APPENDIX D

CUMULATIVE OFF SITE WATERSHED EFFECTS ANALYSIS METHODOLOGY

Equivalent Roaded Area (ERA) Method and Disturbance Coefficients

When utilizing the ERA model, all landscape disturbances are evaluated in comparison to a completely impervious or roaded surface. Road surfaces are considered to represent maximum hydrologic disturbance and rainfall-runoff potential. Other ground-disturbing activities assessed in the Sugarberry Project cumulative off-site watershed effects (CWE) analysis area include timber harvest and related silvicultural treatments on private and public lands, residential development, mines, wildfire, prescribed burning, and off-highway vehicle (OHV) trails. These components are assigned disturbance coefficients that represent a typical ratio of their hydrologic impact compared to the same roaded area. Disturbance coefficients are assigned based on local conditions. The Plumas National Forest has assigned coefficients based on local estimates of the hydrologic impact of land management activities and wildland fire (Table 1). In applying the ERA method, all known disturbances within the subwatersheds where management activities are proposed are cataloged and included in the ERA summation. It is assumed that all proposed and future foreseeable activities without a well-determined implementation date would occur in the same year as the analysis. This represents a conservative assumption in terms of the immediate impact of these activities on the landscape.

Recovery Coefficients

The response of landscapes to disturbances is influenced by climate, physiographic, geologic and ecologic conditions. Therefore, recovery coefficients are assigned based on local conditions. On the Feather River Ranger District, twenty-five years is used as the average recovery period for disturbed sites. The western slope of the Sierra Nevada in the Plumas National Forest area has a high rate of vegetative establishment and growth, due to high annual precipitation quantities and the presence of highly productive forest soils. Therefore, within a twenty-five year period, vegetation generally has sufficient opportunity to reestablish canopy closure, provide interception of rainfall energy, provide soil cover from needle cast and other organic debris-fall, and to add organic material to the soil to moderate soil erosion. Roots have reoccupied the soil mantle and most effects from compaction have been negated except along established roadways. A twenty-five year linear recovery curve has been incorporated into the analysis, reducing the calculated site disturbance with time. This curve represents a 4% annual linear recovery trend, and assumes

Table 1: Disturbance Coefficients for the Plumas National Forest

Harvest Activities:	
Clear Cut, Rehabilitation, Group Selection, Shelterwood, and Seed Tree (Group Selection coefficients divided by 5 to 10 to account for groups distributed across the prescribed area):	
Tractor Pile	0.35
Tractor Yard w/ Broadcast Burn	0.30
Grapple Pile	0.30
Skyline w/ low burn intensity	0.20
Skyline w/ high burn intensity	0.25
Skylines w/ no burn	0.15
Helicopter w/ low burn intensity	0.10
Helicopter w/ high burn intensity	0.15
Helicopter w/ no burn	0.08
Leave Tree, Multi-Product Thinning, Pre commercial Thinning, Individual Tree Selection, Transition and Biomass Removal:	
Tractor (hand pile and burn)*	0.10 – 0.20
Tractor (hand pile and burn) w/ heavy removal	0.25
Skyline*	0.05 – 0.15
Helicopter*	0.02 – 0.05
** Smaller coefficients are for ITS with open canopies and larger coefficient is for ITS with closed canopies and for older sales*	
Salvage and Sanitation:	
Range 0.05 to 0.3, use criteria similar to ITS	
Non-Harvest Activities:	
Hand Cut Tractor Pile:	0.15
Hand Cut Pile Burn:	0.01
Wildland Fire:	
High Intensity Burn	0.20
Moderate Intensity Burn	0.15
Low Intensity Burn	0.05
Note: If there is an underburn, coefficient is equivalent to a low intensity burn *If salvage includes an underburn, add underburn coefficient to salvage coefficient* *Broadcast burn is equivalent to a moderate intensity burn*	
New treatments with burn piles *(range depends on piles/acre and methods)*	0.02 to 0.05
Mastication with or without pruning:	
On slopes less than 25%	0.05
On slopes greater than 25%	0.10
Grapple Pile and Grapple Pull:	0.1
Grazing Public and Private Lands:	
If lands have not been grazed recently and/or recovering, do not give it an ERA	
Healthy	0 – 0.10
At risk	0.10 – 0.20
Unhealthy (bare ground)	0.20 – 0.30
(Consider soil and vegetation cover for health of meadows)	
Roads, Private Landings, Parking Lots, Mines, and Quarries:	1.0
Powerline Cuts:	0.3

Urbanization (based on county land use codes and photo-interpretation):	
Industrial	0.7
Public Facilities	0.5
Highway Commercial	0.5
Rural Commercial	0.2
Single Family Residence/Mobile Home Park (< 0.5-acre lots)	0.5
Single Family Residence (1-10 acres)	0.2
Recreational Facility	0.1 – 0.5
Residential Agriculture (20-80 acres)	0.05 – 0.1
Summer Camps	0.2

complete hydrologic recovery due to vegetative reestablishment in twenty-five years following the last major disturbance. The recovery coefficient is applied to vegetation management activities; it does not apply to land disturbance that does not naturally recover without active restoration and revegetation, such as roads, mines, hydroelectric infrastructure and urban development. Burned areas typically recover faster than areas of timber harvest – a five-year recovery period is applied to wildland fire, except in areas of very high burn severity. The recovery coefficient for vegetation management was calculated using the following equation (the year of project implementation was assumed to be 2008):

$$\text{Recovery coefficient} = [25 - (2008 - \text{date of activity})] \div 25.$$

Existing Condition ERA

Subwatersheds were delineated with areas between 500 and 2,500 acres, as recommended in the Region 5 CWE methodology (USDA Forest Service 1990). The area of each subwatershed in acres is displayed in Table 1 of the Sugarberry Hydrology Report. The delineations are based on Hydrologic Unit Code (HUC)-6 watershed boundaries, Herger-Feinstein Quincy Library Group (HFQLG) watershed boundaries, and topography. The HUC-6 watershed and HFQLG watershed GIS layers are located in the Plumas National Forest Geographic Information System (GIS) Library and are available upon request. Subwatersheds along the main stem channels of Slate and Canyon Creeks are composite watersheds that include numerous small interfluvial drainages. They were divided into sections based on prominent internal drainage divisions to achieve the recommended subwatershed area. The locations of each subwatershed with respect to the proposed treatments are displayed in Figure 1 of the Sugarberry Hydrology Report.

A Riparian Habitat Conservation Area (RHCA) layer was then delineated, in order to define near-stream sensitive areas for the CWE analysis. Streams derived from the Plumas National Forest corporate stream coverage were checked and added to using stream location data from topographic maps, private land Timber Harvest Plans (THPs), and aerial photos. The Plumas National Forest stream layer frequently overestimates the extent of 1st-order headwater tributary

streams, because many topographic map crenulations were delineated as streams that do not pass field criteria for stream channels, i.e. they do not display definable channels and annual scour. While some editing of the Sugarberry stream layer was performed based on this premise, it is assumed that the layer still overestimates the extent of the 1st-order channel network.

To define the extent of RHCAs, streamlines were buffered using HFQLG (SAT) guidelines for RHCA widths. Polygons were created as follows:

- Fish-bearing streams were buffered 300 feet from each side of the stream;
- Non-fish-bearing streams were buffered 150 feet from each side of stream;
- 1st order stream channels assumed to lack annual scour were buffered 50 feet from each side of the stream;
- Lakes, meadows, and springs were buffered 150 feet around polygon edges; and
- The extent of known landslide-prone areas was added to the layer.

All RHCA polygons were combined to form a near-stream sensitive area layer. Ephemeral swales (1st-order channels lacking annual scour) were not included in the near-stream sensitive area layer. Ephemeral swales are not defined as RHCAs under SAT guidelines.

The near-stream sensitive area layer was unioned with the subwatershed layer. Sensitive areas were labeled with the letter A, and non-sensitive areas were labeled with the letter B. This was done to calculate near-stream sensitive area ERA and total subwatershed ERA. HFQLG monitoring requires the reporting of both of these numbers. Since the stream coverage overestimates the extent of many stream channels, near-stream sensitive area ERA is likely over-reported within the analysis area.

To calculate existing condition ERA, the subwatershed and near-stream sensitive area layers were intersected with GIS layers representing the extent of the existing landscape disturbances listed above. The existing condition ERA values were derived by summing the ERA of past ground-disturbing activities within the analysis area, and calculating their distribution by subwatershed. Then the ERA of each disturbance was calculated using the following equation:

ERA = (Acres of treatment) x (Disturbance coefficient) x (Recovery coefficient).

The datasets and methods for ERA calculation are described below.

Meadows – Riparian Areas and Grazing ERAs:

Meadows are mapped and evaluated for several purposes relevant to the Sugarberry Project CWE analysis. Meadows that are actively grazed, or are within grazing allotments that have been grazed within the past five years are assigned an ERA based on their condition. Meadow condition as affected by grazing is related to surface disturbance by grazing animals and their effects on meadow hydrologic function. Little grazing activity is evident in the Sugarberry CWE analysis area on private lands, and no active grazing allotments are present in the analysis area on federal lands. Therefore, no grazing disturbance was calculated for the Sugarberry CWE analysis.

Meadows are considered riparian areas, and all meadows within the Sugarberry CWE analysis area were included in the near-stream sensitive areas (equivalent to RHCAs) on both Plumas National Forest and private lands within the analysis area.

Plumas National Forest meadows were digitized based existing information, photo-interpretation and new field data. The existing data consisted of meadows plotted onto 7.5-minute topographic maps based on interpretation of 1:15,840-scale color aerial photography and field knowledge. These data were later transferred to a GIS layer by heads-up digitizing, and corrections to meadow locations were made based on the additional photo-interpretation. These corrections helped reduce limitations of this layer included data gaps and incorrect locations of some meadows

Roads:

This layer is based largely on existing information. For National Forest system roads, the Plumas National Forest corporate transportation layer clipped to the analysis area was used as the base layer. County and private roads were added from the Yuba county road layer from private THP transportation maps. All road locations were verified using color aerial photography or digital orthoquads (DOQs). Surveyed locations of user-created Off Highway Vehicle (OHV) routes were also included, with widths assigned based on the type of vehicle use. Un-recovered landings on private land were also included in this layer, because they impact the land to the same degree as roads. Landing locations were derived in the same manner as newly added roads.

Limitations to this layer include a probable underestimate of road network length and errors in the digitized position of many features in the corporate layer. The location or existence of

many unclassified roads (also known as legacy or "ghost" roads) is unknown, and they consequently do not appear in the layer. Also, un-recovered landings on National Forest System lands, skid trails and temporary roads have similar impacts to roads, but those locations are not known or not digitized.

A 12.5-foot buffer was applied to all roads, which is based on 25-foot average road width. Acreage was calculated based on buffered areas. ERA was derived directly from the road acreage, since the road disturbance coefficient is equal to 1.0. A recovery coefficient was not used, because road surfaces do not recover normal hydrologic function unless they are rehabilitated.

Plumas National Forest Past Timber Harvest Activities:

The records of past timber harvest activities on National Forest System lands within the analysis area were initially extracted from the Plumas National Forest Stand Record System (SRS) database and accompanying GIS layer, and the updated version of those data in the FACTS database. Data gaps were present in these databases for harvest and site preparation activities for many treatment units. The data were subsequently supplemented by examining hard-copy stand record cards for the units in question, and referring to maps of past timber sales for cross-reference where necessary and available. While doing so, numerous stand records which had not been entered in the SRS database and GIS layer were discovered. These units were added to the digital layer for the analysis. Additional units not found in any of these information sources but visible on aerial photography were digitized and assigned disturbance coefficients based on the estimated age and nature of the activity that occurred. The most recent major ground disturbing activity in a unit and the year of the activity were used for the ERA calculations. A list of past Plumas National Forest harvest activities is located in Appendix E, and a list of future foreseeable activities is included in Appendix F.

Limitations to this layer include additional data gaps in the SRS and FACTS databases and incomplete accomplishment records on the stand record cards.

Private Land Past Timber Harvest Activities:

Timber harvest activities on private timberlands within the analysis area were inventoried by examining timber harvest plan (THP) maps and documents, supplemented by photo-interpretation. THP maps dating back ten years are available from the California Division of Forestry (CDF). The plan maps are available in digital format from CDF for Yuba County;

Plumas and Sierra County THPs are not yet available in digital form from the State. Plans for the years 1995-2004 in Plumas and Sierra Counties were requested from the CDF office in Redding, California, and copies of the appropriate plan accomplishment maps and reports were made. The areas of private harvest activities and the years that harvest was accomplished were entered into a GIS database. Disturbance coefficients were assigned using the closest equivalents in the Plumas National Forest ERA classification. Areas of alternative prescriptions with no close equivalents in the Plumas National Forest classification were assigned coefficients based on photo-interpretation and judgment. Areas where group selection was prescribed included large areas from which scattered groups would be harvested - the disturbance coefficient for group selection was reduced to account for the scattered distribution of harvest areas within the unit boundaries.

To account for past harvest activities older than 10 years, stand areas and activity types were photo-interpreted. The years that activities were performed were estimated based on the apparent recovery visible on the aerial photography. Harvest activities for photo-interpreted stands were classified using a simplified version of the Plumas National Forest ERA classification. Harvest areas most closely resembling clear cuts were assigned the clear cut disturbance coefficient of 0.35 or 0.25, depending whether the unit was tractor- or cable-yarded. Yarding methods were interpreted based on slope gradient and visible evidence of activities, such as landings, skid trails, and cable patterns. Harvest areas most closely resembling select cuts were assigned a select harvest disturbance coefficient of 0.2 for tractor yarding and 0.15 for cable yarding. The definition of select cut for the private timberland photo-interpretation included broad areas where multiple or extensive entries appear to have occurred, but the canopy cover appears more dense compared to areas where clear cut, seed tree or shelterwood prescriptions were applied. A list of known past private land harvest activities is included in Appendix E, and a list of foreseeable future activities is included in Appendix F. The list of future foreseeable activities is based on THPs filed but without completion reports, where the period allowed for completion (five years following filing of the THP) has not yet expired.

Limitations to the private harvest layer include incomplete final accomplishment records for some THPs, absence of documented harvest records prior to 1995, and limited information regarding site preparation activities. Where site preparation was indicated in a THP, Plumas National Forest site preparation ERA values were assigned.

Wildland Fire:

The PNF wildland fire coverage was queried for the presence of burned areas within the analysis area. No large fires have occurred within the Sugarberry CWE analysis area within the recent past, and so therefore no wildland fire ERA values were assigned.

Urbanized Areas:

ERA values for urbanization were assigned based on the Yuba, Plumas and Sierra County parcel and zoning layers. Digital parcel and zoning data was acquired from the county GIS departments or was available online, and disturbance coefficients were assigned based on the relative amount of land disturbance typical of various land uses. These values are displayed in Table 1. These values were adapted from urban interface disturbance coefficients developed by the Eldorado National Forest.

Mines:

As noted in the Sugarberry Hydrology Report, many areas where historic hydraulic mining occurred are present within the Sugarberry CWE analysis area. These areas are starkly evident on aerial photos; many have experienced little vegetative or hydrologic recovery since they were mined 100 or more years ago. A Tahoe National Forest hydrologist recommended a disturbance coefficient of approximately 0.5 for these features (Biddinger, pers. comm.2006 Aerial photo interpretation and site visits indicated varying degrees of revegetation and canopy cover to be present. Consequently, disturbance coefficients ranging from 0.3 to 0.7 were applied to these features. The extent of the features was photo-interpreted and they were digitized into a GIS database.

Project-Related Disturbance

Defensible Fuel Profile Zone (DFPZ) and Individual Tree Selection (ITS) Treatments:

The district silviculturist and the GIS specialist created the GIS layer for proposed treatments, based on the proposed layout of treatment units. ERA was calculated by multiplying the total proposed acres of treatment by the corresponding disturbance coefficients.

Group Selection Treatments:

The district silviculturist and GIS specialist created this layer, based on the proposed layout of treatment units. Proposed group selection units were assumed to be 1.5 acres in size, which is the average area of an individual group. An estimate was made of the percent area of each unit available for group selection that would actually be included in harvest groups. This percentage ranges from 5 to 20 percent of the unit polygon. ERA was calculated by multiplying this percent estimate by the unit area in acres by the corresponding disturbance coefficient for the prescribed harvest method (tractor, cable or helicopter).

Transportation Improvements:

Road decommissioning was included in the ERA calculation as a credit. Road closure was not included. When a road is closed, the roadbed remains and continues to hydrologically impact the watershed. Also, drainage conditions on closed roadbeds are likely to deteriorate, because no road improvements or maintenance would occur. To calculate post-project road ERA values this equation used was:

ERA = [(Existing road acres) – (Decommissioned road acres)].

The ERA credit for road decommissioning is based on the assumption that decommissioned roads will be entirely obliterated, slopes re-contoured to original slope topography, including the removal of all artificial fill, and that all drainage will be restored to original channel location, form and function.

Post-Project ERA of Watersheds:

Post-treatment ERA values were calculated as if all proposed activities would occur in 2008. Consequently, total ERA values for the first post-project year will be somewhat over-estimated, because treatments will actually occur over a several-year time span. The method for calculating post-harvest ERA is similar to that used for existing condition. Each post-harvest activity layer was intersected with the unioned watershed layer, and the resulting ERA totals were added to the existing condition ERA totals to calculate the total watershed ERA following proposed treatments for both action alternatives.

Reasonable Foreseeable Future Actions:

Proposed activities in the CWE analysis area with a well-defined implementation date were included in the final cumulative effects evaluation. The ERA totals for these disturbances were calculated in the same manner as were those for the proposed Sugarberry project activities. If the foreseeable action's implementation date was equal to or later than the proposed Sugarberry implementation date of 2008, no recovery coefficient was assigned. Disturbance from these future foreseeable actions was calculated and included in the cumulative effects evaluation. For those future foreseeable actions that would occur simultaneous with or after the proposed Sugarberry project, the assumed Sugarberry implementation year of 2008 was assigned. This represents a conservative assumption in terms of the combined immediate impact of these activities on the landscape. A list of future foreseeable actions is included in Appendix F.

Threshold of Concern (TOC)

Watershed sensitivity is an estimate of a watershed's natural ability to tolerate land use impacts without increasing the risk of cumulative impacts to unacceptably high levels. Measures used to evaluate watershed sensitivity for individual watersheds included the potential for 1) soil erosion, 2) high intensity and/or long duration precipitation events, including rain-on-snow, 3) landslides and debris flows and 4) channel erosion within alluvial stream channels.

Watershed response to elevated levels of ground disturbance may begin to negatively impact downstream channel stability and water quality. To describe the level of disturbance when such impacts may begin to occur, upper estimates of watershed "tolerance" to land use may be established based on basin-specific experience, comparison with similar basins, and modeling of watershed response. These indices of tolerable levels of disturbance are called thresholds of concern (TOC). The tolerance of a watershed is used to determine acceptable levels of disturbance and prescribe mitigation measures to prevent detrimental responses. The TOC does not represent an exact level of disturbance above which cumulative watershed effects will occur. Rather, it serves as a "yellow flag" indicator of increased risk of significant adverse cumulative effects occurring within a watershed.

Currently the Plumas National Forest uses TOC values that range from 10 to 14 percent. A range is appropriate and is determined by the overall watershed sensitivity. Sensitivity Ratings for HFQLG watersheds were calculated for the HFQLG Final Environmental Impact Statement (USDA Forest Service 1999), and are listed in Table 2 of Appendix N of that document. These sensitivity ratings were used to determine TOC values for the subwatersheds located in the

corresponding HFQLG watersheds. The sensitivity ratings were assigned to rating categories of low (< 8), moderate (7.5-12.5), and high (>12.5). Table 2 below displays the relationship between Sensitivity Ratings and TOC. This relationship is estimated by observations and research conducted on the Plumas National Forest and is subject to change as more site-specific information is developed. It is a requirement for HFQLG monitoring that near-stream sensitive areas are distinguished and analyzed independently for risk of adverse CWEs. These sensitive areas are assigned a lower TOC, indicative of greater sensitivity to disturbance than the watershed as a whole. The Plumas National Forest uses TOC values of five to six percent for near-stream senstive areas, described in the tables in the HFQLG FEIS and the Sugarberry Hydrology report as Area A. Table 3 below lists the sensitivity rating, rating factor, and TOC value of the HFQLG watersheds located in the analysis area.

Table 2: Relationship Between Sensitivity Rating and Threshold of Concern (Taylor, 2002)

Sensitivity Rating	Threshold of Concern (Percent ERA)
Low	14-16
Moderate	12-14
High	10-12

Table 3: Sensitivity Ratings of HFQLG Watersheds Located In the Project Area

HFQLG Number	HFQLG Sensitivity Rating	Sensitivity Rating Factors	TOC as Percent of Entire Watershed	TOC as Percent of Area A
110019	9	Moderate	14	6
110020	10	Moderate	13	6
110021	10	Moderate	13	6
110022	12	Moderate	12	6
110023	10	Moderate	13	6
110024	10	Moderate	13	6
110040	11	Moderate	13	6
110041	11	Moderate	13	6
110042	12	Moderate	12	6
110043	9	Moderate	14	6

For subwatersheds that are not located within an HFQLG watershed, it was assumed that these subwatersheds have similar sensitivity ratings and the same TOC as the neighboring HFQLG Watersheds.

The calculated ERA values for existing condition, for the proposed action, and for the alternative action were compared to TOC values. These comparisons were established 1) near-stream; 2) on a subwatershed scale; and 3) for the entire analysis area. The risk of cumulative

effects is generally reported at a subwatershed scale in order to categorize the distribution of potential effects across the landscape, and to determine the potential impacts to off-site stream and riparian resources at the level of the second-to third-order channel, where such effects tend to concentrate.

The results of these comparisons are reported as percent disturbed and percent of TOC for each subwatershed. Percent disturbance is calculated by dividing total ERA for the subwatershed by the total subwatershed acres, and multiplying the result by 100 to report the proportion as a percentage. This number represents the percent of acres disturbed in the watershed, and is required to be reported for HFQLG monitoring. The percentage of TOC is calculated by the following equation:

$$\text{Percent TOC} = [\text{ERA} \div (\text{acres of watershed} \times \text{TOC})] \times 100$$

If this number is less than 100% than the watershed disturbance is under threshold of concern, and if it is over 100% then it exceeds threshold of concern. This number provides a simple ratio of watershed condition compared to unit value equivalent to the TOC. This number is required to be reported for HFQLG monitoring.