS	.00232	.34	.235	.89	13.6	.0000679	317.19				345.90			
							VCS	.00464	.1	.305	.54	10.4	0	.00				.00			
							Median	.00131													
							Total							13766.00	14600	.94		15012.05	1.03	9.00	9.14
Mississippi R., St. Louis, Missouri																					
December 27, 1955	57700	2.33	17.00	1500	.0001029	36	VFS	.000285	.015	.0133	17.03	17000	.0037773	5804.61			.10	7652.15			
							FS	.00058	.3	.051	4.65	990	.0030010	5922.76				7701.75			
							MS	.001150	.41	.13	1.82	66	.0002028	315.88				410.76			
							CS	.00232	.13	.24	.99	18.7	0	.00				.00			
							VCS	.00464	.06	.305	.62	11.4	0	.00				.00			
							Median	.00105													
							Total							12123.25	6950	.1.74		15764.65	2.27	10.45	4.61

TABLE NO. C-6

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location Date	Q	V	R	W	S	T°F	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	V'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Red River, Alexandria, Louisiana February 21, 1962	45022	3.39	23.15	583	.0000729	60	VFS	.000205	.229	.019	12.26	9700	.0345223	42710.02			.13	45099.30			
							FS	.00050	.617	.064	3.64	485	.0042031	3670.20				6040.42			
							MS	.001150	.11	.105	1.61	47	.0000601	79.27				84.05			
							CS	.00232	.006	.235	.91	16.4	.0000003	.30				.00			
							VCS	.00464	0	.305	.61	11.3	0	.00				.00			
							Median	.000492													
							Total							48460.67	36200	1.34		51624.77	1.43	88.55	62.09
Red River, Alexandria, Louisiana March 21, 1962	36000	2.73	23.20	560	.0000661	57	VFS	.000205	.330	.0103	12.14	9300	.0293157	28609.25			.10	37206.40			
							FS	.00050	.372	.0622	3.57	680	.0014058	1366.12				1771.70			
							MS	.001150	.050	.143	1.58	44	.0000110	11.34				14.93			
							CS	.00232	.14	.253	.88	15.6	0	.00				.00			
							VCS	.00464	.039	.305	.58	11	0	.00				.00			
							Median	.000492													
							Total							30066.80	16530	1.82		38993.31	2.36	60.65	29.10
Red River, Alexandria, Louisiana December 13, 1962	26000	2.03	16.90	543	.0000761	44	VFS	.000205	.325	.0152	13.38	11300	.0442296	43193.75			.12	46089.74			
							FS	.00050	.315	.085	3.70	300	.0000463	2900.30				3090.13			
							MS	.001150	.133	.135	1.34	40	.0000570	40.01				43.53			
							CS	.00232	.002	.25	.84	14.2	0	.00				.00			
							VCS	.00464	0	.305	.53	10.2	0	.00				.00			
							Median	.000492													
							Total							46074.26	24130	1.91		50123.39	2.08	92.31	44.08
Red River, Alexandria, Louisiana July 1, 1959	14400	1.90	13.70	532	.0000752	87	VFS	.000205	.103	.026	7.00	2730	.0030922	1124.09			.09	1536.60			
							FS	.00050	.016	.083	2.19	112	.0006900	268.59				367.02			
							MS	.001150	.072	.165	1.10	22	0	.00				.00			
							CS	.00232	0	.27	.67	12	0	.00				.00			
							VCS	.00464	0	.305	.47	9.7	0	.00				.00			
							Median	.000374													
							Total							1393.08	3230	.43		1903.62	.59	3.58	6.07
Red River, Alexandria, Louisiana June 26, 1960	9710	1.52	12.20	525	.0000797	90	VFS	.000205	.304	.027	6.35	2300	.0039320	1030.86			.08	1697.62			
							FS	.00050	.352	.086	2.06	95	.0000564	14.79				24.36			
							MS	.001150	.305	.160	1.05	21	0	.00				.00			
							CS	.00232	.007	.27	.65	11.7	0	.00				.00			
							VCS	.00464	.004	.305	.46	9.6	0	.00				.00			
							Median	.000357													
							Total							1045.65	1125	.93		1721.97	1.53	3.28	2.14

TABLE NO. C-7
MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location Date	Q	V	R	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	I	T'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Rio Grande near Bernalillo, New Mexico, Section A-2																					
May 27, 1958	10100	7.71	4.80	273	.0008	74	VFS	.000285	.052	.0225	15.62	14700	.9130028	249194.03			.62	63023.14			
							FS	.00058	.28	.074	4.75	1020	.3804416	103746.44				23021.96			
							MS	.001160	.53	.155	2.27	125	.0770306	26462.42				4006.36			
							CS	.00232	.088	.262	1.34	32	.0044002	1210.85				301.37			
							VCS	.00464	.017	.385	.91	16.4	.0004541	123.04				30.62			
							Median	.000997													
							Total							380736.72	85000	4.48		94762.45	1.11	347.12	311.36
Rio Grande near Bernalillo, New Mexico, Section A-2																					
June 10, 1958	5800	6.27	3.43	270	.00074	65	VFS	.000285	.052	.0202	16.15	12200	.8274474	129370.27			.60	32900.00			
							FS	.00058	.28	.0675	4.23	760	.3001453	48285.56				12938.35			
							MS	.001160	.53	.148	1.93	78	.0453357	10231.30				2637.29			
							CS	.00232	.088	.26	1.10	22	.0033411	507.56				130.05			
							VCS	.00464	.017	.385	.74	13	.0003656	57.25				14.76			
							Median	.000997													
							Total							188630.21	52300	3.61		48621.36	.93	180.08	195.70
Rio Grande near Bernalillo, New Mexico, Section A-2																					
May 3, 1961	3360	3.99	3.12	270	.00083	66	VFS	.000285	.06	.0204	16.15	12200	.3924671	35604.64			.60	13238.52			
							FS	.00058	.524	.068	6.24	770	.2304110	21265.04				7902.39			
							MS	.001160	.370	.16	1.80	62	.0341140	1280.50				473.03			
							CS	.00232	.032	.26	1.11	22.4	.0000044	36.60				13.63			
							VCS	.00464	.002	.385	.75	13.2	.0000101	.91				.34			
							Median	.000728													
							Total							58180.58	18500	3.15		21622.61	1.17	80.08	68.52
Rio Grande near Bernalillo, New Mexico, Section A-2																					
June 22, 1960	2030	2.09	2.93	260	.00082	74	VFS	.000285	.041	.0225	12.36	9700	.1292587	7089.99			.30	3427.76			
							FS	.00058	.383	.074	3.76	53	.0069391	380.33				183.08			
							MS	.001160	.442	.155	1.79	62	.0090476	495.90				239.75			
							CS	.00232	.101	.262	1.06	21.2	.0005334	29.35				14.19			
							VCS	.00464	.019	.385	.72	13.6	.0000027	.15				.07			
							Median	.000919													
							Total							7995.72	4900	1.63		3865.65	.79	14.42	18.30
Rio Grande near Bernalillo, New Mexico, Section A-2																					
May 24, 1960	1240	2.71	3.44	133	.00083	65	VFS	.000285	.03	.0202	15.00	13300	.0921106	3084.13			.36	1699.20			
							FS	.00058	.323	.0675	4.49	890	.0670121	2270.35				1250.05			
							MS	.001160	.538	.148	2.05	94	.0111055	373.15				208.59			
							CS	.00232	.075	.26	1.17	25	.0002764	9.25				5.10			
							VCS	.00464	.015	.385	.79	13.9	0	.00				.00			
							Median	.000904													
							Total							5736.88	4300	1.33		3160.74	.74	23.76	32.33

TABLE NO. C-8

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location Date	Q	V	R	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	Z	T'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Rio Grande near Bernalillo, New Mexico, Section F																					
May 27, 1958	9970	5.93	2.64	437	.0000	68	VFS	.000285	.052	.021	12.41	9000	.0001859	236937.24			.64	57062.27			
							FS	.00058	.28	.0695	3.75	535	.2071525	77290.59				10616.04			
							MS	.001150	.53	.151	1.73	58	.0642677	17300.22				4166.46			
							CS	.00232	.008	.26	1.00	19	.0036071	995.21				239.68			
							VCS	.00464	.017	.385	.60	12.2	.0004514	121.52				29.27			
							Median	.000997													
							Total							332652.78	106000	3.14		72113.72	.76	128.77	166.41
Rio Grande near Bernalillo, New Mexico, Section F																					
June 25, 1958	5960	5.36	2.09	532	.0000	77	VFS	.000285	.052	.0233	9.93	6000	.6239099	100399.59			.65	23037.75			
							FS	.00058	.38	.076	3.05	395	.1029645	29442.65				6990.53			
							MS	.001150	.53	.157	1.00	38.5	.0091017	7901.44				1876.03			
							CS	.00232	.008	.263	.80	15.6	.0034635	557.34				132.33			
							VCS	.00464	.017	.385	.60	11.3	.0004670	75.15				17.84			
							Median	.000997													
							Total							138376.17	44600	3.10		32054.49	.74	61.76	83.83
Rio Grande near Bernalillo, New Mexico, Section F																					
May 3, 1961	3890	3.49	1.73	638	.000052	65	VFS	.000285	.066	.0202	10.04	7300	.4625909	68385.92			.46	15690.68			
							FS	.00058	.559	.0675	3.24	350	.2027099	21299.02				4878.43			
							MS	.001150	.337	.100	1.00	38.5	.0138238	1452.09				468.93			
							CS	.00232	.034	.26	.04	14.8	.0004915	51.60				16.66			
							VCS	.00464		.385	.57	10.7	0	.00				.00			
							Median	.000699													
							Total							71308.64	23000	3.10		21054.74	1.00	36.14	36.08
Rio Grande near Bernalillo, New Mexico, Section F																					
April 6, 1960	2100	3.03	1.09	632	.00121	62	VFS	.000285	.032	.0195	10.56	7100	.3807020	21985.00			.51	6395.10			
							FS	.00058	.288	.0655	3.14	320	.1630030	9335.67				2771.79			
							MS	.001150	.525	.147	1.00	34.3	.0337044	1911.04				366.10			
							CS	.00232	.109	.257	.80	14.1	.0026234	140.75				44.07			
							VCS	.00464	.018	.385	.53	10.3	.0001964	11.13				3.30			
							Median	.00103													
							Total							33012.39	12000	2.75		9700.52	.82	15.40	18.99
Rio Grande near Bernalillo, New Mexico, Section F																					
May 24, 1960	1240	2.03	1.32	459	.00113	65	VFS	.000285	.03	.0202	10.04	7300	.1174560	3932.43			.31	1808.53			
							FS	.00058	.323	.0675	3.24	350	.0612005	2051.94				943.69			
							MS	.001150	.538	.100	1.00	38.5	.0097946	327.92				150.81			
							CS	.00232	.075	.26	.04	14.8	.0002499	8.37				3.85			
							VCS	.00464	.015	.385	.57	10.7	0	.00				.00			
							Median	.000904													
							Total							6320.65	2500	2.53		2906.89	1.16	6.33	5.45

TABLE NO. C-9

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location Date	Q	V	R	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	1	T'	C %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Middle Loup R., Dunning, Nebraska, Section E																					
March 1, 1950	469	3.08	.97	144	.00120	38	VFS	.000205	.024	.0139	14.38	12700	.6020638	7623.93			.55	2111.26			
							FS	.00050	.413	.052	3.84	570	.3026791	6365.03				1762.75			
							MS	.001150	.461	.132	1.31	40	.0006040	516.19				142.39			
							CS	.00232	.074	.235	.85	15	.0022501	28.59				7.92			
							VCS	.00464	.015	.385	.52	10.2	.0001992	2.52				.70			
							Median	.000902													
							Total							14534.67	2533	5.74		4025.02	1.59	27.95	17.59
Middle Loup R., Dunning, Nebraska, Section E																					
October 31, 1951	428	2.72	1.03	152	.00131	39	VFS	.000205	.01	.0142	14.67	13200	.1986779	2296.15			.47	731.05			
							FS	.00050	.28	.0525	3.97	630	.2037691	2817.00				896.07			
							MS	.001150	.52	.133	1.57	65.5	.0385230	445.17				141.73			
							CS	.00232	.15	.256	.81	14.2	.0030239	34.94				11.13			
							VCS	.00464	.04	.385	.54	10.4	.0002821	3.26				1.04			
							Median	.00113													
							Total							5596.53	1802	3.11		1781.02	.99	11.72	11.86
Middle Loup R., Dunning, Nebraska, Section E																					
August 13, 1952	386	2.41	1.08	140	.00134	79	VFS	.000205	.02	.0239	9.03	8900	.1901353	1981.59			.41	719.07			
							FS	.00050	.31	.0767	2.81	230	.0801834	835.67				303.24			
							MS	.001150	.43	.159	1.36	33	.0134775	161.31				58.53			
							CS	.00232	.13	.0264	0.17	14.4	.0015691	16.35				5.93			
							VCS	.00464	.05	.385	.56	10.6	.0000396	.41				.15			
							Median	.00108													
							Total							2995.33	598	5.01		1086.93	1.82	7.34	4.04

TABLE NO. C-10

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location Date	Q	V	R	N	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	Z	Y'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Niobrara R. near Cody, Nebraska, Section C-2																					
September 6, 1951	746	4.27	1.60	118	.00129	66	VFS	.000205	.022	.0205	12.57	10000	.0066671	8191.09			.59	2116.83			
							FS	.00050	.346	.060	3.79	500	.3737430	7560.22				1788.88			
							MS	.001150	.316	.15	1.72	56	.0620009	1230.43				323.15			
							CS	.00232	.072	.26	.99	18.5	.0020076	58.16				15.03			
							VCS	.00464	.014	.305	.67	12	.0003160	6.38				1.65			
							Median	.000919													
							Total							17074.29	5960	2.86		4412.56	.74	37.39	30.51
Niobrara R. near Cody, Nebraska, Section C-2																					
May 8, 1952	406	2.78	1.25	117	.001345	58	VFS	.000205	.017	.0105	12.57	10000	.1922162	2107.07			.44	717.09			
							FS	.00050	.335	.0620	3.70	310	.2040917	2237.25				762.24			
							MS	.001150	.315	.144	1.61	47	.0209503	317.37				108.13			
							CS	.00232	.068	.254	.72	16.7	.0011550	12.66				4.31			
							VCS	.00464	.017	.305	.60	11.2	.0000703	.86				.29			
							Median	.000904													
							Total							4675.21	1746	2.68		1592.87	.91	13.61	14.92
Niobrara R. near Cody, Nebraska, Section C-2																					
August 3, 1951	314	2.37	1.30	110	.00123	75	VFS	.000205	.027	.0229	9.90	6000	.1165151	987.01			.37	305.73			
							FS	.00050	.418	.074	3.06	295	.0721031	780.05				312.82			
							MS	.001150	.459	.155	[illegible]	30	.0122135	103.55				41.40			
							CS	.00232	.058	.262	[illegible]	15.3	.0004214	3.97				1.63			
							VCS	.00464	.016	.305	[illegible]	12	-.000032	-.27				-.11			
							Median	.000849													
							Total							1875.32	1232	1.52		734.35	.64	6.03	11.20
Niobrara R. near Cody, Nebraska, Section C-2																					
July 18, 1951	270	2.13	1.22	115	.00131	65	VFS	.000205	.018	.0254	8.93	4730	.0540730	611.00			.34	176.50			
							FS	.00050	.353	.082	2.76	220	.0500613	301.76				163.67			
							MS	.001150	.531	.164	1.30	33.5	.0104310	78.30				33.57			
							CS	.00232	.059	.260	.05	15	.0002060	2.15				.92			
							VCS	.00464	.017	.305	.59	12	-.000079	-.60				-.26			
							Median	.000919													
							Total							873.49	820	1.06		374.40	.45	3.26	7.30
Niobrara R. near Cody, Nebraska, Section C-2																					
September 26, 1952	226	2.15	.94	114	.00138	58	VFS	.000205	.020	.0105	11.04	7600	.2062150	1280.33			.39	475.46			
							FS	.00050	.309	.0620	3.23	345	.1341139	818.36				309.22			
							MS	.001150	.477	.144	1.42	36	.0157992	96.41				36.43			
							CS	.00232	.067	.254	.00	14	.0005427	3.31				1.25			
							VCS	.00464	.019	.305	.53	10.2	-.000072	-.44				.00			
							Median	.000902													
							Total							2175.97	337	6.46		822.56	2.44	7.21	2.96

TABLE NO. C-11

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	W	S	TDF	Bed Composition: Size Class	Geom. Mean Size, ft.	Pb	w	f	τ'	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Dardanelle, Ark., Range 3 Sta. 420, June 27, 1957	140.14	5.23	26.8	--	.000172	76	VFS	.000285	.033	.023	16.74	16200	.0231864	87.75			.18	67.09	
							FS	.00058	.136	.075	5.13	1230	.0079077	30.23				23.25	
							MS	.001150	.57	.157	2.45	155	.0043014	16.28				12.52	
							CS	.00232	0	.262	1.47	38.5	0	.00				.00	
							VCS	.00464	0	.385	1.00	19	0	.00				.00	
							Median	.001213											
							Total							134.25	105.65	1.27		103.26	.98
Arkansas R. near Dardanelle, Ark., Range 3 Sta. 820, June 27, 1957	90.29	4.63	19.5	--	.000172	76	VFS	.000285	.033	.023	14.20	12300	.0224690	54.77			.18	40.74	
							FS	.00058	.136	.075	4.30	890	.0064617	15.75				11.71	
							MS	.001150	.57	.157	2.09	97	.0033136	8.08				6.01	
							CS	.00232	0	.262	1.25	30	0	.00				.00	
							VCS	.00464	0	.385	.85	13.2	0	.00				.00	
							Median	.001213											
							Total							78.61	115.67	.68		58.46	.51
Arkansas R. near Dardanelle, Ark., Range 3 Sta. 1220, June 27, 1957	67.70	4.50	14.8	--	.000172	76	VFS	.000285	.033	.023	12.44	9700	.0250775	47.36			.21	31.00	
							FS	.00058	.136	.075	3.82	560	.0066312	12.17				8.07	
							MS	.001150	.57	.157	1.82	66	.0033829	6.19				4.10	
							CS	.00232	0	.262	1.09	32	0	.00				.00	
							VCS	.00464	0	.385	.74	13	0	.00				.00	
							Median	.001213											
							Total							65.72	85.35	.77		43.30	.51
Arkansas R. near Dardanelle, Ark., Range 3 Sta. 1620, June 27, 1957	49.25	3.42	14.4	--	.000172	76	VFS	.000285	.033	.023	12.27	9600	.0144207	19.19			.16	16.36	
							FS	.00058	.136	.075	3.76	530	.0034222	4.55				3.88	
							MS	.001150	.57	.157	1.80	63	.0016137	2.15				1.83	
							CS	.00232	0	.262	1.08	21.5	0	.00				.00	
							VCS	.00464	0	.385	.73	13	0	.00				.00	
							Median	.001213											
							Total							25.88	39.23	.66		22.07	.56
Arkansas R. near Dardanelle, Ark., Range 3 Sta. 2020, June 27, 1957	40.57	4.14	9.8	--	.000172	76	VFS	.000285	.033	.023	10.12	6400	.0230239	28.79			.23	17.06	
							FS	.00058	.136	.075	3.10	310	.0035326	6.08				3.67	
							MS	.001150	.57	.157	1.48	39	.0029949	3.28				.00	
							CS	.00232	0	.262	.89	16	0	.00				.00	
							VCS	.00464	0	.385	.60	11.2	0	.00				.00	
							Median	.001213											
							Total							37.65	43.25	.87		20.72	.48

TABLE NO. C-12

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	d	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	τ'	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Dardanelle, Ark., Range 7 Sta. 500, June 28, 1957	95.38	4.63	20.6	--	.000172	76	VFS	.000285	.033	.023	14.60	13100	.0216700	55.81			.10	42.55	
							FS	.00058	.134	.075	4.50	890	.0065201	16.81				12.82	
							MS	.001150	.57	.157	2.15	105	.0032935	8.48				6.47	
							CS	.00232	0	.262	1.29	29	0	.00				.00	
							VCS	.00464	0	.385	.88	15.7	0	.00				.00	
							Median	.001213											
							Total							81.10	42.49	1.91		61.83	1.46
Arkansas R. near Dardanelle, Ark., Range 7 Sta. 600, June 28, 1957	113.49	5.23	21.7	--	.000172	76	VFS	.000285	.033	.023	15.06	16000	.0275696	84.48			.20	59.06	
							FS	.00058	.134	.075	4.62	900	.0086400	26.48				18.51	
							MS	.001150	.57	.157	2.21	115	.0044296	13.57				9.49	
							CS	.00232	0	.262	1.32	31	0	.00				.00	
							VCS	.00464	0	.385	.90	16.1	0	.00				.00	
							Median	.001213											
							Total							124.53	97.17	1.28		87.06	.90
Arkansas R. near Dardanelle, Ark., Range 7 Sta. 900, June 28, 1957	153.72	6.1	25.2	--	.000172	76	VFS	.000285	.033	.023	16.23	15500	.0334332	138.77			.21	90.32	
							FS	.00058	.134	.075	4.98	560	.0054539	22.64				14.73	
							MS	.001150	.57	.157	2.38	140	.0060661	25.18				16.39	
							CS	.00232	0	.262	1.43	37	0	.00				.00	
							VCS	.00464	0	.385	.97	18	0	.00				.00	
							Median	.001213											
							Total							186.58	154.03	1.21		121.44	.79
Arkansas R. near Dardanelle, Ark., Range 7 Sta. 1300, June 28, 1957	148.96	6.71	22.2	--	.000172	76	VFS	.000285	.033	.023	15.24	14300	.0453834	182.53			.25	102.93	
							FS	.00058	.134	.075	4.67	1000	.0144124	57.97				32.69	
							MS	.001150	.57	.157	2.23	120	.0077097	31.33				17.67	
							CS	.00232	0	.262	1.34	32	0	.00				.00	
							VCS	.00464	0	.385	.91	16.3	0	.00				.00	
							Median	.001213											
							Total							271.83	140.03	1.94		153.28	1.09
Arkansas R. near Dardanelle, Ark., Range 7 Sta. 1500, June 28, 1957	118.04	5.49	21.5	--	.000172	76	VFS	.000285	.033	.023	15.00	13700	.0302407	96.38			.21	64.22	
							FS	.00058	.134	.075	4.60	930	.0094216	30.03				20.01	
							MS	.001150	.57	.157	2.20	112	.0048905	15.59				.00	
							CS	.00232	0	.262	1.32	31	0	.00				.00	
							VCS	.00464	0	.385	.90	16.2	0	.00				.00	
							Median	.001213											
							Total							141.99	103.21	1.38		84.22	.82

TABLE NO. C-13

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	Y'	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Dardanelle, Ark., Range 10																			
Sta. 300, July 1, 1957	160.38	6.33	26.60	--	.000172	79	VFS	.000285	.033	.024	15.90	15100	.0323003	147.24			.22	94.97	
							FS	.00058	.136	.077	4.90	1100	.0114447	52.03				33.56	
							MS	.001158	.57	.16	2.40	144	.0062340	28.34				18.28	
							CS	.00232	0	.264	1.45	37.5	0	.00				.00	
							VCS	.00464	0	.385	1.00	19	0	.00				.00	
							Median	.001213											
							Total							227.61	201.53	1.13		146.81	.73
Arkansas R. near Dardanelle, Ark., Range 10																			
Sta. 700, July 1, 1957	89.96	5.23	17.20	--	.000172	79	VFS	.000285	.033	.024	12.85	10000	.0290935	70.67			.22	44.40	
							FS	.00058	.136	.077	4.01	660	.0002095	20.13				12.67	
							MS	.001158	.57	.16	1.93	76	.0041957	10.19				6.41	
							CS	.00232	0	.264	1.17	24.5	0	.00				.00	
							VCS	.00464	0	.385	.00	14	0	.00				.00	
							Median	.001213											
							Total							100.99	119.03	.85		63.56	.53
Arkansas R. near Dardanelle, Ark., Range 10																			
Sta. 1100, July 1, 1957	51.15	4.70	10.70	--	.000172	79	VFS	.000285	.033	.024	10.14	6300	.0299850	41.41			.26	22.81	
							FS	.00058	.136	.077	3.16	32.5	.0006939	.96				.53	
							MS	.001158	.57	.16	1.52	42	.0039353	5.43				2.99	
							CS	.00232	0	.264	.92	16.5	0	.00				.00	
							VCS	.00464	0	.385	.63	11.5	0	.00				.00	
							Median	.001213											
							Total							47.80	58.09	.82		26.33	.45
Arkansas R. near Dardanelle, Ark., Range 10																			
Sta. 1700, July 1, 1957	57.20	4.40	13.00	--	.000172	79	VFS	.000285	.033	.024	11.17	7000	.0232940	35.90			.22	23.33	
							FS	.00058	.136	.077	3.40	425	.0056415	8.71				5.65	
							MS	.001158	.57	.16	1.60	53	.0030249	4.67				3.03	
							CS	.00232	0	.264	1.02	20	0	.00				.00	
							VCS	.00464	0	.385	.70	12.5	0	.00				.00	
							Median	.001213											
							Total							49.36	37.27	1.32		32.00	.86
Arkansas R. near Dardanelle, Ark., Range 10																			
Sta. 2300, July 1, 1957	31.36	3.92	8.00	--	.000172	79	VFS	.000285	.033	.024	8.77	4550	.0222777	18.86			.24	10.90	
							FS	.00058	.136	.077	2.73	215	.0046635	3.95				2.20	
							MS	.001158	.57	.16	1.31	30	.0027773	2.35				.00	
							CS	.00232	0	.264	.80	14.1	0	.00				.00	
							VCS	.00464	0	.385	.55	10.5	0	.00				.00	
							Median	.001213											
							Total							25.16	16.61	1.52		13.10	.79

TABLE NO. C-14

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	U	S	T°F	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	I	Y'	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Dardanelle, Ark., Range 14																			
Sta. 240, July 2, 1957	273.29	7.08	38.60	--	.000172	80	VFS	.000285	.033	.0241	19.17	20000	.0307716	227.06			.20	136.62	
							FS	.00058	.136	.078	5.92	1800	.0125545	92.64				63.90	
							MS	.001150	.57	.16	2.09	250	.0078245	57.74				39.82	
							CS	.00232	0	.264	1.75	59	0	.00				.00	
							VCS	.00464	0	.385	1.20	22	0	.00				.00	
							Median	.001213											
							Total							377.43	301.22	1.25		260.34	.86
Arkansas R. near Dardanelle, Ark., Range 14																			
Sta. 440, July 2, 1957	234.36	7.56	31.00	--	.000172	80	VFS	.000285	.033	.0241	17.18	15300	.0374452	236.94			.24	139.49	
							FS	.00058	.136	.078	5.31	1400	.0156000	98.72				58.12	
							MS	.001150	.57	.16	2.39	180	.0090830	57.48				33.84	
							CS	.00232	0	.264	1.57	45	0	.00				.00	
							VCS	.00464	0	.385	1.08	21.7	0	.00				.00	
							Median	.001213											
							Total							393.14	277.19	1.42		231.45	.83
Arkansas R. near Dardanelle, Ark., Range 14																			
Sta. 640, July 2, 1957	112.55	5.49	20.50	--	.000172	80	VFS	.000285	.033	.0241	13.97	11900	.0282263	85.77			.21	55.93	
							FS	.00058	.136	.078	4.32	880	.0085301	25.92				16.90	
							MS	.001150	.57	.16	2.10	98	.0046059	14.00				9.13	
							CS	.00232	0	.264	1.20	29	0	.00				.00	
							VCS	.00464	0	.385	.87	15.3	0	.00				.00	
							Median	.001213											
							Total							125.69	90.62	1.39		81.96	.90
Arkansas R. near Dardanelle, Ark., Range 14																			
Sta. 840, July 2, 1957	77.60	3.88	20.00	--	.000172	80	VFS	.000285	.033	.0241	13.00	11700	.0139393	29.25			.15	25.01	
							FS	.00058	.136	.078	4.26	760	.0039395	8.25				7.28	
							MS	.001150	.57	.16	2.08	97	.0020505	4.30				3.79	
							CS	.00232	0	.264	1.26	28.5	0	.00				.00	
							VCS	.00464	0	.385	.86	15.2	0	.00				.00	
							Median	.001213											
							Total							41.80	61.13	.68		36.09	.60
Arkansas R. near Dardanelle, Ark., Range 14																			
Sta. 1240, July 2, 1957	34.62	3.01	11.50	--	.000172	80	VFS	.000285	.033	.0241	10.47	7000	.0112577	10.52			.16	9.10	
							FS	.00058	.136	.078	3.23	345	.0023420	2.19				1.89	
							MS	.001150	.57	.16	1.38	45	.0011591	1.00				.88	
							CS	.00232	0	.264	.96	17.8	0	.00				.00	
							VCS	.00464	0	.385	.66	11.9	0	.00				.00	
							Median	.001213											
							Total							13.79	18.60	.74		10.99	.59

TABLE NO. C-15

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	V'	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Dardanelle, Ark., Bridge Sta. 410, April 1, 1958	96.10	4.50	21.00	--	.0001436	55	VFS	.000285	.033	.010	17.30	17100	.0268603	69.75			.18	54.17	
							FS	.00058	.136	.061	5.11	1230	.0086900	22.58				17.53	
							MS	.001158	.57	.142	2.19	110	.0032615	8.47				6.58	
							CS	.00232	0	.252	1.24	30	0	.00				.00	
							VCS	.00464	0	.385	.81	14.4	0	.00				.00	
							Median	.001213											
							Total							100.80	85.99	1.17		78.28	.91
Arkansas R. near Dardanelle, Ark., Bridge Sta. 610, April 1, 1958	124.85	5.50	22.70	--	.0001436	55	VFS	.000285	.033	.010	17.99	18100	.0349451	124.54			.20	84.91	
							FS	.00058	.136	.061	5.31	1300	.0126495	42.64				29.07	
							MS	.001158	.57	.142	2.28	125	.0050394	16.99				11.58	
							CS	.00232	0	.262	1.24	.28	0	.00				.00	
							VCS	.00464	0	.385	.84	14.8	0	.00				.00	
							Median	.001213											
							Total							184.17	183.09	1.01		125.56	.69
Arkansas R. near Dardanelle, Ark., Bridge Sta. 850, April 1, 1958	102.24	4.26	24.00	--	.0001436	55	VFS	.000285	.033	.018	18.50	18700	.0206087	56.89			.13	50.11	
							FS	.00058	.136	.061	5.46	1500	.0072929	19.99				17.61	
							MS	.001158	.57	.142	2.34	135	.0027122	7.49				6.59	
							CS	.00232	0	.262	1.27	29	0	.00				.00	
							VCS	.00464	0	.385	.86	15.2	0	.00				.00	
							Median	.001213											
							Total							84.37	110.18	.77		74.31	.67
Arkansas R. near Dardanelle, Ark., Bridge Sta. 1130, April 1, 1958	83.22	4.38	19.00	--	.0001436	55	VFS	.000285	.033	.010	16.46	16000	.0266409	59.06			.10	46.26	
							FS	.00058	.136	.061	4.86	1100	.0080066	18.17				14.04	
							MS	.001158	.57	.142	2.09	97	.0030201	6.79				5.24	
							CS	.00232	0	.252	1.18	25	0	.00				.00	
							VCS	.00464	0	.385	.77	13.5	0	.00				.00	
							Median	.001213											
							Total							84.02	80.69	1.05		65.55	.81
Arkansas R. near Dardanelle, Ark., Bridge Sta. 1390, April 1, 1958	62.95	3.66	17.20	--	.0001436	55	VFS	.000285	.033	.010	15.66	14600	.0193530	32.89			.16	28.59	
							FS	.00058	.136	.061	4.62	980	.0056150	9.55				8.30	
							MS	.001158	.57	.142	1.90	27.5	.0006349	1.08				.00	
							CS	.00232	0	.252	1.12	102	0	.00				.00	
							VCS	.00464	0	.385	.73	13	0	.00				.00	
							Median	.001213											
							Total							43.52	44.75	.98		36.88	.83

TABLE NO. C-16

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	Y'	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Dardanelle, Ark., Range 3																			
Sta. 230, April 1, 1958	155.63	5.94	26.20	--	.0001436	55	VFS	.000205	.033	.018	19.33	20000	.0305206	161.06			.20	109.83	
							FS	.00058	.136	.061	5.70	1600	.0105006	61.27				41.57	
							MS	.001158	.57	.142	2.45	153	.0038033	24.72				16.77	
							CS	.00232	0	.252	1.30	34	0	.00				.00	
							VCS	.00464	0	.305	.90	16.2	0	.00				.00	
							Median	.001213											
							Total							247.05	201.32	1.23		168.17	.84
Arkansas R. near Dardanelle, Ark., Range 3																			
Sta. 620, April 1, 1958	82.10	4.21	19.50	--	.0001436	55	VFS	.000205	.033	.018	16.67	14700	.0216550	48.00			.17	38.90	
							FS	.00058	.136	.061	4.92	1130	.0073139	16.21				13.14	
							MS	.001158	.57	.142	2.11	100	.0027103	6.01				4.87	
							CS	.00232	0	.262	1.15	24	0	.00				.00	
							VCS	.00464	0	.305	.78	13.7	0	.00				.00	
							Median	.001213											
							Total							70.22	60.49	1.16		56.91	.94
Arkansas R. near Dardanelle, Ark., Range 3																			
Sta. 1010, April 1, 1958	66.36	4.74	14.00	--	.0001436	55	VFS	.000205	.033	.018	14.13	12300	.0303261	60.67			.22	43.04	
							FS	.00058	.136	.061	4.17	720	.0100244	17.96				11.26	
							MS	.001158	.57	.142	1.79	203	.0122953	22.03				13.81	
							CS	.00232	0	.262	.97	18.1	0	.00				.00	
							VCS	.00464	0	.305	.66	12	0	.00				.00	
							Median	.001213											
							Total							100.66	67.26	1.62		68.11	1.01
Arkansas R. near Dardanelle, Ark., Range 3																			
Sta. 1400, April 1, 1958	29.52	3.28	9.00	--	.0001436	55	VFS	.000205	.033	.018	11.33	8100	.0227771	18.15			.19	13.00	
							FS	.00058	.136	.061	3.34	380	.0046182	3.68				2.64	
							MS	.001158	.57	.142	1.44	37.5	.0018350	1.46				1.05	
							CS	.00232	0	.252	.81	14.2	0	.00				.00	
							VCS	[illegible]	0	.305	.53	10.3	0	.00				.00	
							Median	[illegible]											
							Total							23.30	19.06	1.22		16.68	.88
Arkansas R. near Dardanelle, Ark., Range 3																			
Sta. 1700, April 1, 1958	12.40	2.48	5.00	--	.0001436	55	VFS	.000205	.033	.018	8.44	4230	.0160217	5.36			.20	3.79	
							FS	.00058	.136	.061	2.09	160	.0025148	.84				.60	
							MS	.001158	.57	.142	1.07	21.5	.0012382	.41				.00	
							CS	.00232	0	.252	.60	11.2	0	.00				.00	
							VCS	.00464	0	.305	.39	8.9	0	.00				.00	
							Median	.001213											
							Total							6.62	8.52	.78		4.39	.51

TABLE NO. C-17

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	U	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	f	Y′	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Dardanelle, Ark., Range 8																			
Sta. 290, April 1, 1958	42.70	3.72	11.50	--	.0001436	55	VFS	.000285	.033	.018	12.80	10300	.0260590	30.10			.19	21.49	
							FS	.00058	.136	.061	3.78	540	.0059763	6.90				4.93	
							MS	.001150	.57	.142	1.62	40	.0022018	2.54				1.82	
							CS	.00232	0	.232	.91	16.4	0	.00				.00	
							VCS	.00464	0	.385	.60	11.2	0	.00				.00	
							Median	.001213											
							Total							39.55	34.70	1.14		28.23	.81
Arkansas R. near Dardanelle, Ark., Range 8																			
Sta. 690, April 1, 1958	68.64	4.16	16.50	--	.0001436	55	VFS	.000285	.033	.018	15.34	14300	.0264690	49.05			.18	37.27	
							FS	.00058	.136	.061	4.53	900	.0073325	13.39				10.32	
							MS	.001150	.57	.142	1.94	70	.0026724	4.95				3.76	
							CS	.00232	0	.262	1.05	21	0	.00				.00	
							VCS	.00464	0	.385	.72	12.7	0	.00				.00	
							Median	.001213											
							Total							67.40	101.99	.66		51.35	.50
Arkansas R. near Dardanelle, Ark., Range 8																			
Sta. 1100, April 1, 1958	66.64	3.92	17.00	--	.0001436	55	VFS	.000285	.033	.018	15.57	14600	.0227090	41.00			.17	33.32	
							FS	.00058	.136	.061	4.59	930	.0064757	11.65				9.47	
							MS	.001150	.57	.142	1.97	82	.0023076	4.15				3.37	
							CS	.00232	0	.262	1.07	21.4	0	.00				.00	
							VCS	.00464	0	.385	.73	12.9	0	.00				.00	
							Median	.001213											
							Total							56.81	77.20	.74		46.16	.60
Arkansas R. near Dardanelle, Ark., Range 8																			
Sta. 1500, April 1, 1958	54.00	4.50	12.00	--	.0001436	55	VFS	.000285	.033	.018	13.00	8100	.0286106	41.71			.23	25.56	
							FS	.00058	.136	.061	3.86	380	.0039046	8.73				5.35	
							MS	.001150	.57	.142	1.66	37.5	.0025571	3.73				2.28	
							CS	.00232	0	.252	.93	14.2	0	.00				.00	
							VCS	.00464	0	.385	.61	10.3	0	.00				.00	
							Median	.001213											
							Total							54.17	44.20	1.23		33.19	.75
Arkansas R. near Dardanelle, Ark., Range 8																			
Sta. 1900, April 1, 1958	41.50	3.30	12.60	--	.0001436	55	VFS	.000285	.033	.018	13.40	4250	.0072520	8.14			.16	6.75	
							FS	.00058	.136	.061	3.95	160	.0011702	1.31				1.09	
							MS	.001150	.57	.142	1.70	21.5	.0006201	.70				.00	
							CS	.00232	0	.252	.96	11.2	0	.00				.00	
							VCS	.00464	0	.385	.63	8.9	0	.00				.00	
							Median	.001213											
							Total							10.15	34.09	.30		7.84	.23

TABLE NO. C-18

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	ω	R	V'	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Dardanelle, Ark., Range 13																			
Sta. 330, April 2, 1958	136.25	5.45	25.00	--	.0001434	55	VFS	.000285	.033	.018	18.80	19700	.0334146	122.92			.19	88.27	
							FS	.00058	.136	.061	5.57	1550	.0120290	44.25				31.78	
							MS	.001150	.37	.142	2.39	105	.0049306	18.14				13.02	
							CS	.00232	0	.252	1.35	32.5	0	.00				.00	
							VCS	.00464	0	.305	.80	15.7	0	.00				.00	
							Median	.001213											
							Total							185.32	150.17	1.23		133.07	.89
Arkansas R. near Dardanelle, Ark., Range 13																			
Sta. 710, April 2, 1958	94.24	4.96	19.00	--	.0001434	55	VFS	.000285	.033	.018	16.46	16000	.0305100	87.82			.20	60.66	
							FS	.00058	.136	.061	4.86	1120	.0107907	27.46				18.96	
							MS	.001150	.37	.142	2.09	99	.0041034	10.35				7.29	
							CS	.00232	0	.262	1.13	104	0	.00				.00	
							VCS	.00464	0	.305	.77	13.4	0	.00				.00	
							Median	.001213											
							Total							125.63	152.79	.82		86.91	.57
Arkansas R. near Dardanelle, Ark., Range 13																			
Sta. 1100, April 2, 1958	49.63	3.76	13.20	--	.0001434	55	VFS	.000285	.033	.018	13.72	11700	.0245584	32.91			.18	24.77	
							FS	.00058	.136	.061	4.05	690	.0063233	8.48				6.38	
							MS	.001150	.37	.142	1.74	54	.0020440	2.74				2.06	
							CS	.00232	0	.262	.94	17.2	0	.00				.00	
							VCS	.00464	0	.305	.64	11.6	0	.00				.00	
							Median	.001213											
							Total							44.13	48.27	.91		33.21	.69
Arkansas R. near Dardanelle, Ark., Range 13																			
Sta. 1400, April 2, 1958	13.44	2.24	6.00	--	.0001434	55	VFS	.000285	.033	.018	9.25	6200	.0100738	5.11			.16	4.30	
							FS	.00058	.136	.061	2.73	215	.0019565	.71				.60	
							MS	.001150	.37	.142	1.17	24.7	.0007311	.27				.22	
							CS	.00232	0	.252	.66	12	0	.00				.00	
							VCS	.00464	0	.305	.43	9.2	0	.00				.00	
							Median	.001213											
							Total							6.08	16.32	.37		5.12	.31
Arkansas R. near Dardanelle, Ark., Range 13																			
Sta. 1860, April 2, 1958	13.20	2.49	5.30	--	.0001434	55	VFS	.000285	.033	.018	8.69	4500	.0156524	5.58			.19	4.03	
							FS	.00058	.136	.061	2.56	176	.0025407	.91				.66	
							MS	.001150	.37	.142	1.10	22	.0011627	.41				.00	
							CS	.00232	0	.252	.62	11.4	0	.00				.00	
							VCS	.00464	0	.305	.41	9.1	0	.00				.00	
							Median	.001213											
							Total							6.90	14.33	.48		4.69	.33

TABLE NO. C-19

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	U*	S	T°F	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	I	Y:	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Morrilton, Ark., Range 5																			
Sta. 360, April 7, 1950	43.03	3.31	13.00	--	.000166	55	VFS	.000205	.03	.010	14.64	13200	.0196309	22.83			.16	19.15	
							FS	.00058	.2105	.061	4.32	800	.0090177	10.48				8.79	
							MS	.001150	.0965	.142	1.86	70	.0016054	1.96				1.64	
							CS	.00232	0	.252	1.08	21	0	.00				.00	
							VCS	.00464	0	.305	.60	12.3	0	.00				.00	
							Median	.001213											
							Total							35.27	49.45	.71		29.57	.60
Arkansas R. near Morrilton, Ark., Range 5																			
Sta. 810, April 7, 1950	88.19	4.24	20.80	--	.000166	55	VFS	.000205	.03	.010	18.31	19000	.0234196	55.77			.16	46.24	
							FS	.00058	.2105	.061	5.46	1900	.0143098	34.17				28.33	
							MS	.001150	.4165	.142	2.35	136	.0024734	5.89				4.89	
							CS	.00232	0	.262	1.27	29	0	.00				.00	
							VCS	.00464	0	.305	.87	15.4	0	.00				.00	
							Median	.001213											
							Total							95.83	142.24	.67		79.45	.56
Arkansas R. near Morrilton, Ark., Range 5																			
Sta. 1110, April 7, 1950	73.92	3.83	19.30	--	.000166	55	VFS	.000205	.03	.010	17.83	17000	.0198277	39.57			.15	34.77	
							FS	.00058	.2105	.061	5.26	1550	.0115345	23.02				20.23	
							MS	.001150	.4165	.142	2.36	122	.0019286	3.85				3.38	
							CS	.00232	0	.262	1.23	27	0	.00				.00	
							VCS	.00464	0	.305	.83	14.6	0	.00				.00	
							Median	.001213											
							Total							66.44	92.64	.72		58.38	.63
Arkansas R. near Morrilton, Ark., Range 5																			
Sta. 1300, April 7, 1950	49.40	3.58	13.80	--	.000166	55	VFS	.000205	.03	.010	15.08	14000	.0225025	30.02			.17	24.09	
							FS	.00058	.2105	.061	4.45	880	.0108306	14.45				11.60	
							MS	.001150	.4165	.142	1.91	76	.0017233	2.30				1.85	
							CS	.00232	0	.252	1.08	21.7	0	.00				.00	
							VCS	.00464	0	.305	.71	12.6	0	.00				.00	
							Median	.001213											
							Total							46.76	18.03	2.59		37.53	2.08
Arkansas R. near Morrilton, Ark., Range 5																			
Sta. 1700, April 7, 1950	27.58	3.17	8.70	--	.000166	55	VFS	.000205	.03	.010	11.97	9000	.0225234	16.77			.19	12.20	
							FS	.00058	.2105	.061	3.53	445	.0084670	6.30				4.59	
							MS	.001150	.4165	.142	1.52	42	.0014467	1.08				.00	
							CS	.00232	0	.252	.86	15.2	0	.00				.00	
							VCS	.00464	0	.305	.56	10.6	0	.00				.00	
							Median	.001213											
							Total							24.15	13.74	1.76		16.78	1.22

TABLE NO. C-20

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q (cfs/ft)	V	D	W	S	TBF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	T	V'	C (Σ)	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Morrilton, Ark., Range 7																			
Sta. 1300, April ?, 1958	6.40	2.70	2.40	--	.000164	55	VFS	.000205	.03	.018	6.29	2130	.0260821	4.70			.31	2.21	
							FS	.00058	.2105	.061	1.06	70	.0067742	1.19				.56	
							MS	.001158	.0965	.142	.88	14.1	.0030071	.53				.25	
							CS	.00232	0	.252	.45	9.5	0	.00				.00	
							VCS	.00464	0	.385	.29	8	0	.00				.00	
							Median	.001213											
							Total							6.41	3.70	1.74		3.01	.82
Arkansas R. near Morrilton, Ark., Range 7																			
Sta. 1600, April ?, 1958	32.14	3.28	9.80	--	.000164	55	VFS	.000205	.03	.018	12.71	10300	.0231209	20.07			.18	14.94	
							FS	.00058	.2105	.061	3.75	530	.0090697	7.87				5.86	
							MS	.001158	.4165	.142	1.61	87.5	.0014002	1.28				.96	
							CS	.00232	0	.262	.87	15.3	0	.00				.00	
							VCS	.00464	0	.385	.59	11.1	0	.00				.00	
							Median	.001213											
							Total							29.23	18.69	1.56		21.75	1.16
Arkansas R. near Morrilton, Ark., Range 7																			
Sta. 1960, April ?, 1958	107.07	4.59	23.30	--	.000164	55	VFS	.000205	.03	.018	19.60	20500	.0240000	72.23			.17	58.90	
							FS	.00058	.2105	.061	5.81	1750	.0165309	48.17				39.28	
							MS	.001158	.4165	.142	2.49	160	.0029206	8.51				6.94	
							CS	.00232	0	.262	1.35	32.5	0	.00				.00	
							VCS	.00464	0	.385	.92	14.3	0	.00				.00	
							Median	.001213											
							Total							128.90	128.06	1.01		105.12	.82
Arkansas R. near Morrilton, Ark., Range 7																			
Sta. 2260, April ?, 1958	125.02	5.32	23.50	--	.000164	55	VFS	.000205	.03	.018	19.60	20500	.0337040	113.77			.19	84.19	
							FS	.00058	.2105	.061	5.81	1750	.0227709	76.86				54.85	
							MS	.001158	.4165	.142	2.49	160	.0041394	13.97				9.97	
							CS	.00232	0	.252	1.41	32.5	0	.00				.00	
							VCS	.00464	0	.385	.92	14.3	0	.00				.00	
							Median	.001213											
							Total							204.61	130.37	1.57		146.02	1.12
Arkansas R. near Morrilton, Ark., Range 7																			
Sta. 2540, April ?, 1958	86.32	3.32	26.00	--	.000164	55	VFS	.000205	.03	.018	20.70	22000	.0114322	26.64			.11	30.00	
							FS	.00058	.2105	.061	6.11	2000	.0076892	17.92				20.50	
							MS	.001158	.4165	.142	2.62	190	.0012313	2.87				3.28	
							CS	.00232	0	.252	1.08	39	0	.00				.00	
							VCS	.00464	0	.385	.97	10.1	0	.00				.00	
							Median	.001213											
							Total							47.43	13.84	3.43		54.27	3.92

TABLE NO. C-21

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	R	S	TDF	Bed Composition Size Class	Bed Composition Geom. Mean Size, ft.	Bed Composition Pb	w	X	Y'	c %	Bed-Material Sediment Load Tons Per Day/Ft Computed	Bed-Material Sediment Load Tons Per Day/Ft Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Morrilton, Ark., Range 11																			
Sta. 370, April 7, 1958	50.62	3.42	14.00	--	.000166	55	VFS	.000205	.03	.010	15.62	14600	.0191330	26.15			.16	22.57	
							FS	.00058	.2105	.061	4.61	980	.0097431	13.32				11.50	
							MS	.001150	.0965	.142	1.90	82	.0017099	2.39				2.06	
							CS	.00232	0	.252	1.12	22.5	0	.00				.00	
							VCS	.00464	0	.385	.73	12.9	0	.00				.00	
							Median	.001213											
							Total							41.85	51.04	.82		36.14	.71
Arkansas R. near Morrilton, Ark., Range 11																			
Sta. 640, April 7, 1958	85.54	4.32	19.00	--	.000166	55	VFS	.000205	.03	.010	18.06	18200	.0251421	58.07			.17	66.39	
							FS	.00058	.2105	.061	5.33	1400	.0130360	34.77				27.72	
							MS	.001150	.4165	.142	2.29	127	.0026174	6.04				4.82	
							CS	.00232	0	.262	1.24	27.5	0	.00				.00	
							VCS	.00464	0	.385	.84	14.9	0	.00				.00	
							Median	.001213											
							Total							98.88	89.30	1.11		78.84	.88
Arkansas R. near Morrilton, Ark., Range 11																			
Sta. 920, April 7, 1958	79.28	3.83	20.70	--	.000166	55	VFS	.000205	.03	.010	18.47	19000	.0190260	40.73			.15	36.94	
							FS	.00058	.2105	.061	5.05	1500	.0113013	24.62				22.33	
							MS	.001150	.4165	.142	2.34	135	.0019071	4.08				3.70	
							CS	.00232	0	.262	1.27	28.5	0	.00				.00	
							VCS	.00464	0	.385	.86	15.1	0	.00				.00	
							Median	.001213											
							Total							69.43	86.27	.80		62.97	.73
Arkansas R. near Morrilton, Ark., Range 11																			
Sta. 1220, April 7, 1958	56.09	3.55	15.00	--	.000166	55	VFS	.000205	.03	.010	16.14	15200	.0193296	29.58			.16	25.43	
							FS	.00058	.2105	.061	4.76	1030	.0100044	15.27				13.13	
							MS	.001150	.4165	.142	2.05	94	.0016756	2.54				2.18	
							CS	.00232	0	.252	1.15	24	0	.00				.00	
							VCS	.00464	0	.385	.75	13.1	0	.00				.00	
							Median	.001213											
							Total							47.39	43.23	1.10		40.74	.94
Arkansas R. near Morrilton, Ark., Range 11																			
Sta. 1500, April 7, 1958	72.31	4.33	16.70	--	.000166	55	VFS	.000205	.03	.010	16.59	16200	.0291096	56.03			.19	41.07	
							FS	.00058	.2105	.061	4.98	1120	.0157198	30.69				22.61	
							MS	.001150	.4165	.142	2.10	99	.0026829	5.24				3.86	
							CS	.00232	0	.252	1.10	25	0	.00				.00	
							VCS	.00464	0	.385	.70	12.2	0	.00				.00	
							Median	.001213											
							Total							92.76	18.88	4.91		68.34	3.62

TABLE NO. C-22

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and date	q cfs/ft	V	D	R	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	Y'	c %	Bed-Material Sediment Load Tons Per Day/Ft: Computed	Bed-Material Sediment Load Tons Per Day/Ft: Observed	Ratio Comp/Obs	Froude Number Fr	Adjusted Computed Load Tons/Day/Ft	Adjusted Ratio Comp/Obs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Arkansas R. near Morrilton, Ark., Range 24																			
Sta. 200, April 7, 1958	104.74	4.14	25.30	--	.000166	55	VFS	.000205	.03	.018	20.42	21500	.0187100	52.94			.15	49.00	
							FS	.00058	.2105	.061	6.03	1960	.0131090	37.19				34.42	
							MS	.001150	.0965	.102	2.39	183	.0027370	7.74				7.17	
							CS	.00232	0	.232	1.46	38	0	.00				.00	
							VCS	.00464	0	.305	.95	12.4	0	.00				.00	
							Median	.001213											
							Total							97.86	49.32	1.98		90.59	1.84
Arkansas R. near Morrilton, Ark., Range 24																			
Sta. 450, April 7, 1958	84.15	4.25	19.80	--	.000166	55	VFS	.000205	.03	.018	10.66	10200	.0242946	55.20			.17	48.66	
							FS	.00058	.2105	.061	5.33	1000	.0145222	33.00				29.70	
							MS	.001150	.4165	.102	2.29	126	.0020930	5.67				4.30	
							CS	.00232	0	.262	1.24	27.5	0	.00				.00	
							VCS	.00464	0	.305	.84	14.8	0	.00				.00	
							Median	.001213											
							Total							93.86	63.54	1.48		82.66	1.30
Arkansas R. near Morrilton, Ark., Range 24																			
Sta. 660, April 7, 1958	80.98	4.02	16.00	--	.000166	55	VFS	.000205	.03	.018	16.64	16100	.0338393	78.36			.21	52.53	
							FS	.00058	.2105	.061	4.91	1130	.0190416	43.38				29.00	
							MS	.001150	.4165	.102	2.11	101	.0035004	7.65				5.13	
							CS	.00232	0	.262	1.14	24	0	.00				.00	
							VCS	.00464	0	.305	.78	13.8	0	.00				.00	
							Median	.001213											
							Total							129.39	154.06	.84		86.75	.56
Arkansas R. near Morrilton, Ark., Range 24																			
Sta. 880, April 7, 1958	90.28	5.05	16.00	--	.000166	55	VFS	.000205	.03	.018	16.64	16100	.0534144	141.74			.25	79.76	
							FS	.00058	.2105	.061	4.91	1130	.0299554	79.49				44.73	
							MS	.001150	.4165	.102	2.11	101	.0054340	14.42				8.11	
							CS	.00232	0	.252	1.19	24	0	.00				.00	
							VCS	.00464	0	.305	.78	13.8	0	.00				.00	
							Median	.001213											
							Total							235.65	173.69	1.36		132.61	.76
Arkansas R. near Morrilton, Ark., Range 24																			
Sta. 1090, April 7, 1958	48.93	4.66	10.50	--	.000166	55	VFS	.000205	.03	.018	13.15	11000	.0464664	61.39			.25	34.31	
							FS	.00058	.2105	.061	3.00	58	.0019393	2.56				1.43	
							MS	.001150	.4165	.102	1.67	52	.0034580	4.57				2.55	
							CS	.00232	0	.252	.94	17.2	0	.00				.00	
							VCS	.00464	0	.305	.62	11.4	0	.00				.00	
							Median	.001213											
							Total							68.52	49.89	1.37		38.30	.77

TABLE NO. C-23

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and Run No.	Q	V	D	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	T	Y'	c Σ	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Flume Tests by Simons and Richardson, .19mm Sand																					
Run No. 8	14.81	1.99	.93	0	.0007	65	VFS	.000285	.043	.02	7.24	3000	.0937338	37.40			.36	15.11			
							FS	.00058	.707	.068	2.13	105	.0599312	23.96				9.89			
							MS	.001150	.10	.15	.96	10	.0019763	.79				.33			
							CS	.00232	0	.250	.56		0	.00				.00			
							VCS	.00464	0	.385	.38		0	.00				.00			
							Median	.000623													
							Total							62.24	20.8	2.99		25.33	1.22	3.17	2.60
Flume Tests by Simons and Richardson, .19mm Sand																					
Run No. 20	4.49	1.04	.54	0	.00079	64	VFS	.000285	.043	.02	5.06	1000	.0269061	3.26			.25	1.85			
							FS	.00058	.707	.066	1.77	60	.0102233	1.24				.70			
							MS	.001150	.10	.144	.81	14	-.000356	.00				.00			
							CS	.00232	0	.239	.05		0	.00				.00			
							VCS	.00464	0	.385	.30		0	.00				.00			
							Median	.000623													
							Total							4.50	.41	10.90		2.55	6.23	.32	.05
Flume Tests by Simons and Richardson, .19mm Sand																					
Run No. 15	21.84	3.46	.79	0	.00112	67	VFS	.000285	.043	.021	8.03	3800	.4929222	290.67			.69	66.04			
							FS	.00058	.707	.0685	2.46	155	.0005692	234.21				53.66			
							MS	.001150	.10	.15	1.12	23	.0142343	8.39				1.91			
							CS	.00232	0	.26	.65		0	.00				.00			
							VCS	.00464	0	.385	.44		0	.00				.00			
							Median	.000623													
							Total							535.27	118	4.54		121.61	1.03	15.20	14.75
Flume Tests by Simons and Richardson, .19mm Sand																					
Run No. 21	16.13	4.03	.50	0	.00542	66	VFS	.000285	.043	.02	14.76	13200	4.667345	2032.60			1.00	327.19			
							FS	.00058	.707	.068	4.34	790	5.636289	2454.66				395.11			
							MS	.001150	.10	.15	1.97	80	.1404326	61.16				9.84			
							CS	.00232	0	.239	1.14		0	.00				.00			
							VCS	.00464	0	.385	.77		0	.00				.00			
							Median	.000623													
							Total							4548.50	1097	4.15		732.15	.67	91.52	137.13
Flume Tests by Simons and Richardson, .19mm Sand																					
Run No. 37	21.84	4.20	.65	0	.0095	63	VFS	.000285	.043	.02	22.20	24000	6.217830	3666.53			.92	640.13			
							FS	.00058	.707	.066	6.75	2500	13.06750	7705.65				1345.30			
							MS	.001150	.10	.147	3.03	290	.3720792	219.00				38.39			
							CS	.00232	0	.257	1.73		0	.00				.00			
							VCS	.00464	0	.385	1.16		0	.00				.00			
							Median	.000623													
							Total							11592.05	2789	4.16		2073.82	.73	252.98	340.63

TABLE NO. C-24

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and Run No.	Q	V	D	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	I	Y'	c Σ	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Flume Tests by Simons and Richardson, .27mm Sand																					
Run No. 51	9.86	1.24	.99	8	.00046	61	VFS	.000285	.039	.0192	6.30	2150	.0206712	5.90			.22	3.90			
							FS	.00058	.376	.065	1.86	70	.0030336	1.34				.08			
							MS	.001150	.455	.146	.03	14.5	.0001661	.04				-.01			
							CS	.00232	.095	.256	.47	9.7	-.000368	.00				.00			
							VCS	.00464	.03	.385	.31	8.1	-.000342	.00				.00			
							Median	.000086													
							Total							6.09	.32	21.52		4.30	13.69	.35	.04
Flume Tests by Simons and Richardson, .27mm Sand																					
Run No. 55	17.8	2.06	1.00	8	.0013	65	VFS	.000285	.039	.02	10.63	7200	.1992217	95.75			.35	60.04			
							FS	.00058	.376	.068	3.13	315	.0053715	41.03				17.16			
							MS	.001150	.455	.15	1.42	36	.0104442	5.02				2.10			
							CS	.00232	.095	.26	.02	14.3	.0004475	.22				.09			
							VCS	.00464	.03	.385	.55	10.5	-.000156	.00				.00			
							Median	.000086													
							Total							142.01	31.1	4.57		90.39	1.91	7.42	3.09
Flume Tests by Simons and Richardson, .27mm Sand																					
Run No. 45	21.04	3.25	.54	8	.00138	64	VFS	.000285	.039	.02	7.74	3400	.7040034	415.61			.70	84.12			
							FS	.00058	.376	.066	2.35	135	.2940402	173.07				35.20			
							MS	.001150	.455	.144	1.00	21.5	.0600034	35.30				7.16			
							CS	.00232	.095	.258	.60	12.2	.0049763	4.11				.03			
							VCS	.00464	.03	.385	.40	9	.0012992	.77				.16			
							Median	.000086													
							Total							629.74	76	8.29		127.40	1.68	15.94	9.30
Flume Tests by Simons and Richardson, .27mm Sand																					
Run No. 46	21.76	3.60	.74	8	.00167	65	VFS	.000285	.039	.02	9.97	6100	1.014400	996.00			.75	124.34			
							FS	.00058	.376	.068	2.93	265	.4642342	273.92				57.15			
							MS	.001150	.455	.15	1.33	32	.0725752	42.64				8.90			
							CS	.00232	.095	.26	.77	13.5	.0064072	3.76				.79			
							VCS	.00464	.03	.385	.52	10.2	.0013000	.77				.16			
							Median	.000086													
							Total							917.10	96.77	9.48		191.35	1.98	23.92	12.10
Flume Tests by Simons and Richardson, .27mm Sand																					
Run No. 41	15.41	4.20	.45	8	.00952	52	VFS	.000285	.039	.0161	23.06	25000	11.96721	4979.20			1.12	723.73			
							FS	.00058	.376	.06	6.19	2050	10.48350	4361.90				634.01			
							MS	.001150	.455	.14	2.65	195	1.311944	545.86				79.34			
							CS	.00232	.095	.25	1.08	38.5	.0567971	23.63				3.41			
							VCS	.00464	.03	.385	.96	17.7	.0079785	3.32				.48			
							Median	.000086													
							Total							9913.91	1479	6.70		1441.00	.97	100.13	104.60

TABLE NO. C-25

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and Run No.	Q	V	D	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	w	X	Y'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Flume Tests by Simons and Richardson, .45mm Sand																					
Run No. 20	8.14	1.60	.61	8	.00193	62	VFS	.000205	.01	.0195	9.90	6100	.0000904	17.60			.30	6.04			
							FS	.00050	.1	.066	2.95	265	.0351520	7.73				3.00			
							MS	.001150	.49	.146	1.33	32	.0181123	3.90				1.55			
							CS	.00232	.36	.256	.76	13.4	.0026259	.58				.22			
							VCS	.00464	.04	.385	.51	10.1	0	.00				.00			
							Median	.00140													
							Total							29.89	11.06	2.70		11.61	1.05	1.45	1.38
Flume Tests by Simons and Richardson, .45m Sand																					
Run No. 23	13.34	2.57	.65	8	.00247	61	VFS	.000205	.01	.0192	11.04	8700	.2566197	92.43			.56	25.16			
							FS	.00050	.1	.065	3.50	440	.1399052	50.39				13.72			
							MS	.001150	.49	.146	1.56	44	.0702515	25.30				6.89			
							CS	.00232	.36	.256	.89	16	.0170476	6.14				1.67			
							VCS	.00464	.04	.385	.59	11.1	.0007796	.28				.08			
							Median	.00140													
							Total							174.54	30.76	5.67		47.51	1.54	5.94	3.85
Flume Tests by Simons and Richardson, .45mm Sand																					
Run No. 40	21.41	3.32	.81	8	.00301	66	VFS	.000205	.01	.02	14.00	12000	.4300030	249.03			.65	59.40			
							FS	.00050	.1	.060	4.12	700	.2752701	159.13				37.95			
							MS	.001150	.49	.15	1.87	70	.1431418	82.75				19.74			
							CS	.00232	.36	.26	1.08	21.5	.0320025	18.55				4.42			
							VCS	.00464	.04	.385	.73	13	.0017094	1.03				.25			
							Median	.00140													
							Total							510.49	141.7	3.60		121.76	.86	15.22	17.71
Flume Tests by Simons and Richardson, .45mm Sand																					
Run No. 39	20.64	4.71	.55	8	.00344	66	VFS	.000205	.01	.02	12.69	10200	1.336506	744.01			1.12	108.71			
							FS	.00050	.1	.060	3.73	540	.7872765	430.73				64.04			
							MS	.001150	.49	.15	1.69	54	.4229275	235.69				34.40			
							CS	.00232	.36	.26	.98	19	.1169432	65.17				9.51			
							VCS	.00464	.04	.385	.66	12	.0002906	4.62				.67			
							Median	.00140													
							Total							1489.03	221.2	6.73		217.33	.98	27.17	27.65
Flume Tests by Simons and Richardson, .45mm Sand																					
Run No. 42	13.43	5.36	.31	8	.00706	68	VFS	.000205	.01	.021	16.93	13500	5.035670	1971.03			1.70	197.52			
							FS	.00050	.1	.069	4.54	900	4.049299	1468.32				147.14			
							MS	.001150	.49	.141	2.22	101	2.462200	892.05				89.47			
							CS	.00232	.36	.26	1.21	26	.5073514	183.97				18.44			
							VCS	.00464	.04	.385	.81	14.2	.0324401	11.77				1.18			
							Median	.00140													
							Total							4527.93	411.3	11.01		453.76	1.10	56.72	51.41

TABLE NO. C-26

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

Location and Run No.	Q	V	D	W	S	TDF	Bed Composition: Size Class	Bed Composition: Geom. Mean Size, ft.	Bed Composition: Pb	ω	X	V'	c %	Bed-Material Sediment Load Tons Per Day: Computed	Bed-Material Sediment Load Tons Per Day: Observed	Ratio Comp/Obs	Fr	Adjusted Computed Load Tons/Day	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft: Computed	Adjusted Load Tons/Day/Ft: Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Flume Tests by Simons and Richardson, .93mm Sand																					
Run No. 17	10.83	2.10	1.00	8	.00136	67	VFS	.000205	.003	.021	9.96	6100	.0236018	6.92			.37	2.75			
							FS	.00058	.013	.0605	3.05	265	.0047251	1.30				.35			
							MS	.001150	.101	.15	1.39	32	.0043690	1.20				.31			
							CS	.00232	.453	.26	.80	13.4	.0046469	1.94				.77			
							VCS	.00464	.426	.385	.54	10.1	.0012117	.35				.14			
							VFG	.00920	.004	.57	.37	8.7	-.000063	-.02				.00			
							Median	.00305													
							Total							11.06	9.59	1.24		4.72	.49	.59	1.20
Flume Tests by Simons and Richardson, .93m Sand																					
Run No. 38	22.60	2.78	1.02	8	.00336	65	VFS	.000205	.003	.0192	17.00	17000	.1203835	73.72			.49	22.91			
							FS	.00058	.013	.065	5.26	1330	.0430781	26.30				8.20			
							MS	.001150	.101	.146	2.34	135	.0350606	21.47				6.67			
							CS	.00232	.453	.256	1.33	32	.0380625	21.96				6.83			
							VCS	.00464	.426	.385	.89	15.9	.0125301	7.60				2.39			
							VFG	.00920	.004	.57	.60	11.2	-3.13e-8	.00				.00			
							Median	.00305													
							Total							151.21	66.2	2.28		46.99	.71	5.87	8.28
Flume Tests by Simons and Richardson, .93mm Sand																					
Run No. 12	22.19	3.12	.89	8	.00437	65	VFS	.000205	.003	.0192	18.42	19000	.2001021	119.09			.58	31.36			
							FS	.00058	.013	.065	5.44	1500	.0751992	45.03				11.86			
							MS	.001150	.101	.146	2.42	150	.0622740	37.31				9.82			
							CS	.00232	.453	.256	1.30	34	.0636233	38.12				10.04			
							VCS	.00464	.426	.385	.92	16.7	.0252643	15.14				3.99			
							VFG	.00920	.004	.57	.62	11.3	.0000700	.04				.01			
							Median	.00305													
							Total							255.52	113.8	2.25		67.27	.59	8.41	14.23
Flume Tests by Simons and Richardson, .93mm Sand																					
Run No. 1	22.33	4.10	.60	8	.0071	67	VFS	.000205	.003	.021	18.77	19200	.5207235	310.77			.93	58.05			
							FS	.00058	.013	.0605	5.75	1700	.2254122	135.90				24.75			
							MS	.001150	.101	.15	2.63	193	.2173799	131.06				23.87			
							CS	.00232	.453	.26	1.52	42	.2256090	136.02				24.77			
							VCS	.00464	.426	.385	1.02	19.5	.0982237	59.22				10.78			
							VFG	.00920	.004	.57	.69	12.2	.0004849	.29				.05			
							Median	.00305													
							Total							701.27	242	3.23		142.28	.59	17.78	30.25
Flume Tests by Simons and Richardson, .93mm Sand																					
Run No. 39	20.88	6.07	.43	8	.0120	69	VFS	.000205	.003	.0212	19.85	20500	2.479359	1397.76			1.63	145.13			
							FS	.00058	.013	.07	6.01	1950	1.144603	645.33				67.00			
							MS	.001150	.101	.151	2.79	225	1.140090	642.74				66.73			
							CS	.00232	.453	.26	1.62	40	1.200209	676.63				70.25			
							VCS	.00464	.426	.305	1.09	22	.5568093	313.95				32.60			
							VFG	.00920	.004	.57	.74	13	.0031722	1.79				.19			
							Median	.00305													
							Total							3678.20	395.2	9.31		381.72	.97	47.71	49.40

TABLE NO. C-27 LASMS015

MODIFIED LAURSEN METHOD
SEDIMENT LOAD CALCULATIONS

	Q	V	D	S	TDF (Assumed)	Bed Composition			n	X	Y'	Concentration c		Ratio Comp/Obs	Fr	Adjusted Computed c %	Adjusted Ratio Comp/Obs	Adjusted Load Tons/Day/Ft	
						Size Class	Geom. Mean Size, ft.	Pb				Computed %	Observed %					Computed	Observed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Flume Tests by Tech, .04mm Silt Run NO. 101	—	1.07	.566	.00101	65	Median	.000131	1	.0043	31.53	34000	19.36	8.34	2.32	.44	6.60	.79	180.51	230.34
Flume Tests by Tech, .04mm Silt Run No. 102	—	1.74	.462	.00117	65	Median	.000131	1	.0043	30.66	33000	21.08	8.2	2.67	.45	7.26	.89	157.59	177.98
Flume Tests by Tech, .04mm Silt Run No. 103	—	1.91	.674	.00086	65	Median	.000131	1	.0043	31.75	34000	15.51	5.04	2.66	.41	5.61	.96	195.10	202.99
Flume Tests by Tech, .04mm Silt Run No. 104	—	2.13	.478	.00107	65	Median	.000131	1	.0043	29.83	33000	32.26	9.7	3.33	.54	9.06	.93	208.95	266.65
Flume Tests by Tech, .04mm Silt Run No. 105	—	2.61	.565	.00114	65	Median	.000131	1	.0043	33.47	36000	41.99	8.34	5.04	.61	10.58	1.27	421.21	332.06
Flume Tests by Tech, .04mm Silt Run No. 106	—	1.23	.542	.00081	65	Median	.000131	1	.0043	[illegible]	30500	6.98	3.03	2.30	.29	3.41	1.12	61.36	54.54
Flume Tests by Tech, .04mm Silt Run No. 107	—	.85	.38	.00078	65	Median	.000131	1	.0043	22.71	24700	3.56	.73	4.87	.24	2.07	2.03	10.02	6.37
Flume Tests by Tech, .04mm Silt Run No. 108	—	2.42	.663	.001	65	Median	.000131	1	.0043	33.96	36000	28.08	9.01	2.86	.52	8.14	.83	352.76	424.97
Flume Tests by Tech, .04mm Silt																			

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Edward B. Madden

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Consulting Engineer, 10109 McCree Road,
Dallas, TX 75238

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The sediment transport function developed by Emmett M. Laursen was adopted for the Arkansas River navigation project because it expresses transport rate using terms that permit separating the effects of hydraulic and sediment parameters. However, in attempting to reproduce measured data from the lower Arkansas River, the Laursen function gave results that were systematically low. The same trend appeared when the function was applied to Missouri River data. Therefore, Laursen's functional relationship

$$f\left(\frac{\sqrt{\tau_o/\rho}}{w}\right)$$

was replotted for the Arkansas River planning studies based on Arkansas River data. Subsequently, another graph of the relationship was developed using data from several other rivers. The work reported in this study is an effort

(Continued)

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to collapse those functional relationships into a single graph. The approach was to introduce a correction coefficient based on Froude number.

The resulting relationship was tested using data from eight field sites and five flume studies. Results, with adjustments for Froude number effects, are satisfactory for sediment sizes ranging from 0.031 mm to 4 mm, flow depths from 0.25 to 54 ft, flow velocities from 0.85 to 7.7 fps, energy gradients from 0.00001 to 0.1 ft/ft, water temperatures from 36 to 90° F, and Froude numbers from 0.07 to 1.7 except when the grain tractive force is less than about two times the critical tractive force. Sediment transport is very small in this case, and there is probably a hiding effect beyond that included in Laursen's formulation.