APPENDIX 6.4-C – SOIL LOSS CALCULATIONS

UNIVERSAL SOIL LOSS CALCULATION

FOR

ORANGE GROVE ENERGY, L.P.

ORANGE GROVE POWER PLANT

JUNE 5, 2008

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Sega Project No. 07-0098

Table of Contents

Topic	Page(s)
Introduction …….……..……..……..	3
RUSLE Method….……..……..…..…….…….	3
RUSLE Factors...…….……	3
Conclusion .....……...……..	3
References .....……...……..	4

- Site Location and Project Vicinity Map
- Figure 4 Isoerodent Map of California
- NRCS Web Soil Survey 2.0 –K Factor, Whole Soil
- LS Table for Construction Sites –USDA Agricultural Handbook No. 703
- Erosion Mgmt Factors – Table 1
- Pre and Post-Development RUSLE Calculations

Introduction

Orange Grove Energy, L.P.'s proposed Orange Grove Power Plant (OGPP) is located in Unincorporated San Diego County (SDC) west of Pala, California 92059 about 0.1 mile north of the intersection of State Road 76 (Pala Road or SR-76) and a private road called Pala Del Norte Road. The 8.5 acre proposed project site is located on approximately 202 acres of property owned by San Diego Gas & Electric (SDG&E) in San Diego County, California in Section 29, Township 9 South, Range 2 West (Please refer to Figure 1 - Site Location and Project Vicinity Map in the References section).

RUSLE Method

The soil loss for the Orange Grove Power Plant was analyzed by utilizing the Revised Universal Soil Loss Equation (RUSLE). The RUSLE utilizes five factors to average annual soil loss from sheet and rill erosion caused by rainfall and associated overland flow in tons/ac/yr, computed by selecting values for each factor (soil type, climate, ground cover, geographic location, slope, and erosion control structures) and multiplying them together. The five factors are known as the R, K, LS, C, and P factors.

The Universal Soil Loss Equation is: **A** = **R** x **K** x **LS** x **C** x **P**

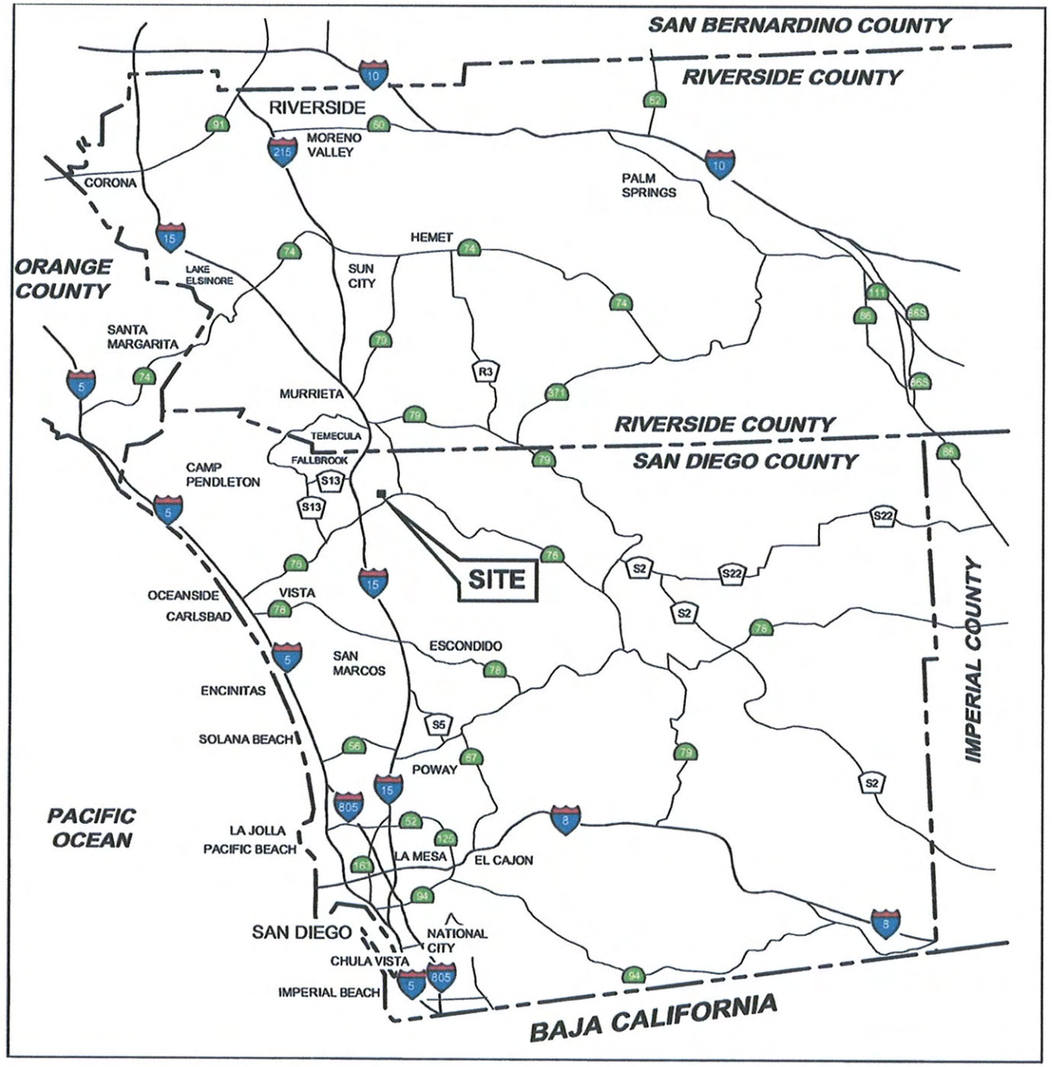
RUSLE Factors

- The **R factor** for the RUSLE was found using an Isoerodent map (Please refer to Isoerodent Map of California in the References section).
- The **K factor** is the soil erodibility factor and was found using the NRCS website (Please refer to the NRCS Web Soil Survey 2.0 in the References section).
- The **LS factor** is a function of the length of the slope of the site and the slope grade (Please refer to LS Table for Construction Sites in the References section).
- The **C factor** is the erosion management factor, found in tables for differing types of erosion control (Please refer to Erosion Mgmt Factors - Table 1 in the References section).
- The **P factor** is the support practice factor and has a maximum value of one. To be conservative a value of one was used in our calculations (Please refer to Erosion Mgmt Factors - Table 1 in the References section).

Conclusion

The pre-development citrus orchard site is at approximately a 10% slope from the north to south. The proposed development will transform the landscape into a 1% sloped site set between 3:1 cut/fill slopes. Reduced erosion will be due to improved vegetated cover on the proposed site slopes, as well as, on-site drainage will be redirected to a proposed detention basin, thus allowing for settlement of sedimentation while also controlling the post-development discharged runoff off-site. The pre and post-development RUSLE values were calculated to be approximately 1.43 tons/acre/year and 0.40 tons/acre/year, respectfully (Please refer to Pre and Post-Development RUSLE Calculations in the References section). The RUSLE values indicate that the proposed development will decrease the soil loss by erosion from the site.

REFERENCES

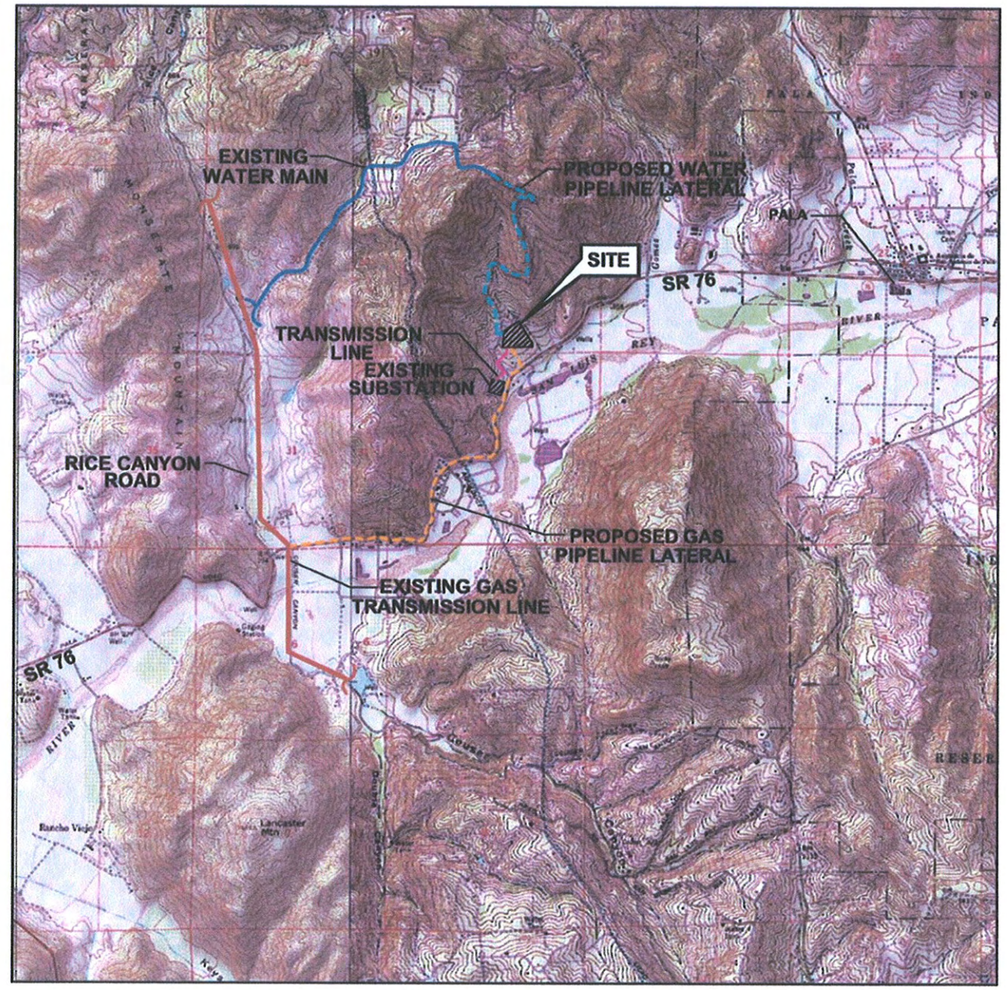


N

0 10 20 30 40 MILES

SCALE IN MILES

SITE LOCATION MAP



N

0 1/2 1 1 1/2 2 MILES

SCALE 1:48,000

SOURCE:

United States Geological Survey
7.5 Minute Topographic Map, 2000:
Pala, Bonsall, Temecula,
and Pechanga Quadrangles

PROJECT VICINITY MAP

Sega

Engineers - Architects - Technicians
Design - Construction - Field Service

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ORANGE GROVE ENERGY L.P.
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MUP 07-009

FIGURE 1
ORANGE GROVE POWER PLANT
SITE LOCATION AND PROJECT VICINITY MAP

DESIGN BY: J. LANGEL	CHECKED BY:
DRAWN BY: J. CLAUSSEN	DATE: 11-28-07
CLIENT I.D.	SEGA PROJECT NO. 07-201
FILE NAME: OG_site_vicinity.mxd	
DRAWING NO.	REV.

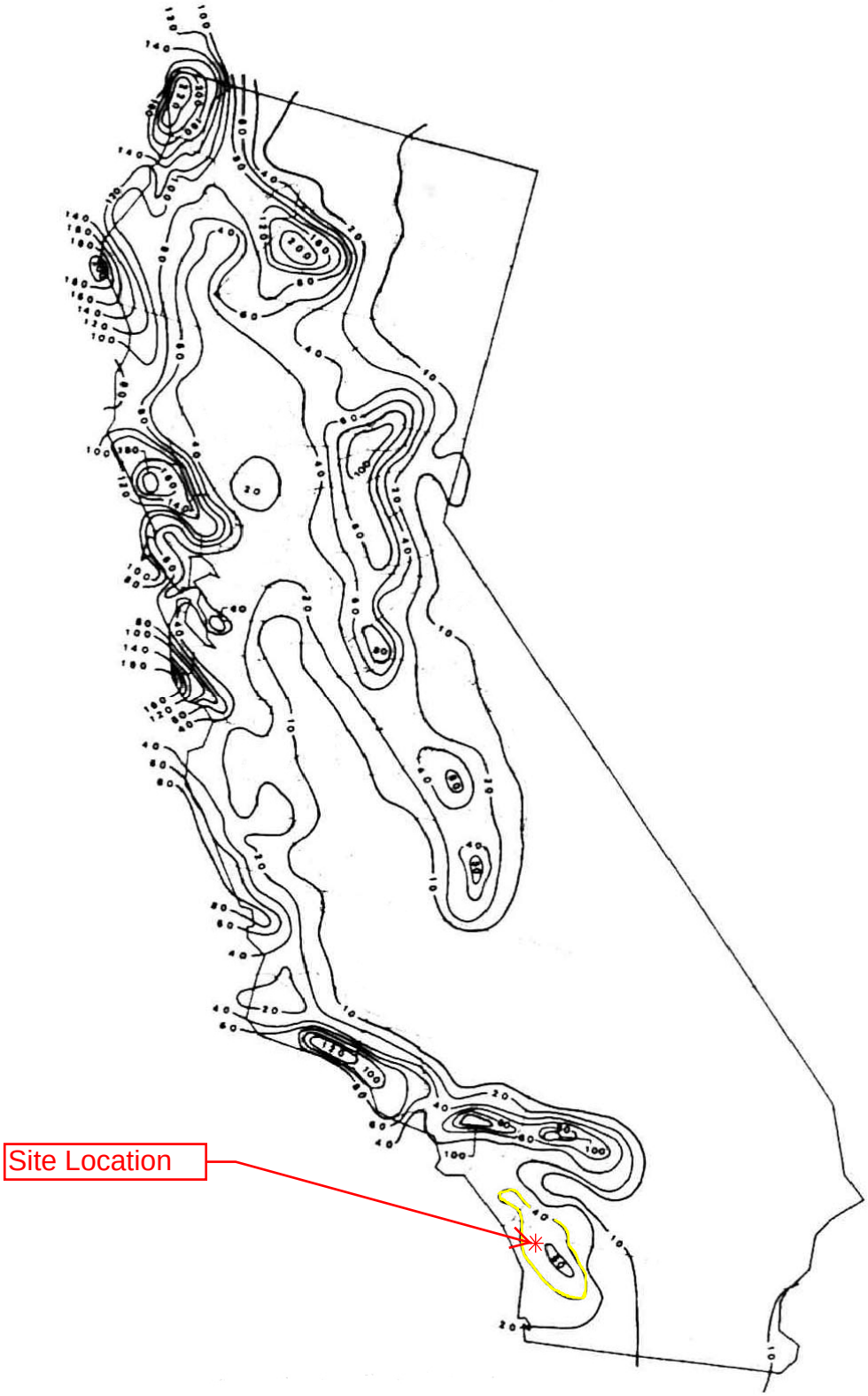
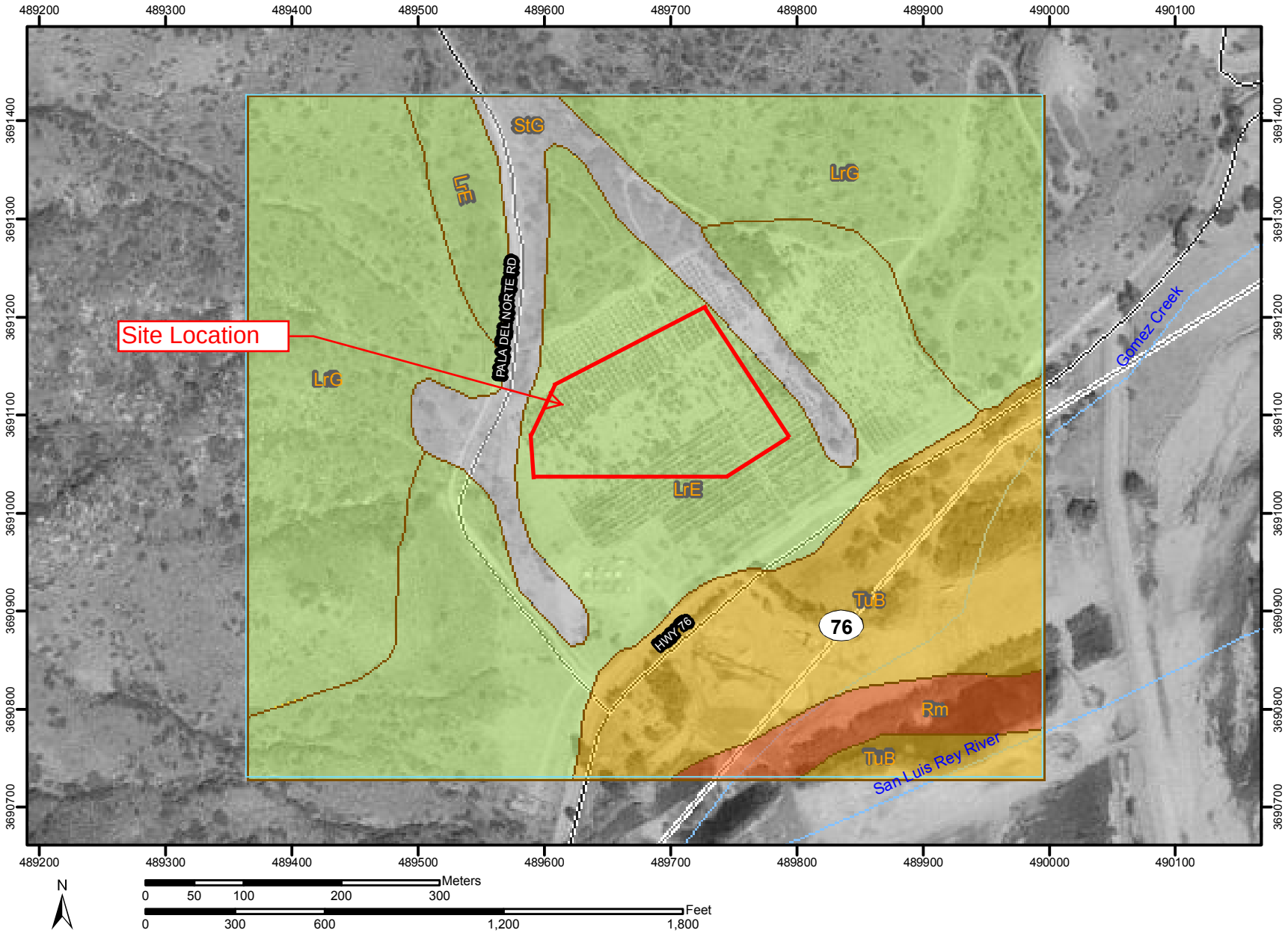


Figure 4-4c. Isoerodent map of California (EPA 2001).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489300
489400
489500
489600
489700
489800
489900
490000
490100
3691400
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3691200
3691100
3691000
3690900
3690800
3690700
StG
LrE
LrG
LrG
LrE
TuB
TuB
Rm
PALA DEL NORTE RD
HWY 76
76
Site Location
Gomez Creek
San Luis Rey River
N
Meters
0 50 100 200 300
Feet
0 300 600 1,200 1,800

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

.02

.05

.10

.15

.17

.20

.24

.28

.32

.37

.43

.49

.55

.64

Not rated or not available

Political Features

Municipalities

Cities

Urban Areas

Water Features

Oceans

Streams and Canals

Transportation

Rails

Roads

Interstate Highways

US Routes

State Highways

Local Roads

Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 6, Dec 17, 2007

Date(s) aerial images were photographed: 10/2/1995

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

K Factor, Whole Soil

K Factor, Whole Soil— Summary by Map Unit — San Diego County Area, California				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
LrE	Las Posas stony fine sandy loam, 9 to 30 percent slopes	.24	51.2	36.6%
LrG	Las Posas stony fine sandy loam, 30 to 65 percent slope s	.24	47.4	33.9%
Rm	Riverwash	.05	4.7	3.4%
StG	Steep gullied land		11.5	8.2%
TuB	Tujunga sand, 0 to 5 percent slopes	.15	25.1	18.0%
Totals for Area of Interest (AOI)			139.9	100.0%

Description

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Layer Options: Surface Layer

LS Table for Construction Sites

The following table shows LS factors for freshly prepared constructed and other highly disturbed soil condition with little or no cover (not applicable to thawing soil)

Post-Development (1% Slope)

Slope (%)	Slope Length (ft.)																
	<3	**6**	**9**	**12**	**15**	**25**	**50**	**75**	**100**	**150**	**200**	**250**	**300**	**400**	**600**	**800**	**1000**
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.5	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.12	0.12	0.13
1.0	0.09	0.09	0.09	0.09	0.09	0.10	0.13	0.14	0.15	0.17	0.18	0.19	0.20	0.22	0.24	0.26	0.27
2.0	0.13	0.13	0.13	0.13	0.13	0.16	0.21	0.25	0.28	0.33	0.37	0.40	0.43	0.48	0.56	0.63	0.69
3.0	0.17	0.17	0.17	0.17	0.17	0.21	0.30	0.36	0.41	0.50	0.57	0.64	0.69	0.80	0.96	1.10	1.23
4.0	0.20	0.20	0.20	0.20	0.20	0.26	0.38	0.47	0.55	0.68	0.79	0.89	0.98	1.14	1.42	1.65	1.86
5.0	0.23	0.23	0.23	0.23	0.23	0.31	0.46	0.58	0.68	0.86	1.02	1.16	1.28	1.51	1.91	2.25	2.55
6.0	0.26	0.26	0.26	0.26	0.26	0.36	0.54	0.69	0.82	1.05	1.25	1.43	1.60	1.90	2.43	2.89	3.30
8.0	0.32	0.32	0.32	0.32	0.32	0.45	0.70	0.91	1.10	1.43	1.72	1.99	2.24	2.70	3.52	4.24	4.91
10.0	0.35	0.37	0.38	0.39	0.40	0.57	0.91	1.20	1.46	1.92	2.34	2.72	3.09	3.75	4.95	6.03	7.02
12.0	0.36	0.41	0.45	0.47	0.49	0.71	1.15	1.54	1.88	2.51	3.07	3.60	4.09	5.01	6.67	8.17	9.57
14.0	0.38	0.45	0.51	0.55	0.58	0.85	1.40	1.87	2.31	3.09	3.81	4.48	5.11	6.30	8.45	10.40	12.23
16.0	0.39	0.49	0.56	0.62	0.67	0.98	1.64	2.21	2.73	3.68	4.56	5.37	6.15	7.60	10.26	12.69	14.96
20.0	0.41	0.56	0.67	0.76	0.84	1.24	2.10	2.86	3.57	4.85	6.04	7.16	8.23	10.24	13.94	17.35	20.57
25.0	0.45	0.64	0.80	0.93	1.04	1.56	2.67	3.67	4.59	6.30	7.88	9.38	10.81	13.53	18.57	23.24	27.66
30.0	0.48	0.72	0.91	1.08	1.24	1.86	3.22	4.44	5.58	7.70	9.67	11.55	13.35	16.77	23.14	29.07	34.71
40.0	0.53	0.85	1.13	1.37	1.59	2.41	4.24	5.89	7.44	10.35	13.07	15.67	18.17	22.95	31.89	40.29	48.29
50.0	0.58	0.97	1.31	1.62	1.91	2.91	5.16	7.20	9.13	12.75	16.16	19.42	22.57	28.60	39.95	50.63	60.84
60.0	0.63	1.07	1.47	1.84	2.19	3.36	5.97	8.37	10.63	14.89	18.92	22.78	26.51	33.67	47.18	59.93	72.15

(From: USDA Agricultural Handbook No. 703).

Pre-Development (10% Slope)

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Post-Development (33% Slope)

The Universal Soil Loss Equation gives us an easy way to predict the effectiveness of erosion control products.

Erosion Control on land, as opposed to Stream and Channel Erosion (see the Stream and Channel Section), can be predicted based on standard designs. For each geographic location there are a number of factors that affect erosion. The Universal Soil Loss Equation is a way of calculating the effect of Erosion Control practices on the expected soil loss for a particular area. The Universal Soil Loss Equation is defined as: **A**=R x K x LS x **C** x **P**

Where:

- **A** = The annual soil loss due to erosion.
- R = Rainfall factor for a particular location.
- K = The erodibility factor for the soil type.
- LS = The length and slope factor (gradient).
- **C** = Cover management factors.
- **P** = Support practice factors (structures).

For each geographic area there is a characteristic combination of rainfall factors (R), erodibility factors (K), and slope gradient factors (LS) that we cannot control. These factors represent the erosion potential for that particular site. For a more complete discussion of the Universal Soil Loss Equation please contact your representative. The equation is only shown here to demonstrate that **C** and **P** factors control the loss of soil independent of the erosive potential of the site.

The factors that we can control are the **C** factors and **P** factors of a site. These are the management factors of a site. The **C**, or the Cover Management Factors include such techniques as ground cover, vegetation, and pavements. Layfield provides Erosion Control Blankets (ECB's), Turf Reinforcement Mats (TRM's), Erosion Control Geotextiles, Geo Cells, and Flexible Forms for Concrete as **C**factor materials.

If erosion is already taking place then we need to stop the silt and sediment from running off the construction site. **P**, or Support Practice factors, trap sediment that is suspended in flowing water. Layfield provides Silt and Sediment control products such as Silt Fence, Silt Dikes, Silt Bags, Catch Basin Filters, and Floating Silt Curtain for **P** factor use. Note that the erosion has already taken place with a **P** factor tool, while **C** factor tools prevent erosion from starting.

Table 1 Erosion Management Factors

Erosion Control Treatment	*C* Factor	*P* Factor
Bare Soil	1.00	1.00
Disked Bare Soil	1.00	0.90
Sediment Basin/Trap	1.00	0.50
Straw Bale Barrier	1.00	0.80
Silt Fence Barrier	1.00	0.50
Asphalt/Concrete Pavement	0.10	1.00
Competant Gravel Layer	0.05	1.00
Established Native Grass (100% coverage)	0.03	1.00
Sod Grass	0.01	1.00
Agricultural Crop	0.45	1.00
Erosion Control Blankets	0.002 to 0.003	1.00
Turf Reinforcement Mats	0.002 to 0.003	1.00

Bare soil has a **P** and **C** factor of 1.0 which has no effect in the equation of preventing erosion. Each erosion management treatment has a measurable effect on erosion. Table 1 shows how different **C** and **P** factors affect the measured soil loss of a site.

If we look at Table 1 we can see that **C** factor management (cover) techniques are more effective than **P** factor (support practice) techniques. The use of **C** factor techniques can reduce the soil loss on a given site to

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OGPP - RUSLE CALCULATIONS

PRE-DEVELOPMENT

R = 40
k = .24
LS = 4.95
C = 0.03
P = 1

$A = R * k * LS * C * P$
$= 40(0.24)(4.95)(0.03)(1) = \underline{1.43 \text{ tons/acre/year}}$

POST-DEVELOPMENT

1st SLOPE (110' @ 33%)
R = 40
k = 0.24
LS = 5.58
C = .01
P = 1

$A_1 = 40(0.24)(5.58)(.01)(1)$
$= 0.54$

2nd SLOPE (440' @ 1%)
R = 40
k = 0.24
LS = 0.24
C = 0.05
P = 1

$A_2 = 40(0.24)(0.24)(0.05)(1)$
$= 0.12$

3rd SLOPE (90' @ 33%)
R = 40
k = 0.24
LS = 5.58
C = 0.01
P = 1

$A_3 = 40(0.24)(5.58)(0.01)(1)$
$= 0.54$

$$A_{AVG} = \frac{A_1 + A_2 + A_3}{3} = \frac{0.54 + 0.12 + 0.54}{3} = \underline{0.40 \text{ tons/acre/year}}$$