Draft Report to Sonoma County Agricultural Commissioner
Review of Erosion and Sediment Control Policies for Vineyard and Orchard Developments with Tree Removal
Recommendations for Revisions to Chapter 11 and Best Management Practices for Agricultural Erosion and Sediment Control

1. Executive Summary

Vineyard and orchard site development requires earthwork activities and the removal of existing vegetation. Converting hillsides into vineyards and orchards has the potential to result in soil loss through an increase in sheet, rill, and gully erosion[1] and can trigger an increase in slope instability. Soil is the connection between the air and the rock below and maintaining soil in good condition is integral to sustainable vineyard lands[2]. In Sonoma County, soil loss prevention and sediment control from vineyard and orchard site development is governed by Chapter 11 of the Sonoma County Code.

Soil erosion generally occurs through the action of wind, rainfall and flowing water as well as the downslope movement of land under the force of gravity. Sedimentation is the movement and deposition of eroded soil into lowlands and water ways. Erosion rates are primarily a function of rainfall intensity, soil type, slope configuration, and vegetative cover. Surficial erosion of soils is reduced by vegetation (canopy and ground cover) and conservation practices. Densely forested lands with thick ground cover have at least a thousand times less soil erosion than mechanically prepared bare ground. The most significant factors in reducing surficial erosion associated with grading of hillsides and removal of vegetation are the placement of mulches and the reduction of slope lengths followed by restoration of ground cover[3].

Based on the current Chapter 11 exemption for hobby vineyards (1/2-acre or less), we understand the proposed threshold for application of tree removal standards will be the removal of more than ½ acre of canopy as shown on existing aerial photography.

To guide the application of erosion control practices, the USDA and others have developed predictive models to evaluate vegetative cover management and soil conservation practices[4]. To reduce erosion and conserve soils, applicants can employ the following practices: 1) cover crops; 2) buffer strips; 3) strip cropping; 4) terracing and contour farming; and 5) reduction in effective slope length.

LACO Associates (LACO) makes the following recommendations for modifying the County's standards and practices for vineyard and orchard site development, as well as Chapter 11 of the Sonoma County Code. LACO specifically recommends modifications in the following areas:

[1] USDA Soil Conservation Service. 1975. Guides for erosion and sediment control. Davis, CA: USDA SCS.
[2] White, R. E. 2003. Soils for fine wines. New York: Oxford University Press, Inc.
[3] Gray, D. H., and R. Sotir. 2007. Landforming. New Jersey: John Wiley and Sons.
[4] Wischmeier, W.H. and D.D. Smith. 1978. Predicting rainfall erosion loss: A guide to conservation planning. USDA Agricultural Handbook #537, Washington, D.C.

1) Stability of slopes with cohesionless soils
2) Matching post development soil losses and/or sediment delivery with pre-development conditions using predictive models
3) Requiring Level II review for specified ridgetop site developments
4) Setbacks and prohibitions for areas of instability and steep slopes
5) Monitoring post development performance of erosion controls

2. Background and Current Conditions

The Grading, Drainage, and Vineyard and Orchard Site Development Ordinance (Chapter 11 of the County Code) was enacted for the purpose of regulating grading, drainage improvement, and vineyard and orchard site development within the unincorporated area of the county, and to establish ministerial standards that minimize hazards to life and property, protect against soil loss and the pollution of watercourses and protect streams and other watercourses. (Sec. 11.02.020.) Prior to the adoption of Chapter 11, vineyard development was governed by the Vineyard Erosion and Sedimentation Control Ordinance (VESCO). Today, Chapter 11 is commonly referenced as VESCO.

Chapter 11 applies to all grading, drainage improvement, and vineyard and orchard site development occurring within the unincorporated area of the county, except for grading and drainage improvement for timber operations conducted under an approved timber harvesting plan or nonindustrial timber management plan. (Section 11.02.40). The Agricultural Commissioner is responsible for reviewing and making decisions on permits for vineyard and orchard site development, agricultural grading, and agricultural drainage improvements (Section 11.10.010).

a. Permit Required

A vineyard and orchard site development permit is required prior to commencing any vineyard or orchard site development or related work, including preparatory site clearing and soil disturbance, except where exempted (Section 11.08.010).

i. Chapter 11 classifies projects as either a Level I or Level II development based on slope, soil type, and if the project is a new development or replanting of vineyard or orchard stock.
ii. Level I development shall be performed in compliance with approved plans and specifications prepared by the property owner or the authorizing agent of the property owner. New Level I projects are those on slopes ≤ 15 percent on areas without highly erodible soils or on slopes ≤ 10 percent on slopes with highly erodible soils.
iii. New Level II development shall be performed in compliance with approved plans and specifications prepared by a civil engineer. Level II projects are those on slopes > 15 percent on non-highly erodible soils or > 10 percent on all highly erodible soils.
iv. New vineyard and orchard development projects on slopes > 50 percent is prohibited.
v. Chapter 11 contains standards for development, including setback distances, operations during the rainy season, and re-vegetation. Chapter

11 covers a Best Management Practices (BMP) handbook that provides guidance and examples of erosion and sedimentation controls that can be used to prevent and minimize soil and other pollutant discharges during operations and post development. The title of the BMP guide is Best Management Practices for Agricultural Erosion and Sedimentation Control.

vi. Chapter 11 does not specifically address erosion and sedimentation from the removal of trees as part of new vineyard or orchard development, including the removal of trees from certain landforms such as ridgetops, active and inactive landslides, and other areas of geologic instability.

vii. Agricultural uses, including the cultivation of crops, are exempt from the Sonoma County Tree Protection and Replacement Ordinance, No. 4014.

b. Urgency Ordinance

On January 31, 2012, the County Board of Supervisors adopted an urgency ordinance to establish a temporary moratorium on the processing and approval of applications for permits for Level I vineyard and orchard site development on ridgetops, and Level II vineyard and orchard site development on any land that includes the removal of trees.

The urgency ordinance was supported by several findings, and the fact that Chapter 11 does not include any specific standards governing the removal of trees to prevent erosion and minimize sedimentation during operation and post-development. The Board of Supervisors acknowledged that tree canopies and tree parts (leaves, branches, and roots) provide stability to natural drainage features of the land and are an important habitat component of the watersheds and watercourses. Tree removal for vineyard and orchard site development on ridgetops and sloped land may impair the habitat value of watersheds and watercourses, and could potentially harm aquatic species.

The urgency ordinance was intended to provide time for staff to develop and for the Board to consider standards for tree removal as part of the vineyard and orchard site development process. During this time, applications for projects involving the removal of trees could still be submitted but not processed and approved. There are approximately seven Level II applications for new vineyard development totaling 341.8 acres that have been applied for but not yet approved. All seven applications propose some tree removal.

Clear standards and BMPs are clearly needed to reduce the potential threat to water quality. Concern has been expressed that amendments to Chapter 11 should be science-based and focused on activities with demonstrated risk. A transparent and technically defensible process is needed to develop tree removal standards and BMPs for erosion and sediment control, which are determined by such factors as slope length/angle, soil type, and other variables. A similar method of BMP development is used in the State Water Resources Control Board Construction General Permit, and

by predictive models used since the 1940's to control erosion and minimize sedimentation.

c. Actions to date

On January 31, 2012, the Board of Supervisors directed the Agricultural Commissioner to develop science-based amendments to Chapter 11, and to present those amendments for Board of Supervisor consideration on April 24, 2012, with final ordinance adoption by May 8, 2012. The Agricultural Commissioner prepared and released a Request for Qualifications to assist his office in this regard.

i. On February 3, 2012, a Request for Qualifications (RFQ) for consulting services was released. The RFQ solicited professional services to develop standards and best management practices to guide tree removal as it relates to erosion and sediment control associated with vineyard and/or site development on sloped hillsides and ridgetops.
ii. On February 21, 2012, the Agricultural Commissioner reviewed the RFQ responses and selected LACO Associates (LACO) to perform the work. The LACO project team has professional expertise that includes engineering geology, forester, geotechnical engineering, erosion/sediment control, hydrology, and land use planning/permitting.
iii. On February 23, 2012, the Agricultural Commissioner hosted an evening public meeting at the Agatha Furth Center in Windsor. Verbal public input, and written comments and other information were received from the audience. At the conclusion of the meeting, citizens, organizations, public agencies, and business owners were invited and strongly encouraged to submit written information for consideration in the development of ministerial standards to prevent erosion and minimize soil loss from tree removal. LACO Associates attended this public meeting.
iv. On March 29, 2012, the Agricultural Commissioner held two separate meetings with a working group of representatives from the environmental community, as well as a working group of representatives from the agricultural community. Each group met separately with staff and LACO Associates and was given a PowerPoint presentation of a "working draft" proposal. The primary purpose of the meetings was to allow those representatives an opportunity to review potential amendments and offer input relative to modifications that might be made to account for environmental and agricultural practices, as appropriate prior to the draft becoming public.
v. On April 3, 2012, the Agricultural Commissioner again held two separate meetings with a working group of representatives from the environmental community as well as a working group of representatives from the agricultural community. The primary purpose of these meetings was to receive additional feedback from those representatives following the March 29 meeting and to have a dialog about the proposed amendments prior to the public release of the draft proposal.

3. Approach

LACO Associates followed the declaration in the January 31, 2012, County of Sonoma Agenda Item Summary Report that the current Chapter 11 for agricultural grading did not directly consider the potential for erosion and sedimentation from the removal of trees from ridgetops and slope lands. While the current Ordinance specifies a clear purpose to protect against soil loss and the discharge of sediment to watercourses and contains common and effective BMPs, neither Chapter 11 nor the Agricultural Commissioner's BMP Manual contains a method to quantify the potential for erosion and sediment movement of proposed site developments that include the removal of trees. A method to quantify the effectiveness of erosion and sediment controls would help property owners, staff, and the public verify the sufficiency of proposed erosion and sediment controls, and thus provide a further analytical tool to help protect natural resources and the environment.

In this light, LACO took a broad view on the application of erosion and sediment control in the design of site developments by using predictive modeling methodologies, some of which have been in use by government agencies since the 1940's. Additionally, we used our practical knowledge and experience with already existing and accepted standards and practices used by the agricultural community and government agencies and public input. Overall, LACO Associates sought to identify a relatively simple yet effective predictive model for soil losses before and after development. We developed an application that is focused on the specific conditions associated with the development of vineyards and orchards on ridgetops and sloped lands that includes the effects of tree and vegetation removal.

a. Available Science

The United State Department of Agriculture (USDA) and others have developed predictive models for soil loss and sedimentation. These models are tools to guide the design of vineyards and orchards. The USDA model titled Universal Soil Loss Equation (USLE) is based on field observations and statistical analysis made in the 1940's. The modern versions of these models can be used to specify erosion controls in the design of vineyard and orchard site developments in order to limit soil losses and sedimentation to pre-development conditions. Erosion control methods are commonly called best management practices (BMPs). Common BMPs include: 1) cover crop; 2) contour farming: 3) buffer strips; 4) strip cropping; 5) terracing; 6) reduction in effective slope length; and 7) rock armor.

i. Technical Qualifications and Experience

The LACO Associates team has applied knowledge, experience and expertise in forestry, engineering geology, geotechnical engineering, and planning. They have developed or provided technical support for hundreds of Timber Harvest and Timberland Conversion Plans which include vineyards; performed slope instability studies on a wide range of soil types and geologic terrains; and, developed erosion and sedimentation control plans for hillside developments.

ii. Public Input and Information

In addition to the predictive models for soil loss and sedimentation, a significant amount of information was garnered from individuals, stakeholder organizations, public agencies, and the Sonoma County Agricultural Commissioner's office. LACO Associates reviewed the collection for relevant technical information and citied references that were applicable to the project scope. An index of the information received from outside sources and information used by LACO Associates is provided at the end of this document.

b. Predictive Models for Soil Loss

There are a number of models for predicting soil loss and applying erosion controls in the design of vineyard and orchard site developments. Two models described in this report are widely used in agricultural settings. One model is primarily limited to agricultural settings, and the other has application on agriculture and a wide range of other land uses.

In 1978, the USDA published a conservation planning document titled *Predicting Rainfall Erosion Loses* which quantified erosion losses and preventative measures on agricultural land. The semi-empirical formula promulgated by the USDA is known as the Universal Soil Loss Equation or USLE:

$$A = R \times K \times LS \times C \times P$$

Where A = computed soil loss per acre for a given storm period of time interval;

R = rainfall factors
K = soil erodibility value
L = slope length factor
S = steepness factor
C = vegetation factor and
P = erosion control practice factor

USLE predicts sheet and rill erosion from typical rainfall events and is still in use today. It provides a widely accepted guide to the effectiveness of erosion controls on slopes less than 25%. The current BMP Manual lists cover crop, filter strips, reduction of slope lengths, and rock armor as permanent erosion control methods. However, the Manual does not require quantification of erosion control method effectiveness.

The USLE does not predict sedimentation rates or soil losses from gully erosion and large storm events. However, the BMP Manual addresses sedimentation by recommending drainage systems that maximize infiltration and reduce sedimentation through the use of vegetated swales, energy dissipaters, and sediment basins/check dams designed to handle at least a 25-year storm event.

The Revised Universal Soil Loss Equation Version 2 (RUSLE2) is a computer-based modeling program that includes cover management and conservation practices not covered by the USLE. For projects with complex slope configurations and slopes that exceed 25%, the USLE has limited accuracy to predict soil losses and use of RUSLE2 is appropriate.

c. Slope Instability

In general, unsaturated soils at slope gradients less than 50% that are covered by the ministerial permit process are inherently stable because of inter-granular friction between soil particles. However, certain soil types (described as cohesionless) lose inter-granular friction when saturated and trigger a significantly increased risk of slope failure at gradients between 25 and 40% and are highly likely to fail at gradients greater than 40%. Tree roots mechanically reinforce the soil by transfer of shear stress in the soil to tensile resistance in the roots. The stabilizing effect of trees in areas of instability or in cohesionless soils will be difficult if not impossible to replicate with herbaceous plants and grasses which typically only provide surface cover for rainfall and preventing superficial erosion.[5] The BMP Manual requires exploration for areas of instability but does not specifically require identification of all areas of instability or cohesionless soils, prohibit development on areas of instability or tree removal on slopes which have an increased risk of failure following tree removal, or require setbacks from areas of instability and steep slopes.

d. Ridgetops

Ridgetops are relatively flat topographic divides above steep divergent and descending slopes. As the length of slope below a ridgetop increases, the erosion potential increases. Under current regulations, most ridgetops developments would be classified as Level I projects if based solely on the gradient of the ridgetop slope. However, ridgetop developments above long steep slopes have a higher potential to increase erosion. This is supported by the increase in erosion predicted by the USLE slope length and gradient table. Therefore, ridgetops in certain geographic locations and with specific descending slope conditions would become Level II projects (refer to the flowchart-Attachment 1). A Level II project already requires a design to be prepared by a licensed professional. It is our recommendation that you require an engineering geologic report for Level II projects.

e. Monitoring and Reporting

Serves the purpose to verify the effectiveness and provide the opportunity to make adjustments to erosion and sediment controls. Currently, other than through nuisance complaints, the Chapter 11 and the BMP manual do not contain a method to evaluate the performance of erosion and sediment control BMPs.

[5] Gray, D. H., and R. Sotir. 2007. Landforming. New Jersey: John Wiley and Sons.

4. Key Definitions

a. Tree Canopy

The continuous cover of branches and foliage formed collectively by the adjacent trees with an average fall height of water drops falling from the canopy to the ground at an average distance of 13 feet but not exceeding a drop fall height of 33 feet.

b. Methodology for the Determination of Tree Canopy Cover

A sampling procedure placed in a uniform grid shall be used to determine canopy cover prior to operations by a Registered Professional Forester. Plots shall be placed on a 50'x 50'grid or a minimum of 10 plots/area. A densitometer shall be used to measure canopy cover (cover/no-cover) at each plot center. Per-cent canopy cover shall be determined from the number of positive readings (cover) relative to the number of negative readings (no-cover).

c. Ground Cover

All materials in contact with the soil surface. Examples are rock fragments, portions of live vegetation including basal area and plant leaves that touch the soil, plants and plantlike organisms, such as mosses, algae, ferns, and fungi, duff, plant litter, crop residue, applied materials, including manure, mulch and manufactured erosion control products.

d. Methodology for the Determination of Ground Cover

A sampling procedure placed in a uniform grid shall be used to determine the ground cover of the area prior to operations. Plots shall be placed on a 50'x 50' grid or a minimum of 10 plots/contiguous area. Ground cover shall be measured from the per-cent organic material covering the circle (estimated) relative to the area absent of organic material (rock, bare soil, etc.) within a $1/300^{th}$ acre circle (6'8"). Ground cover shall be determined from the average amount of cover within each plot, within the project area.

e. Ridgetop

A topographic divide with slopes less than 10 percent on highly erodible soils or less than 15 percent on all other soils with divergent and descending slopes that exceed 50% gradient for more than 50 feet.

f. Slope Length

The distance from the origin of the overland flow to where deposition begins, which is the traditional definition of slope length in USLE and RUSLE2.

g. Tree

A woody perennial plant, typically large with a well-defined stem carrying a definite crown, with a minimum diameter at breast height of five inches, a minimum height of 15 feet, with no branches within three feet of the ground.

5. Recommendations for Chapter 11

a. Vineyard and orchard site development shall be setback from steep slopes and areas of instability in compliance with the requirements listed below, unless stricter requirements are established in the general plan, local coastal program, and and/or zoning code. Existing vegetation should be retained in setback areas to limit erosion and maintain slope stability.
    i. 50 feet above and laterally to natural slopes steeper than fifty (50) percent that have a slope length of more than 50 feet.
    i. 50 feet below or laterally to areas of instability or as recommended in an engineering geologic report.
    ii. 100 feet above areas of instability or as recommended in an engineering geologic report.
b. Additional Level II project designation for developments on ridgetops located between the watersheds listed in the County General Plan or with a descending slope length more than 500 feet long at 50 percent gradient above a stream listed in the County General Plan, Local Coastal Plan, or Zoning Ordinance.
c. Revise Chapter 11.16.050 (soil and other pollutant discharges) to limit erosion and/or sediment discharge into lakes, streams, and wetlands in accordance with the permitting authority's BMP guide.

6. Recommendations for BMP Manual Chapter 6 for Tree Removal Projects

a. Require projects to limit soil loss and/or sediment delivery to pre-development levels as shown by a predictive model (no increase in erosion or sediment delivery).
b. Professional peer review of project plans and reports
    i. Retain the services of a qualified professional to peer review of project plans and reports to verify compliance with Chapter 11, the BMP Manual, and the standard of care. For example, the Agricultural Commissioner should retain the services of a registered civil engineer and a certified engineering geologist.
c. Soil Loss or Sediment Delivery Model
    i. For projects with slopes less than 25%, use tabulated USLE slope length/gradient, cover management, and conservation practice factors listed in the BMP Manual to calculate the pre- versus post-development soil loss ratio. RUSLE2 or another scientifically validated erosion model acceptable to the Agricultural Commissioner can be used at the discretion of the applicant.
    ii. For projects with slopes greater than 25%, use RUSLE2 or another scientifically validated erosion model acceptable to the Agricultural Commissioner to calculate the pre- versus post- development soil loss ratio.
    iii. Alternatively, submit a project design with BMPs that:
        a. Limits soil loss to the USDA Soil Conservation Service Survey ("T" values), and;
        b. Shows through a scientifically validated sediment budget that the project will not increase the delivery of sediment to streams, lakes, or wetlands to greater than the pre-development sediment delivery.

d. Slope instability
    i. For all Level 2 projects with tree removal, require an engineering geologic report that identifies and characterizes areas of slope instability and cohesionless soils.
    ii. Prohibit tree removal on slopes with a gradient greater than 40% and cohesionless soils.
    iii. Require a factor of safety analysis for tree removal on slopes with gradients between 25 and 40% and cohesionless soils. Allow tree removal if the factor of safety is greater than or equal to 1.5.
    iv. Prohibit vineyard and orchard site development on areas of slope instability unless the area is repaired in accordance with engineered plans.
    v. Setback of 50 feet below or laterally from areas slope instability or as recommended in an engineering geologic report
    vi. Setback of 100 feet above areas of slope instability or as recommended in an engineering geologic report.

ATTACHMENT 1

Flowchart for Identifying Level I or Level II Ridgetop Development Projects

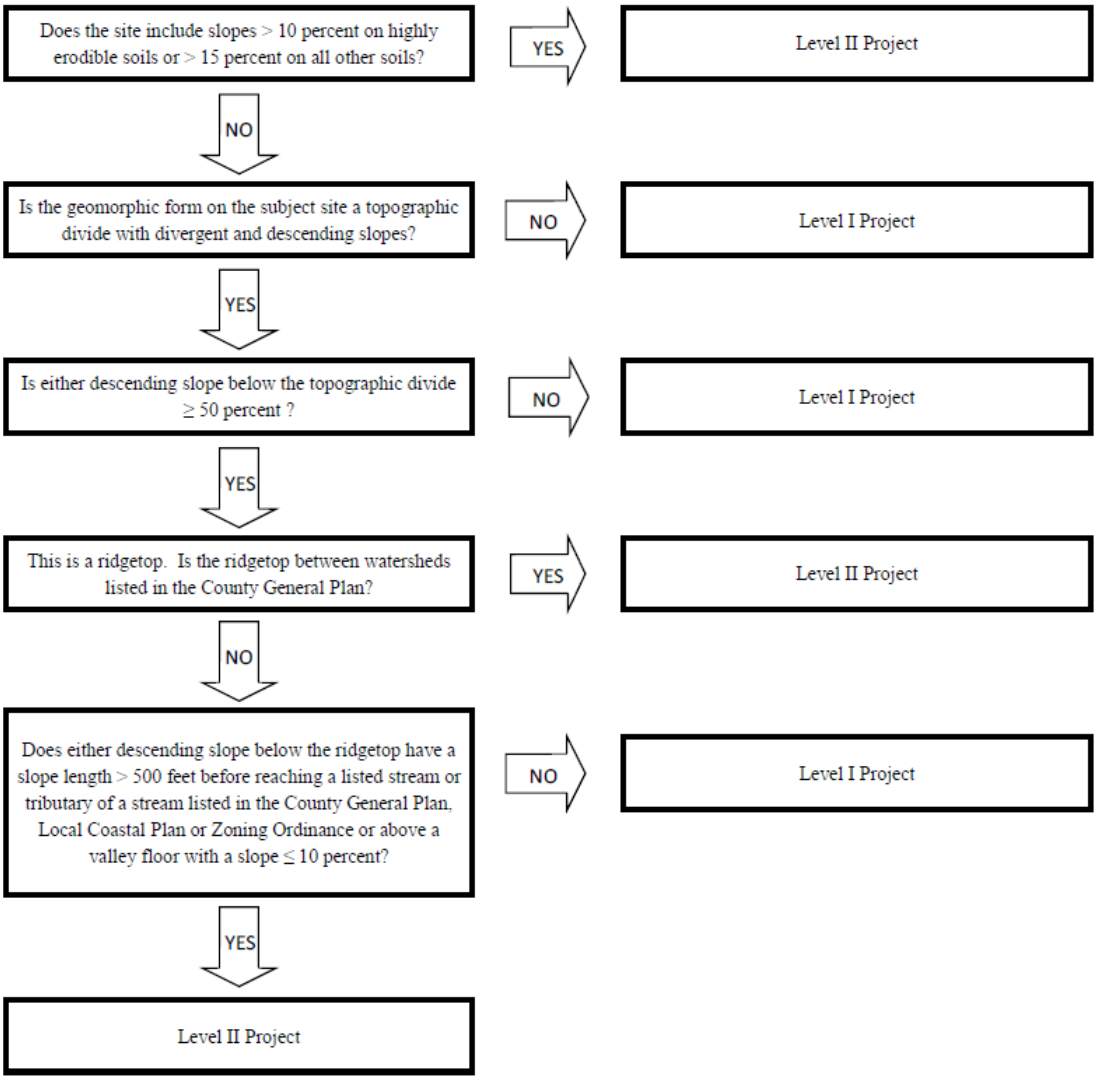

DIAGRAM OF RIDGETOP
TO BE INSERTED LATER

ATTACHMENT 2

Chapter 6

Soil Loss Ratio (Permanent and Temporary BMPs)

The ratio between post-development and pre-development predicted soil loss is called the soil loss ratio. Projects not using a sediment budget model require a soil loss ratio of 1 or less. Pre- and post-development soil loss shall be calculated using the Universal Soil Loss Equation (USLE) for projects with slopes less than 25% and the computer based RUSLE2 system for projects with slopes between 25 and 50%, or another scientifically validated model accepted by the Agricultural Commissioner. The latest version of RUSLE2 can be downloaded for free from the NRCS website. Alternatively, another scientifically validated erosion model acceptable to the Agricultural Commissioner may be used to calculate the pre- versus post-development soil loss ratio, or an applicant may show, through a scientifically-validated sediment budget, that the project will not increase the delivery of sediment to stream, lakes, or wetlands to greater than the pre-development sediment delivery. The latest version of RUSLE2 can be downloaded for free from the NRCS website.

Soil Loss Equations

The USLE and RUSLE2 soil loss equations are based on the following formula:

$$A = R \times K \times LS \times C \times P$$

Where A = computed soil loss per acre for a given storm period of time interval;
R = rainfall factors;
K = soil erodibility value;
L = slope length factor
S = steepness factor
C = vegetation factor; and
P = erosion control practice factor

For the purposes of calculating the soil loss ratio, the factors of R and K are removed from the equation given the assumption that rainfall and soil type will be unchanged by site development.

Site Evaluation

Divide the development into blocks with similar landforms and slopes, generally no more than 20 acres in size. For example, use existing drainages, major slope breaks, and topographic divides as natural boundaries between blocks. Then calculate a soil loss factor for pre-development conditions and post-development (temporary and permanent BMPs) for each block using the topographic (LS), vegetation (C) factors, and erosion control practice (P) factors as described below or using the RUSLE2 computer model.

Pre-development Soil Loss Factor

This soil loss factor sets the target for the post-development (temporary and permanent) erosion control requirements.

1. Topographic Factors for Slopes (LS_i)
    a. Determine the slope length of the block and the gradient of the slope using the methods outlined by the USLE.
    b. For projects with slopes less than or equal to 25% find the LS_i factor on the table below.
    c. For projects with slopes greater than 25%, determine LS using RUSLE2.

Ratio of Slope Length and Slope Steepness (LS)

Slope ratio (H/V)	Slope Gradient 'S', %	LS Values for Selected Slope Lengths 'L', ft						
		10	30	50	100	300	500	1000
20 to1	5	0.17	0.29	0.38	0.53	0.93	1.20	1.69
10 to 1	10	0.43	0.75	0.97	1.37	2.37	3.06	4.33
8 to 1	12.5	0.61	1.05	1.36	1.92	3.33	4.30	6.08
6 to 1	16.7	0.96	1.67	2.15	3.04	5.27	6.80	9.62
5 to 1	20	1.29	2.23	2.88	4.08	7.06	9.12	12.90
4 to 1	25	1.86	3.23	4.16	5.89	10.20	13.17	18.63
3 to 1	33.5	2.98	5.17	6.67	9.43	16.33	21.09	28.82
2.5 to 1	40	4.00	6.93	8.95	12.65	21.91	28.29	40.01
2 to 1	50	5.64	9.76	12.6	17.82	30.87	39.85	56.36
1.75 to 1	57	6.82	11.80	15.24	21.55	37.33	48.19	68.15
1.50 to 1	66.7	8.44	14.61	18.87	26.68	46.22	59.66	84.38
1.25 to 1	80	10.55	18.28	23.6	33.38	57.81	74.63	105.55
1 to 1	100	13.36	23.14	29.87	42.24	73.17	94.46	133.59

2. Vegetation Factor (C_i)
    a. Determine the type/height of raised canopy and percent canopy/ground cover using methods outlined by USLE.
    b. For projects with slopes less than or equal to 25% find the C_i factor on the table below.
    c. For projects with slopes greater than 25%, determine C_i using RUSLE2.

C Values

				C Values for Selected Canopy and Ground-Cover Conditions					
Vegetation Factor (C) Values for Pasture, Rangeland, and Idle Land	Type and Height of Canopy	Canopy Cover (%)	Canopy Type	Ground Cover (%)					
				0	20	40	60	80	95 -100
	No significant canopy	0	G	0.45	0.20	0.10	0.042	0.013	0.003
			W	0.45	0.24	0.15	0.090	0.043	0.011
	Canopy of tall	25	G	0.36	0.17	0.09	0.038	0.012	0.003

	weeds or short brush (average drop height[2] of ≥20 inches or 0.5 m fall height)		W	0.36	0.20	0.13	0.082	0.041	0.011
		50	G	0.26	0.13	0.07	0.035	0.012	0.003
			W	0.26	0.16	0.11	0.075	0.039	0.011
		75	G	0.17	0.10	0.06	0.031	0.011	0.003
			W	0.17	0.12	0.09	0.067	0.038	0.011
	Appreciable brush or bushes (2 m fall height)	25	G	0.40	0.18	0.09	0.040	0.013	0.003
			W	0.40	0.22	0.14	0.085	0.042	0.011
		50	G	0.34	0.16	0.09	0.038	0.012	0.003
			W	0.34	0.19	0.13	0.081	0.041	0.011
		75	G	0.28	0.14	0.08	0.036	0.012	0.003
			W	0.28	0.17	0.12	0.077	0.040	0.011
	Trees but no appreciable low brush (4 m fall height)	25	G	0.42	0.19	0.10	0.041	0.013	0.003
			W	0.42	0.23	0.14	0.087	0.042	0.011
		50	G	0.39	0.18	0.09	0.040	0.013	0.003
			W	0.39	0.21	0.14	0.085	0.042	0.011
		75	G	0.36	0.17	0.09	0.039	0.012	0.003
			W	0.36	0.20	0.13	0.083	0.014	0.011
	Mechanically prepared sites, with no live vegetation and no topsoil, and no litter mixed in.	0	N	0.94	0.44	0.30	0.200	0.100	Not given

3. Existing Erosion Control Practice Factor (P_i)
    a. If the site is being converted from an existing development use, determine the P_i factor using the table below.
    b. If the site is undeveloped, use a value of 1.

Conservation Practice Factors (P)

Land Slope percent	Contouring	Maximum length between cross slope drains (ft)	Strip Cropping	Strip width (ft)	Maximum length between cross slope drains (ft)	Outsloped Terrace	Insloped Terrace with at grade outlet	Insloped Terrace connected to sedimentation basin
1 to 2	0.6	400	0.30	130	800	0.60	0.12	0.06
3 to 5	0.5	300	0.25	100	600	0.50	0.10	0.05
6 to 8	0.5	200	0.25	100	400	0.50	0.10	0.05
9 to 12	0.6	120	0.30	80	240	0.60	0.12	0.06
13 to 16	0.7	80	0.35	80	160	0.70	0.14	0.07
17 to 20	0.8	60	0.40	60	120	0.80	0.16	0.08
21 to 25	0.9	50	0.45	50	100	0.90	0.18	0.09

terraces need revised LS factor
farming up and down slope P =1.0

4. Pre-development soil loss factor
    a. Calculate using the following formula:
        i. Soil loss factor = LS_i x C_i x P_i

Permanent BMP Selection and Soil Loss Ratio

The final soil loss ratio for a site design must be less than or equal to 1, which means soil loss cannot be increased by site development. Through the judicious use of BMPs such as buffer/filter strips, drainage controls, cover crop, tree canopy, slope contouring, and slope terracing the predicted final post-development soil loss can be designed to be less than or equal to the pre-development predicted soil loss of the site.

1. Vegetation Factor (C_f)
    a. Determine the type/height of raised canopy and percent canopy/ground cover using the following method.
    b. Ground Cover - a sampling procedure placed in a uniform grid shall be used to determine the ground cover of the area prior to operations. Plots shall be placed on a 50'x 50'grid or a minimum of 10 plots/contiguous area. Ground cover shall be measured from the per-cent organic material covering the circle (estimated) relative to the area absent of organic material (rock, bare soil, etc.) within a 1/300th acre circle (6'8"). Ground cover shall be determined from the average amount of cover within each plot, within the project area.
    c. Canopy - sampling procedure placed in a uniform grid shall be used to determine canopy cover prior to operations by a Registered Professional Forester. Plots shall be placed on a 50'x 50'grid or a minimum of 10 plots/area. A densitometer shall be used to measure canopy cover (cover/no-cover) at each plot center. Per-cent canopy cover shall be determined from the number of positive readings (cover) relative to the number of negative readings (no-cover).
    d. For projects with slopes less than or equal to 25% find the C_f factor on the table below.
    e. For projects with slopes greater than 25%, determine C_f using RUSLE2.

2. Determining the Final Erosion Control Gap
    a. Divide the pre-development soil loss factor by the C_f value determined above.
    b. This will result in the gap that a site designer needs to close in order to meet or exceed the pre-development soil loss conditions. Through an iterative process, the BMPs which will result P_f and LS_f values that close the gap will be selected. Examples are shown at the end of this Chapter.

3. Final Post-development Soil Loss Factor
    a. Calculate using the following formula:
        i. Soil loss factor = LS_f x C_f x P_f

Temporary BMP Selection and Soil Loss Ratio

The interim soil loss ratio during the period between completion of earthwork and maturity of cover crop and other vegetation used as final BMPs must be less than or equal to 1. This means through the use of BMPs such as straw blankets, mulches, wood chips, and dense stands of tree

seedlings the predicted interim post-development soil loss is less than or equal to the pre-development predicted soil loss of the site.

1. Determining the Interim Erosion Control Gap
    a. Divide the pre-development soil loss factor by the product of the LS_f and P_f values determined above.
    b. This will result in the gap that a site designer needs to close in order to meet or exceed the pre-development conditions. Through an iterative process, the temporary BMPs which will result a C_t value that closes the gap will be selected. Examples are shown at the end of this Chapter.
    c. Find the C value as shown on the table below.

Type of Mulch	Mulch Rate (tons per acre)	Land Slope (%)	Mulching C Factor	Length Limit (ft)[1]
None	0	all	1.0	n/a
Straw or hay, tied down by anchoring and tacking equipment[2]	1.0	5-10	0.20	200
	1.0	6-10	0.20	100
	1.5	1-5	0.12	300
	1.5	6-10	0.12	150
	2.0	1-5	0.06	400
	2.0	6-10	0.06	200
	2.0	11-15	0.07	150
	2.0	16-20	0.11	100
	2.0	21-25	0.14	75
	2.0	26-33	0.17	50
	2.0	34-50	0.20	35
Crushed stone, $^1/_4$ - $1^1/_2$ inch	135	<16	0.05	200
	135	16-20	0.05	150
	135	21-33	0.05	100
	135	34-50	0.05	75
	240	<21	0.02	300
	240	21-33	0.02	200
	240	34-50	0.02	150
Wood Chips	7	<16	0.08	75
	7	16-20	0.08	50
	12	<1 6	0.05	150
	12	16-20	0.05	100
	25	21-33	0.05	75
	25	<16	0.02	200
	25	16-20	0.02	150
	25	21-33	0.02	100
	25	34-50	0.02	75

[1] Maximum slope length for which the specified mulch rate is considered effective. When this limit is exceeded, either a higher application rate or mechanical shortening of the effective slope length is required.

[2] When the straw or hay mulch is not anchored to the soil, C values on moderate or steep slopes of soils having K values greater than 0.30 should be taken at double the values given in this table.

2. Interim Post-development soil loss factor
    a. Calculate using the following formula:
        i. Soil loss factor = LS_f x C_t x P_f

Monitoring and Reporting

1. Monitoring Frequency
    a. Monitoring is required for a minimum period of 3 years. During the first year after site development is completed, the project owner shall inspect the site for significant erosion or instability prior to the storm season and then monthly from October to May. Any identified erosion shall be repaired and will require additional erosion control measures.
    b. Identical color photographic scenes will be taken before development activities and during each January for a minimum period of 3 years, at the same time of day.
    c. Annual monitoring reports will be prepared and submitted to the Agricultural Commissioner December 31 of each monitoring year. Year one will be considered the first full calendar year after the completion of the site development activities and submittal of the as-built report.

2. Photo-documentation
    a. Identity photo points on the project plans which reflect the overall project area.
    b. Take pre-development baseline photographs of the site area.
    c. The photos will be used to qualitatively assess changes in general site conditions as well as tree/vegetative composition, cover, dominance, and structure.
    d. Document photographs in the field with the following information: photograph number, photo reference point number, and general direction toward object of photograph, reference points, and description of surroundings.

3. Annual Reports
    a. The first year's report will summarize the baseline information as well as the first year monitoring results.
    b. Thereafter, annual reports will consist of a summary of information contained in previous reports, as well as a presentation of the current year's results and discussion of any comparisons between years or trends noted.
    c. Annual reports will include, at the minimum, the following information:
        i. Summary description of the monitoring methods, including data collection and analysis.
        ii. An overview including a general discussion of site conditions and changes since previous report.
        iii. Color photographs of the re-vegetation areas taken from the same reference points on the ground and standardized with respect to direction, lens type, etc.
4. Inspection
    a. Projects are subject to spot site inspections for a minimum of 3 years or until final inspection and approval by Agricultural Commissioner.

b. Failure to submit annual reports or to maintain BMPs will trigger in enforcement action.

Pre/Post-Development USLE Examples

EXAMPLE 1

An example of a site, before and after vineyard construction, with a **15%** slope and 500 ft slope length. Before construction, the site had a 75% ground cover from trees and grass, after construction, there is a grass ground cover of 75% but no significant canopy during winter months.

Factor	Pre-development		Final Development		Interim	
LS	500' length 15% gradient	6.00	500' length 15% gradient	6.00	fiber roll every 20 feet 15% gradient	1.20
C	75% canopy/80% gc	0.014	0% canopy/75% gc	0.013	2 tons/straw per acre, anchored	0.07
P	none	1	none	1	none	1
Soil Loss		0.084		0.078		0.084
Soil Loss Ratio				0.93		1.00

EXAMPLE 2

An example of a site, before and after vineyard construction, with a **25%** slope and 500 ft slope length. Before construction, the site had a 75% ground cover from trees and grass, after construction, there is a grass ground cover of 75% but no significant canopy during winter months.

Factor	Pre-development		Final Development		Interim	
LS	500' length 25% gradient	13.00	500' length 25% gradient	13.00	fiber roll every 20 feet 25% gradient	1.30
C	75% canopy/80% gc	0.014	0% canopy/75% gc	0.013	2 tons/straw per acre, anchored	0.14
P	none	1	none	1	none	1
Soil Loss		0.182		0.169		0.182
Soil Loss Ratio				0.93		1.00

EXAMPLE 3

An example of a site, before and after vineyard construction, with a **20%** slope and 500 ft slope length. Before construction, the site had a 75% ground cover from trees and grass, during interim there is a 40% grass ground cover, after construction, there is a grass ground cover of 75**%** but no significant canopy during winter months.

Factor	Pre-development		Final Development		Interim	
LS	500' length 20% gradient	12.9	50' lengths 20% gradient	2.88	fiber roll every 50 feet 20% gradient	2.00
C	75% canopy/95% gc	0.003	0% canopy/75% gc	0.013	40% gc	0.1
P	none	1	Insloped Terrace with at grade outlet	0.16	none	0.16
Soil Loss		0.0387		0.0059904		0.032
Soil Loss Ratio				.129		0.83