APPENDIX H
COVER EROSION CALCULATIONS

COVER SOIL EROSION CALCULATIONS

OBJECTIVE

Determine soil loss potential of the cover soil due to water erosion.

METHODOLOGY

Soil loss potential at the proposed site for the Jungo Road Landfill due to water erosion was evaluated using the Revised Universal Soil Equation (RUSLE), developed by the U.S. Department of Agriculture, which considers soil and vegetation type as well as physical and climatic features of the landfill area.

The RUSLE can be used to evaluate landfill cover soil loss. This equation may be stated as:

A = R K LS C P, Where

A = Average annual soil loss, in tons per acre per year

R = Rainfall and runoff erosivity index

K = Soil erodibility factor

LS = Hill slope length and steepness factor

C = Cover-management factor

The results of the analysis are shown in Table 1.

The RUSLE factors for proposed site for the Jungo Road Landfill were assigned as follows:

R = 10 Index for the Nevada area, which best represents weather conditions at the site.

K = 0.42 It is assumed that the textural class of the final cover material will be of a "silt loam" based on the average grain size distribution curve of the proposed final cover material and will contain less than 2.0 % organic.

LS = 1.64 Calculated using the following equation:

$$LS = [\frac{L}{72.6}\cos(\tan^{-1} s)]^{1/2}[\frac{\sin(\tan^{-1} s)}{\sin(5.143)}]^{1.4}$$

C = 1.0 "C" represents the effects of plants, soil cover, soil biomass (roots and incorporated residue), and soil-disturbing activities on soil loss. A value of 1.0 a conservative value associated with no vegetative cover.

P = 1.0 "P" accounts for reduction of erosion due to land management practices and is conservatively assumed to be 1.0 (highest value) or the entire landfill site.

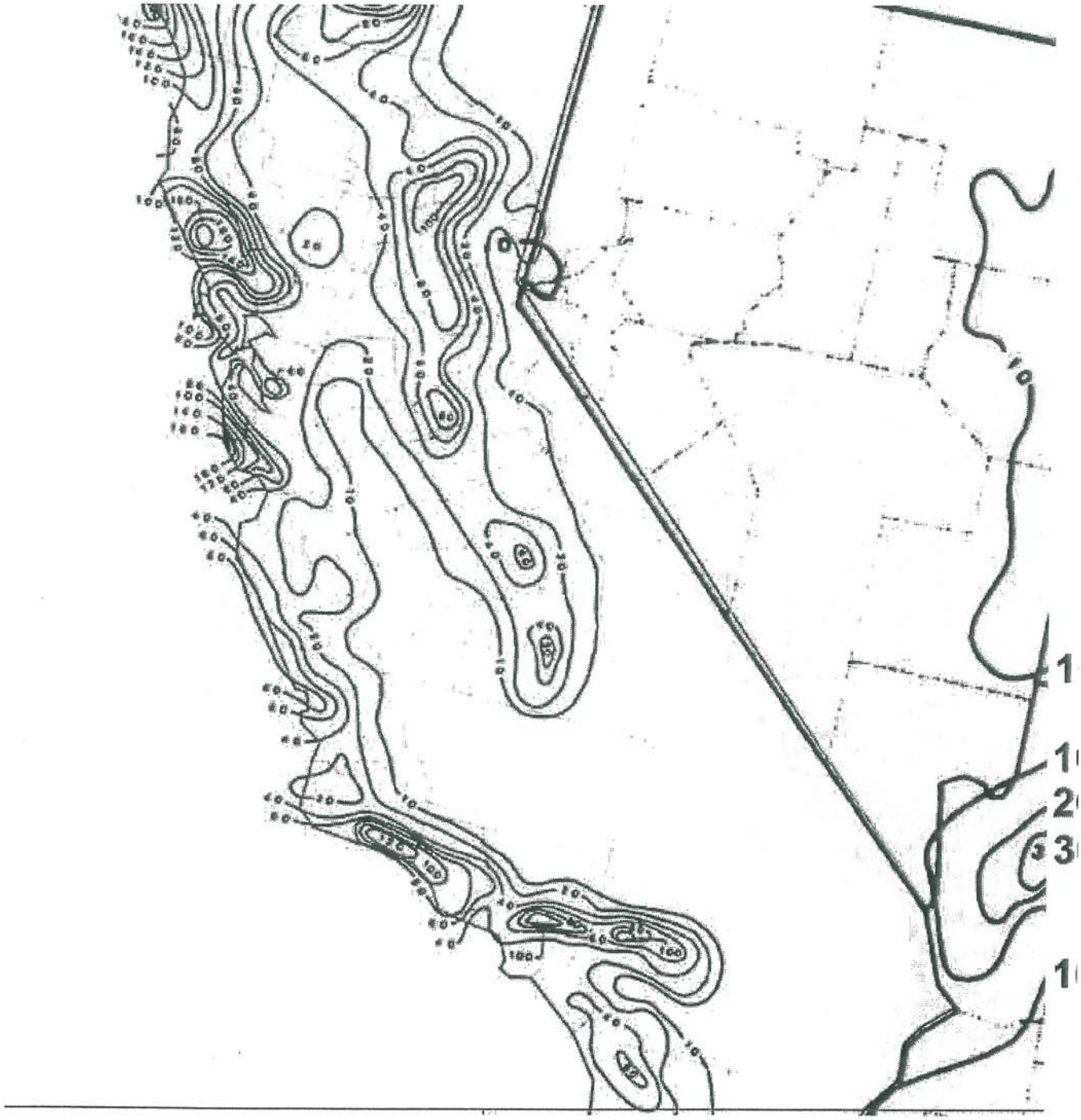
RESULTS SUMMARY

Using the values listed above, we estimate the average soil loss depth due to water erosion to be 0.032 inch per year and 0.95 inches over a 30 years period

TABLE- 1
SOIL LOSS ESTIMATES
JUNGO ROAD

Approx. Area (acres)	Avg. Slope Length (ft)	Average gradient (%)	R	K	LS	C	P	Soil Loss (tons/acre/year)	Soil Loss (tons/sq. ft/year)	Soil Loss (tons/year)	Soil Loss (CY/year)	Soil Loss (inches/year)
640	1000	5	10	0.42	1.64	1	1	6.87	0.00016	4395.15	2713.06	0.0315
											30 year cover loss (inch):	0.9459

Notes:
C=1.0 assumes no vegetative cover



Attachment 2

APPROXIMATE VALUES OF FACTOR K
USDA TEXTURAL CLASSES

Texture class	Organic matter content <0.5% K	2% K	4% K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay	0.13 to 0.29		

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

Reference: Lutton, R. J., et al, 1979. Design and Construction of Covers for Solid Waste Landfills, EPA 600/2-79-165. August, 1979.

Type of Mulch	Mulch Rate (tons/acre)	Land Slope (%)	Max Length (ft)	C Factor
None	0	all	-	1.0
Poor grass	-	-	-	0.01
Good grass	-	-	-	0.004
GECB		* consult manufacturer		
Straw/hay	1.0	1-5	200	0.20
Straw/hay	1.0	6-10	100	0.20
Straw/hay	1.5	1-5	300	0.12
Straw/hay	1.5	6-10	150	0.12
Straw/hay	1.5	1-5	400	0.06
Straw/hay	2.0	6-10	200	0.06
Straw/hay	2.0	11-15	150	0.07
Straw/hay	2.0	16-20	100	0.11
Straw/hay	2.0	21-25	75	0.14
Straw/hay	2.0	26-33	50	0.17
Straw/hay	2.0	34-50	35	0.20
Crushed stone	135	<16	200	0.05
Crushed stone	135	16-20	150	0.05
Crushed stone	135	21-33	100	0.05
Crushed stone	135	34-50	75	0.05
Crushed stone	240	<21	300	0.02
Crushed stone	240	21-33	200	0.02
Crushed stone	240	34-50	150	0.02
Wood chips	7	<16	75	0.08
Wood chips	7	16-20	50	0.08
Wood chips	12	<16	150	0.05
Wood chips	12	16-20	100	0.05
Wood chips	12	21-33	75	0.05
Wood chips	25	<16	200	0.02
Wood chips	25	16-20	150	0.02
Wood chips	25	21-33	100	0.02
Wood chips	25	34-50	75	0.02

COVER SOIL WIND EROSION CALCULATIONS

OBJECTIVE

Determine soil loss potential of the cover soil for the final cover resulting from wind erosion.

METHODOLOGY

Soil loss potential at the proposed site for the Jungo Disposal Site due to wind erosion was evaluated using Single-Event Wind Erosion Evaluation Program 1.0 (SWEEP), which is a part of the Wind Erosion Prediction System (WEPS), developed by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS), which considers soil and vegetation type as well as physical and climatic features of the landfill area. WEPS is a process-based, continuous, daily time-step model that simulates weather, field conditions, and erosion. The SWEEP processes hourly wind data and additional input parameters and determines the daily wind soil erosion.

SWEEEP INPUT PARAMETERS

The SWEEP input parameters include:

- Site boundary area including barriers;
- Soil type and characteristics;
- Soil surface characteristics;
- Vegetative (Biomass) characteristics; and,
- Wind Input Parameters.

The SWEEP input data screens are attached to this section of the Appendix.

Site Boundary
The boundary was input as a square parcel 1500 m by 1500 m with no barriers.

Soil Characteristics
Golder reviewed the NRCS Custom Soil Resource Report for the Humbolt County to determine the soil characteristics for the Site. The Site consists of two soil types: Soil 831 Boton-Playas and Soil 990 Playas. Soil Type 831 Boton Plays is the primary soil type at the Site and is used in this analysis. NRCS developed soil templates to use with the WEPS and SWEEP programs. Golder input the soil template for the Soil 831 Boton-Playas into the SWEEP program.

Soil Surface Characteristics
Upon review with NRCS representatives, the surface crust density of 1.8 Mg/m^3 and crust stability of 2.65 J/kg are applicable input parameters for the Boton-Playas soil type. However, the SWEEP model was run with assuming no surface crust is present on-site to simulate the final cover suface.

The allamaras random roughness coefficient was assumed to be 4 mm, simulating a relatively smooth ground surface without any larger particles on the surface. The ridge thickness and spacing was input as 10 mm; although, the ridge height is 0.

All other surface soil input parameters are zero.

Vegetative Cover Characteristics

The Vegetative Cover input variables for SWEEP are: average crop height, crop stem area index, leaf area index, and row spacing. The kind of vegetative cover used this analysis are desert grasses. The applicable vegetative cover variables for desert grasses are listed below.

- Average Crop Height = 6-inches = 0.15 m
- Crop Stem Index (CSI) = Stem diameter (m) x stem height (m) x stem population (#/m^2)
  = 0.006 m x 0.15 m x 10 plants/m^2
  = 0.01
- Leaf Area Index (LAI) = 0.2 - 0.4 (varies seasonally)
- Row Spacing = 0 (not planted in rows)

Residue vegetative cover was conservatively ignored in this analysis.

Daily Wind Input Parameters

Wind data from May 2008 to May 2009 was reviewed. Based upon soil input parameters, SWEEP estimates a threshold wind speed. The threshold value is the minimum wind speed that causes wind soil erosion, which is 11 m/s for the Jungo Disposal Site.

Maximum Wind Speed data is shown on Figure 1. The days with maximum wind speeds above 11 m/s were segregated into three categories, as shown in Table 1.

Table 1 – Wind Speed Categories

Category #	Wind Speed	Number of Days
1	11 m/s to 12 m/s	8
2	12 m/s to 13 m/s	5
3	>= 13 m/s	3

Hourly wind data for one day from each category was entered input into SWEEP. The SWEEP results for the day were multiplied by the number of days in each category to calculate the annual wind erosion for each category. The total annual wind erosion was determined by adding the annual wind erosion for each category together.

CALCULATIONS

One SWEEP analysis was performed for each wind speed category. SWEEP analyses were performed with three types of vegetative cover scenarios:

1. No Vegetative Cover (for comparison purposes only);
2. LAI = 0.2;
3. LAI = 0.3.

RESULTS SUMMARY

The daily SWEEP output results for the vegetative cover scenario LAI = 0.2 are attached in this appendix. The annual soil erosion rates are shown in Table 2.

Table 2 – SWEEP Analysis Results

Category #	Annual Wind Erosion (tons per acre per year)		
	No Vegetative Cover	LAI = 0.20	LAI = 0.30
1	57	0	0
2	78	31	0
3	48	32	0
TOTAL	**183**	**63**	**0**
TOTAL (inches/year)	**0.84**	**0.29**	**0**

Using the SWEEP analysis and assuming the LAI = 0.2 occurs 50% of the year; we estimate the soil loss resulting from wind erosion to be 25 tons/acre/year or 0.15 inches/year. Additionally, wind erosion soil loss was also estimated for the worst case scenario with no vegetative cover. The worst case scenario wind soil erosion is 183 tons/acre/year or 0.84 inches/year. However, the worst case scenario wind erosion rates are not applicable to the Site because the Site will be vegetated with desert grasses.

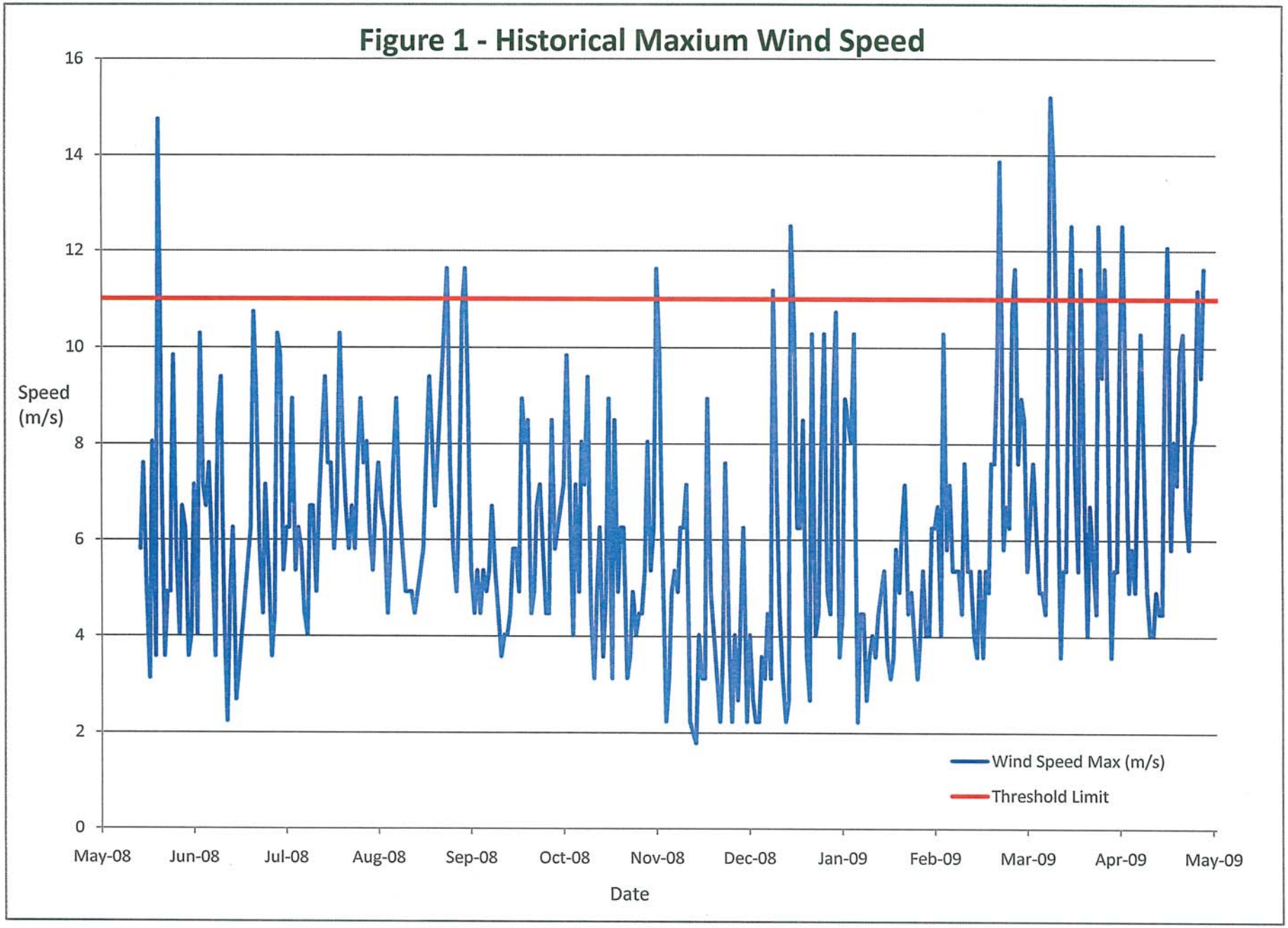
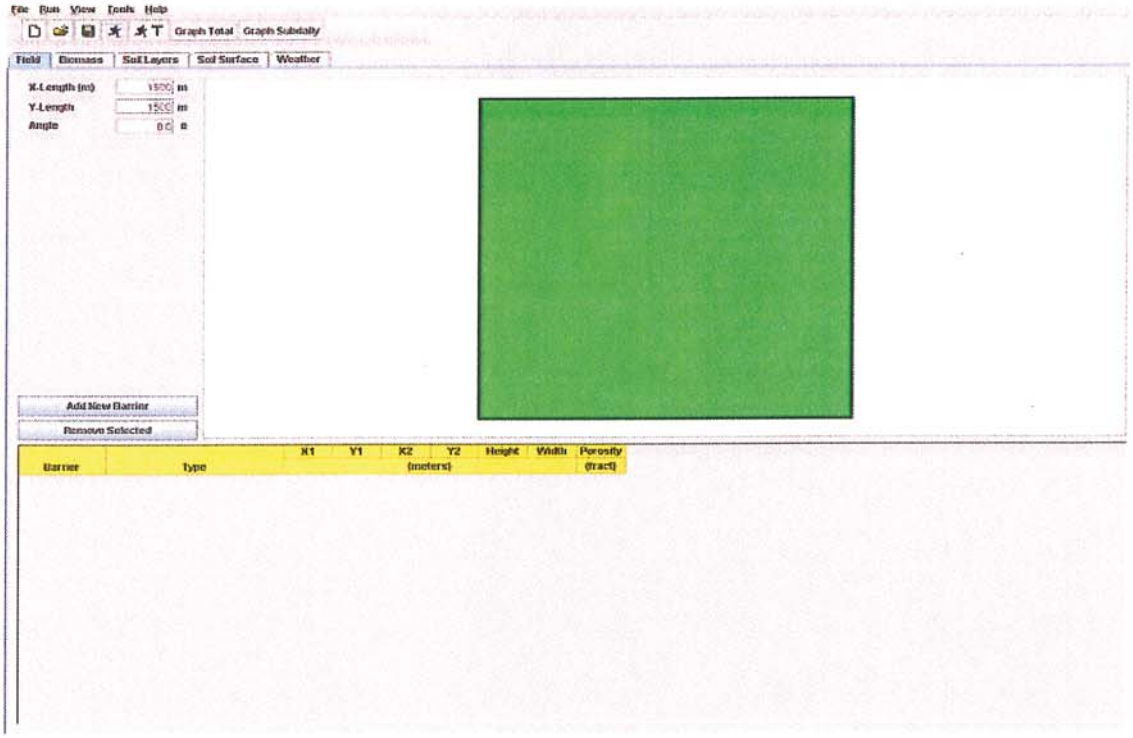


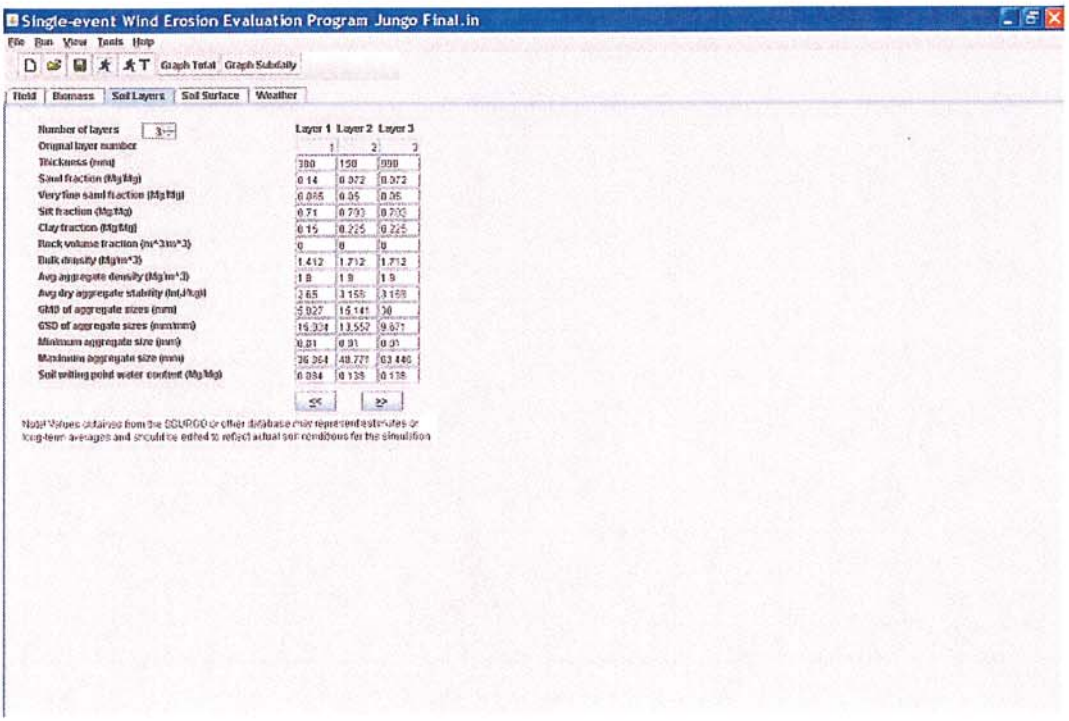
Figure 1 - Historical Maxium Wind Speed
16
14
12
10
8
6
4
2
0
Speed (m/s)
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Date
Wind Speed Max (m/s)
Threshold Limit

SWEEP INPUT PARAMETERS

Site Boundary

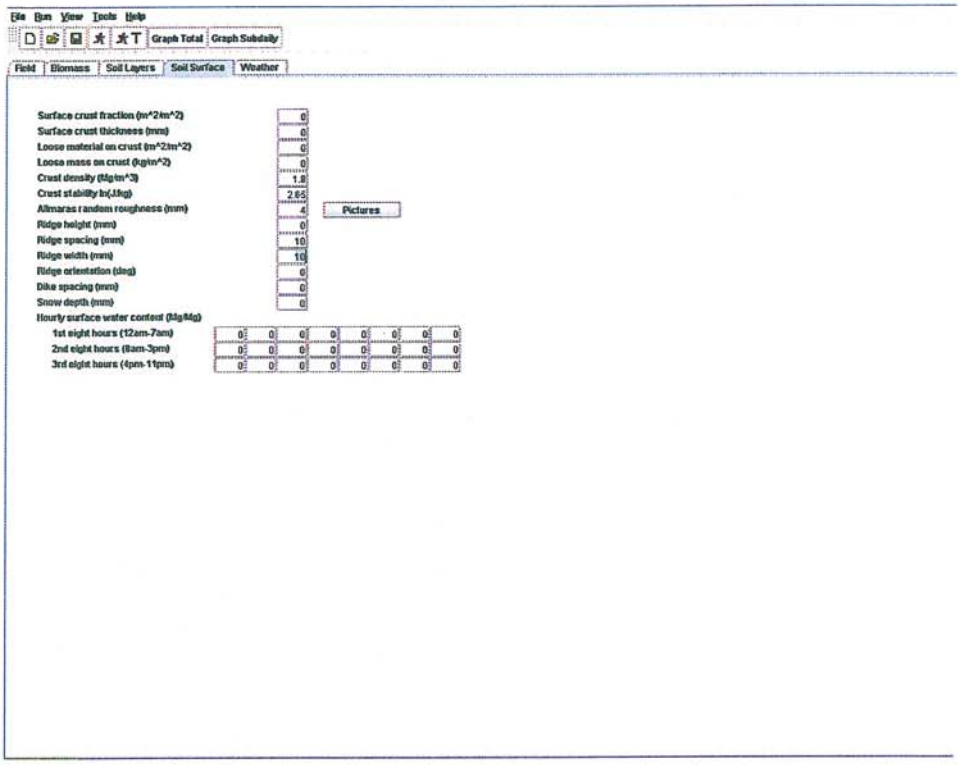


Soil Characteristics

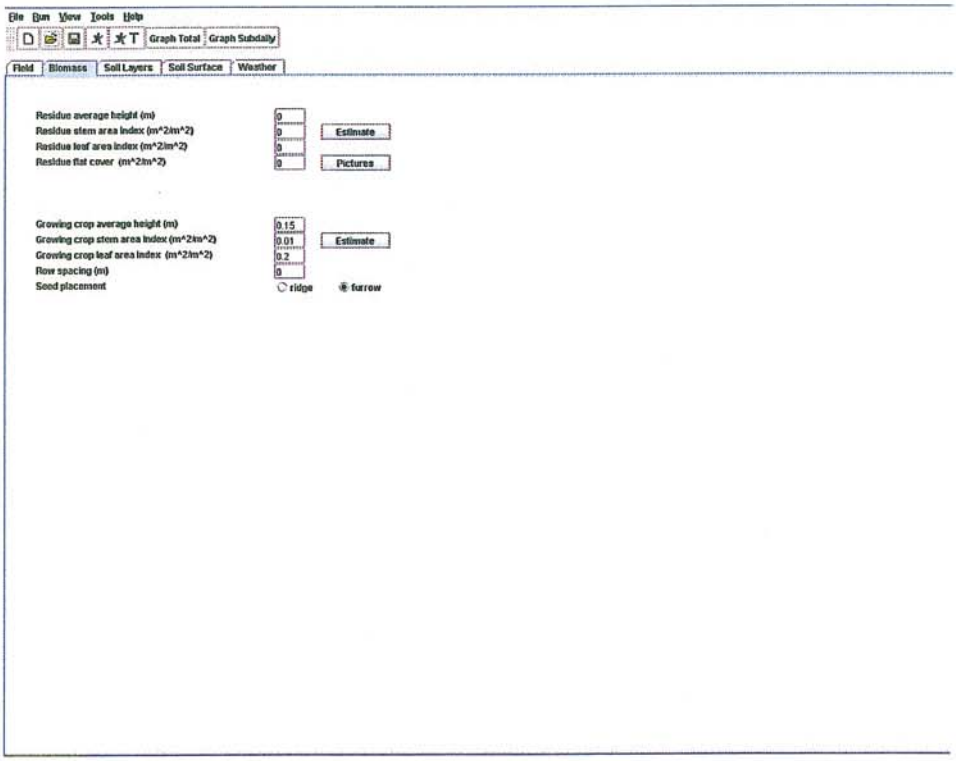


SWEEP INPUT PARAMETERS

Soil Surface Characteristics

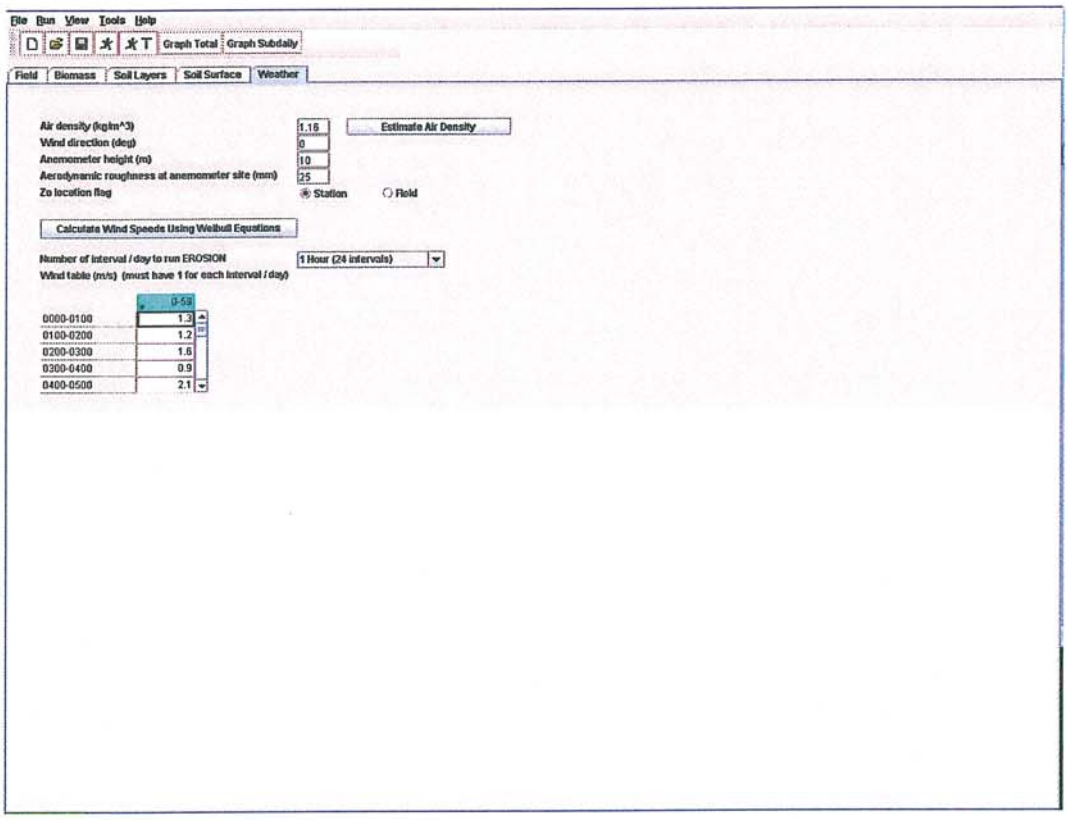


Vegetative Cover Characteristics



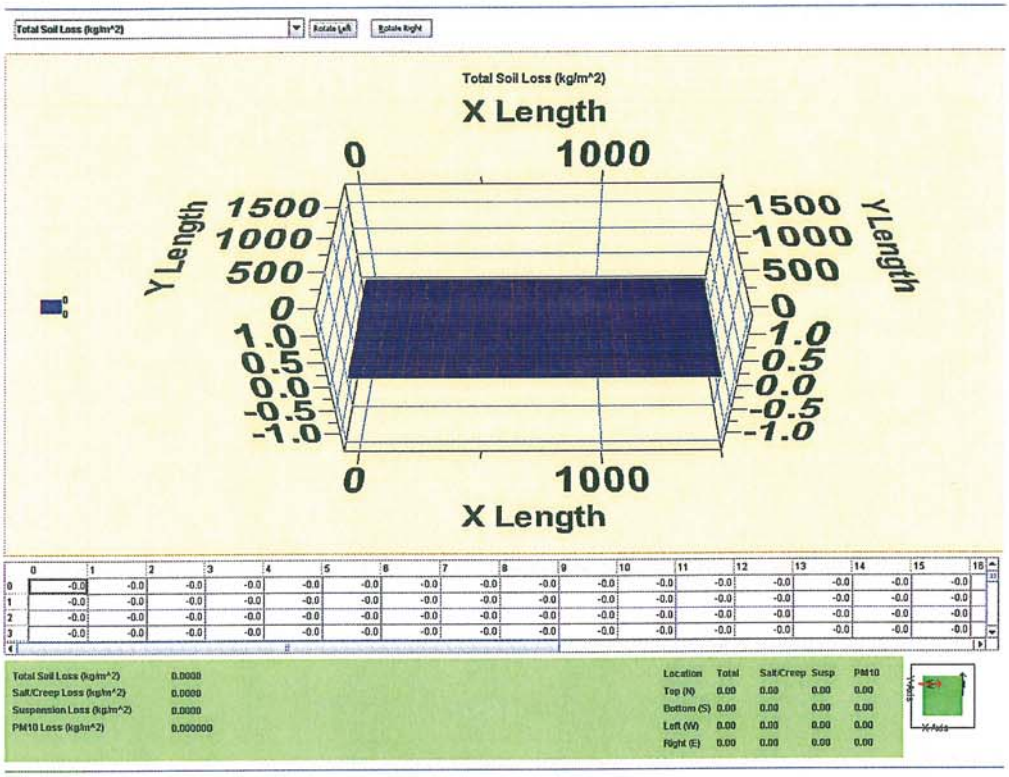
SWEEP INPUT PARAMETERS

Daily Wind Input Parameters

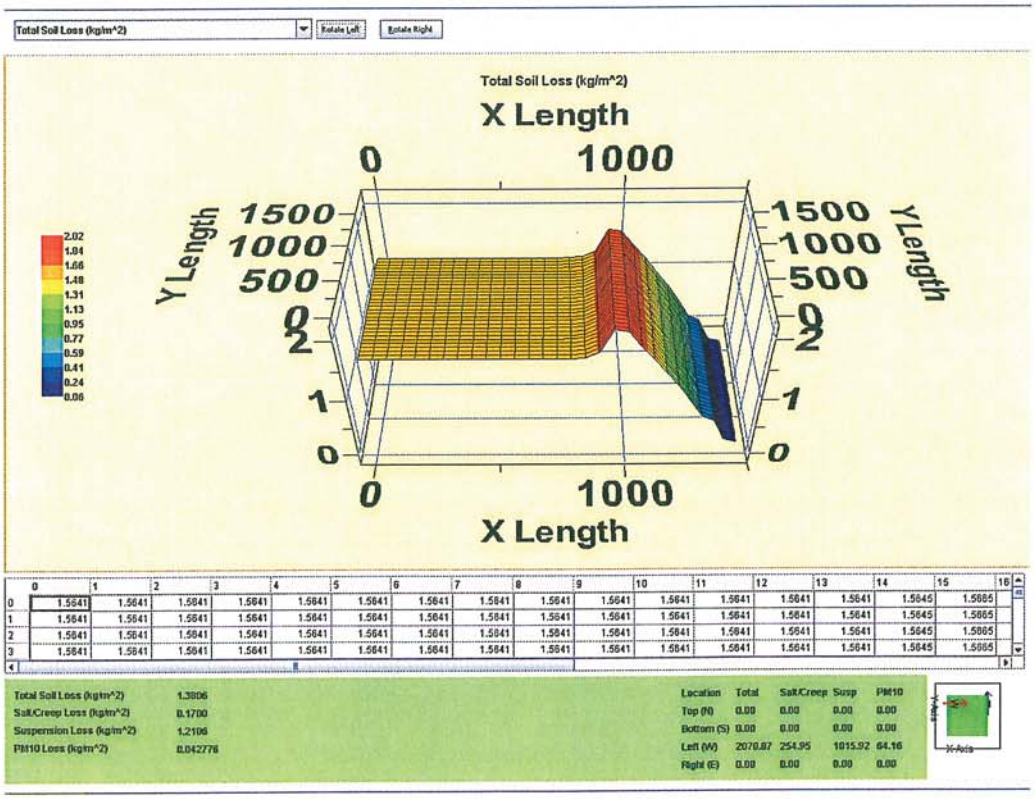


SWEEP DAILY WIND EROSION OUTPUT
Vegetative Cover Scenario LAI = 0.2

Wind Speed Category 1

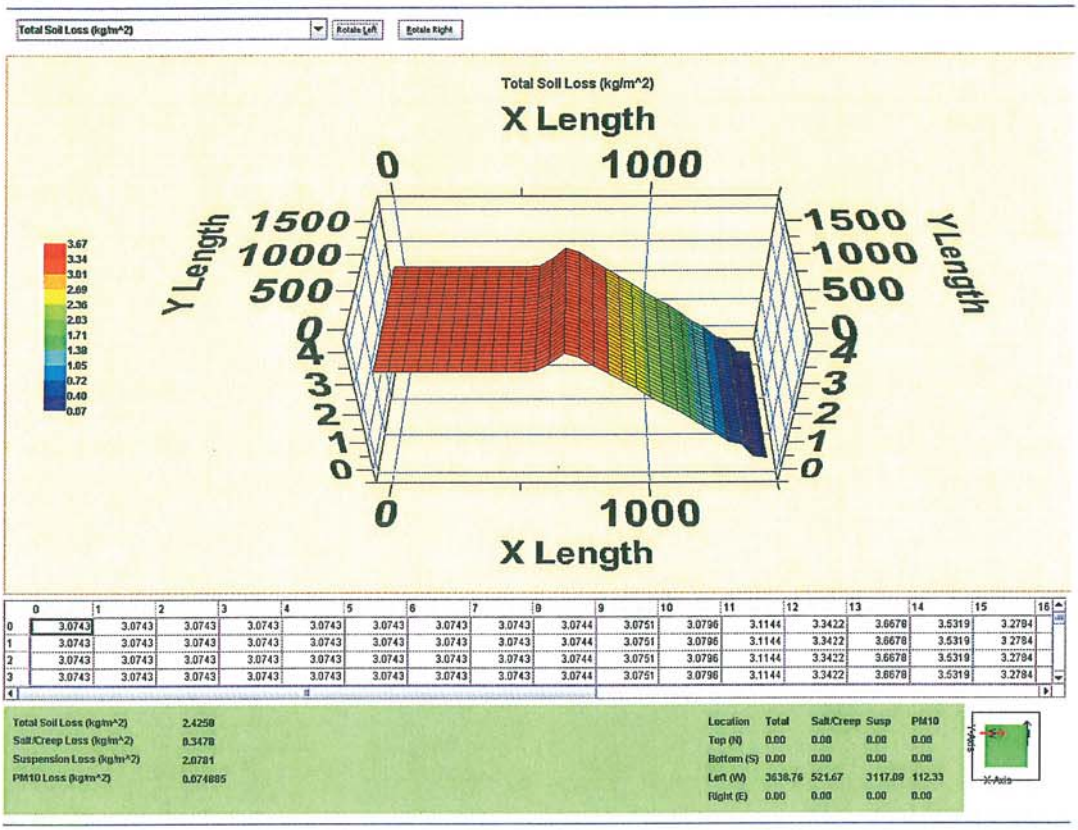


Wind Speed Category 2



SWEEP DAILY WIND EROSION OUTPUT
Vegetative Cover Scenario LAI = 0.2

Wind Speed Category 3



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0744	3.0751	3.0796	3.1144	3.3422	3.6678	3.5319	3.2784	
1	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0744	3.0751	3.0796	3.1144	3.3422	3.6678	3.5319	3.2784	
2	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0744	3.0751	3.0796	3.1144	3.3422	3.6678	3.5319	3.2784	
3	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0744	3.0751	3.0796	3.1144	3.3422	3.6678	3.5319	3.2784	

Total Soil Loss (kg/m^2)	2.4258
Salt/Creep Loss (kg/m^2)	0.3478
Suspension Loss (kg/m^2)	2.0781
PM10 Loss (kg/m^2)	0.074885

Location	Total	Salt/Creep	Susp	PM10
Top (N)	0.00	0.00	0.00	0.00
Bottom (S)	0.00	0.00	0.00	0.00
Left (W)	3638.76	521.67	3117.09	112.33
Right (E)	0.00	0.00	0.00	0.00