

## Appendix 6-B

### Evaluation of Peakflow Changes on Suspended Sediment Loads in Reference Sub-basin in Upper Elk River

Suspended sediment increases in harvested tributaries are correlated with increases in peak flows and peak flow volumes (Lewis 1998 and Lewis 2011). Reid et al. (2010) find that during years free of landslides, the major sediment sources appear to be from in-channel sediment sources and that peak flow increases associated with timber harvesting results in increased drainage density. Cafferata (2012) estimates the suspended sediment loads associated with peak flow increases for Mendocino coast timber harvest plans (THPs) based upon the relationship resulting from regression analysis of peak flows and associated suspended sediment loads in Caspar Creek (Equation 1.):

$$\Delta L = 100 * (1 + (\Delta Q_p) / 100)^m - 100 \quad \text{Equation 1}$$

Where,

$\Delta L$  = percent change in suspended sediment load from in-channel sources

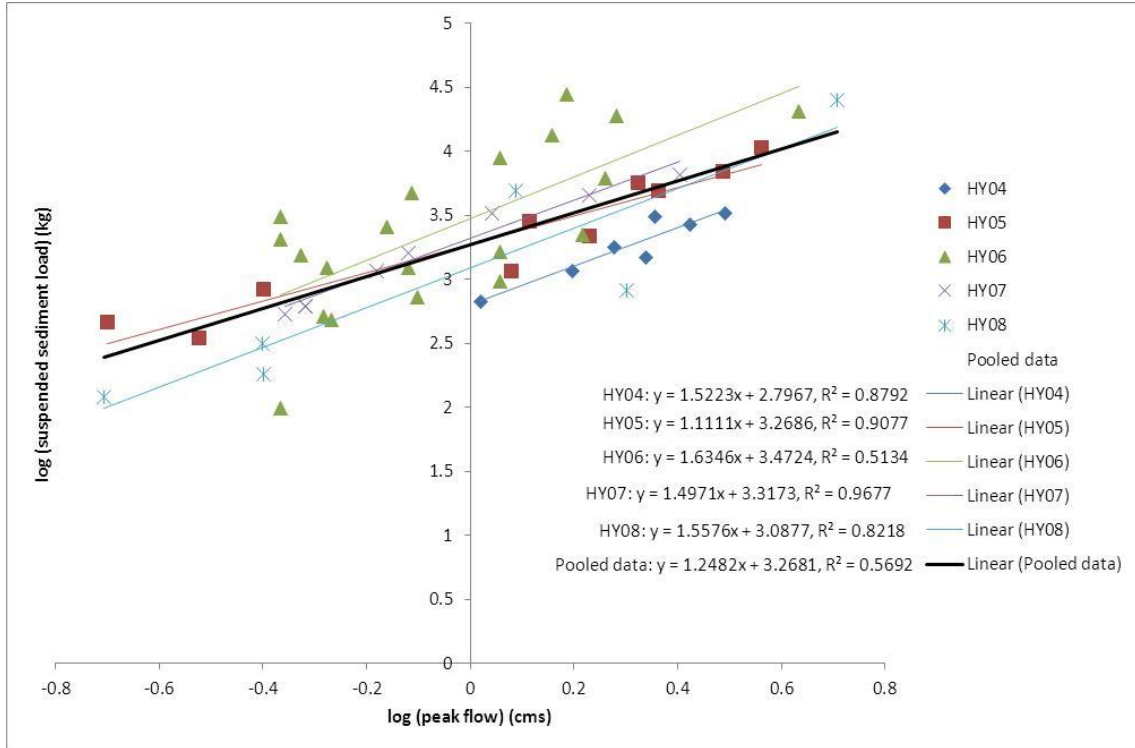
$\Delta Q_p$  = percent change in the peak flows, and

$m$  = slope of linear regression line between  $\log(L)$  and  $\log(Q)$

Equation 1 can be solved for a value of  $\Delta Q_p$  that would limit the suspended sediment load associated with peak flow increases to 120% of the natural suspended load, as per the load allocations described in Section 5.5 of the Staff Report.

In order to evaluate the influence of changes in peak flows due to canopy removal on suspended sediment loads, staff evaluated data from a reference subbasin in Upper Elk River. Using 51 storms that occurred during hydrologic years 2004-2007, staff used linear regression to estimate the slope of the line defining the relationship between a change in suspended sediment load and a change in peak flow. The data are provided in Table 1.

The resulting regression relationships are shown in Figure 1 for each of the hydrologic years evaluated, as well as for all the years pooled. In general, the relationship has a high residuals squared value, with the exception of HY 2006. Staff relied upon the pooled data to estimate the slope of the regression line in Upper Elk River to be 1.25.



**Figure 1 Regression analysis of measured Upper Little South Fork Elk River suspended sediment loads and peak flows in response to storm events for hydrologic year 2004-2005.**

Caspar Creek data indicate the slope of the regression line is 2.52 (Cafferata, 2012). The mean of the Upper Elk River relationship and that of Caspar Creek is 1.88.

For each of the slopes, staff explored how peakflows would need to be controlled in order to ensure suspended sediment loads did not exceed a 20% change over background (Figure 2). Based upon the regression relationships explored, to ensure background suspended sediment loads are not increased more than 20% as a result of peak flow changes, incremental peak flows would need to be controlled to 16% above background based upon Upper Elk River, 8% based upon Caspar Creek, and 10% based upon the mean slope.

Staff recommend relying on the mean value of Upper Elk River and Caspar Creek, as a margin of safety for the Upper Elk River data.

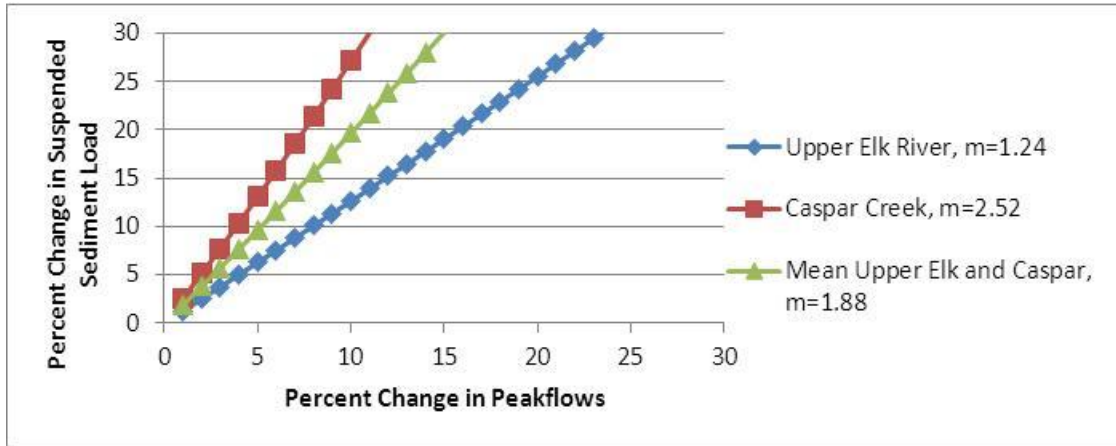


Figure 2 Predicted percent change in suspended sediment loads associated with changes in peak flows based upon the slope of linear regression lines (m) as developed in Upper Little South Fork Elk River, Caspar Creek, and the mean of the two estimates.

Appendix 6B-Evaluation of Peakflows in Conformance with Load Allocations

**Table 1. Peak flow and suspended sediment load data for peakflow events measured in Little South Fork Elk River, HY 2004-2007.**

storm	start date	start time	end date	end time	volume(m3)	peak (cms)	load (kg)	log (volume)	HY	Log (peak)	log(load)
401	12/12/2003	16:00:00	12/13/2003	21:10:00	46,667	1.049	673.21	4.669013606	2004	0.0207755	2.828151
402	12/13/2003	21:20:00	12/17/2003	0:00:00	82,184	2.18	1500.265	4.914789389	2004	0.3384565	3.176168
403	12/28/2003	20:10:00	12/31/2003	14:30:00	150,991	2.658	2712.827	5.178951637	2004	0.424555	3.433422
404	12/31/2003	14:40:00	1/5/2004	0:00:00	200,341	3.097	3310.794	5.301770271	2004	0.4909412	3.519932
405	2/16/2004	10:10:00	2/17/2004	23:20:00	156,182	2.275	3148.026	5.193632092	2004	0.3569814	3.498038
406	2/17/2004	21:30:00	2/20/2004	12:00:00	141,466	1.577	1175.432	5.150652688	2004	0.1978317	3.070198
407	2/25/2004	2:20:00	2/29/2004	0:00:00	197,087	1.898	1817.541	5.294657538	2004	0.2782962	3.259484
501	12/6/2004	9:20:00	12/7/2004	19:40:00	13,020	0.2	457.416	4.114610984	2005	-0.69897	2.660311
502	12/7/2004	19:50:00	12/11/2004	0:00:00	183,901	2.101	5705.453	5.264583146	2005	0.3224261	3.75629
503	12/30/2004	18:00:00	1/4/2005	0:00:00	295,680	2.3	4901.727	5.47082195	2005	0.3617278	3.690349
504	1/7/2005	4:00:00	1/8/2005	8:50:00	56,700	1.2	1149	4.753583059	2005	0.0791812	3.06032
505	1/8/2005	9:00:00	1/11/2005	0:00:00	168,900	1.7	2164.855	5.22762965	2005	0.2304489	3.335429
506	3/19/2005	6:40:00	3/23/2005	1:20:00	90,660	1.3	2850.949	4.957415715	2005	0.1139434	3.454989
507	3/27/2005	12:30:00	3/31/2005	12:00:00	171,041	3.0683	6938.929	5.233100227	2005	0.4868978	3.841292
508	4/6/2005	23:50:00	4/8/2005	6:50:00	26,700	0.3	348.996	4.426511261	2005	-0.522879	2.54282
509	4/8/2005	7:00:00	4/12/2005	6:00:00	204,089	3.648	10580.81	5.309819172	2005	0.5620548	4.024519
510	5/7/2005	19:20:00	5/11/2005	12:00:00	57,120	0.4	825.464	4.756788199	2005	-0.39794	2.916698
601	11/30/2005	22:50:00	12/4/2005	12:00:00	252,277	1.823	6298.211	5.401876969	2006	0.2607867	3.799217
602	12/18/2005	4:30:00	12/20/2005	6:00:00	117,306	1.14	1665.802	5.069320226	2006	0.0569049	3.221623
603	12/20/2005	6:10:00	12/21/2005	14:10:00	104,538	1.14	988.412	5.019274187	2006	0.0569049	2.994938
604	12/22/2005	7:00:00	12/24/2005	22:00:00	201,888	1.65	2264.566	5.305110506	2006	0.2174839	3.354985
605	12/28/2005	1:30:00	12/30/2005	8:30:00	174,087	4.305	21040.27	5.240766341	2006	0.6339732	4.323051
606	12/30/2005	8:40:00	1/3/2006	11:50:00	210,417	1.535	28208.33	5.323080824	2006	0.1861084	4.450377
607	1/10/2006	10:00:00	1/13/2006	14:40:00	123,006	1.14	9042.235	5.089926296	2006	0.0569049	3.956276
608	1/13/2006	14:50:00	1/17/2006	10:40:00	133,446	0.77	4772.593	5.12530556	2006	-0.113509	3.678754
609	1/17/2006	10:50:00	1/18/2006	5:50:00	23,976	0.43	100.906	4.37977673	2006	-0.366532	2.003917

Appendix 6B-Evaluation of Peakflows in Conformance with Load Allocations

storm	start date	start time	end date	end time	volume(m3)	peak (cms)	load (kg)	log (volume)	HY	Log (peak)	log(load)
610	1/18/2006	6:00:00	1/20/2006	13:00:00	90,168	0.53	1251.211	4.955052437	2006	-0.275724	3.097331
611	1/20/2006	13:10:00	1/22/2006	12:00:00	81,924	0.69	2584.068	4.913411149	2006	-0.161151	3.412304
612	1/28/2006	7:00:00	1/30/2006	4:10:00	67,608	0.79	738.556	4.829998089	2006	-0.102373	2.868383
613	1/30/2006	4:20:00	2/1/2006	1:40:00	61,116	0.54	488.713	4.786154922	2006	-0.267606	2.689054
614	2/1/2006	1:50:00	2/4/2006	0:50:00	115,278	0.76	1244.738	5.061746433	2006	-0.119186	3.095078
615	2/26/2006	19:10:00	3/1/2006	18:20:00	33,330	0.43	2069.421	4.522835314	2006	-0.366532	3.315849
616	3/1/2006	18:30:00	3/5/2006	2:00:00	69,714	0.43	3101.772	4.843320002	2006	-0.366532	3.49161
617	3/5/2006	2:10:00	3/7/2006	0:00:00	89,808	1.915	19064.89	4.953315025	2006	0.2821688	4.280234
618	3/7/2006	0:10:00	3/8/2006	20:20:00	77,919	1.435	13471.83	4.89164337	2006	0.1568519	4.129427
619	3/16/2006	8:00:00	3/18/2006	12:00:00	41,520	0.47	1552.092	4.618257345	2006	-0.327902	3.190917
620	4/15/2006	9:40:00	4/18/2006	12:00:00	68,190	0.52	519.893	4.83372069	2006	-0.283997	2.715914
701	12/13/2006	1:30:00	12/14/2006	21:00:00	47,709	0.48	629.576	4.678600314	2007	-0.318759	2.799048
702	12/25/2006	22:30:00	12/29/2006	12:00:00	111,312	1.1	3305.737	5.046541986	2007	0.0413927	3.519268
703	1/3/2007	6:10:00	1/6/2007	16:10:00	140,877	1.7	4565.736	5.148840095	2007	0.2304489	3.659511
704	2/10/2007	5:00:00	2/13/2007	12:00:00	80,838	0.66	1173.673	4.90761556	2007	-0.180456	3.069547
705	2/20/2007	14:30:00	2/24/2007	14:30:00	274,122	2.53	6696.619	5.437943892	2007	0.4031205	3.825856
706	2/24/2007	14:40:00	2/27/2007	8:00:00	114,570	0.76	1631.224	5.059070913	2007	-0.119186	3.212514
707	2/27/2007	8:10:00	3/3/2007	12:00:00	142,587	0.48	621.713	5.154079932	2007	-0.318759	2.79359
708	3/26/2007	10:00:00	3/29/2007	12:00:00	57,492	0.44	540.777	4.759607417	2007	-0.356547	2.733018
801	1/4/2008	3:20:00	1/6/2008	14:30:00	94,002	1.226	5000.436	4.97313848	2008	0.0884905	3.699008
802	1/8/2008	5:00:00	1/11/2008	12:00:00	77,580	0.4	186.132	4.889749775	2008	-0.39794	2.269821
803	1/30/2008	22:30:00	2/2/2008	4:10:00	262,481	5.091	25763.44	5.419098534	2008	0.7068031	4.411004
804	2/2/2008	4:20:00	2/6/2008	0:00:00	197,959	2	831.9805	5.29657569	2008	0.30103	2.920113
805	2/24/2008	1:00:00	2/27/2008	0:00:00	45,847	0.398	317.901	4.661309976	2008	-0.400117	2.502292
806	3/12/2008	18:50:00	3/17/2008	12:00:00	39,621	0.197	122.925	4.597922144	2008	-0.705534	2.08964