SEDIMENTATION

This sediment computation method is for small watersheds with less than one square mile of drainage area and where provisions of National Engineering Manual (NEM) 520.22(a) apply (class a dams).

Steps for computation:

1. Use RUSLE2 to determine the average sediment loss per acre in the watershed. Note any non-contributing area as such.

2. Use Table 11-1 below to determine the percent gross sheet erosion from the drainage area that will actually reach the design site. Figure 11-1 indicates the location of the zones for sediment delivery in Minnesota.

Table 11-1. Percent (%) Gross Sheet Erosion Delivered to Site

Drainage Area, acres	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
20-100	85	70	55	40	30
100-320	75	60	50	40	25
320-640	60	55	40	35	20

3. Use the appropriate table to estimate the volume of sediment storage needed above and below the crest of the principal spillway as appropriate. Interpolate between values as needed.

Assumptions for all sites:
Sediment below the crest weighs 1300 tons/acre-foot.
Sediment above the crest weighs 1750 tons/acre-foot
100% trap efficiency
35 year storage life

If the site does NOT have permanent storage (a pool of water), the assumption is made that 100% of the sediment is stored above the crest of the principal spillway. Use Table 11-2a to determine sediment quantity.

If the site has permanent storage (a pool of water), the assumption is made that 85% of storage is below the crest of the principal spillway and 15% of the storage is above the crest of the principal spillway. Use Table 11-2b for storage below the crest of the principal spillway and use Table 11-2c for storage above the crest of the principal spillway.

Table 11-2a. Storage in acre-feet

	20%	25%	30%	35%	40%	45%	50%	55%	60%	70%	75%	85%
0	0	0	0	0	0	0	0	0	0	0	0	0
50	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.7	0.75	0.85
100	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.4	1.5	1.7
200	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.8	3.0	3.4
300	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	4.2	4.5	5.1
400	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.6	6.0	6.8
500	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	7.5	8.5
600	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6	7.2	8.4	9.0	10.2

Left column is soil loss in tons/year. Top row is delivery ratios expressed as percent.

Table 11-2b. Storage below crest (85%) in acre-feet

	20%	25%	30%	35%	40%	45%	50%	55%	60%	70%	75%	85%
0	0	0	0	0	0	0	0	0	0	0	0	0
50	0.23	0.28	0.34	0.4	0.46	0.51	0.58	0.63	0.69	0.80	0.86	0.97
100	0.45	0.57	0.67	0.80	0.92	1.02	1.15	1.26	1.38	1.61	1.72	1.96
200	0.90	1.13	1.35	1.60	1.84	2.03	2.30	2.52	2.75	3.21	3.43	3.91
300	1.35	1.70	2.02	2.4	2.76	3.06	3.45	3.78	4.13	4.82	5.17	5.86
400	1.8	2.27	2.69	3.2	3.68	4.08	4.60	5.03	5.49	6.41	6.88	7.8
500	2.25	2.83	3.37	4.00	4.60	5.10	5.75	6.29	6.87	8.02	8.60	9.75
600	2.67	3.40	4.04	4.80	5.52	6.10	6.90	7.55	8.24	9.63	10.32	11.71

Left column is soil loss in tons/year. Top row is delivery ratios expressed as percent.

Table 11-2c. Storage above crest (15%) in acre -feet

	20%	25%	30%	35%	40%	45%	50%	55%	60%	70%	75%	85%
0	0	0	0	0	0	0	0	0	0	0	0	0
50	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.10	0.11	0.12
100	0.06	0.07	0.09	0.10	0.11	0.13	0.14	0.16	0.17	0.20	0.22	0.25
200	0.12	0.15	0.18	0.21	0.23	0.25	0.29	0.31	0.34	0.39	0.42	0.47
300	0.18	0.22	0.26	0.31	0.34	0.38	0.43	0.47	0.51	0.59	0.64	0.72
400	0.23	0.30	0.35	0.42	0.46	0.51	0.57	0.63	0.69	0.80	0.86	0.97
500	0.29	0.37	0.44	0.52	0.57	0.63	0.72	0.78	0.85	0.99	1.06	1.20
600	0.35	0.44	0.52	0.62	0.69	0.76	0.86	0.94	1.02	1.19	1.28	1.45

Left column is soil loss in tons/year. Top row is delivery ratios expressed as percent.

4. When active uncontrolled gullies will not be controlled by the structure, estimate the volume eroded per year and convert to tons/year. Add these volumes to the above and below crest amounts. Gully erosion delivery ratio is assumed to be 100 percent.

5. Reduce the storage requirements in the structure by any storage provided behind culverts or in depressional areas. The areas used in this computation must pond water and sediment for 24 hours.

6. For water conservation storage structures such as farm ponds, when appropriate, above and below crest volumes may be combined into a single volume to be used below the principal spillway crest.

Sample problem:
A field has Lester loam soil on at 15% average slope in Green County, Minnesota. The multi-year rotation includes soybeans and corn. No active gullies exist that will not be controlled by the structure. A permanent pool is planned.

Solution: Use Form MN-ENG-004 to record the erosion from the respective subareas. Use Figure 11-1 to identify the MLRA as 102. Use Table 11-1 to determine the delivery ratio to use in Tables 11-2a through 11-2c. Multiply the soil loss calculated by RUSLE2 by the acres involved to obtain a product. If the drainage area has more than one subarea, sum the products and record the values at the bottom of the table on form MN-ENG-004.

Record the particular chart in Table 11-2 that is used in the computations. Read the values of sediment storage from the table, starting with the tons of soil loss per year calculated. Here, charts b and c were used to separately determine the sediment above and below the crest. Interpolate within the table as needed.

Sediment Computation Sheet

Watershed_____Jones in Green County, MN_sample_____ By ___B.K._____

See attached output from RUSLE2. Date _____6/23/2006_____

Subarea	Soil Loss (Ton/Ac/Yr)	Acres	Sheet Erosion Total (Ton/Year)
Field 1	0.45	500	225
		Total: 500	Total: 225

Divide total sheet erosion by the number of acres to obtain soil loss in tons/acre/year:
225 tons/year / 500 acres = 0.45 tons/ac/year

MLRA: _102A_____ Delivery Ratio (from Table 11-1) _40%_ Table(s) _11-2b, 11-2c

Storage Needs for Initial Structural Plan:
Sheet Erosion
Below Crest = ____2.07_____ acre-feet
Above Crest = ____0.26_____ acre-feet
Add for Gully: ___0_____ below and above crest
Total for All Sources
Below Crest = _____2.1_____ acre-feet
Above Crest = _____0.3_____ acre-feet

Notes: Enter Table 11-2b with 225 tons of soil loss and a delivery ratio of 40%. Interpolate between 1.84 and 2.76 (for 200 and 300 tons soil loss respectively) for a soil loss below the crest of 2.07 acre-feet. Round to 2.1 acre-feet. Enter Table 11-2c with 225 tons of soil loss and a delivery ratio of 40%. Interpolate between 0.23 and 0.34 (for 200 and 300 tons soil loss respectively) for a soil loss above the crest of 0.26 acre-feet. Round as appropriate for level of accuracy.

See file Sediment_zones.pdf for the “Zones for Sediment Delivery Computations, August 2006” map.