

APPENDIX E - TOTAL MAXIMUM DAILY LOADS

E.1 SEDIMENT

E.1.1 Overview

A percent reduction based on average yearly loading was used as the primary approach for expressing the sediment TMDLs within this document because there is uncertainty associated with the loads derived from the source assessment, and using the estimated sediment loads alone creates a rigid perception that the loads are absolutely conclusive. However, in this appendix the TMDL is expressed using daily loads to satisfy an additional EPA required TMDL element. Daily loads should not be considered absolutely conclusive and may be refined in the future as part of the adaptive management process. The TMDLs may not be feasible at all locations within the watershed but if the allocations are followed, sediment loads are expected to be reduced to a degree that the sediment targets are met and beneficial uses are no longer impaired. It is not expected that daily loads will drive implementation activities.

E.1.2 Approach

In order to determine a daily load, the means of daily mean values for suspended sediment discharge in tons per day were reviewed from USGS gage stations in northwest Montana within reasonable proximity to the Lower Clark Fork tributaries. The USGS station on the Fisher River near Libby (12302055) was selected to represent the daily variability in sediment loading in the Lower Clark Fork tributaries due to its relative proximity to the Lower Clark Fork TPA, and therefore similar climate; its similarity in flow regime to the Bull River; and the fact that it had a period of record for annual total suspended sediment (most USGS stations in the region did not have daily sediment data). Although there is some variability in size between the Bull River (represented by the Fisher River data) and other tributaries of interest in the watershed, the true size of the streams is of less concern in this case because it is the relationship between sediment load (a function of sediment concentration and flow) and the day of the year that is the primary focus for this analysis. It is assumed that the hydrologic properties and rate of loading on a given day is similar throughout the watershed, regardless of the stream, and therefore is appropriate to use for these purposes.

The mean of daily mean values for suspended sediment discharge, in tons per day, was calculated based on approximately 8 years of record (October 1, 1967 – January 31, 1976) (**Table E-1**). This period of record is the only period of record with available daily suspended sediment data. The mean annual suspended sediment load for USGS gage 12302055, based on a summation of the mean of daily mean values, is 76,399 tons per year. Although the suspended sediment load is a portion of the total load from the source assessment, it provides an approximation of the relationship between sediment and flow in the Lower Clark Fork tributaries. Using the mean of daily mean sediment loads, a daily percentage relative to the mean annual suspended sediment load was calculated for each day (**Table E-2**). **Figure E-1** visually represents the average daily percentage of the total yearly sediment load for each day of the calendar year.

To conserve resources, this appendix only provides the base data from the USGS stream gage, and the daily percentages of the total annual load. For specific streams, all daily TMDLs may be derived by using the daily percentages in **Table E-2** and the TMDLs expressed as an average annual load, which are discussed in **Section 5.6**. For instance, the total allowable annual sediment load for Marten Creek is

3689.2 tons. To determine the TMDL for January 1, this value is multiplied by 0.01% which provides a daily load for January 1st for Marten Creek of 36.9 tons. The daily loads are a composite of the allocations, but as allocations are not feasible on a daily basis, they are not contained within this appendix. If desired, daily allocations may be obtained by applying allocations provided in **Section 5.6** to the daily load.

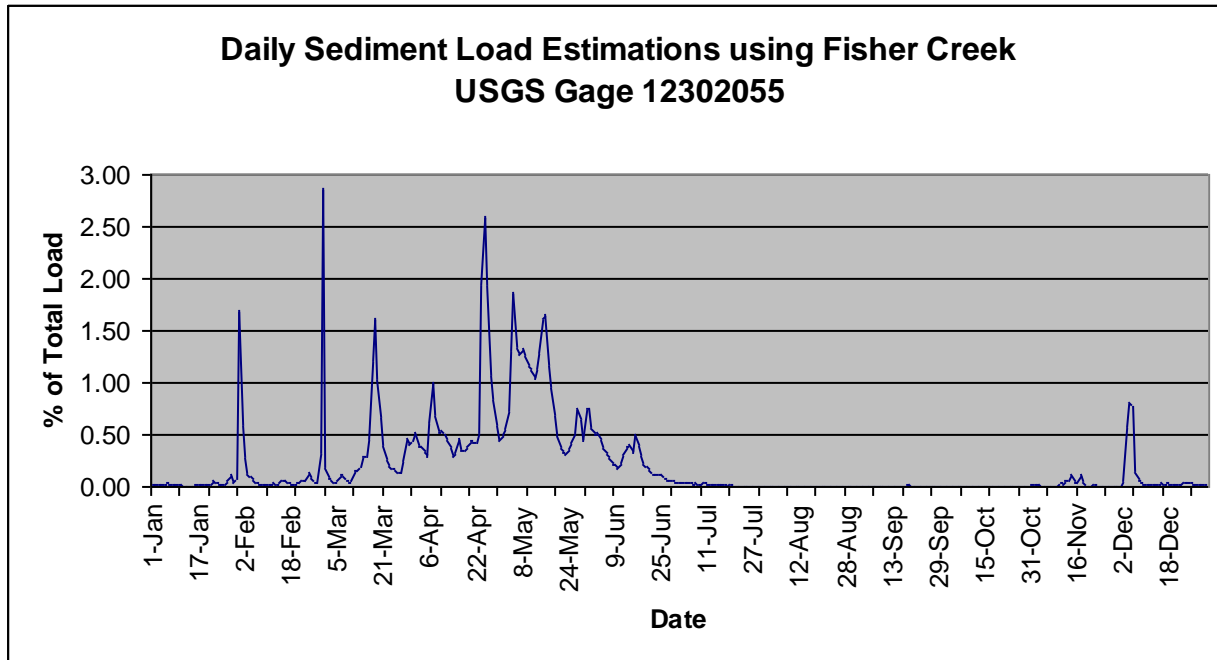


Figure E-1. Average Percentage of Total Daily Sediment Loading Throughout the Calendar Year.

The percent of total daily sediment loading from the Fisher Creek near Libby USGS gage station information in **Figure E-1** illustrates the fluctuating nature of sediment loads, driven by climate and precipitation, in many western Montana streams. In general, it appears that elevated sediment loading is linked to spring runoff, with occasional sporadic elevated loads, probably as the result of individual runoff events, mostly in winter and early spring, potentially as a result of wet spring snows with rapid melting or rain-on-snow events. (Sediment load records during January of 1974 were removed from the average calculations because these values corresponded to an extreme flood event that was not deemed representative of typical conditions in the Lower Clark Fork watershed.)

Table E-1. USGS Stream Gage 12302055 (Fisher Creek @ near Libby) - Mean of daily mean suspended sediment values for each day of record in tons/day (Calculation Period 1967-10-01 -> 1976-01-31)

| Day of Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|--------------|--------|--------|--------|--------|--------|-------|------|-----|------|-----|-------|-------|
| 1 | 12.0 | 561.9 | 164.0 | 520.0 | 490.3 | 546.5 | 45.0 | 3.2 | 2.4 | 1.1 | 15.0 | 3.8 |
| 2 | 16.1 | 267.2 | 74.4 | 385.2 | 545.0 | 492.5 | 34.0 | 3.8 | 1.5 | 1.5 | 15.6 | 50.7 |
| 3 | 21.9 | 106.2 | 64.0 | 378.3 | 712.6 | 506.5 | 38.2 | 3.4 | 2.1 | 1.4 | 9.7 | 570.5 |
| 4 | 24.0 | 99.2 | 38.0 | 322.8 | 1288.8 | 429.8 | 32.3 | 2.8 | 1.6 | 4.8 | 3.1 | 799.0 |
| 5 | 20.5 | 56.7 | 52.9 | 278.1 | 1832.8 | 358.2 | 29.1 | 2.4 | 1.6 | 5.0 | 5.2 | 755.5 |
| 6 | 28.8 | 36.9 | 123.1 | 602.9 | 1314.8 | 305.5 | 26.7 | 2.2 | 1.6 | 1.7 | 3.9 | 138.2 |
| 7 | 28.2 | 27.3 | 86.9 | 984.1 | 1258.0 | 257.5 | 28.8 | 2.8 | 1.4 | 2.0 | 2.8 | 51.4 |
| 8 | 10.8 | 26.4 | 55.0 | 659.3 | 1314.3 | 213.6 | 23.3 | 2.9 | 1.6 | 1.7 | 2.0 | 34.6 |
| 9 | 10.9 | 27.1 | 42.7 | 521.0 | 1232.8 | 206.1 | 19.4 | 3.9 | 1.5 | 1.9 | 1.2 | 28.2 |
| 10 | 11.4 | 22.3 | 61.0 | 532.5 | 1131.1 | 175.9 | 35.1 | 2.1 | 1.8 | 1.7 | 36.6 | 22.2 |
| 11 | 13.1 | 18.5 | 147.0 | 495.9 | 1098.3 | 218.2 | 22.8 | 1.9 | 2.2 | 2.2 | 26.4 | 18.7 |
| 12 | 5.5 | 30.3 | 147.6 | 440.5 | 1031.3 | 306.2 | 15.9 | 1.9 | 3.0 | 3.9 | 52.1 | 13.0 |
| 13 | 5.6 | 27.0 | 181.0 | 364.4 | 1128.1 | 383.8 | 13.5 | 2.4 | 2.8 | 4.2 | 55.9 | 21.1 |
| 14 | 6.1 | 35.9 | 283.0 | 293.1 | 1274.6 | 392.5 | 13.4 | 3.4 | 2.0 | 3.1 | 115.1 | 21.1 |
| 15 | 6.6 | 59.8 | 280.8 | 317.1 | 1592.0 | 326.9 | 11.3 | 2.7 | 1.3 | 4.2 | 40.7 | 32.5 |
| 16 | 12.7 | 50.9 | 446.2 | 457.1 | 1639.4 | 491.5 | 9.6 | 2.7 | 1.2 | 2.9 | 38.3 | 27.6 |
| 17 | 23.8 | 34.0 | 1188.8 | 348.0 | 1143.6 | 377.1 | 9.7 | 2.3 | 1.6 | 2.2 | 112.4 | 29.3 |
| 18 | 19.5 | 25.4 | 1584.1 | 338.6 | 930.1 | 275.6 | 8.0 | 2.1 | 14.2 | 1.4 | 35.2 | 20.0 |
| 19 | 20.3 | 27.6 | 1004.8 | 378.5 | 664.6 | 216.7 | 9.7 | 2.0 | 18.1 | 1.8 | 6.0 | 18.6 |
| 20 | 18.0 | 46.8 | 644.4 | 442.4 | 464.8 | 186.9 | 8.3 | 1.7 | 3.2 | 2.2 | 6.6 | 15.2 |
| 21 | 24.8 | 45.7 | 380.6 | 417.4 | 355.3 | 142.5 | 7.8 | 2.0 | 2.3 | 2.1 | 6.3 | 10.6 |
| 22 | 63.6 | 65.7 | 247.7 | 408.5 | 323.5 | 121.9 | 5.9 | 2.0 | 3.1 | 1.8 | 10.5 | 20.9 |
| 23 | 31.1 | 61.9 | 198.9 | 518.4 | 306.1 | 110.4 | 5.9 | 1.8 | 2.5 | 2.9 | 8.3 | 31.9 |
| 24 | 22.8 | 141.0 | 172.3 | 1919.9 | 367.9 | 111.7 | 4.8 | 1.9 | 3.3 | 1.8 | 4.7 | 33.4 |
| 25 | 19.3 | 82.6 | 147.9 | 2556.7 | 410.5 | 108.3 | 4.2 | 2.1 | 2.3 | 2.1 | 3.6 | 31.7 |
| 26 | 16.5 | 41.5 | 124.6 | 1895.3 | 519.8 | 82.9 | 4.1 | 2.2 | 2.5 | 4.3 | 3.8 | 18.9 |
| 27 | 55.5 | 43.5 | 128.3 | 1043.4 | 743.6 | 65.7 | 3.7 | 2.2 | 2.0 | 4.0 | 4.7 | 17.9 |
| 28 | 108.1 | 328.0 | 241.6 | 821.0 | 621.1 | 59.0 | 5.1 | 1.6 | 1.4 | 5.8 | 7.0 | 13.5 |
| 29 | 34.8 | 2816.5 | 464.5 | 567.8 | 440.3 | 52.9 | 2.5 | 1.6 | 1.4 | 6.8 | 4.5 | 15.0 |
| 30 | 73.8 | | 389.2 | 442.0 | 730.0 | 47.1 | 3.1 | 2.1 | 0.9 | 4.4 | 3.0 | 15.0 |
| 31 | 1672.8 | | 435.8 | | 745.0 | | 3.8 | 2.0 | | 9.8 | | 11.2 |

Table E-2. USGS Stream Gage 12302055 (Fisher Creek near Libby) - Percent of Mean Annual Suspended Sediment Load Based on Mean of Daily Mean Suspended Sediment Values for each Day of Record (Calculation Period 1967-10-01 -> 1976-01-31)

| Day of Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|--------------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1 | 0.01 | 0.57 | 0.17 | 0.53 | 0.50 | 0.55 | 0.05 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| 2 | 0.02 | 0.27 | 0.08 | 0.39 | 0.55 | 0.50 | 0.03 | 0.00 | 0.00 | 0.00 | 0.02 | 0.05 |
| 3 | 0.02 | 0.11 | 0.06 | 0.38 | 0.72 | 0.51 | 0.04 | 0.00 | 0.00 | 0.00 | 0.01 | 0.58 |
| 4 | 0.02 | 0.10 | 0.04 | 0.33 | 1.31 | 0.44 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.81 |
| 5 | 0.02 | 0.06 | 0.05 | 0.28 | 1.86 | 0.36 | 0.03 | 0.00 | 0.00 | 0.01 | 0.01 | 0.77 |
| 6 | 0.03 | 0.04 | 0.12 | 0.61 | 1.33 | 0.31 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 |
| 7 | 0.03 | 0.03 | 0.09 | 1.00 | 1.28 | 0.26 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 |
| 8 | 0.01 | 0.03 | 0.06 | 0.67 | 1.33 | 0.22 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| 9 | 0.01 | 0.03 | 0.04 | 0.53 | 1.25 | 0.21 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| 10 | 0.01 | 0.02 | 0.06 | 0.54 | 1.15 | 0.18 | 0.04 | 0.00 | 0.00 | 0.00 | 0.04 | 0.02 |
| 11 | 0.01 | 0.02 | 0.15 | 0.50 | 1.11 | 0.22 | 0.02 | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 |
| 12 | 0.01 | 0.03 | 0.15 | 0.45 | 1.05 | 0.31 | 0.02 | 0.00 | 0.00 | 0.00 | 0.05 | 0.01 |
| 13 | 0.01 | 0.03 | 0.18 | 0.37 | 1.14 | 0.39 | 0.01 | 0.00 | 0.00 | 0.00 | 0.06 | 0.02 |
| 14 | 0.01 | 0.04 | 0.29 | 0.30 | 1.29 | 0.40 | 0.01 | 0.00 | 0.00 | 0.00 | 0.12 | 0.02 |
| 15 | 0.01 | 0.06 | 0.28 | 0.32 | 1.61 | 0.33 | 0.01 | 0.00 | 0.00 | 0.00 | 0.04 | 0.03 |
| 16 | 0.01 | 0.05 | 0.45 | 0.46 | 1.66 | 0.50 | 0.01 | 0.00 | 0.00 | 0.00 | 0.04 | 0.03 |
| 17 | 0.02 | 0.03 | 1.21 | 0.35 | 1.16 | 0.38 | 0.01 | 0.00 | 0.00 | 0.00 | 0.11 | 0.03 |
| 18 | 0.02 | 0.03 | 1.61 | 0.34 | 0.94 | 0.28 | 0.01 | 0.00 | 0.01 | 0.00 | 0.04 | 0.02 |
| 19 | 0.02 | 0.03 | 1.02 | 0.38 | 0.67 | 0.22 | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.02 |
| 20 | 0.02 | 0.05 | 0.65 | 0.45 | 0.47 | 0.19 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 |
| 21 | 0.03 | 0.05 | 0.39 | 0.42 | 0.36 | 0.14 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| 22 | 0.06 | 0.07 | 0.25 | 0.41 | 0.33 | 0.12 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 |
| 23 | 0.03 | 0.06 | 0.20 | 0.53 | 0.31 | 0.11 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 |
| 24 | 0.02 | 0.14 | 0.17 | 1.95 | 0.37 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| 25 | 0.02 | 0.08 | 0.15 | 2.59 | 0.42 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| 26 | 0.02 | 0.04 | 0.13 | 1.92 | 0.53 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| 27 | 0.06 | 0.04 | 0.13 | 1.06 | 0.75 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| 28 | 0.11 | 0.33 | 0.25 | 0.83 | 0.63 | 0.06 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 |
| 29 | 0.04 | 2.86 | 0.47 | 0.58 | 0.45 | 0.05 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 |
| 30 | 0.07 | | 0.39 | 0.45 | 0.74 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |
| 31 | 1.70 | | 0.44 | | 0.76 | | 0.00 | 0.00 | | 0.01 | | 0.01 |