State of California

The Resources Agency

FREDERICKSON/MCGRATH
OP-216

Memorandum

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Date: May 14, 2001

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From: **Department of Forestry and Fire Protection**

MAY 16 2001

Subject: Freshwater Watershed Peak Flow Analysis

The effects of harvesting on peak flows in the Freshwater watershed are summarized in attached Tables 1 through 3b. These peak flow changes were determined using Equation 1 in Lisle et al. (2000). Factors considered in this approach are limited to canopy removal, watershed wetness, flow return periods, and number of years since harvest. Attached Tables 4 through 6b provide examples of the spreadsheets that were used for the peak flow calculations.

Canopy removal values were based on harvesting levels described in the recently approved and currently proposed PALCO Freshwater watershed THPs, as listed in Tables 1 and 2, with adjustments for different silvicultural treatments based on coefficients given in Lisle et al. (2000). Wetness values were selected to represent dry, average, and wet watershed conditions at the time a storm begins based on values suggested in Lisle et al. (2000) and data displayed in Lewis et al (in press). Selected return periods include the frequently occurring two-year flow (Table 1) and the larger 15-year event (Table 2) that is at the upper limit of data used to develop the peak flow model.

Both Table 1 and Table 2 show that the proportionate impact of canopy removal on peak flow declines as watershed wetness increases, and comparison of Table 1 with Table 2 indicates that the proportionate effect of harvesting is also reduced with increasing flow size. In addition, for both return periods, the recovery of peak flow from past harvesting approaches zero as the amount of canopy removal in 2001 exceeds 500 acres.

Tables 3a and 3b show that the peak flow model predicts some increment of recovery each year with an annual canopy removal of up to 500 acres. This trend would be expected to continue until 2012, when prior year harvesting of more than 500 acres in 1998 would be considered to have fully recovered, and then stabilizes in 2014 when all of the unrecovered prior years harvest are based on the assumed 500 acres of canopy removal. Comparison of the Tables 3a and 3b results also indicates that the relative recovery trends are similar for both the 2-year and 15-year return periods.

Overall, these results support the general conclusions that the proportionate effect of timber harvesting on peak flows declines with both increasing watershed wetness and, to a lesser extent, storm size and that canopy removal rates of up to 500 acres per year will not result in an increase in peak flow over current conditions.

References

Lisle, T., L. Reid, and R. Ziemer. 2000. Addendum: Review of Freshwater Flooding Analysis Summary. Report prepared by the USDA, Forest Service, Pacific Southwest Research Station in Arcata for the California Department of Forestry and Fire Protection, Sacramento, CA. 16 p.

Lewis, Jack, S. R. Mori, E. T. Keppeler, and R.R. Ziemer. In Press. Impacts of logging on storm peak flows, flow volumes and suspended sediment loads in Caspar Creek, California. *In:* Mark S. Wigmosta and Steven J. Burges (eds.) The Influence of Land Use on the Hydrologic-Geomorphic Responses of Watersheds. Water Resources Monograph, American Geophysical Union, Washington, D.C.

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TABLE 1: PEAK FLOWS SUMMARY FOR 2-YEAR RETURN PERIOD

Freshwater THPs Under Review in 2001							
		Silviculture System (acres)					
THP No.	Status	Clearcut	ST/SW	Selection			
1-00-069	Approval	81.0	0.0	12.0			
1-00-114	Approval	69.0	0.0	0.0			
1-00-253	Approval	60.0	0.0	2.0			
Subtotal		210.0	0.0	14.0			
1-00-106	2nd Review	81.0	0.0	5.0			
1-00-112	2nd Review	95.0	0.0	0.0			
Subtotal		386.0	0.0	19.0			
1-00-032	Filed	51.0	0.0	6.0			
1-00-085	Filed	0.5	0.7	30.1			
1-00-216	Filed	163.0	0.0	6.4			
1-00-428	Filed (est. 1/3 in Freshwater)	21.0	7.0	1.0			
Total		621.5	7.7	62.5			
Freshwater 2001 Peak Flow Changes for Proposed THPs [1]							
		Dry (WI=50)[2]		Average (WI=304)[2]		Wet (WI=400)	
		Increase	Recovery	Increase	Recovery	Increase	Recovery
Year	Harvest Level	%	%	%	%	%	%
2000	No harvest	17.48	--	6.21	--	4.52	--
2001	No harvest	15.51	2.0	5.52	0.7	4.02	0.5
2001	Approved THPs	16.30	1.2	5.80	0.4	4.22	0.3
2001	Approved + 2nd Review THPs	16.95	0.5	6.03	0.2	4.39	0.1
2001	All Submitted THPs	17.92	-0.4	6.38	-0.2	4.64	-0.1
2001	All Submitted THPs w/o No. 1-00-216	17.30	0.2	6.16	0.0	4.48	0.0
(1) Increased peak flow calculated using eq. 1 in Lisle, T., L. Reid, and R. Ziemer. 2000. Addendum: Review of Freshwater Flooding Analysis Summary.							
(2) Wetness index values for dry and average conditions from Lisle, T., L. Reid, and R. Ziemer. 2000. Addendum: to Review of Freshwater Flooding Analysis Summary.							

TABLE 2: PEAK FLOWS SUMMARY FOR 15-YEAR RETURN PERIOD

Freshwater THPs Under Review in 2001							
		Silviculture System (acres)					
THP No.	Status	Clearcut	ST/SW	Selection			
1-00-069	Approval	81.0	0.0	12.0			
1-00-114	Approval	69.0	0.0	0.0			
1-00-253	Approval	60.0	0.0	2.0			
Subtotal		210.0	0.0	14.0			
1-00-106	2nd Review	81.0	0.0	5.0			
1-00-112	2nd Review	95.0	0.0	0.0			
Subtotal		386.0	0.0	19.0			
1-00-032	Filed	51.0	0.0	6.0			
1-00-085	Filed	0.5	0.7	30.1			
1-00-216	Filed	163.0	0.0	6.4			
1-00-428	Filed (est. 1/3 in Freshwater)	21.0	7.0	1.0			
Total		621.5	7.7	62.5			

Freshwater 2001 Peak Flow Changes for Proposed THPs [1]							
		Dry (WI=50)[2]		Average (WI=304)[2]		Wet (WI=400)	
		Increase	Recovery	Increase	Recovery	Increase	Recovery
Year	Harvest Level	%	%	%	%	%	%
2000	No harvest	15.75	--	4.51	--	2.83	--
2001	No harvest	13.97	1.8	4.01	0.5	2.51	0.3
2001	Approved THPs	14.68	1.1	4.21	0.3	2.64	0.2
2001	Approved + 2nd Review THPs	15.27	0.5	4.38	0.1	2.74	0.1
2001	All Submitted THPs	16.14	-0.4	4.63	-0.1	2.90	-0.1
2001	All Submitted THPs w/o No. 1-00-216	15.59	0.2	4.47	0.0	2.80	0.0

(1) Increased peak flow calculated using eq. 1 in Lisle, T., L. Reid, and R. Ziemer. 2000. Addendum: Review of Freshwater Flooding Analysis Summary.

(2) Wetness index values for dry and average conditions from Lisle, T., L. Reid, and R. Ziemer. 2000. Addendum: to Review of Freshwater Flooding Analysis Summary.

TABLE 3: PEAK FLOW EFFECTS OF 500 ACRES PER YEAR CANOPY REMOVAL

3a: 2-Year Return Period and Average Watershed Wetness

Year	Equivalent Canopy Loss (ac)	Peak Flow Increase (%)	Annual Peak Flow Recovery (%)	Cumulative Peak Flow Recovery [1] (%)	Cumulative Relative Recovery [2] (%)
2000	0	6.21	--	--	--
2001	500	6.17	0.04	0.04	0.6
2002	500	6.08	0.09	0.13	2.1
2003	500	5.97	0.11	0.24	3.9
2004	500	5.84	0.13	0.37	6.0
2005	500	5.69	0.15	0.52	8.4
2014	500	4.76	--	1.45	23.3

3b: 15-Year Return Period and Average Watershed Wetness

Year	Equivalent Canopy Loss (ac)	Peak Flow Increase (%)	Annual Peak Flow Recovery (%)	Cumulative Peak Flow Recovery [1] (%)	Cumulative Relative Recovery [2] (%)
2000	0	4.51	--	--	--
2001	500	4.48	0.03	0.03	0.7
2002	500	4.42	0.06	0.09	2.0
2003	500	4.34	0.08	0.17	3.8
2004	500	4.25	0.09	0.26	5.8
2005	500	4.13	0.12	0.38	8.4
2014	500	3.54	--	0.97	21.5

(1) Cumulative Peak Flow Recovery = Cumulative sum of percent Annual Peak Flow Recovery.

(2) Cumulative Relative Recovery = Percent Cumulative Peak Flow Recovery relative to year 2000 Peak Flow Increase.

TABLE 4: 2001 PEAK FLOW CALCULATIONS FOR 2-YEAR RETURN PERIOD
(Assuming Average Wetness and all filed THPs except 1-00-216)

Recurrance Interval (yrs)			2					
Index Logging Year			2001					
Logging Recovery Coef. (B2)			-0.0771					
Constant (B4)			1.1030					
Storm Size Coef. (B5)			-0.0963					
Watershed Wetness Coef. (B6)			-0.2343					
Watershed Wetness Index (w)			304					
Control Peak Flow (ynfc)			0.0091					
Expected Control Pk. Flow (yc)			0.0073					
					Proportion	Summers	Observed/	Annual
	Clearcut	ST/SW	Selection	Canopy	Wtrshd.	Since	Expected	Peak Flow
	Equiv.	Equiv.	Equiv.	Equiv.	Logged	Logged	Peak Flow	Change
Year	(ac.)	(ac.)	(ac.)	(ac.)	(c)	(t)	Ratio	(%)
1988					0.0054	13	1.00010	0.010
1989				436.8	0.02219	12	1.00080	0.080
1990				134.0	0.00681	11	1.00037	0.037
1991				182.0	0.00925	10	1.00067	0.067
1992				806.3	0.04096	9	1.00373	0.373
1993				319.3	0.01622	8	1.00177	0.177
1994				90.0	0.00457	7	1.00058	0.058
1995				587.3	0.02983	6	1.00436	0.436
1996				2171.0	0.11028	5	1.01825	1.825
1997				1357.8	0.06897	4	1.01265	1.265
1998				867.4	0.04406	3	1.00888	0.888
1999	94.0	0.0	353.0	270.5	0.01374	2	1.00301	0.301
2000	0.0	0.0	0.0	0.0	0.00000	1	1.00000	0.000
2001	458.5	7.7	56.1	492.3	0.02501	0	1.00641	0.641
Sum								6.157

TABLE 5: 2001 PEAK FLOW CALCULATIONS FOR 15-YEAR RETURN PERIOD
(Assuming Average Wetness and all filed THPs except 1-00-216)

Recurrance Interval (yrs)			15					
Index Logging Year			2001					
Logging Recovery Coef. (B2)			-0.0771					
Constant (B4)			1.1030					
Storm Size Coef. (B5)			-0.0963					
Watershed Wetness Coef. (B6)			-0.2343					
Watershed Wetness Index (w)			304					
Control Peak Flow (ynfc)			0.0172					
Expected Control Pk. Flow (yc)			0.0143					
					Proportion	Summers	Observed/	Annual
	Clearcut	**ST/SW**	**Selection**	Canopy	Wtrshd.	Since	Expected	Peak Flow
	Equiv.	**Equiv.**	**Equiv.**	Equiv.	Logged	Logged	Peak Flow	Change
Year	**(ac.)**	**(ac.)**	**(ac.)**	(ac.)	(c)	(t)	Ratio	(%)
1988					0.0054	13	1.00007	0.007
1989				436.8	0.02219	12	1.00058	0.058
1990				134.0	0.00681	11	1.00027	0.027
1991				182.0	0.00925	10	1.00049	0.049
1992				806.3	0.04096	9	1.00271	0.271
1993				319.3	0.01622	8	1.00129	0.129
1994				90.0	0.00457	7	1.00042	0.042
1995				587.3	0.02983	6	1.00317	0.317
1996				2171.0	0.11028	5	1.01324	1.324
1997				1357.8	0.06897	4	1.00919	0.919
1998				867.4	0.04406	3	1.00645	0.645
1999	94.0	0.0	353.0	270.5	0.01374	2	1.00219	0.219
2000	0.0	0.0	0.0	0.0	0.00000	1	1.00000	0.000
2001	458.5	7.7	56.1	492.3	0.02501	0	1.00466	0.466
Sum								4.473

TABLE 6a: 2005 PEAK FLOW CALCULATION FOR 500 ACRES PER YEAR CANOPY REMOVAL
(Assuming Average Wetness and 2-Year Return Period)

Recurrance Interval (yrs)			2					
Index Logging Year			2005					
Logging Recovery Coef. (B2)			-0.0771					
Constant (B4)			1.1030					
Storm Size Coef. (B5)			-0.0963					
Watershed Wetness Coef. (B6)			-0.2343					
Watershed Wetness Index (w)			304					
Control Peak Flow (ynfc)			0.0091					
Expected Control Pk. Flow (yc)			0.0073					
					Proportion	Summers	Observed/	Annual
	Clearcut	ST/SW	Selection	Canopy	Wtrshd.	Since	Expected	Peak Flow
	Equiv.	Equiv.	Equiv.	Equiv.	Logged	Logged	Peak Flow	Change
Year	(ac.)	(ac.)	(ac.)	(ac.)	(c)	(t)	Ratio	(%)
1992				806.3	0.04096	13	1.00073	0.073
1993				319.3	0.01622	12	1.00058	0.058
1994				90.0	0.00457	11	1.00025	0.025
1995				587.3	0.02983	10	1.00217	0.217
1996				2171.0	0.11028	9	1.01007	1.007
1997				1357.8	0.06897	8	1.00756	0.756
1998				867.4	0.04406	7	1.00563	0.563
1999	94.0	0.0	353.0	270.5	0.01374	6	1.00200	0.200
2000	0.0	0.0	0.0	0.0	0.00000	5	1.00000	0.000
2001	500.0			500.0	0.02540	4	1.00464	0.464
2002	500.0			500.0	0.02540	3	1.00511	0.511
2003	500.0			500.0	0.02540	2	1.00557	0.557
2004	500.0			500.0	0.02540	1	1.00604	0.604
2005	500.0			500.0	0.02540	0	1.00651	0.651
Sum								5.686

TABLE 6b: 2005 PEAK FLOW CALCULATION FOR 500 ACRES PER YEAR CANOPY REMOVAL
(Assuming Average Wetness and 15-Year Return Period)

Recurrance Interval (yrs)			15					
Index Logging Year			2005					
Logging Recovery Coef. (B2)			-0.0771					
Constant (B4)			1.1030					
Storm Size Coef. (B5)			-0.0963					
Watershed Wetness Coef. (B6)			-0.2343					
Watershed Wetness Index (w)			304					
Control Peak Flow (ynfc)			0.0172					
Expected Control Pk. Flow (yc)			0.0143					
					Proportion	Summers	Observed/	Annual
	Clearcut	ST/SW	Selection	Canopy	Wtrshd.	Since	Expected	Peak Flow
	Equiv.	Equiv.	Equiv.	Equiv.	Logged	Logged	Peak Flow	Change
Year	(ac.)	(ac.)	(ac.)	(ac.)	(c)	(t)	Ratio	(%)
1992				806.3	0.04096	13	1.00053	0.053
1993				319.3	0.01622	12	1.00043	0.043
1994				90.0	0.00457	11	1.00018	0.018
1995				587.3	0.02983	10	1.00158	0.158
1996				2171.0	0.11028	9	1.00732	0.732
1997				1357.8	0.06897	8	1.00549	0.549
1998				867.4	0.04406	7	1.00409	0.409
1999	94.0	0.0	353.0	270.5	0.01374	6	1.00146	0.146
2000	0.0	0.0	0.0	0.0	0.00000	5	1.00000	0.000
2001	500.0			500.0	0.02540	4	1.00337	0.337
2002	500.0			500.0	0.02540	3	1.00371	0.371
2003	500.0			500.0	0.02540	2	1.00405	0.405
2004	500.0			500.0	0.02540	1	1.00439	0.439
2005	500.0			500.0	0.02540	0	1.00473	0.473
Sum								4.133